AUTOMOBILE SUPER USING FIVE TUBES

RADIO WORLD

REG. U.S. PAT. OFF.

The First and Only National Radio Weekly

630th Consecutive Issue *Thirteenth Year*

APRIL 21

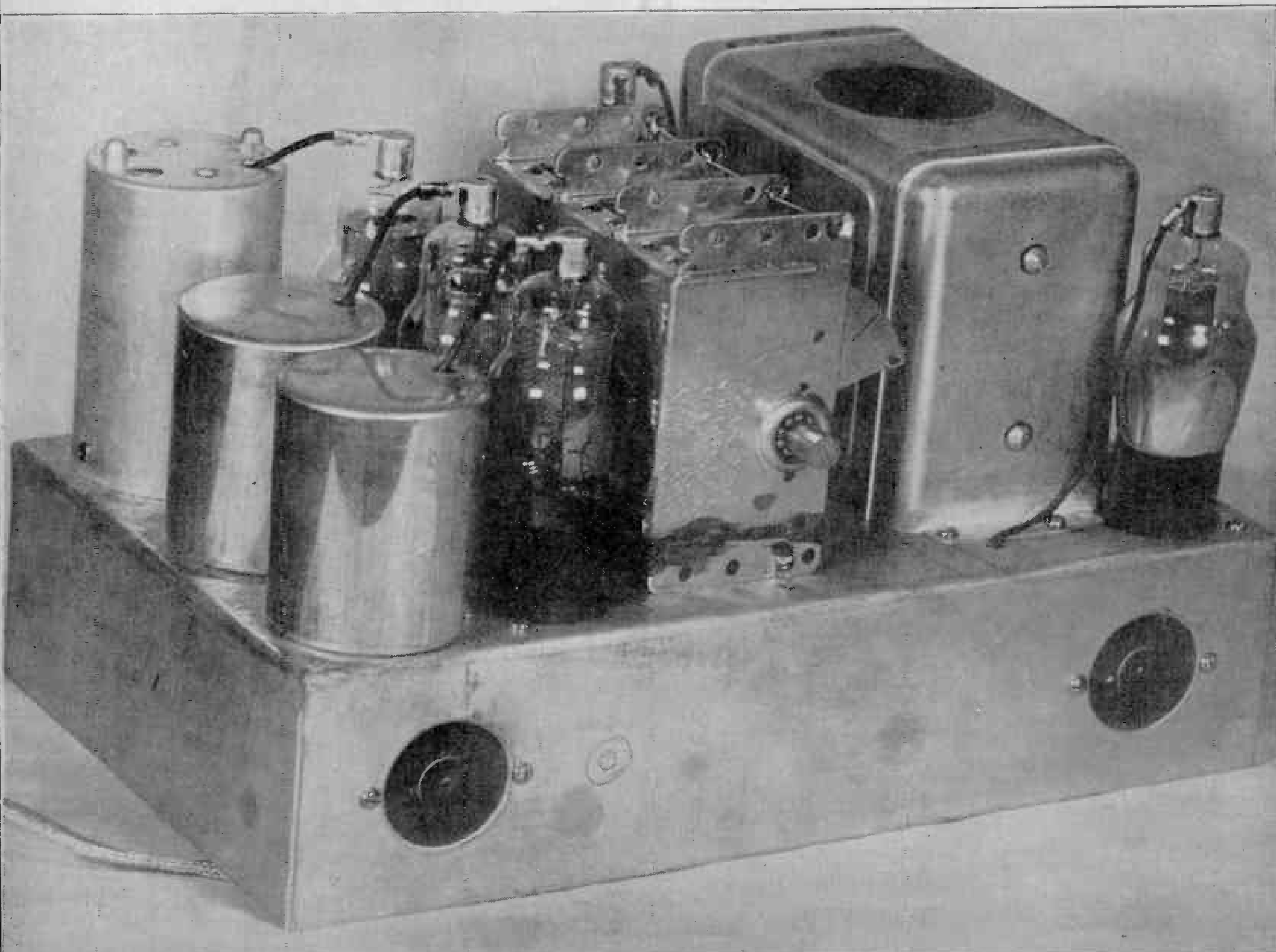
How Short Waves Are Sent and Received

—

Indoor Doublet Rotated for High Frequencies

—

A Large Power Amplifier



15c. Per Copy

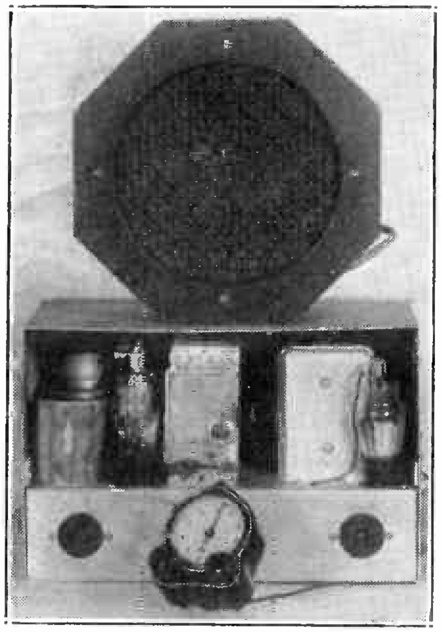
This compact auto set has automatic volume control, motor generator and a new remote control unit. See pages 12 and 13 for article on the "Wanderlust"

New Motor Generator, New Remote Control in New Supertone "Wanderlust" Auto Radio

The "Wanderlust" automobile receiver is a five-tube superheterodyne with complete automatic volume control. It is extremely sensitive because of the high gain tubes used in it and because the coils have been selected for use in the circuit only after rigid comparative tests in the interests of sensitivity and selectivity. The tubes used are a 78 radio frequency amplifier, a 77 autodyne (combination first detector and oscillator), a 78 high gain intermediate frequency amplifier, a 75 for greatest efficiency in detection and automatic control, and an 89 pentode output tube.

The tone quality is excellent for several reasons. The most important is that it has been carefully guarded in the design of the set and has not been sacrificed for greater volume. The great volume of the "Wanderlust" is due to the high overall amplification of the set and not to overloading of the output stage. An aid to both quality and volume is the large Rola dynamic speaker, which has a cone fully 8" in diameter. This speaker is larger than many which are used in the home.

The "Wanderlust" is operated entirely from the car's storage battery, and, due to the floating filaments, may be used on any car, no matter which side of the battery is grounded, without changing the wiring. The "B" supply is not a vibrator, but a much superior motor generator. This generator, a Pioneer Gen-E-Motor, is built into the set and needs no separate mounting. The generator is well filtered so that all ripple is eliminated.



The de luxe car radio — the Supertone "Wanderlust" — uses a perfected remote control unit, a tone-quality speaker, and the latest tubes.

The "Wanderlust" is offered to you only after a long period of development and testing. After the design had been approved and experimental models built, the set was tested on extensive motor trips. It was found to give good results when only a foot of wire was used as the aerial. With an ordinary automobile antenna, Texas and Colorado stations were received from New York City without fading and with good volume.

The set is easy to install in a car. Merely mount the set and speaker, connect the remote control and connect two leads, one to the antenna and one to the "hot" side of the car battery or ammeter—and the set is ready for use.

The complete kit for the "Wanderlust," including all parts; A Pioneer Gen-E Motor, five Arcturus tubes, an eight-inch Rola automobile speaker, an airplane type remote control, spark suppressors and condenser for the the car generator. **$32.50**

A wired and tested model of the same set. **$37.50**

A 25% deposit is required on all C.O.D. orders.

SUPERTONE PRODUCTS CORPORATION

35 HOOPER STREET **Telephone: EVergreen 7-0580** **BROOKLYN, N. Y.**

A Test Oscillator at $15 Unexcelled in Performance by $100 Instruments

EVERY one who does radio work needs a test oscillator to line up intermediate, broadcast and short-wave channels in receivers. The best way is to buy one already made and calibrated. If you don't buy or build one you pay for it anyway, in loss of time, business and customers.

The new Bernard Test Oscillator, Model 34-AB, meets every necessary requirement. It is universal. The same model works on 90-120 volts a.c. (any frequency), d.c. or batteries, hence wherever there is a set there is the power to work the oscillator. It is direct-reading in frequencies, 132 to 1,520 kc. The broadcast band is represented completely, every channel. Short waves are indirect-reading. All scales are readable to an accuracy of better than 1 per cent. The line is blocked, the oscillator completely shielded, the frequency is stable and the output, adjustable by the attenuator from 0 to 3 volts, is steady. The oscillator is constantly modulated; on a.c. by the line frequency, in other uses by a neon tube audio oscillator. Electron coupling is used for both audio-frequency input and radio-frequency output.

It may seem ridiculous to say that for $15 you can get such an instrument, but remit for a Model 34-AB, now announced for the first time, try it for five days after receipt, and get your money smack back if you don't want the oscillator.

HERMAN BERNARD

145 West 45th Street New York, N. Y.

"RADIO TROUBLE SHOOTING," E. R. Haan. 328 pages. 300 illustrations. $3. RADIO WORLD, 145 W 45th St., N. Y. City.

TUBE SHIELDS FREE!

Send $1.50 for a 13-week subscription for RADIO WORLD and get FREE eight (8) tube shields suitable for the 57, 58 and other modern tubes.

SUBS. DEPT., RADIO WORLD
145 West 45th St. New York, N. Y.

Complete parts for the

LINE NOISE FILTER

as described in this issue.

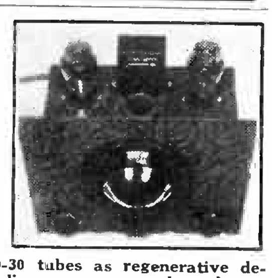
FOUNDATION KIT - $2.75

Consisting of— (Regular value $4.30)
4—Polymet .0055 Moulded Mica Condensers
5—Special 100 Turn Duo-lateral Coils.
1—100 mmf. trimmer condenser.

SHORT WAVE SPECIALISTS

HARRISON RADIO CO.
142 Liberty St. Dept. RW New York City
(One block south of Cortlandt St.)

World-Wide Short Wave Receivers



Model DC2—Uses 30-30 tubes as regenerative detector, one stage audio amp.; mounted on heavy black crackle finished chassis and panel; beautiful appearance; foreign station reception guaranteed; wiring instructions furnished.
Kit, assembled $5.95
Wired and tested, $6.95 Tubes, $1.50 extra
Also available for broadcast band exclusively at same price.
Model 1A plate voltage supply—uses 25Z5 tube; voltage variable up to 200 v. capacity, 65 MA; diagram included.
Kit, assembled $4.95

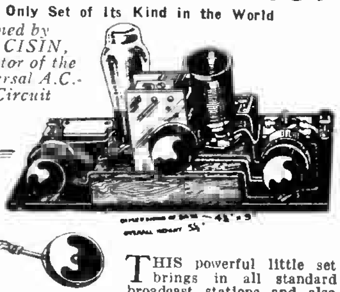
EILEN RADIO LABS., 24 West 20th St., N. Y. C.

"SOUND PICTURES," by Cameron & Rider. Over 1,100 pages, 500 illustrations. The whole question of Sound Motion Pictures treated from a new angle. A Complete Guide for Trouble Shooting. Explains in detail the construction, operation and care of sound recording and reproducing equipment. Price $7.50. Radio World, 145 W 45th St., New York City.

ALL-WAVE AIR SCOUT

Only Set of Its Kind in the World

Designed by H. G. CISIN, Inventor of the Universal A.C.-D.C. Circuit



THIS powerful little set brings in all standard broadcast stations and also police calls, foreign stations, code and trans-atlantic phone conversations. Powered by inexpensive batteries. Available in KIT form. Novel terminal color coding feature eliminates need for wiring diagram. Red is connected to red, black to black, etc., and set is ready to operate. Used by thousands of Boy Scouts. Scout John Stott of Sanford, Me., brought in England, Holland, Germany and South America on this set.

COMPLETE KIT with tube, Earphone, Two Coils, clear instructions, valuable data, etc.
NOTHING ELSE TO BUY except inexpensive batteries........**POSTPAID** **$5.00**
COMPLETE KIT, same as above, but less earphone..................**POSTPAID** **$4.50**
ASSEMBLED, WIRED AND READY TO USE, INCLUDING PHONE, less batteries, $9.95 Postpaid
SPECIAL OFFER: Valuable data on All-Wave Set sent free upon receipt of 10c to cover handling costs.

ALLIED ENGINEERING INSTITUTE
98 Park Place, Dept. R.W., New York, N. Y.
Phone: BArclay 7-9540

They Work!

FILTER CONDENSERS

Here is a dry electrolytic self-healing condenser of 8 mfd. capacity which will give long, hum-free service in power supplies. The condenser is intended for use with an operating voltage of 400 volts, or slightly over, but will withstand a peak voltage of 600.

Type D Condenser, 49c

RELIABLE RADIO CO.
143 West 45th St. New York, N. Y.

[SHORT WAVES ARE FEATURED ON PAGES 4, 5, 6, 7, 8, 9, 10 AND 11.]

ROLAND BURKE HENNESSY
Editor

HERMAN BERNARD
Managing Editor

RADIO WORLD
REG.U.S.PAT.OFF.
The First and Only National Radio Weekly
THIRTEENTH YEAR

J. E. ANDERSON
Technical Editor

J. MURRAY BARRON
Advertising Manager

Vol. XXV APRIL 21st, 1934 No. 6. Whole No. 630

Published Weekly by Hennessy Radio Publications Corporation, 145 West 45th Street, New York, N. Y.
Editorial and Executive Offices: 145 West 45th Street, New York
Telephone: BR-yant 9-0558

OFFICERS: Roland Burke Hennessy, *President* and *Treasurer*. M. B. Hennessy, *Vice-President*. Herman Bernard, *Secretary*.

Entered as second-class matter March, 1922, at the Post Office at New York, N. Y., under Act of March 3, 1879. Title registered in U. S. Patent Office. Printed in the United States of America. We do not assume any responsibility for unsolicited manuscripts, photographs, drawings, etc., although we are careful with them.

Price, 15c per Copy; $6.00 per Year by mail. $1.00 extra per year in foreign countries. Subscribers' change of address becomes effective two weeks after receipt of notice.

Short-Wave Behavior

Transmission and Reception Now on a Ratable Basis—Chart Defines Ranges

By Einar Andrews

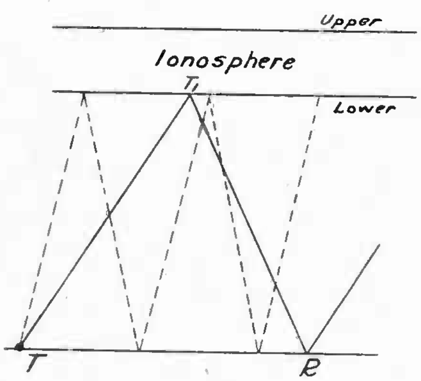


FIG. 1
This shows how a radio wave from a transmitter T travels up to the ionosphere and is reflected at T1 to R, the receiver.

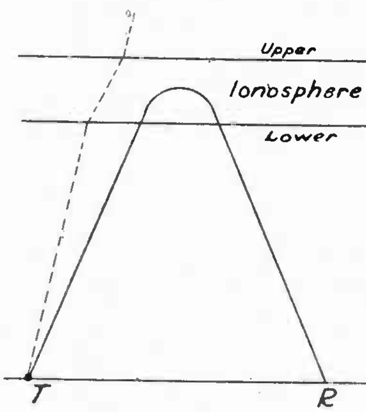


FIG. 2
The wave may enter the ionosphere and curve back to earth as shown by the solid line, or it may pass through the layer.

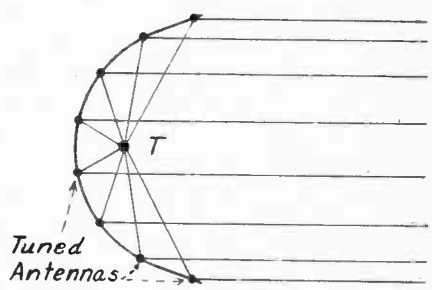


FIG. 3
Paraboloidal reflectors are often used for directing the wave toward any desired point. They are used in beam transmitters.

A NEW term has been added to radio nomenclature—the ionosphere. Just what is the ionosphere? It is that region in the earth's atmosphere where ions and free electrons exist. It is another name for the Heaviside-Kennelly layer. Although the ionosphere is not a sphere, in general, perhaps the new name is preferable to the old. It is a somewhat shorter term.

By whatever name we call this region in the atmosphere, it has much to do with the behavior of short-wave propagation. It accounts for fading, echoes, and also for long-distance reception. It is at the same time both a blessing and a nuisance. But not all fading can be attributed to the ionosphere, for fading exists sometimes under conditions not brought about by an ionized region. Fading can occur under any condition where the same signal reaches a point by two or more routes of different effective lengths, and when the two distances do not remain constant.

Reflection from Ionosphere

In Fig. 1 we have a representation of the manner in which waves are reflected by the ionosphere. The ionosphere is represented by a layer having lower and upper limits. Suppose a radio wave originates at T, a transmitting antenna. Part of the wave will travel close to the ground to the receiver at R, and part of the wave will go up to T1. At this point it will be reflected down to earth. At R, then, the signal arrives from two directions, one directly from the station at T and the other from its image in the ionosphere. The distances between the two points, that is, the real transmitter and the image, are different. The signals from the two points will in general be out of phase. If the phase between the two signals varies due to a change in the difference between the two paths, fading will result at R.

It may be that the distance TR is so large that the direct wave cannot be received, for that attenuates rapidly. The sky wave may still be very strong. Then reliable reception can be enjoyed at R but over a certain range between T and R there is no audible signal. That is called the skip-distance. When the sky-wave reaches point R it may be reflected by the ground and the reflected beam will then go up to the ionosphere once more. There it may or it may not be reflected back to earth. If it is reflected the second time from the ionosphere, there will be a second skipped distance.

High Angle Transmission

The transmitted wave at T may be directed upwards so that the ground wave is negligible. It may, for example, follow the dotted line. It will then be reflected back to earth at a nearer point than before, if it is reflected at all. In this case it may be tossed back and forth many times before it is finally dissipated.

