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RADIO WORLD

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The First and Only National Radio Weekly

425th Consecutive Issue—NINTH YEAR

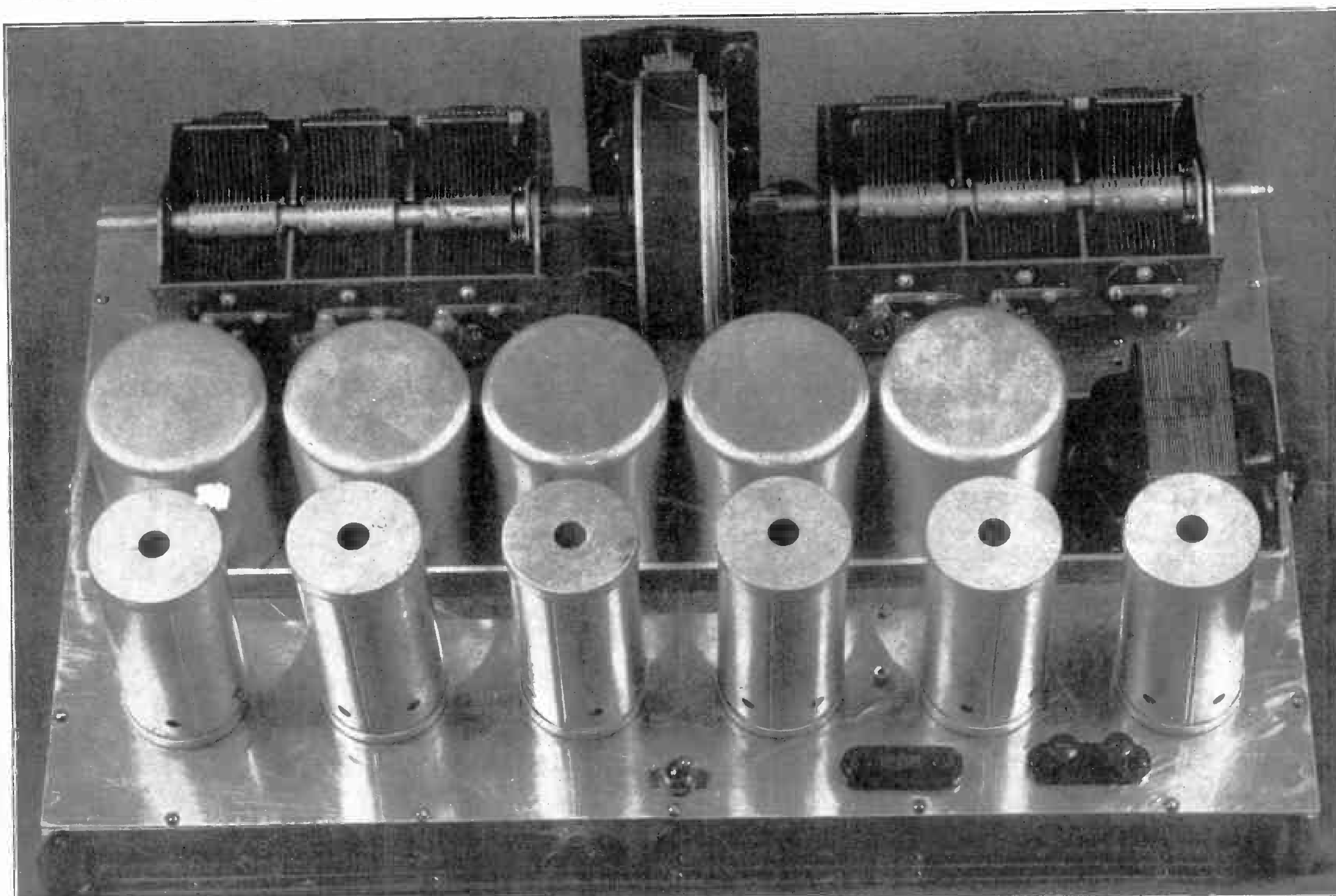
Coupling Efficiency on Short Waves

Shooting Hum Trouble in Dynamics and Sets

Transient Interference

Is Push-Pull Necessary?

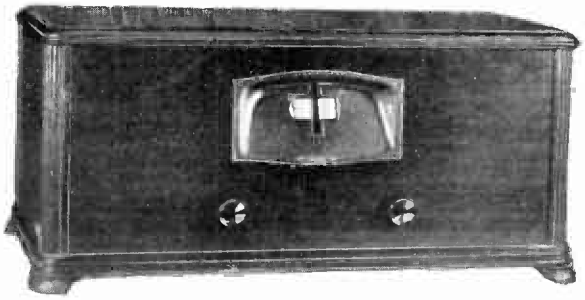
THE FINISHED 6-CIRCUIT TUNER!



First complete view of the finished Six-Circuit Tuner. **See article on pages 3, 4 and 5.**

RADIO WORLD, Published by Hennessy Radio Publications Corporation. Roland Burke Hennessy, editor; Herman Bernard, managing editor and business manager, all of 145 West 45th Street, New York, N. Y.

Balkite Push-Pull Receiver



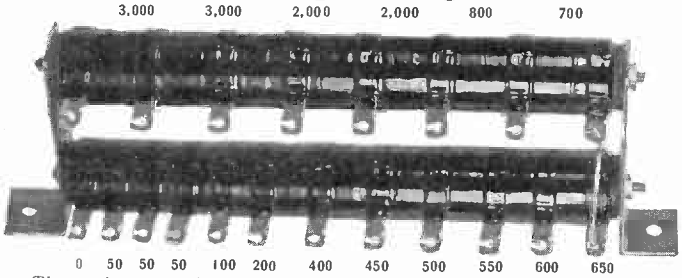
The Balkite A-5 Neutrodyne, one of the most sensitive commercial receivers ever developed; 8 tubes, including 280 rectifier. Wholly AC operated, 105-120 v. 50-60 cycles; in a table model cabinet, genuine walnut, made by Berkey & Gay.

Three stages of tuned RF, neutralized, so there's no squealing; easy tuning; operation on short piece of wire indoors perfectly satisfactory; no repeat tuning points; no hum; phonograph pickup jack built in; excellent tone quality; good selectivity. Two posts are accessible for connecting the field coil of a DC dynamic speaker.

The parts of which this receiver is made are all ace-high and the wiring is done with extreme expertness, by Gilfillan. The power supply is exceptionally fine, the set being worked at 50% less than the rated capacity of the power transformer and chokes, assuring long life. There is no hum, as filtration is remarkably good.

The illuminated drum dial, at center, reads 0-100 at left, and at right has a blank space in which to write call letters. The little knob at left is the volume control, and the one at right is the AC switch. Each RF stage is filtered and bypassed individually, and the RF coils, tuning condenser and power transformer are separately and totally shielded. The lead from antenna binding post to antenna winding of the first coil is of shielded wire that is grounded. Also, the receiver as a whole is totally shielded, with metal chassis and metal undercover, so there is no stray pickup. Cat. BAL-A5, list price $135; net price........ **$44.00**

New Multi-Tap Voltage Divider



The resistance values between the twenty taps of the new Multi-Tap Voltage Divider are given above. The total is 17,100 ohms and affords nineteen different voltages.

The Multi-Tap Voltage Divider is useful in all circuits, including push-pull and single-sided ones, in which the current rating of 100 milliamperes is not seriously exceeded and the maximum voltage is not more than 400 volts. Higher voltages may be used at lesser drain.

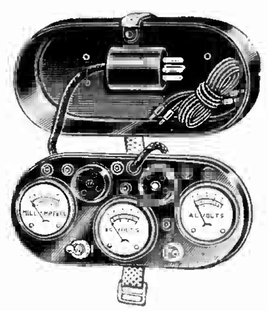
The expertness of design and construction will be appreciated by those whose knowledge teaches them to appreciate parts finely made.

When the Multi-Tap Voltage Divider is placed across the filtered output of a B supply which serves a receiver, the voltages are in proportion to the current flowing through the various resistances. By making connection of grid returns to ground, the lower voltages may be used for negative bias by connecting filament center, or, in 227 and 224 tubes, cathode to a higher voltage.

If push-pull is used, the current in the biasing section is almost doubled, so the midtap of the power tubes' filament winding would go to a lug about half way down on the lower bank.

Order Cat., MTVD, list price $6.50, net price.................... **$3.90**

R-245 Set and Tube Tester



With the R-245 Tube and Set Tester you plug the cable into a vacated socket of a receiver, putting the removed tube in the tester, and using the receiver's power for making these tests: Plate current, on 0-20 or 0-100 ma. scale, changed by throwing a built-in switch; 0-60, 0-300 v. DC, changed by moving one of the tipped cables to another jack; filament or heater voltage (AC or DC), up to 10 volts, or any other AC voltage source, measured independently, up to 140 volts, including AC line voltage. Also screen grid voltage and screen grid current may be read by following connections specified in the new 8-page instruction sheet.

Each meter may be used independently. The two test leads, one red, the other black, with tip jack terminals, enable quick connection to meters for independent use.

With this outfit you can shoot trouble in receivers and test circuits using the following tubes: 201A, 200A, UX199, UX120, 210, 171, 171A, 112, 112A, 245, 224, 222, 226, 227, and pentodes.

When the R-245 is plugged into the vacated socket of a set and the removed tube is placed in the proper socket of the Tester, the receiver's power supplies all the voltages and currents. You see the vital tests made right before your eyes, all three meters registering immediately, all three reading at the same time.

Here are some of the questions answered by the Tester when plugged into the receiver:

What is the filament or heater voltage (no matter if DC or AC)? What is the plate voltage at the plate itself? What is the plate current drawn by the tube? Is the tube in good condition or does it require replacement? What is the grid bias voltage? What is the cathode voltage? What is the screen grid voltage? Besides, when meters are used independently, you can answer these questions: What is the screen grid current? What is the line voltage (no mater if AC or DC)? Is the circuit continuous or is it open? What is the total plate current drawn in the receiver? What are the respective B voltages at the B batteries or voltage divider?

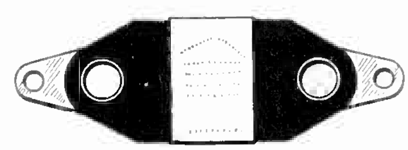
Order Cat. R-245. List price, $20; net price........... **$11.40**

Silver-Plated Coils

Wound with non-insulated wire plated with genuine silver, on grooved forms, these coils afford high efficiency because of the low resistance that silver has to radio frequencies. The grooves in the moulded bakelite forms insure accurate space winding, thus reducing the distributed capacity, and keep the number of turns and separation constant. Hence the secondary reactances are identical and ideal for gang tuning.

