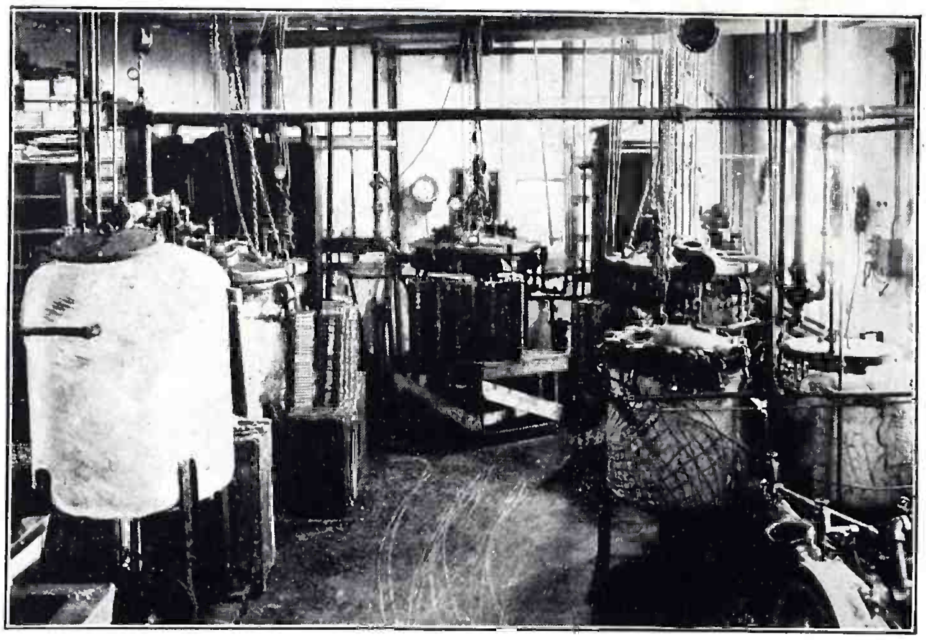
Popular Radio
and TELEVISION

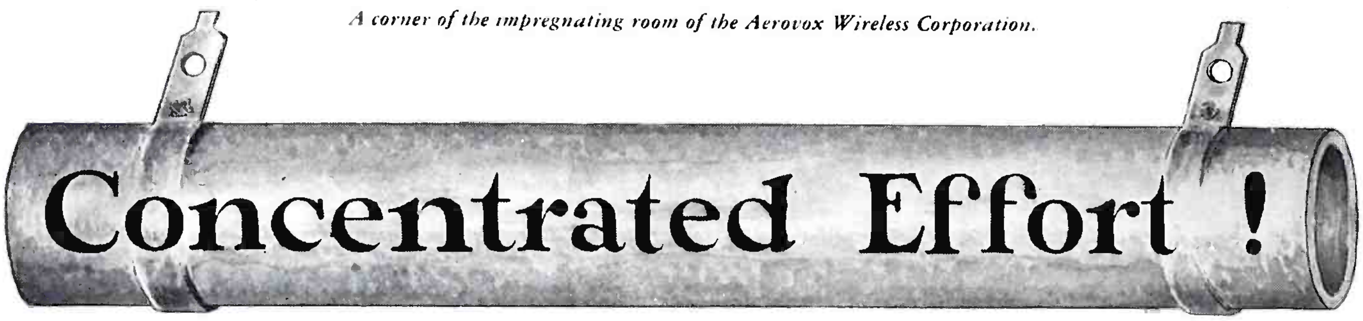
MAY · 1928 ★

25¢

How to Make Television Apparatus at Home



A corner of the impregnating room of the Aerovox Wireless Corporation.



IN specializing on and perfecting condensers and resistors which have stood up under every test made to determine their worth, the Aerovox Wireless Corporation has attained a goal made possible only by perfect co-ordination, co-operation, and concentration of every element in an organization devoted exclusively to the production of high quality condensers and resistors.

The Aerovox "Research Worker" is devoted to the dissemination of interesting and useful technical data. Send for copy.

Aerovox Filter Condensers are made in single units and combination blocks to meet every socket power need.

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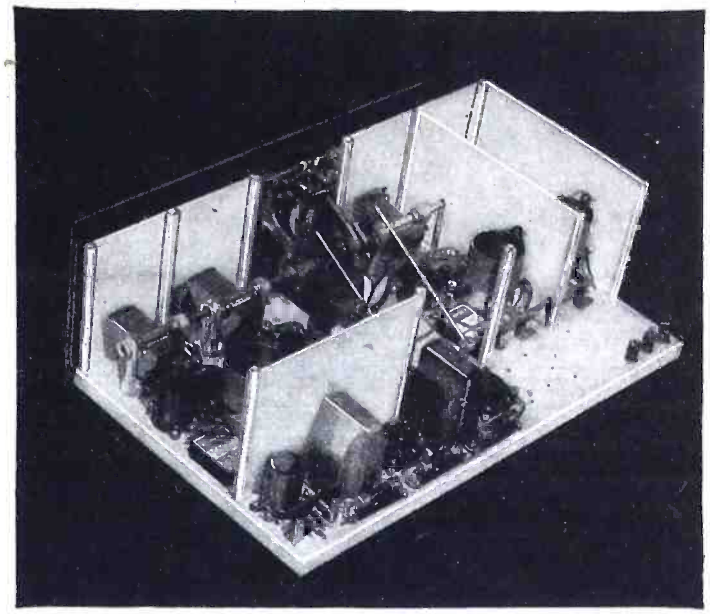
"The man who tries to save a few cents by buying cheap condensers is always in danger of having to pay out many dollars for replacement parts. A cheap condenser is expensive when it breaks down."

Leslie G. Biles



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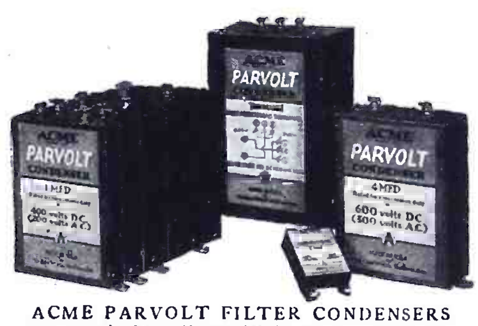

ACME PARVOLT FILTER CONDENSERS *are supplied in all standard mfd. capacities for 200, 400, 600, 800, 1000, and 1500 Volt D. C. requirements. Uniform height and width for easy stacking. Supplied singly or in complete housed blocks for the important power supply units such as Thordarson, Samson and others.*

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Popular Radio

EDITED *by* RAYMOND FRANCIS YATES

FOUNDED 1911

VOLUME XIII | May, 1928 | NUMBER 5

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DEPARTMENTS

VOLUME XIII | MAY, 1928 | NUMBER 5

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LAURENCE M. COCKADAY, *Technical Editor* — CHARLES L. DAVIS, *Managing Editor*

RACON – EXPONENTIAL – HORNS

Radio Sales–

up to the mark and more–

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Racon Exponential Air-Column Horns

Perfection of Performance—Clearness—Depth—Beauty of Tone and such faithfulness and accuracy of reproduction as to give the "sales-clinching" proof expected by the exacting radio customers of today.

INTERNATIONALLY known Acoustical Engineers have pronounced Racon Exponential Air-Column Horns the finest made and an advance step in the History of Acoustics;—a tribute to the engineering exactness with which they are designed and manufactured.

Racon Exponential Air-Column Horns are made of impregnated and hardened fabric and are of absolutely homogeneous, non-porous and vibrationless *one-piece* construction. The Lightest Horn made. Nothing to break, chip or crack. No servicing required. Unaffected by climatic conditions. Stand hard abuse. Ship safely. Manufactured under Racon Processes and Materials Patented in the United States, Great Britain and Canada.

Special models manufactured giving longest air-column in smallest space; acoustically correct and with a mellowness and richness of amplification having demonstration and sales value heretofore unknown.

The NEW RACON Exponential Air-Column HORN

Bell 54 inches by 54 inches square. Depth 31½ inches. Weight, 60 lbs.

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A Page With The Editor

A Photograph of Governor Alfred Smith, of New York, Received by Radio on Rayfoto Apparatus

SEVERAL weeks ago the Editor experienced the indescribable thrill of tuning in a moving picture from the emptiness of space. Out of an incoherent and jumbled mass of flashes in a mirror there appeared, as though by magic, the picture of a little girl jumping rope. The impressions of this little girl were on a motion picture film at a broadcasting station eight miles away. An ordinary radio receiver was used and the manipulation of the tuning control either destroyed or created the picture.

* *

NOT MANY living men have tuned "movies" in from the air, but it will not be very long before hundreds of thousands of people are daily experiencing this thrill.

* *

IT IS rumored that certain of the larger manufacturers of receivers will show for the first time at the Chicago Trade Show, in June, a television receiver for home use. The art is moving fast. Nobody dreamed of that a year ago. Tomorrow it will be commonplace.

IN THIS issue of POPULAR RADIO AND TELEVISION the Editors have made an attempt to supply information on television, so that the home experimenter can proceed with this fascinating work. Next month, the actual details and constants of the circuits employed will be given.

* *

TELEPHOTOGRAPHY is a step toward television. Three days each week WOR, in Newark, N. J., broadcasts photographs which may be received on the Rayfoto machine. Richard Lord, an old contributor to POPULAR RADIO AND TELEVISION, begins a description of the apparatus in this issue, cn page 370. Next month Mr. Lord will give the constructional and circuit details of the Rayfoto apparatus.

* *

IN THIS issue POPULAR RADIO AND TELEVISION introduces to its readers for the first time the constructional details of the Tyrman "70." In laboratory tests, the Tyrman has demonstrated a performance that is a real credit to radio engineering.

IT HAS been the object of the Editor to make the new department, THE PROFESSIONAL SET-BUILDER'S SHOP, more and more useful to those readers who make their livelihood in the construction of custom-built receivers. This department is filled with good things this month, and the editorial sanctum sends out an appeal to all professional set-builders who would like to help their fellow craftsmen by sending in small contributions.

* *

IN THIS issue the department, IN THE WORLD'S LABORATORIES, is resumed. New discoveries announced in this department will be related to radio science, and not to general science, as was the practice in the past.

* *

DURING the past several months the POPULAR RADIO Laboratory has become interested in crystal detection, and the LC-28 Junior, described in this issue on page 378 embodies a modern crystal unit of the permanently adjusted type. Due to the perfect detection afforded by this unit, the LC-28 Junior is admirably suited to local, high-quality reception. Today there are hundreds of thousands of people who have gotten over the "distance" fever, and who demand, in the way of a radio receiver, simplicity, high-quality, and ease in manipulation. The LC-28 Junior will meet every one of these demands

* *

BY WIRE and letter from all parts of the country there is daily arriving at POPULAR RADIO AND TELEVISION congratulations on its foresight in entering the field of television. It is the first radio publication in the country to officially announce its devotion to this new science. Henceforth this magazine will be an important factor in developments that are to come in "seeing by radio."

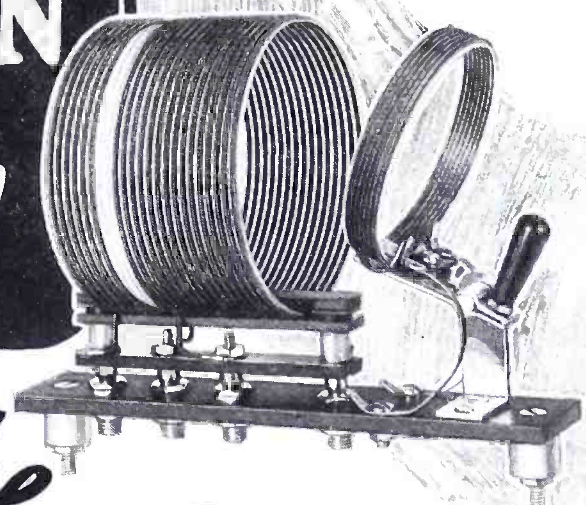
* *

SOME day, in the yet distant future, the readers of POPULAR RADIO AND TELEVISION may have the opportunity of peeking into the POPULAR RADIO AND TELEVISION laboratory while sitting in their easy chairs at home. All of which reminds us of a pun from a recent visitor to the office, who said: "People who live in television houses should never throw parties."

Raymond F. Yates

The *Perfected* PLUG-IN COIL

It's the Hammarlund!



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Coils........$2.50 each
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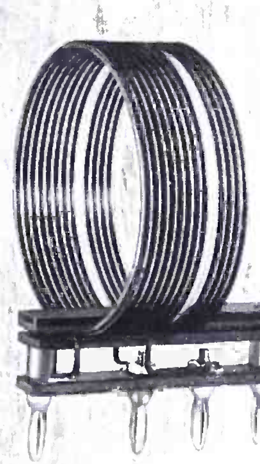

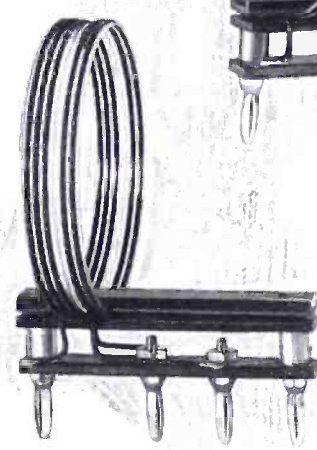

FOR several seasons Hammarlund low-loss, space-wound coils, have been universally approved by those who "know their stuff" in radio.

Now they may be had in the convenient plug-in form—a set of three coils efficiently covering the low-wave bands from 20 to 80 meters. Also special coils for higher wave-lengths.

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The variable primary coil has phosphor-bronze spring connections and is integral with the Bakelite base. Friction holds it at any desired coupling.

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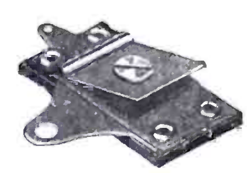
HAMMARLUND Equalizing Condenser



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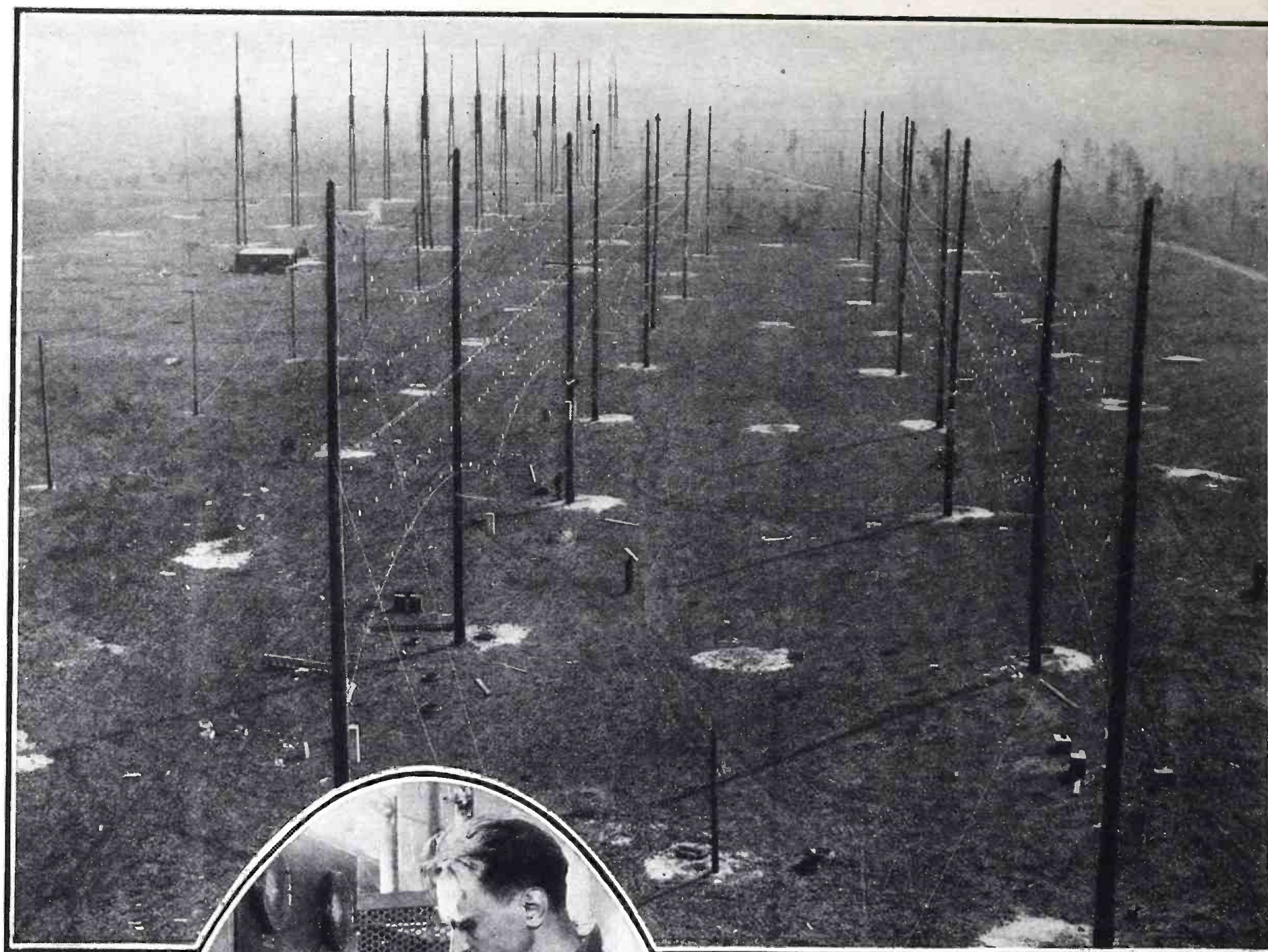
PRECISION
PRODUCTS

Foresight and Courage . . .

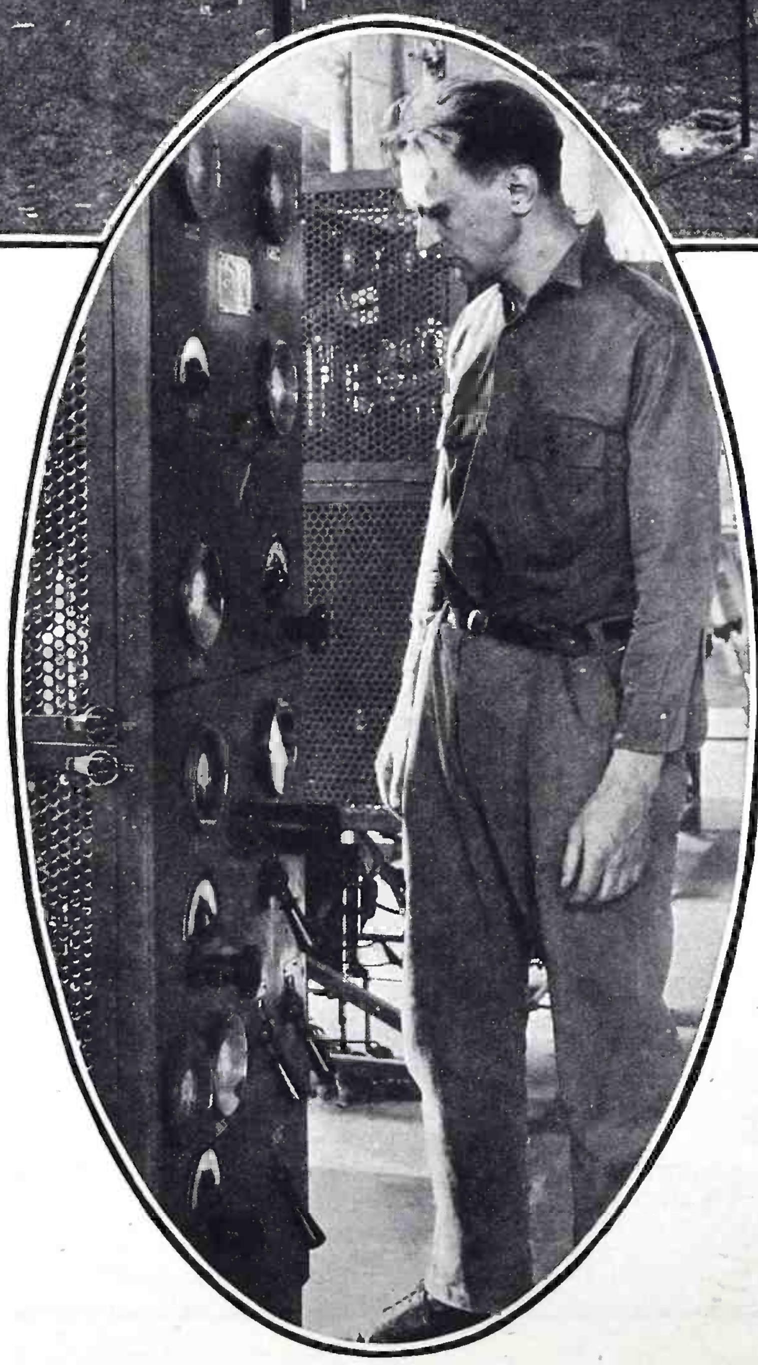
"It seems to me that the primary functions of a radio magazine are to unearth new and effective developments and to present them to its readers in a thoroughly comprehensive manner. Given such a background the manufacturer who prepares the necessary essentials to supply the demand thus created is enabled better to serve those readers who desire to take advantage of such opportunities. POPULAR RADIO *is to be congratulated on its foresight in discerning this business fundamental, and on its courage in following this conviction."*

Arthur H. Lynch

PRESIDENT,
ARTHUR H. LYNCH, INCORPORATED.



Underwood & Underwood



A Modern "Forest" of Radio Antennas

This bewildering tangle of poles, wires and insulators is the antenna system of the Radio Corporation of America's gigantic new beam transmitting station, located at Rocky Point, Long Island. It is claimed that the new projector is the most efficient beam system ever devised. It is used for commercial radio communication, and its operation will put the Radio Corporation another long step ahead on the road to world-wide domination in radio communication. At the left is one of the control panels of the station. Transmission is made on a wavelength of 22 meters, and 20 kilowatts of power are used to wing the electrical impulses on their way. Ten thousand volts are used on the plates of the valves. Despite the amazing complexity of the apparatus, the control of the transmitter is quite simple.

Popular Radio

VOLUME XIII — May, 1928 — NUMBER 5

Experimenting With TELEVISION

Here is POPULAR RADIO'S first direct contribution to the advancing art of "seeing by radio." The following article outlines the Technical Staff's experiments with the use of the fundamental components of modern television systems—scanning disc, photo-electric cell, and neon lamp. These experiments have been purposely made with apparatus that is within the reach of the fan of modest means, so that all those interested in the advance of television may follow the course of our investigation, from month to month, with apparatus similar to that used in the Laboratory.

By ROBERT W. TAIT

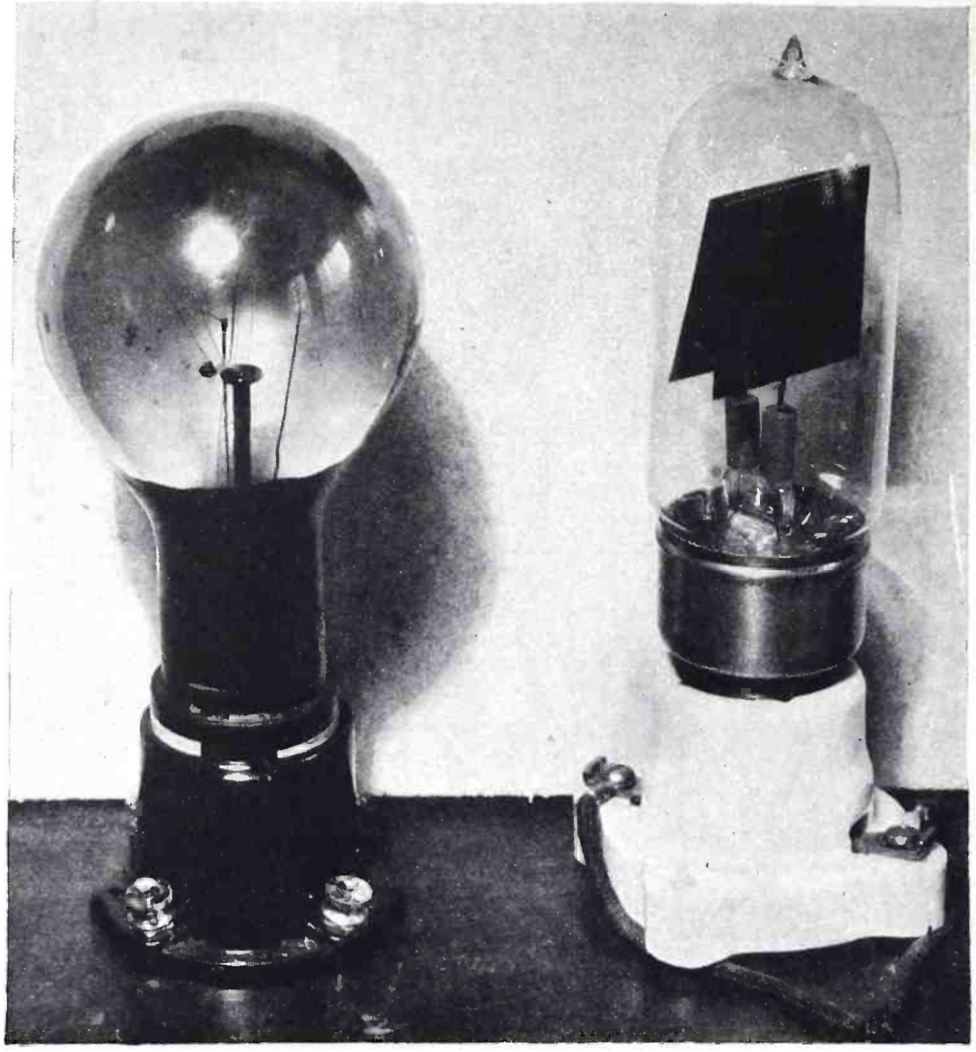
TELEVISION reception and even television transmission has at last been reduced to the stage of simplicity and practicability, where it becomes available for home experimentation. The apparatus involved in these experiments is not expensive, nor does its manipulation require anything more than an empirical knowledge of radio. Any alert experimenter and radio fan who has had the experience of assembling radio receivers and who understands, even superficially, the principal laws of radio and electricity, may plunge into the construction of television apparatus with every assurance of some measure of success.

The equipment about to be described was recently assembled in the POPULAR RADIO Laboratory and, while this article is more in the nature of a report on the results, an article which will appear in a subsequent number which will give full details and constructional data.

The experimental equipment involved comprises not only a television receiver but a simple transmitter as well, the television transmitter being connected to the receiver by wire.

The equipment about to be described is, in a sense, not really a television transmitter. For actual television an extremely powerful source of light is necessary and large and expensive photo-electric cells must be used to intercept the scanning beams. Naturally, this large and expensive equipment is quite beyond the pocketbook of the average experimenter. Consequently, the POPULAR RADIO Laboratory decided to confine its efforts to modest equipment that could easily be purchased and that would be inexpensive. This plan made it necessary to be satisfied with the transmission of ordinary photographic negatives and little black and white cartoons, drawn on celluloid or glass in simple outlines.

A television transmitter of the type about to be described involves three principal components: the source of light, the scanning disc, and the photo-electric cell. The source of light, in the case of the experiments under discussion, was simply a 500-watt lamp mounted in an aluminum shield or can and provided with proper ventilation. In the front of the can an aperture was cut which was the size of the picture to be projected over the apparatus. This arrangement will be clear by referring to Figure 3, which shows the laboratory set-up. If the experimenter has a small motion picture arc lamp available, it would be advisable to use this source of light; for it must be remembered that the more powerful the source of light the more pronounced the fluctuations at the receiving end will be. Consequently the picture will be clearer. During normal operation this source of light is moved as close to



THE TWO EYES OF TELEVISION

FIGURE 1: *The photo-electric cell at the left and the neon lamp at the right were used in the Laboratory experiments in television. The photo-electric cell was painted dull black, except on the clear glass window, to eliminate the danger of distortion due to reflected light.*

the scanning disc as possible so that there will be no waste of light energy. Naturally, the position of the light source and the aperture must coincide with the holes in the scanning disc, so that successive holes will move across the light source in the proper sequence.

On the opposite side of the disc a small frame, with an aperture measuring 1½ inches by 1½ inches, was placed. In this frame the picture was mounted. Back of the picture there was placed a photo-electric cell of the vacuum type. The cell was in a small metal or cardboard box, painted a dull black inside to eliminate the danger of reflection. An aperture was cut in the box so as to accommodate the frame holding the picture.

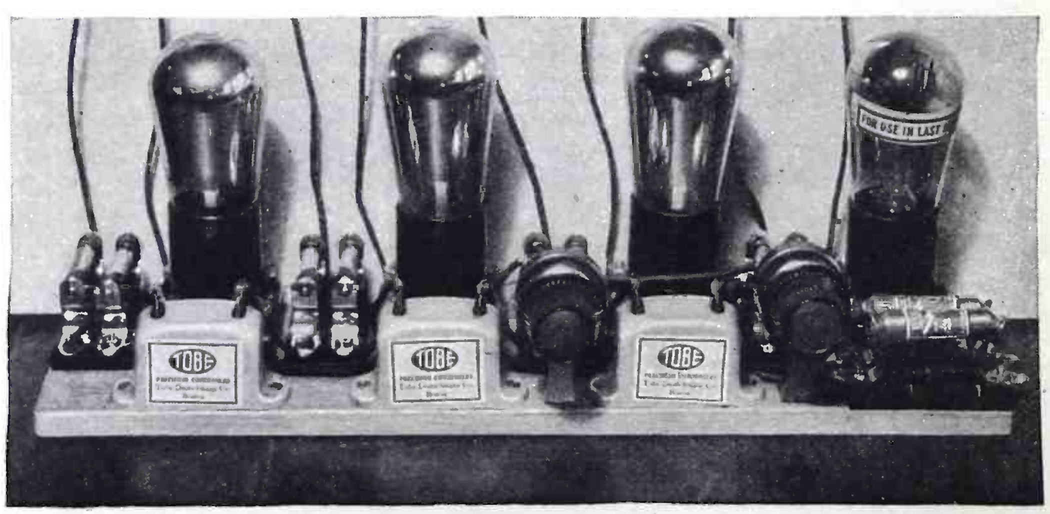
The photo-electric cell was connected to a four-stage, resistance-coupled amplifier, properly biased. To the output of this resistance-coupled amplifier a neon lamp was attached. Modulation of the cell was brought about in the manner shown in Figure 4. The voltage of the "B" eliminator was adjusted to a point somewhere near the critical voltage of the neon lamp, and the biasing of the resistance-coupled amplifier was adjusted so that when the light fell upon the photo-electric cell the neon lamp would function.

To facilitate research and to avoid the necessity, for the time being, of using two independent motors, only one scanning disc was employed and transmission was made on one side of the disc and reception on the opposite side. This entirely solved the problem of synchronization, for it is obvious that the apparatus was perfectly synchronized. Subsequent experiments, however, proved that the transmitter and receiver could be widely separated by employing two scanning discs and two ordinary ¼-horse-power synchronous motors. A subsequent article in the June issue will outline the details of this arrangement. With the present apparatus it was possible to see, at the receiving side of the disc, a crude outline of the picture in the frame at the transmitting side. The neon lamp, which takes the place of a loudspeaker, and which might be called a "light loudspeaker," was placed back of the scanning disc so that it could be viewed through the holes that were arranged in the spiral. A small cardboard frame was cut to dimensions corresponding to the aperture in the transmitting frame. This cardboard frame was then mounted before the scanning disc in exact line with the neon lamp so that it too could be scanned with holes in the spiral.

The scanning disc used was made of aluminum, 23 inches in diameter and provided with 48 holes .033 inches in diameter. This corresponds to a No. 61 drill. The spiral was off-set 1½ inches and the holes were placed 1½ inches apart, corresponding to a picture sized 1½ by 1½ inches.

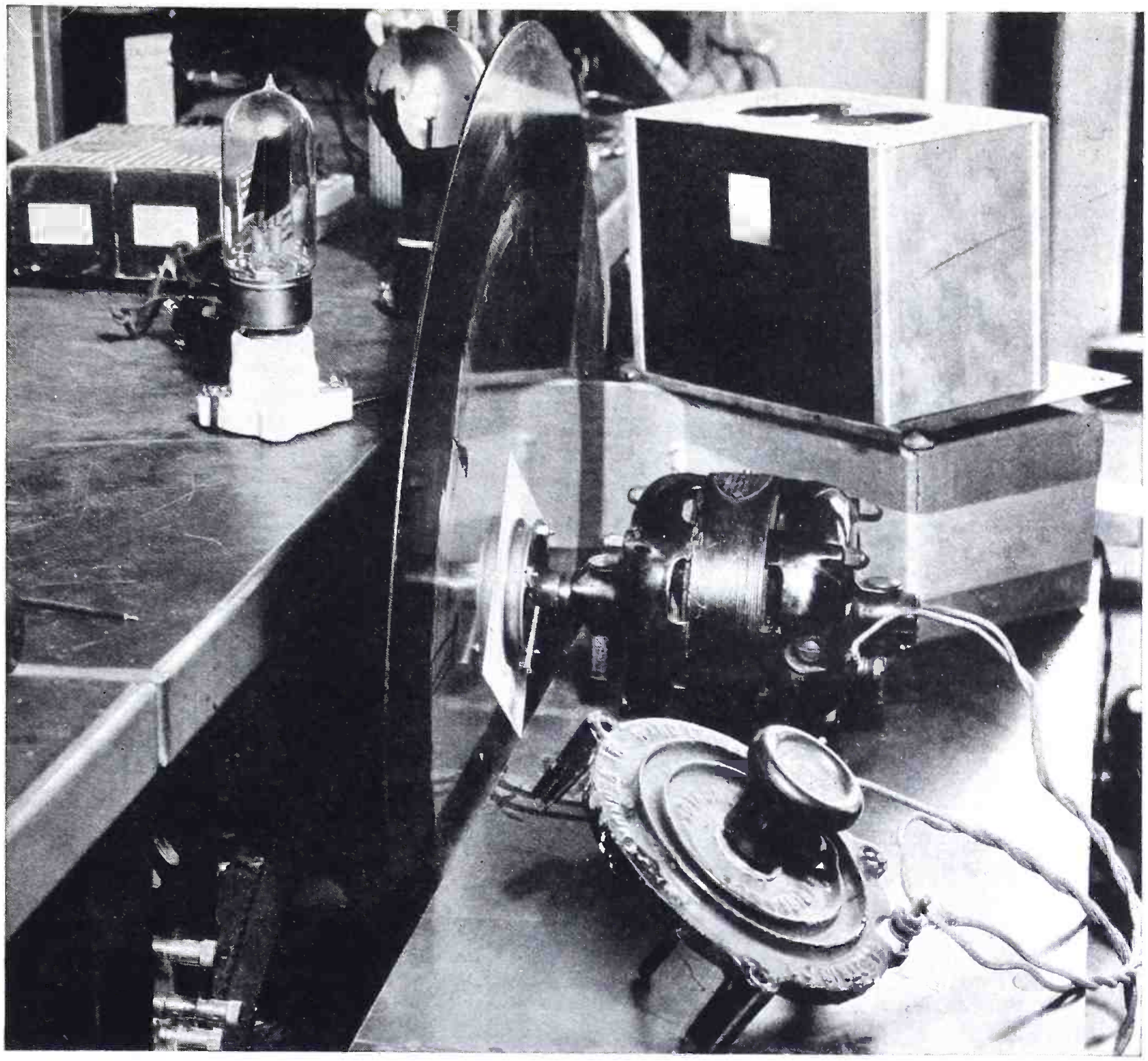
The method of laying out the spiral will be made clear by reference to the article on this subject which appears in this number on page 390. The aluminum disc, owing to its highly polished surface, was painted with an egg shell black preparation, care being taken to see that the preparation did not fill up any of the holes in the disc.

In these experiments, the motor speed was by no means critical and, to avoid mechanical difficulties involved in high



THE AMPLIFIER FOR THE TELEVISION RECEIVER

FIGURE 2: *The above resistance-coupled low-frequency amplifier was constructed especially for the television experiments. It employs standard parts in an easily assembled layout. Its construction will be described in the June number of this magazine.*



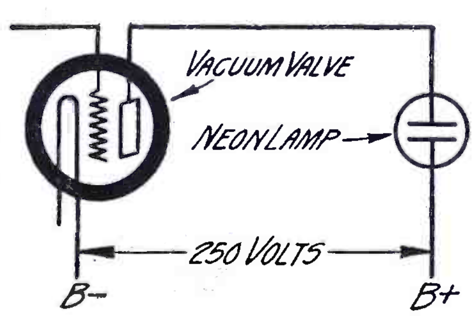
THE APPARATUS USED IN THE EXPERIMENTS

FIGURE 3: *At the left are the photo-electric cell and the neon lamp. The scanning disc, with its driving motor and resistor for controlling the motor speed, are in the center. At the right is the light source, in this case a 500-watt lamp mounted in a standard aluminum box shield with a small window in front and ventilating holes in the top. Egg shell black paint was applied to all the surfaces which might cause distortion from reflected light.*

speed, which would have made the mounting of the disc on the shaft somewhat of a problem, the resistance was placed in series with the motor to cut it down to low speed. To those who have gone into the subject of television, it is obvious that the picture, whether still or moving, must be transmitted at the rate of sixteen times per second; that is, the scanning disc must scan the picture sixteen times every second, which means a minimum R. P. M. of 960. Due to visual persistency, the eye insists on seeing an impression for at least 1/16th of a second, and any speed below this produces unsatisfactory results. However, in the experiments mentioned, it was found possible to cut down the speed as low as twelve per second and to still preserve the illusion.

When the outfit described above is used in the transmission of pictures, the room must be darkened. Otherwise the photo-electric cell will respond to extraneous light and the picture illusion which appears in front of the neon lamp will be considerably weakened.

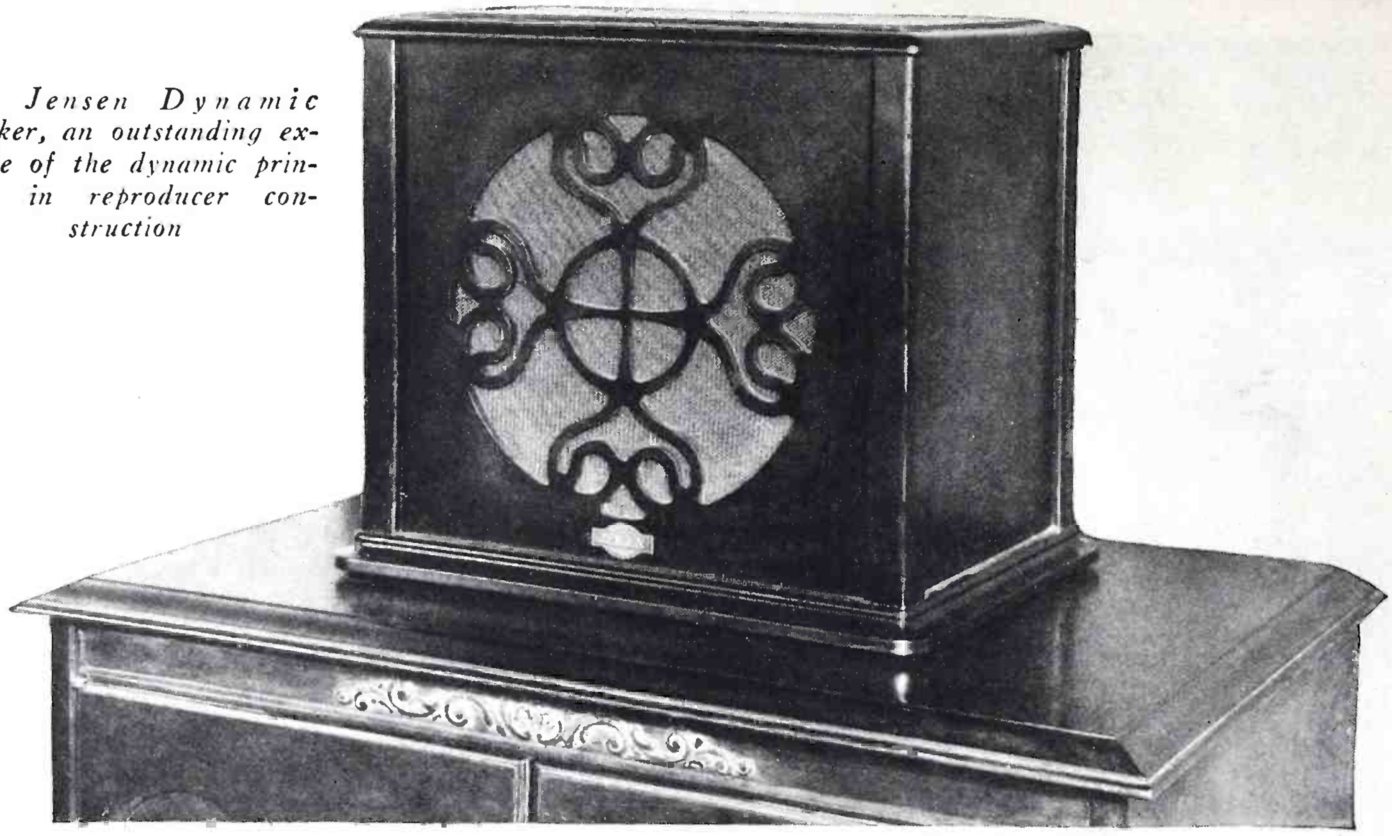
A resistance-coupled amplifier was chosen for these experiments owing to its aperiodic reproducing qualities. When simple silhouettes are to be transmitted, it is perfectly feasible to use an



THE NEON LAMP CIRCUIT

FIGURE 4: *This detail diagram shows the circuit connections between the last stage of the resistance-coupled amplifier, shown in Figure 2, and the neon lamp.*

ordinary transformer or impedance-coupled amplifier, for the frequencies involved are well below the critical point of this type of transformer-coupled amplification. The average low-frequency transformer will not respond to impulses over 10,000 cycles, and if a complicated picture is being transmitted (that is, a picture that breaks the light beam up a large number of times per second), the frequencies involved may well become high enough to go beyond that point where a low-frequency transformer will not pass them without distortion. In resistance-coupling this problem is entirely obviated, and if the experimenter plans to go into television, it will be wise for him provide himself with the proper kind of resistance-coupled amplification. The details of the particular amplifier used in these experiments will be described in the June issue of POPULAR RADIO.



The Jensen Dynamic Speaker, an outstanding example of the dynamic principle in reproducer construction

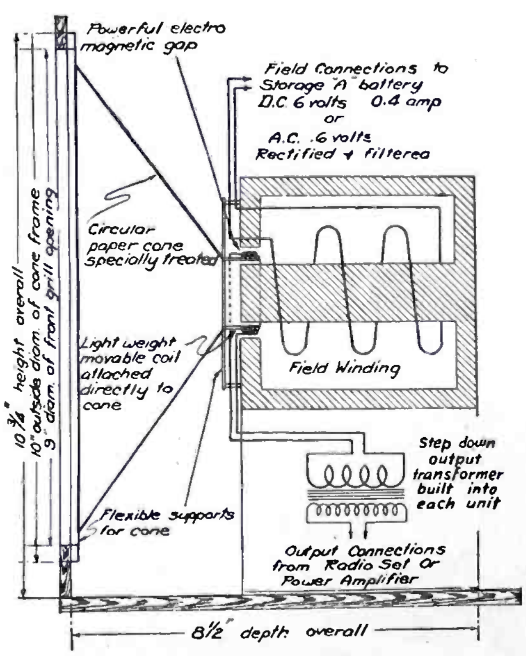
DYNAMIC SPEAKERS
How They Work

By HENRY GIBSON

HIGH power loudspeakers may be roughly divided into two distinct classes, the direct drive and the moving coil drive. In the direct drive type, the driving rod is attached both to the armature of the speaker and to the cone or diaphragm. Impulses imparted to the armature are conducted to the cone or diaphragm through the medium of a small coil attached to the apex of the cone member.

The Jensen "Dynamic" speaker (a term applied to all moving coil speakers) is a fine embodiment of the dynamic principle. The constructional details of this speaker are exceptionally well executed and many subtle refinements have been incorporated which give it an especially flat reproduction curve. In Figure 1 the reader will find the general layout of these essential components. The cone, which is of a special grade of paper, measures 8 inches in diameter, with a depth of approximately 3¼ inches. Through the medium of soft leather, the cone is permitted to float in a cast-metal frame, its small end being held in the proper position with a light aluminum member which keeps the coil in concentric position in relation to the core of the exciting coil. The driving coil proper is affixed to the apex of the cone, being wound on a small fibre tube.

Those who understand the operation of electrical measuring instruments are familiar with the D'Arsonval principle which, in a nutshell, might be stated as the tendency of a coil to move when subject to a fluctuating magnetic field. In electro-dynamic speakers, there is response of the coil to the magnetic field



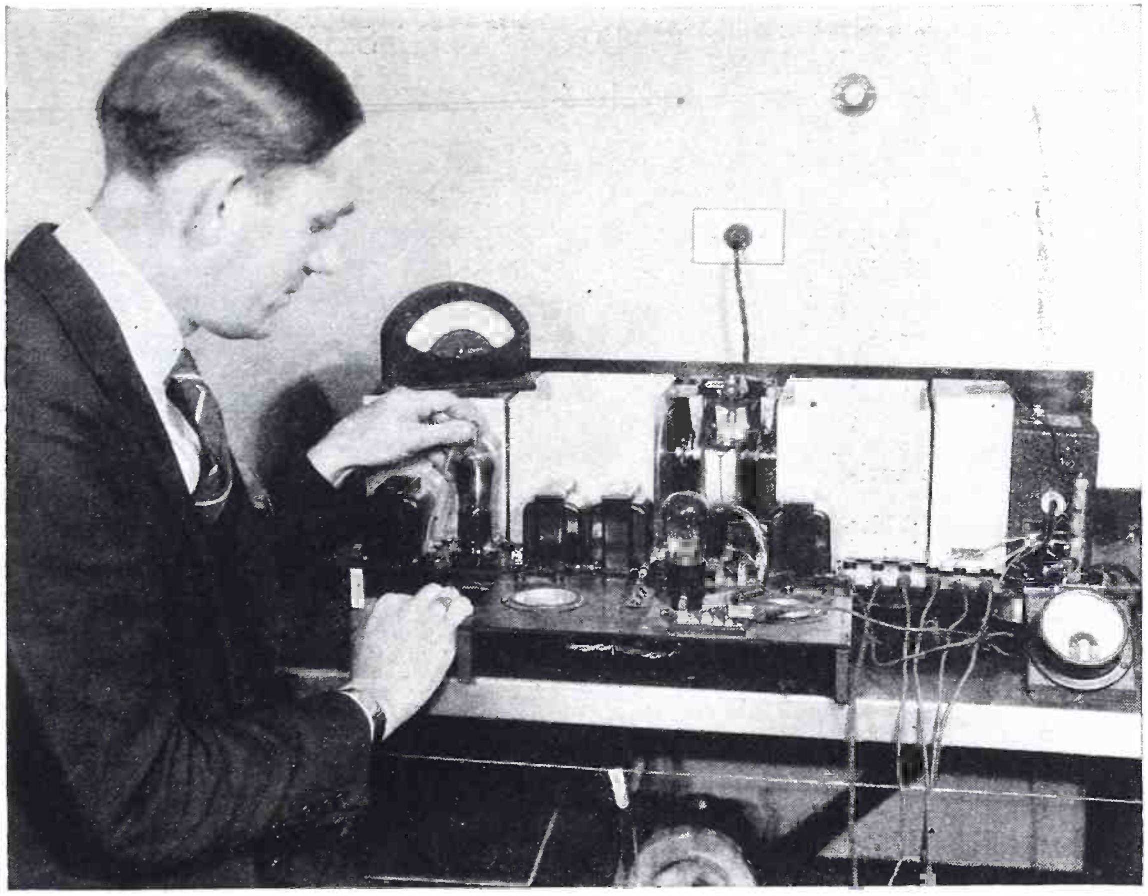
HOW THE SPEAKER WORKS

FIGURE 1: *The heavy field magnet is excited by an outside source. The output of the amplifier is fed through the step-down transformer to the light moving coil attached to the cone.*

that provides the actual driving force. The output from a radio receiver is permitted to flow through the small coil mounted at the apex of the cone, while a steady and unvarying magnetic field is constantly maintained by a powerful electro-magnet. The interaction of the two fields, one constant and one varying, provides the mechanical motion.