Certain wavelengths will not be reflected from the ionized layer, especially when the angle is steep. Fig. 2 shows what might happen. If the wave follows the dotted line, when striking the lower limit of the ionosphere it may enter that region, refracting only a little away from the normal. It passes through the ionosphere to the upper limit and at this point it leaves, refracting a little toward the normal. The only effect of the ionosphere is then to shift the wave parallel to its original direction. This is the course of a light ray striking a glass plate with parallel sides. When the wave takes this course, there is no reflection and signals are lost forever.

If the wavelength is somewhat shorter the wave may enter the ionosphere and then take a curved course ultimately emerging from the lower limit of the ionized layer and continue to ground at R.

Directional Transmission

Short waves are suitable for directional transmission because directive devices may be physically small and yet electrically large. Fig. 3 shows the plan of a paraboloidal reflector that has been used to create beams. T is a tuned antenna to which power is supplied from the oscillator. The dots on the parabola are also antennas, parallel to the transmitting antenna.

It is a property of the parabola that if a source of light or other wave motion is located at the focus, T, all energy is radiated in straight lines parallel to the axis of the parabola. It is this property that is taken advantage of in the paraboloidal transmitter. The lines from T to the various antennas in the parabola indicate the directions. Of course, not all the energy from T will be reflected by the tuned antennas. Some of it will not go in that direction but forward. Just what proportion of the total energy that will be reflected in the beam depends on how far the parabola extends in the direction of transmission. If the cup of the parabola is deep a very large proportion of the energy will be in the beam.

A paraboloidal antenna such as that shown in Fig. 3, when designed for very short waves, can be mounted so that it can be rotated in any direction. First, it can be rotated about the vertical antenna T. In this way a horizontal beam, of vertically polarized waves, would be sent out in the direction of the axis, that is, in the direction of the parallel lines. Second, the antenna can be mounted horizontally and then rotated about the horizontal T. This would send out a horizontally polarized beam in whatever direction the antenna pointed. It might be horizontal, vertical, or it may have any angle. Thus it can be turned so that the wave beam traveled up to the ionosphere, making any desired angle with the lower boundary of that region. Transmission at various angles have been done for the purpose of studying the height and nature of the reflecting layer and for the purpose of testing the transmission efficiency of short waves.

The rotating antenna has also been used for the purpose of studying the direction from which waves seem to come. It has been found that although the waves have been sent out with vertical polarization they have arrived at the receiver at different angles.

A Transmitting Circuit

Fig. 4 shows the essential elements of a transmitting circuit that might be used to supply a directional antenna. It consists of an oscillator and an amplifier. What constants to use depends, naturally, on what the wavelength is to be. The antenna is coupled to the output of the amplifier by means of a step-down transformer, a transmission line, and a step-up transformer. In practice the primary of the step-down transformer would be tuned and the antenna would also be tuned. The transmission line might consist of a copper tubing and a heavy copper rod in the center of it. The antenna is shown tilted at an angle of 45 degree with ground. This particular antenna might be T in Fig. 3 when the paraboloid has been turned so that T is inclined 45 degrees.

Range of Short-Wave Transmitters

The range of a short-wave transmitter depends, for a given sensitivity of the receiver, on the power of the transformer, the wavelength or frequency, the time of day, the season of the year, and on the relative latitudes and longitudes of the transmitter and receiver. This question of range is of primary interest to those who are attempting to receive stations located at distant points, especially those operating on short waves.

In Fig. 5 we have a set of peculiar curves which show what reception to expect if we have a 5 kw transmitter and a rceiver having a sensitivity of about 2.5 microvolts. The curves require some explanation.

The first curve on the graph is marked "Limit of ground wave." The abscissas give the distances in miles between a possible receiver and the transmitter and the ordinates give the wavelengths in meters, or the frequency in megacycles. Now the ground wave is the ordinary wave that follows the ground. The first curve shows the limit of the distance that the ground wave can be picked up. Thus if the wavelength

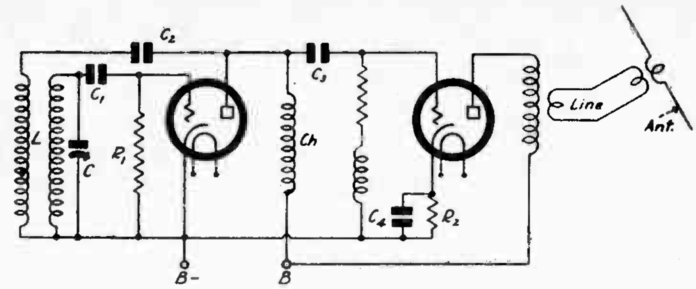


FIG. 4

This shows a method of coupling an oscillator and r-f amplifier to a transmitting antenna. The antenna may also be coupled directly to oscillator tuned circuit, and this is more practical when the wave is very short.

is 1,000 meters (300 kc), the signal can be received any distance up to 200 miles. Beyond 200 miles it will be too weak to be received clearly through the noise. If the wave is only 20 meters (15 mc), the distance is only 54 miles. Therefore the ground wave travels much farther on long waves than on short.

There are also three curves in the form of an S. They give the maximum range for the different waves, first, during the day, second, during a summer night, third, during a winter night. Besides these there are two curves giving the minimum range of the sky wave for day and a winter night. The minimum curves give the distances away where the sky wave comes down to earth. Let us trace the 20-meter wave. At 54 miles the signal disappears because the ground wave has become attenuated. At 700 miles the wave comes down from the sky and there good reception begins, provided we are listening in the day time. If we are listening on a winter night it does not come down. But suppose we are listening on a summer day. The "max. day range" curve crosses the 20-meter abscissa at about 3,600 miles. Therefore anybody with the receiver specified located within the range 700-3,600 miles the signals will be received.

40-Meter Band

If we are listening on the 40-meter wave we lose the ground wave at 77 miles, but we pick it up again at 170 miles, in the day time, and at 1,800 miles on a winter night. In the daytime we lose it again at 4,000 miles, on a summer night at 8,000 miles, and on a winter night at 12,000 miles. Chances are that on a winter night we never would lose it, for the greatest distance on the earth is 12,500 miles.

Suppose we have time to spare on a summer day, between sunrise and sunset, to listen for stations located 4,000 miles away, for example, Berlin stations in New York. What waveband would be best to explore? Going up the 4,000-mile ordinate we come to the "max. day range" at 24 meters and again at 40 meters. Therefore we have a chance of receiving station operating in this range, provided, of course, that the waves have come down. The curve for the minimum range of the sky wave during the day shows that it has. The most favorable wave is 33 meters.

If we are listening on a summer night, or even a winter night, the reception at 4,000 miles is still favorable on the same waveband, at least between 30 and 40 meters.

The least favorable waveband for long distance reception is 200 to 300 meters. The limit of the ground wave is about 150 miles and the maximum day range is the same. We can expect strong fading at 150 miles in this waveband. This agrees with observations on WGY signals in New York and other places about the same distance away from Schenectady. Apparently there is no minimum range for the sky wave in this band. This fact would indicate that even at shorter distances there will be fading difficulties. On a winter night reception in this band can be obtained up to about 900 miles, and this will be relatively free of fading, since the limit of the ground wave is only 150 miles. That is, fading will not be severe, say, at 500 miles.

Skip Distance

Skip distance is indicated by the difference between the ground wave curve and the minimum sky-wave range. Consider the 30-meter wave, for example. The ground wave ceases to be audible at 67 miles whereas the sky wave does not come down until 400 miles has been reached. It would be practically useless to attempt to receive a 30-meter signal at points between. At night the skip distance is much greater, the wave not coming down until 1,800 miles.

The values given in the curves are averages taken from a large number of observations. There is much variation from

(*Continued on page 7*)

SUMMER, WINTER, DAY AND NIGHT RANGES FOR WAVES 1,000 TO 10 METERS

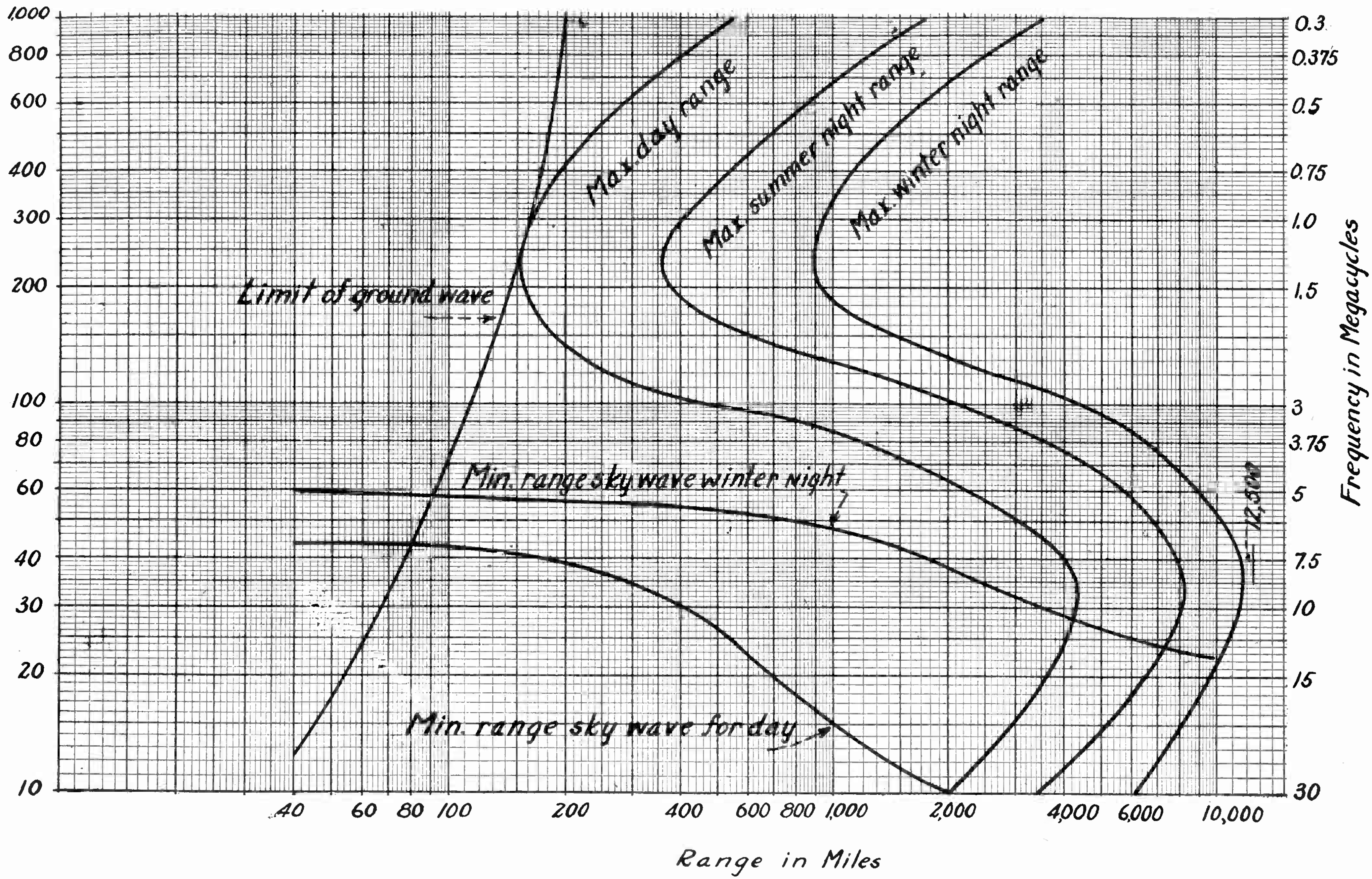


FIG. 5

These curves show the behavior of waves below 1,000 meters and give the approximate distances away from the transmitters the various waves may be received. The curves are the result of thousands of observations and are averages.

Line-Filter Construction

DEVICE PUT IN THE A-C SUPPLY CIRCUIT TRAPS OUT DISTURBANCES SO SHORT WAVES ARE RECEIVED WELL

By A. D. Lodge
Harrison Radio Company

CIRCUIT AND LAYOUT FOR INTERFERENCE SQUELCHER

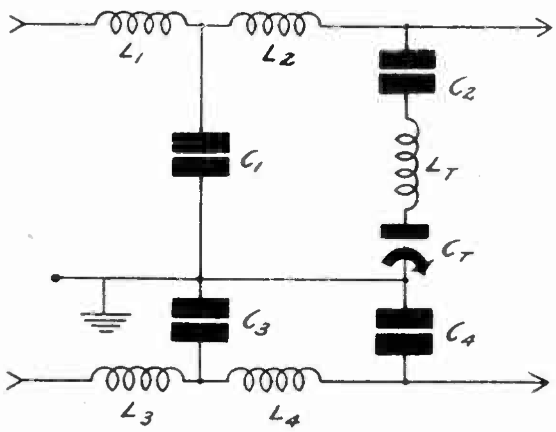


FIG. 1
The circuit diagram of the line noise filter. The effectiveness is due to the fact that the noise is tuned out by the circuit LtCt.

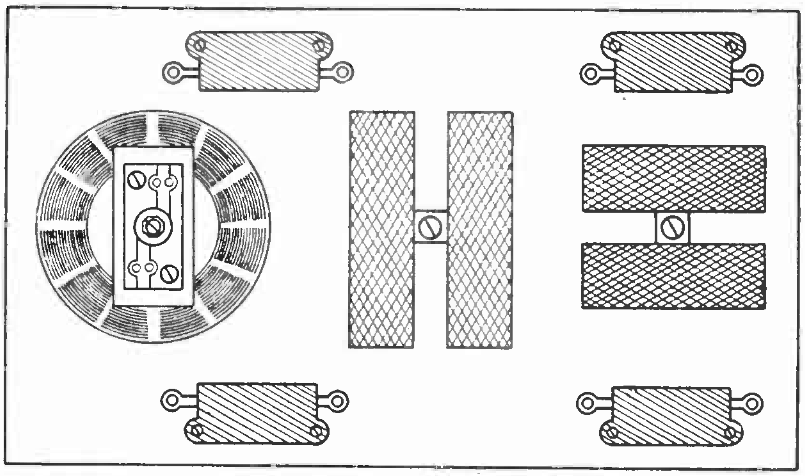


FIG. 2
This illustrates the construction of the line noise filter shown in diagram in Fig. 1. Note that coils are placed at right angles to prevent back coupling. The inductance are 100-turn honeycomb coils and the condensers 0.055 mfd.

SINCE publication in the March 17th issue of the diagram and constructional details of a short-wave line filter, the author has received letters from radio fans and engineers commenting on the results obtained from this unique device. The results have been indeed gratifying and the author feels that his time has been well spent in perfecting and presenting this line filter, and thus making possible the true enjoyment of short-wave and broadcast reception in many locations where it was previously impossible.

While many readers have reported excellent results, some have requested more details about construction. For this reason the following is presented for their information in the sincere hope that it will fully answer all inquiries.

Works on Broadcast Waves

Many wish to know if the filter will operate equally well on both broadcast (200 to 550 meters) and short waves. The answer is yes. This is due to the unique feature of being tunable to the exact frequency of the disturbance. The range of this filter has been found to be so flexible that there is practically no disturbance of any frequency that has not been effectively and permanently eliminated. This has not only been the author's personal experience, but it has been corroborated.

At this point it may be repeated that too much emphasis cannot be placed on the importance of following the correct specifications of parts. The coils should each be 100-turn honeycomb coils, and the fixed condensers all alike and each 0.0055 mfd. in capacity. The use of other values at these points will rarely produce good results, but frequently will make the completed job practically valueless as a line-noise eliminator.

Essentially, the filter consists of five 100-turn honeycomb coils, four 0.0055 mfd. moulded mica condensers, and a trimmer condenser with a range of 5 to 100 mmfd. (0.000005 to 0.0001 mfd.). In addition to this, several other small parts are needed to build the outfit: two pieces of bakelite—½" x 2" each, one piece 1" x 2½" and one bakelite panel 3½ x 7".

Referring to the schematic diagram, mount coil Lt flat at one end of the panel, using the 1 x 2½" piece of bakelite. The same piece of bakelite holds the trimmer condenser. Two machine screws, about 1¾" long each, placed through the two mounting holes of the trimmer condenser, through the piece of bakelite, and through the panel, will hold the coil and trimmer in place.

Mounting Coils

Coils L1 and L3 are placed standing upright at the other end of the panel, parallel to each other and about ¼" apart. A machine screw, about 1" long, through the center of a ½ x 2" piece and through the panel, will mount these two coils. The other two coils, L2 and L4 are also mounted upright, similarly, with the remaining piece of ½ x 2", in the center of the panel, between L1, L3, and Lt. They are turned at right angles to L1, L3. The fixed condensers are attached near the edge of the panel by means of small screws through the mounting eyes.