The radio frequency transformer may be perpendicularly or horizontally mounted, and has braced holes for that purpose. It has a center-tapped primary, so that it may be used as antenna coil with half or all the primary in circuit, or as interstage coupler, with all the primary on a screen grid plate circuit, or half the primary for any other type tubes, including pentodes. The three-circuit tuner has a center-tapped primary, also. This tuner is of the single hole panel mount, but may be mounted on a chassis, if preferred, by using the braced holes. Pair consists of RF transformer and three-circuit tuner, both for .0005 mfd. only. Order Cat. G-RF-3CT, list price $5.00; net price.................. **$2.48**

Fixed Condensers

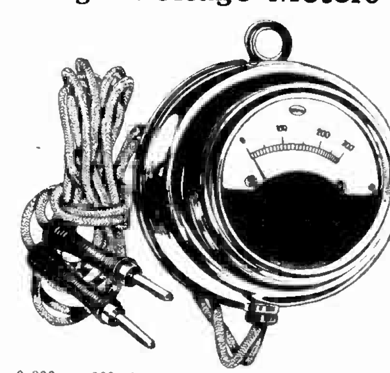


Dubilier Micon fixed condensers, type 642, are available at following capacities and prices:

.0001 mfd.	10c	.006	20c
.00025 mfd.	10c	.00025 with clips.	20c
.0003 mfd.	10c	All are guaranteed	
.00035 mfd.	15c	electrically perfect and	
.001	17c	money back if not	
.0015	17c	satisfied within five	
.002	18c	days.	

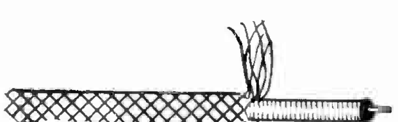
Order Cat. MICON .0001 etc. at prices stated.

High-Voltage Meters



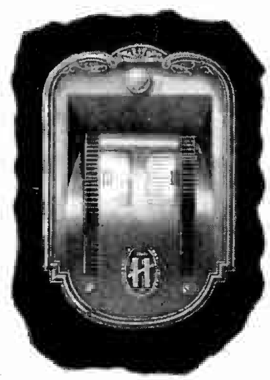
0-300 v., 200 ohms per volt. Cat. F-300 @ $2.59
0-500 v., 233 o.p.v. Cat. F-500 @...... 3.73
0-600 v., AC and DC (same meter reads both); 100 ohms p.v. Order Cat. M-600 @ 4.95

Shielded Lead-in Wire



No 18 solid wire, surrounded by a solid rubber insulation covering, and above that a covering of braided copper mesh wire, which braid is to be grounded, to prevent stray pick-up. This wire is exceptionally good for antenna lead-in, to avoid pick-up of man-made static, such as from electrical machines. Also used to advantage in the wiring of receivers, as from antenna post of set to antenna coil, or for plate leads, or any leads, if long. This method of wiring a set improves selectivity and reduces hum. This wire is now appearing on the general market for the first time although long used in the best grade of commercial receivers. Order Cat. SH-LW. List price 9c per ft.; net price per foot **5c**

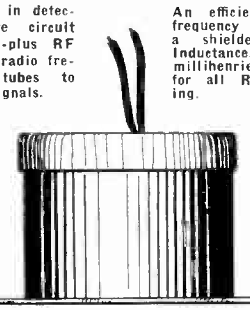
Double Drum Dial



Hammarlund double drum dial, each section individually tunable. Order Cat. H-DDD. List price $6.00; net price **$3.00**

Shielded RF Choke

Excellent in detector plate circuit or in B-plus RF leads of radio frequency tubes to purify signals.



An efficient radio frequency choke in a shielded case. Inductance, 50 millihenries. Useful for all RF choking.

In some instances one outlead is connected to case, so use this lead for B-plus or for ground, otherwise ground the case additionally. Order Cat. SH-RFC. List price, $1.00; net price **50c**

Guaranty Radio Goods Co., 143 West 45th St., New York, N. Y. (Just East of Broadway)

Enclosed please find $.. (Canadian must be express or post office money order, for which please ship:

☐ BAL-AS @ $44.00	☐ Ft. of SH-LW @........5c p. f.	☐ M-600 @.... $4.95
☐ MTVD @ ... 3.90		☐ F-300 @..... $2.59
☐ G-RF-3CT @ 2.48	☐ H-DDD @... $3.00	☐ F-500 @..... 3.73
☐ R-245 @..... 11.40	☐ SH-RFC @... 50c	☐ MICON.... @ ....
		☐ MICON.... @ ....

☐ If C.O.D. shipment is desired put cross here.

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Final 6-Circuit Tuner

Circuit and Layout Shown in Finished Form for First Time

By J. E. Anderson and Herman Bernard

THE wiring diagram of the Six Circuit Tuner in final form, with the views of the assembly as completed, are shown this week for the first time.

It will be noted that each coil is shielded, also that each tube has an individual shield. Also it is a fact that a separate bottom piece is secured underneath the chassis, so that the wiring underneath is totally metal-enclosed. Of course there are holes in the chassis for the sockets, but the sieve effect otherwise present is obviated by the use of the tube shields. These effectively bottle up what otherwise would be an opening.

The size of the chassis, overall, is 2⅛ inches high, 20½ inches wide and 11½ inches front to back. These dimensions permit mounting the National drum dial directly on the chassis top, leaving about ¼ inch space between the top of the escutcheon and the top of the front panel used. Also, the drum itself nicely clears the top of the chassis, obviating any cutout for clearance.

Tuning Condensers Elevated

This method requires the elevation of the tuning condensers, accomplished by using three bored bushings 1 inch high, for each frame, through which a machine screw is passed, the head being accessible at the condenser mounting hole on top, and the nut being fastened from underneath. The actual height between top of the chassis and bottom of the condenser frame is 1 1-16 inch, but the condenser mounting holes, of which there are three for each of the two frames, are extruded 1-32 inch. The remaining tolerance is taken up by a 1-32 flat bakelite washer. In some instances it will not be necessary to provide this extra thickness.

There is abudant room for clearance on all shields when a cabinet lid closes down over the assembly, since the overall height is 6¾ inches, which allows for a 7x21 in front panel.

In console installations it will not be necessary to have a panel wider than the front opening of the console, although it may be necessary to provide for greater height than 7 inches, as many such openings are 8 inches high. For this reason the choice of a panel is left to the constructor, but the dimensions for locating the three main holes will be given.

The volume control is at left, the tuning dial at center and the adjustable trimmer at right. As the AC switch that controls the line input is built into the volume control, the front panel knobs are restricted to three.

Two Small Mounting Problems

Underneath there are only two fitting problems—one concerning the audio transformer and the other concerning the voltage divider. The transformer is mounted in the only direction in which it fits, and this requires readjusting the position of the connection lugs of the transformer 45 degrees and removing by bending the protruding part of the bottom frame of the transformer. The voltage divider is accommodated to the space requirements simply by bending back the lugs. Since two lugs are united at the factory by a stiff wire to connect the two component units of the voltage divided in series, stiff pressure of the fingers will be needed to bend these particular lugs to avoid any possibility of touching the under cover when it is affixed to the chassis.

How the parts are mounted underneath will be shown in detail in a subsequent article. Sufficient to state now that there are no mounting problems, other than the two just discussed, and these are obviously slight. Everything fits and everything works.

One of the most annoying trials to which a set-builder is subjected is to obtain parts that do not fit physically into the layout. It just spoils one's enthusiasm for a circuit to find that the assembly abounds in physical miscues. After these difficulties are straightened out the circuit might work well, but the chances are that it will not come up to expectations, since if not enough care was taken by the designer to provide for the nice fitting of every part and item, it may be assumed with fortified safety that not enough care was taken in the electrical design to make the performance come up to the promise.

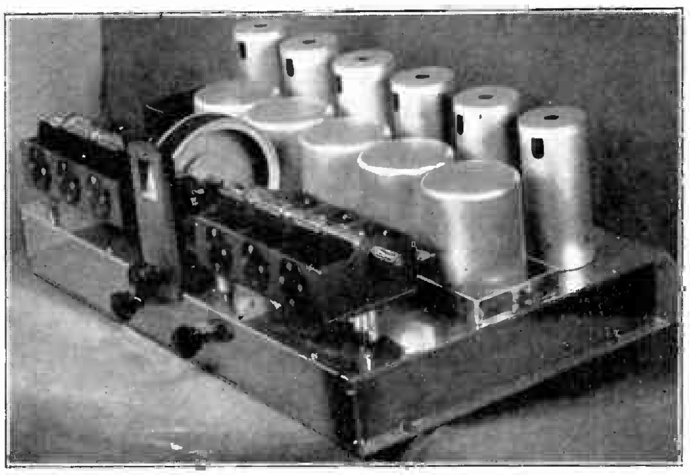


FIG. 1

THE NATIONAL DIAL IS MOUNTED DIRECTLY ON THE CHASSIS. THE GANG CONDENSERS ARE ELEVATED TO AFFORD ALIGNMENT, BY BUSHINGS 1 INCH HIGH. THE FILAMENT TRANSFORMER IS AT EXTREME LEFT.

The assembly work takes a long time, even though all parts fit in place. A man likes to exercise abundant care, drive home each screw fast, anchor each nut in place with a lockwasher, and snip off the protruding ends of screws, so that the view below does not resemble a field of asparagus illustrating unequal race for growth.

Data on Coils

The wiring is somewhat simplified by the fact that the coils have distinctive outleads. All five coils are alike. They are wound on 1¾ inch diameter bakelite tubing, 2½ inches high, with secondaries consisting each of 70 turns of No. 28 enamel wire. An insulating material, which may be Empire cloth or equal, or para rubber, covers enough of the secondary to prevent any short between primary and secondary after the primary is wound. The primary consists of 40 turns of the same kind of wire, wound over in the insulation, in the same direction. The position of the primary determines in part the degree of coupling, and it is advisible to put the end of the primary winding a little nearer one end of the secondary. The shields will fit over these coils nicely, but some method of obtaining proper coil elevation and security is advisable. Either the tubing should be longer than 2½ inches, to enable you to bracket it to the shield base so that the coil will be tautly in place, equi-distant from

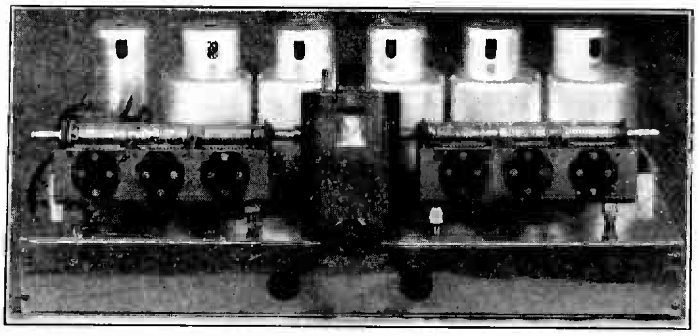


FIG. 2
FRONT VIEW SHOWS THE ALIGNMENT OF THE TWO THREE-GANG CONDENSERS. THE TUBES, LEFT TO RIGHT, REPRESENTED BY REAR SHIELDS, ARE OUTPUT, FIRST AUDIO, FIRST, SECOND AND THIRD RF AND ON EXTREME RIGHT, DETECTOR.

top and bottom of the shield, or a shellacked wooden base may be used for elevation and security. There are two objects: to have the top and bottom of the secondary equi-distant from the top and bottom of the shield, and to have the primary and secondary individually equi-distant from the side walls of the shield. Rigidity must be excellent, otherwise the coil may get out of alignment and this would tend to spoil the fine operation of the receiver, because upsetting the inductive and capacitative balance.

Not only the number of turns on the secondary, but also the distance of the shield wall from the coil determines the inductance, and indeed this shield effect influences the total capacity as well. Hence it is not unusual to read conflicting directions for the number of secondary turns on the same diameter, using the same size wire, to be tuned with the same maximum capacity condenser, the difference being accounted for by the size and treatment of the shield. The inductance obtained from the secondaries in the present instance is almost exactly the same with the shields on as with them off, so the number of turns is more nearly that prescribed for unshielded circuits.