The field coil of the Jensen type D44 speaker is excited from either a 6- or 12-volt source, which may be a storage battery or an "A" battery eliminator. The AC type D45 obtains its field coil supply from the power amplifier circuit, the coil acting as a choke. With a field resistance of 2,250 ohms, the energizing current of the field coil is somewhere between 30 and 40 milliamperes at a voltage between 80 and 90. The resistance of the magnetizing coil of the DC or D44 type is 15 ohms and the current consumption is in the neighborhood of .4 amperes at 6 volts. All types of Jensen speakers are provided with a step-down output transformer having a ratio of 25 to 1, into which the power amplifier feeds. This step-down or output transformer is really an impedance balancer, since it is obvious to experimenters that the low resistance moving coil, which is comprised of only a few turns, could not possibly be con-

(*Continued on page 423*)



CHECKING UP THE CHARACTERISTICS

The engineer is testing the low-frequency circuits of the QSA-5 receiver. This part of the receiver is of new circuit design, has been very carefully tested in the POPULAR RADIO *Laboratory.*

Building *the* QSA-5

The construction and operation of the QSA-5 screen grid receiver is given in complete detail in this article. The constructor will find this new receiver, with its unusual features in circuit design and construction, a set of extraordinary quality and range.

By LAURENCE M. COCKADAY

THE outstanding features of the QSA-5 receiver were described in detail in the April number of POPULAR RADIO, and the reader is referred to the article on page 293 of that issue for a thorough theoretical consideration of the circuit. Briefly, the receiver consists of two stages of high-frequency amplification employing screen grid valves, a vacuum valve detector, a two-stage low-frequency amplifier, and a self-contained "B" voltage supply. The first stage of low-frequency employs a screen grid valve, coupled to the detector through a transformer, and the screen grid valve stage is coupled to the final 171 power valve stage through an impedance coupling of new design. The schematic diagram of the circuit is shown in Figure 4.

Assembling the QSA-5

While at first glance the QSA-5 may seem a little complicated, yet by a steady progressive system of construction this set can be assembled and wired comparatively quickly. The first instruments to mount are the three Benjamin brackets, T1, T2 and T3, as shown in the diagram in Figure 5. Then the panel may be turned over and the assemblying of the instruments located on the top of the panel is now ready to commence. Mount the Aero coils A1, A2 and A3 on the bases of the aluminum cans, C1, C2 and C3. Likewise locate and fasten in position the Benjamin sockets, L1, L2 and L3, followed by the Hammarlund high-frequency chokes, E1 and E2, in cans C2 and C3, respectively.

The Aerovox grid condenser, N4, and the Aerovox by-pass condenser, N3, should then be fastened to the Benjamin socket, L3. The Aerovox moulded condenser, N2, should similarly be placed and fastened to coil A3 and choke coil E2. The Aerovox wire wound resistances, M1 and M2, should then be fastened to their respective sockets and to the aluminum base at the free end. These three bases of the shields, C1, C2 and C3, with the various instruments before mentioned, should now be placed upon the Westinghouse Micarta sub-panel, together with the Thordarson power compact, I, and the Aerovox condenser "B" block, J, and fastened securely in position as shown in Figure 1. The Yaxley Junior 10-ohm rheostats, R1 and R2, which are centrally located on the sub-panel should now be secured firmly in position. The Thordarson transformer unit, F, the autoformers, G1 and G2, and the output transformer, H, should now be fastened down securely by means of screws. Benjamin sockets L4, L5 and L6 may now be placed and fastened. The Centralab 5,000-ohm potentiometer, R5, and the XL binding posts, U1 to U6, may readily be located and

POPULAR RADIO WORK SHEET

The QSA-5 Receiver

List of Parts Used in Building This Receiver

Cost of Parts—*Not over $139*

A1—Aero antenna coil, type No. 96;
A2 and A3—Aero universal coils, type No. 43, equipped with two special Aero primary coils, type No. 111;
A4—Special home made plate coil;
B1 to B3—Hammarlund midline variable condensers, .0005 mfd.;
C1 to C3—Hammarlund stage shields;
D—Hammarlund double-drum dial;
E1 and E2—Hammarlund high-frequency chokes, type No. 85;
F—Thordarson low-frequency transformer, type R-200;
G1 and G2—Thordarson Autoformers, type R-190;
H—Thordarson Speaker coupling transformer, type R-76;
I—Thordarson power compact, type R-171;
J—Aerovox filter condenser block, type TH-862;
K1 and K2—XL vario-densers, type G-1;
L1 to L6—Benjamin Cle-ra-tone sockets, No. 9040;
M1 to M3—Aerovox wire wound resistances, 10 ohms, type No. 980;
N1 and N2—Aerovox moulded condensers, .00025 mfd.;
N3—Aerovox moulded condenser, .001 mfd.;

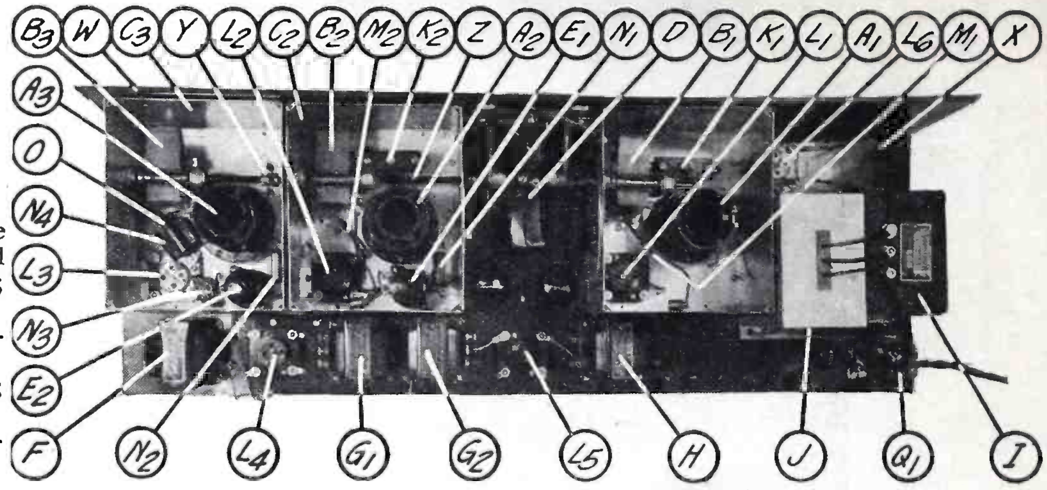
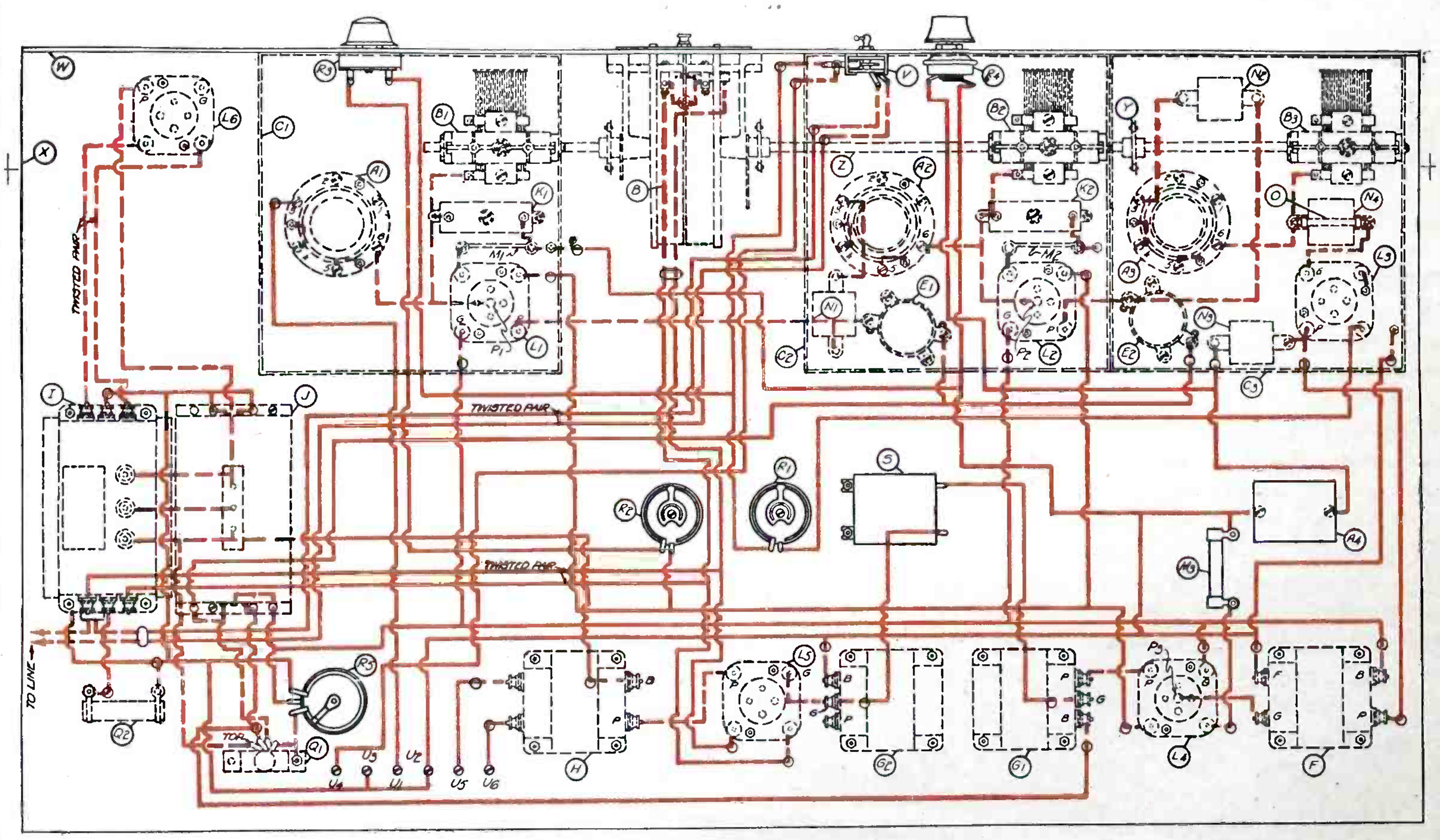


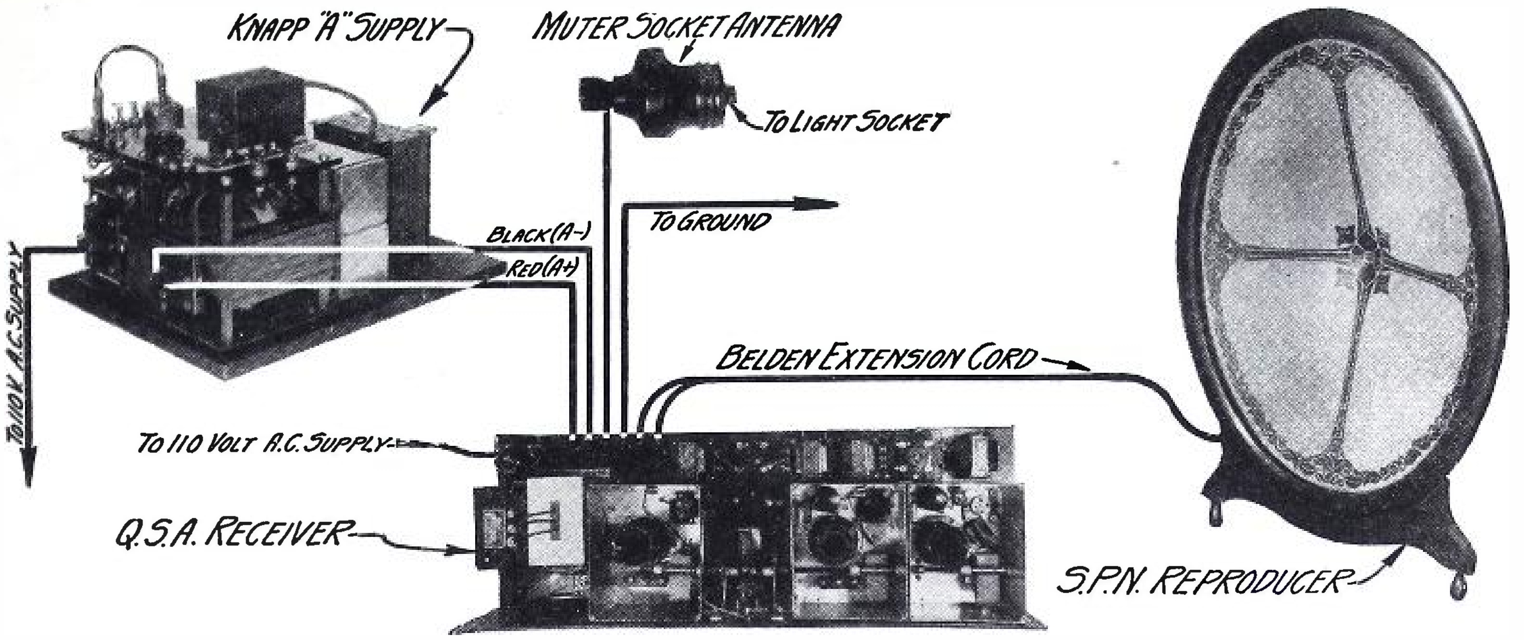
FIGURE 1: A VIEW OF THE SET FROM ABOVE

N4—Aerovox moulded condenser, .00025 mfd., with clips for gridleak mounting;
O—Durham metallized resistor, 1 megohm;
P1 to P3—Control grid connectors;
Q1—Aerovox Pyrohm resistance, with two extra taps, 10,000 ohms, type 994 QSA;
Q2—Aerovox Pyrohm resistance, 2000 ohms, type No. 992;
R1 and R2—Yaxley Junior rheostats, 10 ohms, type 510;
R3—Yaxley Junior rheostat, 3 ohms, type 503;
R4—Clarostat volume control;
R5—Centralab heavy-duty potentiometer, 5000 ohms;
S—Aerovox filter condenser, .25 mfd., type 200;
T1 to T3—Benjamin brackets, type No. 8629;
U1 to U6—XL push-posts with new bakelite top;
V—Carter automatic power switch, type No. 115;
W—Westinghouse micarta panel, 9 by 30 by 3/16th inch;
X—Westinghouse micarta sub-panel, 10 by 30 by 3/16th inch;
Y—Hammarlund insulated flexible coupling;
Z—Hammarlund brass extension shaft, 7½ inches long and ¼ inch in diameter;
Gavitt hook-up wire, brackets, etc.



HOW TO WIRE THE SET

FIGURE 2: *The solid* RED *lines indicate wires that run under the sub-panel, the dotted* RED *lines wires above the sub-panel. The instruments mounted on the sub-panel are in dotted* BLACK *lines, those under the sub-panel in solid* BLACK.



THE OPERATING HOOK-UP

FIGURE 3: *The self-contained "B" supply in the QSA-5 eliminates the necessity of "B" batteries or power-pack, and the receiver is made completely socket-operated by the use of the Knapp "A" supply.*

placed in position by reference to Figure 2. The Aerovox Pyrohm resistance, Q1, together with the Aerovox Pyrohm 2000-ohm resistance, Q2, should now be mounted at the extreme right of the panel condensers (looking from the rear of the set). The XL Variodensers, K1 and K2, should be mounted on the Hammarlund condensers, B1 and B2. The assembly of the cans, C1, C2 and C3, may be resumed after mounting of the Hammarlund condensers, B1, B2 and B3. The can assembly should be completed with the exception of that part of the can which extends toward the back. This will facilitate the wiring which takes place later. The Hammarlund double drum dial, B, may now be placed in position with its attendant shafts. This completes the top assembly.

Referring to Figure 2 the location of the Yaxley 3-ohm rheostat, R3, will be noted on the left of the Westinghouse Micarta panel. On the right is located the Clarostat control, R4. The front panel may now be fastened to the sub-panel by means of the brackets, T1, T2 and T3. The dial assembly should now be completed and the knobs for the Yaxley rheostat, R3, and the Clarostat volume control, R4, should be fastened in position by means of the set-screws. The set should now be turned over so that the front panel rests flat on the work bench. The Aerovox 1/4 mfd. filter condenser, S, which is located beneath the sub-panel, should be securely fastened in position by means of two screws. The special home-made plate coil, A4, should next be fastened in position and the Aerovox 10-ohm resistor, M3, then should be tightly fastened in position by means of nuts and bolts. The plate coil, A4, is made of 80 turns of No. 30 double silk covered wire on a tube 1 5/8 inches outside diameter and 2 inches long.

Wiring the QSA-5 Receiver

It is always good practice in wiring up any receiver to have some definite method of procedure. Professional set builders generally follow some precedent plan such as the following.

Proceed to wire up the filament circuits of the various valve sockets together with their attendant rheostats or voltage regulating devices, such as fixed resistances, etc. Follow this with the grid and plate leads of the sockets, the coils and variable condensers. The grid and plate leads of the low-frequency transformers and output device should be wired next. Then connect the low-frequency transformers to their respective "C" and "B" battery binding posts. By-pass condensers should then be wired up and finally the volume control. Then begin the wiring of the Thordarson power compact. Constant reference should be made to the picture wiring diagram in Figure 2 to eliminate the possibility of error. The high voltage wires should be connected to the rectifier valve. These wires issue from the side of the Thordarson power compact nearest the panel. The last low-frequency power valve also receives its filament current from this compact and should be wired up next. The Aerovox condenser block, J, should then be wired and following this the Pyrohm

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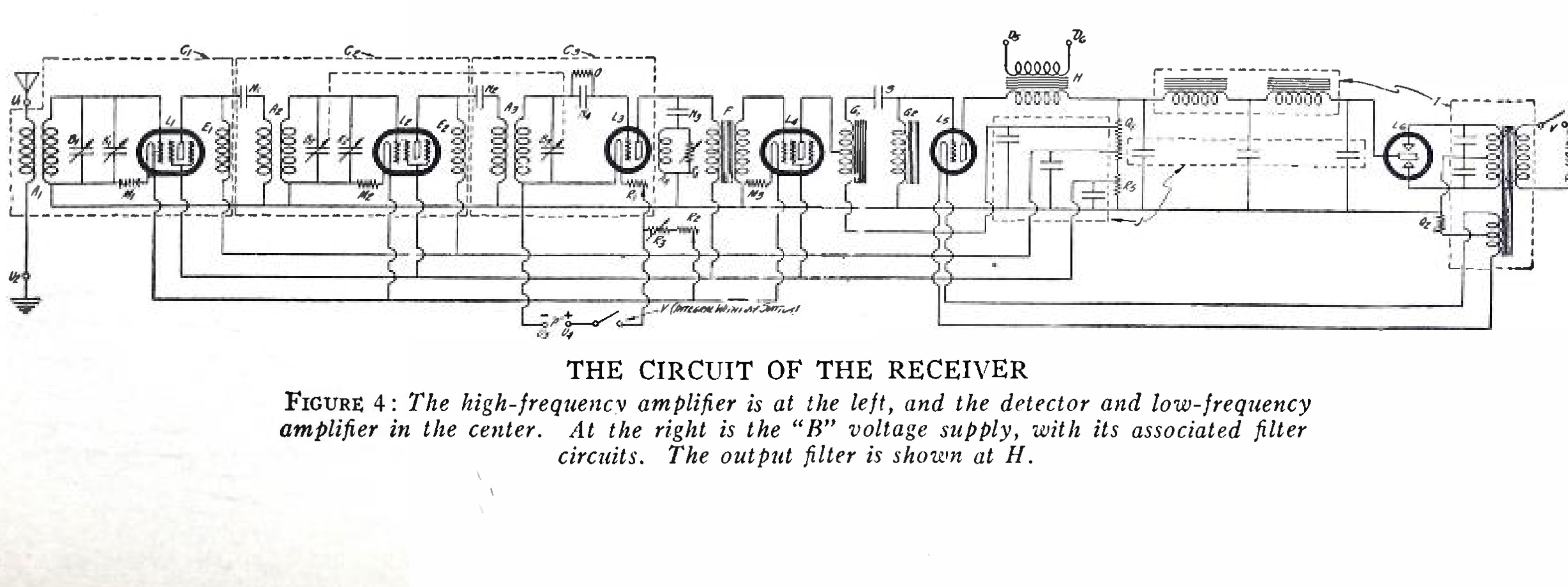
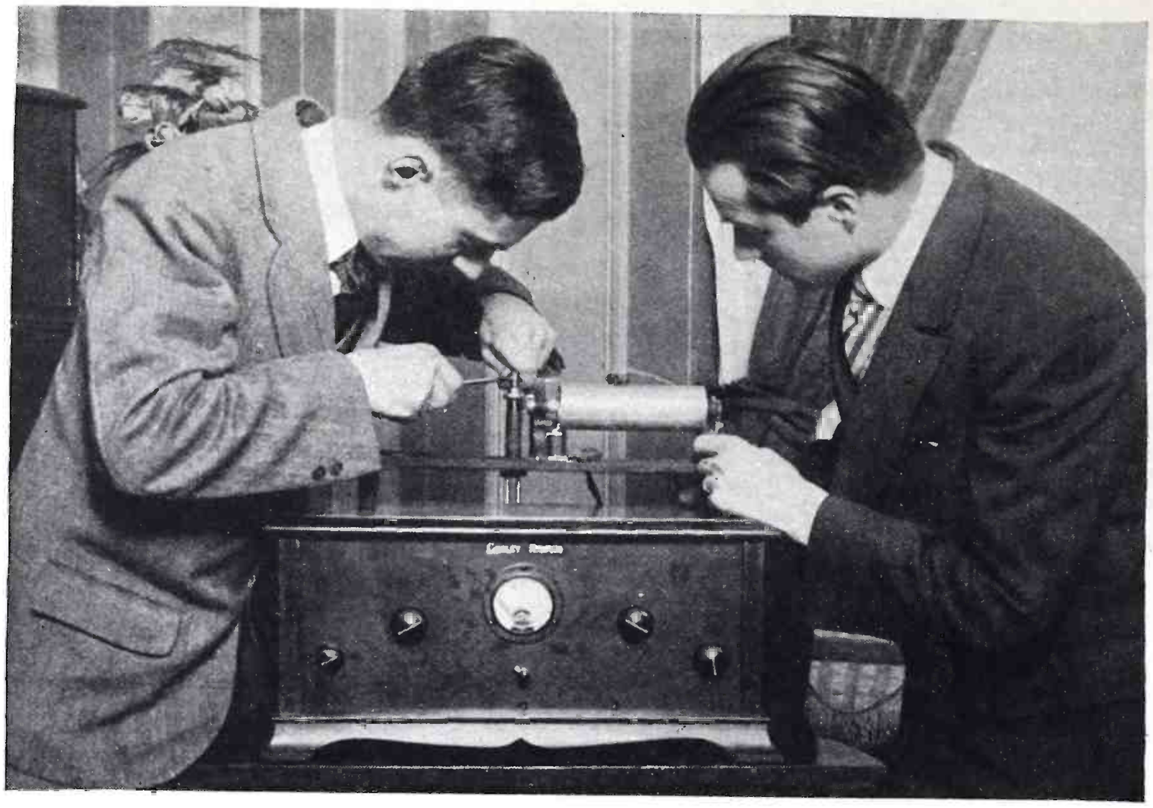


THE CIRCUIT OF THE RECEIVER

FIGURE 4: *The high-frequency amplifier is at the left, and the detector and low-frequency amplifier in the center. At the right is the "B" voltage supply, with its associated filter circuits. The output filter is shown at H.*



MAKING READY FOR PICTURE RECEPTION

The construction and operation of the Cooley Rayfoto apparatus is only slightly more complicated than that of the average broadcast receiver. This picture shows the adjustment on the clutch that controls the recording cylinder.

THE ONWARD MARCH OF RADIOVISION

The modern marriage of radio to the optic sciences is not confined to television alone. Radiophotography is a fascinating and useful art that is much farther along the road to true practicability for the broadcast listener than television. This description of the Cooley Rayfoto apparatus for receiving photographs by radio should convince the fan that it is time to enter this interesting field.

By RICHARD LORD

THE latest field of activity for the radio experimenter is the visual reception of still and moving images. Radiovision and radiophotography are even now emerging from the laboratories of science into the home constructor's workshop.

For many years, the enterprising radio enthusiast has been dreaming of that day when he might see at a distance as readily as he now hears entertainment from remote points. His appetite for attainment along these lines has been whetted considerably by the recent spectacular public demonstrations by Alexanderson, Baird, Jenkins and Ives, of their methods of receiving moving images, and by Ranger, Alexanderson, Belin, Korn, Ives and Cooley, of their systems of high grade still picture reception.

With the possible exception of the last named system, the high cost of the apparatus involved, or the slow speed of transmission, places these systems out of reach of the practical experimenter.

The coming radio season, however, promises to bring the set builder full opportunity to participate in broadcast picture reception. In fact, scores of amateur experimenters are already receiving pictures in this manner. WOR of L. Bamberger & Company, at Newark, N. J., has been broadcasting Cooley Rayfoto pictures on a regular schedule for some months, and many other broadcasting stations have applied for permission to conduct similar services.

The cost of essential parts for a Cooley picture recorder is $150.00, exclusive of those standard radio parts which the amateur is likely to have on hand. Shadowgraph apparatus may also be available soon, capable of making crude moving silhouettes. The still picture apparatus produces high quality pictures in home of any subject to which the camera responds, provided it has fair contrast and not too much detail. From the "program" standpoint, still picture reception has real fascination to offer. Pictures of prominent artists, of sporting and news events and "illustrations" to accompany radio lectures can be flashed into the home with the aid of picture recorders which the set builder can readily assemble.

It would be worth while for the experimenter to consider the present status of the picture broadcasting art, if he would derive the fullest benefit from the events of the coming radio season. So much has been prophesied and written about forthcoming developments that the experimenter may be led to expect too much, unless he familiarizes himself with the capabilities of the various systems likely to be offered him.

Regardless of the specific system of picture transmission used, the same basic process is employed in putting any picture on the air. It consists of the successive transmission of an electrical impression of the intensity of each spot on the picture until the entire surface of the picture has been explored. This process of dissecting a picture by areas in a predetermined progression, is called "scanning."

The more thoroughly a picture is scanned, that is, the more electrical impressions per square inch are made, the greater will be the detail. Conversely, the more impressions involved, the longer the time required to transmit a single picture.

Electrical impression of each such spot is secured either by reflecting a beam of light from the subject itself, or by rotating a photograph on a cylindrical drum, mounted on a threaded shaft within the focus of a photo-electric cell. The mechanism used in still picture transmission is similar to the old type cylindrical phonograph or dictaphone.

The light beam reflected from the subject upon the photo-electric cell varies in intensity with the shading that falls within the "scanning" of the beam. The space current through the photo-electric cell varies as the intensity of the light reflected upon it. When a black part of the rotating picture is exposed to the light beams, much light is absorbed and little reflected, causing a small photo-electric current. When a white portion is being scanned, much light is reflected to the cell, and a greater amount of current flows. In this way, shading of the picture is progressively converted into a varying electric current.

The light beam reflected from the picture to the cell is interrupted by a revolving shutter or other means, so that the resultant "picture signal" is a low-frequency current, fluctuating with the intensity of the picture. This signal is then combined with the carrier of the transmitting station and broadcast.

A PICTURE RECEIVED BY RADIO

Making allowances for the fact that this reproduction is made with a coarser screen than the original received picture, it can be seen that the Cooley apparatus has a fidelity that should give it high entertainment value to every fan and listener-in.

This is true of all systems. In television, however, the entire surface of the picture must be scanned in a sixteenth of a second. That is the only fundamental difference between television and radio photography.

The distinction between still and motion picture transmission is, therefore, almost entirely a matter of the speed with which the complete image is sent and received. Radiovision is simply radiophotography speeded up to the point where complete picture is scanned and reproduced each sixteenth of a second. The ideal to be attained with radiovision is a high grade motion picture of any event occurring at a transmitting point.

The layman has been misled into believing that present-day television can present to his eye a visual reproduction of any event that his ear can hear by radio. There has been conjured for his imagination a football field spread before him on a ground glass screen, whereon he can watch the players, even as the announcer describes the action taking place. We are a million miles from any such accomplishment. No one has the slightest suggestion, yet, of how this ideal may be arrived at. The reader who has understood the general principles already outlined can readily calculate for himself the magnitude of the problem of attaining true radiovision.

Reverting to actualities, the process of moving picture transmission consists in reflecting a ray of light from the subject to a photo-electric cell, progressively covering the subject each sixteenth of a second. To be practical for use on the broadcasting band, no higher speed of modulation than five thousand cycles is desirable. That means 5,000 picture impressions per second, or 312 each sixteenth of a second.

Furthermore, since the light must be reflected from the subject to the photo-electric cell, it must be reasonably close

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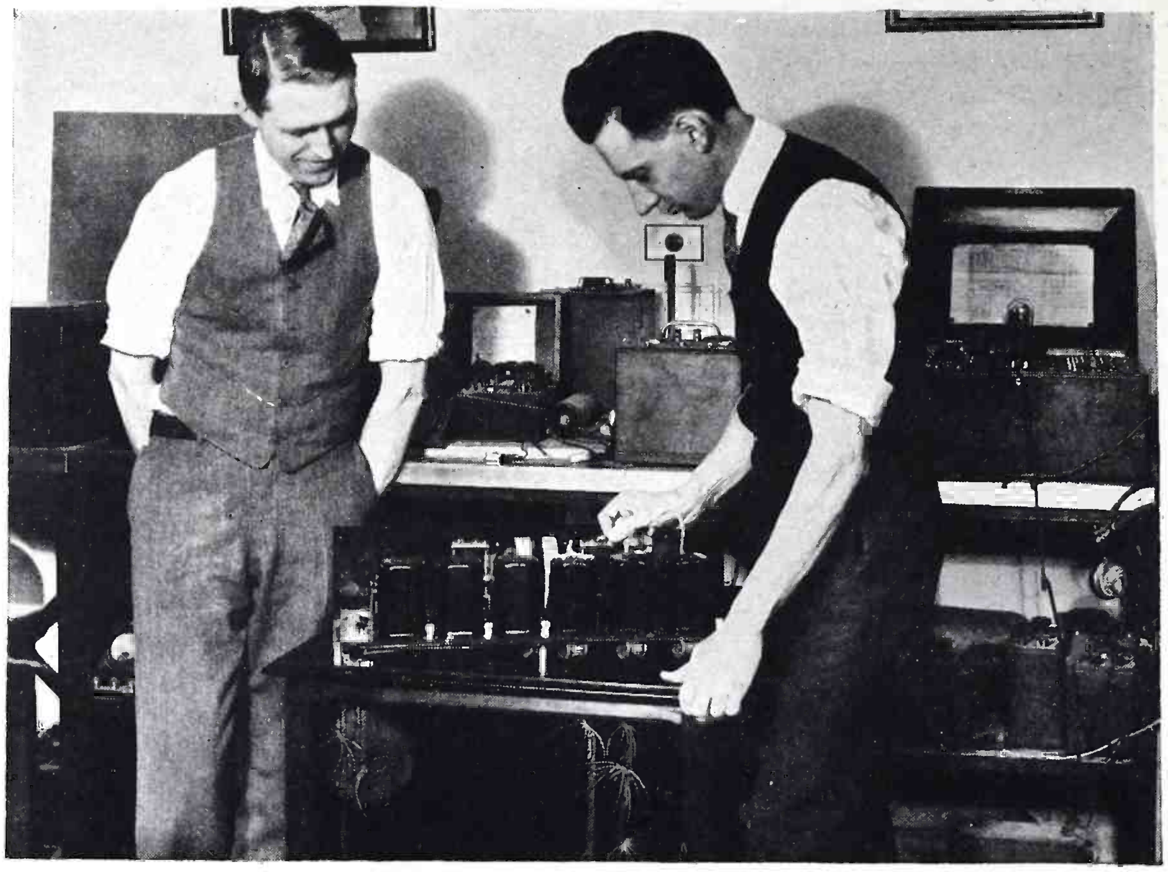


ANOTHER TRIUMPH FOR THE SCREEN GRID VALVE

The design and construction of the Tyrman "70" has convinced the Laboratory Staff of this magazine that this receiver is another step forward in the ever-widening field of use for the screen grid valve.

Here's a Superheterodyne *With* Screen Grid Valves

Superheterodyne construction gets a new boost in the Tyrman "70" receiver, which incorporates a three-stage intermediate amplifier that makes use of screen grid valves. In addition to this feature, the receiver has a compactness and simplicity in construction and operation that is very unusual in this type of circuit.

By MORRIS M. SILVER

SIMULTANEOUSLY with the advent of the 222 screen grid valve on the market there appeared the Tyrman "70" screen grid Amplimax set. This is a superheterodyne designed especially for the use of the 222 screen grid valve. The circuit itself is of extreme interest to the radio enthusiast because of the high degree of amplification possible in this set, together with the possibility of very good selectivity without danger of cutting the side-bands, thereby assuring very faithful reproduction. A very short antenna, consisting of but a few feet of wire, may be used with this set with surprisingly good results.

Instead of the usual form of frequency transformer a single coil of several hundred thousand ohms impedance is used so that the internal impedance of the valve may be more nearly matched.

Due to the high degree of amplification of this set it is essential that there be complete shielding of the coils and valves. An actual amplification of 30 to 50 per valve is possible in this set as against an intermediate-frequency amplification of 6 or 7 in ordinary superheterodyne circuits.

Properly designed apparatus is an important factor in this set. Background noises are particularly noticeable by their absence, and the 340 kilocycle impedances which are used as the means of intermediate coupling assure a single spot reception.

The filament of the screen grid valve is similar to that of the UX-120 type low-frequency amplifier, and draws .125 amperes at 3.3 volts. It is important that the filament voltages of these valves are not exceeded beyond that of the given rating. A plate voltage of 135 volts is recommended in this set with a screen grid potential of 45 to 67½ on the screen grid valves, with a negative "C" bias of 1½ to 3 volts on the control grids.

Upon completion of assembly of this set the symmetry will become apparent

POPULAR RADIO WORK SHEET

The Tyrman "70" Receiver

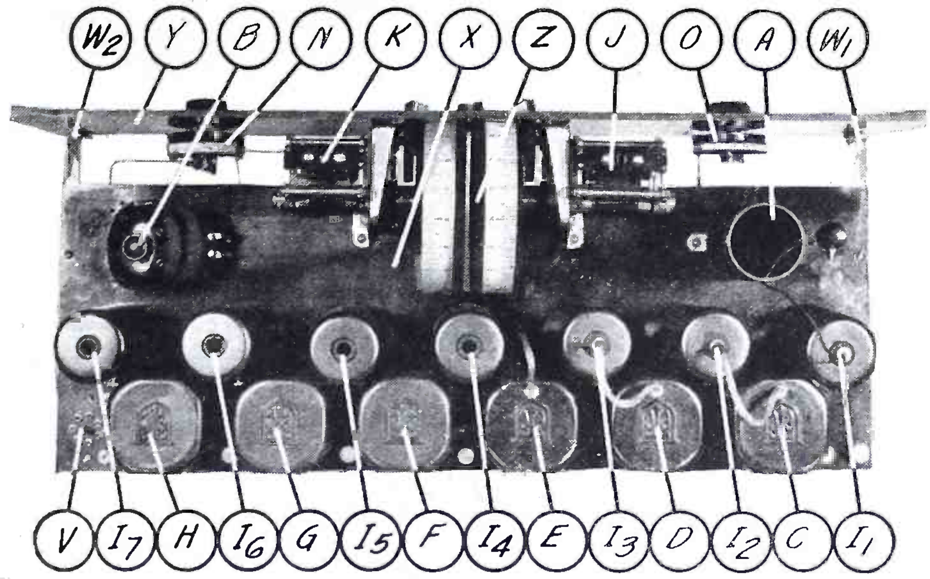
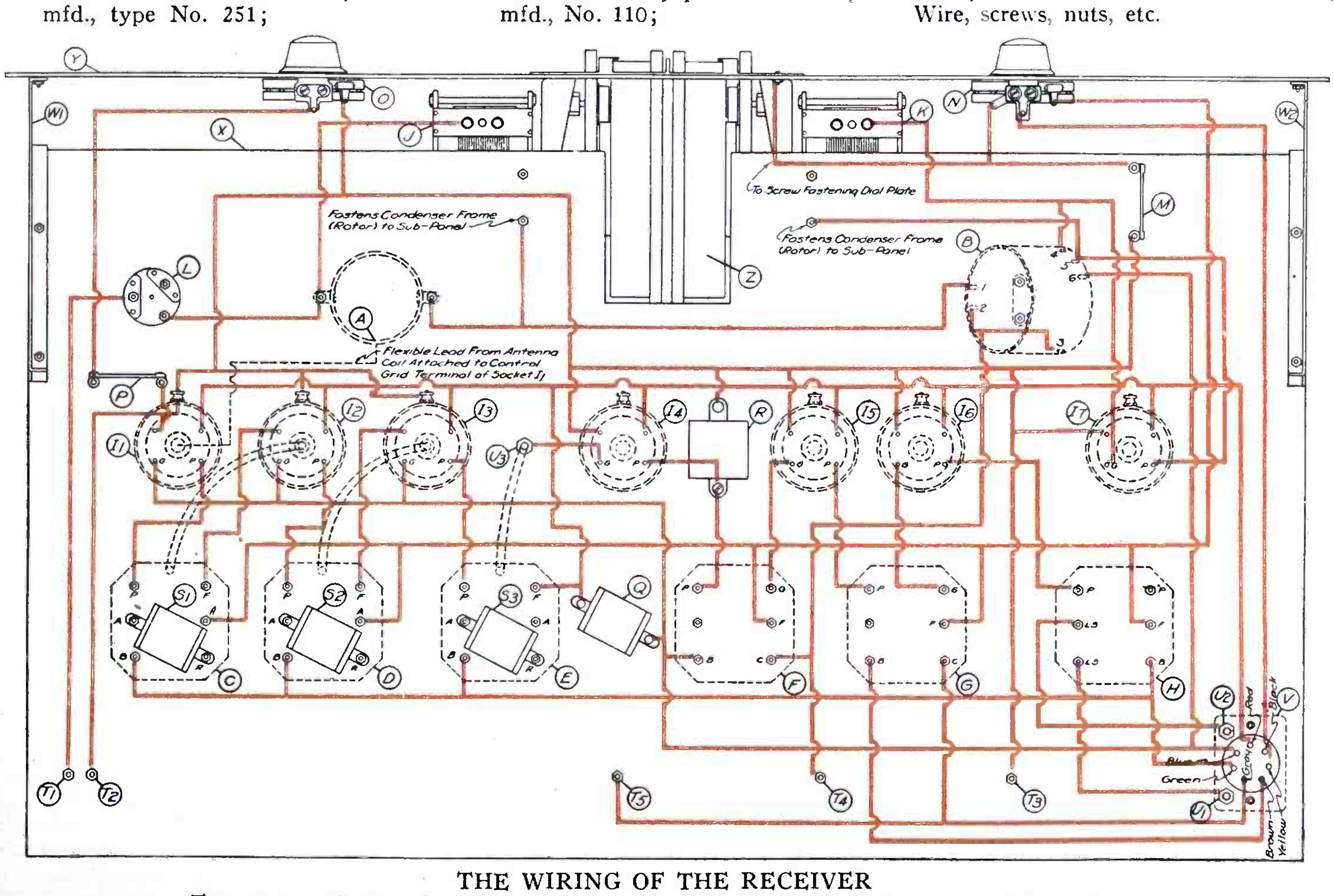


FIGURE 1: THE MOUNTING OF THE INSTRUMENTS

List of Parts Used in Building This Receiver

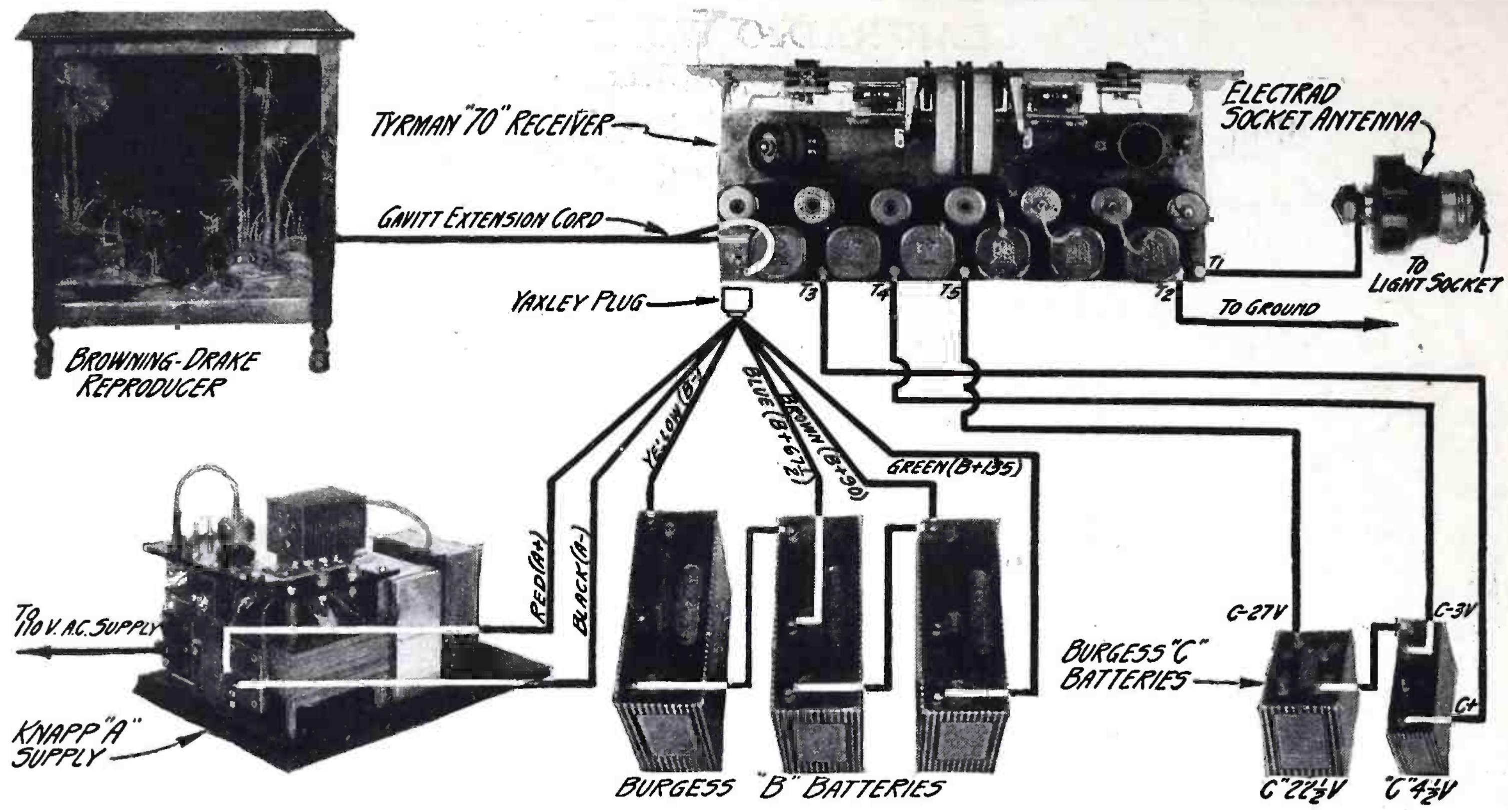
Cost of Parts: *Not over $127.00*

A—Tyrman antenna coil, type 9-80;
B—Camfield oscillator coupler, type 622;
C, D and E—Tyrman shielded high-frequency impedance units, type 9-90;
F and G—Tyrman low-frequency transformer, type 3-30;
H—Tyrman output transformer, type 3-51;
toI7—Tyrman shielded sockets;
J—Camfield variable condenser, .0005 mfd., type No. 501;
K—Camfield variable condenser, .0005 mfd., type No. 251;
L—Chelton midget condenser, 50 mfd.;
M—Yaxley fixed resistance, 1 ohm, type No. 4-L;
N—Yaxley combination switch and rheostat, 15 ohms, type 915-K;
O—Yaxley rheostat, 25 ohms, type 125-K;
P—Yaxley fixed resistance, 15 ohms, type No. 815;
Q—Carter by-pass condenser, 1 mfd., No. 110;
R—Carter moulded condenser, .0005 mfd.;
S1 to S3—Carter by-pass condensers, 1 mfd., No. 110;
T1 to T5—Binding posts;
U1 and U2—Phone tip jacks integral with Yaxley Cable Conductor Plug, V;
U3—Yaxley pup jack, No. 416;
V—Yaxley cable connector plug with cable, No. 669;
W1 and W2—Benjamin brackets No. 8629;
X—Composition drilled sub-panel, 8 by 23 by 3/16 inch;
Y—Composition drilled and engraved front, 7 by 24 by 3/16 inch;
Z—Tyrman double vernier drum dial;
Wire, screws, nuts, etc.



THE WIRING OF THE RECEIVER

FIGURE 2: *All the wiring is done under the sub-panel, and is shown in solid* RED *lines. The parts under the panel are in solid* BLACK, *and those above in dotted* BLACK *lines.*



HOW TO HOOK UP THE RECEIVER

FIGURE 3: *A light socket antenna is indicated in the above diagram, but under certain conditions it may be found that a short wire, 8 or 10 feet long, will produce better results.*

and the general appearance will compare very favorably with any commercially-made receiver on the market.