The reader's attention is called to the first article, where the adjustment of the filter was explained. Do not remove

(Continued on next page)

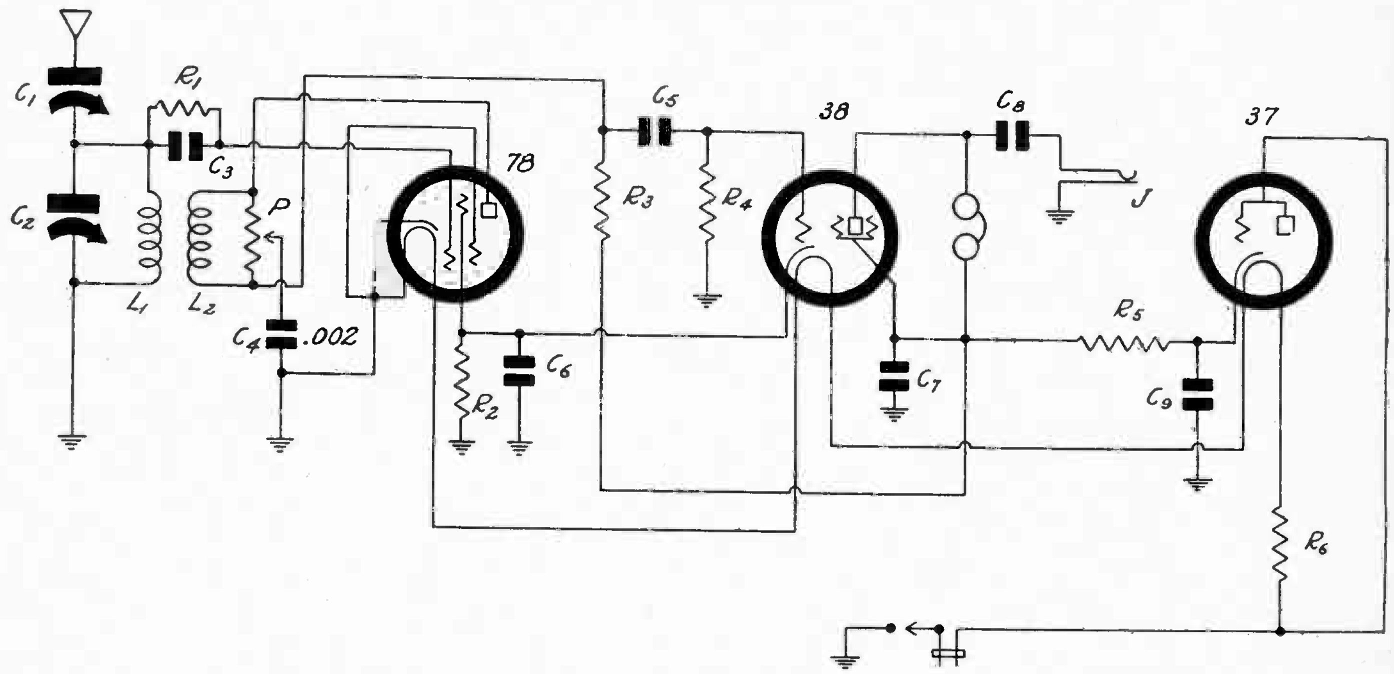
Non-Reception Areas Plotted

(Continued from page 5)

day to day and from month to month. Hence the curves can only be general guides. Reception can be expected on the left of the ground-wave curve but no reception on the right. Reception can also be expected to the left of any of the three "max." curves, provided the "min." curves are favorable. No reception can be expected below the "min." curves and to the right of the ground-wave curve. Moreover, no reception can be expected to the right of the "max." curves and below the "min." curves.

Constants for Universal
To be Used in Short-Wave Reception

By Samuel Fender



The values of the constants for this universal short-wave receiver will be found in the list of parts herewith.

IN THE previous issue, April 14th, we showed the circuit diagram and a photograph of a three-tube universal receiver designed primary for short waves. The details of constants are given herewith and the circuit is repeated.

The set is universal because a 37 type tube is used as rectifier and this tube is always in the circuit regardless whether the power supply is a.c. or d.c. For power tube a 38 is used, and this tube is employed whether or not the listening is done with a pair of earphones or a loudspeaker. There is a jack provided for plugging in the earphones. The speaker, which is of the magnetic type, is always connected in series with the plate circuit of the 38. The earphones are plugged in between the plate of the tube and ground, through a small condenser.

(*Continued on next page*)

Secret of Success in a Noise Filter

(*Continued from preceding page*)

turns from coil Lt unless it is necessary. After connecting the filter, vary condenser Ct. It is possible that a point will be found immediately, where the noise level is reduced or eliminated. In this case no further adjustments need be made. Turns are removed from Lt only if the correct point is not found in this first adjustment. Although, as originally stated, the coil may finally be as small as ten turns, it is most probable that the resonant point will be reached before the coil has been reduced to this size. Be sure to follow the directions carefully for best results, particularly to attaching a good ground connection. Make the ground wire as short as possible. Solder all connections securely, for a poorly made connection is a cause of noise. It would be jest, indeed, if an additional noise were to be caused by your noise eliminator.

The secret of the success of this filter is the tuning of it to the frequency of the noise. As is well known, noise arising from sparking in an electrical circuit sets up radio waves the frequency of which is determined by chance resonators in the line. If we have a tuned circuit and there is sparking in that circuit or in one that is coupled to it, the frequency will be determined by the inductance and capacity of that circuit. If there are more circuits than one in which resonance may take place, each will select its own frequency from the spark, which is always of a complex nature. It is always possible to trap out any radio frequency noise by a tuned circuit that has the same natural frequency as the circuit that was excited by the spark. It is on this principle that this noise filter works. The spark excites a resonant circuit somewhere in the line and the noise is then carried farther by the radio wave generated—the noise being a modulation on the carrier. The filter, tuned to the carrier and properly coupled traps out the carrier and the noise modulation with it.

Because of this fact it is essential that the line noise filter be tuned accurately to the predominating noise carrier. Since there is no means of knowing what the carrier frequency may be, the only way of trapping out the noise effectively is to tune the filter experimentally until it wipes out the noise. The receiver should be set at highest sensitivity when the adjustment of the noise filter is about to be begun, and then the tuning condenser CT should be varied throughout its range. Careful note should be made whether or not the noise decreases during this process. If there is a decrease as the capacity is reduced, turns should be removed from the coil Lt, say ten at a time, and the condenser should be varied as before after each change. When a point of minimum noise has been found, the condenser should be left in that position. If there is no noticeable change in the intensity of the noise as the condenser is turned, turns should still be removed, for there are too many at the start. This is intentional in order to allow a greater variation. It is possible that the minimum will not be found until only 10 turns remain on the coil, but that is an extreme case.

There will be different amounts of noise depending on which way the power plug is inserted into the outlet. For that reason it should be reversed and that position in which the noise is minimum should be retained. The plug should then be marked so that it may be inserted the correct way every time with certainty. If there are two plugs between the outlet and the receiver, both should be reversed and the best combination found. It is, of course, necessary to mark both for otherwise it will be impossible to return to the correct combination.

While the length of the a-c cable is not a strong factor, nevertheless any extraordinarily long cable should be in a grounded sheath.

Harrison Radio Company, of New York City, is merchandising the filter itself, as well as parts for its construction.

Movable Indoor Doublet

Prophesies as Imminent All-Wave Antenna

By Herman Bernard

IN SHORT-WAVE reception now, as in the beginning of broadcasting, there is great interest in aerials. It was recognized away back that a lofty and effective antenna was a great help. Broadcast receivers later were developed to such a degree of sensitivity that antenna precautions became of small consequence, indeed with superheterodynes a small pickup was preferable, as the resultant loose coupling between the transmitter and the receiver aided in the suppression of image interference. The fact remained, however, that with a stronger antenna pickup there would be less comparative noise, as the amplification used could be less in the set, where some receiver noises are inevitably present and amplified along with the rest.

Now, when short waves are to be tuned in, or short waves and broadcasts, using superheterodynes, the same idea holds, that a small aerial suffices for broadcasts, and any attempt at antenna improvement would be directed toward short-wave results. These are the waves that are as intriguing now as were the broadcast waves of years gone by, before powers of 50,000 watts were used at all, much less being common, and before even a test was made of 400,000 or 500,000 watts, as is now going on in Cincinnati.

Transmission Technique to Be Used

The question arises: What shall I do with the antenna to reduce fading (if that is possible), to improve the signal-to-noise ratio, and to render more certain the repeated and deliberate tuning in of foreign stations?

What probably will be done eventually for reception of short waves is substantially what is being done for their transmission, since reception is merely transmission reversed. Take every step that is present in the transmission process. It must be repeated, reversed or not, in the reception process. The wave is propagated or radiated from the station. Into it are put variations of an audio-frequency nature, this mixing being called modulation. From the carrier as received this modulation must be removed, a reversal of the transmitting process. But, like the transmitter, the receiver must have amplification, this being both before and after detection. The microphone at the studio has its counterpart in the reversed transducer at the set end—the reproducer or loudspeaker.

Not only with the radio wave itself must we be concerned, but the amplification processes have to be considered. Also detecting methods become important. Likewise audio-frequency response is a ratable factor in association with short waves, and for somewhat different reasons than for broadcast generally. However, the field is too large for an unlimited discussion. It is enough to try to consider the radio-frequency wave or carrier, and what can be done to take better advantage of it.

The Doublet Is Selected

The start has been made with the doublet antenna and the transposed leadin. The doublet is growing in popularity because it works well. It consists of a horizontal stretch of two equal wires, separated at what would be their center by an insulator, and where the respective wires are joined to the insulator two leads are brought down to the set. It is a half-wave antenna.

A necessity is to bring these down as a transmission line, which is the technical phrase for a conducting system that introduces no losses. Moreover, a true transmission line itself contributes no pickup, so that the receiver, in effect, is lifted to the aerial proper, the electrical equivalent of the transmission line being proximity of the set to the aerial. The transposed leadin, consisting of insulators on which the two down-wires are crossed every foot or so, is used merely for convenience. It is not the best transmission line. Nothing can beat a hollow copper tubing, in the core of which is a solid copper rod, the hollow and the solid copper pieces representing the conducting elements. This form is best because there is no radiation from a transmitting viewpoint, and it is best therefore because there is no anti-radiation, that is, pickup, from a receiving viewpoint.

But the doublet is directional. And besides it is reactive. By directional is meant that pickup is non-uniform from the various points of the compass. By reaction is meant that the voltage developed is non-uniform for the various frequencies. Therefore something has to be done in an attempt to overcome these effects.

Doublet Direction

First let us consider in what direction or directions the doublet acts best. It picks up best from the broadside. That means at right angles to the direction in which the antenna wire points. If the pattern were drawn it would look like a figure 8, with the central crossing of the lines coinciding with the stretch of wire. Hence in the direction of the wire itself there is no pickup, no voltage developed, and no current flowing.

To correct for a blank condition or direction would require that the antenna be rotatable. This is not a commercial proposition at present. Doublets are on the roof. Previously all antennas were on the roof. Soon enough many of them were brought indoors. That is what will have to happen to doublets or their substitutes. They will be made into smaller, rotatable indoor antennas, perhaps located above or otherwise near the receiver.

Loose Coupling to Antenna in Universal Set

(*Continued from preceding page*)

In order to obtain a high sensitivity with the single r-f tube and single tuner, regeneration is employed. A potentiometer P is connected across the tickler coil and the slider of this potentiometer is connected to ground through a small condenser C4. If the slider is set at the top, all the radio-frequency current in the plate circuit is shunted to ground and no regeneration results. When the slider is set at the other extreme, nearly all the r-f current in the plate circuit is forced through the tickler. The optimum setting is found somewhere between the two extremes.

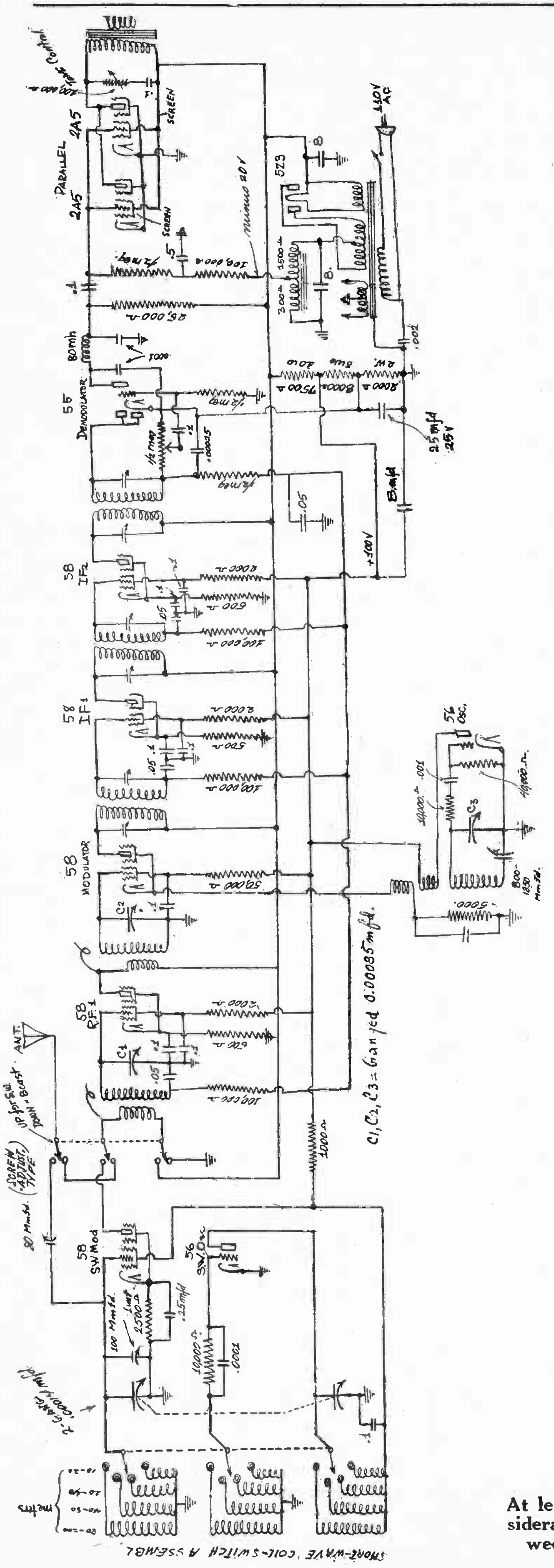
The adjustment will require some care, as with all regenerative circuits.

The coil L1L2 is of the plug-in type and a set can be obtained that will cover the frequencies from 20 megacycles to 540 kilocycles. Thus the circuit is not only universal in respect to the power supply but also in respect to the frequencies that may be tuned in.

The primary coil is tuned by means of a 140 mmfd. condenser C2 and a small condenser, C1, is put in the antenna lead to insure loose coupling between the antenna and the tuned circuit.

LIST OF PARTS

L1L2—One set of plug-in coils (20,000-540 kc)
C1—One small, compression type, adjustable condenser (100 mmfd. max.)
C2—One 140 mmfd. variable condenser, with knob
C3—One 250 mmfd. grid condenser
C4—One 0.002 mfd. fixed condenser
C5—One 0.006 mfd. condenser
C6—One 25 mfd., low voltage, electrolytic condenser
C7, C9—Two 8 mfd. electrolytic condensers
C8—One 0.01 mfd. fixed condenser
R1—One 2-meg. grid leak
R2—One 1,000-ohm bias resistor
R3—One 250,000-ohm coupling resistor
R4—One 0.5-meg. grid leak
R5—One 1,000 ohm resistor
R6—One 300-ohm, 30-watt ballast resistor
P—One 50,000-ohm potentiometer
One four-contact socket (for coils)
Two five-contact sockets
One six-contact socket
Two grid clips
One phone jack (single circuit open)
One line switch (mounted on potentiometer)
One small magnetic speaker
One cord and plug
One small chassis



The Building of the 11-Tube Sky-Raider

By Alan Mannion

Mannion Radio Laboratories

THE interest shown in the 10-to-556-meter receiver, the Sky-Raider, concerning which preliminary information was printed last week, proves the direction in which the minds of the home set-builders are turning, and also the recognition of a worth-while receiver.

The Sky-Raider is a superheterodyne for broadcast reception, a double super from 10 to 200 meters. That is, for short waves the signal is amplified at three frequencies or levels. Different tuning condensers are used for both short waves and broadcast, and there are two decided advantages to this system.

The first and more obvious reason is that a frequency ratio of 2-to-1 obtains over the high-frequency bands, while the conventional 3-to-1 ratio is retained for broadcast.

Secondly, the shortwave dial may be left at the setting of any station and the receiver tuned over the broadcast band. When the short-wave station is again wanted, the broadcast dial is reset at the previously-determined reference point, and the switch set for "short waves."

Individual Filtration Helped

A glance at the diagram shows a well-designed broadcast superheterodyne preceded by a high-frequency mixer circuit. The output of this high-frequency circuit is an intermediate frequency within the broadcast band. In the present model this is about 640 kc. Thus the broadcast tuner acts as an intermediate-frequency amplifier for short waves. Since this broadcast frequency is again translated to a 175 kc level, the signal is amplified at three frequency levels before detection. A 55 tube is used for the three purposes of diode rectifier, automatic volume control and audio amplifier. A pair of 2A5's in parallel complete the gain circuit.

Less trouble than that expected arose from this multiple-frequency arrangement. Individual filtering of screen and cathode circuits partly accounts for this, while good layout will work wonders where keeping down parasitic coupling is a requirement.

A Condenser Precaution

Since the 100-volt potential is common to screens in both broadcast and short-wave tubes, and also to the high-frequency oscillator, heavy by-passing is essential. Note that in addition to the 8-mfd. at this point on the voltage divider, an extra 0.1 mfd. is placed *on the short-wave coils,* at the plus end of the oscillator's plate coils. This is desirable, as electrolytic condensers may show considerable inductance effects at high frequencies.

A departure from the usual coupling method is used in the short-wave-broadcast switch. Referring to the diagram, when this switch is in the "up" position the aerial lead in brought through a screw type series condenser to the band-selector switch. The primary of the first coil in the broadcast band is connected between the short-wave modulator's plate and the 250-volt source, thus coupling the modulator closely into the succeeding channel.

The "down" position of this switch disconnects the aerial lead from the short-wave coils, also the plate and B plus connection of the modulator tube. The signal is now fed directly to the first radio-frequency coil in the broadcast channel.

Separate Grounding

The time-tried precaution, bus bar wiring in the short-wave section, and a ground wire exclusively for this section will repay the extra effort. Do not depend on the plated metal chassis for short-wave "returns."

The broadcast section of the receiver is designed for high gain.

(*Continued on next page*)

At left is the Sky-Raider circuit diagram. Theoretical considerations, with views of the completed set, were given last week. Practical considerations are treated this week.

And it accomplishes just that. An hour spent at the controls makes apparent the ease of operation, and gives abundant evidence of satisfying sensitivity. The nine tuned circuits on broadcasts—eleven on short waves—take care of selectivity requirements.

The four coils for the 10-200 meter band are single-hole mounted on a 5 in. x 7 in. piece of aluminum fastened to the front flap of the chassis. This leaves the coils suspended an inch above the chassis at the nearest point. All possible care should be taken that wires carrying high-frequency currents are isolated from each other and from the chassis. A little distributed capacity here can cause more headaches than an equal amount of capacity in the broadcast channel. In addition to causing high-frequency losses, such accidental capacity in the short-wave tuned circuits reduces the frequency ratio considerably. Intelligent care in this respect pays high dividends in performance.

Separation of Oscillators

In an earlier model along the same lines, some months ago, trouble was encountered when the two oscillator tubes were close together. A number of squeals attested the presence of mixture frequencies due to coupling of fields. When the two tubes were kept six inches apart the trouble vanished. Even though the short-wave modulator is disconnected for broadcast use, there is a considerable field around the first 56 and its associated wiring. Keep other wiring away from this oscillator!