Leads Identified

The commercial coils have their outleads identified. The beginning of the primary has a copper shielded mesh covering, over the rubber insulation. The end of the primary is red. The beginning of the secondary is blue. The end of the secondary is yellow.

Thus the antenna coil is connected with antenna to the shielded wire, the stator of the first section of the left-hand three-gang condenser to red, stator of the second condenser to blue and one side of the band pass filter coupling coil to yellow. The second coil has its shielded lead going to grid (cap) of the first RF tube, red to ground bar, blue to the stator of the last section of the first three-gang condenser, and yellow again to the same post of the band pass filter coil to which the other yellow was connected. The remaining side of the band pass filter coupler goes to the ground bar.

The coils used for interstage coupling have the shielded lead going to plate, red lead to B plus, blue to stator and grid, and yellow to ground.

All ground connections, also representing B minus, are made to a special copper bar, called the ground bar, which has a heavy lead soldered from it to the ground binding post. Thereby also the chassis itself is grounded, but the chassis is never used as a ground connection, the bar rendering this service instead, as it will have a lower impedance and will be more suitable for maintenance of stability. Each frame of a three-gang condenser has a ground lug, accessible through a hole in the chassis, for connection to the bar.

Ground Shield Braid

Wherever the shielded wire is used, the shielded mesh should be connected to the ground bar, but not the "hot" lead inside the rubber covering that the mesh surrounds. You can solder directly to the copper mesh without injury to the wire inside or the rubber insulation that covers this wire.

For hookup wire No. 18 stranded will do nicely. This should be rubber-covered, preferably of soft push-back insulation, which is easier to work with. But for the heaters of the tubes use No. 16 or larger stranded wire or solid wire, suitably insulated, and twist the leads.

Looking at the assembly from the front, the last audio tube is at extreme left, the first audio is second from left, and then come the three screen grid RF tubes in succession, while the tube at extreme right is the detector.

To go from the detector plate to the primary of the audio transformer a short lead is used, but the secondary of the transformer has its grid connection going to the a tube about 7 inches away, therefore use shielded wire for this long lead and ground the shield mesh. It is an audio lead, but the precaution is suitable.

As the heater currents are large it is advisable to use a separate pair of twisted wires for each heater circuit from the lugs on the socket to the heavy 2.5-volt terminals of the supply transformer, unless No. 16 or larger wire is used. Either tends to equalize the heater currents, preventing any one tube from getting more than any other. This is a precaution well worth taking.

On the circuit diagram is shown a switch in the heater circuit which controls the heater currents of all the radio frequency and the detector tubes. The object of this switch is to cut out the tubes not needed when the audio amplifier is used in conjunction with a phonograph pick-up.

As the wiring of the circuit proceeds it is a good policy to check the connections just made for shorts and opens. It is much easier to discover errors and defects before all the connections have been made than when the wiring is complete, because in many instances it is necessary to open up certain connections to make tests. Cumulative work can be avoided by checking immediately when a connection has been made.

Examples of Checking

Suppose, for example, a plate lead has been connected between the coil and the tube socket, that is, the shielded lead from an interstage coil. When this lead has been connected it is easy to tell by a test whether the terminal on the coil is actually connected with the plate spring in the socket, and tell it without any ambiguity. Another test that should be made immediately is between the plate spring of the socket and the B plus lead on the interstage coil, that is, the red lead. This tests the coil for continuity. At the same time test this circuit for a possible short to ground. There should be no connection yet between the plate and ground, which in effect means the chassis frame and the condenser frame. Complete all the plate connections and test each one in the same manner before the B plus leads have been connected.

The grid circuits, that is, the blue leads after the first tube, should be tested in the same manner before the yellow leads have been connected to anything. This will obviate a later disconnection of the yellow leads in case the circuit does not function when it is supposed to have been completed.

This connect-and-check process should be followed throughout the set. Suppose we begin with the antenna. The inside of the shielded lead on the first coil is connected to the antenna binding post. Then check to see that the red lead of this winding is actually connected to the stator of the first condenser and that there is no direct connection to ground or the chassis. Test to make certain that the antenna is now connected to the stator or this section and that it is not grounded for any setting of the condenser. The rotor and frame of the condenser will be connected automatically.

Connecting the Pre-Tuner

Connect the blue leads of the first and second coils to the stators or the second and third condensers respectively, and do this before the yellows have been connected. Test each for continuity and shorts between the yellow and the condenser stator. If all checks as it should, join the two yellow leads and connect them to the filter coupling coil. Since the other side of this coil connects to ground, a check with DC between either blue and ground should show current. This does not mean that the stators are grounded to signal frequency voltages but only to direct current.

Connect the shielded lead on the second coil to the grid clip for the first tube before connecting the red and make certain by testing that there is no short to ground and that there is continuity between the red lead and the grid clip. Now connect the red lead to ground and test again. This time the grid clip should show connection with ground for direct current.

The connections of the other plate and grid leads have already been explained.

This progressive testing and wiring can be facilitated if a voltmeter connected in series with a suitable battery and provided with two exploring leads is kept handy.

The audio circuit is connected and tested in the same way, both for shorts and continuity, but it should be kept in mind that high resistance couplers are now involved. This is particularly true when testing between the detector and the first audio tube, one circuit having .25 meghom and the other 5 megohms. When testing between the plate of the detector and the B plus end of the coupling resistor a mere flicker should be shown on the test voltmeter of the test battery voltage is of the order of 45 volts. When testing between the grid of the first audio tube and the ground end of the grid leak not even a flicker may be observable. This, however, does not matter, for the most important test here is for shorts.

Testing the Audio Amplifier

In testing between the first audio tube and the output tube the checks should show in about the same way as in testing the radio tubes because the resistances of the windings of the transformer, although high, are not so high that voltmeter will not show good readings. The important thing to look for is a reduction in the test voltage readings as compared with the voltage of the battery used, and the reduction should be greater in the secondary. If these reductions are not noted a short to ground should be looked for.

In testing the plate circuit of the output tube allowance must

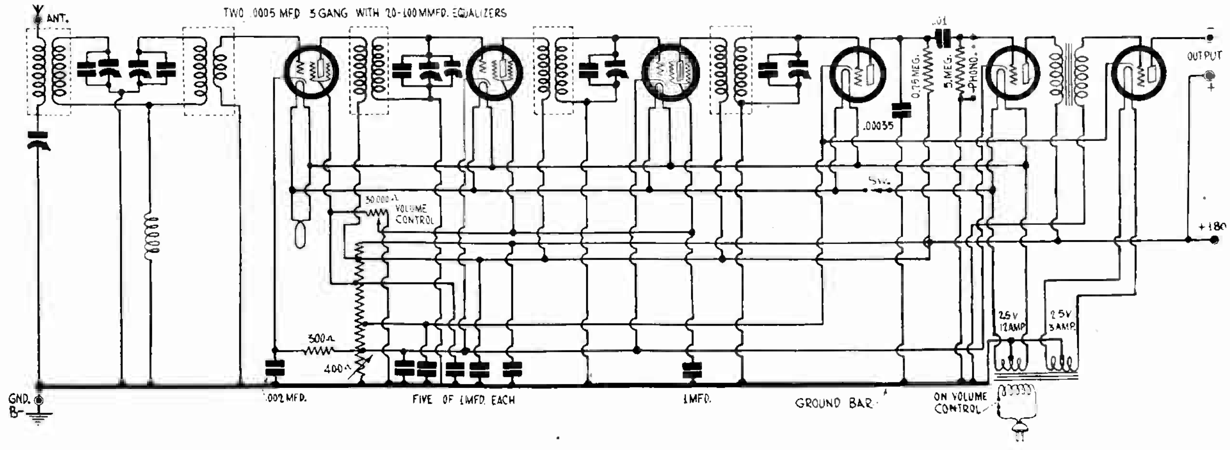


FIG. 3

DIAGRAM OF THE SIX-CIRCUIT TUNER IN ITS FINAL FORM, AS BUILT ON THE CHASSIS ILLUSTRATED ON OPPOSITE PAGE AND ON FRONT COVER.

be made for the resistance of the loudspeaker winding, and it is advisable to connect the speaker while the test is made.

When all the "hot" sides of the couplers have been connected to the plates and the grids and all the tests made as suggested proceed to the low sides, first making the connections in the grid circuits. All should be connected to the ground bar. Now a test should be made to see that all the grids are connected to ground through the coil, as shown by the DC tester. Only one grid will not show a positive test and that is the one which has a 5 megohm resistance in series. It might be well to short circuit this resistor while the test is made, or after the first test has shown no appreciable voltage reading.

The conections to the plate voltage source have been left purposely in order that the tests might be free of ambiguity.

The first thing to do about the plate return connections is to test the voltage divider. Start when nothing is connected to it, but with the unit mounted. Test all the taps with the voltmeter tester from the negative or B minus end. There should be a progressive decrease in the reading of the voltmeter as the included resistance increases. At first, near the end with crowded lugs, the decrease will be scarcely noticeable because the resistance steps are very small. There are four points that should be tested particularly for possible ground, namely the four ends. There must be no connections between them and the chassis. If a reading is obtained between the chassis and any tap or end the fault must be located and remedied. A break in the resistance will show up during the progressive test. If there is a break get a new voltage divider.

Connection of Voltage Divider

Make the first connection to the voltage divider at the negative end. This is not connected to the chassis or to the ground but to the 400 ohm rheostat, which in turn is connected to ground. Now connect the various cathodes to the voltage divider as indicated. Test each cathode lead from the socket to the lead that is to be connected to the voltage divider before this connection is made. Make the connections firmly without soldering because they may have to be moved. Connect the high resistance potentiometer to the proper tap, testing first as previously, before the connection is made. Do not solder yet. Now make the plate return connections, that is, the red leads and the return from the speaker and audio transformer. Make connections temporarily, except those which go to the highest voltage tap, that which is next to the low voltage end but on the other part of the divider.

The heater circuit, which should have been made first, is best tested by putting tubes in the circuit and noting whether or not they light. Be sure to close the auxiliary switch.

Now connect a high voltage source, 180 volts, between the high end and the chassis. The high end is available from the top of the panel at the insulated plus speaker terminal.

The Test on Signals

With the tubes in the sockets adjust the positions of the cathode and plate returns so that the proper voltages are obtained. Test this with the voltmeter without the battery in series with it. A high resistance meter is preferable although good adjustments can be obtained with an ordinary service meter. The bias can be adjusted both by varying the 400 ohm rheostat and by moving the cathode taps. The voltage for the screens and the plates which take less than 180 volts can be tested with the meter. When the right values have been found complete by soldering.

The set should now be ready for testing on a signal and it should only be necessary to adjust the trimming condensers.

If the suggested method of wiring and testing has been followed out carefully, signals should come through just as soon as the power has been turned on and the cathodes have become hot enough to emit electrons. However, there is no absolute certainty that the circuit will work, because so far no tests have been made for shorted tuning coils. While this fault is extremely unlikely it is well to test for it. First note whether there is a short between the windings. This is most easily made by measuring the voltage on the grids. If there is a short between the two windings the voltages will be the same on both elements. If this is found, locate the defect and correct it.

In the event that signals still don't come through well, the best plan is to test for capacity alignment of the condensers. If the trimmers do not appear to be sufficient to compensate for slight differences in the distributed capacities, it may be necessary to loosen the rotors on the shaft and reset them. Try one at a time until the best average result is obtained over the entire waveband, beginning with the low frequency end. The alignment of the plates is done by moving the rotors along the shaft so that each rotor plate is centered between the stators.