The Assembly of the Instrument

The sub-panel and panel are factory-drilled, which greatly assists the home or professional set builder in rapid assembly of parts. Referring to Figure 1 we note the three high-frequency impedances, C, D and E, are located at the right, the two low-frequency transformers, F and G, are located next to the three intermediate impedances, with the output transformer, H, at the extreme left.

These units should have their trade marks facing the front panel. Referring to Figure 2, the three 1 mfd. by-pass condensers, S1 to S3, hook into the specially provided terminal screws of the high-frequency impedances. A Yaxley No. 699 cable socket, V, is conveniently placed at the lower right corner for battery connections. It will be necessary to remove the mounting bracket, as this cable receptor is positioned on top of the sub-panel. A Yaxley pup jack, U3, will be mounted between the third and fourth sockets. This is for the grid lead of the third high-frequency impedance. A flexible lead of the antenna coil, A, connects to the cap of the first valve. The grid leads of the first two impedances terminate in bushings that fit over the valve caps of the second and third screen grid valves. The oscillator coupler, B, is fastened next in position at the right of the subpanel. Two variable condensers, J and K, .0005 and .00025 capacity are used for tuning the antenna and oscillator coupler, respectively. These are mounted with the Tyrman vernier drum, Z. Auxiliary brackets are used for the purpose of bracing the main brackets to the sub-panel. These also provide the rotor terminal of the condenser, permitting almost complete sub-panel wiring. Referring to Figure 2, the position of the rheostat O, which controls the filament of the first detector valve in series with the fixed resistance, P, may be ascertained. Likewise, the 15-ohm switching rheostat, N, which regulates the filament temperature of the second

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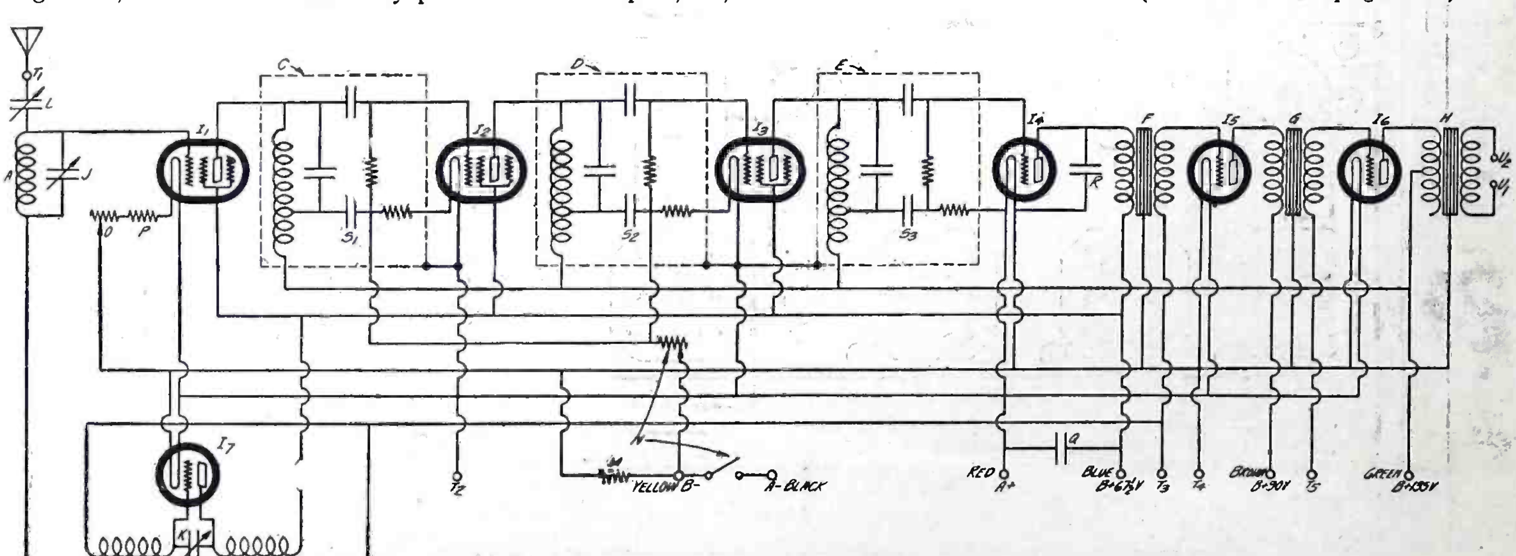
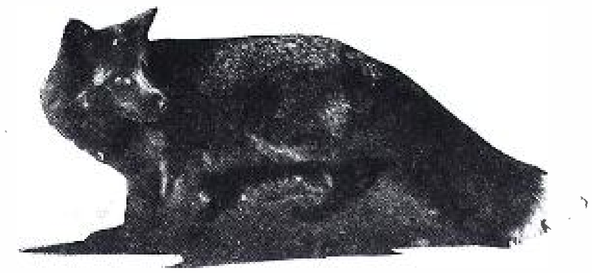


THE CIRCUIT OF THE TYRMAN "70"

FIGURE 4: *The complete shielding of the intermediate-frequency impedance units is indicated by the dotted lines at C, D and E. In addition, all the valves in set have shields.*



Radio Helps on a Silver Fox Farm

Radio instruments have been used in the past to solve many unusual problems, but the application described below seems to the editors to be the most unusual example of radio ingenuity that has come to their attention.

By ELVA M. GILLCASH

IN Prince Edward Island, where the ranching of silver foxes originated, there has recently been developed, in connection with this industry, a new and interesting use for radio equipment. Silver foxes have proven a profitable source of revenue in this little province by the sea. The greatest barrier to success in raising them lies in the fact that the mother fox is possessed of an exceedingly nervous temperament, which is liable to manifest itself in curious ways if she is disturbed when her young ones arrive.

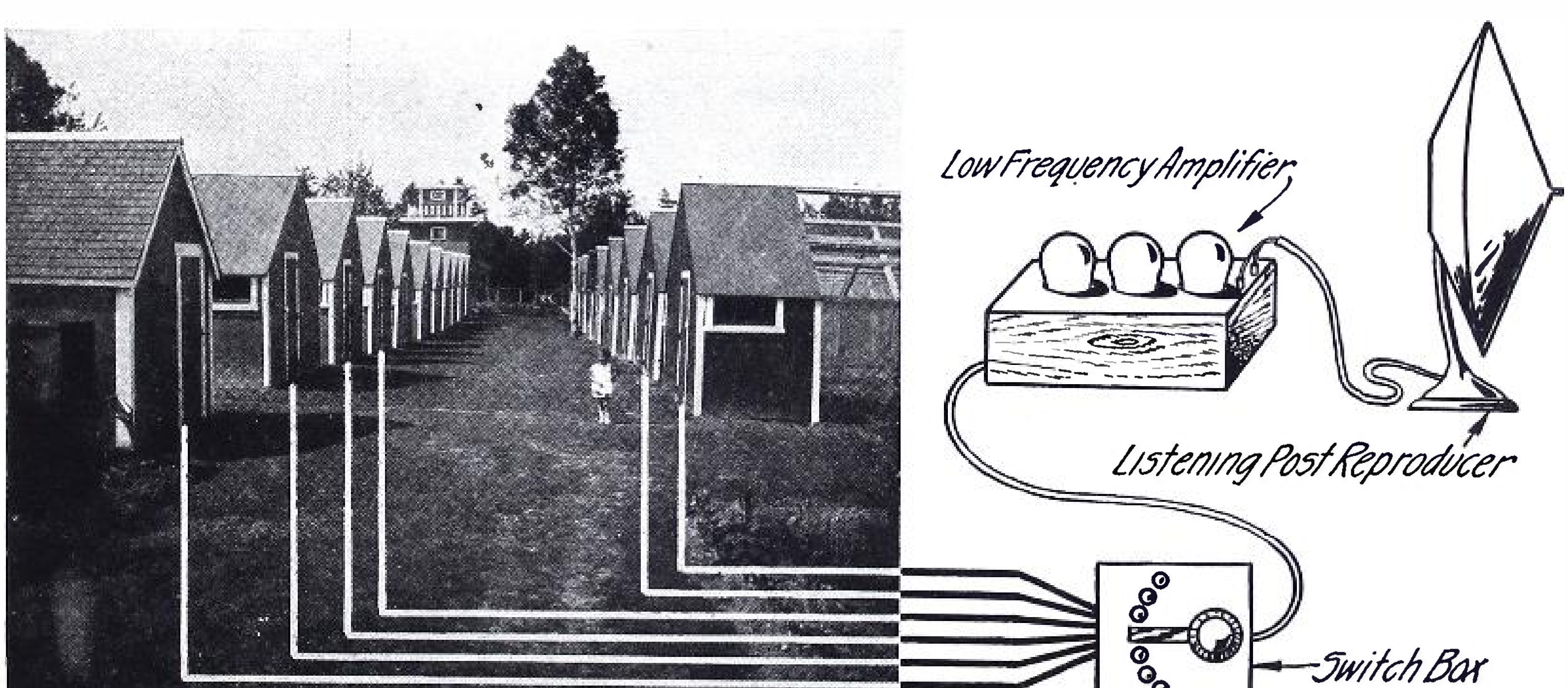
One cannot say with any degree of certainty whether or not a particular vixen is expecting a litter. However, if she fails to come out of her den the presumption is that the important event has occurred. Then follows a period of anxiety for the rancher. Has a new litter arrived? If so, are they living? Is the mother giving them proper care and nourishment, or is it advisable to give them to a foster-mother temporarily or permanently?

These questions can be answered by looking into the den; but in the majority of cases such an intrusion results in the vixen either killing the pups outright, burying them in the snow or clay, or starting to carry them around.

"Of two evils choose the lesser" is the policy followed by most ranchers, and this means that for three weeks the vixen must be left undisturbed. At the end of that time the rancher may discover a fine litter, or conditions may be such that he regrets not having made an investigation before.

Both these evils have, however, been overcome by one large ranch owner, Mr. W. K. Rogers, of Charlottetown. This is how he did it. Into each vixen's den he installed a very sensitive microphone, connected with a central switch in the watch tower. By means of a low-frequency radio amplifier the sounds in the den are raised to a volume sufficient to operate a radio loudspeaker.

By this means the ranch owner can, at any time, ascertain what is going on in any particular den, and govern his actions accordingly. The increased number of young foxes raised to maturity has more than justified the expense of installation and upkeep, and radio will undoubtedly become part of the equipment of every progressive rancher in the near future.



HOW THE INSTALLATION WAS MADE

Microphones were installed in every fox den, and connected through a switch box to an ordinary low-frequency amplifier and loudspeaker. In this manner the owner could listen in on what was going on in each den without the danger of disturbing the irritable vixens by a visit in person.

THE INVENTOR AND HIS WORK
Here is Dr. A. Ristow with the tele-control he devised. This simple instrument controls from a distance the receiving set of the Berlin police department.

Tuning With a Tele-Control

In the heart of Berlin a man sits at a small instrument and controls the receiving set of the Berlin police department with three small switches. The receiver itself is located in the outskirts of the city, well away from interference and other noises. The ingenious device used to accomplish this is described in this article.

By DR. ALFRED GRADENWITZ

IT is often found desirable to install radio receivers at a considerable distance from the listener's location. In fact, the existence of zones characterized by poor reception (e. g. in mines, in large cities, zones termed "radio shadow," etc.), as well as the proximity of electric motors, automatic telephone plants and the like, frequently make such a course imperative.

One case in point was the location of the police radio system covering the whole of Germany, and which had necessarily to be controlled from central Police Headquarters, in the very focus of Berlin traffic, where radio reception left much to be desired. This problem had been solved by installing the receiver on the outskirts of the city, in the suburb of Lichterfelde, where it was operated and tuned by special officials and whence any signals received were retransmitted over a special telephone line to the various offices at headquarters.

Realizing that this state of affairs was anything but satisfactory, a police officer who at the same time is a distinguished scientific worker, Dr. A. Ristow, has just devised an ingenious and most useful apparatus which enables the actual receiving plant to be controlled from Police Headquarters without any need for employing special officials as heretofore and without any additional lines of conductors; in fact, without any but the telephone line so far required. This apparatus, which should prove useful in many other cases, enables the antenna and valves to be switched in and out and all tuning devices to be controlled from the listener's location about 10 kilometers away.

No loss of time, as compared with manual control, had, of course, to be entailed by the adoption of the automatic arrangement.

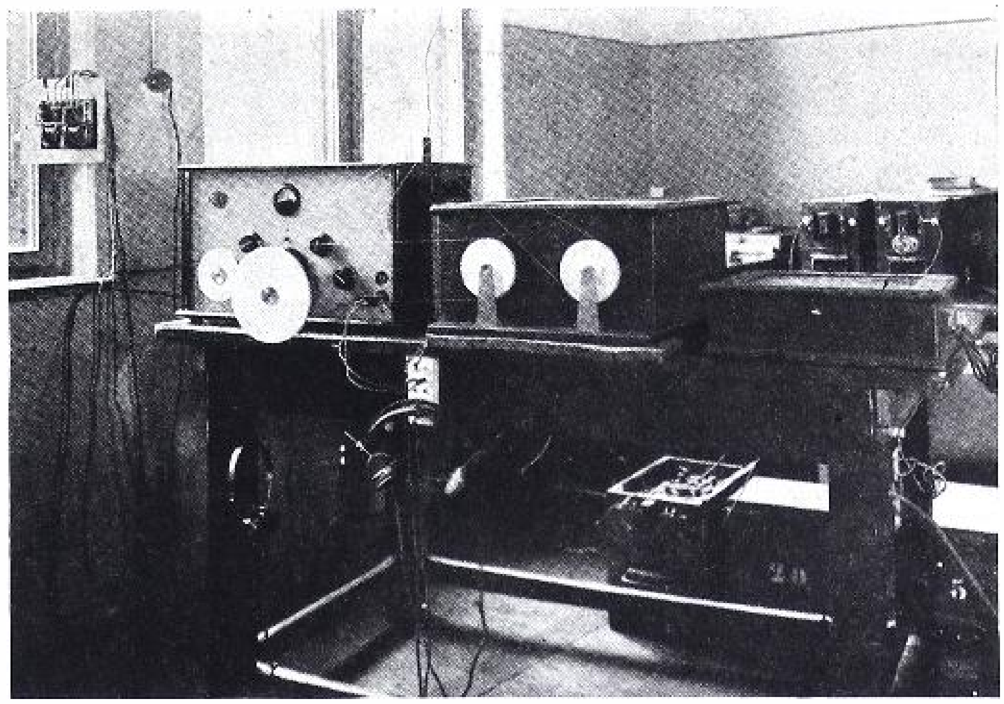
This arrangement utilizes on the one hand, the inversion of direction of the controlling current, and, on the other, its actual intensity. The mechanical energy used in connection with the remote control is supplied by a small electric motor the rotation of which is reversed by changing the direction of the controlling current. The switching and tuning devices to be operated are each time chosen automatically in accordance with the actual intensity of the controlling current. A resistance inserted in the controlling circuit enables the actual position of the tuning device to be always checked accurately.

At the place where the listener is posted (see Figure 1) there are, for him to operate, two double-pole switches, S1 and S2. The fulcrum of S1 is connected over a milliammeter with the central tapping of the primary of a transformer applied to the lines *a* and *b*. The fulcrum of S2, on the other hand, is connected to the ground. The contacts of S1 and S2, which in their position of rest are open, are connected up to the negative pole of a controlling battery, whereas these contacts while closed are applied to the levers of a three-pole switch, Sb, connected with three different voltages of the controlling battery. The listener's telephone is on the secondary of the transformer.

At the place where the radio receiver is installed, there is a connection leading from the central tapping of the primary of the transformer, across a polarized relay, PR, across the relays R1, R2 and R3, across the contact set *3* of R2, across W1 to the earth. The contact sets, *1*, *2* and *4*, are so arranged with regard to the clutches, K1, K2 and K3, that while R1 is making contact, the armature of K1 is attracted. While R1 and R2 are in contact, the armature of K2 is attracted and while R1, R2 and R3 are in contact the armature of K3 is attracted. The axes of clutches K1, K2 and K3 are permanently connected with the gearing. W1 and W2 are permanently connected with the armatures of K1 and K2. The armatures of K1 and K2 control the tuning devices of the receiving apparatus, while the armature of K3 controls the switch earthing the antenna and the switch operating the heating current.

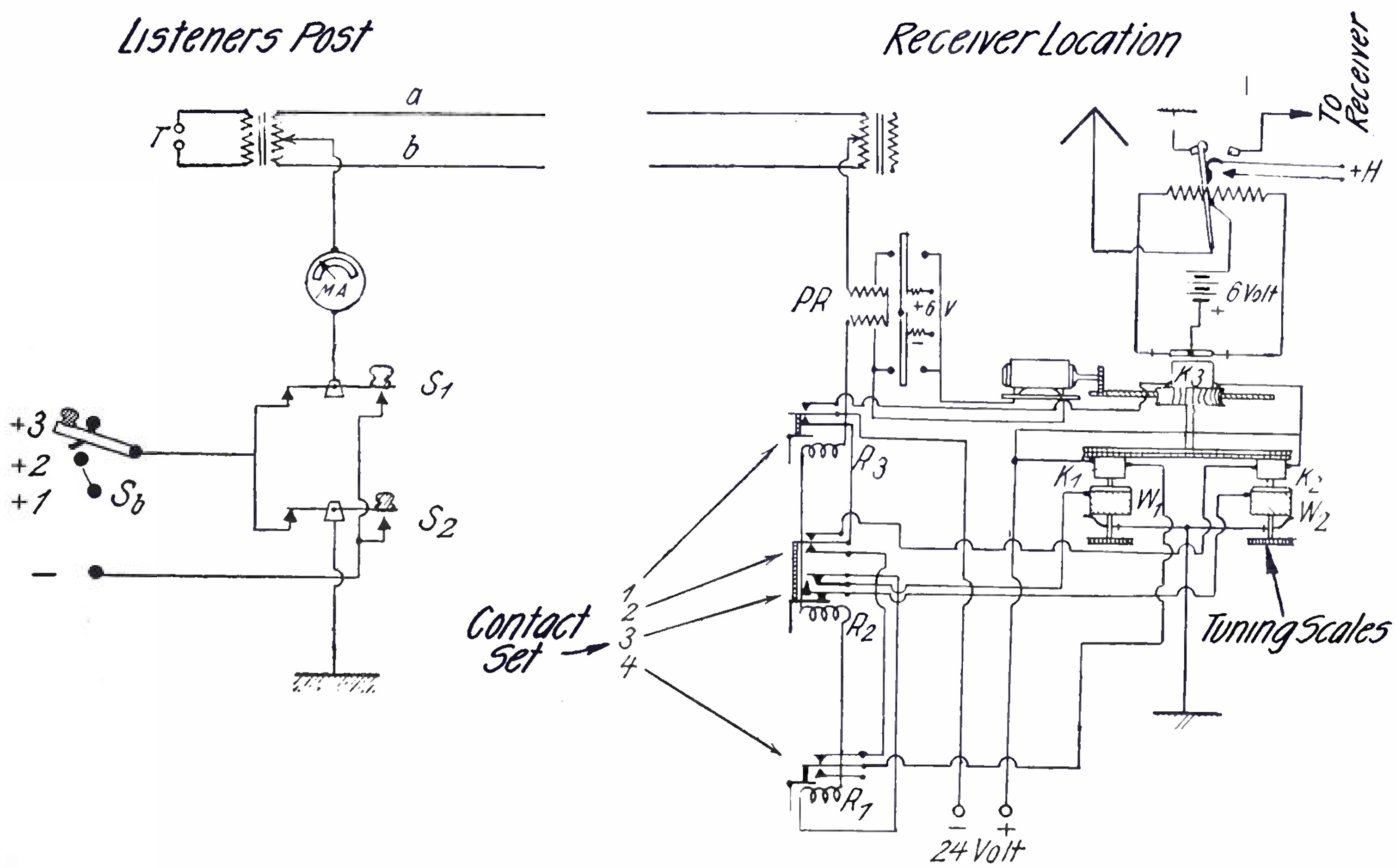
The electric motor is thus started clockwise or counter-clockwise according as the positive or negative pole of the battery from the listener's post is connected to the line leading to the place where the receiver is installed. When the three-pole switch Sb is making contact across contact *1*, a small voltage (15 volts) is applied to the line, which just suffices to operate the first relay magnet R1, which in turn connects the magnetic clutch K3 of the gearing with an axis operating the antenna and heating current switches. When the same three-pole switch Sb is making contact across *2*, the tension applied to the line will be 45 volts, which will cause a somewhat stronger relay magnet to be actuated at the remote end, thus disengaging the former smaller magnet and closing the magnetic clutch K2 with another axis operating the variable condenser. When, finally, the three-pole switch Sb is making contact across *3*, a third relay magnet is actuated by the slightly higher voltage (48 volts), thus connecting the second tuning device with the gearing. The motion of the rotary condenser is transmitted by a disc, which throws in variable amounts of the resistance, W1 and W2, as checked from the listener's post by a milliammeter.

An addition to the apparatus can be made for enabling even a set of spare valves to be taken into operation from the listener's post. This will practically exclude any risk of failure of the receiving set to operate properly.



A RECEIVER TUNED BY ELECTRIC IMPULSES

The receiving apparatus shown here is tuned and switched "on" and "off" at a distance of seven miles by electric impulses that come over a single telephone line. Note the clutches attached to the tuning knobs and switches.



THE CIRCUIT OF THE TELE-CONTROL SYSTEM

Figure 1: *All tuning and switching of the receiver is done by means of the three switches, S1, S2 and Sb, in conjunction with the milliammeter. The apparatus makes use of both the direction of the current flowing in a and b and its intensity.*

For the Modest Pocketbook—
The LC-28 Junior

The LC-28 Junior is built on the same chassis as the LC-28, and embodies the same high-quality principles as older set, but is constructed so as to be within the reach of the fan of limited means. The set embodies two stages of high-frequency amplification using screen grid valves, a crystal detector, and a complete low-frequency amplifier. This assures the builder of real LC-28 quality—at a considerably lower price than before.

By LAURENCE M. COCKADAY

THE development of the LC-28 Junior receiver was undertaken with a number of definite ends in view. First was the attainment of true quality in reproduction. The timely development of the new carborundum stabilizer detector "tube" and the use of high-grade transformers in the low-frequency amplifier adequately fill this requirement.

This new crystal detector is an excellent rectifier, as it is sensitive to weak signals and reproduces naturalness of tone. It is simply inserted in the detector socket in place of the standard vacuum valve.

A feature of this receiver is the use of the completely drilled sub-panel used in the original model of the LC-28 described in the October, 1927, issue of POPULAR RADIO. In the LC-28 Junior receiver both the high-frequency and low-frequency amplifiers are mounted on the one sub-panel. The power supply is the only external unit.

While there is one less stage of high-frequency amplification in this receiver than in the older model, the two screen grid valves utilized in the high-frequency amplifier more than compensate by the greater amplification per stage they provide.

As with the LC-28 screen grid receiver, a description of which appeared in the April, 1928, issue of POPULAR RADIO, the tuning units and shielding arrangements used in the original LC-28 receiver are again employed. The DC plate current of each screen grid valve is passed through a high-frequency choke. The primary of the coupling coils are left unused; the amplified voltage in the plate circuit of the preceding valve is impressed directly across the tuned secondary coil of the next valve through the medium of a small coupling condenser.

The screen grids are by-passed by the fixed condenser, H, to the filament circuit to prevent interstage coupling through the plate supply. The circuit diagram appears in Figure 4.

The construction of the receiver is simplified to such an extent that the set builder should be able to assemble and wire the receiver in one evening. The receiver when installed in the special console or cabinet made for it, presents an appearance in keeping with the highest priced manufactured sets.

The Construction of the Receiver

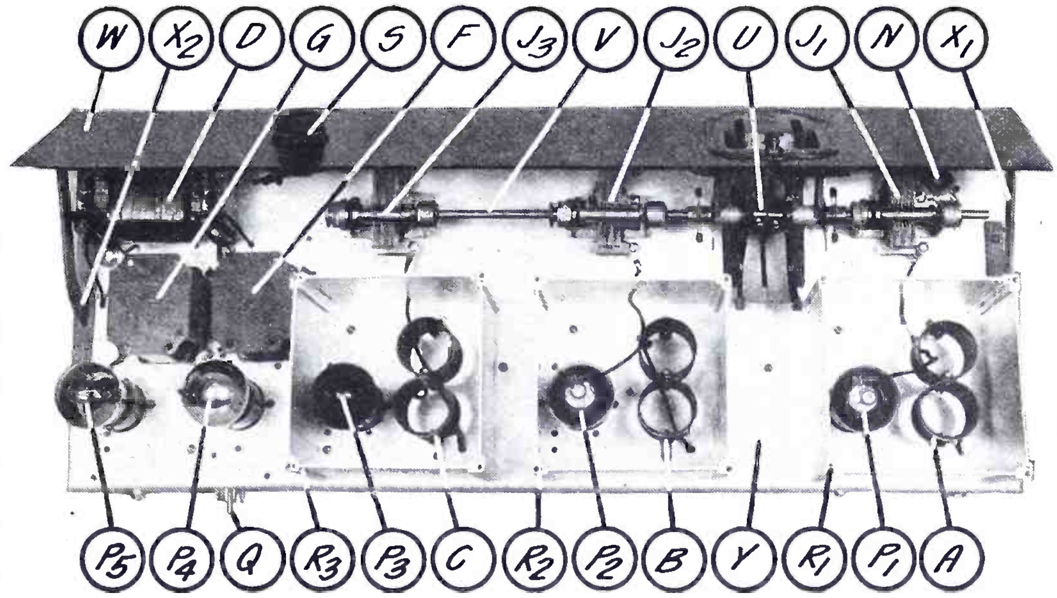
In building the receiver the same general constructional features should be followed as outlined for the original LC-28 receiver, a description of which appeared in the October, 1927, issue of POPULAR RADIO, except for the mechanical changes necessary for replacing the standard base type of socket for the sub-chassis type sockets, P1 to P5, and mounting the two stage low-frequency amplifier on the right-hand end of the sub-panel, Y, in the space formerly occupied by the detector box shield. Filament resistors O1 and O2 are ten ohms each and are mounted underneath the sub-panel, Y, as shown in Figure 5. The 1 mfd. by-pass condenser, H, is added to by-pass the high-frequency current from the screen grid to the filament circuit. In addition there is a 2 mfd. output filter condenser, I, which is mounted underneath the sub-panel, Y, as shown in Figure 5. The filament resistors, O3 and O4, are four ohms each, and are also mounted underneath the sub-panel. These resistor units control the filament voltage on the two low-frequency valves.

The coupling condensers, K1 and K2, have been decreased to .00005 mfd. capacity. These two instruments, as well as the by-pass condenser of .00025 mfd., L, are fastened underneath the sub-panel and are shown in Figure 5.

The equalizing condenser, N, is fastened to the stator connection of the first tuning condenser, J1. This equalizing condenser, N, is used to balance up the condenser, J1, so that its dial reading will be approximately the same as the dial reading of the other two condensers, J2 and J3. The combination

POPULAR RADIO WORK SHEET

The LC-28 Junior Receiver



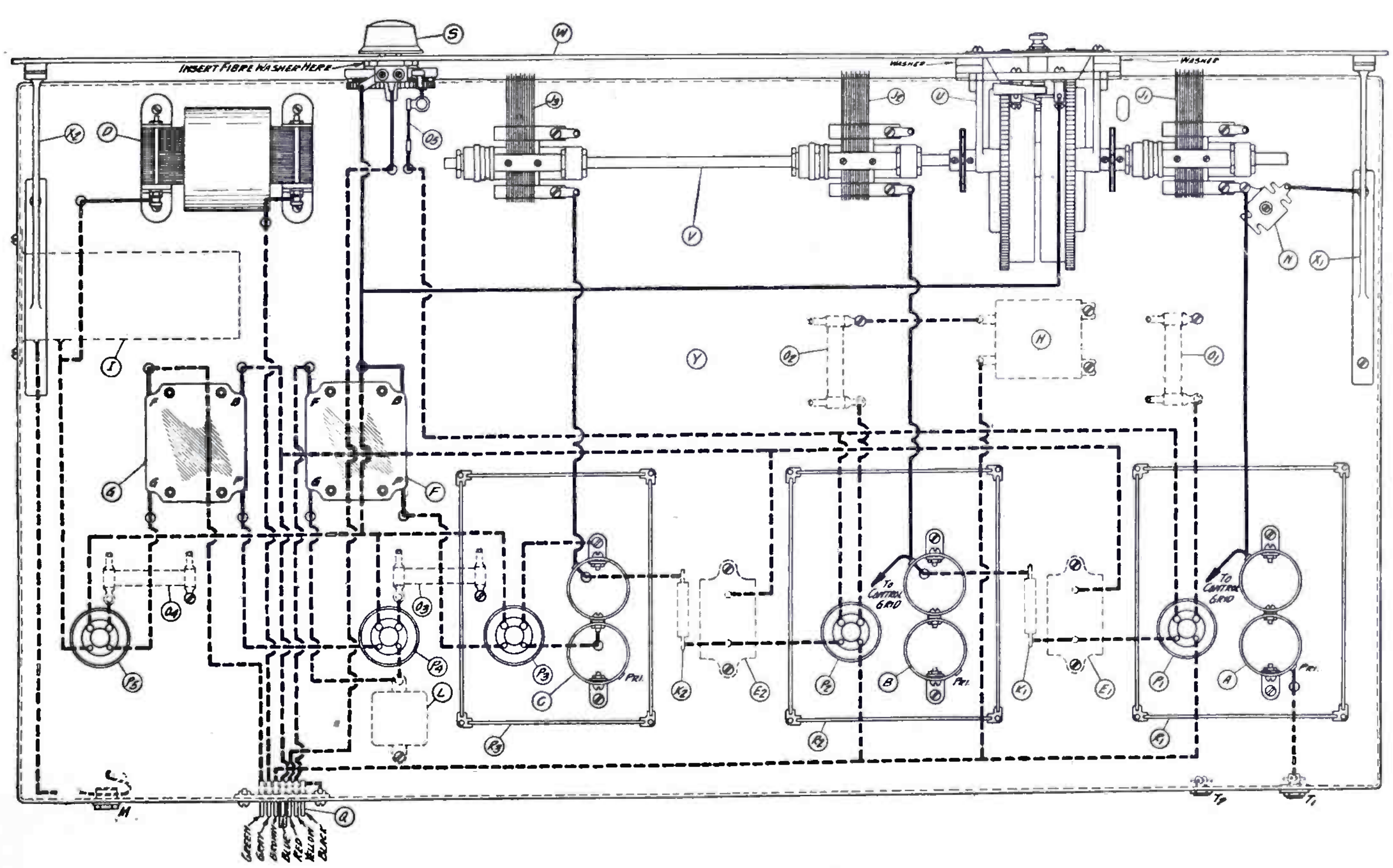
THE TOP VIEW OF THE SET

Figure 1: *This view show clearly the mounting positions for the instruments that comprise the low-frequency amplifier.*

List of Parts Used in Building This Receiver

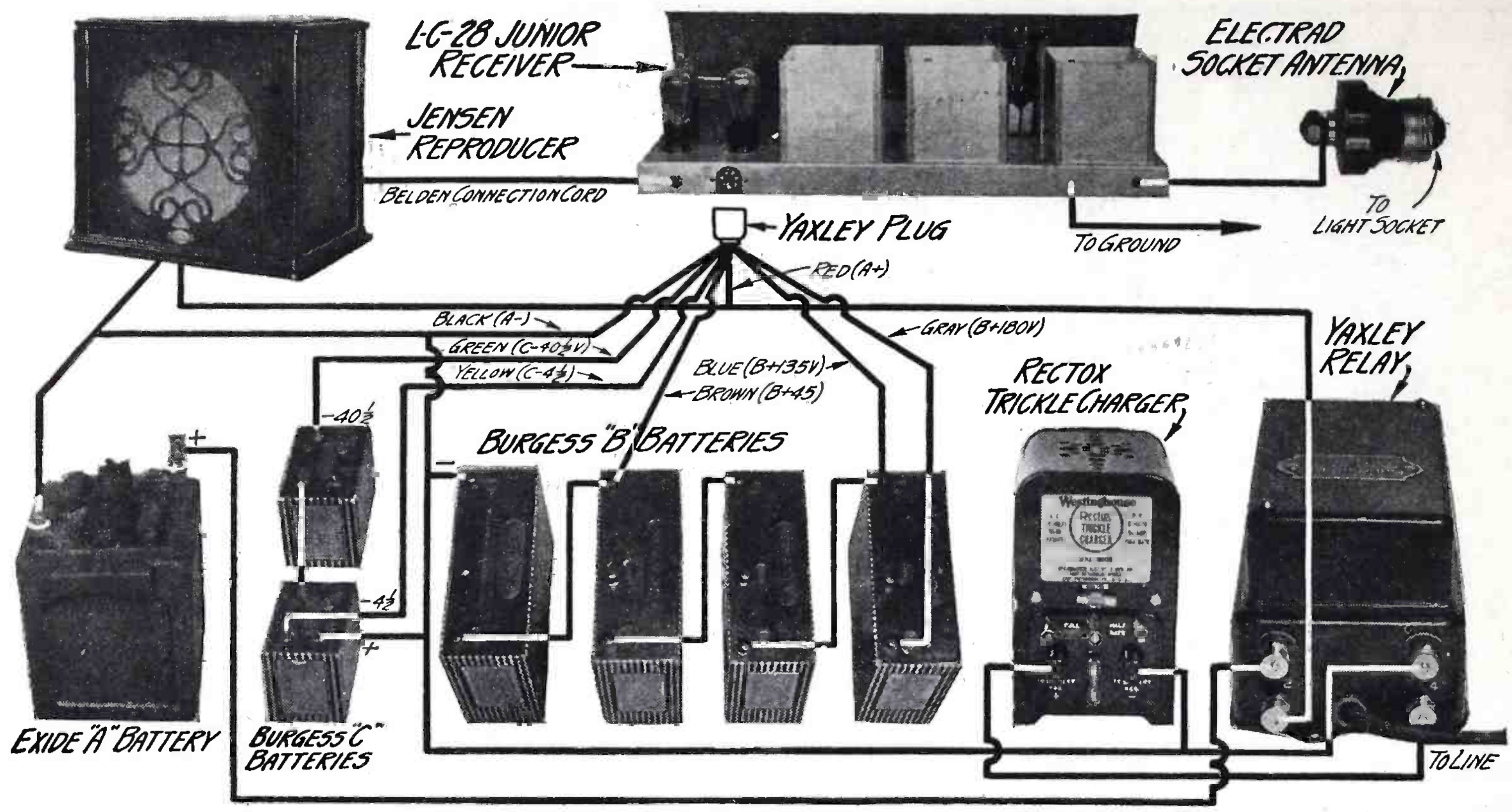
Cost of Parts—*Not over $98.00*

A, B, and C—Precision high-frequency transformers, type 4-B;
D—AmerChoke, type No. 854;
E1 and E2—Samson high-frequency chokes, type No. 125;
F—AmerTran DeLuxe 1st stage low-frequency transformer;
G—AmerTran DeLuxe 2nd stage low-frequency transformer;
H—Aerovox filter condenser, 1 mfd., type No. 200;
I—Aerovox filter condenser, 2 mfd., type No. 402;
J1 to J3—Hammarlund mid-line variable condensers, .000275 mfd.;
K1 and K2—Aerovox moulded condenser, .00005 mfd.;
L—Aerovox moulded condenser, .00025 mfd.;
M—Yaxley Junior jack, type No. 701;
N—Hammarlund equalizer;
O1 and O2—Aerovox wire wound resistances, 10 ohms, type 980;
O3 to O5—Aerovox wire wound resistances, 4 ohms, type 980;
P1 to P5—Eby UX sockets;
Q—Yaxley cable connector plug with cable, type No. 660;
R1 to R3—Special small size aluminum box shields for the LC-28 Junior, made by the Aluminum Company of America;
S—Yaxley combination switch and rheostat, 10 ohms, type No. 910-K;
T1 and T2—Carter Imp plugs and tip jacks marked "antenna" and "ground," respectively, with insulating washers for the antenna;
U—Hammarlund double drum dial;
V—Brass extension shaft, 10 inches long, 1/4 inch in diameter;
W—Aluminum panel, 6 by 26 inches, drilled and decorated, made by Wholesale Radio Service Company;
X1 and X2—Tait brackets;
Y—Aluminum chassis for the LC-28 Junior, made by the Aluminum Company of America;
Corwico Braidite hook-up wire, screws, nuts, etc.



THE WIRING DIAGRAM

Figure 2: *The wiring is shown in heavy* BLACK *lines, solid where it is done above the sub-panel, and dotted for wiring underneath.*



HOOKING UP THE LC-28

FIGURE 3: *This hook-up is entirely automatic in operation, being controlled by the switch on the receiver. The Yaxley relay controls both the charger and the field magnet of the Jenson speaker.*

switch and rheostat, S, is ten ohms. The four-ohm resistor, O5, is an additional fixed resistor connected in series with the rheostat, S, to the common filament circuit of the two high-frequency amplifier valves.

The set builder should refer to Figure 1 and note the positions for mounting the first and second low-frequency transformers, F and G, the choke coil, D, the five sockets, P1 to P5, and the single circuit jack, M.

This completes the constructional work on the receiver and the wiring is ready to be started.

How the Receiver is Wired

The complete wiring details will be found in the picture wiring diagram Figure 2. The set builder should follow these wiring instructions exactly. The wiring that is to run above the metal sub-panel, Y, is shown in heavy BLACK lines. The dotted BLACK lines indicate the wiring to be run below the sub-panel, Y.

This diagram carries out the theoretical circuit shown in Figure 4. In wiring this receiver, it is recommended that the set builder use insulated wire, such as Corwico Braidite hook-up wire.

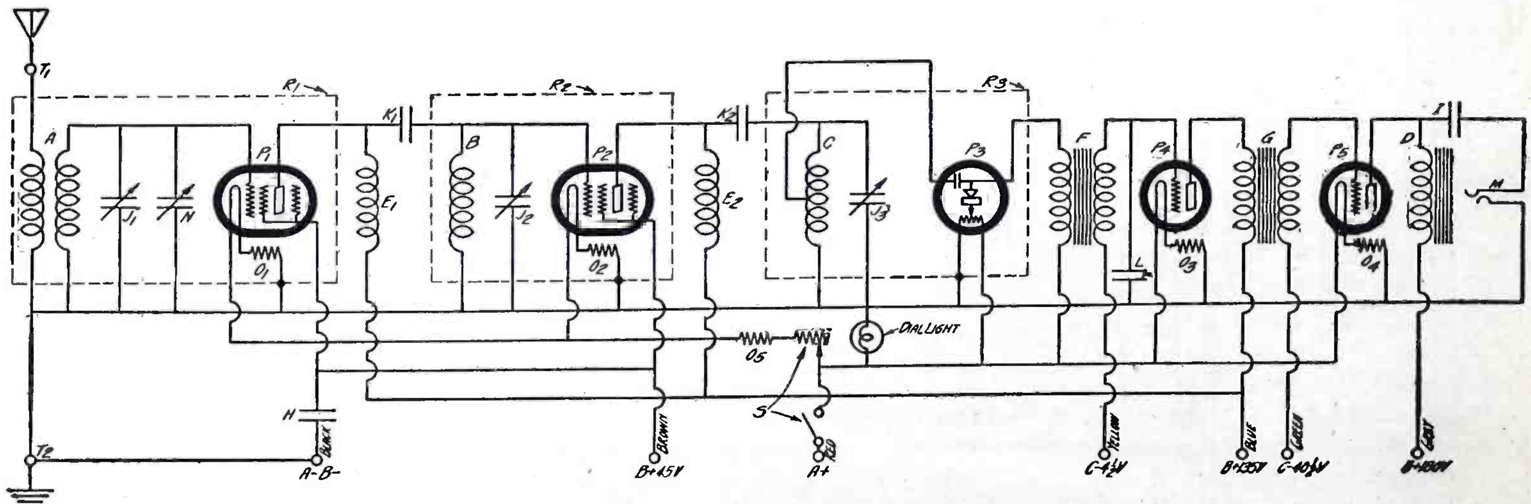
The connection to the control grid is made to the terminal at the top of the screen grid valve. Make this connection with a piece of hook-up wire. Loop and solder in a circle the end which is to slip over the terminal cap at the top of the screen grid valve as shown in the top view picture, Figure 1.

Re-check the wiring to be sure that no mistakes have been made. When this is done the receiver is ready for operation.

Operating Data for the LC-28 Junior

The LC-28 Junior may now be inserted in the top portion of the Corbett deck console. The Exide "A" battery, the Burgess "B" and "C" batteries, and the Yaxley automatic relay may then be inserted in the lower portion of the console. The Electrad light-socket antenna should then be attached to the tip jack T1. Of course an ordinary antenna may be used if desired; or a small antenna of a few feet may be

(*Continued on page 432*)



THE SCHEMATIC WIRING DIAGRAM

FIGURE 4: *Through the use of screen grid valves, only two stages of high-frequency amplification are necessary. The crystal detector and low-frequency amplifier are at the right. The latter employs standard transformer coupling.*

Synchronizing Television With Light Beams

Television's two great problems—speed sufficient for faithful reproduction of moving images, and proper synchronism of receiver with transmitter—are still awaiting a final and perfect solution. Proof that the challenge of these problems is not being declined is given in this article, which describes a method whereby synchronism is made automatic, being controlled by the light impulses of the received energy itself.

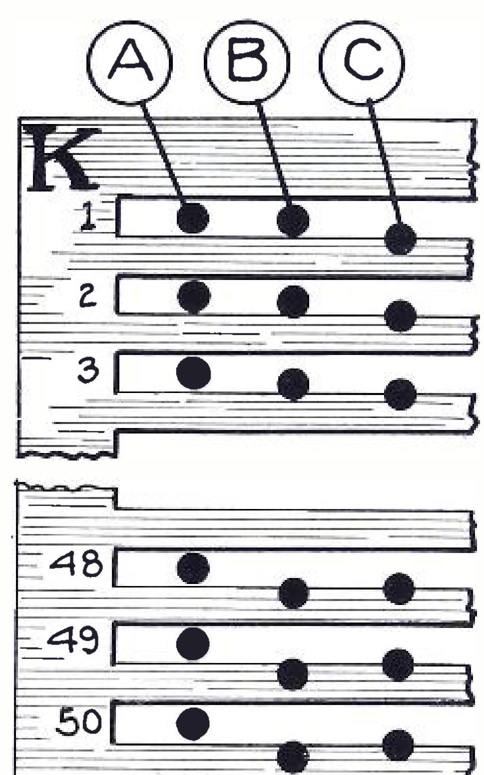
By PAUL L. CLARK

SENDING pictures by television may be likened to a military drill or maneuver having many lines of soldiers in regimental order, supervised by a single individual, the troops advancing as a single unit or as related units of the command, marching in step to rhythmic music. But what happens on the long turns, platoon formation? The line bulges a little in the center, recedes, advances, surges slightly and straightens out. It is largely a matter of alignment. Each man determines his position and speed by watching the rest of his outfit, and must be ever alert. So it is with the sending and receiving of pictures by apparatuses which are miles apart and yet which must keep in orderly arrangement the many parallel lines of shaded dots that make up the picture.

Experimenters on television term this aligning process "synchronizing," which means keeping the receiving set in step with the transmitter, so that the pictures will not bounce around the screen. You tune your radio set by *listening* to your loudspeaker; but only by *watching* the pictures on the small television screen is the experimenter given a clew to tuning his motor speed and framing the incoming pictures, the light flashes of which follow each other so fast that the eye fails to note a break in illumination. Once the picture is manually framed, no more attention to motor speed should be required, enabling the operator to control merely the brightness of the picture, letting synchronism take care of itself.

The experimental art has now arrived at the stage of sending 16 small pictures each second, each consisting of 50 lines having 50 shaded dots in each line, forming a picture which consists of 2,500 tiny areas, each of these areas being of a light or shade corresponding to one of the successive areas which compose an illuminated object such as the bust of a person seated in front of the transmitter, certain elements of the transmitter being driven by a motor at constant speed.

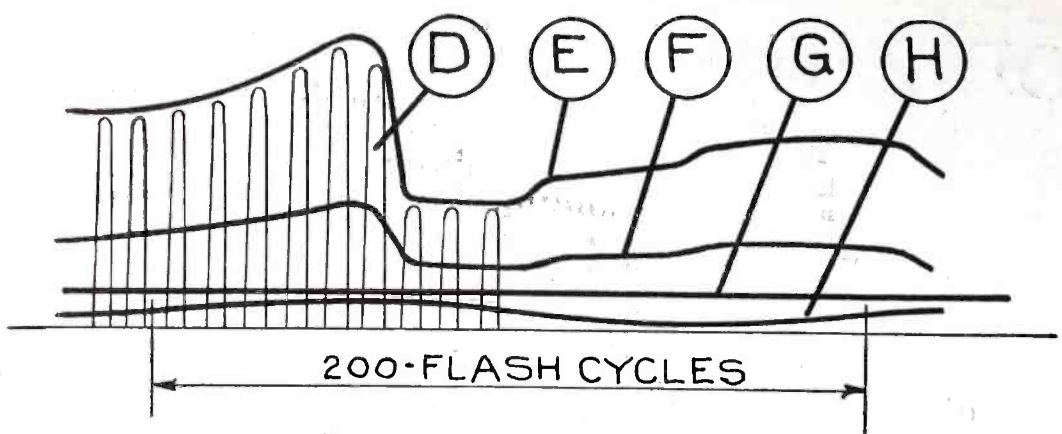
The receiver must have a motor which runs at the same speed as that in the transmitter. Motor speed is regulated by varying the electric current in the field coils of the motor, a strongly excited field slowing down the motor. The motor of the receiver of Figure 3, in addition to the regular shunt winding, is provided also with an extra coil, G, which is wound so as to weaken the field and speed up the motor when current is passed through the coil. This is the coil which automatically regulates the motor speed, being energized by current which is set up in the local photo-electric cell, F, by virtue of light rays falling upon the cell, as described below. The motor should be manually started and brought up to run at a speed about one per cent below the speed of the transmitter motor, it being assumed for the time being that there is no current in the reverse field coil so that the received picture tends to travel slowly backwards across the screen, thereby indicating motor underspeed. The speed-correcting system herein described is designed to speed up the motor automatically at least two per cent, so that the speed with the reverse coil full strength will be about one per cent too high. The effect of the underspeed and overspeed field control is such, when applied successively at intervals a fraction of a second apart, as to hold the picture quite steady, the automatic feature of this device being merely a simple form of photo-electric light valve governed by different degrees of stoppage of successive flashes of the received picture light, these flashes being swept in the form of a swinging beam rapidly across a stationary grid or "light-chopper," made up of bars and slits, as shown in Figures 1 and 3.