All values shown on the diagram are actual, as used in the receiver, and selected after careful test and consideration. Receivers built as shown have given excellent service in both urban and suburban localities.

Alignment of the receiver is along conventional lines. In the high frequency end it will be noted that a parallel variable condenser of 100 mmfd. maximum capacity is shunted across the gang-section which tunes the modulator. This is on the front panel, to the right and below the band-selector switch. The short-wave-broadcast selector switch is centered on a level with the small condenser. Equally-spaced to the right of this is the volume control, with a-c switch operated by the same shaft.

Needs Husky Transformer

The drain of this receiver is relatively high, and a husky power transformer is used. A 5Z3 rectifier will handle the load with something to spare. Returning the grids of the output tubes to a field tap at a voltage negative with respect to ground is without doubt an excellent method of assuring good tone quality. Not only is this voltage extremely steady but the elimination of the usual bias resistor, and by-pass condenser, makes for economy. The usual degenerative effects across this resistor (due to variations in plate current) are thus largely avoided.

The use of a "high-gain" coil of the choke-primary type to couple the short-wave modulator to the succeeding tubes removes the bugbear of losses at this point. The result is a substantial lowering of background hash.

Byrd is Awarded Medal for Communication Work

Rear Admiral Richard E. Byrd has been designated as recipient of the Columbia Broadcasting System Medal for Distinguished Contribution to Radio. Presentation was made during the expedition's broadcast to the United States over the Columbia network recently.

Only five other persons have previously been awarded the medal. They are Colonel Charles Lindbergh; Sir John A. Reith, director-general of the British Broadcasting Corporation; Leopold Stokowski, conductor of the Philadelphia Orchestra; Amelia Earhart, and Nino Martini, Metropolitan Opera tenor.

TRADIOGRAMS

By J. Murray Barron

James B. Post, of World Broadcasting System, announces the placement of the following business: Provident Mutual Life Insurance Co., of Philadelphia, four 15-minute electrical transcriptions, "The Stories Behind the Claims," one a week over stations WHK, Cleveland, O.; WRVA, Richmond, Va.; KYW, Chicago, and WCAU, Philadelphia; Niagara Hudson Power Corp., New York, through Batten, Barton, Durstine & Osborn, Inc., New York, 75 fifteen-minute electrical transcriptions program, "Little Jack Little and His Orchestra," three a week, on seven stations.

* * *

Walter C. Evans, manager of the Chicopee Falls Radio Division of Westinghouse, has announced the appointment of C. J. Burnside as manager of that plant. R. L. Davis, former manager, will devote his full time to development work. Police and Aircraft radio apparatus are the chief radio products of the plant. Mr. Burnside was graduated in 1924 from South Dakota School of Mines. Since then he has been associated with the radio departments of Westinghouse.

* * *

James Fouch, test technician at the Universal Microphone Co., Inglewood, Cal., and Julia Weiser, were married recently. He is a nephew of James Fouch, president and general manager.

* * *

So often when one is tuning for a short-wave station the weak station fails to make its presence known. This may be caused by various things—too-quick tuning, fading or other causes. However, a beat-note oscillator will tell one when a station is being passed. It spots the carrier, even the weak one. It may be cut in or out and will in no way interfere. A kit and a finished product are produced by Sol Perlman, 647 East 96th St., Brooklyn, N. Y.

* * *

An inexpensive type of volt-ohm-milliammeter kit has been designed by Jack Grand, of Sun Radio Co., Fulton and Greenwich Streets, New York City. It is meeting with much favor.

* * *

Olmsted-Hewitt, Inc., advertising and marketing agency, 1200 Second Ave., South, Minneapolis, Minn., has issued a booklet on the value of radio advertising.

The Cleartone Radio Speaker Service, as conducted at 72 Cortlandt Street, New York City, by Frank Van Der Meyer and William W. Windrath, announces additional space taken at this address. While both are men of long experience in the radio field, the new organization has recently opened at this address. The addition will more than double the floor space. This action was made necessary by the increase in speaker repairs and also to enable the carrying of a wide assortment of speakers, repair parts and essentials.

* * *

Thor Radio Co., 167 Greenwich Street, New York City, who also operates the Thor Bargain Basement, is now offering practically anything in the small short-wave kits. This is in addition to the Thor seven-tube kit and short-wave converters. In the store upstairs a full line of short-wave receivers of the nationally-known types is carried.

* * *

A series of questions and answers concerning patents, of particular interest to the inventor of limited resources, has been prepared in mimeographed form by Ray Belmont Whitman, 2 Rector Street, New York, N. Y., and is available from Mr. Whitman on request.

* * *

Postal Radio Corp., 135 Liberty Street, New York, reports a large demand for its Booster. To many the name should really signify more than it does, for great numbers do not realize that for some time now many short-wave listeners have wished for something to add more amplification to their present receivers. The Booster is just what is needed. There is free literature.

* *

Baltimore Radio Company, New York City, is making preparations now for an enormous Fall catalogue. Special arrangements are being made to give a big play to the leading short-wave kits and sets, as well as a short-wave line manufactured by Baltimore in its large quarters on Broadway. One of the largest radio catalogues ever issued is under consideration.

CORPORATE ACTIVITIES

Stromberg Carlson Telephone Manufacturing Company.—Net loss for the year 1933, after taxes and other charges, $331,128, as against a loss in 1932 of $777,592.

Wolverine Tube Company.—Net income for 1933, after depreciation, interest and other charges, $48,358, which equals, after 7% preferred dividends, 19 cents a share on 116,455 common shares, as compared with 25,245, or $6.65 a share on 3,798 preferred shares in 1932.

Central Tube Company—Net loss for the year 1933, after depreciation and other charges, $85,892, as compared with net loss of $1,757 for the year 1932.

G. E. Directors Submit Employe Profit Plan

Schenectady, N. Y.

The board of directors of the General Electric Company submitted to stockholders a profit-sharing plan designed to affect all employes of the company, which number nearly 50,000.

If approved by the stockholders, the application of the profit-sharing principle to such a large group of workers will make the plan unique in the history of business.

A 5-Tube Auto Su
A. V. C. and M

By Edwin

Supertone Pro

HERE is the first automobile receiver of the new season. It is a five tube affair. Notwithstanding it has only five tubes it has all the latest trimmings, including built-in B supply, automatic volume control, diode detection, pentode power amplification, and unified tuning. It is a superheterodyne with an intermediate frequency of 175 kc. and is called "Wanderlust."

Can a receiver of the superheterodyne type containing only five tubes be sensitive enough for an automobile? Surely, it all depends on the kind of tubes used. If all are high gain, and if all are utilized to the fullest extent, the circuit will be about as sensitive as an eight-tube receiver was before we had the super-sensitive tubes.

Let us examine the present circuit to see how it gets its sensitivity! The first tube in the circuit is a 78 high-gain tube. That takes care of the radio-frequency gain. The second tube is a 77, employed as a detector and oscillator. Doubling up at this point eliminates a tube without making the circuit less sensitive than it would have been had two separate tubes been used as oscillator and detector. Following the 77 oscillator-detector is another 78 used as intermediate-frequency amplifier. This tube in conjunction with two doubly-tuned intermediate-frequency transformers accounts for a very high gain.

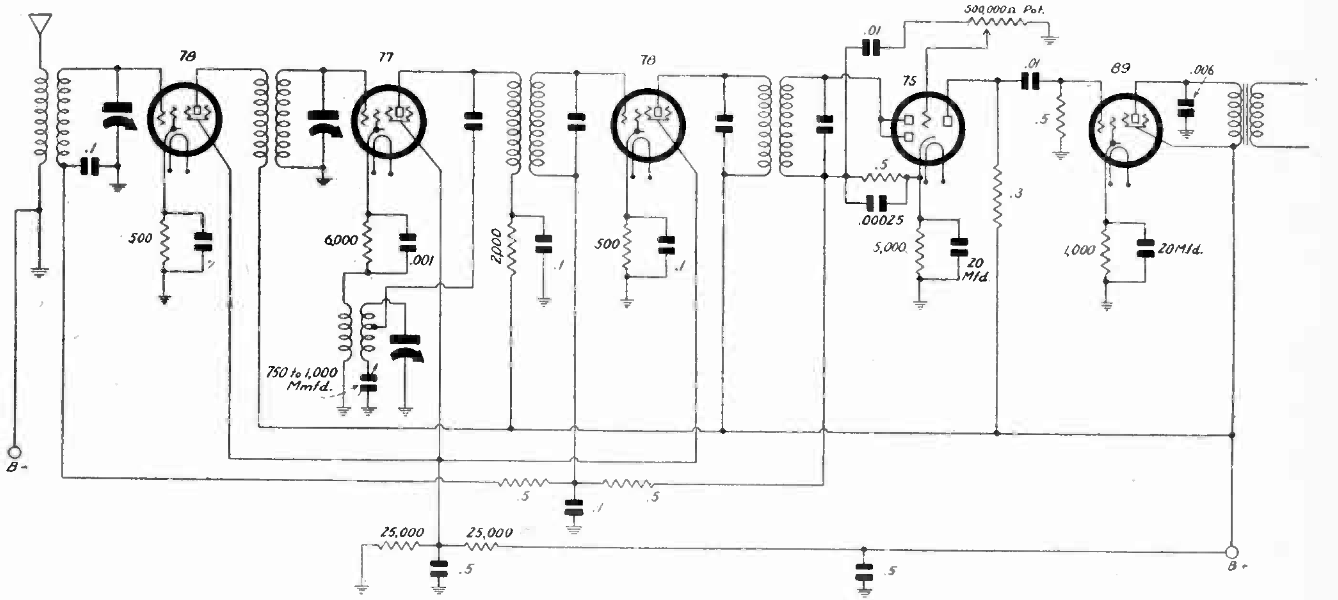


FIG. 1

The circuit of the five-tube automobile superheterodyne receiver. It is equipped with manual and automatic volume controls.

The Detector and A. V. C.

For second detector the diode section of a 75 is employed. The two diode plates are tied together and the secondary of the second intermediate transformer is connected in the detector circuit so as to impress the entire voltage across the coil on the detector. Thus there is no split-up as there is when full-wave rectification is employed. There is a load resistance of 0.5 megohm.

The entire audio-frequency voltage developed across the load resistance is impressed on the grid of the triode of the 75. Now the triode of this tube has a high mu. Therefore the output of the tube is very high for a given voltage across the load resistance. The tube has an amplification factor of 100 and an internal resistance of 91,000 ohms. Therefore when the load resistance is 300,000 ohms, as in this instance, the amplification in the tube is of the order of 75, which means that if there is one volt across the diode load resistance, there will be 75 volts across the 300,000-ohm coupling resistance, and the same will be impressed on the grid of the output tube. Of course, the output tube will not stand anywhere near as much as that, but that fact does not alter the ratio. The power tube will not take more than about 18 volts, peak value. Therefore it will be loaded up to the limit when the audio voltage amplitude across the load resistance is about one-fourth volt.

The a.v.c. voltage is taken off the diode load resistance and is applied to the grids of the two 78s, both of which are of the remote cut-off type.

Manual Control

The manual volume control is placed in the grid circuit of the 75 triode. It takes the form of a half-megohm potentiometer, which serves also as the grid leak. The high potential side of the potentiometer is connected to the negative end of the diode load resistance through a 0.01 mfd. stopping condenser. The triode, therefore, is self-biased, since it has a 5,000-ohm resistor in the lead between the cathode and ground. Diode bias would not work out satisfactorily in a tube like the 75 because of the very high amplification factor. But if the tube is properly biased by means of a cathode resistance and the volume is controlled in the grid circuit independently of the bias, the 75 is a splendid tube.

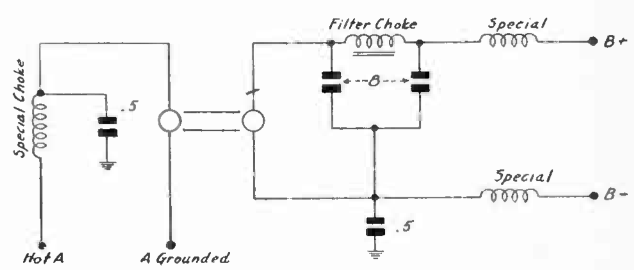


FIG. 2

The circuit of the generator and filter of the B supply employed in the auto set in Fig. 1.

The a.v.c. is so effective there is little for the potentiometer to do, except to vary the output. That is, it is not necessary to use it as a means of varying the sensitivity of the circuit.

Biasing and Filtering

Every tube in the circuit is self biased. Each of the 78s has a 500-ohm cathode resistor, and each has a 0.1 mfd. condenser across it. In the cathode lead of the 77 is a 6,000-ohm resistor and this is shunted by a 0.001 mfd. condenser.

In the cathode of the 75, as was mentioned, there is a 5,000-ohm resistor, and this resistor is shunted by a 20 mfd. electrolytic con-

uperheterodyne with Motor Generator

Stannard

lucts Corporation

The B supply used with this receiver is a Genemotor, which is a comparatively new device that steps up the storage battery voltage and rectifies it. The output voltage is close to 250 volts. The filtering is done externally to the generator and the filter consists of two 8 mfd. electrolytic condensers and one filter choke. In addition to these there are three special radio-frequency chokes for removing high-frequency noise. There is one of these in series with each output lead of rectifier. These two chokes need not be wound with heavy wire but may be small 10 millihenry chokes such as are used in intermediate frequency transformers. As an aid in filtering there is also a 0.5 mfd. condenser connected between the common side of the two large filter condensers and the chassis. The chassis is regarded as ground for that is connected to the chassis of the car and is the only ground possible in the car.

In series with the lead from the storage battery to the Genemotor is a heavy duty coil, which is a solenoid, containing about 50 turns of No. 18, or heavier, enameled copper wire, wound on a form approximately 1.25 or 1.5 inches in diameter. This should be exposed to circulating air. A 0.5 mfd. condenser from the generator side of this coil and the chassis helps to remove the noise.

The generator has three leads. One, an isolated black lead, always goes to the "hot" side of the car battery. The other two leads are blue and black. When A minus is grounded (and A plus is "hot") the blue is B plus and the black is B minus. When A plus is grounded and A minus is "hot" the black is B plus and the blue is B minus.

The three tuning condensers in the circuit are a gang of three 350 mmfd. units. This requires padding in the oscillator, and this is done by using a special oscillator inductance and an adjustable condenser having a range of from 750 to 1,000 mmfd.

LIST OF PARTS

Coils

One antenna coil for 350 mmfd. condenser
One r-f interstage coupler for 350 mmfd. condenser.
One special coupler with one doubly-tuned i-f transformer (175 kc) and one oscillator transformer (for 175 kc and 350 mmfd. tuning condenser)
One intermediate-frequency, doubly-tuned transformer, 175 kc
One output transformer and speaker
One heavy-duty r-f choke for high voltage generator
Two light-duty air-core chokes for B supply filter
One iron-core transformer for B supply

Condensers

One gang of three 350 mmfd. condensers with trimmers
One padding condenser, 250-to-1,000 mmfd.
One 0.001 mfd. by-pass condenser
Two 0.01 mfd. condensers
Five 0.1 mfd. condensers
One 250 mmfd. condenser
Four 0.5 mfd. condensers
Two 8 mfd. electrolytic condensers
Two 20 mfd. electrolytic condensers
One 0.006 mfd. condenser

Resistors

Two 500-ohm resistors
One 2,000-ohm resistor
Two 2,500-ohm resistors
One 1,000-ohm bias resistor
One 5,000-ohm resistor
One 6,000-ohm resistor
One 0.3-meg. resistor
Four 0.5-meg. resistors
One 0.5-meg. potentiometer (part of remote control)

Other Requirements

Five grid clips
One 75 socket
Two 78 sockets
One 77 socket
One 89 socket
One remote control unit (cable, dial, and potentiometer, with gear attachment)
One Genemotor
One metal box and chassis

denser. A very large condenser across the bias resistor in this tube is essential because of the high mu of the tube. Without it, there would be excessive reverse feedback. If this condenser is of the polarized type, the positive terminal should be connected to the cathode.

In the cathode lead of the power tube, which is an 89 used in the pentode connection, there is a self-bias resistor of 1,000 ohms, and this resistor is shunted by another 20 mfd. electrolytic condenser. A large value of capacity is also needed here because the amplification of the 89 in the pentode connection is very high, and reverse feedback would make the set insensitive without the large capacity.

B Supply and Filter

Thorough filtering of the a.v.c. voltage is also done. Thus in the grid circuit of the first 78 is a 0.5-megohm resistor and a 0.1 mfd. condenser. There is no resistor or separate condenser in the lead to the grid of the second 78 on the a.v.c., but there is a common 0.1 mfd. condenser and a common 0.5-megohm resistor. The main purpose of the common 0.5-megohm resistor is to prevent shorting of the audio signal through the filter condensers associated with the a.v.c. But it helps to filter as well.