(Continued next week)

LIST OF PARTS

Two Scoville three-gang .0005 mfd. condensers (Cat. SC-3-G-5).

Two National ⅜ inch extension shafts (Cat. XS-R).

Five Hammarlund 20-100 mmfd. equalizers (Cat. EQ-100).

One Dubilier .002 mfd. fixed condenser (Cat. MICON-002).

One Dubilier .00035 mfd. fixed condenser (Cat. MICON-00035).

Six Polymet 1 mfd. bypass condensers, 200 volts, grounded frame (Cat. POLY-1).

One De Jur-Amsco midget variable condenser of 30 mmfd. for compensating (Cat. MC-30).

One .01 mfd. Sprague fixed condenser (Cat. SPR-01).

Five Screen Grid shielded coils for .0005 mfd. (Cat. C-6-CT-5).

One Screen Grid band pass filter coupling coil (Cat. BP-6).

One Gold Bond 1-to-3 audio transformer (Cat. GBS-3).

One Polo filament transformer, with AC cable and plug, pri-110v. AC, 50-60 cycles, two 2.5 volt secondaries, both center tapped, 12 and 3 amps respectively (Cat. F-25-D).

One Electrad Multi-tap Voltage Divider (Cat. MTVD).

One Clarostat wire wound 30,000 ohm potentiometer with AC switch attached, knob and two insulating washers (Cat. CLA-30,000).

One Lynch metallized .25 meg. resistor with pigtails (Cat. LY-P-25).

One Lynch metallized 5 meg. resistor with pigtails (Cat. LY-5).

One Electrad 300 ohm wire wound flexible resistor (Cat. EL-300).

One Frost 400 ohm rheostat (Cat. FRO-400).

One National Modernistic drum dial with color wheel, knob and 2.5 v. AC pilot lamp (Cat. HC).

One ground bar (Cat. GRO).

One Eby antenna-ground post assembly (Cat. E-AG).

One Eby speaker post assembly (Cat. E-SP).

One Eby phonograph pickup post assembly (Cat. E-PHONO).

One shielded chassis, with six UY sockets affixed (Cat. 6-CT-CHAS).

One convenience outlet, for power pack or AC dynamic speaker (Cat. CVO).

Six National tube shields, satin finish aluminum, with six bases (Cat. N-T-S).

Two National 3/16 inch diameter knobs for vol. control and compensator (Cat. KNOB).

One AC switch for chassis top (Cat. AC-SW).

One roll of No. 18 stranded Corwico Super Braidite rubber covered hookup wire, push-back insulation (Cat. HOW).

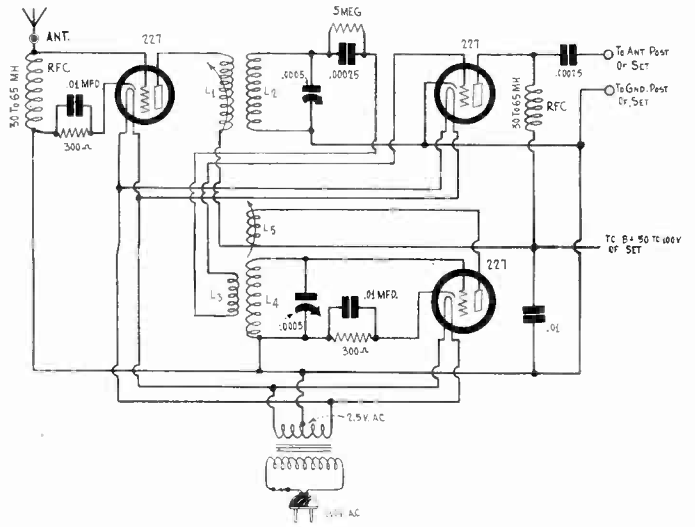
Six feet of shielded wire (Cat. SH-LW).

Hardware package, including nickeled 6/32 machine screws ⅜ inch long, nickeled nuts, six elevating bushings for condenser, six auxiliary elevating washers, lugs.

Methods of Coupling in

Pickup Coil Next to Modulator Grid Proves

By Herman



DESIGN OF A SHORT-WAVE CONVERTER, WITH PICKUP COIL NEXT TO THE MODULATOR GRID. THE CHOKE COIL AND BYPASS CONDENSER TO STOP RF STAGE OSCILLATION ARE SHOWN, ALSO.

LIST OF PARTS

L1L2, L3L4—Two sets of short-wave coils, wound on air dielectric, three coils to a set, total of six coils.
Two .0005 mfd. Hammarlund de luxe straight frequency line tuning condensers.
Three radio frequency choke coils, 30 to 65 millihenrys (50 mh shielded type used in orginal model). (One not in diagram.)
One .00025 mfd. fixed condenser.
One .00025 mfd. fixed grid condenser with clips.
One 5 meg. Lynch metalized grid leak.
Two Electrad wire-wound flexible type biasing resistors, 300 ohms each.
Four .01 Mfd. fixed condensers. (One not in diagram.)
One 7x14-inch drilled bakelite panel, with three UY sockets (5-spring) and coil receptacle built in.
One cabinet to fit.
Four binding posts.
One 2.5-volt center-tapped filament transformer, 6 ampere rating, with AC cable and plug attached.
Two vernier dials.

IN building a short-wave converter, which enables the reception of short waves by converting them to a frequency that can be amplified by your broadcast receiver, not only is it possible to select any one of several different oscillator hookups, but also there are options for coupling the modulator and oscillator.

The subject of oscillator types has been discussed, and the preferred one was the simple tickler coil type, so that the oscillator tuning condenser was connected from grid to grid return. This gives the benefit of a grounded rotor, and virtually eliminates body capacity. But the subject of coupling methods between oscillator and modulator has not been treated.

If the secondary winding of the modulator tuning circuit is returned to ground through an extra winding inductively coupled to the oscillator secondary, excellent coupling is afforded. The tuning condenser in the modulator circuit may occupy either of two positions: the rotor may be returned to the end of the secondary or to ground. In the second instance the tuned circuit includes the small coupling coil.

Objections Analyzed

There are objections to both of these methods. The really serious objection applies to the connection of the rotor of the modulator tuning condenser to the end of the secondary, instead of to ground. This leaves the rotor at a "hot" potential. The very condition of body capacity which was almost entirely eliminated from the oscillator circuit by selection of the tuned grid with grounded rotor, is simply transferred to the modulator circuit. It is obvious that only a few turns, indeed perhaps only a single turn, intercept the end of the modulator secondary, on its course to ground, but this is sufficient to develop an annoying potential drop, and cause the modulator tuning condenser to be subject to just as bad body capacity as was true of the oscillator when the worst form of oscillator was used.

The second objection is a small one, in that it can be overcome by coil design. Suppose that the two secondaries, modulator and oscillator, are identical in inductance, just as the two tuning condensers are identical in maximum and minimum capacity. Now, if we include the coupling winding in the tuned circuit of the oscillator we introduce a wide divergence of dial settings. Although the mixer will work into an intermediate frequency substantially lower than the lowest short-wave frequency, the dial readings, with equal coils, will be almost the same. When the coupling coil's inductance is added to one circuit, this circuit tunes to lower dial settings than the other, and the divergence is the greater the higher the frequencies tuned in, since the coupling coil's inductance is a larger percentage than of the total inductance in use.

Coil Elevated in Grid Circuit

As stated, the coils may be wound to compensate for this difference. However, another method presents itself: the introduction of the coupling coil in the grid circuit, next to the tube. Thus is is out of the tuned circuit and has substantially no effect on the dial settings, except to act as a loading coil. Hardly any loading effect is introduced unless a very large inductance is used, and as the inductance here is small, we find ourselves able to meet an important situation in a highly acceptable manner.

The location of the coupling coil right next to the grid not only effectuates a stronger coupling, requiring fewer turns, but also enables us to maintain the rotor of the modulator, just as we maintain the rotor of the oscillator, at ground potential.

With these problems solved we have a mixer that is free from body capacity if the hand is held so that, as the fingers grasp the knob, the knuckles are as far away from the knob as practical; that is, nearest to you. This simply means that you should not rest your hand on the panel or dial moulding or otherwise bring your hand close to the coil which the condunser tunes.

The body capacity arises in these instances from association with the coil field, rather than from interception of the field of the grounded condenser.

The same precautions may be taken in tuning the modulator circuit, although this is wholly free from body capacity effects, unless oscillating.

At some settings, for higher frequencies, on the smallest coils, oscillation may be present in the modulator tube. It is not wanted, and can be suppressed by introduction of an RF choke coil, of 30 to 65 microhenries inductance, in series with the B plus lead going to the plate of the modulator. It is essential to include a bypass condenser from the high side of the choke to ground, of .01 mfd. or higher capacity.

Even if oscillation is present, and no choke coil or other quieting device is used, the converter is still operative, only the modulator tuning becomes almost as critical as the oscillator tuning. The reason is that resonance stops the oscillation and permits reception, but, if you get just the tiniest bit off resonance, oscillation is restored and no signals will be heard unless the oscillator dial is tuned to the same frequency to which the modulator now is tuned. This, of course, re-establishes resonance.

Voltages for Oscillation

The design most usually shown in the articles on the mixer has called for three 227 tubes, so that there are one stage of untuned RF, a tuned modulator and a tuned oscillator. So the receiver itself is depended on for only one item of power, the B plus voltage. This may be from 22½ to 100 volts, and is not critical, but it should not be much more than 100 volts, and at all hazards it should be high enough to insure oscillation in the oscillator. If no oscillation is obtained at 50 volts, then there is some open or short, or the tube used as oscillator is in such poor condition that it will not oscillate. Any good tube will oscillate in this circuit and this position at 50 volts for a certainty, and the only objects of suggesting more than 50 as the upper limit are the possibility of a weak tube being used as oscillator, and the benefit of somewhat increased volume due to the higher voltage increasing the mutual conductance of the untuned RF tube.

As for the tuning, it should be realized by all who desire to experiment with short waves for the first time, that a critical aspect is present that transcends anything experienced with modern broadcast receivers. It is possible, for instance, to get four different stations, and without interference, within the

a Short-Wave Converter

Excellent Solution of Important Problem

Bernard

narrow margin of a single division of the dial. It is therefore possible, in theory, to get, say, 400 stations over the sweep of a dial using a single set of coils. (Two coils are needed for each band because of the two tuned circuits.) You will not get 400 stations, because there aren't that many on the air in that band at the same time, nor within reach, but you can visualize the situation.

If It Gets Code It Gets Programs

The volume is not nearly as great as on broadcast waves, and there is an abundance of code received. So many readers are interested only in programs that they feel that some converters are of the non-program type, because they tune in code aplenty, but no programs. Of course, if the converter brings in code it will bring in programs. There are code stations, including amateurs, all around you, and the chances are worse than 100 to 1 that you'll tune in code rather than programs. But the programs are there and you can get them. All you need do is to tune in a program once, note the dial settings for modulator, oscillator and receiver proper, and repeat these settings to bring in the same station when it is on the air some other time.

The object of the untuned stage is to build up the short-wave signals, since it is followed by a mixer, and it is undeniably true that the amplitude of the output of the mixer is far less than the amplitude at the antenna input. The frequency changing is made at a heavy expense of amplitude. But the intermediate amplifier, if a modern receiver, or any sensitive receiver, will more than make up for this loss, as the degree of amplification will be higher than that ordinarily obtained in a Superheterodyne with an intermediate frequency of 70,000 kc.