A MAGNIFIED VIEW OF THE LIGHT CHOPPER

FIGURE 1: *At A successive flashes from the neon lamp register with successive slits in the chopper, showing that the motor speed is too high. At B the flashes overlap the chopper bar, showing a speed drop from high to low. At C the flashes are intercepted by the bar, and half the light passes through the slits so as to fall on the photo-electric cell (F in Figure 3). This condition is the ideal interception of flashes to produce the least oscillation relative to synchronism.*

The action of this valve is such as to vary the quantity of light which falls upon the photo-electric cell, the light used for this purpose being about 10 per cent of the light in each signal flash emitted by the neon lamp, these flashes being produced by signals received from the transmitter at the dizzy rate of many



TYPICAL ENERGY CURVES

FIGURE 2: *At D are indicated the neon lamp flashes, 40,000 per second, is the total flash energy applied to delineate the image on the screen. F indicates the energy reflected by the small mirror (C in Figure 3) to fall upon the chopper. G indicates the maximum illumination required on the photo-electric cell to compensate for one per cent underspeed. H is the approximate synchronizing cycle made up of 200 flashes.*

thousands during each second. The cell is connected through an amplifier so as to supply energy to the pole-tip coil of the motor, so that bright light on the cell speeds the motor up; dim light slackens the speed; intermediate light flashes, as shown at C in Figure 1, falling upon the cell produce a neutralizing effect essential for accurate synchronizing.

The transmitter motor in Figure 3 drives the scanning disk consisting of 50 concave mirrors arranged at gradually increasing angles in the form of a spiral, so that as the scanner is rotated successive vertical lines of the illuminated image are traversed, point by point, by a single turn of the scanner; and all points of the image are successively changed into corresponding electrical currents by the photo-electric cell and sent to the receiver by a suitable broadcasting set or wire line. The chopper which is placed against the illuminated image is made of a glass plate, 3 inches square, on which are photographed 50 blackened bars each about as wide as a darning needle, alternating with transparent slits of equal width; so that as the scanning beam, SB, rapidly sweeps across the image, due to the rotation of the scanner, a series of lighted picture dots alternating with uniformly dark spots which are formed by the black chopper bars, is focused by the concave mirrors on the scanner, so that the light or shade of each illuminated picture area, alternating with the black chopper areas, falls upon the cell, producing therein a series of electrical currents derived from the bright picture areas, alternating with the electrical currents of extremely low and uniform energy, the latter impulses being derived from the low intensity of the light reflected by the dull surface of the black bars. The advantage of using a chopper in the transmitter is seen to lie in its ability to break up the picture into a large number of disconnected, equispaced areas or lines which, when swept by a pointed beam, give rise to a corresponding number of instantaneous successive current impulses in the photo-electric cell and in the circuit which supplies current to the cell. The number of these impulses which are produced and transmitted in a single second of time, is technically called the "picture point frequency," which we will assume to be 40,000 per second. Changing the series of instantaneous currents into an alternating current by means of a suitable transformer, we find that in each 1-40,000th second we have a complete electrical action or wave which is made up of two parts, one being the positive picture signal which may be either strong or weak, depending on the shade of the picture dot, the time during which this half-wave is formed being 1-80,000th of a second; the other half of the wave being the negative or low intensity chopper bar signal of constant value.

Now, it is evident that if we have a receiving scanning system similiar to that of the transmitter and run them both at the same speed, and if similar choppers are used, we will find that during each successive 1-80,000th second the focused scanning beams will simultaneously register: first, upon corresponding bars; second, through corresponding slits, in both apparatuses; so that when the beam is sweeping bar number 1 in the transmitter, the receiver beam is sweeping bar number 1 of the receiver; and 1-80,000th of a second later, the two beams will simultaneously sweep across slits number 2 of both pieces of apparatus. The above condition is that prevailing during exact synchronization, showing that the picture receiving set is perfectly timed. This idealistic assumption is, however, a little more than we can hope to obtain for periods of more than a few seconds. But we can attain a close registration by limiting the deviation to less than the width of a single slit, *i. e.*, a maximum error of cross-travel of less than one per cent, by providing a reasonable margin of excess energy in the motor-speed compensating circuit of the receiver. Too much cross-travel necessitates manual rephasing.

In order to obtain zero illumination on the cell, F, and consequently no current in the polarity reverse coil, G, throughout both halves of a given picture flash cycle during which cycle are transmitted a complete picture point luminous signal followed by a complete low energy black bar signal, it is evident that the luminous signal must have struck the chopper in such a way that it is entirely stopped by one of the chopper bars as shown at the lower part of the vertical series, B, in Figure 1, due to faulty synchronization resulting from overspeed; for it can be seen that for accurate synchronization the local scanning element should instantaneously be in such an angular position as to reflect the pointed conical beam emanating from the simultaneously produced neon lamp flash, so that the point of the beam shoots squarely against the edge of a corresponding slit of the chopper, as shown at C in Figure 1, at the exact middle of the 1-80,000th second during which the flash occurs. Darkness or bright light on the cell can persist only on account of continued overspeed or underspeed which produce respectively a slightly advanced or retarded scanning element.

As we have assumed the motor to be normally, say, one per cent underspeeded, it will start to slow down from true synchronous speed until it reaches a speed which is one per cent too low, *provided there is no energy supplied to the speed-up coil*, and will backwardly deflect the signal flash beams so that some of them instantaneously pass squarely through the slits as shown at A in Figure 1. This illuminates the cell with full light and excites the speed-up coil with maximum energy, causing the motor and scanner to advance the reflected signal beams a slight degree *ahead* of registration, until light is again shut off from the cell so that the cell circuit ceases to supply excitation to the coil, G, and another drop in speed occurs. This alternate speed-up and slow-down period may be called a "synchronizing cycle." The receiver motor is of about 1-30th h.p., 960 r.p.m., with regulation

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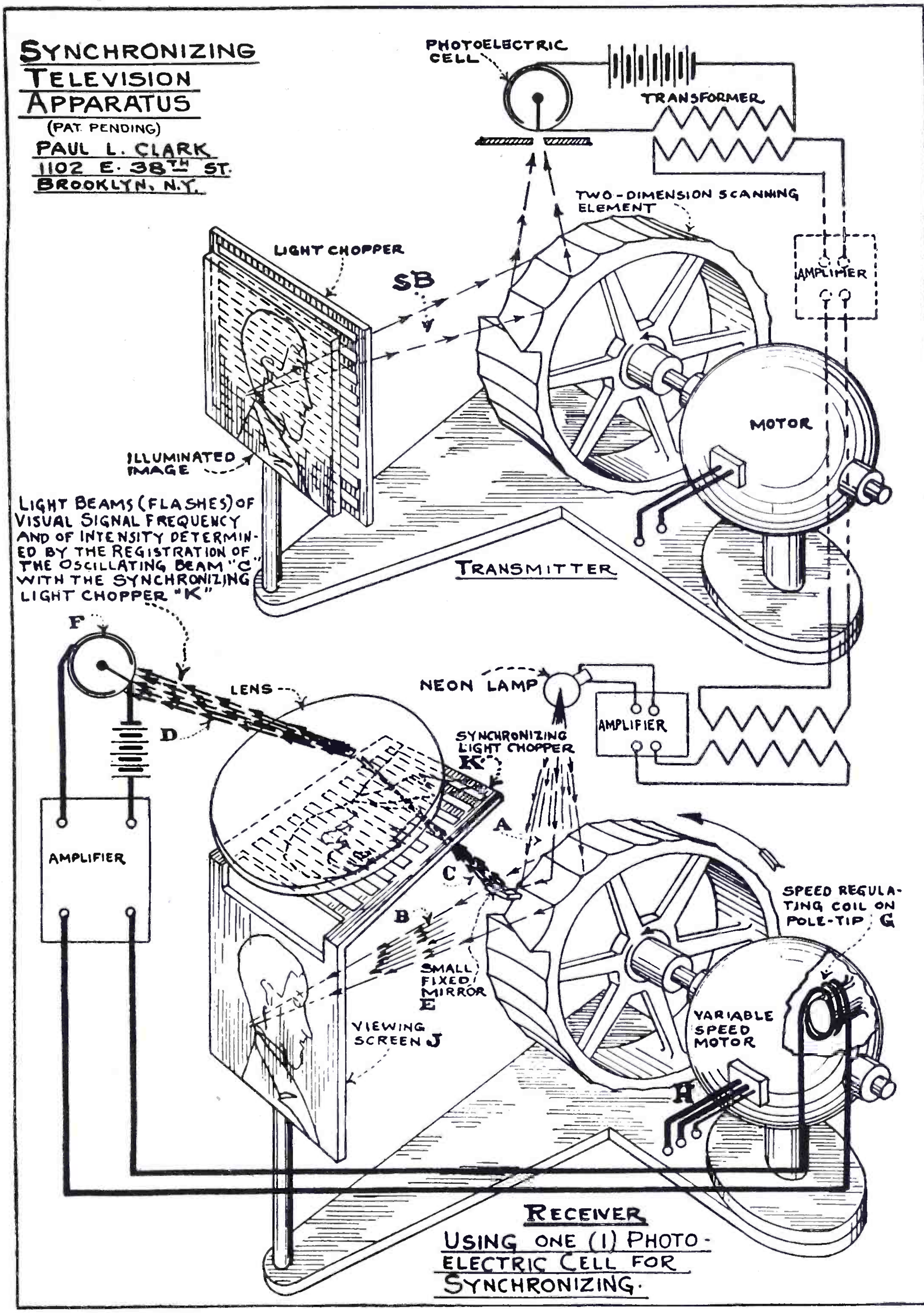


HOW AUTOMATIC SYNCHRONISM IS ACCOMPLISHED

FIGURE 3: *The use of "light choppers" of similar dimensions in the transmitter and receiver is the key to Mr. Clark's solution of the synchronization problem, shown diagrammatically above. The transmitting scanning element scans the image through a light chopper; hence it delivers to the photo-electric cell series of light lines alternating with dark lines caused by the bars of the chopper. At the receiver part of the light energy of the neon lamp is reflected by a small mirror through another light chopper to a photo-electric cell whose output controls a speed regulator on the receiver scanning device motor. It is the registration of the light and dark flashes on the second photo-electric cell that is used to bring about proper synchrony.*

POPULAR RADIO WORK SHEET

The AC Victoreen Superheterodyne

List of Parts Used in Building This Receiver

Cost of Parts—*Not over $139*

A—Victoreen antenna coupler, No. 160;
B—Victoreen coupling unit, No. 150;
C1 to C4—Victoreen high-frequency transformers, No. 170;
D1 and D2—Victoreen variable condensers, .0005 mfd., comprising the Victoreen master control unit, type VU;
E1 to E4—Benjamin 5-prong sockets, type No. 9036;
E5 to E8—Benjamin Cle-ra-tone sockets, type No. 9040;
F—Victoreen filament lighting transformer, No. 326;
G1 and G2—Victoreen low-frequency transformers, comprising the Victoreen 112 unit;
H—Victoreen rheostat, ½ ohm;
I—Victoreen potentiometer, 30 ohms;
J—Victoreen potentiometer, 400 ohms;
K—Yaxley double-pole, double-throw jack switch, type 760;
L and M—Victoreen switch, type 333, and plug unit;
N1 and N2—Aerovox moulded condensers, .0005 mfd., with clips for grid-leak mounting;
O1 and O2—Durham metallized resistors, 2 megohms;

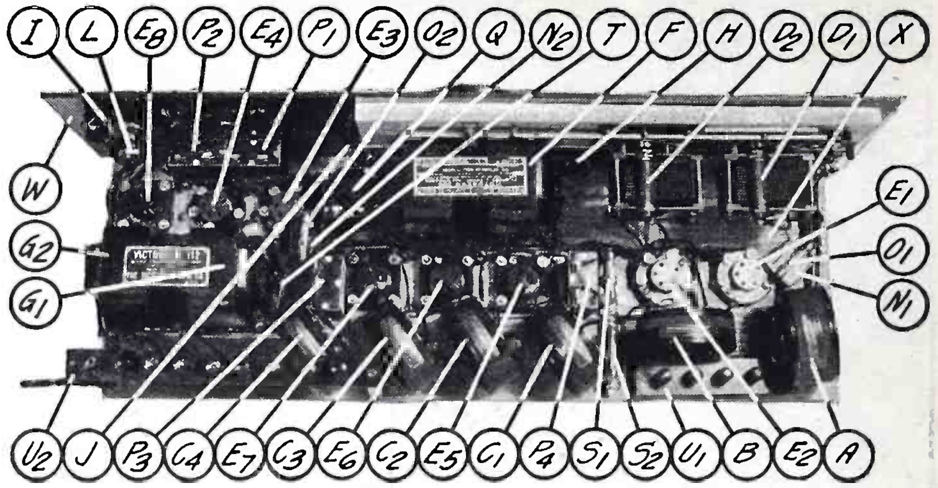
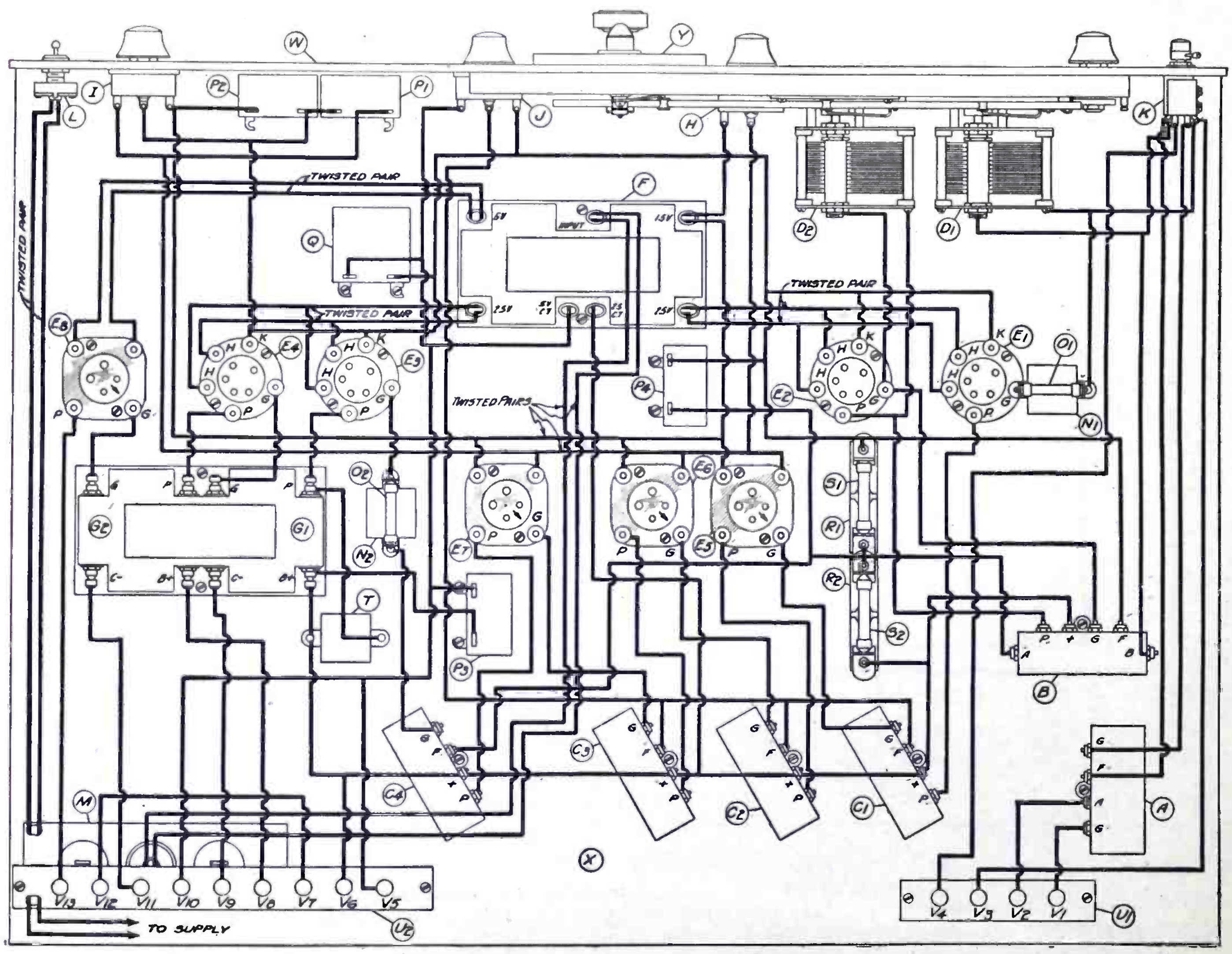


FIGURE 1: THE TOP VIEW OF THE SET

P1 to P4—Acme Parvolt by-pass condensers, 1 mfd., Series A;
Q—Acme Parvolt by-pass condenser, 2 mfd., Series A;
R1 and R2—Lynch single-resistance mountings;
S1—Durham metallized resistor, .05 megohm;
S2—Durham metallized resistor, .25 megohm;
T—Aerovox moulded condenser, .005 mfd.;
U1—Bakelite binding post strip, 1¼ by 5 by 3/16 inch;
U2—Bakelite binding post strip, 1 by 9¾ by 3/16 inch;
V1 to V13—Binding posts;
W—Bakelite front panel, 7 by 26 by 3/16 inch;
X—Wooden baseboard, 9½ by 25 by ½ inch;
Y—Marco Vernier Dial, type No. 192.
Wires, screws, brackets for mounting binding post strips, solder, etc.



THE WIRING OF THE SET

Figure 2: *All the wiring is done above the baseboard, and is shown in heavy black lines. The instruments are outlined in light black lines.*

The Victoreen Socket "Super"

The Victoreen AC superheterodyne combines the qualities that have made this circuit nationally popular with the advantages of operation from the AC lighting lines. Here are the constructional details for the new model.

By P. R. LECKY

TO the average home builder and even to the more experienced professional set builder the superheterodyne is always of intense interest. Probably one of the best examples of the successful "super" construction is the well-known Victoreen. In keeping with the general trend of the elimination of batteries the new AC Victoreen incorporates the best practices of the radio art. This is accomplished without loss of the distance-getting propensities for which this set is famed.

It also has the added advantage of either loop or antenna operation by means of a convenient switch. This feature is especially desirable with the approach of summer, for while the loop is not a cure-all for static, it may certainly be used to advantage in helping to reduce this condition.

Especially noteworthy is the fact that the Victoreen high-frequency transformers are adjusted at the factory to a precision within one-third of 1 per cent, which tends toward selectivity. Internal adjustments, also factory-made, discourage interstage oscillation, which permits the potentiometer to be used as a volume control and not as a losser.

A long aerial is not necessary with this set; in fact, one that is 50 feet long is ample, for any length greater than this brings in much unwanted interference and undesirable noise.

How to Mount the Instruments

In the building and wiring of the Victoreen superheterodyne our first care is the preparation of the baseboard. This baseboard should be sandpapered and stained. After the baseboard is dry we may lay the template, which is supplied by the manufacturer of the kit, in position and punch mark the crosses which designate the location of the mounting screws for the various instruments.

Now mount the sockets, E1, E2, E3, E4, E5, E6, E7 and E8, after making sure that they have the necessary lugs attached. Fixed condensers N1 and N2 should then be fastened to sockets E1 and E3, respectively. The condensers, P1, P2, P3, P4, and Q, should then be placed in position. Follow this by locating the grid-leak mountings, R1 and R2, and fastening them down. The antenna coupler, A, and the oscillator coil, B together with the intermediate transformers, C1, C2, C3 and C4, should then be fastened down. The low-frequency transformer unit, G1 and G2, which is a single unit, should then be screwed in position after fastening the necessary lugs in place. The Victoreen transformer, F, and the Victoreen switch and plug unit, M, should be omitted at this time to facilitate the wiring. The antenna or loop binding post strip, U1, should be fastened in position with lugs under the nuts of the binding posts. Figure 1 shows the position of the parts.

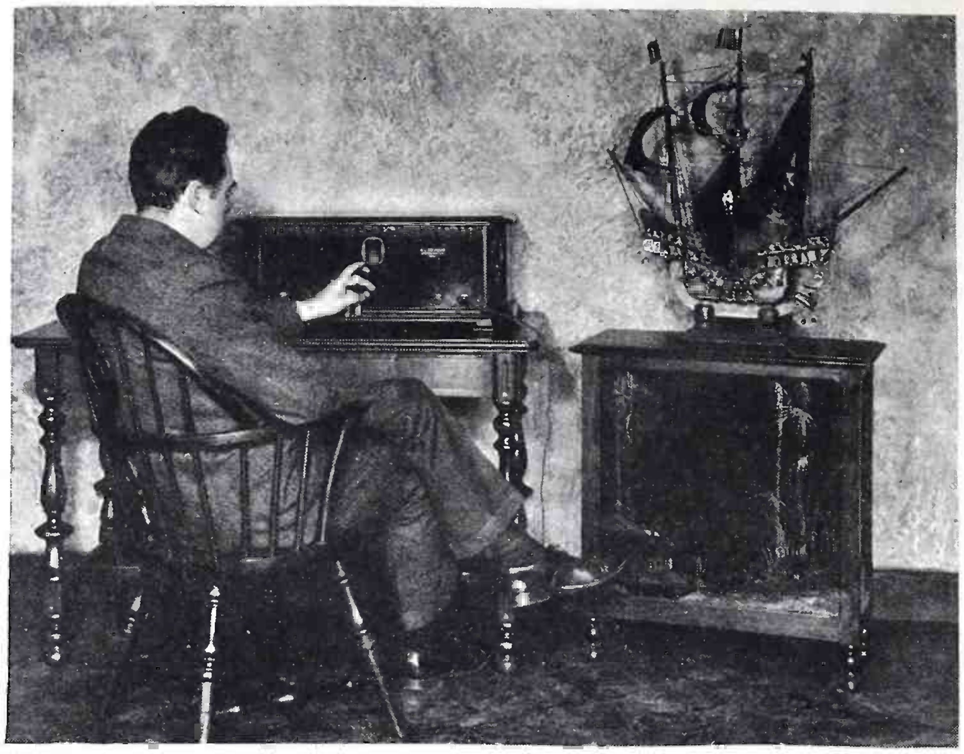
We may now assemble the front panel. The Victoreen master control unit containing variable condensers D1 and D2 should be first mounted, followed by the ½-ohm, H, the 400-ohm potentiometer, J, and the 30-ohm potentiometer, I. The lugs should now be placed on these various instruments and it might be well to tin them to facilitate the wiring later on. The switch, K, should be mounted in position beneath the Victoreen master control unit and the lugs should be bent to widen the space necessary for ease of soldering.

The knobs may now be put in position and the Marco dial template should now be mounted according to the instructions that come with it. The switch, L, should not be used at this time. The panel should then be laid aside for the present.

Wiring the Victoreen AC Set

Figure 2 shows the complete wiring of the receiver. Commencing with terminal K of socket E1, run a wire to terminal K of socket E2, thence to the terminal nearest the front panel of the grid-leak mounting R1. Continue this wire to one terminal of condenser P4, then to one terminal of condenser Q. From this same terminal of condenser Q, run a wire to terminal K of socket E3, and from there to terminal K of socket E4. This wire continues to condensers P1 and P2, and fastens to both of the right-hand terminals of these two condensers. The filament of the three intermediate sockets, E5, E6 and E7, should then be wired up. It will be noted that beneath the left-hand terminal, F, of socket E5 there are two lugs. One of these lugs will be used for wiring the filament circuit, so a wire should be run from the left terminal, F, of socket E5 to the left-hand terminal of socket E6, from there to the left-hand terminal of socket E7, and from there to the left terminal of condenser P2. A lead approximately seven inches long should be left on the terminal of P2. Connecting a wire to the right-

(*Continued on page 428*)



Screen Grid Quality in a Low-Priced Receiver

The Harkness Screen Grid "5"

The high-quality reception made possible by screen grid valve amplification is now available in an extremely low-priced set, due to the perfection of the Harkness Screen Grid "5" receiver. Actual practice has proved the excellence of this receiver, and its low price and easy construction are sure to make its popularity nationwide.

By JOHN R. HUGHES

THE intense interest which greeted the introduction of the screen grid valve has been fully justified by the reports which have followed its use. Its relatively high amplification factor gave promise of great sensitivity and distance possibilities. Since the advent of this valve engineers throughout the country have been working on various circuits with the idea of evolving something simple and easy to build, at the same time combining the present-day requisites of a radio set, namely, quality and sensitivity. As the result of considerable laboratory endeavor Mr. Kenneth Harkness has evolved the Harkness Screen Grid "5" receiver.

The fact that this set may be built in less than three hours, because of the ease of assembly and simplicity of wiring, holds an especial appeal for the home builder who is not as experienced as the professional set builder. Perhaps the biggest advantage is the consideration of price, which is much lower than many five-valve sets upon the market at the present time.

Probably the most distinctive feature of this new circuit is the method of controlling oscillation and volume of the screen grid valves. The two screening grids are attached to the center arm of a 500,000 ohm potentiometer, which is connected across 45 volts positive (+) and "B" negative (—). By means of this high resistance voltage divider the potential of the screening grids of both valves can be varied from zero to 45 volts (+). At zero potential the receiver is practically "dead." Signals from the strongest local stations become inaudible. However, as the potential on the screen grid is increased the volume correspondingly increases until at a position very closely approaching the full 45 volts the set becomes extremely sensitive and a little beyond this point a condition of oscillation may be brought about.

Another important feature of the circuit is the method of interstage high-frequency coupling which is responsible for the sharp selectivity of the set without appreciable sacrifice of sensitivity. Hitherto most of the screen grid sets have used the tuned plate method of coupling or a standard tuned-high-frequency circuit with special 1 to 1 ratio high-frequency transformers. These circuits have been necessary because of the high plate impedance of the screen grid valve and an appreciable amplification gain could only be obtained by an external plate circuit impedance that closely approached the impedance of the valve plate impedance itself.

In the earlier tuned plate circuits the selectivity was not all that could be desired. However, in the Harkness circuit neither of the above methods is used. Instead, a high impedance high-frequency choke is connected in the plate circuit of each screen grid valve and the plate is *capacitively* coupled to the screen grid circuit of the succeeding valve. In this manner the high external plate impedance of each screen grid valve is obtained and a very large high-frequency gain is obtainable, but sharp selectivity is secured by the tuned grid circuits and the capacitive interstage

POPULAR RADIO WORK SHEET

THE HARKNESS SCREEN GRID "5"

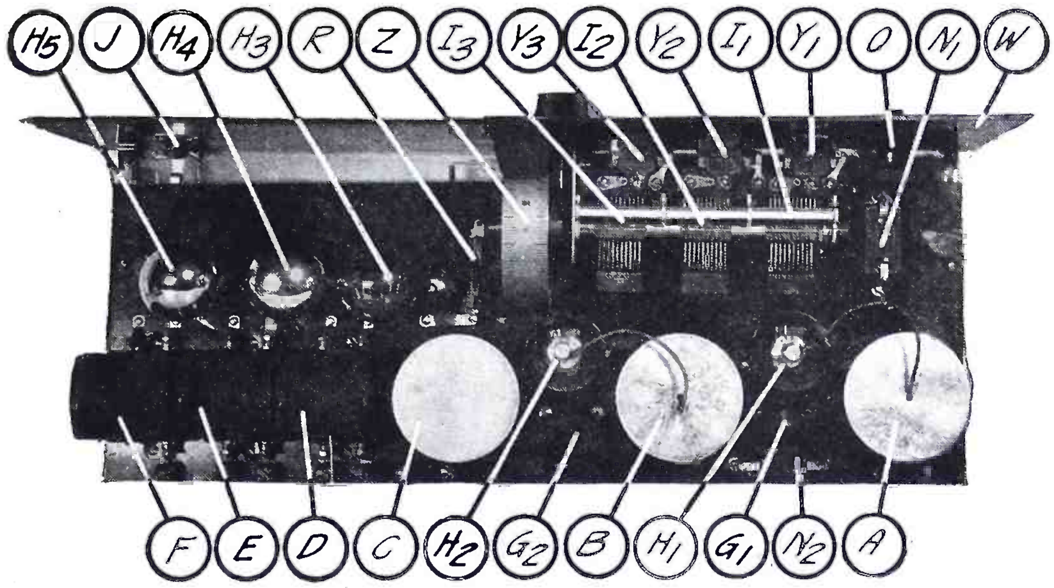


FIGURE 1: THE TOP VIEW

LIST OF PARTS USED IN BUILDING THIS RECEIVER

COST OF PARTS—*Not over $56.00*

A, B, C—Harkness high-frequency transformers, types SG-1, SG-2 and SG-3;
A1, B1 and C1—Harkness aluminum coil shields;
D and E—Harkness low-frequency transformers, type T-500;
F—Harkness output filter unit;
G1 and G2—Harkness high-frequency chokes, type R-85;
H1, H2, H3, H4 and H5—Eby UX sockets;
I1, I2 and I3—U. S. L. 3-gang variable condensers, .00035 mfd. capacity in each section;
J—Carter short jack, type No. 1;
K—Aerovox moulded condenser, .0001 mfd.;
L—Aerovox moulded condenser, .00025 mfd.;
M—Aerovox moulded condenser, .001 mfd.;
N1 and N2—Aerovox by-pass condensers, .5 mfd., type 250;
O—Carter Imp battery switch;
P—Carter fixed resistors, 10 ohms, type H-10;
Q—Carter fixed resistor, 1 ohm, type H-1;
R—Aerovox grid-leak mounting equipped with Aerovox grid-leak, 2 megohms;
S—Binding posts;
T—Carter potentiometer, 500,000 ohms, type 55;
U—Aerovox moulded condenser, .00025 mfd.;
V1 and V2—Harkness one inch sub-panel bracket;
W—Bakelite drilled and engraved front panel, 21 by 7 by 3/16 inch;
X—Bakelite drilled sub-panel, 20 by 7 by 3/16 inch;
Y1, Y2, Y3—Hammarlund equalizers;
Z—Silver-Marshall drum dial;
Corwico Braidite hook-up wire, screws, nuts, clips for control grid connectors, etc.

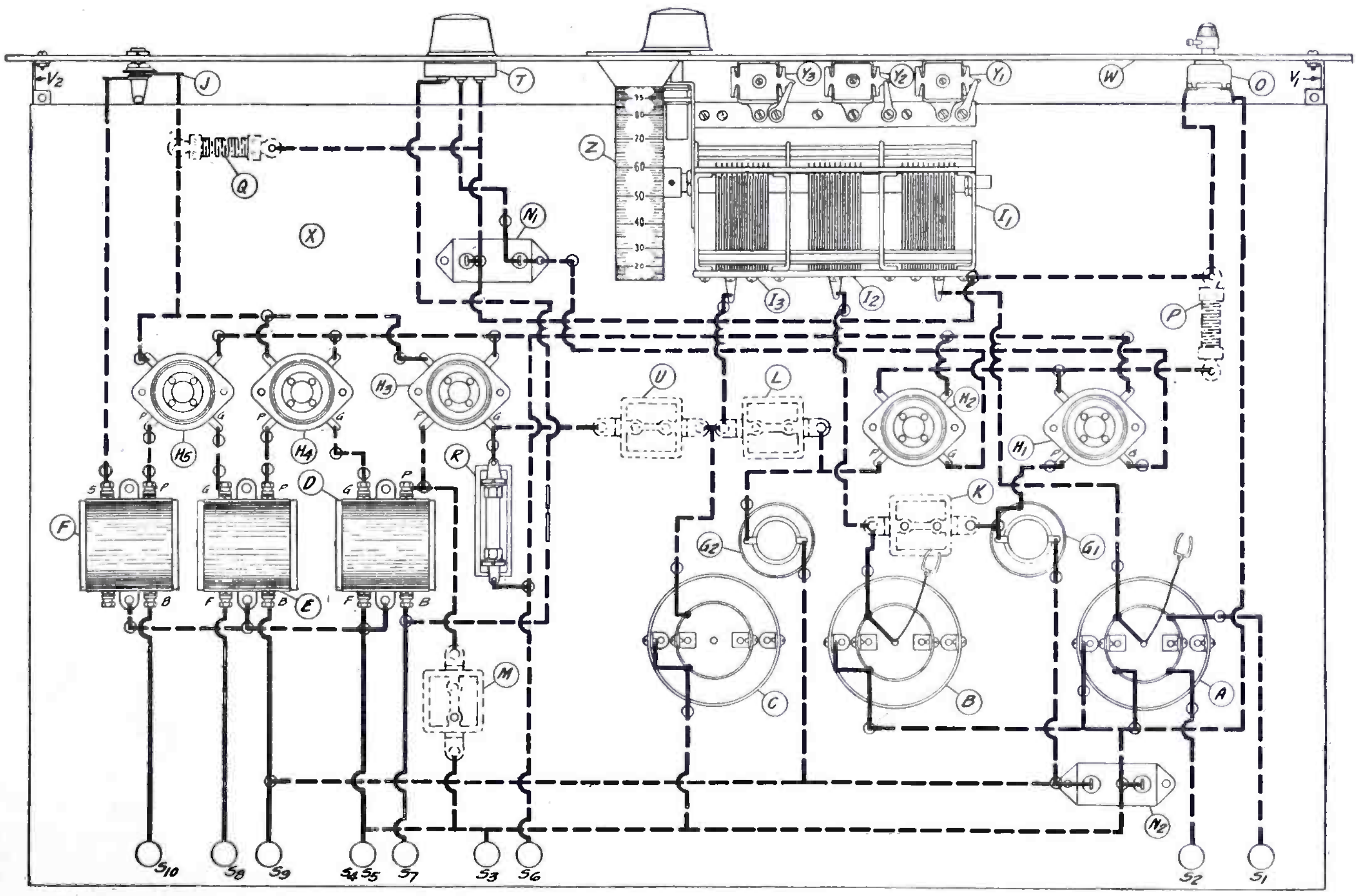
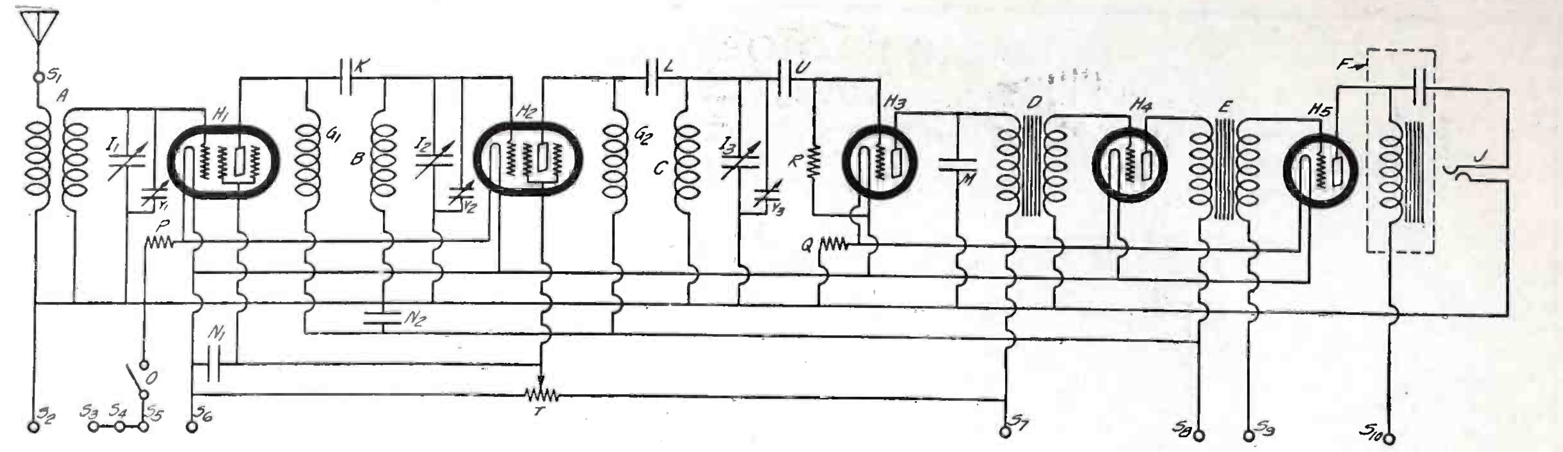


FIGURE 2: HOW TO WIRE THE RECEIVER



THE SCHEMATIC WIRING DIAGRAM

FIGURE 3: *Note the impedance coupling employed in conjunction with the screen grid valves in the high-frequency amplifier. The low-frequency amplifier is of standard transformer-coupled design.*

coupling. Figure 3 gives the circuit of the receiver.

Special aluminum shields are used to prevent magnetic coupling between the three tuned grid circuits, while other sources of undesired feed-back are eliminated by the use of the two ½ mfd. condensers, N1 and N2.

There is the added advantage in this set of being able to use either batteries or socket power.

Assembly

Figure 1 shows the location of the various parts used in this set. The only parts under the sub-panel are the one-ohm and ten-ohm fixed resistances, Q and P, and the small fixed condensers. Most of these condensers are held in place by the wiring. The high-frequency coils, A and B, are mounted on top of the sub-panel inside the shields. Lugs that are attached to these coils pass through holes in the sub-panel so that the wiring may be performed underneath. The second and third high-frequency coils are exactly alike. They have no primary winding and only two terminals each. The first high-frequency coil includes a primary winding and this coil has four terminals. A precaution should be noted at this point. Make sure to thread the flexible leads attached to the first and second coils through the holes in the tops of the shields, then solder the grid terminal clips to the ends of these two leads. The clips are connected to the control grid terminals of the screen grid valves of the set.

The picture wiring diagram, Figure 2, very clearly shows the necessary wiring and connections to the various terminals. This is not a lengthy procedure but care should be exercised in following the diagram exactly as shown. All wiring is shown in heavy black lines.

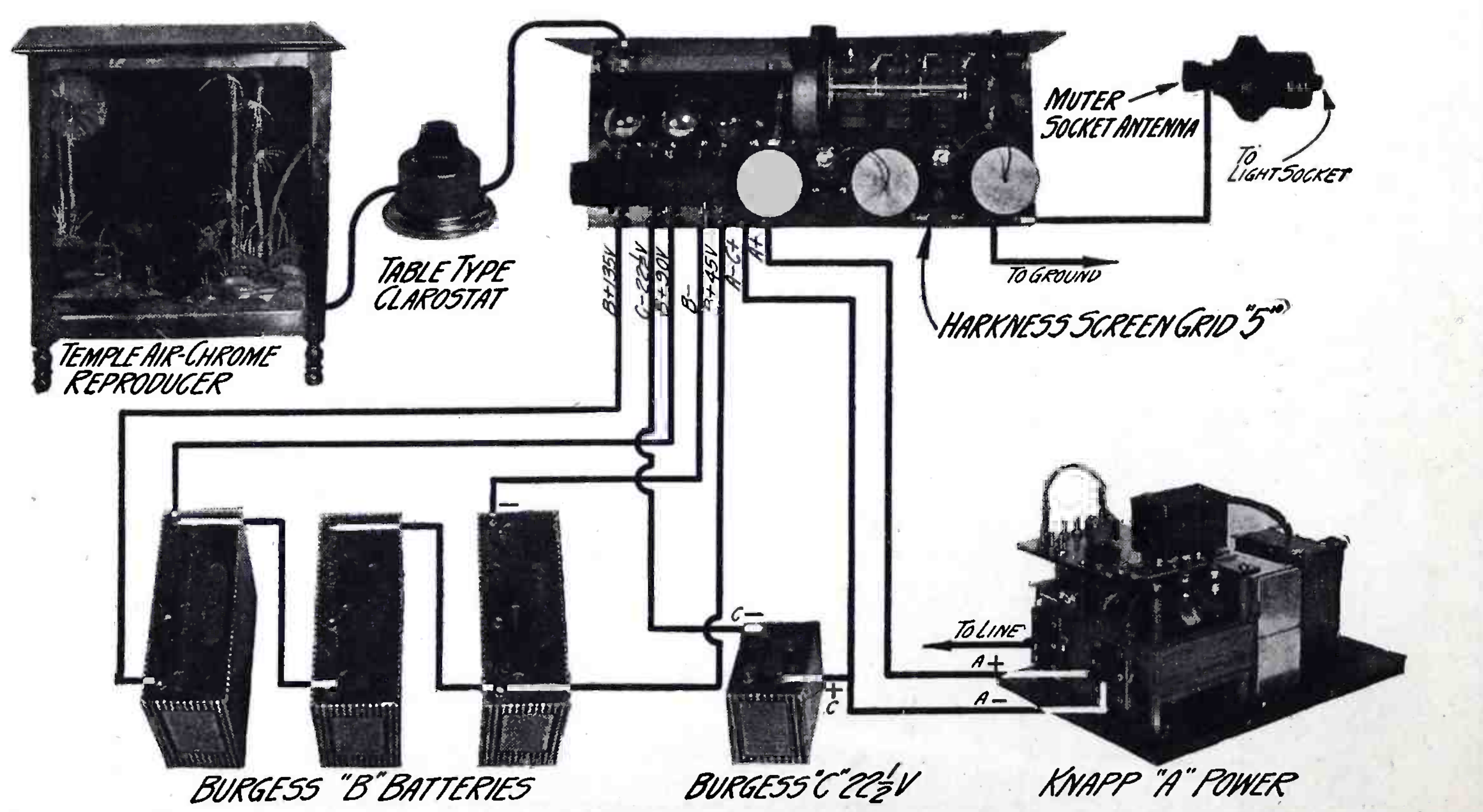
Hints on Operation

After the set has been completely wired it may be installed in a Corbett Cabinet, model C, 7 by 21 by 12 inches.

In the instance where "B" batteries are employed a 112 type valve should be used in the last stage of the receiver with a 12-volt "C" battery. If a 180-volt National "B" power-pack is used a Ceco J-71 tube may be used in the last stage with a 40-volt "C" battery.

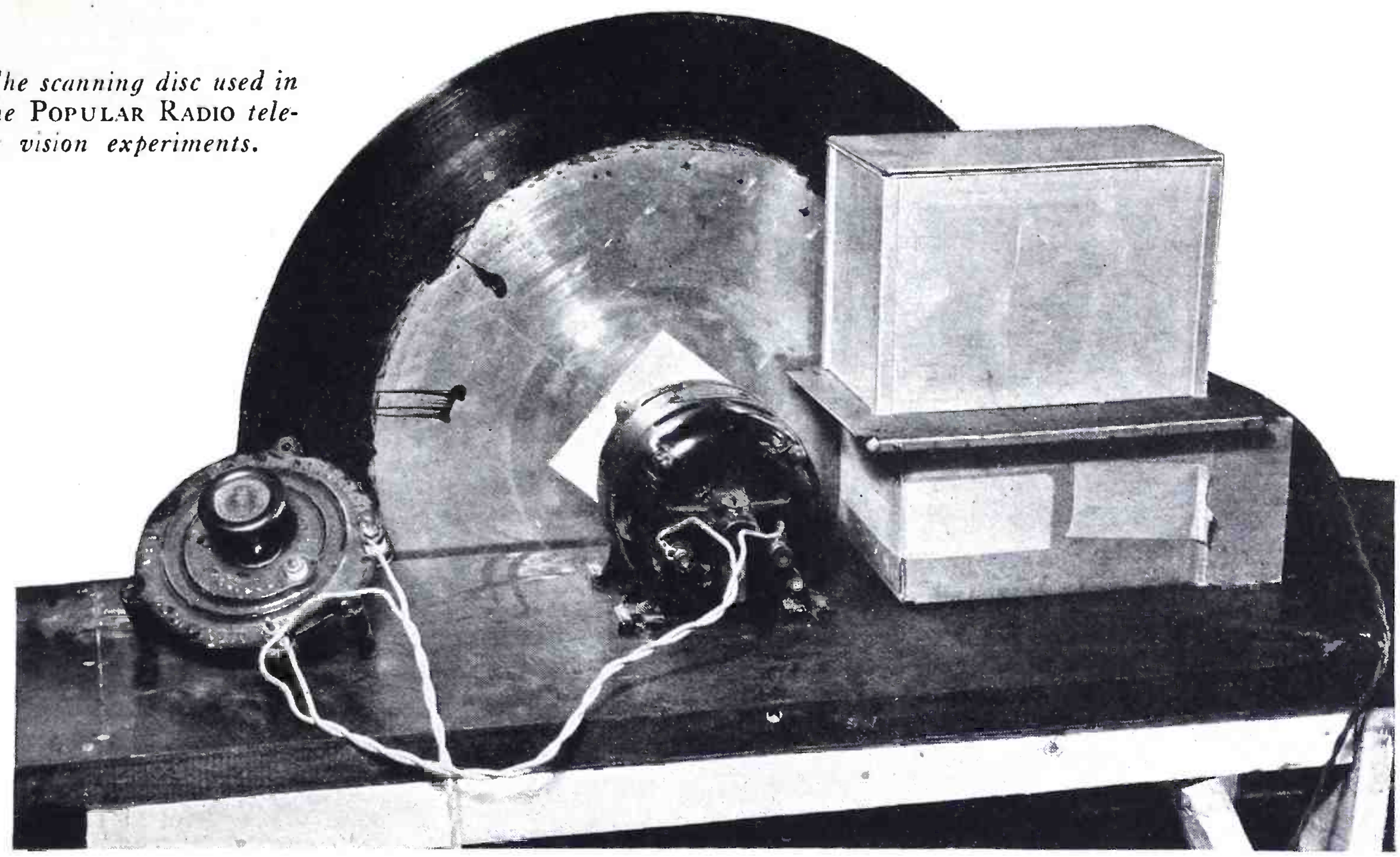
After the batteries or power-pack have been connected to the set and the proper connections made to the an-

(*Continued on page 432*)



THE OPERATING HOOK-UP

FIGURE 4: *Note the table type Clarostat in this hook-up. By means of such a device the volume of the receiver may be controlled from a distance. The proper operating connections are shown in black lines.*



The scanning disc used in the POPULAR RADIO *television experiments.*

SCANNING DEVICES

What They Do *and* How to Make Them

The scanning device may be considered the nerve center of any television system, for it acts as a means of directing and disposing of the light impulses that make up the transmitted image. With reasonable care the home experimenter may construct a simple scanning disc which will satisfy all the needs of home experiments in this fascinating new art.