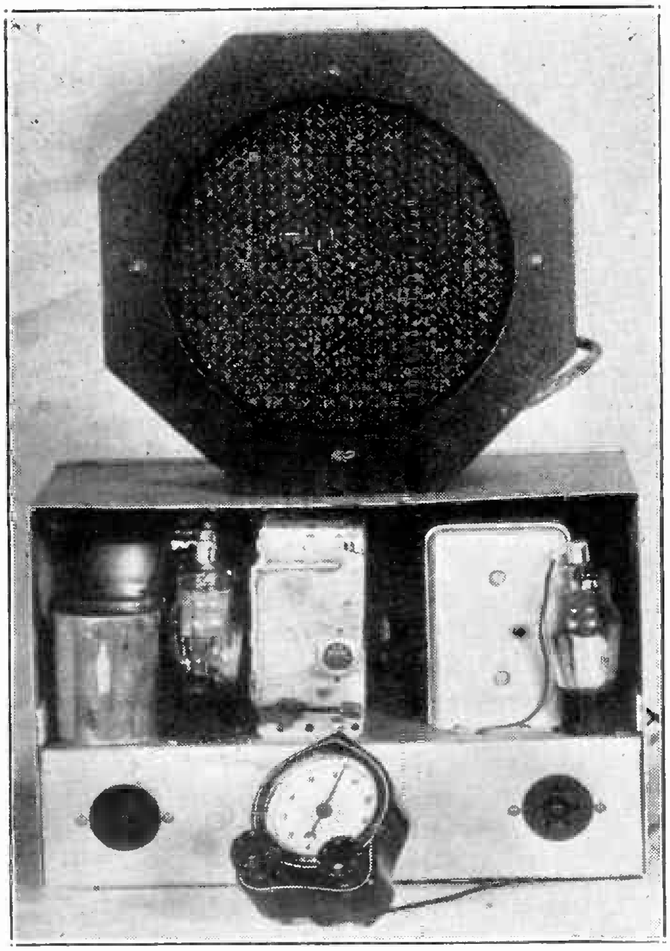
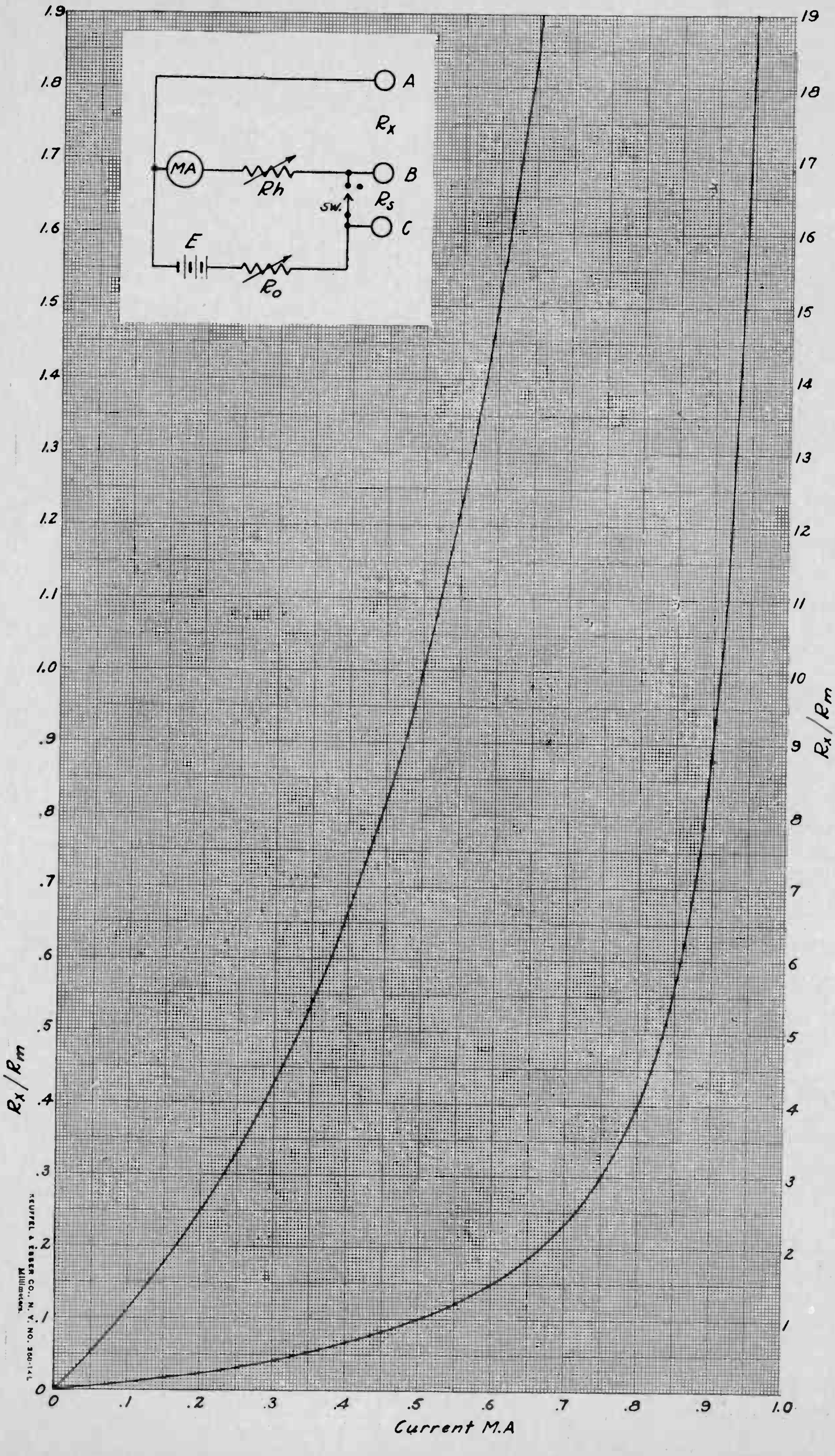


FIG. 3

The larger components of the automobile receiver. The steel cabinet houses everything except the speaker, tuning control and the A battery. The speaker is put anywhere that is convenient. The tuning control, with volume control built in, goes on the steering column. A special coupling is used between the remote control unit and the tuning condenser shaft.



ON the usual ohmmeter it is difficult to measure small resistances accurately. But the ohmmeter can be used just the same for measuring accurately as small resistances as 0.3 ohm provided that the unknown resistance is connected in shunt with the meter movement in place of in series. While very small resistances can be measured accurately in this manner, large values cannot be measured. Still, there is ample overlap between the two methods so that both high and low can be measured with the same instrument. The shunt method covers the range up to about 300 ohms whereas the series method easily goes down to 200 ohms.

The arrangement required for the shunt method is shown in an insert drawing in the diagram. E is the battery supplying the current, and this may be the same for both series and shunt circuits.

Operation

Ro is the limiting resistance, the value of which depends on the sensitivity of the meter and the value of E. In either the shunt or the series method Ro is adjusted

Calibration curves of a shunt type ohmmeter. The insert is both for the shunt and series ohmmeters. Rx is shunt resistance and Rs series resistance. For shunt connection close switch.

The Meter-Shunt Method

of Measuring Small Resistances Very Accurately

By Rodney Lester

so that the meter reads full-scale deflection when the unknown resistance is not connected to the circuit. Rh is a small variable resistance in series with the meter for making adjustments of the meter resistance, Sw is a switch for closing the circuit when the shunt method is employed, and A, B, C, are three terminal posts.

When a resistance is to be measured Sw is closed and Ro is adjusted until the meter reads just full scale. If a large resistance is to be measured, this is connected across BC and the switch is opened. The deflection on the meter will then give a measure of the resistance which can be converted into ohms. When a small resistance is to be measured Sw is left closed and the unknown is connected across AB. Again the deflection of the meter will give a measure of the resistance.

Shunting

If Ro is very large in comparison with the internal resistance of the meter, which includes Rh, the formula that connects the deflection of the meter, the internal resistance Rm, and the external shunt resistance Rx is Rx/Rm=I/(1—I), where I is the meter deflection. The graph of this formula is plotted herewith. Ordinates represent the values of Rx/Rm and the abscissas the values of deflection. The curve on the right covers the whole practical range but the curve on the left only covers the lower values of current, that is, the lower values of resistance. The scale on the right refers to the right-hand curve and the scale on the left to the left-hand scale. The only object of the curve and the scale on the left is to enable the measurement of very low resistances.

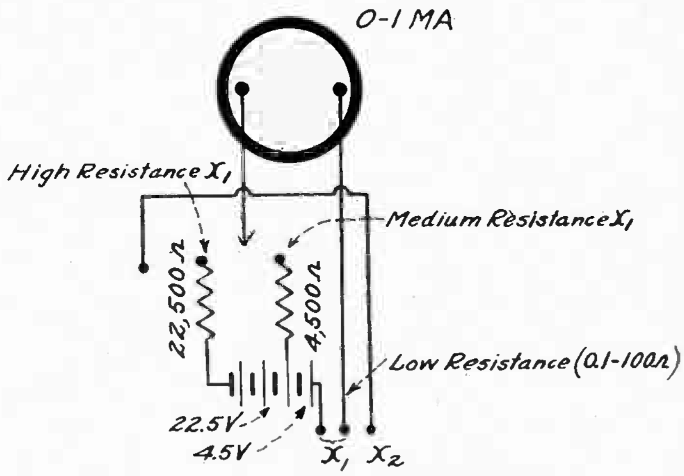
It will be noticed that when the deflection on the meter is 0.01 of full scale, the resistance ratio, Rx/Rm, is also 0.01. Thus if Rm is 30 ohms, the lowest value of Rx would be 0.3 ohm. If the scale on the meter has 20 divisions, 0.01 part of the scale is represented by 1/5 of the smallest division. It is possible to estimate as closely as 1/10 of the smallest division and therefore to measure, approximately, as low a resistance as 0.15 ohm if the value of Rm is 30 ohms.

The formula is given in ratio form so that it is applicable to any meter having any internal resistance and any current range. If the scale is 0-1 milliampere the abscissas give the actual reading of the meter. If the meter has some other range the formula may be written Rx/Rm=I/(Io—I), where I is the actual reading and Io is the full-scale reading.

Application of Curves

Suppose we have a 0-1 milliammeter having an internal resistance of 30 ohms. What is the resistance across the meter when the current is 0.7 milliampere? The right-hand curve crosses the 0.7 ordinate at 2.325. Therefore the resistance is 2.325X30, or 69.75 ohms. Suppose the deflection is only 0.3. Then it is more accurate to read the left-hand curve. This curve crosses the 0.3 ordinate at 0.428. Hence the resistance is 0.428X30, or 12.84 ohms.

It is clear that the small resistances are measured in terms of the internal resistance of the meter. Because of this it is necessary that the internal resistance be known accurately. It is not safe to depend on the value of resistance specified by the manufacturers of the meter, unless the value is given for the particular instrument rather than for that class of instrument. The internal resistance of the meter should be determined so that it can be used as a multiplier.



An ohmmeter, readable from 0.1 to 100 ohms accurately, where the meter resistance is around 30 ohms, and also serviceable from 100 to 2,000,000 ohms in two steps.

It is convenient to have a simple multiplier, such as 30, rather than 27. It is for this reason that the rheostat Rh is inserted. If the meter has a resistance of 27 ohms, 3 ohms can be added externally to make it 30 ohms. The internal resistance of the meter can be determined if any accurately known resistance of approximately the same value is at hand. Suppose, for example, that a resistance of exactly 100 ohms be connected in shunt with the meter. Suppose further that this causes a deflection of 0.8 milliampere. By the formula we have 100/Rm=0.8/(1—0.8). Therefore Rm=25 ohms. Once this has been determined, Rm can be used for measuring other resistances by the shunt method. The resistance of the meter is the same as the shunt resistance when the inclusion of the shunt halves the full-scale deflection.

Major-General Squier Dead

Washington.

Major-General George O. Squier, retired, who invented "wired wireless" and was chief of the Army air service during the World War, died at 69.

"Wired wireless" consisted of having programs originating at studios sent over land wires, such as telephone and lighting company lines, and of carrying on multiplex telephony.

All-Wave Switch Could Be In Condenser

All-wave switching, with automatic indication of the band, is quite the thing today. Drums and discs are used as dials. The drum has the same scale length for every band. The disc diminishes the scale length, due to the concentric effect. Moving lights, fixed progressive lights, and one light with a moving curtain comprise the principal "scanning" systems.

Philco's System

The prime object naturally is to establish reliably some system of having the switch also actuate the illumination, so that the indication automatically will apply to the proper band. Philco's set, for instance, has the light moved up and down by the switch action, and besides has a close vernier that can be introduced for short-wave tuning, by pulling out a knob. This makes for great convenience, although the dial scale itself is concentric, and the highest frequencies occupy the part nearest the hub where the mechanical separation is smallest.

A system can be worked out whereby the switching is made a part mechanical part of the tuning condenser action, so that one could go from highest to lowest frequencies, entirely encompassing the frequency range of the receiver, just by turning the condenser. But this would require a condenser that has continuous rotation, no end stops, and the rotor plates of the condenser could accomplish the switching, being one side of the switch, provided there were at least as many plates in the rotor as the total number of bands to be covered, which is true in every instance examined by the author, who devised such a system.

Frequency Calibration

Frequency calibration is vastly important, and methods of making a calibration in such manner that it will have permanent significance require more precautions and ingenuity than mere introduction of somebody else's dial and condenser to a tuning system employing perhaps the designer's coils. The whole must be worked out as an original entity, and there is no doubt that the lay and technical public would appreciate such a contribution. At present not only is such a method absent from separately purchasable assemblies, but there isn't even a switch-coil system for all-wave coverage that is on the kit market, so it behooves the enterprising experts to get busy.

A 150-Ma B Supply

Separate C Bias Afforded by 30 Tube

By J. E. Anderson

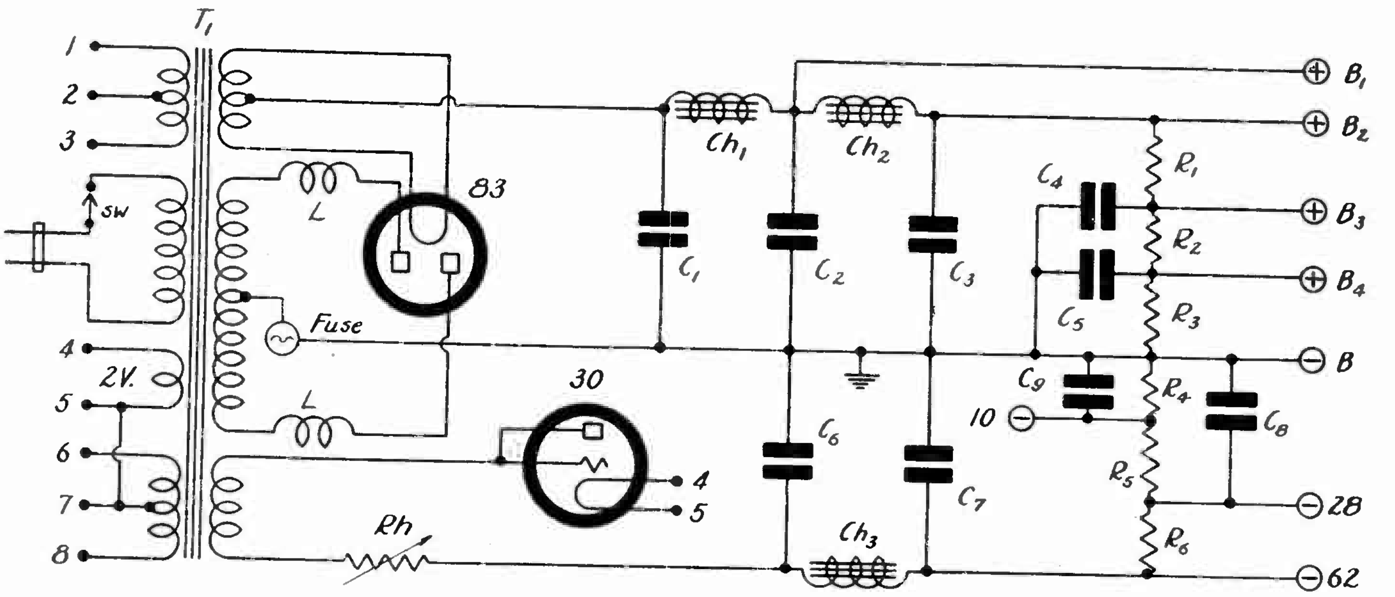


FIG. 1
The circuit of a heavy-duty B supply together with a C supply for the audio tubes.

A HIGH-DUTY B supply is necessary in conjunction with a receiver using many tubes, especially one in which 2A3's are used in push-pull in the output stage. While there is comparatively little use for such a B supply independently of the receiver, there are cases, especially in the laboratory, where such a supply is useful. We shall describe a 150-milliampere B supply capable of a high output and suitable for 2A3's in push-pull. It has been designed for a particular amplifier and radio receiver but it is not limited to that.

A feature of this circuit is that it has a C supply built in for taking care of the bias voltages on all the tubes in the audio amplifier. The rectifier in the C supply is a 30-type tube, which is used because it heats up just as quickly as any power tube that may be used. If this tube, or any filament type tube, is used as rectifier there is no period during which the high voltage is on the tubes without a bias.

The Power Supply

The power transformer contains many windings and is to be regarded as a special job. However, the only extra features are those pertaining to the rectifier for the bias. If no special transformer can be obtained, several other arrangements are possible. For example, instead of providing a separate filament winding of two volts for the 30 tube, its filament may be connected across the winding serving the power tubes. Now in Fig. 1 winding (4-5) is intended for the 30 tube and winding (6-7-8) for the power tubes as well as the other tubes in the audio amplifier. If winding (4-5) is not on the transformer the filament of the 30 can be connected across (6-8), provided that a 10-ohm resistor is connected in series with the 30 filament. Or, the 30 filament may be connected across (6-7) without a resistor in series. While this makes the voltage on the 30 filament a little low, it will be high enough to provide sufficient emission to supply the low current required. The slight unbalance due to the connection of filament across one-half of the 2.5-volt winding is of no importance because it will mean only a difference of 50 milliamperes out of 8 amperes, approximately.

If the high-voltage winding for the rectifier is not available on the transformer, a separate 1-to-1 transformer can be used, and it may be a very tiny one. If its primary is connected to the line, the ratio of the transformer should be about 1-to-1. But if a small filament transformer is available, one designed to convert 110 volts to 2.5 volts, the 2.5-volt winding can be connected across (6-8), and then the secondary voltage will be about right.

High-Voltage Winding

The power transformer, naturally, should have a center-

LIST OF PARTS

Coils

T1—One power transformer with one 115-volt winding, one center-tapped 2.5-volt, 10-ampere winding (1, 2, 3,), one 2-volt winding (4, 5), one 2.5-volt, 8-ampere, center-tapped winding, one 5-volt center-tapped winding (for 83), one 700-volt center-tapped winding, one single 100-volt winding.
LL—Two one millihenry chokes.
Ch1—One 150-milliampere choke, about 20 henries.
Ch2—One 30-henry, 60-milliampere choke.
Ch3—One secondary of small audio transformers.

Condensers

C1—One 4 mfd. 600-volt condenser.
C2, C3—Two 8 mfd. electrolytic condensers (500-volt rating).
C4, C5, C6, C7, C8, C9—Six 2 mfd. by-pass condensers.

Resistors

R1—One 2,000-ohm, 3-watt resistor.
R2, R3—Two 5,000-ohm, 3-watt resistors.
R4—One 10,000-ohm, ½-watt resistor.
R5—One 18,000-ohm, ½-watt resistor.
R6—One 34,000-ohm, ½-watt resistor.
Rh—One 100,000-ohm variable resistor.