Use a Long Antenna

While a short antenna or an indoor antenna or a copper screen antenna may be used with a sensitive broadcast receiver to deliver adequate input to the first coil, when you use a converter, even with such a receiver, be sure to use a good, long aerial. You may use 100 feet or even more. Short aerials, series condensers and small primaries are necessary in some short-wave adapters and receivers to avoid blind spots, but in the three-tube converter there are no insensitive or dead spots anywhere on the dials. Also, the long aerial helps to compensate for the necessary loss in the frequency changer, which loss is inherent to the mixing process, and applies to all receivers or converters using the Superhererodyne principle.

If the wiring is correctly done, and coils and tubes are used that will provide oscillation, there is nothing that will stop the performance, outside of a short or an open, unless it be the receiver. In the example of the receiver, the stoppage will not be complete, if the receiver brings in broadcast stations, but may be partial, due to low sensitivity of the receiver. It is not possible to foretell the sensitivity of the receiver, particularly as any frequency to which the receiver may be tuned also may be used as the intermediate frequency. This range normally is 1,500 to 550 kc, but if the receiver tunes higher than 1,500 kc (below 200 meters) it is well to use a higher frequency for intermediate amplification. Usually the sensitivity is very high at this frequency, but the precaution should be taken to avoid oscillation in the receiver itself. The receiver's tendency to oscillate is greater the higher the frequency, but usually the volume control is also an oscillation control.

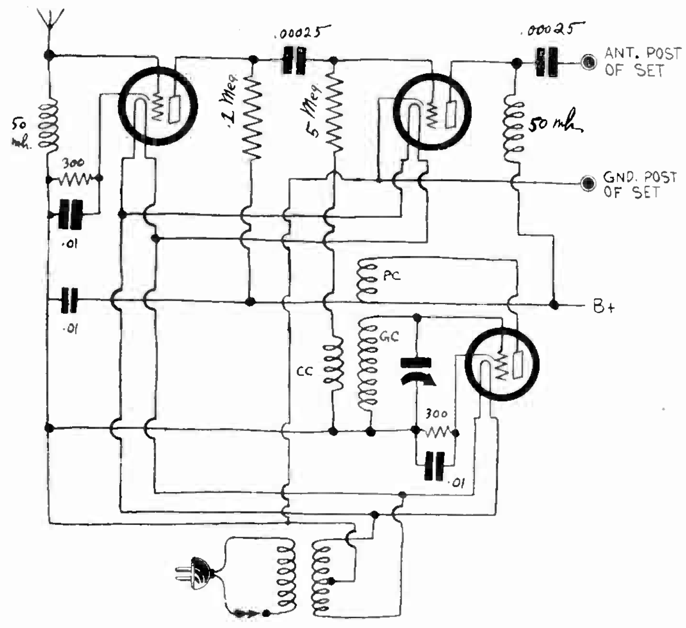
The possibility of dual reception presents itself. Suppose you tune in a broadcast station. Suppose you work the converter. Now you will receive the broadcast station and the strongest short-wave stations, mostly code. So be sure to use as an intermediate frequency one that does not produce broadcast reception. The choice of a frequency higher than 1,500 kc meets this requirement nicely. But if your receiver does not tune higher than 1,500 kc, use any other frequency that does not bring in a broadcast station.

Takes An Hour and a Half to Wire

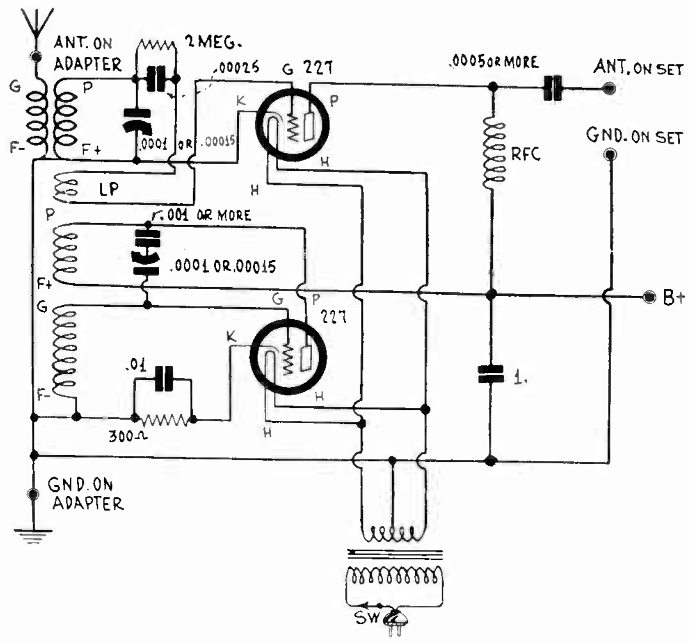
The wiring of the converter is not at all difficult, and takes about an hour and a half, without any rushing. The sockets are not marked, so take this precaution: the five-prong tubes have heater connections as base of a triangle and grid as apex, so look for the apex to find the grid, and use the two large base holes for heater. When the socket is looked at upside down, with apex away from you, the cathode and plate are not in the same relative position as when you look at a five-prong socket from top of the panel, with apex away from you but the cathode right and the plate at right.

A perfect ground is just as important as a perfect antenna. A connection to a cold water pipe is generally satisfactory. The pipe should be cleaned and scraped with a file before connecting the wire to it by means of a ground clamp. Where no water pipe is available, use a metal rod driven several feet into moist earth. Ground wire should be as short as possible.

Try out several types of grounds. Also experiment with antenna in a number of different directions. Use only the best tubes and be sure that the batteries are up to full voltage. Be especially particular about the screen grid tube.



IF ONLY THE OSCILLATOR IS TUNED IT MAY BE POSSIBLE TO OBTAIN RESULTS. THE CIRCUIT DIAGRAMMED HEREWITH IS UNDER INVESTIGATION. IT CAN NOT BE BETTER THAN THE OTHER ONE, WITH TWO TUNED CIRCUITS, BUT IT MAY PROVE NEARLY AS GOOD, AND WOULD REDUCE HE TUNING TO ONE CONTROL.



IN THIS ADAPTER A MODIFICATION OF THE HARTLEY OSCILLATOR IS USED. THIS IS VERY EFFECTIVE BUT IS SUBJECT TO A CERTAIN AMOUNT BODY CAPACITY WHICH RENDERS EXACT TUNING A LITTLE DIFFICULT UNLESS SPECIAL PRECAUTIONS ARE TAKEN TO SHIELD THE CONDENSER FROM THE HAND. THE TUNED CIRCUIT IS COMPLETED THROUGH A ONE MICROFARAD CONDENSER.

Shooting Hum Trouble in

Methods of Tracing Down the Source

By John C.

[*The following article is the ninth of a series on dynamic speakers which began with the March 15th issue, wherein "Design of Dynamic Speakers" was discussed. The pot magnet, voice coil and baffle were treated. The second article, "A Comparative Test of Dynamic Results," appeared in the March 22nd issue, in which comparisons were made between magnetic and dynamic speakers. In the March 29th issue, "Hum Reduction in Dynamic Speakers" was discussed. Reverse-wound coils and condenser-choke systems were included. In the April 6th issue, "Wave Forms of Hum Reducers" was the topic. The use of the bucking coil and some other remedies for hum were discussed. In the April 12th issue, the subject was "Why Coils Have Lag and Condensers Lead." The effect of potential difference on atomic stability was discussed. The subject treated in the April 19th issue was "Why Dynamic Speakers Sound So Well." The effect of baffles, cone stiffness and dampers was analyzed. The issue of April 26th contained a discussion of "Dynamic Sound Waves," and dealt with complex sound pressures and even harmonics. In the issue of May 3rd "Non-Resonant Characteristics Unlike Ear's" was discussed. A flat speaker response curve is sought, but the human organ is a tuned device.*—EDITOR.]

* * *

TOPICS of interest in connection with dynamic speaker design are almost limitless. One of the reasons why dynamic speakers are depended upon in the majority of installations is that they are reliable performers, being more or less free of constructional and operative defects that tend to produce fatigue of various kinds.

The magnetic speaker supplies a fair degree of realism, but has load limitations, and the oscilloplane type, although very good when in good condition, is usually affected sooner or later by atmospheric changes, speaking broadly.

And so the accepted medium of acoustic transmission in the home and in auditorium is the dynamic speaker. Whatever branch of the acoustical entertainment field you are interested in the selection of the best type of dynamic for your purpose is bound to come up for discussion.

Effect of Variables

In previous articles the influence of various variables on the acoustic output quality has been briefly sketched, to provide the reader with sufficient reference material with which to apply his own initiative to the construction or selection of a dynamic speaker for his own use. Of all the variables discussed, I think the baffle is, or at any rate should be, the item of greatest interest because the widest variety of acoustical effects is obtained in the easiest way, by varying the size, shape and mass of the baffle.

Another easily varied dynamic speaker constructional constant is the air-gap flux—and because of this the volume of acoustical output easily can be varied and in such way as to provide the most accurately controllable sound output. This control is smoother than any radio set potentiometer variation method, e.g., control of screen grid voltage, and if the material of the pot magnet or field coil has low magnetic retentivity it will be possible to reduce the volume to a very low level of audibility.

So for the above reasons and many others the dynamic speaker constructional field is still a real proving ground for those who would like to test their mettle on acoustic problems.

Realism of Sound Effects

One of the most diverting, not to say interesting, branches of the sound reproduction art is that which deals with sound effects, and I hasten to point out here that although one may succeed in producing a very realistic whinnying of a horse, or sound of a train accelerating as heard by the ear, the microphone and loudspeaker may not interpret these sounds and reproduce them with quite the same degree of realism, hence a working knowledge of harmonic combinations is most useful, and in some cases indispensable.

It will be recalled that certain definately required emphasis of certain frequencies and harmonics can be attained by variations of the cone material, cone angle, and also by changing the voice coil operating transformer, and in this connection I want to add that the pitch of a speaker may be altered by shunting the primary of the voice coil operating transformer with a small condenser. The pitch revision is of course downward and is due to the change in capacitive reactance with frequency, i.e., the higher the frequency the lower is the reactance offered by the condenser. Although you cannot follow this particular line of reasoning too far, it is nevertheless satisfactory if only a slight drop in pitch is required.

There are many other topics of interest concerning dynamic

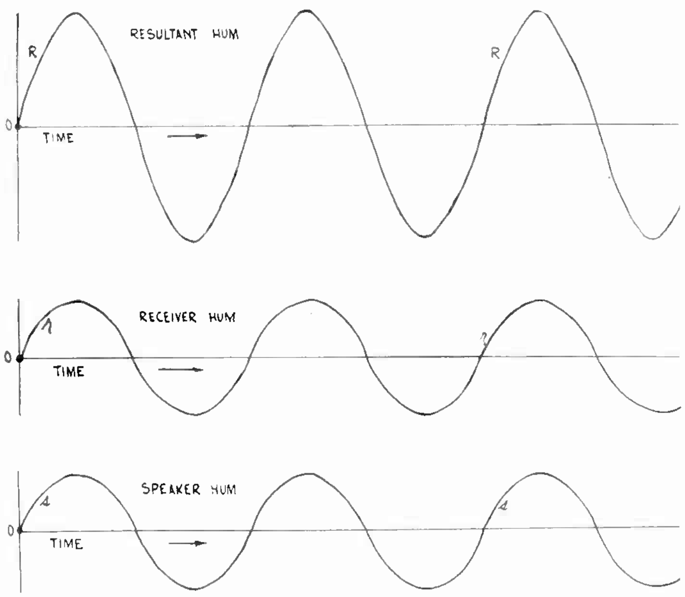


FIG. 1

THIS SHOWS THE BIG HUM RESULTANT DUE TO THE ADDITION OF TWO SMALLER IN-PHASE COMPONENTS.

loudspeakers, and before leaving this discussion to talk briefly of some applications I want to point out some pertinent details of a test and cure for obstinate hum in both a rectifier-operated dynamic speaker and the B supply-operated variety, such as occurs in connection with AC-operated radio reeivers.