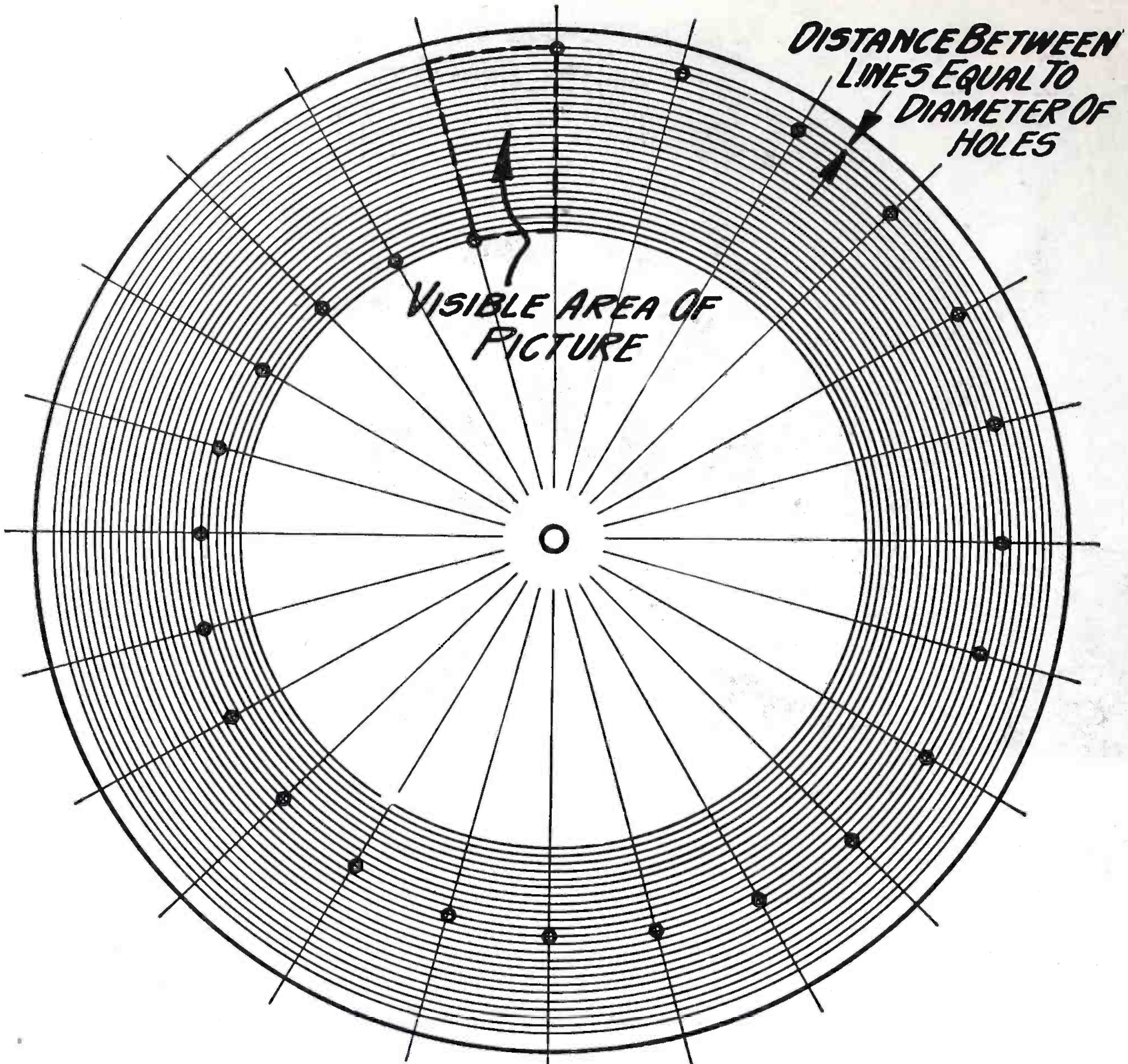
By IRVIN HARRIS

THE scanning device is one of the key components of a television transmitter and receiver. Although simple and inexpensive to construct, it calls for a high degree of accuracy if distortion of the transmitter picture is to be minimized. It is the scanning device that causes the beam of light to explore the picture or object to be transmitted. This is done by a succession of holes which pass before the light source, each hole being so arranged as to cause the exploring beam to sweep across the object, each time at a lower level.

Although various types of scanning devices have been developed, the most simple one is that developed by Nipkow in 1884. Nipkow simply used a revolving metal disc with holes arranged in a spiral. Inasmuch as this spiral must be accurately traced, if the exploring beam is to catch every detail of the object being transmitted, it behooves the experimenter to find some simple way of laying out the disc for the drilling operation. It is obvious that the average workshop is not equipped to trace these spirals with a machine method.

In Figure 1 there is shown a simple and very effective way of developing the spiral which will be sufficiently accurate for all amateur work. Having determined upon the diameter of the scanning disc used, the experimenter makes sure that the sheet metal that he is using is not perceptibly warped and that the exact center of the circle is found. Having done this, one line is drawn through the exact center of the disc. Next, a protractor is set so that its central point rests on the center of the disc. For purposes of illustration, we shall assume that the scanning disc under discussion is to be provided with 36 holes, inasmuch as 36 is a divisor of 360, which is the number of degrees in a circle. This permits the holes to be laid out 10 degrees apart. In marking off the disc, care should be taken that the protractor will not move and, having assured himself of this, the experimenter may proceed by the aid of a sharp prick punch to mark the disc off. In doing this it will be found advisable to lay the disc on a solid metal surface, perfectly flat, so that there will be no danger of springing the metal under the impact of the hammer blows which, although light, may cause damage.

Having laid out the 36 holes, the workman proceeds to draw 36 lines so



HOW THE DISC IS LAID OUT

FIGURE 1: *This drawing is diagrammatic only, and cannot be used for the exact layout of a disc. The visible area of the picture is defined by the radii through two consecutive holes and arcs of circles through the inner and outer holes. Hence, to make the area as nearly square as possible, a large disc should be used, with the arrangement of the holes near the edge of the disc.*

that each line will go through the center of the disc and through each one of the prick punch markings. These markings should be made with a scriber and a straight edge, and patience and care should be exercised to make them as accurate as possible.

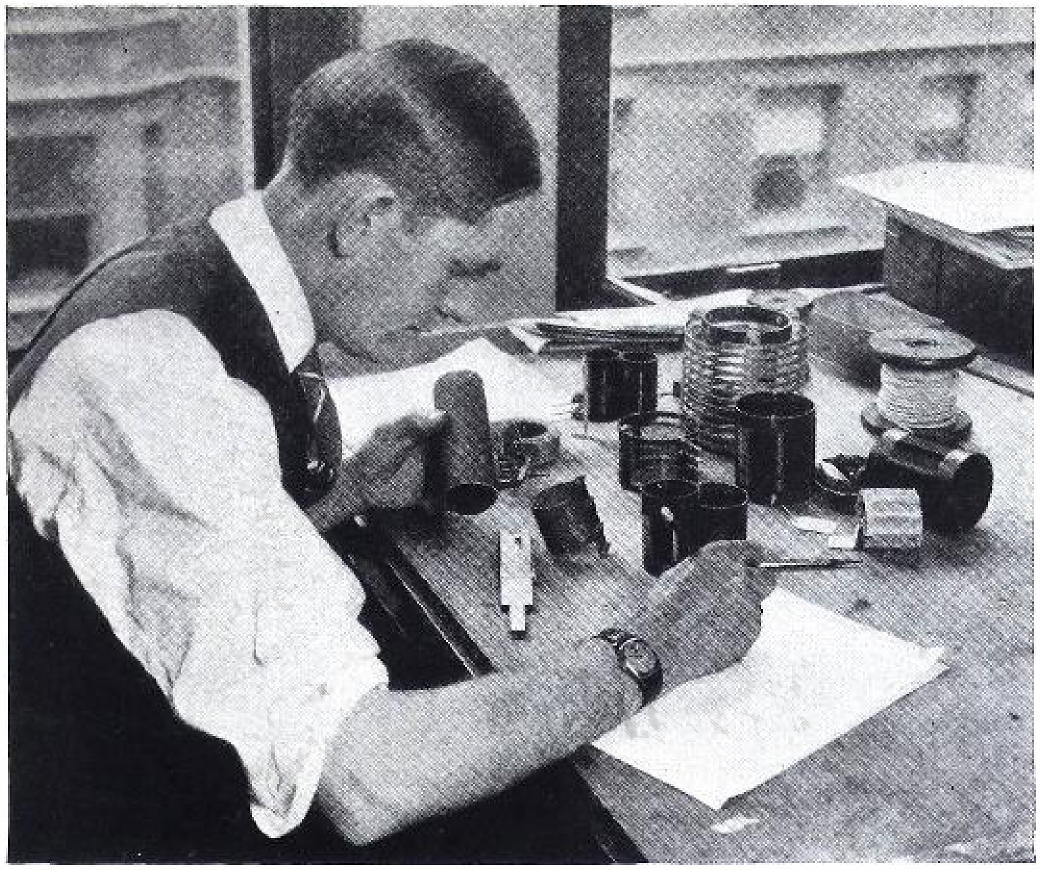
The next operation is that of drawing 36 concentric circles with a special compass sufficiently large to accommodate the work in hand. If this compass is not available in the workshop kit, a splendid substitute can be made readily with two wooden strips screwed together at one end so that they will move freely, the opposite ends each being provided with a phonograph needle. The outermost circle is drawn first, and the distance between this circle and subsequent circles will be determined by the size of the holes to be used in the scanning disc. This, as we shall see later, depends upon the demands to be made upon the apparatus, the degree of quality desired, the speed of the disc, and the size of the picture to be handled. In this case, let us assume that a hole made by a No. 48 drill is chosen. A No. 48 drill has an actual diameter of .036 inch. It is this dimension that determines the distance between the concentric circles.

From a drawing in Figure 1 it is obvious that the matter of laying out the holes so that they will conform to a spiral is comparatively easy. The first hole is placed at any one of the indicated lines that were drawn. The next hole is placed on the intersection where the line of the second circle passes through the line indicating the next 10 degrees. The next hole is placed on the third line down, and so on, until the mark for the last hole is completed. Each hole should be carefully marked at the intersection line with a prick punch *before* the drilling operation is undertaken.

The drilling will have to be done with some care, for it is essential that the holes shall not overlap to any perceptible degree, although a trifle will not do any harm—in fact, it is beneficial. When the drilling has been completed, the holes are then lightly countersunk so as to effectively remove all burrs that may have been developed during the drilling. If the burrs are not removed the definition of the scanning beam will be partially destroyed and will lack the sharpness necessary for good reproduction.

Perhaps it might be advisable at this point to consider the various metals that are available for use in scanning discs. It is obvious that the metal must be thick enough to hold its shape, and that it will exhibit no tendency to warp. Aluminum, due to its light weight and its desirable physical properties, is perhaps the most acceptable of all the

(*Continued on page 431*)



PLANNING THE COIL

With a little skill, and the proper knowledge of coil construction outlined in this article, coils can be made at home that will satisfy all the needs of broadcast reception. Then, with the proper technique, the designing of special coils may be undertaken.

For the Amateur Designer of COILS

By EMIL REISMAN

IN spite of the fact that coil manufacturers have brought the making of coils to a high state of perfection, there are many set builders, both professional and amateur, who still prefer to wind their own coils.

A well designed coil must have a low DC resistance; it must have a very low self capacity; it must have a minimum of dielectric in its field; it must have a minimum of metal in its field; its insulation resistance must be high; and the relation between its length and diameter must be of the proper ratio.

The DC resistance of a coil is determined by the size of wire used in its construction. A wire too heavy leads to excessive eddy current losses. Therefore some of the smaller sizes of wire are to be preferred to the large sizes, even though their ohmic resistance is larger. In general, wire ranging from No. 18 to No. 26 is suitable for inductance coils.

The self capacity of a coil is a very important factor because coil capacity is a highly absorbing condenser. The dielectric is the wire insulation and the material of the coil form. The self capacity of a coil adds greatly to its high-frequency resistance. A coil wound in the form of a solonoid with its turns slightly spaced has been found to have the lowest self capacity.

Any metal in the field of the coil introduces eddy current losses. Consequently, coils should not be mounted near or against metallic objects.

A high insulation resistance between the turns of the coil is essential or else much energy will be dissipated. The insulation of the wire and the form upon which the wire is wound should be of the best.

It has been found by the Bureau of Standards that in order to obtain the lowest possible high-frequency resistance and maximum inductance in a solonoid type of inductance coil, the coil should have such shape that the ratio

$$\frac{\text{diameter}}{\text{length}} = 2.46 \text{ approximately.}$$

The following is a formula whereby the inductance of a solonoid may be determined from its physical dimensions. Of course, when a certain inductance is wanted, the dimensions of the coil may be calculated from the formula by transposing the quantities.

$$L = \frac{.0395\, a^2 n^2}{b} K$$

where L = inductance in microhenries.
a = radius of the coil measured from the axis to the center of any wire.
b = length of coil.
n = number of turns.

The values of *a* and *b* are measured in centimeters. Inches may be converted to centimeters by multiplying by the constant 2.54. The value of *K* is a certain number which depends upon the ratio of the coil diameter to the coil length. The values of K have been calculated by H. Nagoaka and are given in the accompanying table.

Diameter / Length	*K*	*Diameter / Length*	*K*
.00	1.000	.95	.700
.05	.979	1.00	.688
.10	.959	1.10	.667
.15	.939	1.20	.648
.20	.920	1.40	.611
.25	.902	1.60	.580
.30	.884	1.80	.551
.35	.867	2.00	.526
.40	.850	2.50	.472
.45	.834	3.00	.429
.50	.818	3.50	.394
.55	.803	4.00	.365
.60	.789	4.50	.341
.65	.775	5.00	.320
.70	.761	6.00	.285
.75	.748	7.00	.258
.80	.735	8.00	.237
.85	.723	9.00	.219
.90	.711	10.00	.203

The natural wavelength of any coil and condenser in parallel may be determined by means of the following formula.

$$\lambda = 1884 \sqrt{L\ C}$$

where λ = wavelength in meters.
L = inductance in microhenries.
C = capacity in microfarads.

This formula may be used to determine the wavelength range of a coil and variable condenser if the minimum and maximum capacity of the condenser is known. If the inductance of the coil is not known, it may be calculated from the formula previously given.

Good coils, like good valves, are necessary for the satisfactory operation of any set. A set of poor coils in a receiving set may be the cause of broad tuning, interference, and poor volume.

Properly designed coils make for sensitivity, selectivity and quality.

POPULAR RADIO WORK SHEET

The AC PR Short-Wave Converter

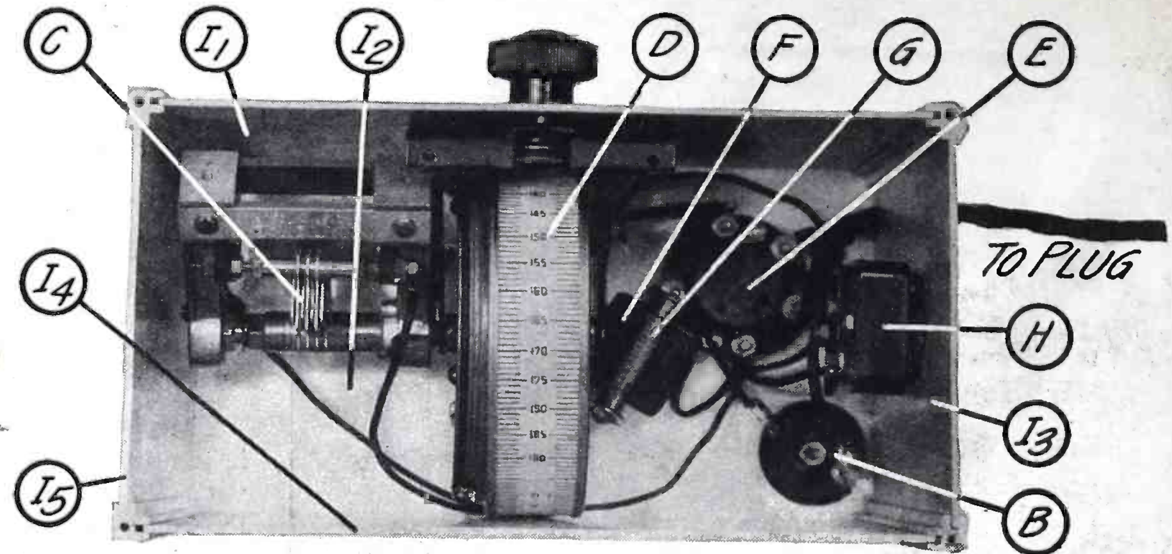
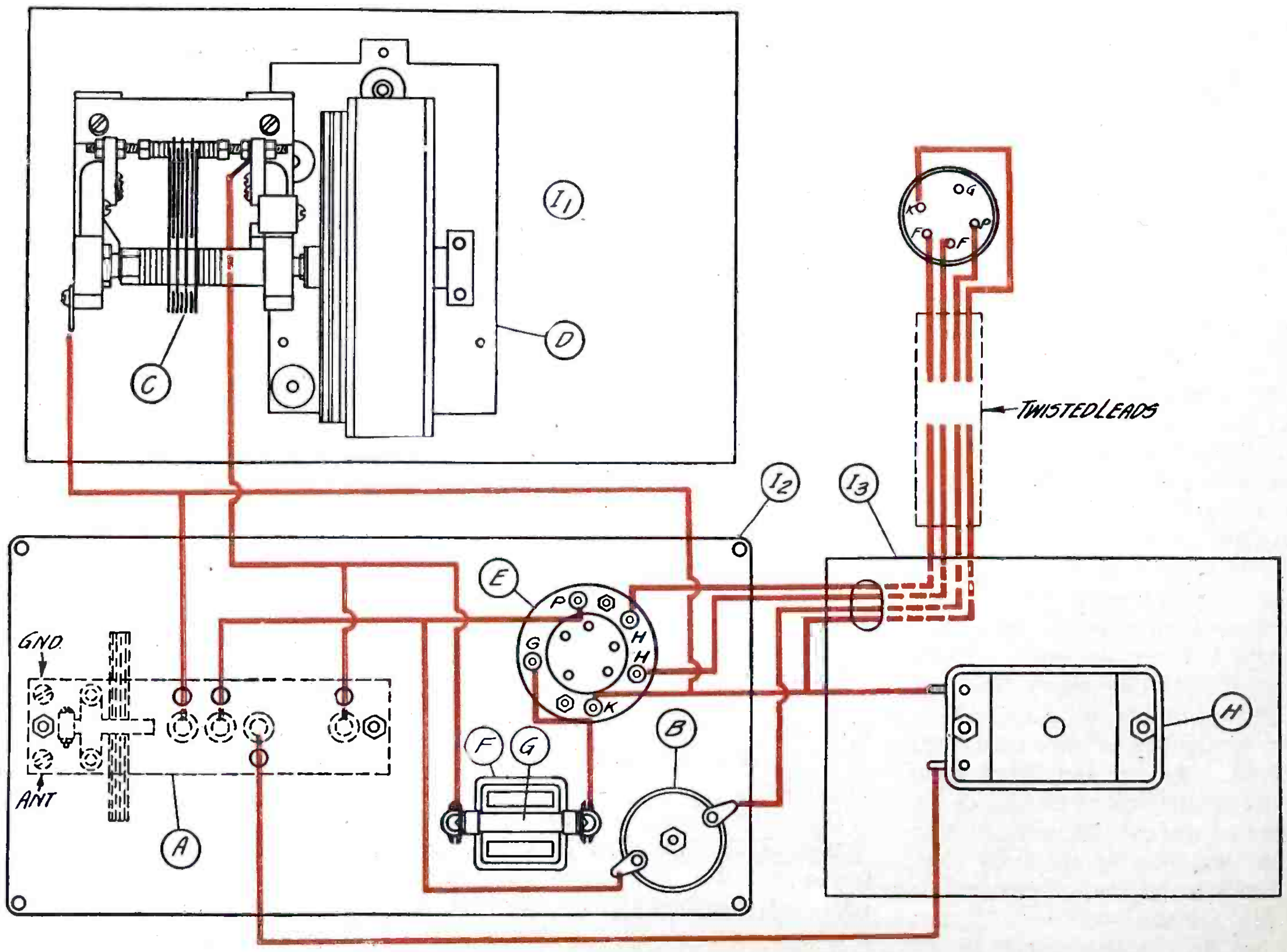


FIGURE 1: A VIEW FROM BENEATH

List of Parts Used in Building This Unit

Cost of Parts—*Not over $30.*

A—Aero coil set, Type LWT-125;
B—Aero choke, Type No. 60;
C—National "Equitune" variable condenser, .00015 mfd.;
D—National Velvet vernier drum dial, Type F;
E—Benjamin 5-prong socket, No. 9036;
F—Aerovox moulded condenser, with clips for grid-leak mounting, .0001 mfd., Type No. 1475;
G—Lynch resistor, 8 megohms;
H—Samson neutralizing condenser, Type No. 61;
I—Standard aluminum box shield, 5 by 9 by 6 inches high, made by the Aluminum Company of America.



HOW TO WIRE THE CONVERTER

FIGURE 2: *The instruments inside the box shield are shown in solid* BLACK *lines; those outside in dotted* BLACK *lines. The wiring inside the shield is in solid* RED *lines, and that outside in dotted* RED *lines.*

A Short-Wave Converter *for* AC Receivers

The success of the PR Short-wave Converter has been so great that the Laboratory staff has designed a new model, built on the same general lines, for use with socket operated sets. The new model is just as easy and inexpensive to build as the older one, and gives an equal order of excellence in operation.

By *the* TECHNICAL STAFF

THE PR Short-Wave Converter was designed so as to be easily adaptable to receivers using either DC valves or the new alternating current valves. Since the description of the PR Short-Wave DC Converter appeared in the April, 1928, issue of POPULAR RADIO, there have been many requests for information on an AC model short-wave converter.

The purpose of this article is to give the simple changes required to construct a short-wave AC converter. There are no batteries required for operating this unit. Reception on short-waves may be accomplished by simply inserting the connector plug in the detector socket of the AC receiver and connecting the antenna and ground leads to the converter as shown in Figure 3. All tuning is done with the new type vernier drum dial mounted on the front panel of the converter. The small knob on the right side of the unit controls regeneration.

The three interchangeable coils of the coil set cover a range of from 15 to 130 meters. The smallest coil covers the band from 15 to 33 meters, the medium size coil covers a range from 31 to 68 meters, and the largest coil covers a range from approximately 57 to 133 meters.

The short-wave listener will find KDKA on 64 meters practically every evening during the week. Experimental programs are broadcast by WGY on waves between 15 and 105 meters. Station 2YT, at Poldhu, Ireland, carries on experimental work on about 94 meters and Station G2NM at London, England, may be heard most nights after 11 P. M. Central Standard Time, on about 44 meters.

This simple and inexpensive addition to your present receiver will open up a new field of reception which will prove a revelation to the broadcast listener.

The Construction of the PR Short-Wave AC Converter

In building the AC Converter the same general construction details should be followed as were outlined for the DC Short-Wave Converter in the April, 1928, issue of POPULAR RADIO.

By referring to Figure 2, it will be noted that the five-prong socket, E, is used in place of the standard four-prong socket. Another replacement is the connecter plug made from the base of a burnt out UY-227 type valve. After the glass and other matter is removed from the base, solder the two heater leads, the plate lead and the cathode lead to their respective prongs of this five-prong base. The two heater leads should be twisted and then all four leads twisted together.

As in the previous converter, all parts are enclosed within the standard aluminum box shield, I, excepting the coil assembly, A, which is mounted on top. The drilling plan of the top panel, for mounting coil assembly A, socket E and choke coil, B, is shown in Figure 4. The neutralizing condenser, H, is

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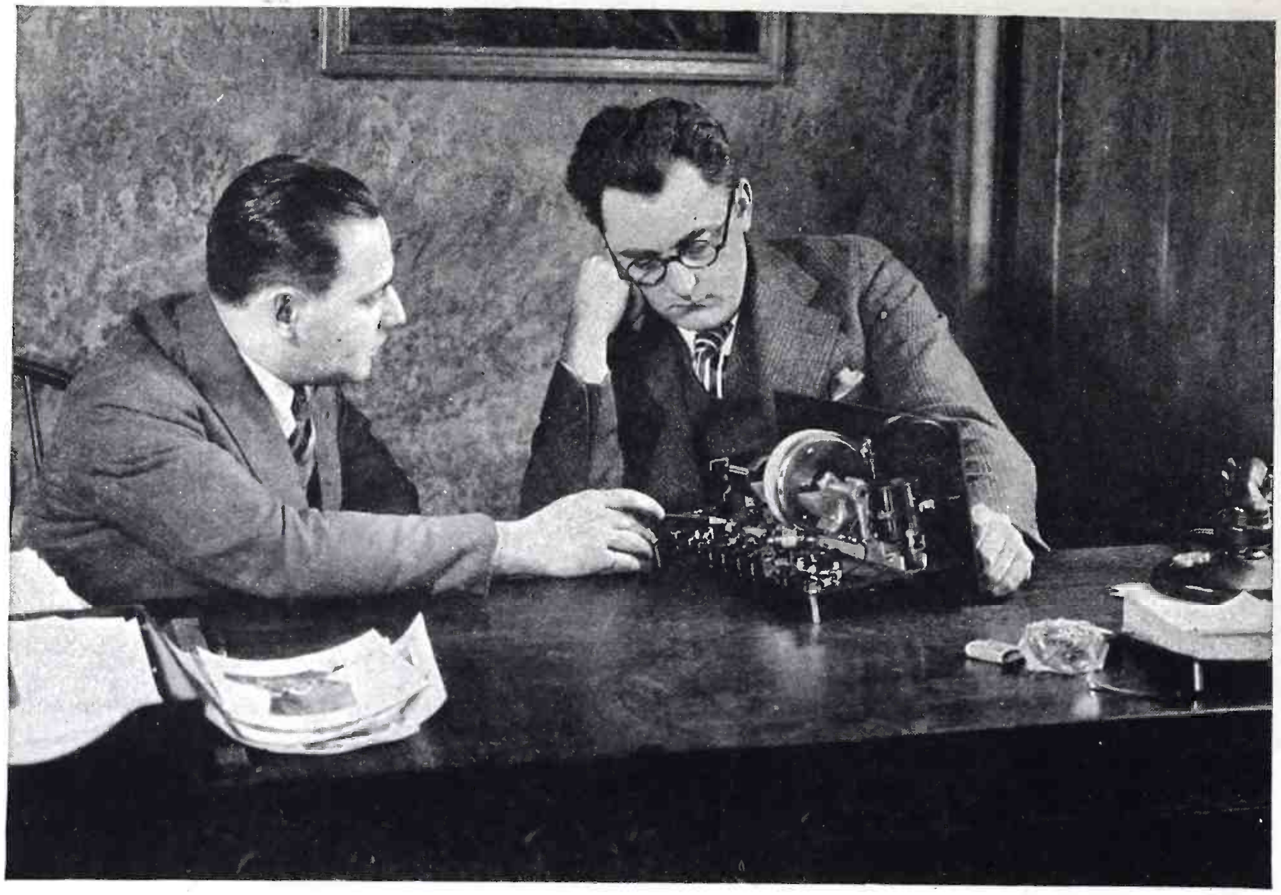


THE FINE POINTS OF THE NATIONAL

The simplicity of the National tuner is evident in this picture. The feature of most interest to the novice at set construction is the tuning unit, which may be procured already assembled and ready for mounting.

Efficiency! Low Cost! Simplicity!

The National Screen Grid Tuner

The National tuner recommends itself to fans of limited means who want the best for their money; for although it embodies a circuit of proved excellence, and makes use of the new screen grid valve, it is inexpensive and quite easy to assemble, and operate.

By VICTOR O'BRIEN

TO the home constructor of modest means and with an appreciation of tonal quality the new screen grid National tuner has an especial appeal. It is easily constructed and has a neat appearance that is comparable with many higher-priced radio sets. One of the outstanding features of this receiver is the aluminum chassis construction for the two coils, two condensers and drum dial which is the nucleus of this receiver. This arrangement simplifies construction, saves time and assures one of the proper placement of parts.

Simplicity is also exemplified in this compact radio set to a remarkable degree. An engraved illuminated drum dial with the attendant escutcheon plate is an example of simple and beautiful design. The unique method of eliminating lost motion in the drum dial shows clearly the thought expended in making this item one of the best that has been called to the writer's attention.

The use of a screen grid valve in the high-frequency portion of the set with the attendant efficient coil and condenser assures the builder of a high degree of amplification.

How to Assemble the Tuner

The panel and sub-panel are drilled and ready for the mounting of the various units. The single control tuning unit, which comprises two coils, two condensers and the drum dial, A, B, C, D and E, in Figures 1 and 2, comes from the factory as a unit and necessitates only the removal of the escutcheon plate and knob prior to its installation on the sub-panel.

Four screws fasten this unit securely to the sub-panel by means of the condenser frames. It will be noted that three of the four screws have lugs beneath the screw heads. Figure 2 shows how two screws will fasten the dial frame to the panel. Next mount the General Radio sockets, F1 and F2, with the grid and plate terminals toward the single control tuning unit. The Lynch single mountings, which will contain the high-frequency choke coils, G1 and G2, may be installed next. After this the Lynch double mounting, N-O, may be centrally located and fastened down. Following this the grid-leak holder, M, should be fastened in position.

The binding posts, R1 to R8, should then be placed in position with the lugs. The grid condenser, J, may now be fastened securely by means of a screw

POPULAR RADIO WORK SHEET

THE NATIONAL SCREEN GRID TUNER

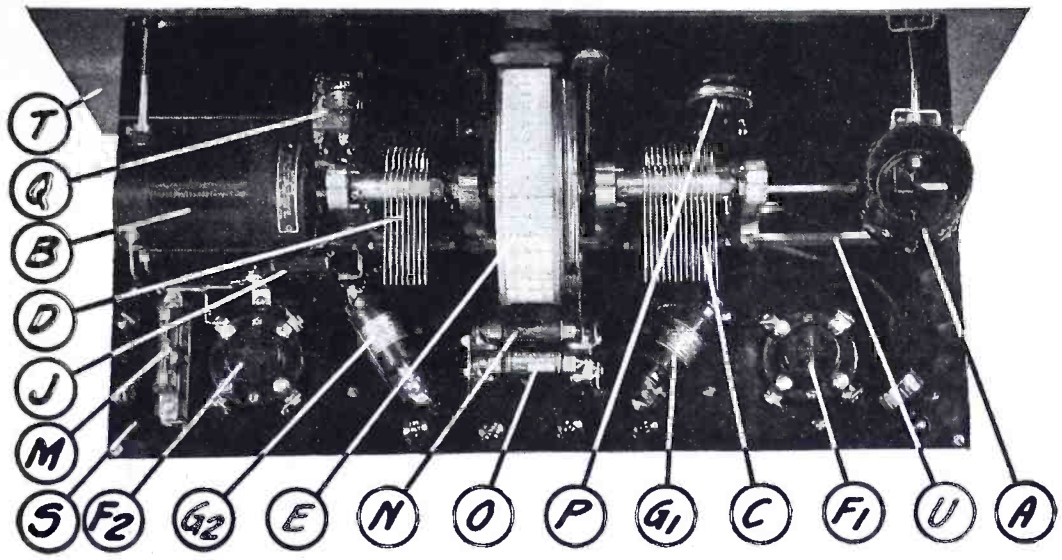


FIGURE 1: THE TOP VIEW

LIST OF PARTS USED IN BUILDING THIS RECEIVER

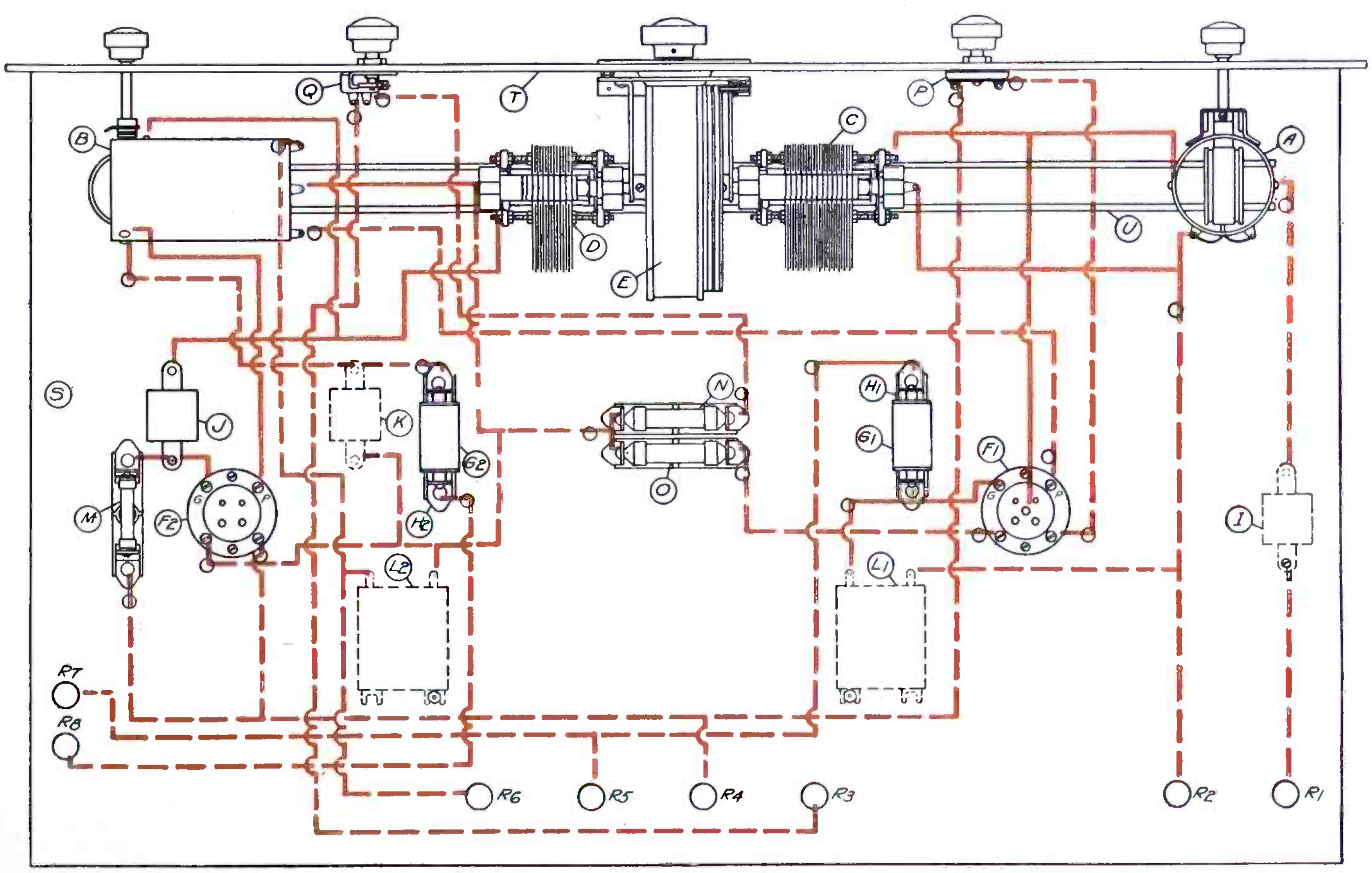
COST OF PARTS—*Not over $47.00*

National single control tuning unit for screen grid valves containing:

A—National screen grid antenna coupler;
B—National Regenaformer;
C—National "Equitune" variable condenser, .0005 mfd.;
D—National "Equitune" variable condenser, .00035 mfd.;
E—National Velvet Vernier Drum dial, type F—with type No. 28 Illuminator;
U—Metal chassis for supporting the above parts;

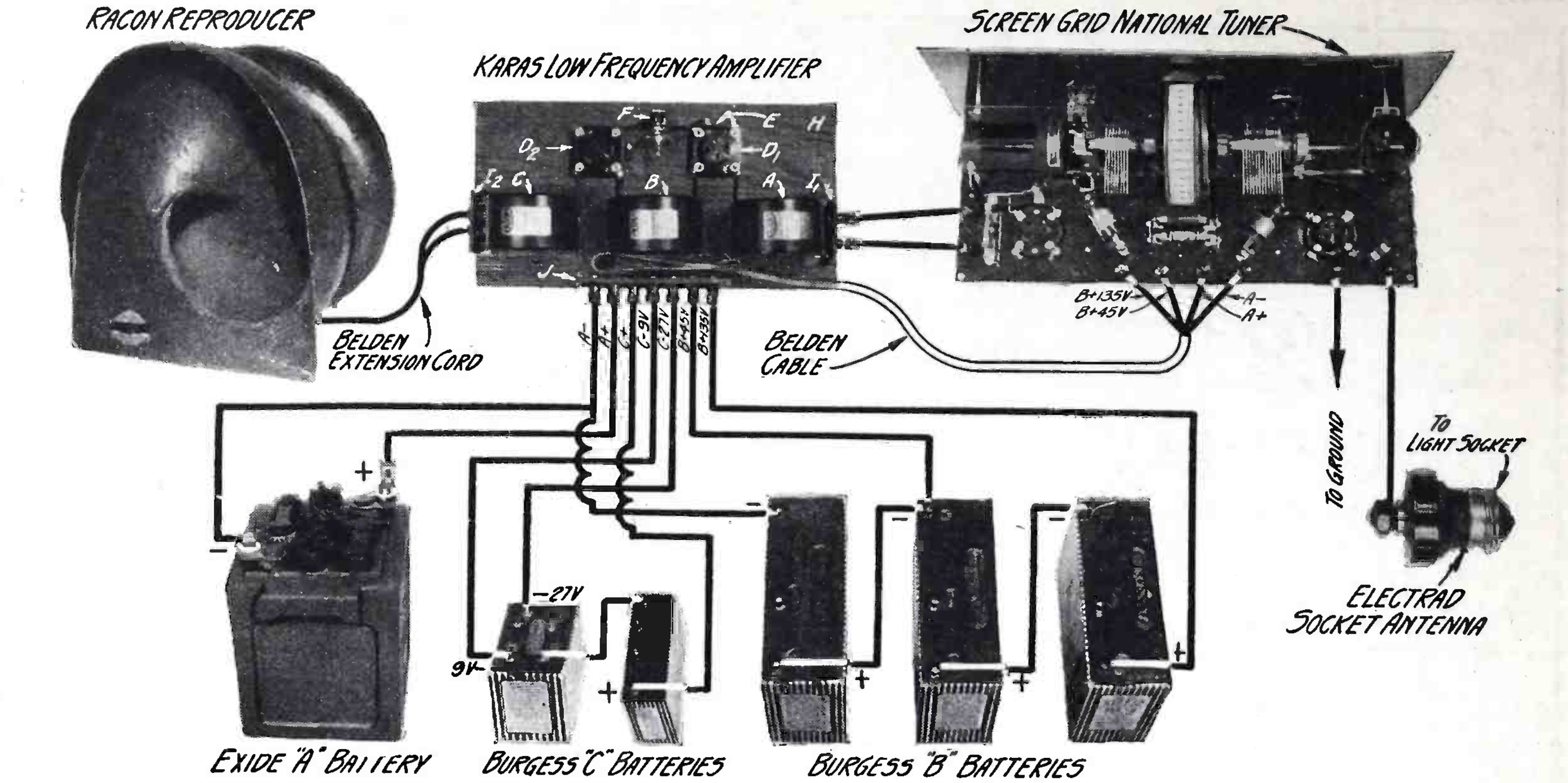
F1 and F2—General Radio sockets, type 349;
G1 and G2—National high-frequency chokes;
H1 and H2—Lynch Equalizer mountings;
I—Aerovox moulded condenser, .0001 mfd.;
J—Aerovox moulded condenser, .00025 mfd.;
K—Aerovox moulded condenser, .001 mfd.;
L1 and L2—Aerovox filter condensers, 1 mfd., type 200;

M—Lynch grid-leak, 2 meghoms, with grid-leak mounting;
N—Lynch Equalizer, type 4/5, with mounting;
O—Lynch Equalizer, type 15, with mounting;
P—Carter Midget rheostat, 20 ohms, type M-20;
Q—Yaxley battery switch No. 10;
R1 to R8—Binding posts;
S—Composition drilled sub-panel, 17 by 7 by 3/16th inch;
T—Composition drilled front panel, 18 by 7 by 3/16th inch.



HOW TO WIRE THE SET

FIGURE 2: *Dotted* RED *lines indicate wiring under the sub-panel; solid* RED *lines wiring above the sub-panel.*



HOW TO HOOK UP THE UNITS

FIGURE 3: *The Karas low-frequency amplifier, which is recommended for use with the National tuner, is described in this article. Its construction is quite clear from the data given in the text and in this diagram and Figure 5.*

and nut to the aluminum bracket and this bracket fastened to sub-panel as shown in Figure 2.

Referring to Figure 2, we find beneath the sub-panel two 1 mfd. condensers L1 and L2, which are mounted using one screw each and with the terminals toward the single control tuning unit. The .0001 mfd. condenser, I, is next mounted, with lug. The two rear corner supports should then be fastened beneath the sub-panel. This completes the sub-panel assembly.

The front panel has a Carter rheostat mounted about five inches from the left edge of panel. A Carter switch is located and mounted a like distance from the right-hand edge of panel.

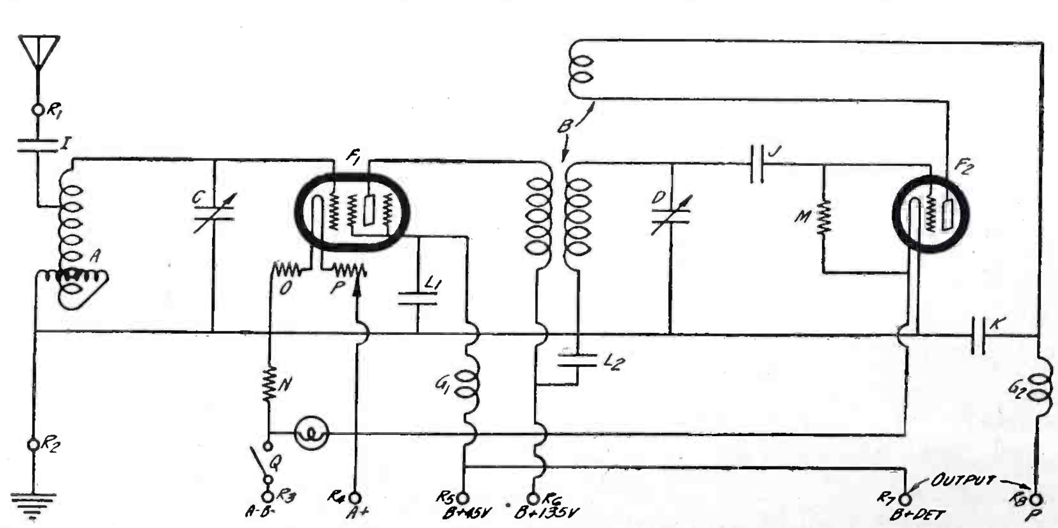
The front panel may now be put in position, fastened to the sub-panel by means of the three screws which go through the escutcheon plate, front panel and thread into the drum dial support.

The five knobs should now be placed in position. This completes the assembly, with the exception of the .001 moulded condenser, K.

The picture wiring diagram, Figure 2, clearly shows the proper placement of wires and connections to the various instruments.

The Karas Amplifier

The Karas low-frequency amplifier has been chosen as fitting companion to the National tuner, as it provides more than sufficient volume for the average home with extremely good quality. The output transformer permits of a power valve being used without endangering the loudspeaker.



THE CIRCUIT OF THE TUNER

FIGURE 4: *Regeneration is employed to a limited extent, and is controlled by varying the coupling in the coil, B.*

The baseboard may first be stained and permitted to dry; then the Karas transformer, two Benjamin sockets, switch and three binding post strips with their attendant binding posts may be mounted in position. A reference to Figure 3 shows this clearly.

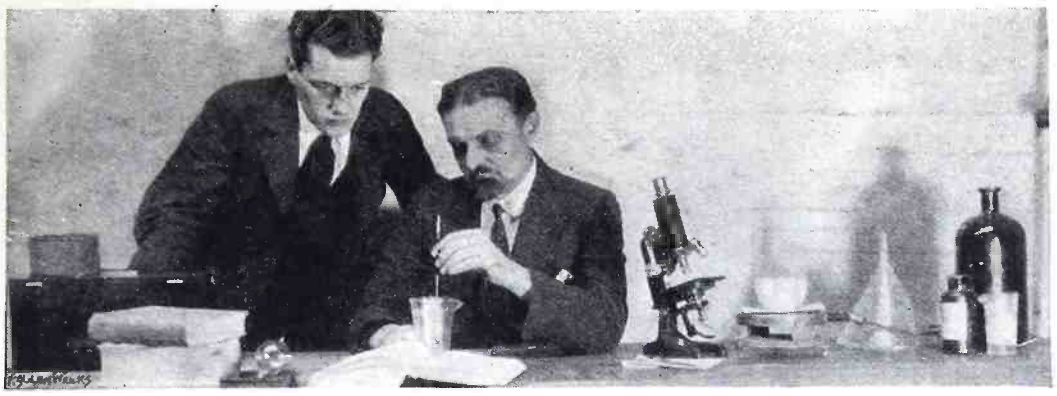
The wiring of this unit is simplicity itself and is clearly shown in the schematic diagram in Figure 5. The parts necessary are listed here:

A and B—Karas low-frequency transformers, type 28;
C—Karas output filter;
D1 and D2—Benjamin Cle-ra-tone sockets, type 9040;
E—Yaxley resistance unit, 2 ohms, type 802;
F—Benjamin battery switch, type 8640;
G1 to G9—Binding posts;
G10 and G11—Yaxley phone tip jacks, No. 422;
H—Hardwood baseboard, 14 by 7½ by ½ inch;
J—Bakelite binding post strip, 6 by 1 by 3/16 inch;
I1 and I2—Bakelite binding post strips 2½ by 1 by 3/16 inch.

How to Operate the Units

To the left of the National screen grid tuner will be noted a small coil that rotates within a larger coil. This piece of mechanism is designed to compensate for the various differences in antennaes and to permit more readily of accurate tuning by means of the National drum dial. The knob at the extreme right controls the feed-back to the detector valve. This in practice tends to tune the detector plate circuit, which sharpens tuning to a considerable

(*Continued on page 423*)



IN THE WORLD'S LABORATORIES

Cathode Ray Television

THERE are many thoughtful research workers who insist that the present methods used in television are impractical and that the limit of perfection has, for the moment, been reached. These men do not mean to infer that television is utterly impossible, but they maintain that we have started off with the wrong foot, and that the apparatus we are at present employing in the scanning process is inadequate.

Actual results obtained, however, do not bear this opinion out, for amazingly perfect living pictures have been successfully transmitted with the very apparatus that has been condemned.

At the present time a revolving disc with spirally arranged holes is used to scan the pictures to be transmitted. Some who have gone into the mathematics of the problem claim that only the simplest arithmetic is necessary to show the utter impossibility of carrying this system to ultimate perfection. Dreadful numbers are encountered that make even the most optimistic of investigators feel more than a little hopeless. The critics of the present system base their conclusions on the problem of projecting at the receiver a television image ten centimeters square—a rather small picture. If one divides each side of the square by a hundred, the picture is divided in 10,000 small squares; and, incidentally, squares of a millimeter do not make up a very fine picture. Each one of these small squares has to be "seen" by the electric eye, and, to give a fair appearance of continuous movement to the picture, the whole has to be transmitted and flashed on the receiving screen about ten times a second. This points to the necessity of flashing 100,000 squares of light every second, and the number that is necessary to make a good moving picture is 300,000 flashes a second.