Other Requirements

One 250-milliampere fuse with holder.
One line switch.
Two four-contact sockets.
One cord and plug.
Seven binding posts or flexible leads.

tapped high-voltage winding with a total voltage of about 700 volts. This will give plenty of voltage even after some is dropped in the filter chokes, because if an 83 rectifier is used there will be little drop in the tube.

There should also be a 5-volt winding on the transformer for the rectifier tube filament. This should preferably be center-tapped, although if it is not, there is no great objection to connecting the filter to one side of the winding.

The winding (1-2-3) on the transformer is intended for the filaments of the tubes in the radio and intermediate frequency amplifiers. It should have a voltage of 2.5 volts and a current capacity of about 10 amperes.

Buffer Chokes

Coils LL are used to remove noise in the rectified current. These are necessary only when a mercury vapor rectifier is used, and they need not be larger than one millihenry each. They should, of course, be wound with wire large enough to carry the rectified current, which may amount to about 100 milliamperes per plate of the rectifier.

Another desirable feature in a power supply of this kind is a fuse in the d-c circuit. This is advantageous in preventing damage to the transformer and the power tubes when excessive current flows, usually as a result of insufficient bias. A quarter milliampere fuse is suggested for this will limit the current to that value but it will not burn out under normal conditions of operation, for it is not likely that the total current will exceed 150 milliamperes.

The Filter

The main filter contains two chokes and three condensers. It is recommended that the first condenser, C1, be of 4 mfd. and 600-volt rating. An electrolytic is not recommended in this position. The other two condensers, C2 and C3, may be 8 mfd. electrolytics with a nominal rating of 500 volts.

The first choke, Ch1, which not only carries the bleeder current and the plate current of the radio and intermediate amplifiers, but also that of the two 2A3 tubes, and these tubes take most of the current. Hence this choke should be capable of carrying at least 150 milliamperes. The inductance rating might be 20 henries.

The second choke, Ch2, will not carry nearly so much current and for that reason it may be a regular choke of 30 henries or more. Its carry-capacity need not be more than 60 or 85 millihenries, depending on what the load is.

The Voltage Divider

The voltage for the push-pull tubes is taken off at the junction of the two chokes, or at B1. All other higher voltages are taken off at the high end of the voltage divider, or at B2. The difference between the voltages at B1 and B2 is small, for it is due only to the drop in the choke Ch2.

The design of the voltage divider, that is, the choice of values for R1, R2, and R3, depends on the circuit with which the B supply is to be used. Hence any values given will apply only to one circuit. The variation in the voltages will be small, however, if we allow a heavy bleeder current. Let us assume a bleeder current of 20 milliamperes. This choice is entirely arbitrary and need not be changed unless the total current drawn from the device is excessive, when it should be reduced. If we decide on 20 milliamperes, and if we want a voltage of 100 volts at B4, R3 should have a value of 5,000 ohms and it should have a wattage rating of 3 watts or more.

B3 is an intermediate voltage tap which we shall assume to be 225 volts normally. There will then, be a drop of 125 volts in R2. If we allow a current of 5 milliamperes to the B4 tap, R2 should also be 5,000 ohms, and this too should have a rating of 3 watts or more. If we assume that when B2 is used no appreciable current flows into tap B3, and also if we assume that the voltage at B2 is 275 volts, R1 should have a value of 2,000 ohms. It should be a 3-watt resistor or heavier.

The two taps, B2 and B3 provide two different voltages for use on the amplifiers and the one that gives the best results should be used.

In case considerable current is drawn from B3, the value of R1 must be smaller, unless we wish a lower voltage at B3.

C4 and C5 are 2 mfd. condensers used for shunting signal currents to ground from the taps.

The C Supply Divider

About the C supply voltage divider we can be more definite, for we shall assume that it is to serve a given audio amplifier alone, one consisting of a 55 triode in a resistance setting, a 59 followed by a transformer and used as triode, and two 2A3s in push-pull. The 55 requires 10 volts for bias. One tap is provided for this on the voltage divider R4, R5, R6. If the current through this combination is one milliampere, R4 should have a value of 10,000 ohms. The 59 used as triode requires a bias of 28 volts. Hence the drop in R5 should be 18 volts. Since the same current flows in this section as in R4, the resistance of R5 should be 18,000 ohms.

The two 2A3 tubes require a bias of 62 volts. Hence the drop in R6 should be 34 volts. Therefore R6 should be 34,000 ohms.

Now it may be that the output of the C supply rectifier is considerably higher than 62 volts. It certainly will be if the effective voltage across the rectifier winding is 110 volts. To cut down the excess voltage, a 100,000-ohm variable resistance

(Continued on next page)

LIST OF PARTS

Coils

T1—One push-pull input transformer
One 100-henry plate choke (used only when transformer is isolated)

Condensers

C1, C2—Two 0.02 mfd. condensers
One 4 mfd. condenser (used only when transformer is isolated)

Resistors

P—One ½-meg. potentiometer
R1, R3—Two ½-meg. grid leaks
R2—One 100,000-ohm plate resistor (preferably wire-wound)

Other Requirements

One six-contact socket
Two four-contact sockets
One medium seven-contact socket (small five-contact for 56)
One grid clip

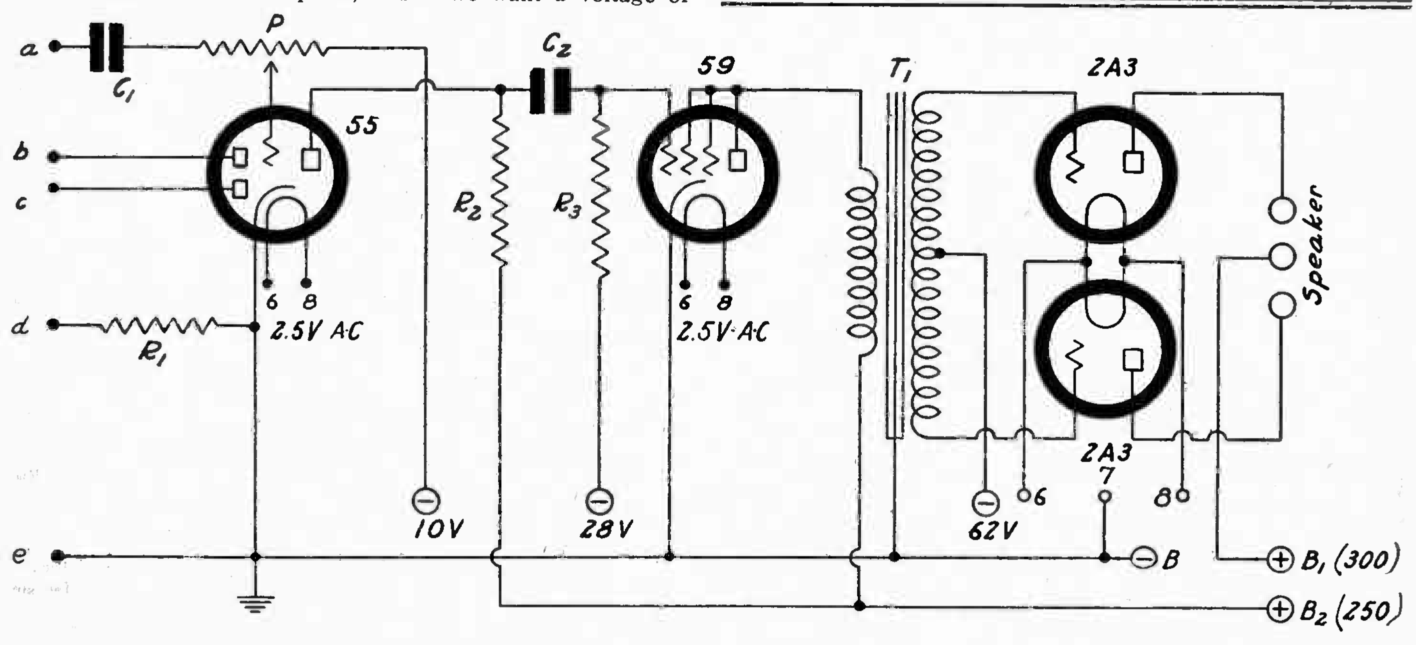


FIG. 2.
The circuit of a three-stage audio amplifier with 2A3 push-pull output. The circuit may be connected either to a radio signal source, detecting with diode of 55, or to other source of audio.

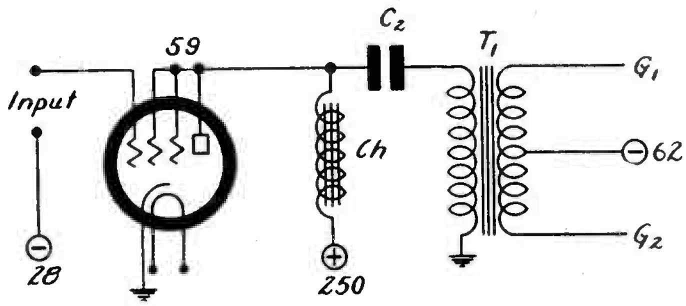


FIG. 3

An optional connection of the push-pull transformer to the middle stage, isolating the transformer from the plate in respect to d.c.

(*Continued from preceding page*)

Rh is connected in the negative lead. By means of this resistance almost any voltage may be obtained across C7 and therefore across the voltage divider. If the total voltage has any other value than 62 volts, the other two voltages will be different in proportion.

Each of the condensers C6, C7, C8, and C9 has a capacity of 2 mfd. The choke Ch3 may be the secondary of an audio transformer. This choke and these condensers will provide ample filtering for the C supply.

A word of caution will not be amiss here. If the power is turned on when the 30 tube is out of its socket, or if it should burn out during operation, the bias on the power tubes, as well as that on the other audio tubes will fall to zero and the current will be very high. It is for this reason mainly that the fuse has been inserted. It is cheaper to burn out a small fuse than to burn out a whole set of amplifier tubes and perhaps the transformer as well. Since the fuse might burn out accidentally now and then, the fuse holder should be placed in an accessible position.

Audio Amplifier for B Supply

In Fig. 2 we have an audio amplifier designed to be used with the power supply shown in Fig. 1. The output tubes are 2A3s, the tube feeding these is a 59 used as triode, and the tube ahead of that is a 55 triode. The bias for the grids of these is supplied by the C supply in the power supply. One side of the potentiometer P in the grid circuit of the 55 is connected to the 10-volt tap on the C supply and the other is connected to a stopping condenser C1. The slider goes to the grid.

The grid return of the 59 goes to the 28-volt tap on the C supply and the grid return of the power tubes goes to the 62-volt tap on that supply. It will be noticed that the cathodes of all the tubes are grounded. C bias from an external source must therefore be applied if the amplifier is to function. By the cathode of the 2A3s is meant the center-tap of the filament transformer, which is marked (7) in both Figs. 1 and 2.

The plate return of the power tubes is connected to B1, which is nominally at 300 volts, and the plate returns of the other tubes are connected to B2, which is nominally at 250 volts. The points (6, 8) in Fig. 2 refer to the same points in Fig. 1, which means that the heater windings of all the tubes in the audio amplifier are connected to the same winding on the power supply transformer.

Input to 55

The 55 diode is supposed to be used as detector, and the triode is supposed to be used for amplification of radio signals as well as signals for pick-up units and other sources. For these reasons we have left the input terminals of the 55 open. Suppose we are to amplify signals from a microphone, a pick-up unit, or a pre-amplifier. The output of this device, whatever it may be, is connected between terminals (a, e). Since condenser C1 will be in series with the signal, it is necessary that this condenser be fairly large. If P has a total resistance of one-half megohm, which is a suitable value, a value of C1 of 0.02 mfd. is large enough, provided the amplifier is not to amplify signals lower than about 25 cycles.

When the diode is used for detection, the signal to be detected is impressed between (d) and (b), or (d) and (c). The two plates (c, b) may be connected together when half-wave rectification is used, or one anode may be used for half-wave detection and the other for half-wave rectification for a.v.c. purpose. If full-wave detection is to be used, (d) is connected to the center of the coil supplying the signal to be detected and (b) and (c) are connected to the ends.

When the diode is used for detection, (a) should be connected to (d), for the detected signal will appear across the load resistance R1. A suitable value for this resistance is 0.5 megohm. A by-pass condenser has not been provided across R1 to remove the radio-frequency ripple, but this condenser can either be connected permanently across the load resistance, or it may be associated with the coil supplying the signal. Its value may be anything from 50 to 250 mmfd.

The stopping condenser C1 makes the bias on the triode independent of the signal and at the same time it permits the connection of (a) to any source of signal. For example, it may be connected to the plate of a pre-amplifier provided that a coupling resistor or coupling choke is used. It may also be connected to the secondary of a transformer.

Audio Coupler

R2 is a coupling resistor of 100,000 ohms, which is suitable for the 55 triode. It should preferably be wire-wound for permanence. C2 is another stopping condenser of 0.02 mfd. and R3 is a grid leak of 0.5 megohm.

The audio transformer T1 should be a push-pull input transformer that will carry the plate current of the 59, which amounts to 28 milliamperes. If such a transformer cannot be obtained, any good transformer of the push-pull type can be used provided that the 59 is fed through a 100-henry choke and a stopping condenser of 4 mfd. is connected in series with the primary, on the plate side. If that is done, the low potential side of the primary can be grounded. This is an excellent plan for if it is done, even a first rate transformer will be better by the removal of the d-c component of the plate current from the winding.

Another plan that can be followed is to use a 56 tube in place of the 59. The only change in the circuit required is the selection of a grid bias suitable to the 56. The bias should be 13.5 volts on this tube. This can easily be provided by changing the voltage divider in the C supply. As a matter of fact, the same bias can be used on the 55 and the 56, for the 55 can take 13.5 volts. This would require only an increase in the first (ground) resistance in the C supply, making this 13,500 ohms instead of 10,000 ohms.

If the 56 is used as second audio amplifier, the primary of the push-pull input transformer can be connected directly in the plate circuit. But even with this tube it is an excellent plan to use the choke and stopping condenser, especially if the audio transformer has a high permeability core. The primary inductance then is not "shrunk" by the direct current.

Literature Wanted

Readers desiring radio literature from manufacturers and jobbers should send a request for publication of their name and address. Address Literature Editor, RADIO WORLD, *145 West 45th Street, New York, N. Y.*

Richard C. Clapp, Radio Service, 205 No. Main St., Concord. N. H.
Wm. K. Savage, Machine Shop, Davison, Mich.
B. A. Snodgrass, R.F.D. No. 2, Box 39C, Charleston, W. Va.
Stanley J. Dolega, 4076 Monticello Ave., The Bronx, New York City
W. E. Caldwell, 930 West Washington St., New Castle, Penna.
J. E. Vassallo, 60 Main St., Malden, Mass.
J. M. Townes, 402 M. Monroe, La.
M. T. Steffy, W9ELR, 915 Fifth St., Aurora, Ill.
William H. Jackson, 1224 Irving St., N.W., Washington, D. C.
Willard Kiesow, Morgan, Minn.
Jackson Radio Co., 809 Fannin St., Houston, Tex.
Mr. W. M. Walker, Radio Service, 239 Columbia St., Cambridge, Mass.
Simon Sopko, 190 Virginia Ave., Shenandoah, Pa.
H. A. Perch, 2, Melbourne Way, Bush Hill Park, Enfield, Middlesex, England
S. B. Macdonald, (short or all wave sets, in kit form), Manager, Puslinch Radio Service, Puslinch, Ont., Canada
Lonneke Radio Laboratory, 436 No. 24th St., Battle Creek, Mich.
Marvin Armstrong, W9EHA, Penthouse, Ralston Theatre Bldg., Moran, Kansas
M. R. Walton, Burr Oak, Iowa
W. G. Brittain, 3408 Park Lane Drive, Parma, Ohio
G. L. Griggs, Radio Service Salvage, 1300 Otoe St., Lincoln, Nebr.
T. H. Diethrich, R.F.D. No. 2, Box 10, Ligonier, Penna.
J. D. Mathews, 2119 N. W. 18th St., Oklahoma City, Okla.
W. A. Moffitt, 510 Pine St., St. Louis, Mo.
P. M. Dunn, 317 W. 13th St., Norfolk, Va.
Arthur Boswell, 76 Kingston Ave., Brooklyn, N. Y.
E. N. Shetter, 550 4th Ave., New Kensington, Pa.
F. A. Starkey, c/o Oregon State Highway, La Grande, Ore.
A. J. McNally, N. E. Cor. 40th and Woodland Ave., Philadelphia, Pa.
Edw. Richter, Jr., 94 W. 10th St., Ashland, Ohio
John E. Sowers, Jr., Box 38, Cleona, Penna.
Bernard Dreskin, 214 Williamson Ave., Hillside, N. J.
G. D. Gratton, Island Falls, Ont., Canada
Walter Skurnack, 144 E. 110th St., Chicago, Ill.
Louis J. Doerr, 3441-47 Juniata St., St. Louis, Mo.
Howard C. Bittner, 718½ N. 15th St., Allentown, Pa.
M. A. Wesling, 1901 Denver St., Covington, Ky.
Al. Guddeck, 2521 Touhy Ave., Chicago, Ill.
Jas. L. Davis, Nespelem, Wash.
John G. Cowell, 218 Mason St., Calumet City, Ill.
J. J. Black, 1773 Marks Ave., Akron, Ohio.
Perry L. Driz, 265 Broadway, Waukesha, Wisc.
R. P. Unbewust, R. D. No. 2, Watervliet, N. Y.
Gordon Fortier, Mountain Avenue, White River Jct., Vermont.

DIRECTION-FINDERS

Several manufacturers of radio specialties are working on inexpensive direction finders for small boats. The Department of Commerce operates beacons on 300 kc (1.000 meters), and supplies directional maps. A loop receiver brings in the identifying signals. An additional method is to use broadcasting channels, but the other way permits of fixed-frequency amplification.