I have written previously about hum effects and some of their causes, so I won't repeat anything elementary here. You can refer to the previous issues of RADIO WORLD in this connection.

Lately I have been interested in some design revisions of three-stage and four-stage screen grid radio receivers and also have experimented with circuit layouts with a view to reducing the hum pickup by receiver wiring and also the influence of degree of filtration upon residual hum, with the result that the revised and very much improved circuits were evolved.

Now in connection with dynamic speaker operation, the **combined** effect of two small hums, i.e., the nearly inaudible one from the AC set, and the nearly inaudible one from the dynamic speaker, to produce one big HUM by an additive process which is depicted by curves of Fig. 1.

Capital R is the resultant hum produced by the two small hum components which are in phase, and which add up to produce the big hum curve, aided in most cases by the baffle.

Process of Hum Removal

And now for the hum removal process.

I will begin with the speaker first, even though it may not be the worst offender, and will select the dry rectifier operated type, paradoxically enough, because it is usually the worst.

First of all the following test is made: Place an AC ammeter (0-5 amperes scale) in series with the speaker pot coil and the rectifier, and measure the voltages with an AC voltmeter (0-20 scale). Both these instruments are now measuring the sum total of all the electrical energy being supplied by the rectifier (dry disc type). Let us assume that the indicated product of the two AC meters (12 volts, 1½ amperes) is 18 watts. Now substitute a DC voltmeter and ammeter (same scale range respectively) and take another reading (rectifier output being constant of course).

We find the DC voltmeter reads 5½ volts and the DC ammeter reads 1½ amperes, but the indicated product of these two DC meters is not the same as before, the indicated wattage now being 8.25; in other words, the DC component wattage. Now is it not apparent that there is a difference between the AC and DC instrument readings that ought to be food for thought and investigation?

If we excite the field coil of the speaker from a variable source of DC power (a variable battery, or DC generator with series resistance to vary the voltage) we find that as we increase the exciting wattage from, say, ½ watt, and increase

Dynamics and Receivers

and of Applying Effective Remedies

Williams

slowly, the flux density in the air gap increases. We keep increasing the wattage until we arrive at 8.25 watts, and obtain a flux density of 3,000 lines. Then a further increase of exciting wattage results in a final flux density of 12,000 lines at 18 watts, but when the dry rectifier was furnishing 18 watts we were only getting 8.25 watt results, and a bad hum to boot. Hence there must be some connection between this wattage disparity and the hum. The explanation is that the difference in indicated wattage above given represents a measure of the hum developed.

Now the above case is a bad one. For purposes of illustration it is as truly representative of the cause of bad dynamic hum as in any other dry rectifier-operated type. Of course the remedy here is to install a new rectifier, but the wave form of the rectifier output is the underlying cause of the hum and the best way to know that you are going to effect a satisfactory repair is to select a rectifier that really rectifies, and this means one that gives absolutely no reverse current.

But all dry rectifier dynamic speaker hums are not as troublesome as I may have led you to suspect, provided you have a fairly good rectifier. The difference between the AC indicated wattage and the DC indicated wattage being of the order of not greater than 40%, the hum may be brought within reasonable bounds by some external remedial measures which consist of connecting a filter system between the rectifier and the speaker. The filter consists of a choke and a unilateral condenser, and the filtering effect is directly dependent upon the inductance of the choke.

Directions for Making Choke

You can make your own choke in a variety of ways. A satisfactory way is to buy some E iron about 3 inches outside, with a ½-inch core. This will provide a window 2½ inches by ¾-inch, which, when provided with a 1/32-inch paper insulating sleeve ½ inch square inside by 2½ inches long, and if wound with No. 20 enameled wire will be found very effective. It is connected in series with the pot and rectifier and a 2,000 mfd. unilateral condenser is connected across the rectifier, observing correct polarity of condenser connections.

For more severe cases the inductance must be increased, i.e., a larger choke used, and the simplest way to do this is to build up the 3-inch by ½-inch E iron to about 2 inches in thickness. This will make the window 2½ inches by 2 inches, and the inside dimensions of the insulating paper sleeve to wind the coil on, ½ inch by 2 inches by 2½ inches. If this space be wound full of No. 19 plain enamel wire it will be found more effective than the first one. All this is a matter of adaptability. The speaker owner can best determine about how far he needs to go along these lines to accomplish the desired results; in all cases a 2,000 mfd. unilateral condenser is used. The necessary E iron is readily obtained, being sold by the pound, and is cheap. There is a lot of 3-inch laminations in a pound, and so it is possible to remove excess hum in AC operated speakers in this fashion and do a really satisfactory job.

Other Types af Dynamics

DC operated speakers, that derive their pot magnet current from a DC generator, usually have sufficient self-contained inductance to eliminate hum due to generator ripple, but those that derive their power supply from a so-called bleeder (another name for shunt) net-work, or are excited by the plate current of the power tubes directly, or perhaps directly connected across the rectifier tube output, **before** it passes through the regular filter choke, are subject to hum due to a variety of causes.

The best plan to follow when looking for the source of a persistent hum is to see whether the power supply to the speaker field coil is smooth or not. To make this test, connect ear phones across the field coil, and if the hum is excessive you can certainly hear it, and if so shunt sufficient high voltage non-inductive fixed condenser capacity around it and if the voltage drop across the field coil is raised then connect sufficient resistance in series with it and the filter systems to reduce the field coil drain to its original value, thereby avoiding the danger of overheating the field coil.

Now, in the other case, the shunt connected field coil, the methods of approach and subsequent treatment are not at all similar, because of the complex effects introduced by the different methods of field excitation.

Where Does Hum Originate?

To make this clearer, let us assume that the field coil in this bleeder connected case has sufficient inductance, so as to preclude the speaker alone from being a source of audible hum (this condition is only assumed) this being verified by short-circuiting the speaker input. So, satisfied that this condition is met, connect the speaker input to the set output, and hear the un-wanted hum, whether the set plays or not.

Where does this hum originate? is the next logical question. Let us don a set of ear phones and go scouting. Remove the power tubes and connect the ear-phones across the output of the transformer that supplies the grids of the power tubes. If the filtration is not good a substantial hum will be heard. Next move to the input side of this transformer and disconnect the B supply lead and test separately. If a hum is heard across the transformer primary this transformer must be relocated to a point or position in which the transformer will be out of the stray field that results in the induced hum. If, however, however, the hum is not here and found across the B+ and plate lead that goes to the audio stage tube, this individual B+ supply lead must have a separate choke in series with it and the resistor tap that supplies the reduced voltage. This choke may take the form of a 1-to-3 audio transformer, connected in series, and also this added system requires at least a 1 mfd. condenser connected between the B+ supply resistor tap and the negative end of this resistor or ground (when the negative end is grounded). This change will be found very effective and the slight drop in DC voltage at the plate of the tube may be compensated for by decreasing the resistance at this tap sufficiently to bring the voltage back to normal, and the hum will not be increased at all.

Phones in Power Tube Circuit

Similarly, if the phones are now connected across the power tube plate circuit and the power tube filament and also between here and power tube grid resistor tap, hum may be detected here, and the same treatment, suitably modified, may be followed out, though perhaps more than 2 mfd. of capacity may be required. It will depend on the value of the resultant hum in the plate circuit of the power tubes and this hum, though complicated in wave form if push-pull stages are used, and either the grid input mid-tap is not properly centered or the power tubes may vary slightly, causing the apparent effect of more hum from one tube than another. The effect of the "all over" hum may now be tested and it will be found very much reduced, and a little further adjustment along the lines previously recorded will result in virtual removal of hum from the output of your electric set.

The troublesome subject of hum while causing considerable worry to those who design and build sets and speakers for home use is not quite such an acute problem in the theatre speaker—at least in the cases of our present installations. Here a moderate amount of hum is unnoticable from the front orchestra seats—and of course the size and type of baffle used—and the volume of the auditorium air-column do not tend to emphasize it as the smaller radio set cabinet baffles do. Hence **extreme** care in this detail is unnecessary.

Theatre dynamics are designed with a view to increasing the audio frequency range as more nearly perfect realism is thereby obtained, and with the arrival of the specially constructed sound theatre an even greater degree of realism will be obtained, and one other highly desirable feature in connection with theatre speaker design is that the engineer has considerably more latitude and can express his individuality of design in the matter of special speakers for special purposes to real advantage, as compared to the speaker that has to reproduce both voice and music and do a good job of both, an obvious impossibility.

Some time ago the writer was asked whether in his opinion the dynamic speaker was the ultimate idea in sound reproduction instruments, or whether it could be improved upon, citing the then commercially new Oscilloplane type of instrument.

Too Quickly Marketed

It has always been my idea that certain electrical developments pertaining to the radio art are marketed too quickly for their own possibilities, and therefore my reply was that dynamic speakers of all types will be subject to increasing improvement and will be more widely used in large installations as the market develops, because they are of sturdy construction and are not as subject to weather vagaries as is the Oscilloplane type, which would be very unsuitable for this class of work generally—especially on an outdoor job.

The home, or domestic type of cabinet dynamic speaker will doubtless undergo quite a few changes before development in that line stops.

Wiring the De Lu

Heavy-Duty Device Will Power Filaments,

By

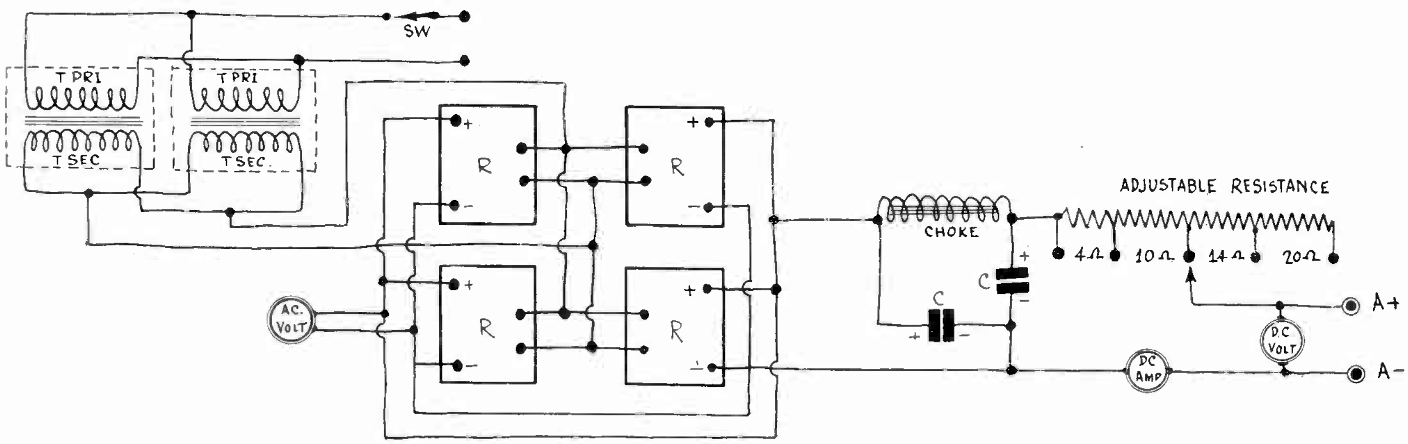


FIG. 1
SCHEMATIC DIAGRAM OF CONNECTIONS, SHOWING HOW AC VOLTMETER IS CONNECTED TO INDICATE PULSATING DC COMPONENT.