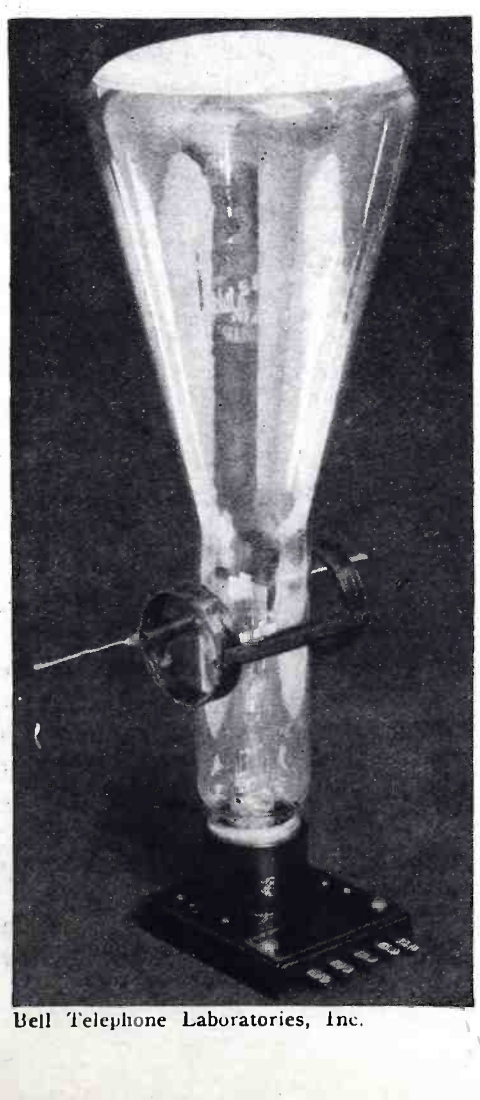
Those who have had the opportunity of viewing television reception have noticed that fast movement of the object produces a blur at the receiving screen. The photoelectric cell is blind to movements that exceed certain speeds.

Professor Max Dieckmann, the German investigator, realizing the inherent weaknesses of the present efforts to obtain perfect television, has launched into a new series of experiments with the object of employing cathode rays at the receiver. It is known that cathode rays are sensitive to even very weak magnetic fields, and that the paths of the rays are easily bent out of their normal path by small magnetic disturbances. Although Professor Dieckmann has had some success with the reproduction of pictures by the use of this method, he still has before him the problem of employing cathode rays in the transmitting equipment.

In applying cathode rays to scan an object to be transmitted, Professor Dieckmann is experimenting with electromagnets, one of which is used to draw the rays laterally, and the other, placed at right angles, to draw them vertical. Alternating currents are used to energize one magnet twenty times as frequently as the other, so as to make the rays zigzag over the object.

In the receiver that Dr. Dieckmann has developed he works on the same principle, using cathode rays, regulated according to the strength of the radio impulse received. These are made to zigzag over a fluorescent screen which glows under the action of the impinging

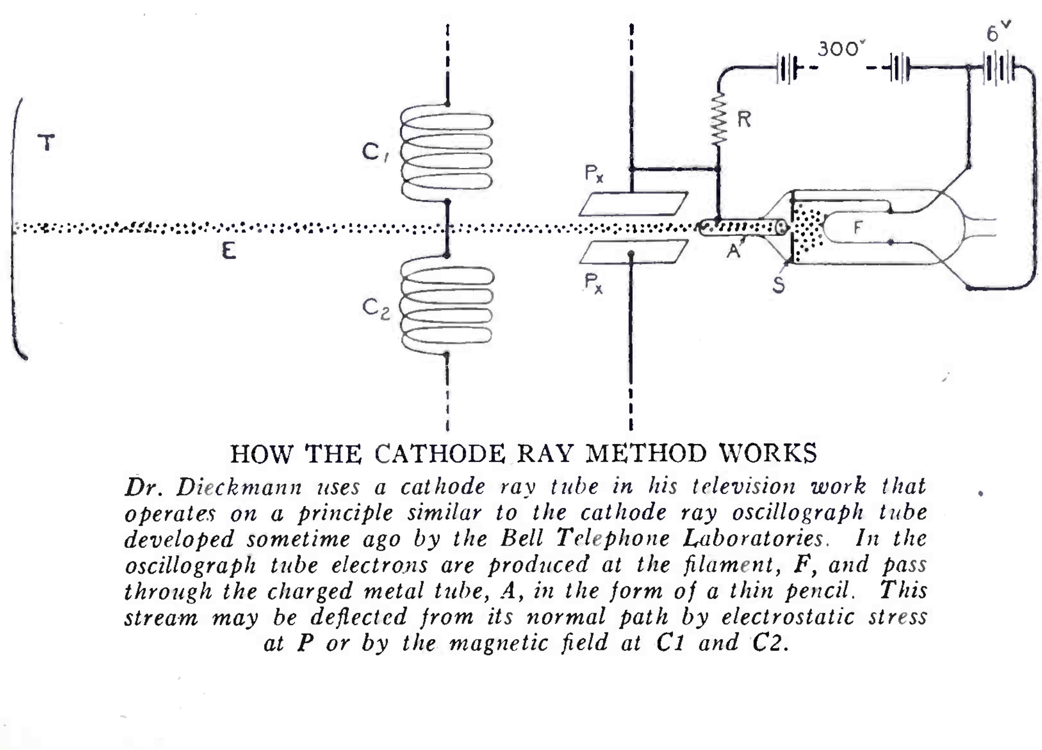
(*Continued on page 406*)



Bell Telephone Laboratories, Inc.

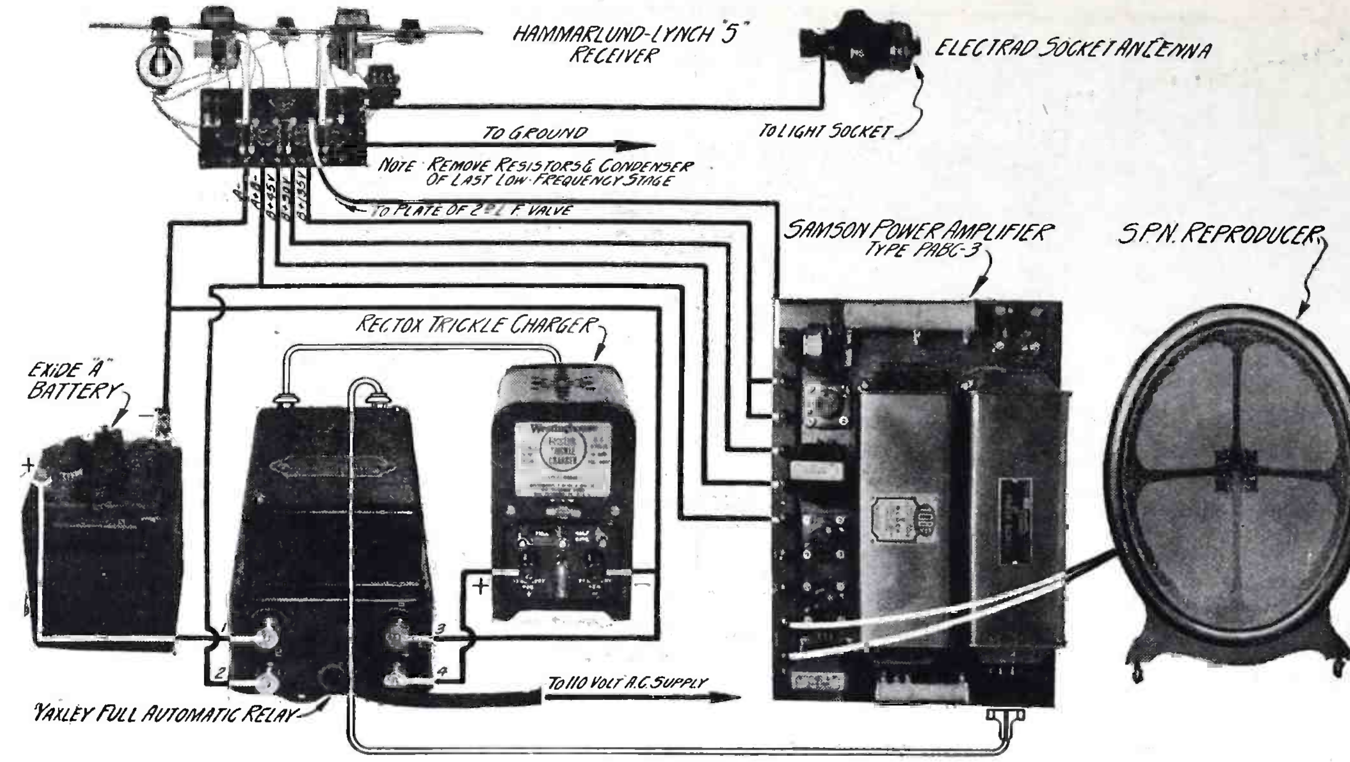
A CATHODE RAY OSCILLOGRAPH TUBE

Although the cathode ray tube shown at the left is used to produce visible effects on a fluorescent screen, this same type of tube is being used by Dr. Dieckmann in his experiments in television, using cathode rays that are subject to the influence of magnetic and electrostatic effects.



HOW THE CATHODE RAY METHOD WORKS

Dr. Dieckmann uses a cathode ray tube in his television work that operates on a principle similar to the cathode ray oscillograph tube developed sometime ago by the Bell Telephone Laboratories. In the oscillograph tube electrons are produced at the filament, F, and pass through the charged metal tube, A, in the form of a thin pencil. This stream may be deflected from its normal path by electrostatic stress at P or by the magnetic field at C1 and C2.



HOW THE UNITS ARE HOOKED UP

FIGURE 1: *The Hammarlund-Lynch "5" is shown here as an example of broadcast receivers that may be used with the Samson power-pack amplifier. The connections to the "A" current supply, reproducer and antenna are also shown in black lines.*

A New Way to Quality Reproduction With the Samson Amplifier

The power-pack amplifier whose construction is described in this article furnishes the set builder and fan with an ideal method of bringing his old receiver up to date by the addition of a push-pull low-frequency stage of 371 type valves. In addition, the unit furnishes all the necessary "B" and "C" voltages for the ordinary broadcast receiver. And in construction it is one of the simplest units ever designed.

By CARL DORF

IN these days the art of power amplification has been reduced to such a simple and efficient formula that there is no reason why any old model receiver should not be brought up to date so that it will furnish excellent power and tone quality in its reproduction. A new power-pack amplifier recently developed by the Samson engineers contains all of the latest developments in power amplification. It can be built by any radio fan or professional set builder and installed in a short time as the power stage of any receiver. It will furnish complete "B" and "C" power for the receiver used with it at the various voltages required.

It also contains a stage of efficient push-pull amplification working into two 371 type power valves. A voltage regulator valve is utilized to keep the "B" voltages constant no matter how much the AC line voltage surges or varies. This is a very important consideration in light-socket operation.

The complete amplifier is pictured in Figure 2, and it will be noticed that it contains the necessary power block consisting of a power transformer and the choke coils for the filter, and a complete filter-capacity block, in the same uniform type of housing, together with the necessary voltage-dividing resistors and sockets accommodating the rectifier valve, the regulator valve, and the two push-pull amplifier valves. A connection strip runs along one side from which the various "B" and "C" voltages for running the set may be taken off.

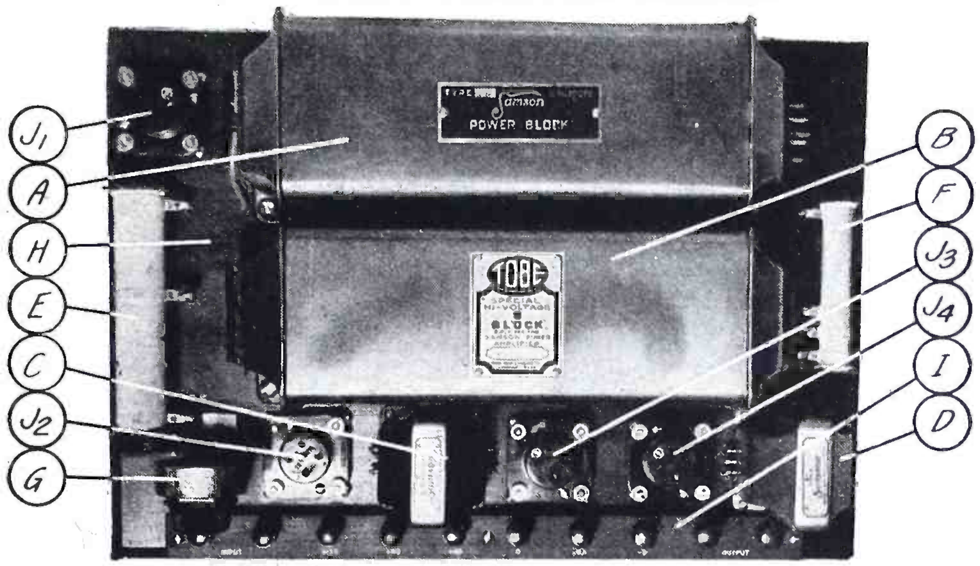
The amplifier may be used in conjunction with any receiver as the last stage of amplification. It does not matter whether the receiver itself incorporates resistance coupling, transformer coupling, impedance coupling or any combination of these. All that is necessary is to disconnect the last stage of amplification in the receiver and use the new power-pack amplifier connected to the receiver at the plate circuit of the amplifier valve that precedes the last stage.

One of these new units connected to a receiver will greatly improve its reception qualities both as to sensitivity (due to having at all times the correct

(*Continued on page 430*)

POPULAR RADIO WORK SHEET

The Sampson Power-Pack Amplifier

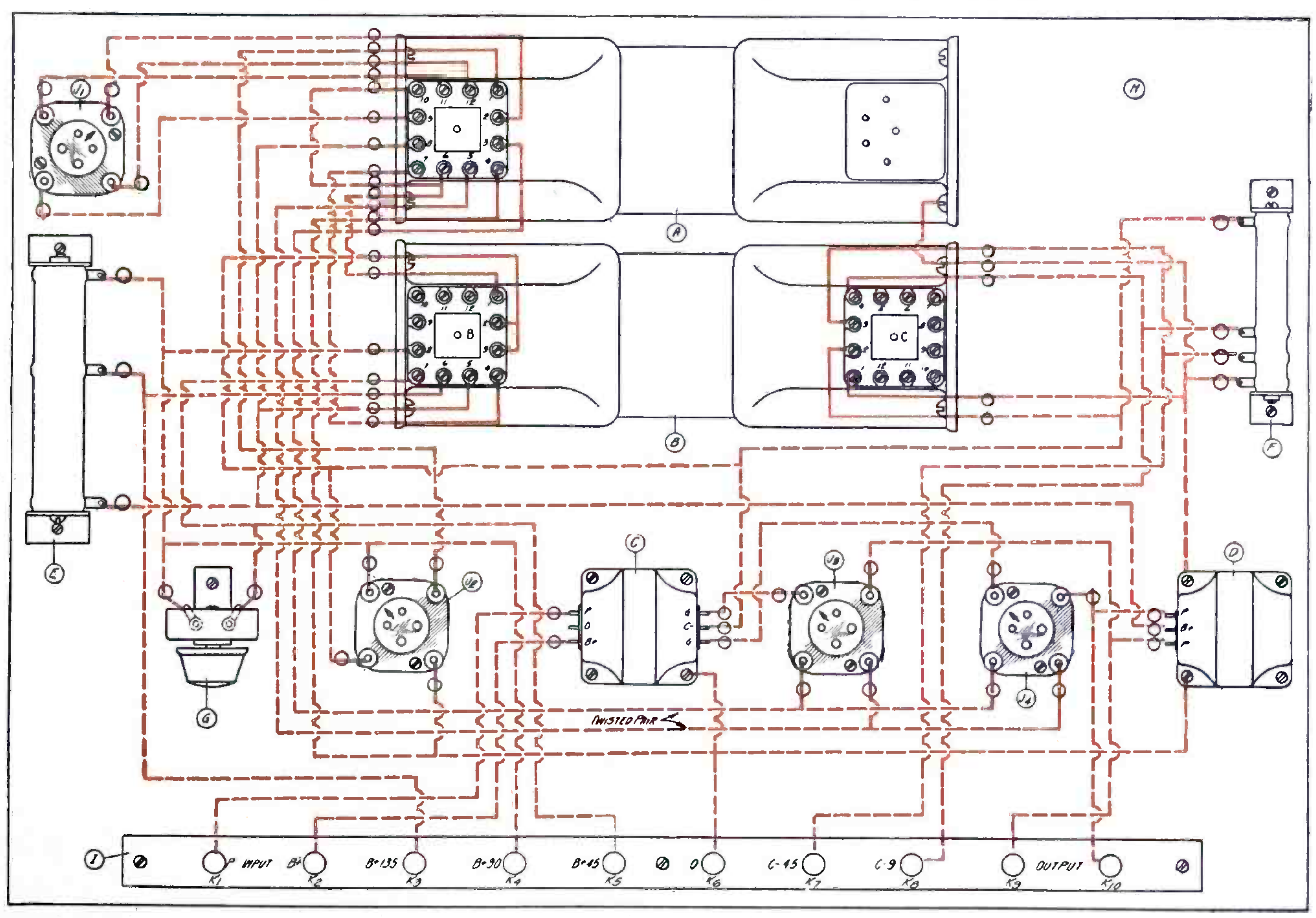


THE UNIT FROM ABOVE

Figure 2: *All the parts are mounted above the panel, and are clearly shown in this view of the unit.*

List of Parts Used in Building This Unit
Cost of Parts—*Not over $90.00*

A—Samson power block, type No. 718;
B—Tobe BC condenser block, No. 718;
C—Samson push-pull input transformer, type Y;
D—Samson push-pull output impedance, type Z;
E—Lynch tapped resistor, 2,850 ohms, type No. SE-28;
F—Lynch tapped resistor, 570 ohms, type No. SE-5;
G—Frost variable resistor, 0 to 50,000 ohms, type No. 880;
H—Baseboard, 12 by 17 by 3/4 inch;
I—Micarta binding post strip, 1 by 14 by 3/16 inch;
J1 to J4—Benjamin Cle-ra-tone sockets, No. 9040;
K1 to K10—Eby binding posts;
Gavitt rubber-covered hook-up wire, solder, screws, rubber feet, etc.



HOW TO WIRE THE UNIT

Figure 3: *By mounting the baseboard on rubber feet, much of the wiring may be done under the baseboard, as indicated here in dotted* Red *lines. Solid* Red *lines show wiring above the baseboard.*

In the Professional Set Builder's Shop

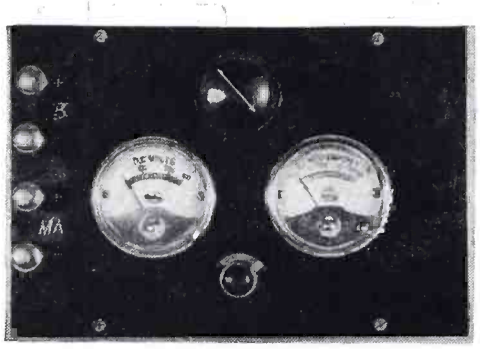
Practical pointers and kinks to increase the efficiency and earning power of those who construct, repair or service receivers for profit. If there is a better and easier way to do it, this department of POPULAR RADIO, *aided by a well-equipped Laboratory, will find it and present the details here to our readers in a practical and concise manner.*

An Inexpensive "B" Eliminator Tester

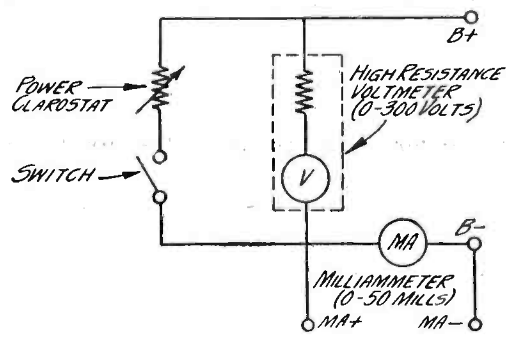
THE service kit for the repair of radio receivers cannot be complete unless it includes a "B" eliminator tester. Ordinary low-resistance voltmeters cannot be applied to this work, since the meter itself draws sufficient current to render accurate readings impossible. This eliminator tester uses a high-resistance voltmeter in combination with a milliammeter of suitable range. Both instruments are inexpensive and accurate enough for all practical purposes in radio testing work.

This "B" eliminator tester requires the following parts:

1 Sterling 0-50 milliammeter, type R-1626;
1 Sterling high-resistance voltmeter, 0-300 volts, with external resistor;
1 Power Clarostat;
4 XL binding posts;



THE PANEL OF THE UNIT
FIGURE 2: *The voltmeter is at the left and the milliammeter at the right. The binding posts are, from top to bottom, "B+," "B—," "MA+" and "MA—."*



THE CIRCUIT OF THE TESTER
FIGURE 1: *The wiring of the instrument is clearly shown in this diagram; all the wires are run under the panel.*

1 Composition panel, 6 by 8 by ¼ inch thick;
1 Carter "Imp" switch.

Figure 1 shows the connections schematically. Figures 2 and 3 show the unit from above and below. This device will measure the output of any "B" eliminator having a maximum load of 50 milliamperes and 300 volts. This is done by connecting the output of the "B" eliminator to the binding posts marked "B+" and "B—." The output load on the eliminator may be measured without load by turning the Carter "Imp" switch to the "off" position. By switching over to the "on" position the Clarostat is put into the circuit, and any load may be placed upon the "B" eliminator, the resulting meter indications showing it. The artificial load is placed upon the "B" eliminator by turning the Clarostat knob, which either increases or decreases the resistance. The amount of the load is shown by the milliammeter. If, for instance, the set which is being checked up draws a total of 35 milliamperes, the Clarostat may be adjusted so that the milliammeter will read this figure. A glance at the voltmeter will show the amount of voltage delivered at that current value.

This device can also serve as a separate "B" voltmeter by simply applying the voltage source to the "B" binding post and turning the switch to the "off" position. A separate current reading may also be obtained by connecting the supply to the binding post marked "MA+" and "MA—." This separate milliammeter load may be very helpful in determining exactly what any set draws. It is only necessary to disconnect the "B—" terminal of the set being tested and attach it to the "MA—" post on the milliammeter. The "MA+" post should now be connected to the point where the "B—" lead to the set was removed. This will complete the circuit and give the current reading.

—MARTIN ZEVIN SILVER

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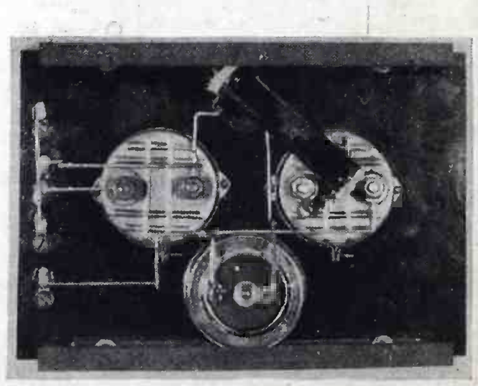


THE UNDER SIDE OF THE PANEL
FIGURE 3: *Note the wooden strips at the top and bottom which support the panel and keep the instruments clear.*

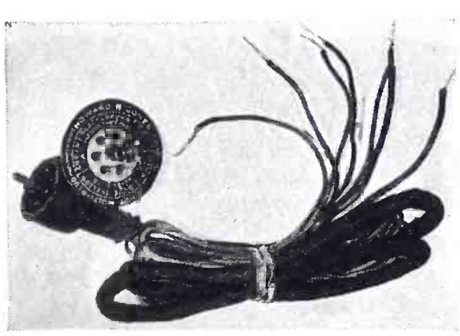
BIGGER AND BETTER EVERY YEAR

The man at the left is holding a 10,000-watt Mazda light, the latest innovation in motion picture lighting. At the right is one of the new 5,000-watt power valves of the type used in all the latest Western Electric transmitters.

What's New *in* Radio

Conducted by
THE TECHNICAL STAFF

The material listed in these columns has been carefully tested in the POPULAR RADIO Laboratory, which is acknowledged to be one of the most completely equipped institutions of its kind. Mention in the following pages signifies that the apparatus illustrated has met the approval of the POPULAR RADIO Engineering Staff.



An Inexpensive Cable Connector Cord

Name of instrument: Connector cable.

Description: Although this particular cable was made with seven connections, G, A, "A" battery +, B+ amplifier, B+ Detector, B—, A—, this type is available with as many as twelve connectors. The plug comes with a soft rubber covering. The connectors, which are of the spring type, are mounted in a molded Bakelite piece in which the seven-cord cable terminates. The plug engages with a receptacle having seven corresponding soldering lugs, which are marked with a color of the corresponding wire. A printed cardboard disc is used as a guide to the proper connections. The cable, from the adapter to the tip of the connecting wires, measures 48 inches, and each connecting wire is encased in a soft rubber insulation, the bare ends being solder-tipped.

Outstanding features: Simplified construction.

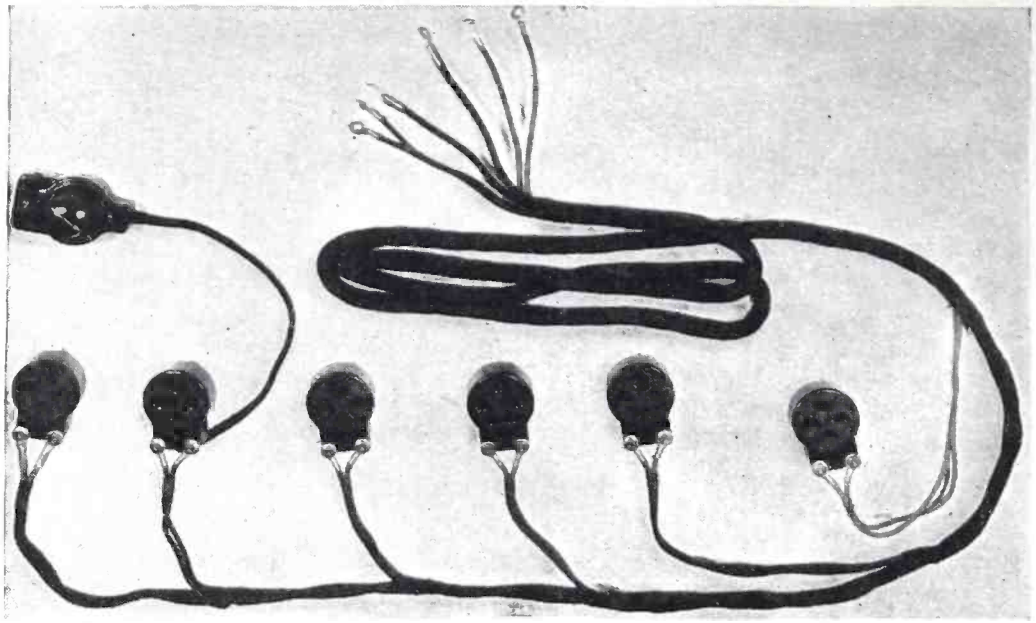
Maker: Howard B. Jones.

Chemical Condensers for Filter Condenser Work

Name of instrument: Electrolytic condenser.

Description: This electrolytic condenser is mounted in a copper can 4¾ inches high and 3 inches in diameter. The

top is of Bakelite sealed into the can with a rubber washer which effectively prevents any leakage of the contents. It also prevents seeping and corrosion. Two terminals from two electrodes are brought out through the Bakelite top and each is provided with a soldering lug. In use the can, or container, is made negative. The condensers are made in various capacities; the one tested had a total capacity of 50 mfd., or 25



mfd. per anode. The peak operating voltage is 450, and the maximum operating voltage for continual service 300. The condenser is self-healing and may be employed for filtering purpose in "B" eliminators and power amplifiers.

Outstanding features: Leakage-proof electrolytic condenser of high capacity, occupying small space.

Maker: Amrad Corporation

Quick Changes to AC

Name of instrument: AC harness with sockets.

Description: This harness, which is provided with heavy connecting wires of various colors, is provided with six adapters—four to accommodate 226 type valves, one for the 227 type valve, and one for the 171 type valve, providing the user desires to put such a valve in the last stage. Otherwise this socket may be used for a 226 type valve. The adapters are well made of moulded Bakelite and each one is provided with large connectors for holding the lugs of the harness securely by means of a 6/32 machine nut. The connecting wires, which are large and flexible, are each provided with lugs that may be readily attached to the transformer. Each harness comes provided with a volume control, mounted in a moulded Bakelite container.

Outstanding features: Liberally designed cords and moulded Bakelite adapters provide for the quick, easy changing of the ordinary receiver to AC operation.

Maker: Enterprise Manufacturing Company.

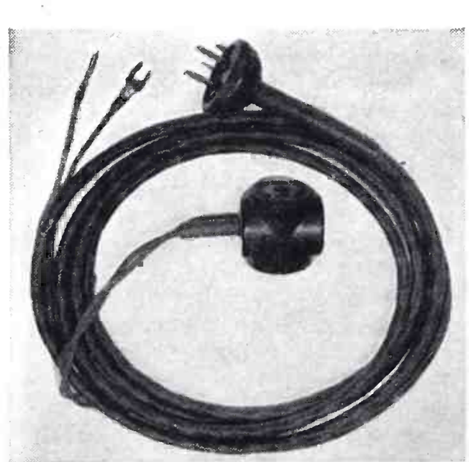
Current Supply for AC Vales

Name of instrument: Filament transformer.

Description: This transformer, which is enclosed in a black Japanned case measuring 6½ by 3¼ by 5½ inches, provides three standard voltages, for the 226, 227, and 171 type valves. This corresponds to voltage outputs of 1½, 2½ and 5. The terminal block is placed under the cover of the transformer, which also has a hole large enough to provide for incoming connections. The cover is easily removed to facilitate connecting. A large, heavy, rubber-insulated connecting cord with a plug is provided with each transformer. The terminal block previously referred to also has a ground connector and a post for the "B" 45-volt connection.

Outstanding features: Compactness. Conservative engineering design.

Makers: Enterprise Manufacturing Company.



Aerial and Power Service Cord All in One

Name of instrument: Service cord provided with socket antenna.

Description: This service cord, which provides for the connection to the "B" eliminator and "A" eliminator or other power device, also incorporates a socket antenna. The leads for the antenna are brought out on two different colors, each provided with a connecting lug. By utilizing the capacity between the two rubber-covered cords a convenient type of indoor antenna is provided. In actual use it is found that one terminal might give better results than the other, owing to a difference in capacity. The cord provided with the equipment is 9 feet long.

Outstanding features: Incorporation of service extension cord and light-socket antenna in one cable.

Maker: Tidmarsh's Radio Supply Company.

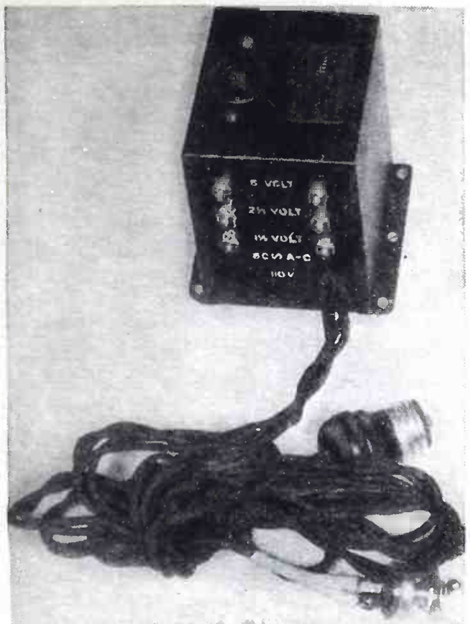
Large Capacity in a Small Space

Name of instrument: Dry "A" condenser.

Description: Although this condenser measures only 7 by 2 by 2 inches, it houses a capacity of 2,000 mfds. It's elements are made up of a very special preparation which allows large working capacity to be incorporated in a small container. The case is finished in aluminum paint, and the terminal are brought out through Bakelite insulators at the top. The condenser shows no polarizing tendencies and may be connected into any "A" battery eliminator circuit. But once connected, the terminals should never be reversed. The user of this condenser is cautioned not to employ it for voltages much above six, if it is to be placed in continuous operation. Due to its extremely high capacity, its use in filtering out the hum of "A" battery eliminators is highly recommended.

Outstanding features: Large capacity in small space.

Maker: Aerovox Wireless Corporation.



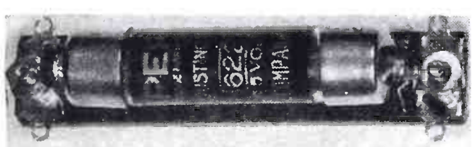
All AC Filament Voltages Obtained from This Unit

Name of instrument: "A" power transformer, type K-1.

Description: This transformer consists of a primary and three secondary windings, the latter to provide output voltages of 1½, 2½ and 5 volts for the operation of 226, 227 and 171 valves, respectively. It supplies all the filament current for the valves in a receiver designed for complete AC operation. The transformer measures 3½ inches in width by 3½ inches in height, and is 4 inches in overall depth. It is inclosed on five sides in a metal case, and has a composition terminal panel for the front side. It is equipped with a power switch intended for mounting on the front panel of the receiver, and there is also an outlet tap in the top of the transformer into which the "B" power-pack may be plugged, in which case the latter will also be turned "on" and "off" from the receiver panel switch.

Outstanding features: Supplies all filament voltages required in the average AC receiver. Small in size. Controlled from receiver panel switch.

Maker: Bremer-Tully Mfg. Co.



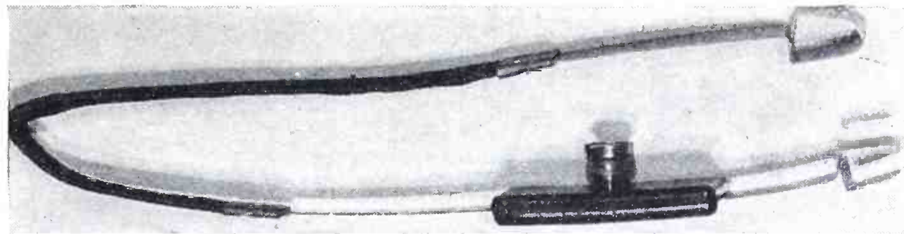
An Automatic Filament Control for Screened-Grid Valves

Name of instrument: Amperite No. 622 filament control.

Description: This is the latest addition to the amperite family and is intended for use with the new CX-322 screened-grid valves when operated from a 6-volt source, as from a storage battery. An amperite connected in series with the filament of one of these valves causes the filament to operate at substantially the rated voltage.

Outstanding features: Maintains proper working voltages for the 322 type valve. Eliminates necessity for an adjustable rheostat.

Maker: Radiall Co.



A Handy Lead-in and Arrester

Name of instrument: Combination lead-in and lightning arrester.

Description: This is a convenient unit for use, inasmuch as it includes a flat, insulated lead-in and a lightning arrester in a single unit and requires a total of only three connections. The antenna connector terminals are of the sliding clip type and the ground connection to the arrester is made to a screw terminal. The overall length of the unit is 16 inches and the insulated section where it passes under a window is 6½ inches in length.

Outstanding features: Easily installed. Lightning arrester outdoors. Good contact assured by clips.

Maker: Swan-Haverstick, Inc.

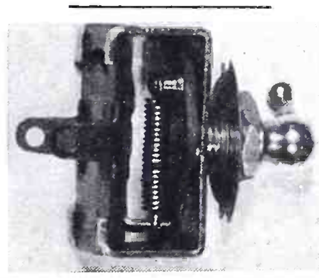
A Compact "C" Battery Eliminator

Name of instrument: "C" power supply.

Description: This unit is in the form of a small metal box, finished in crystalline and with a bakelite top upon which the terminals and controls are mounted. Its overall size is 3 by 3 by 5½ inches. To connect it into any circuit, it requires only that the negative side of the filament circuit be connected to one of its terminals and the negative side of the "B" power-pack be connected to another. Two "C" voltages are provided by this unit and both are adjustable by means of control knobs on the top of the instrument. This arrangement has the advantage over "C" batteries that, when its two control knobs have once been adjusted, any variation in the output voltages of the "B" power-pack will cause similar variations in the "C" voltage, with the result that the "C" bias is maintained at approximately the proper value.

Outstanding features: Easily connected. Eliminates "C" batteries. Provides automatic control of "C" bias.

Maker: Arionola Sales Co.



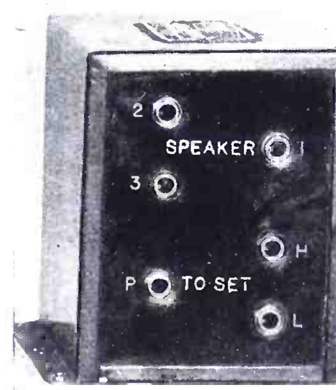
A Switch That Eliminates Relays

Name of instrument: Power switch.

Description: There has been a growing demand for a switch to be mounted on the receiver panel which would control the 110-volt AC supply to the receiver, particularly where the receiver employs AC valves. This new switch is designed to control either an "A" battery or the 110-volt AC supply, and is mounted on the receiver panel by means of a single ⅜-inch hole. The toggle control lever and the metal frame of the switch are both insulated from the contact elements. It measures only 1¼ inches by ¾ inch by ⅝ inch in depth.

Outstanding features: Compact size. Capable of carrying 110 volts AC. Positive in action and shock proof.

Maker: Carter Radio Co.



An Unusually Practical Speaker Coupling Unit

Name of instrument: B-T speaker coupler, type S-1.

Description: This neat unit is intended for coupling the reproducer to receivers which employ power valves in the last low-frequency stage. The overall dimensions are 3½ inches each way, which is small enough to permit mounting the unit inside of most receivers. Terminals take the form of phone tip jacks. The coupling is provided by a transformer with both primary and secondary windings tapped. The tapped primary is for the purpose of matching up the primary load impedance for the best value for working with the impedance of the valve used in the last stage of the receiver; thus the transformer serves with equal effectiveness with either a 210 or a 171 type valve in the last stage. The secondary tap provides a choice of two degrees of coupling, and meets the impedance requirements of several types of reproducers.

Outstanding features: Adjustable input and output impedances. Easily installed in a receiver.

Maker: Bremer-Tully Mfg. Co.

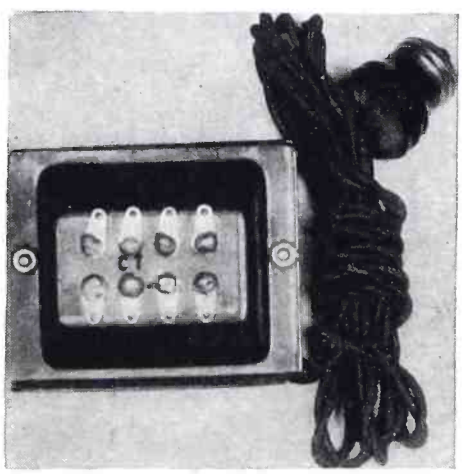
Adjustable Plate Voltages From Any Power-Pack

Name of instrument: Vitrohm Adjustat, type No. 507-77.

Description: This unit is in reality a heavy-duty, high-resistance potentiometer. It is available in several different values of resistance, from the type No. 507-79, which has a maximum resistance of 1 ohm, to the type No. 507-78, with a maximum resistance of 25,000 ohms. All are rated at 20 watts. The particular adjustat illustrated here has a maximum resistance of 10,000 ohms and is capable of carrying 40 milliamperes continuously. The slider, instead of sliding over the resistance winding, slides over copper studs which are connected at regular intervals along the winding. This arrangement eliminates wear on the resistance wire and also permits complete enclosure of the winding proper. The unit is provided for single hole mounting and is equipped with a bakelite knob.

Outstanding features: When one or more are used in series as the resistance network in the output of a power-pack, it is possible to obtain adjustable plate voltages for all valves in the receiver with which the power-pack is used. A variety of types available for any purpose where an adjustable, heavy-duty resistor is required. Accurate in rated values and thoroughly insulated.

Maker: Ward-Leonard Electric Co.



A Filament Heating Transformer for AC Valves

Name of instrument: Filament heating transformer, No. 464-131.

Description: The size of this transformer is 3⅛ by 3¾ by 3¼ inches. It supplies output voltages of 1½ for AC valves of the CX-326 type up to six in number; 2½ volts for a C-327 detector valve; and 5 volts for one or two power valves of the 371 type. This transformer is therefore capable of meeting the requirements of practically any AC receiver. The 2½-volt and 5-volt windings are center tapped. The transformer operates from the 100-120-volt lighting lines, 50 to 133 cycles. It is also obtainable in type No. 464-132 for same voltage at 25 to 40-cycle supply.

Outstanding features: Compact. Low priced. Will supply the AC filament needs of most sets.

Maker: Jefferson Electric Mfg. Co.

A New Automatic Relay

Name of instrument: Yaxley No. 440 full automatic power control.

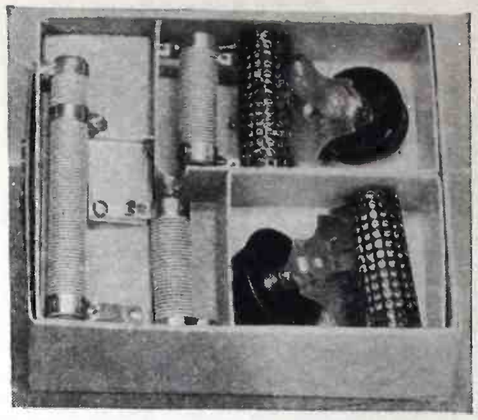
Description: This is a new type of relay which not only automatically connects or disconnects the "A" and "B" power supply, but also prevents the trickle charger from charging the battery to a point where damage will result. As soon as the battery becomes charged to a sufficiently high point, a second relay is thrown into operation and the charger is disconnected from the "A" battery.

With this relay, three automatic operations are possible. When the valves of a radio receiver are switched on, the trickle charger is automatically disconnected from the storage battery, and the "B" battery eliminator is automatically connected to the 110-volt lines. When the valves of the receiver are turned off, the "B" eliminator is automatically disconnected from the AC line and the trickle charger again automatically connected to the proper "A" battery terminals. While this function has been performed by the Yaxley type 444 relay, the new type 440 relay performs the added function of standing guard over the "A" battery charger, cutting it off when the battery has become fully rehabilitated.

The relays are mounted under a pressed steel cover and adequately protected from damage. Four terminals on the back of the relay are used to make the necessary connections between the "A" battery, trickle charger and the receiver. The front of the relay is provided with two electrical receptacles; one to supply the trickle charger with its 110-volt input supply, and the other to supply the "B" battery eliminator.

Outstanding features: Unusually good mechanical construction. Relay provided with large contacts, and long extension cord provided.

Maker: Yaxley Manufacturing Co.



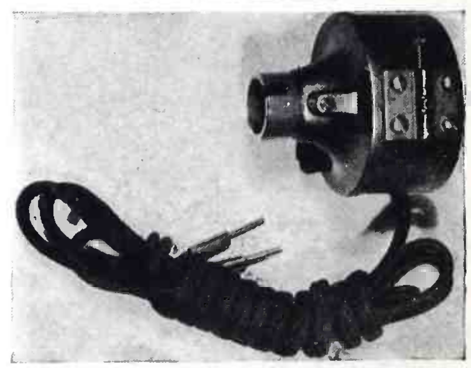
A Resistor Kit for the "H-Q" Power-Pack

Name of instrument: Truvolt "Hi-Q" resistor kit.

Description: This set of heavy-duty resistors provides all the resistances required in the construction of a power-pack for the Hi-Q "Six" receiver. It consists of three fixed resistors and two variable resistors, the latter to provide variable detector and high-frequency plate voltages and a variable "C" bias voltage for the power valve. All of the resistors employ the "Truvolt" type of resistance winding and are designed with an ample safety factor so far as current carrying capacity is concerned. The sliding contacts of the variable resistors work smoothly and provide positive contact.

Outstanding features: Resistance values correct to provide the voltage values required by the Hi-Q receiver. Ample current carrying capacity. Small in size and easily mounted.

Maker: Electrad, Inc.



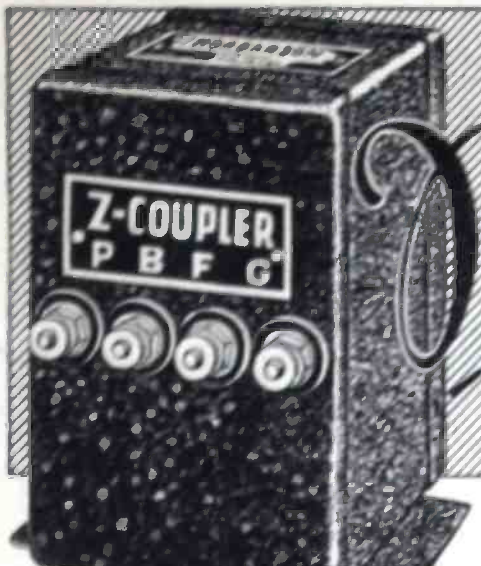
A Pick-up Unit for Old Phonographs

Name of instrument: Baldwin "Needlephone" phonograph pick-up unit.

Description: This pick-up unit is inclosed in a neat bronzed metal case with needle holder and set screw on one side and with an adjustable collar for attachment to the tone arm of a phonograph. It does not require batteries in its operation. It is provided with an extension cord equipped with a pair of tips for connection to the input terminals of a two-stage low-frequency amplifier. When thus connected to the amplifier and with the unit mounted on the tone arm of any phonograph, it is only necessary to operate the phonograph in the usual way to obtain a high grade of reproduction.

Outstanding features: Easily adaptable to different types of phonograph tone arms. Neat appearance.

Maker: Nathaniel Baldwin, Inc.



New! SCREEN-GRID Audio Amplification

The Thordarson Z-Coupler, a special audio impedance coupler for use with screen grid tubes; price each, $12.

Screen grid audio amplification, most revolutionary development in audio systems since the introduction of the power tube, is now an established fact.

The Thordarson Z-Coupler is a special audio coupling device designed for use with the screen grid tube UX-222. With the remarkable amplification thus obtained a mere whisper from the detector is stepped up to a point that gives the power tube all it can handle in the way of signal voltage. In fact, one stage Z-Coupled audio has the amplification equivalent of two, or even three, stages of ordinary coupling. Signals barely audible before may now be heard at normal room volume.

In tone quality, too, the Z-Coupler is unexcelled. Despite the high amplification the tonal reproduction is as nearly perfect as any audio amplifier yet developed. Both high and low notes come through with the same volume increase. Even at 60 cycles the amplification is over 95% of maximum.

Regardless of the type of your receiver you can vastly improve its performance by including this new system of amplification. The Z-Coupler replaces the second audio transformer, with very few changes in the wiring. The screen grid tube is used in the first audio stage. No shielding is required.