Oscillator Accuracy

Established by Careful Testing of Coil and Condenser, Plus Stabilization and Close Calibration

THE attainment of a universal type oscillator that meets high standards of requirement will take several months of experimenting, even though the final circuit will appear quite simple. Indeed, the very simplicity of the appearance of the ultimate circuit is something to commend it. When various and numerous parts are inserted, the oscillator probably will not work as well as when it consists of a few well-chosen essentials. The least is the best. And so the test oscillator of which the diagram is given herewith, though simple to behold, has been the result of discussion, consideration, experimenting, testing and whatnot for going on to two years.

This represents the third model of a series of universal test oscillators put on the commercial market, all of which have stood up excellently, and all of which are known for their accuracy.

Let's Discuss Accuracy

It is common practice to avoid accuracy discussion when dealing with low-priced oscillators, and the reason should be obvious. However, when such discussion is not only undertaken, but invited, there is something of a challenge in that conduct which makes for cocking of the ears. How is it possible for the net results in an expensive oscillator to be accurate to 1 per cent. or better?

The answer is that the circuit itself must be studied carefully, its parts subjected to numerous tests, and after some dozens of oscillators have been built, a general performance record is established, by which attention is focused on the possible sources of inaccuracy.

What one makes himself he may subject to the severest test, so let that be the coil. It must have an inductance of 3,305 microhenries for the secondary, and that inductance must be held to within 0.1 per cent. Since there is a primary, or tickler, the inductance of the tickler becomes important, as well as the coupling co-efficient, as these affect the secondary inductance. The tickler inductance should be 820 microhenries, and the co-efficient of coupling should be 4.3.

The Condenser Is Important

The condenser one does not make, but buys. Therefore it is necessary to have a selection of the same model condensers, as not all of them even of the same model will track a given pre-calibrated dial. In the manufacture itself there is difficulty in making all condensers follow the same curve, and manufacturers have a way of marking the condensers that do not track within their desired amount, but which still are within the standard specification tolerances of trade associations. This standard is all right for its own purpose, but closer than standard tolerance is necessary, and one has to ascertain the secret identification of the condensers by the manufacturer to know in advance which ones, though coming within standard requirements, fall short of the manufacturer's own aim, though they are included in the production output. Knowing this secret saves time. The trouble would show up with a certainty when the oscillator is built, but the easier and cheaper way is to discard the condensers that the manufacturer did not find up to his high aim.

Thus both closeness of inductance values and closeness of capacity variation to a high standard pattern are required. The inductance may be considered as selected for the low-frequency extreme. The minimum capacity is selected for the high-frequency extreme. Hence a trimmer must be adjustable so that the highest frequency on the scale may be peaked.

Accuracy to 1% or Better

If the condenser has the proper capacity variation and the inductance is just right, the pre-calibrated scale will yield results to within 1 per cent. accuracy, provided the escutcheon or other index does not introduce parallax. It is not essential that projection be used for indication. Satisfactory absence of parallax results if the indicator is so close to the scale that it almost "rides" on it.

Of course, when the oscillator circuit is selected, and the calibration is to be done, the circuit calibrated must be exactly the one used later in duplicating the oscillator. That is, the production must exactly duplicate the original if the results are to be duplicated at the scale to have really accurate significance.

The scale is calibrated for the first purpose as follows. The low-frequency extreme is established by condenser maximum, and trimmer half way out. The inductance is selected on this basis. Then a check is made for the high-frequency extreme, the trimmer being adjusted, now, and the span verified. Two frequencies have been calibrated, the extremes. Now we want the complete calibration.

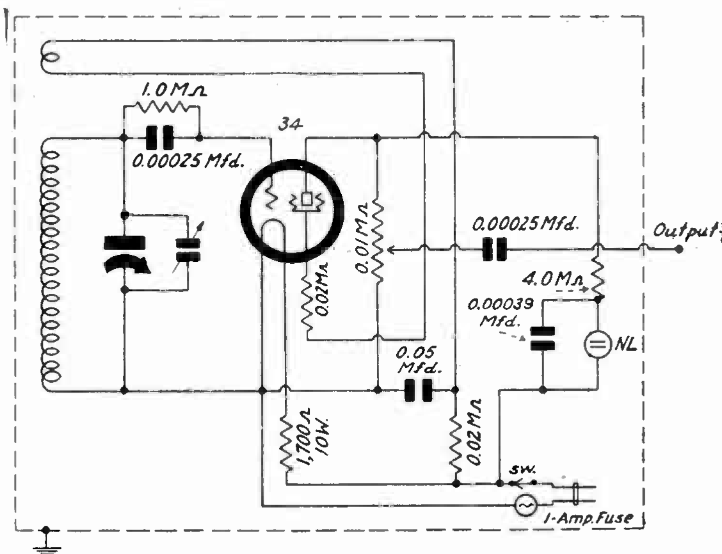
Read in Circle Degrees

By using a precision dial equipped with a protractor scale (degrees of a circle), and being readable to one-quarter of one degree of a circle, the locations of the various frequencies are spotted and recorded, using precision oscillators of the harmonic or doubler types, crystal-controlled. Every desired frequency in the span of, say, 132 to 380 kc, is thus obtained, not merely some points and the rest extrapolated from a curve. The actual position of each and every frequency desired to be recorded must be obtained.

Then the scale is used for protraction, to register the frequencies on a large circular plate, which is photographed down to the size the actual dial scale is to be. Then the first exclusively frequency scale is put on the oscillator and it is carefully checked to see if everything is right. Usually there are a few changes to be made. These result either from experimental error or from what amounts to the same thing, some mechanical shifting in connection with the original dial fixation, condenser shaft, or the like.

The corrected frequency scale consists of frequencies only, but the corrections are given their values (in degrees of a circle) and a curve is drawn on the basis of registering every point for which one has a frequency. This curve is on large paper, perhaps 2 feet by 3 feet. The shape of the curve is examined critically, as it is to be expected that it will be regular, and if it is not, the fact should be that the curve is right. However, any irregularity is checked by exploring again (that is, re-calibrating) for any doubtful region. Errors caught this way are cured, and the frequency scale is tried out anew. The two scales are referred to some dozens of actual oscillators. If there is a difference, see which one is superior in accuracy, and that one is used, or even corrected again, if need be, before duplication in quantity. The accuracy has to be held to 0.5 per cent. in the hand-made models to insure 1 per cent. accuracy in production.

So the final results depend on a combination of endeavors, all of which must be accurate, and then a highly acceptable oscillator results.



The Model 34-AB Test Oscillator. It is universal, it is frequency-stabilized and it is direct-reading from 132 to 1,520 kc.

Performance Tabulated

The general oscillator remarks have been printed in these columns a few times in the last two years and will not be repeated. However, the following is a listing of the performance of the test oscillator as diagramed, when contained in a shield cabinet, which shield may be "grounded" but need not necessarily be, since it is practically impossible really to ground the metal box of practically any oscillator, because current will flow in the so-called "ground" wire.

Frequency coverage: Fundamentals 132 to 380 kc. The frequency separations are from 1 kc at the low end to 5 kc at the high end. Positions for harmonics to register the equivalent of 400, 450 and 465 kc are on the dial. The broadcast band, fourth harmonic, is represented by 10 kc separation all the way through.

Radio-frequency oscillator: This is a 34 tube, used as a triode where the control grid is the usual one, cap of tube, and the screen

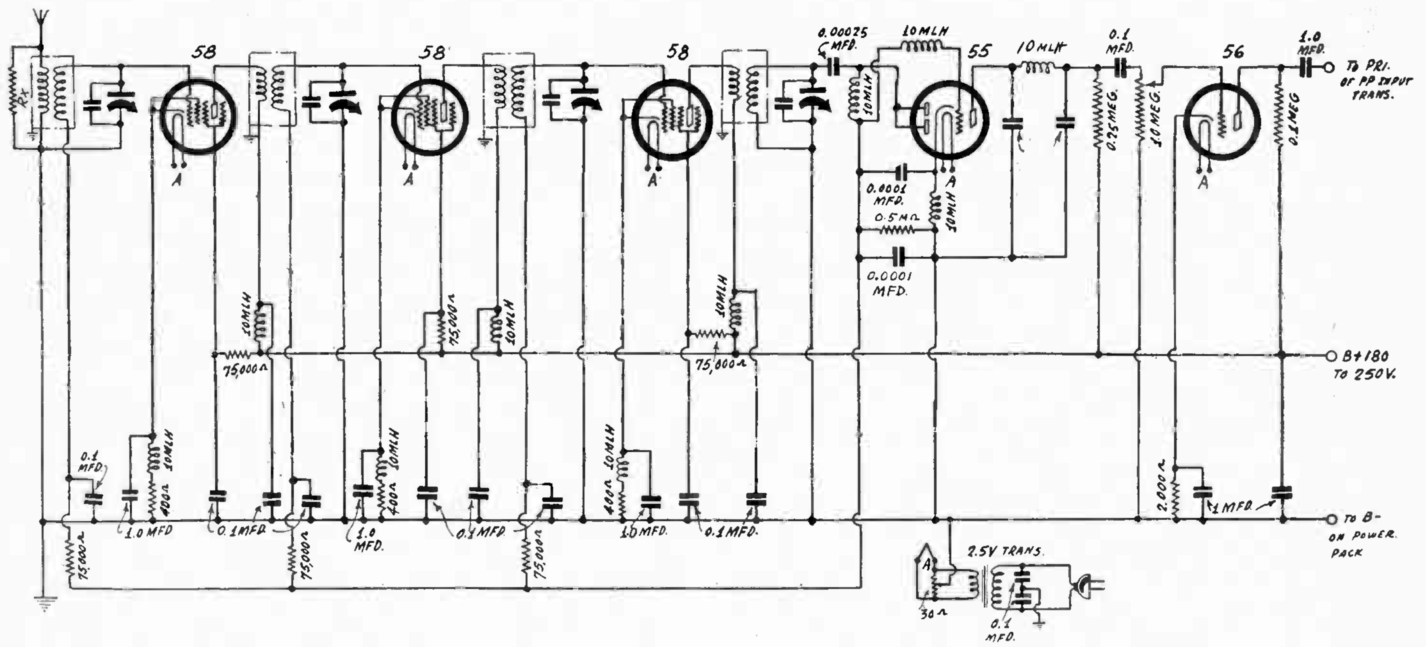
(Continued on next page)

Radio University

Answers to Questions of General Interest to Readers. Only Selected Questions are Answered and Only by Publication in These Columns. No Correspondence Can be Undertaken.

get it, I want to be able to insert it in the tester with the assurance that it will not be burned out.—W. R.

Well, we have had exactly the same experience, in kind, although not to such a disastrous degree. In our case the switch did cost almost as much as the meter, yet it did not help. We confess the difficulty was partly due to carelessness in soldering to the switch lugs. We allowed rosin to flow into the contact surfaces. Although the surfaces were scraped and rubbed, the rosin persisted in keeping the contacts open. Rubbing with alcohol will help remove the rosin, but it is by far better not to allow it to flow where it should not. Next time we shall not use rosin core solder in places like that. It is possible to connect a small fuse, say one of 5 milliampere capacity, in series with the meter. This would probably protect the meter in all cases. Another way which we have found satisfactory is to use a switch with many decks, connecting all the decks together on each stop. If you have four decks and the contact surfaces on each is cleaned, there is a very small chance that all four will fail to make contact at the same time. Of course, in some testers it is not practical to use such a switch, for the different decks are needed for different purposes. At any rate, it is one way of avoiding bad contacts, and it is not limited to meter shunts. It can also be used advantageously in short-wave receivers for picking up different coils.



Rx is a resistor in parallel with the antenna primary. The value must be ascertained experimentally for stopping oscillation.

Switches and Meter Shunts

RECENTLY I FINISHED a tester in which I had a good universal meter. I had arranged it so that I could measure currents up to 100 milliamperes, using shunts. These were picked up by switches. Likewise I had arranged it so that I could measure voltages up to 1,000 volts, using series multipliers, also picked up by switches. I still have the circuits but not the meter. That blew out the first time I tried to measure a current exceeding 5 milliamperes. The trouble was that the switch which was supposed to pick up a shunt did not do it. It left the meter a 0-1 milliammeter. Can you suggest a switch which can be depended on. I don't care much what it costs, for surely any reasonable price will be less than the price of a universal meter. I have another meter on the way, and when I

* * *

Stopping R-F Oscillation

PLEASE REVEAL a simple way to stop a tuned-radio-frequency set from oscillating from 1,300 kc up.—E. L. A.

The method shown in the diagram may be used. A resistor Rx is put across the antenna primary. Experiment will reveal the right value, usually around 5,000 ohms. Use no lower resistance than circumstances require.

Neon Audio Oscillator in Signal Generator

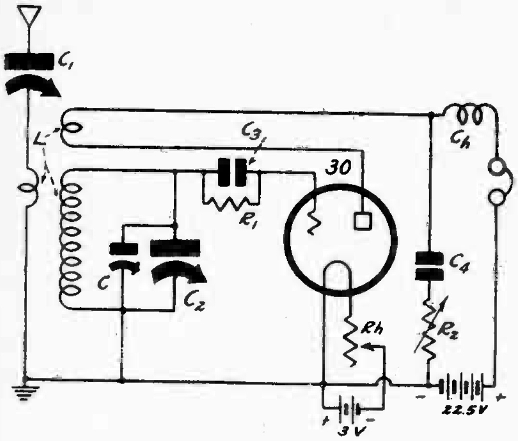
(Continued from preceding page)

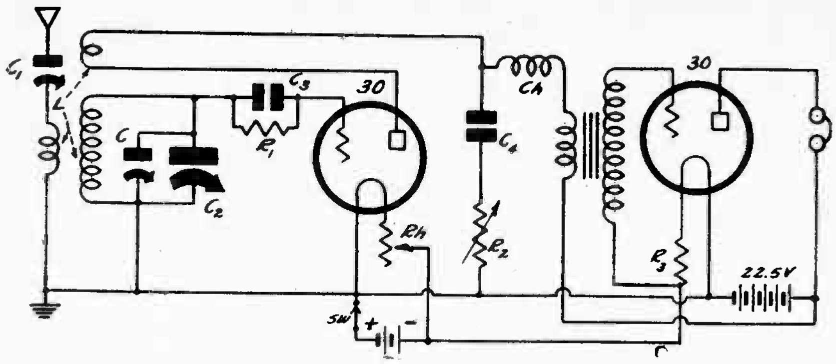
is used as the plate. That enables the use of the standard plate not as a plate exactly, but as a pickup element interposed in the space stream. Thus some electrons are attracted to this pickup element and return to filament through the external circuit. The so-called plate is therefore slightly charged positively, and this may be verified from the fact that small current always flows through the output potentiometer during action. Hence the coupling between the oscillator proper and output is electron coupling. Since the audio oscillation is introduced by the same "back-coupling" method, that too is electron coupling.

Audio-frequency oscillator: This is a small neon lamp, no matter how small, but it should be of the type that has no series resistor built in. The other type will work, but the modulating intensity is lower, and oscillation may not always be self-starting, hence turning on and off would have to be practiced until audio generation was produced.

Attenuation: This means the ability to pick off maximum to zero voltage. It is attained by the potentiometer method, without any detuning of the oscillator, because, first, coupling is of the same degree by the electron method regardless of frequency; second, this oscillator is frequency-stabilized, hence maximum output values are the same for all frequencies, hence current through the output network is substantially the same always, and this condition entitles the designation "constant-impedance attenuator." There is no such thing in science, in reality, but the phrase is applied to anything that is sensibly related to constancy.

Frequency-stabilization: This arises from the unbypassed series resistor of 20,000 ohms, aided by the bypassed resistor of equal value. The real object of the 20,000 resistor associated with the 0.05 mfd. condenser is line-blocking, or prevention of the line from carrying the oscillation voltage by a path independent of the intended output, and which vice would render impossible the usefulness of an attenuator. The higher the series resistance, bypassed or not, the better the frequency stability, but there is no object in using more than 20,000 ohms bypassed, as the 20,000 ohms unbypassed make the plate current practically unchanged throughout the entire tuning, which is a way to check for frequency stability.





A one-tube short-wave set and a two-tube set. A rheostat controls regeneration.

Leading and Lagging Currents

CAN YOU GIVE a brief explanation of why the current into a condenser leads the voltage by 90 degrees and why in a coil it lags by the same amount?—W. N. J.

Perhaps we cannot explain why but we can attempt to explain how, if that will suffice. When a condenser is fully charged, no current flows into it, for the back voltage is equal to the applied voltage. When it is fully discharged, there is no voltage across it but the current in or out is heavy. If the voltage increases the current decreases. The current was maximum when the voltage was minimum. Because the current was maximum when the voltage was minimum and because the current changes in opposite direction to the voltage, the current is said to be leading. In a coil the current is maximum when the voltage across the coil is zero. Hence there is a difference in phase of 90 degrees. As the voltage increases, the current increases, but maximum current is not reached until the voltage is zero. Therefore the current phase is 90 degrees behind. That is, it lags behind the voltage. In the coil voltage is maximum when the current changes most rapidly, and that it does when it is zero.

* * *

Design of Beat Oscillator

IN AN oscillator generating an audio frequency beat of variable frequency, say from 25 to 10,000 cycles, what is the best shape of the variable condenser?—G. H. J.

There is no best shape. It depends on what the rate of change of the audio frequency should be in respect to the dial readings. For a linear change in the audio frequency a straight line capacity vernier condenser is very nearly correct. It is very close if the two beating frequencies are high and the vernier condenser, which is calibrated in audio frequencies, is small compared with the total capacity in either oscillating circuit.

* * *

Large Condenser in Oscillator

IS IT POSSIBLE to use a tuning condenser in a broadcast superheterodyne twice as large as that ordinarily employed? What disadvantages would there be? If the large condenser is used in the radio-frequency tuner as well as in the oscillator, would the sensitivity be greater or less than if the smaller condensers were used? How would the selectivity be affected?—R. T. P.

The sensitivity would not be as great with the larger condensers, for the sensitivity is practically proportional to the L/C ratio. There would be little difference in the selectivity, although it might be a shade better with the larger condensers. As far as the oscillator is concerned there is no difference, provided that the circuit continued to oscillate throughout the tuning band.

* * *

Short-Wave Dielectrics

IS THERE any advantage in removing the tube base for short waves? Should the socket be of special dielectric?—A. L.

For the frequencies up to which you probably intend to go there would be no appreciable advantage. Special sockets help a bit, but if the leakage in the tube proper equals or exceeds the leakage through the socket, the special dielectric helps little.