THE high lights of performance of the de luxe A eliminator described in part last week are: No audible hum up to 45 watts DC load, i.e., 9 volts and 5 amperes or any other combination of amperes and DC volts with product at 45. This eliminator therefore provides ample DC wattage output for a wide variety of uses.

It has three indicating meters that show the exact load conditions within the power pack, and the wattage input to the load circuit also.

Simple to Assemble

The assembly of this device is a very simple matter if ordinary care is observed. Of principal importance to the builder is the fact that if the unilateral condensers (U) are **not** correctly connected they may be ruined quickly.

When the parts are at hand the first necessary steps are to spot and drill the various bolt holes for the special Polo choke, the two Kuprox rectifier units, and unilateral condensers. These are first firmly attached in position on the removable base of the steel cabinet, which is drilled in such a way that the side clamping screw holes line up only one way. So now with the cabinet end that carries the bakelite slotted strip facing you, place the Polo choke in the far left-hand corner with its widest axis parallel to the rear of the cabinet. Then in the right-hand side there will be just enough room for the two unilateral condensers. These are situated in an upright position with the red and black leads coming out on top.

Rectifier Mounting

The two double Kuprox units are next placed in, as the picture plainly shows, so that the AC input leads are at the right and the DC output leads are at the left. Then with the base holding screws removed the cabinet may now be removed, leaving the parts that are to be attached to the base in their approximately correct positions. The places for the holes may be marked out with a pencil and drilled.

The holes for the three meters are laid out on a triangular pattern—the center of the lowest meter hole (for the AC voltmeter) is the intersection of a vertical center line, and a horizontal line drawn parallel to the bottom face. The finished diameter of this hole is 2⅛ inches. The other two holes are of the same finished diameter and their centers are 2¼ inches either side of the center vertical line drawn in pencil down the front face of the cabinet. The intersecting axis, or horizontal line on which the centers of the DC ammeter and DC voltmeter are is 4¾ inches from the bottom of the front face of the cabinet. The best way to "cut" these holes out is to drill a lot of 1-16-inch holes just inside the 2⅛-inch diameter so that they are very close together. When this is finished the knockouts that are formed are easily removable.

Meters Put in Place

The meters are mounted now. The AC voltmeter at the bottom center is mounted first and clamped in place by the clamping ring furnished. Next the DC ammeter is mounted in the upper left-hand hole. The DC voltmeter is mounted in the remaining hole. All meters now are clamped securely. We next mount the 5 tip-jacks in the slotted bakelite strip, spacing them as the photograph shows. Next the insulated binding posts are mounted (both must be insulated from the box, to avoid danger to the meters or rectifiers due to short circuit). The negative terminal at the left is directly over the ammeter and the positive terminal at the right is directly over the low-range DC load voltmeter.

The five tip jacks are the points of connection for a variety of voltages obtainable by means of the resistance values given. These voltages are available at the regular terminals by merely shifting the movable pin jack attached to the red-with-black-tracer lead shown, the tap nearest the negative terminal providing the minimum voltage output and the tap nearest to

LIST OF PARTS

One steel cabinet, 8½x11¼x8¼ inches.
Two Step-down Transformers, 110 v AC to 20 v.
One Polo Special choke.
Two 2,000 mfd. unilateral condensers.
Four 16-Disc Kuprox Rectifiers. (2 double units)
One 0-140 AC Voltmeter.
One 0-10 DC ammeter.
Five tip jacks.
One binding post (marked +).
One binding post (marked —).
One AC follow-through switch.
15 feet double braid lamp cord and plug.
One pin plug.
Five feet red insulated wire.
Five feet blue insulated wire.
One roll friction tape (small roll).
One roll wire solder, bux core.
Twenty 6-32x¾-in. round head iron machine screws and ¼in.x6-32 iron hex nuts.
1 small box 6-32 size lock washers.

Right o

QUESTIONS

(1)—Microphonic noises in tubes present one of the greatest problems in the design of automobile receivers.
(2)—The most successful tubes for automobile sets are those of the heater type, in which the cathode is indirectly heated.
(3)—The more sensitive a receiver is the more selective it must be in order to give satisfactory performance.
(4)—There is only one way in which the four terminals of an oscillator coil can be connected in order to produce oscillation in the circuit.

ANSWERS

(1)—Right. Microphonic noises are due to relative movements between the elements of the tube caused by vibrations of the

xe A Eliminator

No Matter If Set Has Twenty Tubes

William John

the positive terminal being the maximum output connection, for any given load.

Final Task

Now, the final job is to mount the two power input transformers on the inside of the cabinet wall so that they will be directly over the big Polo choke and as close together as possible; indeed, touching. The heavy rubber-covered leads are to extend **downward.**

Measuring from the upper edge of the cabinet, with the cover removed, draw one parallel line, 1⅜ inches down from the top edge, and another 3 1-16 inches down from the top edge of cabinet and parallel to it, and place the two transformers so that these pencil lines pass through the centers of the transformer base screw holes. Simply mark them and drill eight holes to pass 6-32 machine screws.

The transformer primaries are connected so that the external magnetic field surrounding the cores is as small as possible. This is done by trying first one connection scheme, and then reversing connections to one of the transformers. A piece of thin sheet iron held near the 8-32 brass screw that clamps the transformer covers will vibrate violently if the primaries are connected in the wrong parallel way, and hardly at all if they are connected in phase.

The secondary leads, which will be found to be quite long, are to be braided closely. Four leads are to be so braided and finally connected in parallel and made ready to be soldered to the AC input terminals of the two Kuprox units.

Now the two Kuprox units are connected in the following manner.

On the DC output side connect the two positive terminals together. Then connect to one or the other positive junction one of the heavy rubber covered leads from the Polo special choke. To the other choke lead, attach and solder a piece of the red colored wire, leaving a lead about 14 inches in length. Then connect the two negative terminals together, using the blue colored wire and leave a lead of about 14 inches. Then connect the two black leads from the unilateral condensers coming from the top of each to the negative DC terminals of the Kuprox rectifier. The two red leads that come from the tops of the unilateral condensers go to the choke, one to the choke connection on the rectifier positive, and the other to the junction of the other choke lead and the red wire. This joint is now soldered and taped. Next the AC terminals are connected in parallel and the ends of the braided transformer secondary leads are now connected.

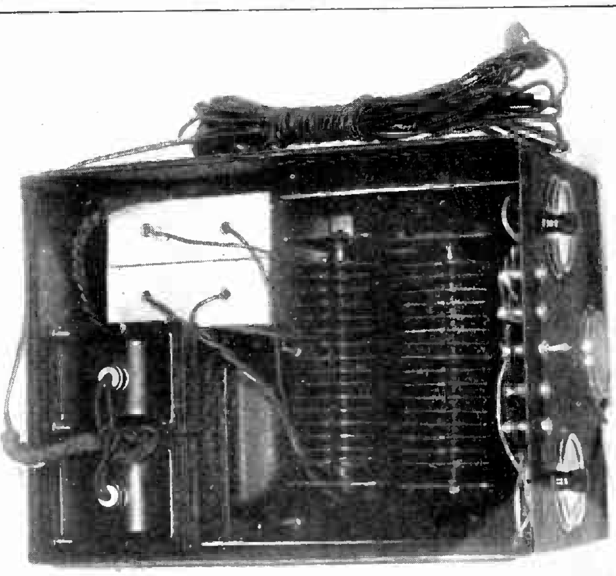
Next the terminals of the lowest meter (the AC voltmeter) are connected (using the red wire) to the DC output terminals of the rectifier and the cabinet is now slipped over and the base holding screws are put in and screwed down tightly.

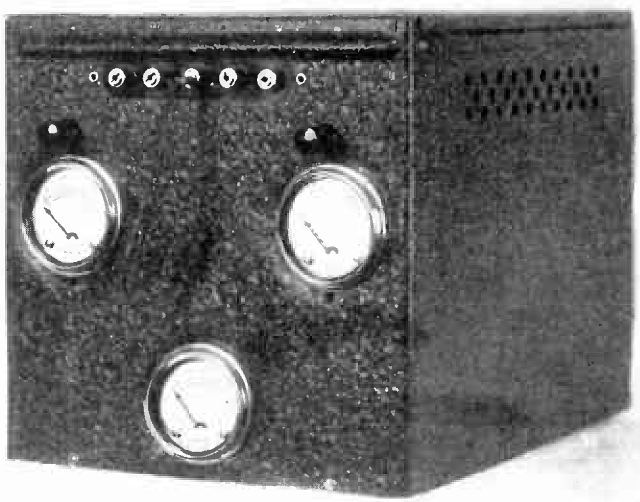
Observe Polarities

Then we continue, attaching the blue wire to ammeter positive post, and the ammeter negative goes to the A minus terminal post, completing that circuit, and the red wire that is still loose is connected to the pin-plug nearest to the positive binding post—then from this point the 48-ohm divided resistance is connected so that we begin with 20-ohm, then 14-ohm, then 10-ohm and finally 4-ohm, and a short length of red wire knotted on both sides of a hole drilled through the cabinet and attached to the **positive** terminal on the cabinet, and the other end of this red wire carries a phone tip to connect in the most suitable resistor value. The terminals of the load **DC voltmeter** are connected, observing polarity, to A— and A+ (the adjustable red wire lead), and with the lamp cord and plug and switch being already assembled, the eliminator is ready for use.

If the constructor wants to use this device as a low power source, for any purpose, merely connect a suitable resistor between A+ and A— and plug in on the pin jacks for the desired low power. The value of this resistor may be anything from 2 to 10 ohms. Also, this device will charge batteries. Provided the load does **not** exceed 3 amps the device may be used **continuously.** Overloads are only harmful if the overload period is too extended.

When you have completed this A eliminator you will have one that will last indefinitely, be hum-free and stand a terrific load, even working several receivers at a time, using quarter-ampere filament tubes. Theoretically it will stand more than a hundred such tubes, but it is conservatively suggested that no more than twenty tubes be used at a time.





FIGS. 2 AND 3

TOP ILLUSTRATION IS OF LAYOUT OF PARTS. NOTE PARTICULARLY THAT TRANSFORMERS ON TOP AT THE LOWER LEFT ARE VERY CLOSE TOGETHER. THE SPECIAL FILTER CHOKE IS DIRECTLY UNDERNEATH THEM, THE DC SIDE OF RECTIFIERS IS AT THE LOWER SIDE. BELOW, FRONT VIEW SHOWS THE LOCATION OF INDICATING METERS. THE DC AMMETER IS AT THE UPPER LEFT, THE AC VOLTMETER IS THE LOWER CENTER INSTRUMENT, AND THE DC LOAD VOLTMETER IS AT THE UPPER RIGHT. A— IS DIRECTLY OVER THE AMMETER, AND A+ IS OVER THE VOLTMETER.

r Wrong?

tube support. In an automobile engine vibrations and road knocks are transmitted to the tube, causing a high microphonic effect.