THORDARSON Z-COUPLER

THORDARSON ELECTRIC MANUFACTURING CO.
Transformer Specialists Since 1895
WORLD'S OLDEST AND LARGEST EXCLUSIVE TRANSFORMER MAKERS
Huron and Kingsbury Streets – Chicago, Ill. U.S.A.

Write TO-Day for Complete Information

THORDARSON ELECTRIC MFG. CO.
Huron and Kingsbury Sts., Chicago, Ill.
Gentlemen:

Without obligation on my part, please send me complete information on screen grid audio amplifiers using your new Z-Coupler. (3578-C)

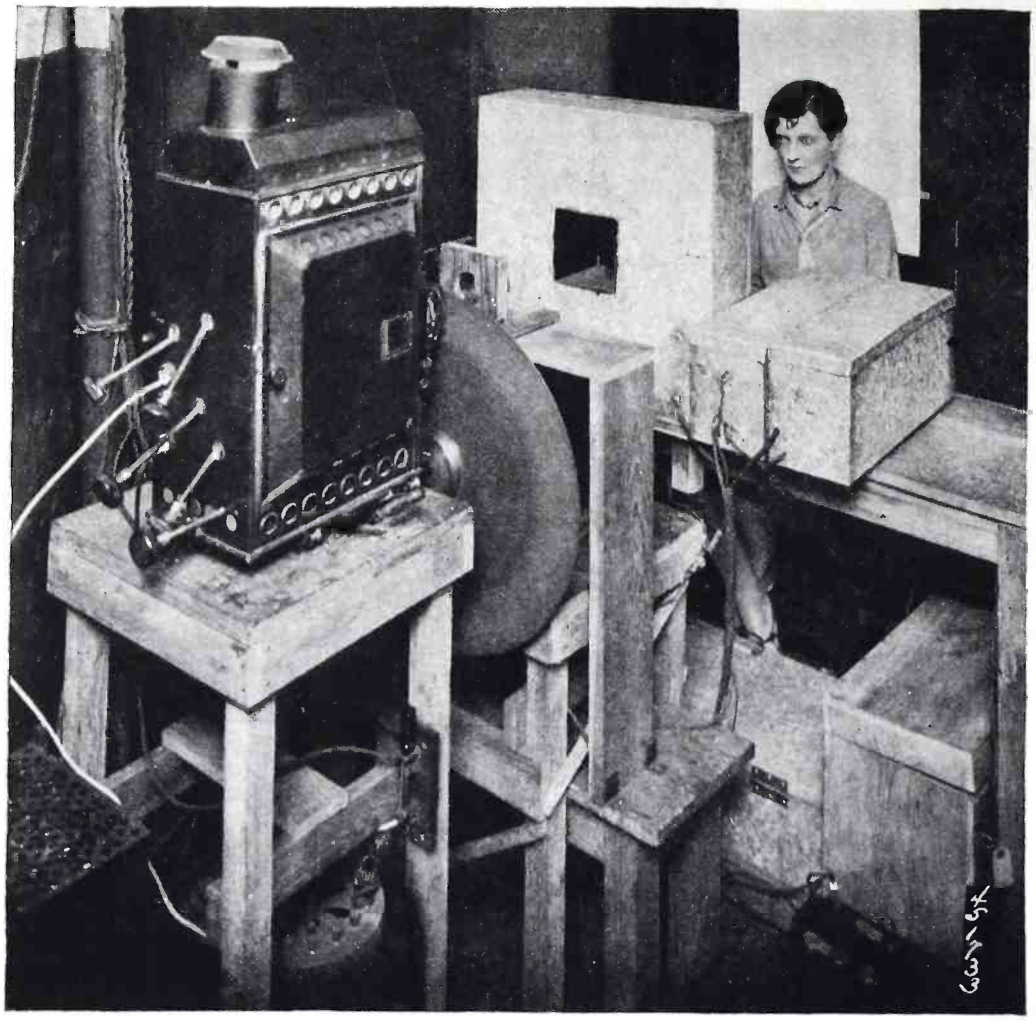
Name ____________________

Street and No. ____________________

Town ____________________ *State* __________

In the World's Laboratories

(*Continued from page 397*)



THE SCANNING DISC METHOD

The more accepted method of television transmission is by the use of a scanning disc such as is shown above. This disc, interposed between the powerful light in the foreground and the image to be transmitted, guides the light beam, by means of small spirally placed holes, so as to cover every part of the image.

rays. The glowing patches correspond to the light and dark parts of the object.

The cathode ray tube employed by Dr. Dieckmann is similar in its construction to the cathode ray oscillograph tube which was introduced by the Bell Telephone Laboratories a few years ago, and which is illustrated in the accompanying picture.

New Radio Circuit Does Not Clip Sidebands

IN A paper delivered at the opening session of the recent convention of the Institute of Radio Engineers, Dr. Frederick K. Vreeland outlined the basic principle of his development which permits reception of the full sidebands of a broadcast signal without loss of selectivity. This is accomplished by means of a system of balanced reactances, which is called a "band selector" inserted in the high-frequency circuit.

The characteristics of this new discovery, its inventor claims, give full leeway for the reception of all the sidebands necessary for faithful tone reproduction.

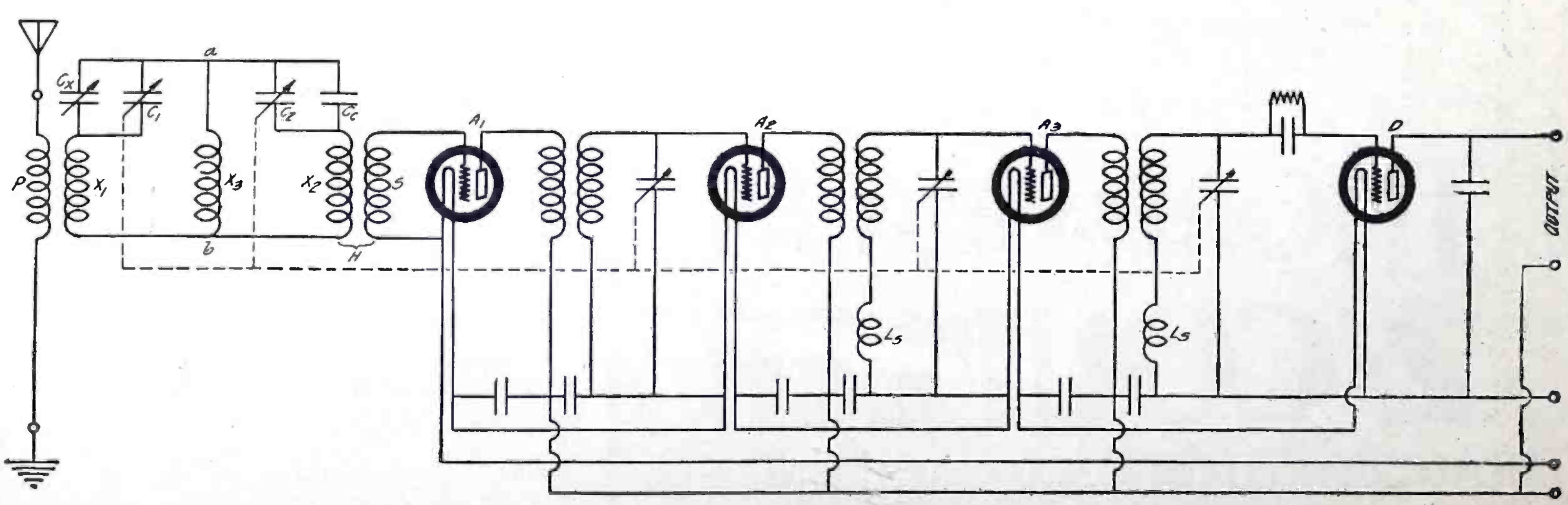
The geometric method of tuning developed by Alexanderson is not used at all in this new circuit. According to Dr. Vreeland, geometric tuning is responsible for much of the distortion of tone in radio reception, because it trims off the sidebands of the signal wave, and the sidebands are what give the tone quality to reception.

The "band selector" is a simple circuit which has the remarkable property of balanced reactances at all the frequencies within a band of 20 kilocycles. An ordinary tuned circuit has its reactances balanced at only one frequency. The balanced reactances are variable and are adjusted by means of an ordinary dial.

Sharp tuning is due, Dr. Vreeland claims, to the unique characteristics of his "band selector." A broadcast signal wave includes sidebands to a width of 20 kilocycles. In an ordinary circuit, the response curve rises to a sharp point, cutting off much of the sidebands. In his circuit Dr. Vreeland shows the response curve takes on the appearance of a rectangle, rising sharply, flattening out at the top to almost the entire 20 kilocycle width, and then descending sharply, thus taking in practically all of the sidebands, yet cutting off the interfering wave sharply at the base.

Distortionless reception and faithful reproduction of tone means that all the frequencies in the transmitted band of the modulated wave shall be received in their true relative intensities. Selectivity requires that a certain group of radio frequencies, comprising a modu-

(*Continued on page 408*)



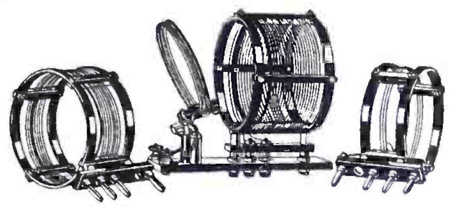
THE "BAND SELECTOR" CIRCUIT

This receiving circuit, Dr. Vreeland claims, is able to receive with equal amplitude all frequencies within a 20-kilocycle band, and exclude all frequencies outside this band. See the oscillograph records on page 408.

Build the Short-Wave Converter Described in This Issue!

Here are the AERO COILS you will need

This kit is the basis of the short wave converter described in this issue.



Experts and amateurs everywhere have found that this Aero Kit improves any circuit.

AERO LOW WAVE TUNER KIT
Code No. L. W. T. 125, Price $12.50

EVERYONE interested in short wave reception should read about the short wave converter described elsewhere in this issue of POPULAR RADIO. This superlative set is designed on sound engineering principles and produces extremely satisfactory results.

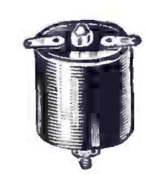
Always the prime favorite of experts and amateurs insistent upon extraordinary short wave performance, the Aero Low Wave Tuner Kit is again specified in this set. Greater volume, finer selectivity, better tone quality and flexibility to a degree never before thought possible is assured by use of these coils.

The Aero Low Wave Tuner Kit illustrated above is completely interchangeable. The kit itself includes three coils and base mounting covering U. S. bands 20, 30 and 80 meters. You can increase the range to 725 meters or decrease the range to 13 meters by securing Aero Interchangeable Coils Number 0, 4 and 5. All coils fit the same base and use the same condensers.

NEW AERO CHOKE COILS

The new Aero Choke 60 has a uniform choking action over a wide range of wave lengths. It eliminates so-called "holes" in the tuning range and is exceptionally efficient in every respect.

Price............................ $1.50



The Aero Choke 248 is an unusually efficient transmitter choke. It presents a high impedance over the usual amateur wave lengths and handles transmitters up to 100 watts.

Price............................ $1.50

Plan for DX Records NOW

Order any of these Aero Coils direct from us if your dealer doesn't happen to have them. Be sure to specify code numbers when ordering.

AERO PRODUCTS, Inc., 1772 WILSON AVE., CHICAGO

Dept. 104

It will pay you to investigate the new Aero Amateur Transmitter Coils and improved Aero Universal Coil, designed for broadcast band usage. These coils are supplied in complete kits for the improved Aero-Dyne Six, the Aero Seven, the Aero Four and other popular circuits. Write for interesting descriptive literature on these and other new Aero products.

In the World's Laboratories

(*Continued from page 406*)

DR. FREDERICK K. VREELAND, THE AUTHOR OF THE NEW CIRCUIT.

lated signal wave, must be separated from all other radio waves.

If we are to receive a full frequency band, or spectrum, of 20 kilocycles width, including modulation frequencies up to 10,000 cycles, obviously the bands of two modulated waves of 20 kilocycles apart will meet with no space between them.

It is claimed that the band selector developed by Dr. Vreeland meets these three stated conditions, i.e., fidelity, selectivity and simplicity. It comprises, in summing up, a system of reactances so related to each other that they are mutually balanced, not merely at a single frequency, as in the case of the ordinary tuned circuit, but also at any frequency within a given band. At any frequency outside of this band the reactances are not balanced and the unbalanced reactance is high. As a result of this property, the band selector unit responds with substantial equality to all frequencies within its characteristic band and is non-responsive to frequencies outside this band. When the system is suitably designed, the cut-off at the limits of the band is very sharp. The electrical and mechanical construction is exceedingly simple, and frequency adjustment is obtained by means of only two variable elements operated by a single control.

Echo Rooms for Broadcast Stations

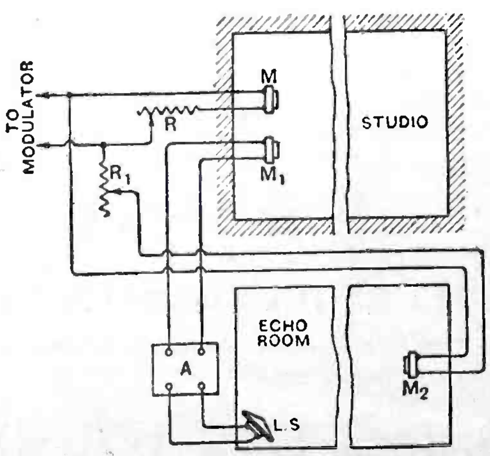
IN AN attempt to add still greater realism to broadcast transmission, an English experimenter and inventor, H. J. Round, has devised an ingenious method of producing echoes, the echo being transmitted simultaneously with the original sound. It is claimed that this method greatly enhances the tonal qualities of the music transmitted, and that it produces a more natural response at the received points.

Our ears are accustomed to hearing echoes. When a symphony plays in a great hall, echoes always accompany the music. As a matter of fact, echo-less music, except in specially prepared broadcast studios, is almost impossible to produce.

To create a radio echo, Mr. Round proposes to use two studios, one of which he calls the echo room. The echo room is really a dummy studio in which there is placed a reproducer connected to a telephone receiver which is placed in the main studio and which is connected to the loudspeaker through a low-frequency amplifier. Thus the music played in the main studio is reproduced in the echo room, where it is again picked up by a microphone and carried to the input of the modulating valves of the radio broadcast transmitter. The dummy or echo studio is free from the usual hangings or drapery used in the main studio, and the microphone picks up all the echoes or reverberations that are produced and which Mr. Round claims are so vital in adding good tonal color and naturalness to the received signal. Rheostats are provided to adjust the relative strengths of the currents flowing in the various microphone circuits.

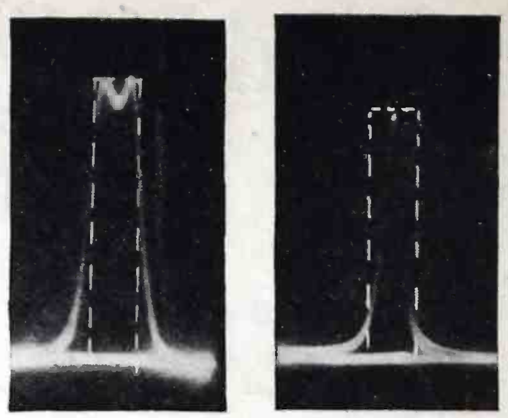
A New German Super-Power Reproducer

SOME authorities on acoustics hold that the principles of the cone reproducer are under a disadvantage in that the driving force is applied virtually at one point on the cone, and that standing waves may be set up in the material of the diaphragm, between the apex and the suspended edge. In an effort to overcome this supposed deficiency, the engineers of Siemens & Halske have designed a super-power speaker operating on the electrodynamic principle. The main object of the design of the new unit is to distribute the driving force over the entire surface of the vibrating medium or diaphragm. The principle used is really that which is now being employed in what we call our moving coil reproducers, similar to the Magnavox and the Radio Corporation's No. 104 power speakers. In these speakers, movement is obtained by permitting the output of the low-frequency system of the radio receiver to flow through a coil suspended in a powerful magnetic field maintained by a separate source of energy. Precisely the same idea is employed in the electrical measuring instruments of the D'Arsonval type.



THE WIRING OF THE ECHO ROOM

The broadcast from the studio is picked up by the microphone M1 and delivered to the reproducer in the echo room. There it is picked up again by the echo microphone, M2, and fed back to be modulated with the original broadcast picked up by the studio microphone, M.



THE OSCILLOGRAPH RECORDS

At the left is the Vreeland wave, showing remarkable broadness at the top with very steep sides, and at the right is an ordinary wave. The dotted lines indicate a breadth of 20 kilocycles.

The moving coil is wound back and forth between the pole faces of a series of powerful magnets. The coil is especially massive, being made up of heavy copper strip, which naturally has a very low value of impedance. A special impedance balancer or matching unit is therefore connected between the amplifier and the moving coil.

The moving coil is attached directly to the diaphragm. Fluctuating currents from the output transformer of the receiver amplifier react with the field between the poles and the magnet, and since the current is the same in each part of the strip the force exerted is the same at each point, assuming that the separate magnetic field is maintained at a uniform value.

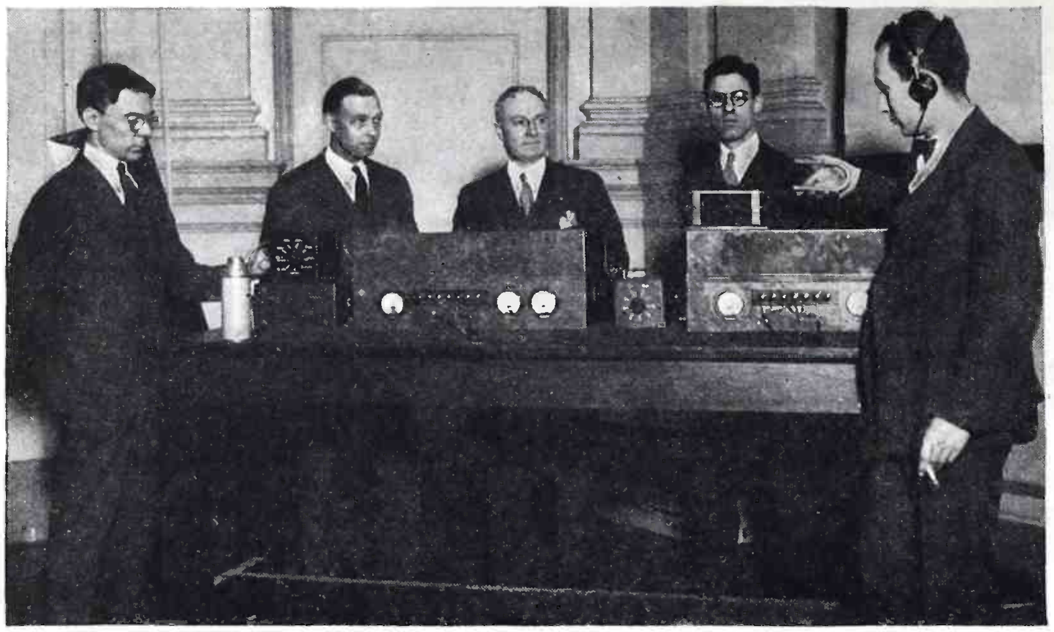
The diaphragm of this huge reproducer has an effective vibrating area of 400 square centimeters, and the electromagnets absorb approximately 600 watts in maintaining the permanent magnetic field surrounding the strip winding. Large baffle boards are used to insure proper radiation at the low frequencies.

This reproducer was first used in public at the opening of the German Museum in Munich and it has since attracted much comment from the German public during demonstrations.

(*Continued on page 410*)

In the World's Laboratories

(*Continued from page 408*)



Underwood and Underwood

ATOMIC NOISES MAKE THEMSELVES AUDIBLE

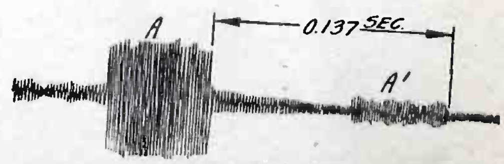
A gathering of scientists at the Engineering Auditorium in New York witnessed this unusual demonstration of atomic upheaval in a magnetized bar of iron. The sounds of the atoms turning about in response to magnetic impulses was amplified ten billion times and made audible to the entire audience through a loudspeaker.

ference. That this reasoning is not necessarily true has been proven on various occasions, and recent experiments at Geltow, Germany, prove beyond all possible doubt the fallacy of this theory. Observers at this point, which is near Berlin, showed that at certain times short waves may travel entirely around the earth's circumference and be received an infinitesimal fraction of a second later at the point where they were first received.

The observations which have finally established this fact were conducted with the assistance of an automatic recording apparatus employing high amplification used in conjunction with an oscillograph, the incoming signals being recorded on a photographic tape strip and carefully analyzed to establish the time element.

The graph shown on this page is a drawing made from the photographic record produced on the oscillograph. A dot was received at Geltow on a wavelength of 15.66 meters from a certain station in Buenos Aires. This dot, indicated in the diagram at *A*, was followed exactly 0.137 second later by a second dot of diminished intensity, A'. These dots were both of exactly the same length, and since they were received with a time separation, 0.137 second, which would be the time required for a signal to circumnavigate the earth at a speed of 186,000 miles a second, there is no doubt but that the wave causing mark A' had traversed the earth before it was recorded.

Considering the great distance traversed by echo impulses, it is amazing to compare its energy with that of the original signal. Yet the faithful oscillograph shows that the amplitude—which is an indication of energy—of the second impulse is astonishingly large when compared with that of the original. Would these experiments seem to prove that there is a definite limit to the degree of sensitivity which we can employ in our receivers? It is obvious that any receiver sensitive enough to receive the original and echo impulses could not afford perfect reproduction, since the echo impulses would obviously be out of phase with the original to the degree of 0.137 second.



A RECORD OF THE FASTEST TRIP AROUND THE WORLD

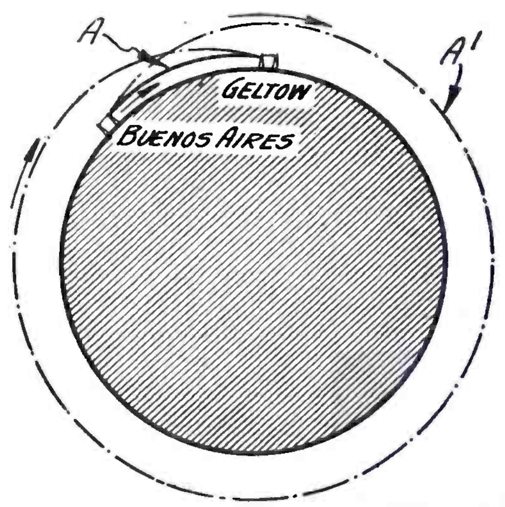
The copy of an oscillograph record shows the original signal, A, received at Geltow, and the esco signal, A', received .137 seconds later. The time interval indicates that the radio waves, travelling at 186,000 miles a second, passed completely around the earth.

Rush of Atoms Heard in a Reproducer

NOISES made by billions of atoms turning over in their beds inside a bar of iron were heard by New York scientists when Dr. H. Clyde Snook, Consulting Engineer of New York City, addressed the New York Electrical Society on "Scientific Conquests of 1927." When iron is magnetized, Dr. Snook explained, it is believed that vast numbers of atoms inside the iron turn around so that all face the same way, as soldiers turn on word of command. In Dr. Snook's demonstration the tiny disturbances created by these acrobatics were magnified electrically to more than ten billion times their original strength and were broadcast to the audience through a powerful reproducer recently developed by the Westinghouse Electric & Manufacturing Company. They sounded a good deal like a carload of dumb-bells turning over as they rolled down a tin roof.

Another noise recovered from the realm of atoms and electrons by the enormous magnifying power of the modern electric apparatus was demonstrated to the society by its discoverer, Dr. J. B. Johnson, of the Bell Telephone Laboratories, New York City. This is the noise made by the tiny particles of electricity jostling against each other when a current flows through a wire. It sounds something like water rushing through a gigantic pipe. Still a third atomic sound was explained by Dr. Snook as the noise made by cooking electricity out of the hot filament of a radio vacuum valve. It sounds not unlike grease frying out of an enormous piece of bacon. By way of contrast to these unusual sounds, phonograph music was reproduced electrically by the new Westinghouse instruments with volume greater than that of a large orchestra.

The means employed for amplifying the minute electrical effects produced by jostling electrons and atoms is that of vacuum valve amplification. Powerful vacuum valve amplifiers of special construction are used to make audible the apparently terrible noises that are beyond the range of the human ear.



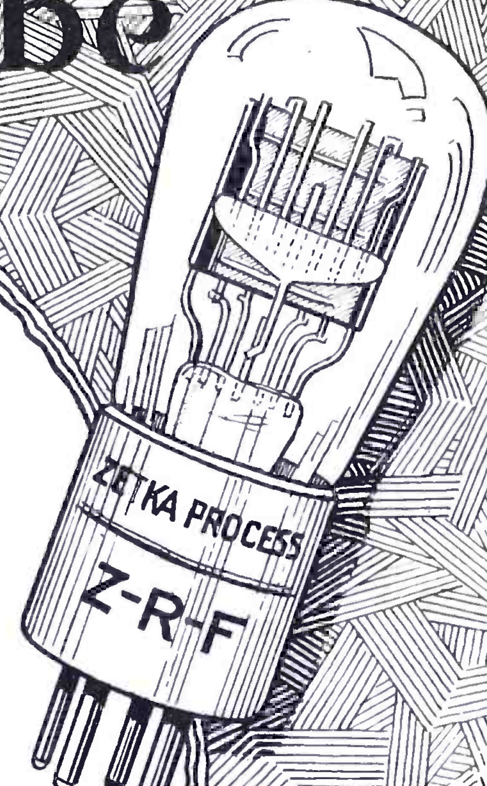
AROUND THE WORLD IN 0.137 SECOND

Part of the signal impulse from the station at Buenos Aires was received at Geltow after traversing the distance A. Another part of the signal impulse, A', passed completely around the world and was received .137 second later at the same station.

Short-Wave Echoes

IN THE early days of radio it was assumed by the investigators of the day that the maximum distance which a radio wave could travel amounted approximately to one-half the earth's circum-

The Individual Tube



THE ZETKA PROCESS SPECIAL DUTY TUBES

This new line of tubes—to deliver the results of which they are capable—require proper operation.

We are trying to restrict their distribution to Dealers who cater to "Fans," Amateurs, Professional Set Builders and Service organizations—the "RADIO-WISE" buyers who handle laboratory products most intelligently.

If your dealer cannot yet supply you, we will appreciate your sending us his name and address. In the meantime, we will fill your order direct on receipt of your check or money-order—or C. O. D., if you prefer.

—ZETKA PROCESS SPECIAL DUTY TUBES are guaranteed to give complete satisfaction in your receiver provided they are operated according to the instructions accompanying each tube.

ZETKA LABORATORIES, Inc.
67-73 WINTHROP ST
NEWARK, N. J.

Z-R-F—Radio Frequency Amplifier. 5 volts, ¼ amp. High amplification constant. Low plate impedance, and low internal capacity. Uses 90 volts on plate... **Price $4.50**

Z-D—Super-sensitive Detector. 5 volts ¼ amp. High amplification constant. Silent (no hiss). Uses 45 volts on plate........ **Price $4.00**

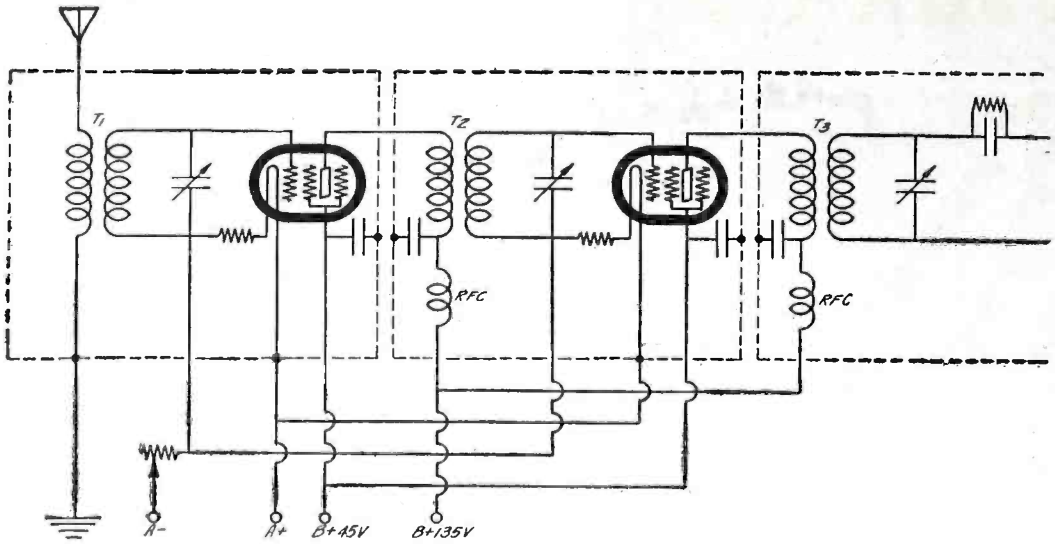
Z-A-F—Audio Frequency Amplifier. 5 volts, ¼ amp, Higher Mu, low impedance. Plate voltage 90 to 135 .... **Price $4.50**

Z-A-O—Audio Output, or Power Amplifier. 5 volts, ½ amp. For handling large output volume without distortion. Plate voltage 180, with 22½ volts 'C'........ **Price $4.50**

ZETKA
CLEAR GLASS TUBES

In the Professional Set Builder's Shop

(*Continued from page 400*)



A TYPICAL SCREEN GRID HIGH-FREQUENCY CIRCUIT

FIGURE 4: *This high-frequency amplifier circuit has been worked out with the characteristics of the screen grid valve in mind, and is devised to take full advantage of their virtues.*

What Screen Grid Valves Mean to the Set Builder

INTENSE interest has been aroused among professional set constructors as to just what effect or benefit the new screen grid valves will hold for them. There seems to be belief in some quarters that this new valve, which has been designated the CX-322, can be substituted for the old-type valves in the high-frequency portion of existing receivers.

Actually the screen grid valve cannot be used except in a specially designed amplifier. The first reason for this is that the control grid terminal is no longer one of the contact prongs in the base of the valve, but instead is brought out at the top of the valve. This means that the grid connections from the coil and condenser are to be made to the top of the valve and the special connections to the new screening grid are to be made to the terminal of the socket that is used for the control grid connections in the usual hookup for standard valves.

The filament requirements of the new valve are much different from those of the standard CX-301-a type valve, in that the new valve filaments operate on 3.3 volts instead of 5 volts, and the filament current required by the screen grid valves is only half that required by 301-a's.

Finally, and perhaps most important of all, the screen grid valves cannot be used to any advantage with the usual type of tuned-high-frequency transformer. They should be used with either tuned-impedance coupling or with high-frequency transformers that have a turn ratio between primaries and secondaries of about 4 to 5. The usual ratio of about 1 to 6 is practically useless.

If more evidence of the necessity for a special circuit is needed, it is found in the fact that the screen grid valve requires a small negative "C" bias on the control grid and a totally new circuit for the screen grid connections.

In circuits especially designed for the new valves, they offer some really remarkable possibilities. A single stage of well-designed high-frequency amplification, employing the CX-322 screen grid valve, is capable of providing up to five times the amplification obtained with a correspondingly well-designed stage which employs a CX-301-a type valve.

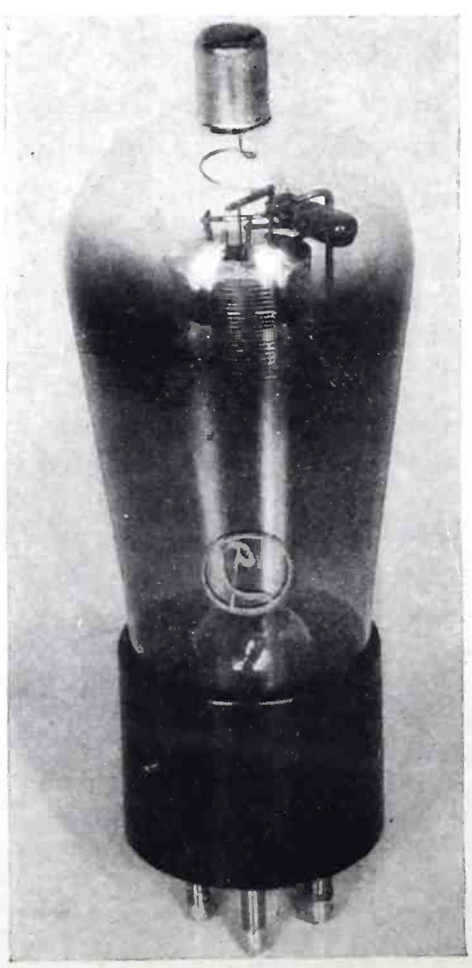


FIGURE 5: THE CX-322 SCREEN GRID VALVE

Their second outstanding feature is the fact that these new valves require no neutralizing because the internal shielding afforded by the screen grid eliminates internal feedback. They are, however, susceptible to external feedback through undesirable interstage coupling, and therefore require careful shielding. As a matter of fact, shielding is more imperative in a two-stage high-frequency amplifier which employs these valves than in a similar amplifier which uses CX-301-a type valves, because of the far higher amplification obtained with the new valves.

Filament requirements of the CX-322 type valves are low enough to permit the use of dry-cell batteries in a receiver where the balance of the valves are of the CX-299 type. The filament current consumption is only twice that of a valve of the CX-299 type and the filament voltage is the same as for the CX-299.

Preliminary tests seem to indicate that as a low-frequency amplifier valve in a resistance-coupled amplifier the CX-322 type valve provides a higher degree of amplification than the standard high-mu type valves. Amplification of approximately 35 per stage is obtainable when thus used, and the frequency curve is unusually flat all the way down to below 60 cycles.

For those who wish to experiment with the new valve, a suitable circuit for a two-stage high-frequency amplifier is shown in Figure 4. The high-frequency transformers, T2 and T3, employed may be some of the new transformers now being placed on the market for use with this valve, or may be standard high-frequency transformers with a new primary wound directly over the secondary and with about four-fifths as many turns as are already on the secondary. The rheostat which controls both valves should have a resistance of 20 ohms and the fixed resistors in the negative side of each filament should have a resistance of 10 ohms. The voltage drop across these fixed resistors will provide the necessary negative bias for the grid, if connections are made as shown in the diagram. The four by-pass condensers may have a capacity as low as .006 mfd. each, although higher capacities up to .5 mfd. are to be preferred. The high-frequency chokes in the plate leads are optional.

If only a single high-frequency stage is employed, the complete shielding shown in the diagram may not be necessary.

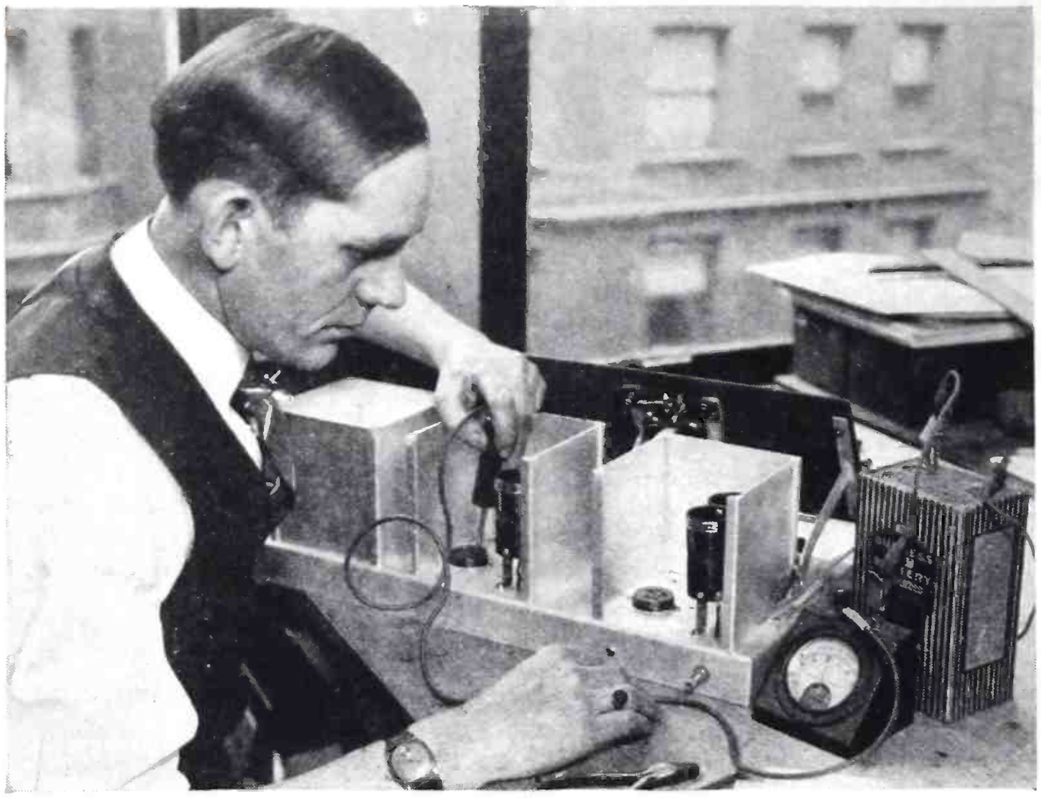
The high-frequency coupler used in the antenna circuit may be any standard high-frequency transformer for antenna tuning.

—RALPH YOUNG

(*Continued on page 414*)

In the Professional Set Builder's Shop

(Continued from page 412)



THE HOOK-UP FOR CONTINUITY TESTS

FIGURE 6: *A 45-volt "B" battery and a high-resistance voltmeter are connected in series, and the various circuits of the receiver tested for continuity by applying the pointed tester to the proper terminals and lugs of the receiver.*

How to Test a Receiver for Circuit Continuity

IT IS doubtful if there are any two radio service men who test a receiver exactly alike. Each one has his own particular system for going over the vital parts of a receiver and bringing to light the defects. The author's method is the result of many years' experience in servicing sets, is offered as a thoroughly practical, simple and efficient way of locating circuit defects in new or old sets.

The practise of first "hooking up" a set with batteries is not a good one. Circuits should first be tested for continuity. In the case of a newly completed receiver, these tests are especially valuable as a check against the possibility of forgotten wiring, rosin-joints, short-circuits, etc.

The LC-28 receiver, shown schematically in Figure 7, is taken as an example to illustrate the author's method. The testing equipment used consists of a 45-volt battery (or the detector tap of a "B" power-pack), a high-resistance voltmeter of 100 volts, a battery clip lead and a pointed tester such as is manufactured by the Universal Tester Equipment Co. These units should be hooked in series as shown in Figure 6. With this hook-up the tests for circuit continuity in the LC-28 are as follows:

TEST ': Apply the clip to the "A" positive (+) binding post, and touch the "A" positive (+) terminal of the detector socket with the pointed tester. Open and close switch A, which is part of the rheostat, several times and watch the voltmeter of the testing hook-up. The voltmeter should show a deflection commensurate with the battery voltage.

TEST 2: With the switch closed and the clip still on the "A" positive (+) binding-post, put the tester on the "A" positive (+) terminal of the first, second and third sockets, respectively. Full reading on voltmeter should result.

TEST 3: Next place the clip on the "A" negative (—) binding-post and check as before, using the "A" negative (—) posts of the sockets.

TEST 4: Leave the clip on the "A" negative (—) binding-post and place the tester in contact with the plate terminal of each successive socket. This is to see if a short-circuit exists between the plate and filament. No voltage reading should be obtainable on the voltmeter in Test 4.

TEST 5: With the clip on the "A" negative (—) post put the tester on the grids of the sockets. This voltage should read a little less than the battery voltage, due to grid suppressor resistance and will read from 2 volts to 5 volts, dependent upon the ohmage resistance of the suppressor. The detector socket in this test will show nothing on voltmeter due to the insertion of the grid condenser. However, temporarily short circuiting the condenser with a small piece of wire will yield a voltage reading. Do not forget to remove this wire upon completion of test. In some sets, where the grid-leak is in parallel with the grid condenser, there will perhaps be an extremely low reading, but a good meter is necessary.

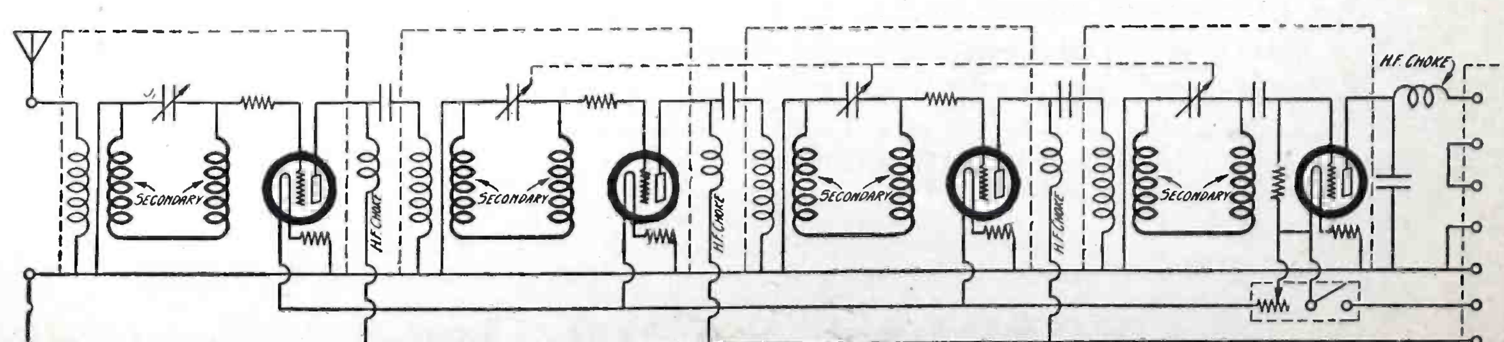
TEST 6: Test between the aerial and ground for full voltage reading, except in such instances as where a condenser is in series with the antenna.

—ROBERT W. TAIT

A Homemade Ground Clamp

A VERY good clamp for connecting the radio ground wire to a water pipe can be made from a discarded "five-minute" vulcanizer. The arms on the threaded portion are sawed off and the end of the shaft filed to a point. The base can be trimmed to a convenient shape and the ground wire fastened to it. The clamp is placed on the water pipe and the point is screwed down so as to bite into the pipe.

—L. C. FERGUSON



THE CIRCUIT TESTED

FIGURE 7: *The circuit of the LC-28 receiver is shown above for the purpose of illustrating the tests described in the article on this page.*

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Aerovox Wireless Corporation

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(Continued on page 418)

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Synchronizing Television With Light Beams

(Continued from page 382)

shunt-wound field coils for normal speed control.

In starting up the apparatus it is essential that the motor speed be regulated by the operator until his picture is steady, which condition implies exact timing with the incoming picture signals. Considering that the picture is steady, the successive flashes, C, reflected by the small mirror shown in the middle of the rapidly vibrating flash beam, B, in Figure 3, will register upon the chopper K (shown also at C in Figure 1), so that about one-half of each flash is stopped by the chopper bar and the other half falls upon the lens next to the chopper and is focused to fall upon the photo-electric cell, F. Now suppose that the motor speeds up a little bit, causing the flashes C, Figure 1 and 3, to overlap the bars *more* than halfway, let us see what takes place: (1) The quantity of flash light which passes through the slits is lessened; (2) Dimmed lights falls upon the cell; (3) The current in the cell is decreased; (4) The current in the reversed-field coil is decreased; (5) The tendency to *reversing* the field is lessened; (6) The field itself resumes its normal full strength by virtue of its fixed shunt-winding excitation; (7) The motor slows down a little bit due to the stronger field; (8) The signal flashes are backwardly deflected by the scanning element due to the lagging action so that more light falls in the slits, passes through the lens and falls upon the cell; (9) The current in the cell and in the reversing field coil is increased, thereby weakening or de-polarizing the field; and (10) The motor again starts to speed up. This swinging, automatic, speed control cycle repeats again and again, as long as there is enough average light during each synchronizing cycle to stir up sufficient speed-up current. By providing an amplifier which has an output of about 1 watt, enough reserve energy is available for control.

Each synchronizing cycle embraces, say, an interval of 1-200th second, and consists of 200 valved flashes passing from dim illumination on the cell, to medium illumination, to bright illumination; and repeating the cycle. The frequency of the synchronizing cycle is determined by considering that 99 bar traversals occur in the time interval during which, for exa-' synchronism, 100 traversals should occur. Figure 2 shows such a synchronizing cycle consisting of 200 successive picture flashes progressively intercepted by virtue of underspeed and overspeed; the line G indicates the comparative value of the reverse energy required to maintain synchronization or "critical speed."

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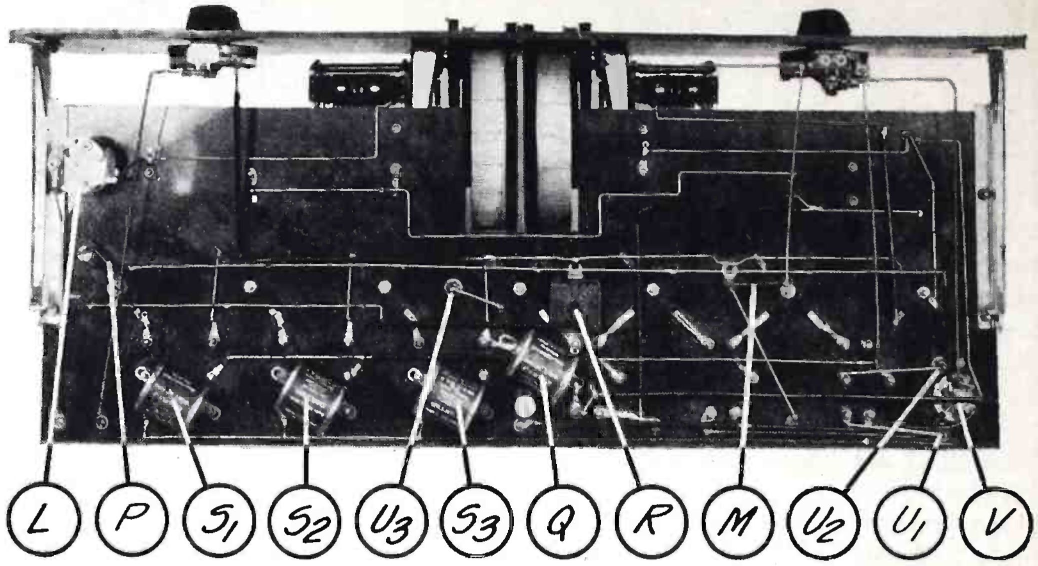
Before me, a Notary Public in and for the State and county aforesaid, personally appeared Douglas H. Cooke, who, having been duly sworn according to law, deposes and says that he is the Publisher of the POPULAR RADIO and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 411, Postal Laws and Regulations, printed on the reverse of this form, to wit: 1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Douglas H. Cooke, 119 West 57th Street, New York City, N. Y.; Editor, Raymond F. Yates, 119 West 57th Street, New York City, N. Y.; Managing Editor, Charles L. Davis, 119 West 57th Street, New York City, N. Y.; Business Manager, E. A. Harm, 119 West 57th Street, New York City, N. Y. 2. That the owner is: POPULAR RADIO, Inc., whose stockholders are: Douglas H. Cooke, 119 West 57th Street, New York City, N. Y.; Laurence M. Cockaday, 119 West 57th Street, New York City, N. Y.; Theodora W. Cooke, 59 Beechmont Drive, New Rochelle, N. Y.; Charles C. Moore, 345 Madison Ave. New York City, N. Y. 3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are, NONE. 4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him. Douglas H. Cooke, Publisher. Sworn to and subscribed before me this 20th day of March, 1928. Gerard J. Traub, Notary Public, Queens County. (My commission expires March 30, 1929.)