* * *

Simple Short-Wave Sets

PLEASE SHOW diagrams of a one-tube regenerative receiver for earphone reception and also show how a tube may be added for audio amplification.—G. E. L.

A one-tube and a two-tube set of this kind are shown at the top of the page. Both are battery-operated and they use the smallest tubes available.

Remote Control of Boat

IS THERE any way in which a toy boat can be controlled by radio from shore? The only control necessary is a means of turning the rudder right or left or to leave it in neutral.—H. S.

A polarized relay might be used for controlling the rudder. Normally it will be in the neutral position, but by means of current through the winding it can be thrown either right or left. To control the relay from the shore, a short-wave carrier might be used, modulated with two different lower frequencies. On the boat there would be one receiver for the carrier and then two tuned circuits for the two lower frequencies. By leaving the short-wave carrier unmodulated the relay would stay in the neutral position, and by modulating it with either of the two lower frequencies it could be thrown in either direction.

* * *

Television Progress

YOU DO NOT write much about television these days. Is that because there is no progress in television, or because short-wave reception is of more general interest?—G. H. W.

There is progress in television. Persistent research is going on in several laboratories. The day has passed when something "new" came out in television every other day. Those things that came out so often at first consisted mostly of hopes of possibilities. What is being done now is more substantial. It is true that there is greater popular interest in short waves than in television. That is because those who use short-wave receivers get something that they can enjoy. Those who work with television get nothing much with any equipment now generally available. Anything now learned about the behavior of short waves will come in handy when television finally "breaks," for there is no doubt that television will be carried on with ultra-high frequencies.

Station Sparks

By Alice Remsen

NBC TENOR IS BACK

It is good news that Franklyn Baur is back on the NBC networks again, after an absence of two years, during which time he went to Europe for further study. Mr. Baur is the tenor of the revised Conoco series, each Wednesday night over an NBC-WJZ network, 10:30 p. m. EST. John B Kennedy and Jack Denny's orchestra are also featured on the program. . . . Irene Rich, noted stage and screen star, will not bid her listeners farewell this month, as originally planned, but will continue to be heard over an NBC-WJZ network, each Wednesday at 7:45 p. m. EST., throughout the spring. By the way; Miss Rich now broadcasts from the New York NBC studios at Radio City, instead of Chicago. . . . Lee Wiley has joined Paul Whiteman, and will be heard with the erstwhile portly maestro for the first time on April 19th, over an NBC-WEAF network at 10:00 p. m. EST. . . . The Pickens Sisters, those famous Georgia Peaches, will continue with the George M. Cohan program. . . . Peter de Rose and May Singhi Breen will soon celebrate their eleventh anniversary on the air. They met, were engaged and married during that time, and are still as happy a couple as you'd wish to meet. Peter has written many songs during that time, too, and he admits that May was the inspiration for most of them. "Wagon Wheels" is Peter's latest tune. Among his other hits are some of your favorites—"When Your Hair Has Turned to Silver." "Somebody Loves You," "Have You Ever Been Lonely," "A Home in Wyoming," "When You Were Only Seventeen," "You'll Always Be the Same Sweetheart," "Back in the Old Sunday School," and "Mothers Quilting Party." . . .

Ralph Kirberry is now at WTAM, Cleveland, for a series of commercial broadcasts in the interests of the Spang Baking Company. He may now be heard each Monday, Wednesday and Friday from 6:30 to 6:45 p. m. EST. Kirberry will return to his NBC network schedule at the completion of his Cleveland engagement. . . . Kathryn Newman, youthful American coloratura soprano, has returned to an NBC-WEAF network in a new series of song recitals, each Thursday at 11:00 p. m. . . . Dr. Walter Damrosch, the Dean of American conductors, inaugurated the new Packard series on April 9th, over an NBC-WJZ network, and will be heard each Monday at 10:00 p. m. EST. . . . It is fine to know that Egon Petri is back from his European concert tour and will be heard again by a nationwide American audience in a series of piano recitals each Sunday at 6:00 p. m. EST. . . . Caught the vaudeville act of the Three Scamps, at the Old Roxy Theatre, New York. Enjoyed it very much. All three boys have very engaging personalities. . . . Robert Simmons is the new tenor of the General Tire program; each Friday at 10:30 p. m. . . .

DIMPLES ON THE AIR

Do you remember the famous lady of the dimples, Lillian Walker? She was the darling of the world during silent film days. You may have a chance to hear Lillian on the air very shortly. She is being groomed for her debut over a nationwide hook-up. . . . Guy Lombardo and His Royal Canadians have started on their Eastward tour. They opened last week at the Orpheum Theatre, San Francisco, and each week of their tour will bring them nearer New York. Their broadcasts will be connected with the studios at KHJ, Los Angeles, where Burns and Allen will broadcast, by special telephone circuits. . . . April birthdays of CBS stars, in case you want to send them cards: Tito Guizar, 8th! Evan Evans, 13th; Casper Reardon, 15th; Betty Barthell, 16th; Edwin C. Hill, 23d, and Felix (Playboys) Bernard, 28th. . . . Lillian Roth, Edward Nell, Jr., and Ohman and Arden, are now being featured on a new series over WABC, each Monday, at 10:30 p. m. EST. . . . Cab Calloway is smashing all records over in England and Scotland, according to reports received from across the pond. . . . Evelyn MacGregor, CBS contralto, received word from a brother whom she had not seen for several years that he had heard her sing over the air and recognized her voice instantly. He was in San Diego, Evelyn in New York. . . .

JULIA, FRANK AND JACK

Jack Shilkret is the new conductor of the orchestra heard with Julia Sanderson and Frank Crumit, over a WABC-Columbia network each Sunday, at 5:30. These folk are old friends, as Jack provided the musical background for Frank on many records. . . . A song ensemble has been added to the Spalding program for the Spring broadcasts. The ensemble consists of a male quartet, with Scrappy Lambert, lead tenor; Tubby Wynant, top tenor; Leonard Stokes, baritone, and Robert Moody, bass. Maria Silviera, and Helen Oelheim, sopranos, join the quartet for mixed ensemble effects. Each Wednesday at 8:30 p. m. EST. . . . The Columbia Broadcasting System has renewed its contract with The Playboys. They will continue to be heard on Wednesdays and Fridays, at 1:45 p. m. over a nationwide Columbia hook-up. . . . Morton Downey is now M-C'ing his own program. Caught him last week; he does a good job, as usual. . . . Bing Crosby will remain on the air until the end of May under a new contract extension. . . . Toscanini will inaugurate a Wagner cycle for the close of the current season of the New York Philharmonic broadcasts. The opening program of the cycle will be heard on April 15th. . . . Mr. and Mrs. Jesse Crawford recently completed a Paramount short. . . . Station WHOM, New York, is moving its studios to the entire second floor of the building at 29 West 57th Street, formerly occupied by WRNY. . . .

GOOD WORK FOR GOOD FOLK

The Actors Dinner Club, that very worthy charity, which gives free meals to actors, puts on a dandy floor show each night during dinner at the Hotel Woodstock. When you pay for a dollar dinner, you are providing a meal for a hungry guest, and nobody knows who does or does not pay. Many radio artists donate their services to the Club. Jimmy Rogers, Claire Miller and Gene and Kathryn Lockhart were heard recently. John Sacco provides piano accompaniment very competently and graciously. Many a well-known dramatic actress gives her services as mistress of ceremonies. The last time I sang there Linda Carlon was the M-C and a very good job she made of it, too. . . . Bill Farren is the demon sports announcer on WNEW, Newark, N. J., and Bill is just bringing thousands of fans to the spot on the dial where WNEW is found. . . . Micheline Smith Pooler, the concert and operatic soprano, who is heard on the WMCA Betty Gould broadcasts Mondays, Wednesdays and Fridays at 10:15 a. m., is a full-fledged ham operator and is one of the seven O W's in the country. She is co-operators with her husband of 1 BCB. . . . Marvin Welt is Jimmy Kemper's new manager; and Jimmy is a lucky boy to get him, for Marvin has piloted many a start to world-wide fame. Marvin Welt thinks Jimmy is the greatest dramatic male singer in radio today; and I'm inclined to second the motion, for Jimmy Kemper is an extraordinary and unique artist.

A THOUGHT FOR THE WEEK

UNLESS SOMEBODY IS MAKING A GRIEVOUS ERROR, a cosmetic concern has become the largest user of advertising on the air. To the Lady Esther Company goes this distinction—unless, to repeat, somebody has added two and two and made five the total.

Incidentally, Lady Esther is not playing favorites, for at 10 P. M. EST, Sunday and Monday she and Wayne King join hands over CBS and the same combination and at the same hour goes after the women of our country over NBC on Tuesday and Wednesday. This doubling up is most unusual, quite outside of the fact that the cost runs up each week to the profit on a great many thousands of sales of Milady's face enhancers.

Television Impractical for Commercial Use, Says Bell Laboratories Expert

By ROBERT G. GOODWIN
Bell Telephone Laboratories

The human voice must be amplified 200,000,000 times to effect trans-Atlantic telephone conversations.

The enormous amplification necessary in ocean telephony is increased to 200,000,000,000,000 times in the operation of a television unit. That is one of the chief reasons why the Bell System claims television is impracticable for commercial use.

Lantern slides can show many of the highly complex and technical aspects of television. One of the slides concerning the two-mile television circuit now in use in New York City between the American Telephone and Telegraph Company and the Bell Laboratories farther uptown deals with Bell engineers are experimenting with new devices aimed at improving the present status of the invention.

Diagrams of apparatus used in the transmitting of voice and vision are complex.

There is an experimental television booth, larger than the telephone booth, equipped with a chair and panel. Secreted in the panel are sound and light receivers which transmit not only voice vibrations but picture points. In this manner vision and sound accompaniment are tested.

Mme. Schumann-Heink at 73 Starts New Series

Mme. Ernestine Schumann-Heink has been signed by the Gerber Products Company, Fremont, Mich., for a series of broadcasts over an NBC network commencing early in May. The sponsor is the manufacturer of strained vegetables and cereals for babies, and the program will be built around Mme. Schumann-Heink as "the world's best loved mother."

Mme. Schumann-Heink, mother of eight, grandmother of eleven and great-grandmother of four, is well qualified to appear on a program addressed to mothers. Her listeners will be given an opportunity not only to hear her magnificent voice which is still rich and full at her age of seventy-three; but she will also convey a message to those who have the welfare of babies at heart.

The program will be produced by Erwin, Wasey & Company, Chicago.

LINE-BLOCKED UNIVERSAL TEST OSCILLATOR

THIS Test Oscillator, Model 30-NB, is serviceable for all intermediate frequencies from 135 k.c. up, and all broadcast frequencies, for lining up the receiver channels. It is constantly modulated and the same instrument works on 90-120 volts a.c. (any line frequency), line d.c. or batteries. A new improvement is line blocking, so the only feed to the receiver is through a wire from output post of Test Oscillator. Frequencies are direct-reading and never more than 1% off. Model 30-NB is contained in shield cabinet. Etched metal scale is non-warping. Oscillator sent tree (complete with 30-tube, ready to operate) on receipt of $12 for a 2-year subscription for Radio World (104 issues, one each week). Order Cat. 30-NB.

RADIO WORLD, 145 West 45th Street, New York, N. Y.

EARLY SHIPMENT!

PUSH-PULL AUDIO TRANSFORMER

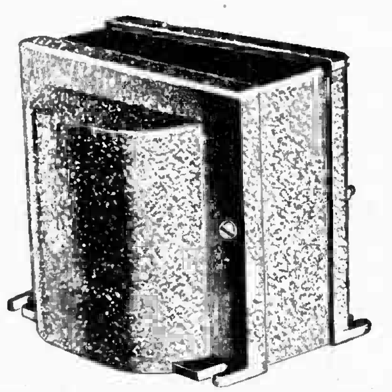
Here is an unshielded audio transformer of the highest quality. Both its windings are center-tapped. Hence it may be used as an input transformer coupling from a single plate into two grids in push-pull, or, it may be used as a push-pull interstage transformer coupling push-pull plates to push-pull grids.

This transformer was made up to special order by a company well known for its excellent transformers of all type. This particular transformer has been used in various circuits and also as a replacement transformer in sets, with uniformly satisfactory results.

Type K Push-pull Audio Transformer, $1.10

RELIABLE RADIO COMPANY
143 WEST 45th ST., NEW YORK, N. Y.

Power Transformer for a BIG SET

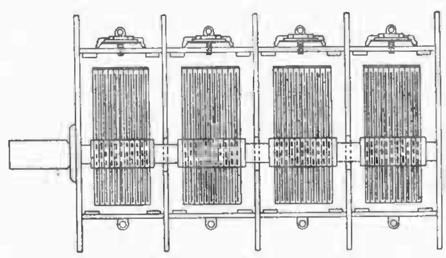


INSTEAD of using undersized, overheating, inefficient power transformers for a big set, why not use a cool-running, efficient transformer and pay the little extra? The Reliable transformer, Model 104-SP, will work an 18-tube set. Provides also the voltage for a 25Z5 rectifier.

Primary = 115 v., 60 cycles
Secondary X = 14 amp., 2½ v., ct.
Secondary Y = 6 amp., 2½ v., ct.
Secondary R = 5 v., ct.
Secondary HV = 400-0-400 v., 200 ma.
Secondary Z = 25 v., 0.6 ma.
Lug terminals at bottom
Price, $3.95
Shipping weight, 13 lbs.
Immediate Delivery

RELIABLE RADIO CO.
145 W. 45th St., New York, N. Y.

Matched Condenser and Coils for Dual-Band Tuning



A four-gang tuning condenser of the semi-precision type. Small in size, exact in adjustment and construction for precise tuning, it ranges in capacity from 18 to 406 mmfd. Has built-in trimmers, 8 to 35 mmfd. With standard coils intended to be tuned with a 0.00035 to capacitance, this condenser will cover the band from 200 to 600 meters.

The sections are separated by half shields, while a shield as high as the maximum height of the rotor plates is at each end. The rotors are turned by a common shaft, ⅜" in diameter which is mounted on ball bearings. Condenser closes to the left and is equipped with mounting spades. Overall size 5x3¼x2¾ inches (not including shaft for dial in measurement). Noted for its extreme compactness. 4-gang condenser Cat. No. 4GG @....................$2.95

Set of four shielded coils for this condenser, for 465 kc super, includes three r-f and oscillator coil. Tapped for police calls. DLC....................................$1.50

RELIABLE RADIO COMPANY
145 WEST 45th STREET NEW YORK CITY

"INVENTIONS, PATENTS AND TRADE-MARKS," by Milton Wright, Attorney and Counselor-at-Law. How to make your inventions pay—how to secure the utmost in legal protection. Second Edition, 310 pages. Price, $2.50. RADIO WORLD, 143 West 45th St., New York City.

SPECIAL

Set of 16 "1934 Design"

BLUE PRINTS

- Short Wave Receivers
- Short Wave Converters
- Public Address-Tuners
- Broadcast Receivers

For Limited Time Only **50c**

Add 5c for postage. 10c for foreign

RELIABLE RADIO CO.
145 W. 45th St., New York City

Selected Quality Tubes FREE With Subscriptions for Radio World

Here is your opportunity to subscribe for RADIO WORLD and get just the tube or tubes you want, made by a very large, reliable, licensed tube manufacturer; picked tubes you'll appreciate. On this offer you have five days after receipt to put the tube to any logical test, and if not entirely satisfied with its performance, return it for replacement.

For an 8-week subscription (8 issues, one each week), at the regular price, $1.00, you may select any one of the following tubes as free premium, or more at the same rate ($2, 16-weeks subscription for two tubes, etc.), from this particular list: 01A, 01AA, IV, 12Z3, 112A, 24A, 26, 27, 30, 31, 35, 36, 37, 38, 39, 45, 47, 51, 56, 71A, 80, 82.

With a 13-week subscription (13 issues), at the regular price, $1.50, any one of the following tubes, or more at the same rate, from this particular list (two for a 26-week $3.00 subscription, three for 39-week $4.50 subscription, four for 52-weekly, yearly $6.00 subscription, etc.), 1A6, 5Z3, 2A5, 2A6, 2A7, 2B7, 6A4, 6A7, 6B7, 6F7, 25Z5, 22, 32, 33, 34, 41, 42, 44, 46, 49, 53, 55, 57, 58, 59, 67, 75, 77, 78, 83, 83V, 84, (6Z4), 85, 89, 483, 485.

For a $4.00 subscription, 34 weeks (34 issues), one No. 10 tube or one No. 50 tube may be obtained.

You may select any assortment of tubes desired and send in a subscription amount for the total required under the above classifications.

RADIO WORLD, 145 West 45th Street, New York, N. Y.

Quick-Action Classified Advertisements

7c a Word—$1.00 Minimum

COLLEGE MAN, EXPERIENCED IN RADIO SALES, service and experimental work; salary secondary; permanent position desired. Box 31, Radio World, 145 W. 45th St., New York, N. Y.

RADIO TECHNICIAN WANTED FOR NEW JERSEY STORE. Must be experienced and well trained. Excellent opportunity for the right man to become partner. Small salary and commission to start. Box 21, Radio World.

RADIO ANALYZER with 5 Readrite Meters for sale. Cheap. Suitable for experimenters. J. Allen, 204 W. 111th St., N. Y. C.

YOUNG MAN WOULD LIKE POSITION as assistant in Radio or Electrical Laboratory or Radio Service Shop. Two years electrical school education. Attended Milwaukee School of Engineering. E. Reckentine, 703 Union St., Rome, N. Y.

"SPECIALIZED AUTO RADIO MANUAL," Vol. I, by John F. Rider—loose leaf—about 300 pages—up to the minute. Letter press printed. All diagrams clear and the figures easy to read. Covers old and new auto radio receivers, and includes recently announced auto radio installations. Price, $3.50. RADIO WORLD, 145 West 45th Street, New York, N. Y.

"DRAKE'S CYCLOPEDIA OF RADIO AND ELECTRONICS." The Standard Reference Book for Radio Men. A 5th Edition of the famous Drake's Cyclopedia covering the whole field of radio and the allied arts in one handy volume. 1048 pages, 1178 illustrations, 130 tables, 105 graphs. Price, $5.00 net. RADIO WORLD, 143 West 45th St., New York City.