Here's a Superheterodyne with Screen Grid Valves

(*Continued from page 374*)



THE UNDER SIDE OF THE SUB-PANEL

FIGURE 5: *This view gives an idea of the simplicity of the wiring of the set—a very remarkable job for a superheterodyne. No wiring is done above the sub-panel.*

and third screen grid valves, should then be placed in position. Figure 2 shows the fixed resistances that are in series with this last mentioned rheostat and that are incorporated within the impedances themselves.

In wiring the receiver, it is recommended that every precaution be taken to follow the wiring diagram *exactly* as shown in Figure 2, using preferably the Acme celatsite. Make sure that all connections are tight and rigid, and in the instances where nuts are used, that they are all tightened down securely.

Upon the completion of the wiring, it would be advisable to check the completed receiver against both the schematic wiring diagram in Figure 4 and the picture wiring diagram in Figure 2.

The Operation of the Tyrman "70"

In placing the Tyrman "70" in operation, place three CeCo screen grid valves in sockets I1, I2 and I3, a Zetka Z-200-a valve in sockets I4 and I5, and a Zetka type Z-171 in socket I6. The oscillator valve, in socket II7, of the Zetka ZP-201-a type. It is necessary to connect the binding posts of the three screen grid valves in back of the second detector to the ground binding post. The Electrad socket antenna should then be connected to binding post T1. T2 is connected to the ground. T3 is the positive binding post of the 4½ volt "C" battery. T4 connects with the 3-volt negative-post on the 4½-volt "C" battery. T5 connects with the negative terminal of the 22½-volt Burgess "C" battery, which is in series with the 4½-volt "C" battery. The Knapp "A" supply positive (+) is connected to the red lead of the Yaxley cable. The negative (—) "A" of the Knapp supply connects with the black lead of this same cable. The "B" battery supply, consisting of three 45-volt Burgess "B" batteries, in series are connected up as follows: The negative (—) lead is connected to the yellow wire of the Yaxley cable; the blue lead of the Yaxley cable is connected to the 67½-volt positive (+); the brown wire is connected to the 90-volt "B" positive (+), and the green wire to the 135-volt "B" positive (+). All these connections are shown graphically in Figure 3.

The Browning-Drake reproducer is connected to the receiver by means of Gavitt extension cord.

It would, perhaps, be well to insert each valve in the socket *after* the batteries have been connected, so as to make sure that no damage will ensue due to defective wiring. In the event that in congested districts it is found that scarcely enough selectivity exists, this may be remedied very simply by the use of a short wire, eight or ten feet long, as an antenna instead of the socket antenna previously referred to. Under favorable conditions the distance possibilities of this set are very great.

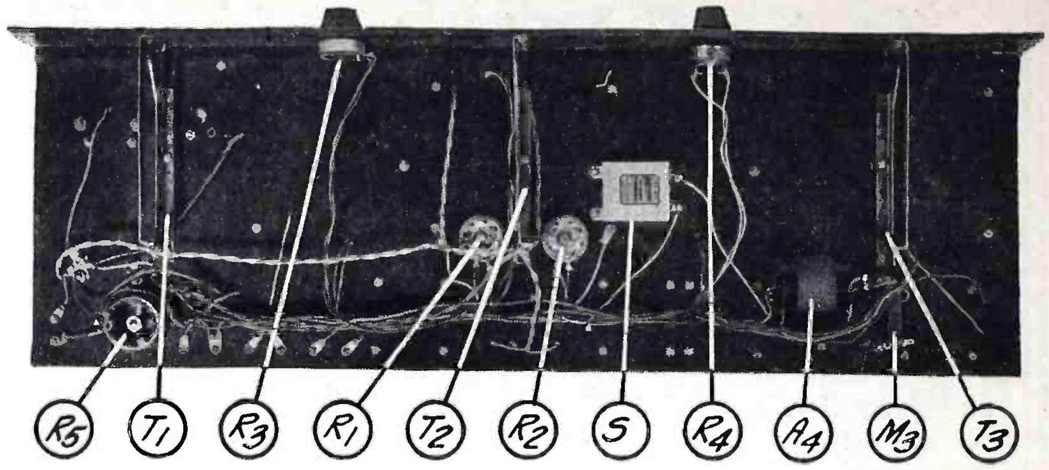
It will be necessary to tune very slowly, and both dials should be rotated simultaneously. They should approximate within ten degrees the setting of each other. Volume is controlled through the regulation of the rheostat, N and O.

Pictures by Radio

The Rayfoto apparatus for receiving pictures by radio will be described next month in POPULAR RADIO

Building the QSA-5

(*Continued from page 369*)



THE UNDER SIDE OF THE RECEIVER

Figure 5: *This view shows the proper method of cabling the wiring, and the placement of the parts mounted under the sub-panel.*

resistances, Q1 and Q2. The Centralab heavy duty potentiometer, R5, should then be connected as shown in Figure 2. Upon completion of your wiring, carefully check for errors, loose connections and forgotten wires.

How to Hook Up the Receiver

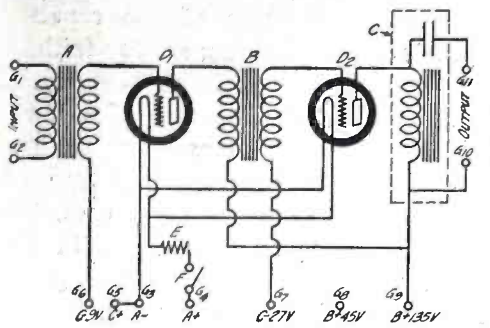
After the wiring has been completed, a Raytheon type BH rectifier valve should be inserted in socket L6. Three Ceco RF 22 screen grid valves should be inserted in sockets L1, L2 and L4, a Ceco type H valve in socket L3, and a Ceco type J-71 valve in socket L5. The ground wire should then be fastened to the proper binding post as shown in Figure 3. The photo-diagram also shows the proper connections for the SPN reproducer, which should be located at some distance from the receiver, and the Knapp "A" power unit. Make sure that a sufficiently low tap on the "A" supply unit is used to insure the valves against too high a filament voltage. The Thordarson compact, I, and the Knapp "A" power unit may be connected to the lighting lines and turned "on." The set should now be in operation. Tuning is controlled by the double drum dial, B. Volume is controlled by the Clarostat unit, R4. The rheostat, R2, is an adjustment for maximum voltage on the filaments of the screen grid valves and R3 is a filament control used in conjunction with the latter rheostat. It is important to adjust the 5,000-ohm Centralab potentiometer, R5, to its best point so that proper "B" voltage may be applied to the screen grid valves. A little aural experimentation will suffice to determine this voltage. It will be found that, due to the great amplification obtainable with the receiver, excellent results on most stations will be had with the volume control only partly advanced. As to distance possibilities, an advance model of the receiver, operating 15 miles from the center of Chicago, brought in stations within the radius of a circle bounded by New York, Havana, San Antonio, Los Angeles and Oakland, California. It was also able to get WEAF clearly through the signals of WCFL in Chicago, and WJZ through the signals of the local station WMAQ.

More Data on Television

The continued research of the Popular Radio and Television Laboratory in the use of simple television apparatus will be featured next month in this magazine. This is an opportunity for every experimenter and fan to enter this absorbing field at the very beginning. Don't wait for the rush—get the June number of Popular Radio and Television.

The National Screen Grid Tuner

(*Continued from page 396*)



THE CIRCUIT OF THE AMPLIFIER

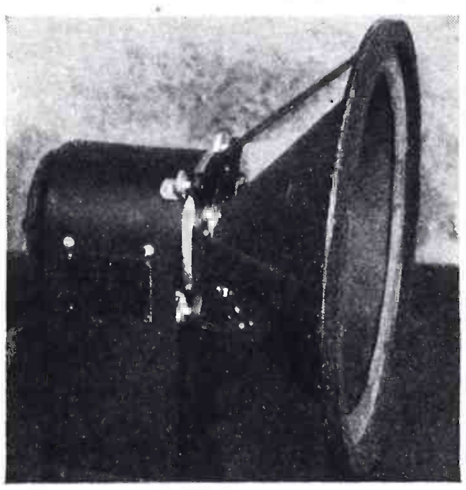
FIGURE 5: *The wiring of the Karas low-frequency amplifier may be ascertained from this diagram. The mounting of the parts is shown in Figure 3.*

extent while increasing sensitivity to a marked degree. The lower left dial which controls the filament of the screen grid valve should be kept turned down as far as possible consistant with good quality and the desired signal intensity. This will help considerably to prolong the life of the screen grid valve. The total absence of lost motion and the smooth and positive action of the drum dial will prove a revelation to the most critical. While this set may be small its distance possibilities are very large.

Figure 3 shows very plainly the Belden cable connections to the various parts which supply the "A" and "B" current for this set. The Electrad socket antenna will supply sufficient radio energy for average needs.

Dynamic Speakers

(*Continued from page 366*)



THE JENSEN SPEAKER WITH CABINET REMOVED

nected directly to the output of a receiver.

The Jensen speaker comes mounted in a highly-polished cabinet measuring 14 by 16 by 12 inches, which also serves as a baffle board. When the units are ordered without the cabinet, some baffle system must be provided.

The response curve of the Jensen is particularly gratifying, responding to frequencies as low as 40 cycles and as high as 10,000.

The Onward March of Radiovision

(*Continued from page 371*)

to that cell. No television transmission demonstration has ever been made, as yet, in which the subject could be placed more than a few feet from the scanning apparatus. Facilities are still limited to sending a single face or a simple object. Where reasonable detail has been attained, as with the system of Alexanderson and that of Bell Laboratories demonstrated by Ives, short waves and several channels were required, so as to increase the number of images handled. To have reproduced Alexanderson's demonstration on the present broadcast band would have necessitated the simultaneous and coordinated use of four broadcasting stations and at the receiving end of four receiving sets.

Television on the broadcasting band, employing a single station, is constrained to the transmission of an image which can be reproduced with but 312 picture impressions, the maximum which can be transmitted with 5,000-cycle modulation. This is roughly a picture one inch square of 17 screen, or 17 dots per linear inch. Pictures in newspapers are of 55 screen and in this magazine, 110 screen.

Television, in order to attain perfection, must be able to thousandfold the capacity of present systems—a task of tremendous magnitude. The screen must go up to at least 50, or 2,500 dots per square inch, and the size of the picture to at least four by five inches, making necessary the transmission of 50,000 impressions each sixteenth of a second. That entails an available modulating frequency of about a million cycles. Present limitation to 5,000 cycle modulation accounts for the very crude results obtained with shadowgraph machines.

With such a system as Cooley's, on the other hand, introduction of photographic processes both in transmission and reception overcomes all of these limitations. The camera at the transmitting end does the work of collecting the images involved, however extensive their area, on a single sheet of photographic paper. Scanning is, therefore, readily accomplished without reflecting lights from subjects confined to a few inches of area.

At the receiving end, photographic processes likewise make it possible to overcome the limitations of ether channels. As much time as is wanted can be taken to transmit a single picture, instead of being limited to a sixteenth of a second, because the photographic paper at the recorder collects images over any desired period. With the Cooley system, for example, a received 4 by 5 picture consists of more than 100,000 image impressions. Modulation of 800 cycles is employed, taking fullest advantage of the capacity of the average receiving set for faithful reproduction. There is no comparison between the program value of a moving picture of 312 impressions with a permanently recorded still picture of 100,000 impressions. In one case, the result is a bare silhouette, and in the latter, a news picture of better grade than appears in the daily press.

The first regular broadcasting of radio photographs was undertaken by WOR, of L. Bamberger & Company, Newark, N. J., using the Cooley Rayfoto system. This system is unique in that it employs a corona discharge for making the photographic print. The corona discharge is obtained by the use of a single vacuum valve. Its light is ultra-violet and blue purple, which most readily affects photographic paper and makes possible the use of insensitive and inexpensive papers. No special dark rooms are required because the paper is not highly responsive to strong light. Furthermore, the corona is sprayed directly on the paper itself, involving no lenses, mirrors or moving parts and thereby greatly increasing the available light. These features account for the simplicity, economy and low initial cost of the Cooley system.

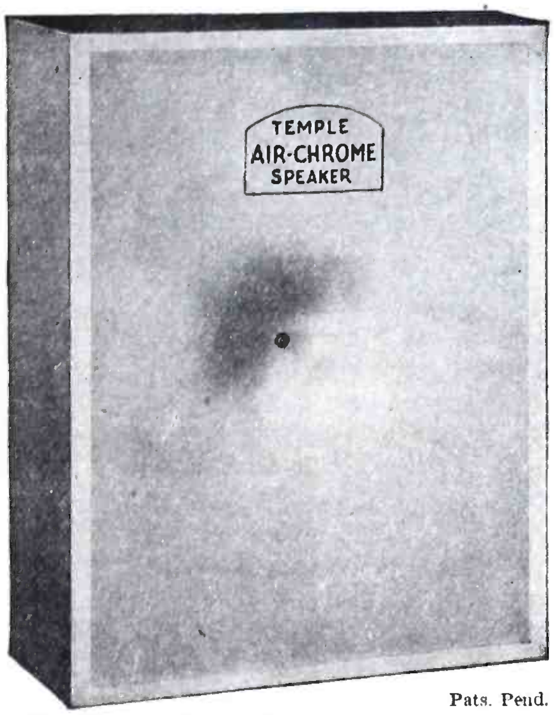
To receive Cooley pictures, any good broadcast receiver may be used. The output of its two-stage low-frequency amplifier is supplied to an amplifier-oscillator unit, which changes the picture signal into a high-frequency modulated current suitable for radiation as corona discharge. This two-valve unit is no more difficult to build than a two-valve radio receiver. The first valve acts as an amplifier-rectifier, the output of which modulates that of the second valve, which is a high-frequency oscillator of the Hartley type. The oscillating circuit is the tuned primary of a Tesla coil. The high voltage end of this Tesla or corona coil is connected with a needle on the printer unit.

The printer unit consists essentially of a revolving drum, a corona needle holder, the movement of which is actuated by a finely threaded shaft across the surface of the paper, a clutch mechanism and a trip magnet for accomplishing synchronization. Any good phonograph may be used as a power source for the printer unit. The printer unit is a precision instrument, in that its functioning determines the correct placing upon the photographic paper of the 100,000 odd picture impressions.

It can be seen from this brief description that the Cooley Rayfoto system is a thoroughly simple, thoroughly practical method of receiving broadcast pictures by radio.

TEMPLE

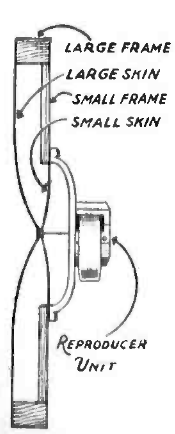
The New Temple Air-Chrome Speaker



Pats. Pend.

Model F. Note the simple and sturdy construction. The straight lines make for easy installation. Temple Air-Chrome Speakers are licensed under the Whitmore inventions.

The "How" and "Why" of the Temple Air-Chrome



The Air-Chrome principle, while it is new, is so logical that the efficiency of this type of construction is readily appreciated. In Air-Chrome construction, two tightly stretched skins, chemically treated, form the diaphragm. This diaphragm is so arranged that the large front half is tuned to the lower frequencies and the smaller or back half to the higher frequencies. Both halves are balanced at the center. At this balanced center the driving unit operates and as there is no dead weight to overcome because of the balanced feature it is easy to understand how the slighest impulse on the driving unit is instantly transmitted to the taut diaphragm. The result is a sensitivity, a frequency response and a handling capacity in undistorted volume that is a revelation in speaker design.

THE Temple Air-Chrome represents one of the most startling speaker developments that the industry has ever seen. It couples Temple engineering and experience in speaker manufacturing with one of the most advanced principles ever developed in sound reproduction and at the same time carries with it more of the essentials demanded by set builders than any speaker developed up to this time.

The Temple Air-Chrome is of the open radiator type. Its diaphragm is so arranged that the larger front half is tuned to the lower frequencies and the smaller, or back half, to the higher frequencies. This type of construction makes possible the balanced tension principle whereby the slightest impulse is carried from the driving unit to the diaphragm without any loss. Lightness is combined with rigidity, climatic changes have no influence in that no paper is used, and the mechanical construction and design eliminates the inherent difficulties ordinarily met with in open radiator types.

Special Temple Double Action Unit Employed

The inherent factors of the Temple Air-Chrome, plus the performance of a specially developed powerful Temple Double Action Unit, accounts for its handling capacity—for its enormous volume—its brilliancy—its full response to all audible frequencies. That's why the Temple Air-Chrome will not chatter—why it is suited particularly to every kind of power output.

Three Standard Sizes:

Model K	Model J	Model F
14″ x 14″	24″ x 24″	18″ x 23″
$20.00	$25.00	$23.00

All Light in Weight

As can be seen from the illustration, Temple Air-Chrome speakers are plain but business-like in appearance. The square or rectangular frames not only offer maximum protection for the entire unit, but makes possible an ease of installation which set builders will appreciate. The three standard sizes lend themselves to a multitude of cabinets or console designs.

AIR-CHROME DIVISION

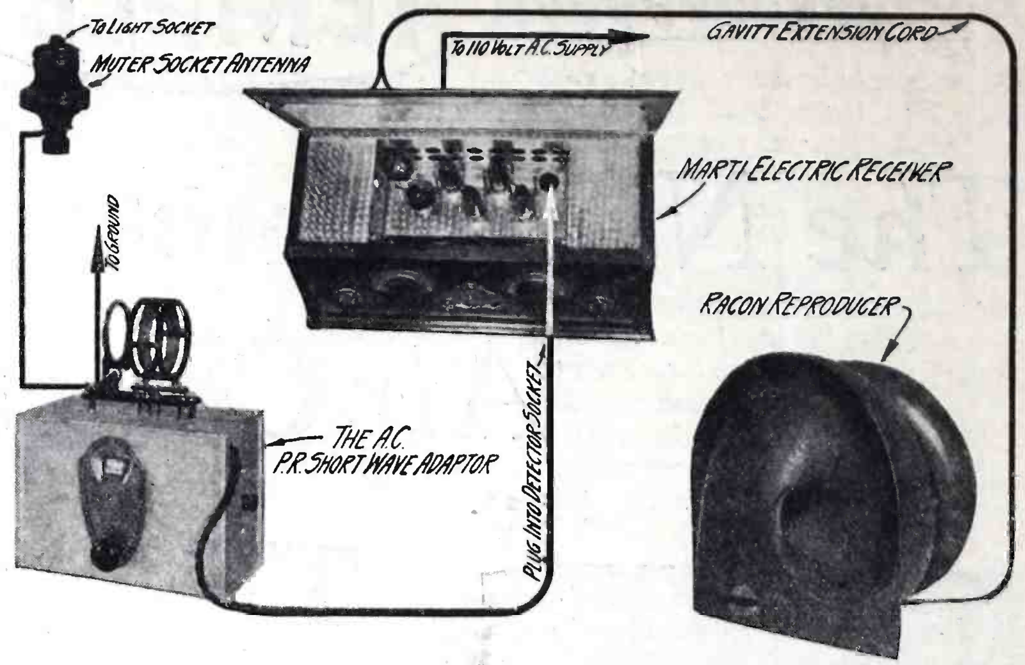
TEMPLE, INC.

1925 S. Western Ave. Chicago, Ill.

LEADERS IN SPEAKER DESIGN

A Short-Wave Converter for AC Receivers

(*Continued from page 393*)



THE OPERATING HOOK-UP

FIGURE 3: *The connection between the converter and the broadcast receiver (Marti Electric illustrated) is made with a plug made from a burnt-out five-prong socket.*

fastened to the right-hand side panel by means of machine screws and nuts. Two spacing washers approximately 1/4 inch thick should be inserted between this instrument and the panel. Drill a hole 3/8 inch in diameter in the upper left-hand corner of this panel for passing through the twisted leads of the connector plug.

How the Converter is Wired

The wiring details and the proper positions of the instruments are shown in Figure 2. The coil assembly, A, which is mounted on top of the box shield, is shown in dotted black lines. The instruments that are mounted within the box shield, I, are outlined in solid black lines. Wiring done inside the shield is shown in solid red lines, and that done outside the shield in dotted red lines. The instruments are outlined in black.

In making the wiring connections on this unit it is recommended that the constructor use insulated wire such as Corwico rubber covered hook-up wire.

When the wiring has been completed, each lead should be re-checked with the picture wiring diagram in Figure 2. After this has been completed the grid-leak, G, is inserted in the grid-leak clips, and the short-wave converter is then ready for connecting to the broadcast receiver.

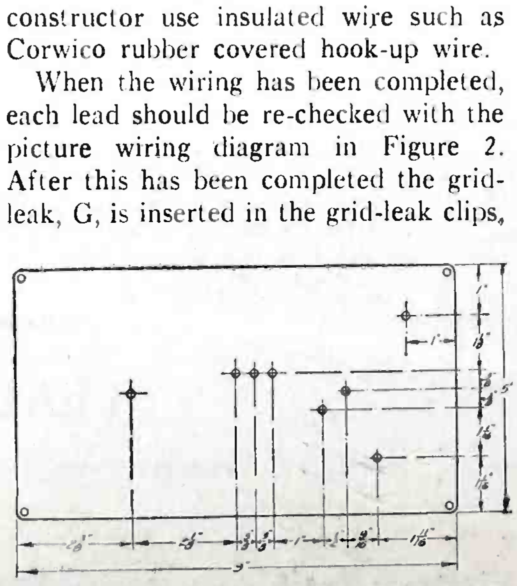


FIGURE 4: THE DRILLING PLAN FOR PANEL 12

How to Operate the Short-Wave AC Converter

Disconnect the antenna and ground connections from the Marti electric set, or any standard broadcast receiver using AC valves. Attach these leads to the antenna and ground terminals of the AC Converter. Then insert the connector plug of the converter into the detector socket of the Marti electric set. The photo-diagram in Figure 3 shows all the connections to be made between the receiver, the Racon reproducer, the Muter light-socket antenna and the short-wave AC Converter.

The broadcast receiver may be restored to its original use for reception on the regular broadcast band by simply disengaging the connector plug and replacing the detector valve in its socket in the broadcast receiver.

A long or short antenna may be used for short-wave reception. If a long antenna is used, the primary of the coil assembly, A, should be loosely coupled to the grid coil. The neutralizing condenser, H, which controls regeneration, should be adjusted for best reception at each particular station received.

When receiving continuous wave code signals it will be necessary to have the converter in an oscillating state. It should be kept just below the point of oscillation for broadcast reception.

It is recommended that a record be kept of the dial setting and the size of the coil used for all stations received This complete data should be kept so that the station may be tuned in again by referring to it.

The Victoreen Socket "Super"

(*Continued from page 385*)

hand terminal, F, of socket E5, continue this wire to the right-hand terminal of socket E6, from there to the right-hand terminal, F, of socket E7, from there to left terminal of condenser P1, where we leave a lead of approximately seven inches projecting from condenser P1.

Now place the filament lighting transformer, F, in position and fasten it down, as shown in Figure 1. The twisted leads coming from the right side of this filament transformer, and marked *5 volts,* should be run to the two filament leads of socket E8. The 2½-volt winding which issues from the right side of transformer, F, should then be led to the terminals, HH, of socket E3, and to the terminals, HH, of socket E4, as shown in the diagram in Figure 2. The 2½-volt winding which issues from the left-hand corner of the filament lighting transformer, F, should be led to socket E2, and fastened to the terminals, HH. These two leads should continue to terminals HH of socket E1. One of the 1½-volt leads issuing from the left-hand of filament transformer F, should be led to the right-hand terminal, F, of socket E5.

The front panel may now be placed in position and screwed to the baseboard.

The remaining 1½-volt wire that issues from the left-hand terminal of filament transformer F should be fastened to the right-hand terminal of the ½-ohm rheostat, H. The center terminal of this rheostat should then be connected to the left-hand terminal, F, of socket, E5. The two seven-inch leads running from condensers P1 and P2 should then be fastened to the two outside terminals of the 30-ohm potentiometer, I. The center terminal on this 30-ohm potentiometer, I, should then be connected to the right-hand terminals of condensers P1 and P2. A wire should be run from the left-hand terminal of potentiometer J to the left-hand terminal of condenser Q. The center terminal of potentiometer J should be connected to the upper terminal of the intermediate transformer, C3, which is nearest the socket, and also to the corresponding terminals of transformers C2 and C1. Run a wire from the right-hand terminal of potentiometer J to the right-hand terminal of condenser Q, and from there to the near terminal of condenser P3.

Take the lead which issues from the transformer F, which is marked *5-volt center-tap,* and connect it with the right-hand terminal of condenser Q.

Run a wire from the rotor of condenser D1 to the second lug (counting from the top) of the switch, K, and continue this wire to the left-hand side of the oscillator coil, B. Connect the stator of the condenser, D1, with the fifth lug of the switch, K, and continue this wire to the unused terminal of grid condenser N1. Terminal 1 of switch K should now be connected to the upper terminal of the antenna coupler A, which is nearest socket E1. The third terminal of the switch should have a wire connected with it, running to loop terminal binding post V4. The fourth terminal should be connected to the lower terminal of antenna coupler A, which is nearest socket E1. The sixth terminal should be connected to the binding post, V3. The antenna binding post, V1, should be connected to the lower terminal of the antenna coupler, A, which is nearest the rear of the baseboard. Binding post V2 should be connected to the upper terminal of antenna coupler A, which is nearest the rear of baseboard.

From terminal K of socket E1 we run a wire to the upper left-hand side of the oscillator coil, B. The lower left-hand terminal of this same unit, B, is run to G on socket E2, thence to the rotor of the variable condenser, D2. From the stator of the variable condenser, D2, run a wire to the terminal P of socket E2. From there this wire continues to the lower right-hand terminal of the oscillator coil, B. A wire is next connected to the upper right-hand terminal of the oscillator coil, B, and is run to the terminal which is nearest the rear of the baseboard of the grid-leak, R2, then to the upper left terminals of the intermediate-frequency transformers, C1, C2, C3 and C4. This same wire continues to the 1 mfd. condenser, P3, and is connected to the terminal nearest rear of baseboard. This wire should extend several inches beyond this point.

The binding post strip, U2, may now be temporarily placed in position. As the connections to this binding post strip are beneath the strip, it is not advisable to bind it down for the present. We will now continue with the wire from the terminal of condenser P3 to the lug of the binding post, V6. The lug of the binding post, V5, should now be connected to the condenser, P3, at the nearest terminal, and then continued to the binding post, V11. Run a wire from P of socket E1 to the lower left terminal of high-frequency transformer C1. Connect a wire between G of socket E5 and the lower right terminal of high-frequency transformer C1. Connect a wire to P of socket E5, and run this wire to the lower left terminal of high-frequency transformer C2. A short wire is now connected between G of socket E6 and the lower right terminal of high-frequency transformer C2. Connect P of socket E6 with the lower left terminal of high-frequency transformer C3. Another short wire connects G of socket E7 with the lower right terminal of high-frequency transformer C3. Next connect a wire with P of socket E7 and the lower left terminal of high-frequency transformer C4. Connect a short wire between the grid condenser, N2, and the lower right terminal of high-frequency transformer C4.

Connecting a wire with terminal P of socket E3, we connect this wire to the lug of terminal P of section G1 of the low-frequency transformer. This wire continues to one terminal of the .005 mfd. condenser, T. From the other terminal of this same condenser we solder a wire which is fastened to the lug of the "B" positive (+) terminal of the unit, G1, and continue this wire to the binding post, V6. A short lead is now connected to terminal G of socket E4, and to G of unit G1. Another short wire connects terminal P of socket E4 with P of unit G2. Continuing to the last low-frequency stage, we connect terminal G of socket E8 with G of unit G2. Solder a wire to P of socket E8, and continue this wire to binding post V13.

Solder a wire from the "C" negative (—) terminal of unit G1 to binding post V9. Fasten a lead from the "B" positive (+) terminal of unit G2 to binding post V10. Solder a lead from the "C" negative (—) terminal of unit G2 to the binding post, V12. A short lead should now connect the lugs of binding posts V7 and V8. Solder a wire to terminal A of coupler B, and connect this wire to the two inner terminals of the grid-leak mountings, R1 and R2. Continue this same wire to condenser P4, and from there the same wire is continued to the upper right-hand terminal of the intermediate-frequency transformer, C4. Connect the wire which issues from transformer F, and is marked *2½-volt center-tap,* to the upper left-hand terminal of intermediate-frequency transformer C2.

The Victoreen unit M should now be fastened to the baseboard with two screws, and the binding post strip, U2, may now be fastened in position by means of the bracket supports.

The switch, L, should now be placed in position on the panel and fastened by means of the threaded round nut. This completes the assembly and wiring of the AC Victoreen superheterodyne.

Constant reference should be made to the picture wiring diagram in Figure 2 to check the wiring as it proceeds, followed by a final recheck after completion.

In the next issue of POPULAR RADIO will appear complete details for operating the receiver, as well as constructional data for the "B" power-pack designed to work in conjunction with it.

A New Way to Quality Reproduction With the Samson Amplifier

(*Continued from page 398*)

"B" voltages supplied to the set) and its quality or reproduction, due to the large amount of power that is available without distortion and the high quality of the coupling transformers in the unit.

Of course, it should be used with a modern type of reproducer to get the best results.

The picture wiring diagram for this receiver is shown in Figure 3, and it contains complete details of construction and wiring so that any set builder will be able to build it and get the expected results, if the directions are carefully followed out.

How to Assemble the Unit

To start building the Samson amplifier, first cut the baseboard, H, to the proper size, 12 by 17 by ¾ inch, as shown in Figure 2. It should be smoothly sandpapered and given a coat of stain and shellac.

Then prepare the binding post strip, I, as shown in Figure 2. The ten binding posts, K1 to K10, should be attached to this strip. The first two binding posts, K1 and K2, are the input connections to the receiver with which the amplifier is to be used. Binding posts K3, K4 and K5 are the "B" battery positive (+) terminals and K6 is the negative (—) "B" battery terminal. The 4½-volt "C" negative (—) terminal is K7 and the 9-volt "C" negative (—) terminal is K8. The reproducer should be connected to the output terminals, K9 and K10.

The binding post strip may then be fastened near the edge of the baseboard, H, as shown in Figure 2, by means of two wood screws and two pieces of ½-inch metal tubing which serve as mountings for this binding post strip.

After all the instruments have been secured, the parts should be mounted on the baseboard, H. The power block, A, and the condenser block, B, should be mounted, side by side, in the positions shown in Figure 2. Then the four sockets, J1, J2, J3 and J4, should be mounted in position by means of two wood screws each. Next the two tapped resistors, E and F, should be fixed in position by means of wood screws at each end of the resistors.

The next job will be to mount the input transformer, C, in position with wood screws. Fasten the output impedance, D, on the right-hand end of the baseboard, as shown in Figure 2. Then make a brass angle to hold the variable resistor, G. Be sure that the mounting brackets on the variable resistor, G, do not touch the metal case or brackets of the other instruments.

This completes the construction work except for the four rubber feet to be attached to the baseboard.

How to Wire the Samson Amplifier

It is recommended that all wiring on this unit be done with Gavitt rubber-covered hook-up wire. Refer constantly to the picture wiring diagram in Figure 3 in making connections. The wiring above the baseboard is shown in solid blue lines and that below the baseboard in dotted blue lines. The position of the holes to be drilled in running the wires from the top of the baseboard to the bottom of the baseboard are indicated by black circles.

How to Install the Unit

The unit may be placed in the radio compartment of the console or radio cabinet or the receiver with which it is to be used. In the photo-diagram in Figure 1 the unit is shown in use with the Hammarlund-Lynch "5" receiver. Make the connections between the receiver and the power-pack amplifier as indicated in Figure 1. This diagram is complete and shows the connections to the S. P. N. reproducer, the Exide "A" battery and the Yaxley relay. By referring to this diagram, it will be noticed that the second input binding post of the amplifier is connected over to the 135-volt "B" positive (+) binding post.

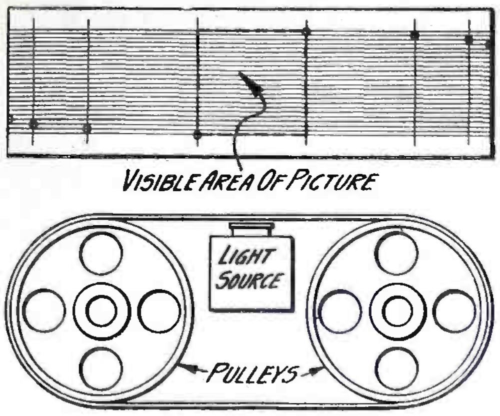
Looking at the front of the Hammarlund-Lynch "5" Receiver, remove the two Lynch fixed resistors and the Lynch coupling condenser from their mounting clips in the rear left-hand corner of the sub-panel. This is the third reistance-coupled stage of the amplifier. The combination diagram, Figure 1, shows a separate lead which should be soldered to the right-hand mounting clip that formerly held the Lynch coupling condenser. This new lead should be connected to the input terminal, K1, of the power-pack amplifier.

It is recommended that a new Donle R. F. DA-2 valve be placed in the high-frequency stage of the Hammarlund-Lynch "5" Receiver; a Zetka ZD valve in the detector socket, and two Zetka ZAF valves in the first and second resistance-coupled stages in the Hammarlund-Lynch "5" Receiver. For the amplifier, place a CX-380 rectifying valve in socket J1; a CX-374 regulator valve in socket J2; and two CX-371 valves in sockets J3 and J4.

When the connections between the receiver and the power-pack amplifier have been completed, the special plug that comes with the power block, A, should be inserted in the power block. Figures stamped on the sides of the plug indicate which side should face upward when the unit is to be operated from line voltages of 110, 115 or 120.

Scanning Devices

(*Continued from page 390*)



A SCANNING BELT

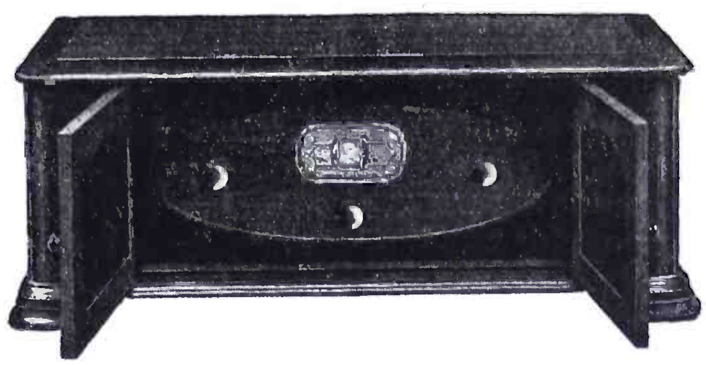
FIGURE 2: *In this sort of scanning device the holes are arranged diagonally on a belt which passes over two wheels, one of which supplies the drinking force. The image is defined by the distance between holes, and the combined width of the holes.*

metals that could be used. It is easy to drill and machine and, owing to its light weight, it is least affected by the high speeds necessary in scanning work. Thin sheets of metal with a slight warp in them will have a tendency to flatten out when revolving at high speed.

Having acquainted ourselves with the mechanical operations necessary for the production of the scanning disc, we are now ready to review the factors determining the physical dimensions of the disc and the laying out of the holes. It is evident that the larger the number of holes on the disc, the greater the tendency toward better reproduction. The number of holes in the disc determine the number of sections or lines into which the picture is divided. Thirty-six holes would simply mean that the picture was divided in to 36 sections or lines.

What actually determines the size of the picture that can be transmitted is the distance between the holes, as well as the size and number of the holes. This becomes clear upon reference to Figure 1. From this diagram it will also be plain that the size of the picture must be adjusted so that only one hole is sweeping across it at one time. Simple arithmetic will show that the scanning disc is more or less limited in its application, and that home experimenters cannot hope to transmit very large pictures with great detail.

Although scanning wheels or discs provide what is perhaps the best known method of illuminating objects to be transmitted, there are several other methods that have been applied successfully and which lend themselves to experimental research. Figure 2 shows how a moving belt, which may be of very thin metal, can be applied to the problem of scanning. Here the holes are arranged diagonally, producing the equivalent of a spiral. In this instance, the size of the picture is determined by the distance between two successive holes and the width of the belt.



For the Modest Pocketbook—the LC-28 Junior

(*Continued from page 380*)

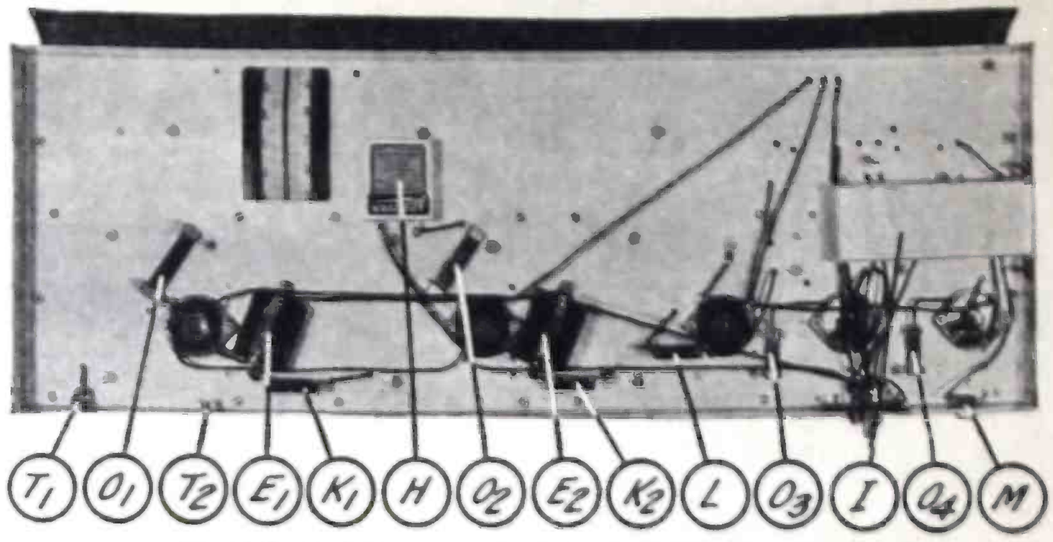


FIGURE 5: THE UNDER SIDE OF THE SUB-PANEL

more convenient in some circumstances. The ground wire is attached to the tip jack, T2. Next place two Cunningham CX-322 type valves in the sockets P1 and P2. In the detector socket, P3, place the new Carborundum stablizing detector tube. Then place a Cunningham CX-301-a type valve in socket P4. In the last socket, P5, place a Cunningham CX-371-a type power valve.

The photo-diagram in Figure 3 shows the exact connections to be made between the various units.

Connect the two field leads on the Jensen Dynamic Reproducer to the "A" storage battery as shown in Figure 3.

The tuning of the antenna circuit is accomplished with the left hand knurled disc of the double drum dial, U. The two remaining stages are tuned with the right hand knurled disc of the drum dial, U. The rheostat, S, permits of zero to maximum control of volume.

The potentiometer "cap" at the top of the Carborundum stabilizer "tube" should be adjusted for best results.

If the set builder follows out exactly all the instructions, this receiver, with its screen grid valves, will provide a high order of amplification, excellent selectivity and a quality of reproduction which will be a pleasure to listen to.

The Harkness Screen Grid "5"

(*Continued from page 388*)

tenna, ground and loudspeaker, as shown in the photo-diagram in Figure 4, the valves should be inserted one at a time and a station should be tuned in slightly below "50" on the dial. Very carefully and slowly adjust the three equalizors until maximum audibility is obtained. Continue turning down the volume control as you proceed so that you can more accurately tell whether you are obtaining the correct adjustment. Check this adjustment on another station, preferably a distant one, to insure absolute resonance of the three tuned circuits at all positions of the tuning dial. After this procedure there will be no further need for these adjustments and tuning will be accomplished solely by the setting of the single control dial on the front panel.

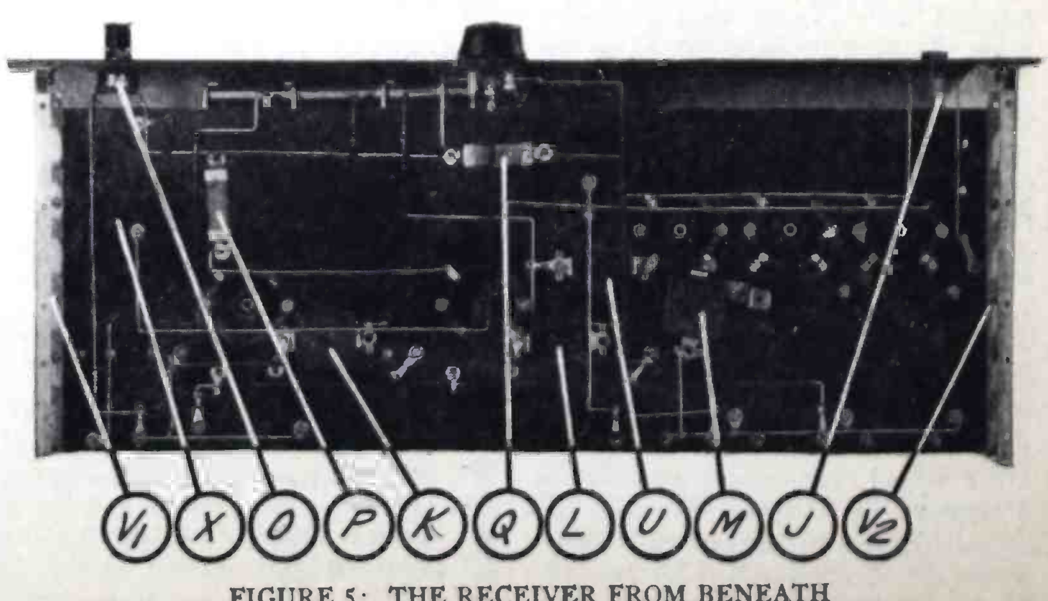


FIGURE 5: THE RECEIVER FROM BENEATH

What Is a Transmission Unit?

MODERN technical radio literature reveals the increasing use of the term transmission unit. Although this term is used a great deal, as yet there has been very little written describing its meaning and the mathematical justification for its existence.

Power is the rate of doing work. For instance, work must be done to light the ordinary electric light. We say the power consumed by the light is 25 watts or 100 watts, as the case may be.

Similarly in the radio set a small amount of low-frequency power is used in the primary circuit of the first low-frequency transformer, and a much larger amount of power with the same frequency or characteristics is used in actuating the loudspeaker.

The ratio of the output power of the amplifier to the input power may be expressed as

$$\frac{P_1}{P_2}$$

There has been a decided gain in power in this amplifier. In some other system there might be a decided loss.

A method of expressing gains and losses is desirable. The transmission unit (abbreviated TU in either singular or plural) was adopted by the Bell Telephone Laboratories in 1924 for the purpose of comparing powers at two points along a system, e.g., the above amplifier. The transmission unit was so chosen that when two powers have the ratio the number of transmission units gain or attenuation (loss) equals

$$N_{TU} = 10 \log \frac{P_2}{P_1}$$

One transmission unit represents about the least difference in the loudness which can be detected by the ear without special training.

The TU replaced the older unit called the "mile of standard cable," an arbitrary unit for measuring attenuation.

Some of the advantages of the transmission unit may be enumerated as follows:

1. It is logarithmic, and the ear also hears in proportion to the logarithm of the sound power ratio.
2. It is distortionless, whereas the "mile of standard cable" had a different effect at various frequencies.
3. It is based on a power ratio, which has an advantage in that powers may be compared, even though they are being expended in different impedances. Also different types of power, such as sound powers and electrical powers, can be compared.
4. It is based on a simple relation.
5. It is approximately equal, in the effect on volume, to the "mile of standard cable."
6. It is convenient for computation.

Powers are commonly measured in telephony by measuring the current (or voltage), in an impedance which is known or can be measured, so that the current and voltage relations at various points are usually known. In cases where the currents associated with the powers are proportional to the square root of the powers

$$N_{TU} = 20 \log \frac{I_1}{I_2}$$

where

$$\frac{I_1}{I_2}$$

is the current ratio.

A table of some common ratios and the number of transmission units corresponding is appended:

TRANSMISSION UNITS	APPROXIMATE POWER RATIOS	
TU	*For Loss*	*For Gain*
1	.8	1.25
2	.63	1.6
3	.5	2.
4	.4	2.5
5	.32	3.2
6	.25	4.
7	.2	5.
8	.16	6.
9	.125	8.
10	.1	10.
20	.01	100.
30	.001	1000.
40	.0001	10000.
50	.00001	100000.
60	.000001	1000000.

—P. A. BURNS

Condensers and Heat

Too little thought is given to the matter of temperature in the handling of condensers. Condensers, when placed in "B" power-packs, should not be exposed to high temperature from the radiated heat of rectifier valves or resistors in their immediate vicinity. The condensers should be protected from heat by proper spacing or by partitions, if necessary, and the valves and resistors should be provided with proper ventilation. In any case, paper condensers should not be heated beyond 110 deg. F.

Tests recently conducted serve to throw considerable light on this matter of heat in the performance of condensers. In a direct comparison between condensers heated to normal room temperature and condensers heated to 125 deg. F., over a period of eighteen hours, so as to make certain that the condensers were heated throughout their mass and not just externally, the condensers heated to the higher temperature withstood a 20 per cent higher breakdown voltage.

This might seem contrary to expectations and would indicate, on its face, that condensers were benefitted by heating. However, such performance is no indication of life, and subsequent life tests have shown that a condenser heated above room temperature has its life shortened materially.

—HARRY F. HOUCK

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TYPE D-45 . . $67.50
For 90 volts operation

TYPE D-44 A.C. . $75.00
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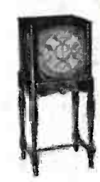
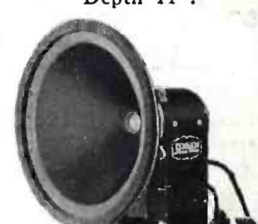


Console Model

TYPE D-54 A.C. . $90.00
Height 34½". Width 14¼". Depth 11".



Jensen Dynamic Units

TYPE D-4 . . . $47.50
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TYPE D-5 . . . $50.00
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