(2)—Right. These are successful because they are more rugged than other tubes and thus less subject to vibrations. Tubes of the 99 and 222 types are the least suitable for automobile use because their filaments vibrate easily.

(3)—Right. The more sensitive a receiver is the more distant stations will be tuned in, and the greater will the off-resonance signals from local stations be in comparison. Hence in order to bring in the weak distant stations and exclude the signals from the locals the greater the selectivity must be.

(4)—Wrong. There are two ways. In all there are four possible ways of connecting the four terminals. Two of these ways are right and two wrong.

Resolved, That Push-Pull Is

AFFIRM

By A. C.

THERE is no question that radio listeners are "sold" on push-pull amplification. Few of them, indeed, will have anything else in a commercial receiver. But there is a question as to the reason why the fans prefer this form of amplification. Do they prefer it because they appreciate the superior quality, or because it is in vogue? Although we contend that best quality can be obtained only with push-pull amplification we are willing to admit that preference is predicated more on vogue than on perception or on appreciation of differences.

Volume Increase Small

The superiority of push-pull amplification is not always evident, or more properly, it is not always audible. It is for that reason that many fans who have just changed from single-sided ampification to push-pull complain that push-pull does not give any better quality and no more quantity. Why, they say, if I take out one tube out of the push-pull stage the set plays just as well, gives just as good quality and just as much volume. If we make due allowance for the flexibility of the "just as good," that is just what should be expected. So many meanings may be attached to "just as good" that it does not mean anything. Certainly, in this case it does not mean that the volume is the same and that the quality is as good when one tube is used in a circuit designed for the use of two. It is quite possible, though, that appearances will favor the "just as" conclusion.

The volume increase resulting from two tubes in push-pull is so small that most ears cannot tell the difference unless that change is made quickly from one to the other. The time it takes to take tube out or to put it in is sufficient to allow the ears to forget. And even when the change is made with a switch which operates quickly, the difference is so small that it takes keen ears to notice it. Measurements have shown that the difference is about three decibels. One decibel is about the smallest difference that can be detected with the ears. The fan who makes the change expects a volume difference of 30 decibels at least.

If the increase in volume is so small as to be scarcely appreciable what is the use of having push-pull amplification? There would be no use at all if volume difference were the only criterion. It would be by far better to put the two tubes in tandem rather than in push-pull. Now if volume is not the reason for using push-pull, what is the reason? Is not increased volume the big appeal in push-pull? Popularly yes, technically not.

One of the reasons for using push-pull is a greater volume capability. The difference between volume and volume capability is the same as the difference between speed of a car and the capability of speed of that car. Just because a car can step out at a 75 mile clip is no reason why it should be driven any faster than another car having a speed capability of 25 miles. The difference is also the same as the difference between the lifting capabilities of a man and a boy. Both might lift a pound weight, but that is not necessarily the limit of either. The boy might try to lift a hundred-weight and fail, while the man could lift it without much difficulty, because his lifting capability is greater than that of the boy. It is obvious that the volume capability of two equal tubes is greater than that of one, just as the pulling capability of two equal horses is greater than that of one.

Volume Capability

The volume capability, for a certain per cent. of distortion, of a tube like the 171A, is 710 milliwatts. At that rate the volume capability of two of these tubes, in parallel, should be 1,420 milliwatts. And that is correct provided they have been loaded up properly. But when these same tubes have been connected in push-pull, the volume capability of the pair is four times that of one alone. The reason for this is that the tubes are so connected that the distortion in one is balanced out by the other, that is, the even order harmonic distortion, such as the second, the fourth, harmonics, and so on. The odd harmonics are not balanced out and it is largely the third harmonic which limits the volume capability of the push-pull amplifier.

If the tubes are not alike, or if they are not operated under similar conditions, all of the even order harmonic distortion is not balanced out, but then the circuit is not truly push-pull.

The Advantage

While the volume of capability of two equal tubes in push-pull is four times as great as that of a single tube it does not mean that the output of the push-pull stage will be any greater than that given by a single tube, or of two in parallel. It simply means that the tubes will handle four times as much volume as a single tube if they are asked to do so. The asking in this case is simply turning up the amplification ahead of the tubes,

NEGA

By Edward

THE only argument in favor of push-pull amplification is that most people want it. But why do they want it? Because people have been led to believe that this form of amplification will give greater volume, because they have been led to believe that in some manner the quality from such amplifiers is superior, because the next-door neighbor has an outfit with push-pull amplification.

Not one fan in a thousand who boast about the unparelleled quality of their push-pull outfits would be able to tell the difference between push-pull amplification and single-sided amplification. Nay, not one in ten thousand could tell the difference. We are not contending that the quality from the push-pull amplifier is not better, for it is, but we are maintaining that the difference is so small that it cannot be discerned by the human ears. This fact is easily demonstrated. Set up two transformer coupled amplifiers and adjust the volume so that both give the same and well within the overloading point of one of the tubes. Then switch from one to the other rapidly and ask a large number of people which comes from the push-pull and which from the single-sided amplifier. Fifty guesses will be right and fifty will be wrong, which shows that they are based on pure guessing. There may be a small percentage in favor of the right guess. for a small number of the guessers may be familiar with the peculiarities of both types. But this number will be small, for some, knowing that better quality should be expected from push-pull and liking the single quality better, will guess the wrong way.

When Waves Break

The only time when push-pull is noticeably better is when extremely low tones are reproduced in full volume. Low tones are extremely rare in the output of a transformer coupled amplifier for in most instances they have been attenuated so greatly that they are not strong enough to overload a 171A tube, let alone the tubes now used in the output stage.

No greater volume is obtained from a push-pull stage than from a single-tube output stage, as is easily demonstrated. Many fans who have push-pull receivers have satisfied themselves on this point and they regularly use only one. And they invariably say that they get just as good quality with one. Then why use push-pull? More volume and better quality are the two main arguments for using it.

There may possibly be a noticeable difference when the last stage is forced to the limit. But when is there any reasonable cause for doing that? Certainly one tube can give all the volume, without appreciable distortion, to give satisfactory service in any home. The day is past when every one tried to entertain the neighbors with something they did not want. There is no longer any tendency to turn the radio set up, but rather to turn it down. When a speaker is before the microphone everybody wants his voice to be reproduced in natural volume, which is low, usually conversational, volume. When an orchestra is before the microphone everybody wonts the reproduced music to be a pleasant background to the conversation in the home. "Turn down that set," is a command one hears everywhere and many times during an evening. "Miniature music" is the desire today. One tube can handle all that anybody wants these days.

No Excuse

What excuse is there for having push-pull for volume when nobody wants volume? None. What excuse is there fore having push-pull for quality when nobody can tell the difference? None. There is no more excuse for installing a 250 push-pull stage in the home than there is for putting a symphony orchestra there.

One of the strong arguments in favor of single-side amplification which the protagonists of push-pull are glad to ignore is that resistance coupling cannot be used successfully with it. Admittedly, resistance coupling gives the best quality in that

Necessary for Best Quality

ATIVE

W. Gordon

either in the radio frequency level or in the audio frequency level.

The question then reduces to whether it is worth while to use tubes in push-pull in order to increase the volume capability in the ratio of four-to-one. It seems there can be no doubt about the answer, especially when the receiver is equipped with a dynamic speaker which can handle a great deal of volume and when the amplifier and the speaker are such as to be effective on the low notes. If the receiver can only handle high notes, those above 100 cycles per second, there is very little need for having push-pull, nor even for having a power tube in the last stage. It is on the very low notes where a high volume capability is needed.

That puts another limitation on the case. Are the notes below 100 cycles per second needed to make the reproduction realistic? Of course they are. Reprodution without the low notes in full strength, as low as 30 cycles per second, is no reproduction at all, it is only a misrepresentation of the original program. There is scarcely any need to argue for the necessity of low notes because nearly everybody is "sold" on them.

It will be recalled that push-pull amplification came into the radio industry about the same time as dynamic speakers. Dynamic speakers were brought out to get better quality, and particularly better response in the bass. In order to bring out the low notes without distortion and thus to justify the use of dynamic speakers, push-pull amplifiers were brought out, for only they could handle the volume when practical and economical tubes were used.

Choice of Power Tubes

It may be argued that instead of using two 171A tubes in push-pull just as good results could be obtained by using a single 245. The maximum undistorted output of two 171A tubes in push-pull is about 2.84 watts. That of a single 245 is 1.6 watts. Thus a greater undistorted output can be obtained from two 171A tubes in push-pull than from one 245. The plate power requirements for these outputs are favorable to the 171A tubes because the plate power for the push-pull tubes is 8.8 watts and that of the 245 is 9.6 watts.

But instead of using one 245 could we not do better by using one 250? This has a maximum undistorted output of 4.65 watts. That is considerably greater than the output of two 171A tubes. But what do we have to pay for the extra output? First, the 250 costs more than two 171A tubes. Second, the filament power is 9.4 watts against 2.5 watts for the 171A tubes. Third, the plate power of the 250 is 29.4 watts as against 8.8 watts for the 171A tubes. Fourth, all the associated apparatus for the 250 tubes must be larger and more expensive, and this is the strongest point against the use of this tube.

If more volume capability than the 171A push-pull amplifier affords is needed it is better to use two 245 tubes in push-pull than to use one 250. The maximum undistorted output of such an amplifier is about 6.4 watts as against 4.65 watts for the 250.

From every point of view it is better to use two tubes in push-pull than to use one in a single-sided amplifier. The quality is better at any given volume, the volume capability for a given amount of distortion is greater, the efficiency of the plate and filament circuits is greater, the associated equipment such as filter chokes, filter condensers, power transformers, and rectifier tubes is less expensive and less bulky.

Use Large Tubes

This is not to be taken as an argument in favor of small tubes in the output stage, for the larger the tubes the greater the volume capability and the less the distortion will be for any given volume. But it is an argument in favor of using push-pull amplification whatever tubes are used in the final stage. For a given output volume, however large or small it may be, and for a given type of tube, the distortion will be much less in a push-pull amplifier than in a single-sided one. What we want is reproduction with the least amount of distortion, and the way to get it is to use push-pull amplification.

In view of the fact that distortion creeps into the signal in all the audio tubes, and also in view of the fact that the final push-pull stage does not eliminate any of the distortion arising in the tubes ahead of that stage, it is advantageous to use push-pull in every audio stage. However, when the signal level is low, as it usually is in the earlier audio stages, the per cent distortion is much smaller than when the signal level is high. For that reason no appreciable gain in purity is obtained by making the earlier stages push-pull. When the output stage comprises two 250 tubes, however, the gain may be sufficient to warrant the use of 112A or 227 tubes in push-pull in the stage preceding the power stage, the output stage may require a signal voltage so high that a single tube ahead would be overloaded at times.

TIVE

Spencer Haas

it amplifies all the frequencies, from the lowest to the highest in the audible range, in practically the same degree. This is one of the first requisites for a realistic quality. When push-pull is used transformers must also be used, and transformers, no matter how good, do not permit equal amplification over the entire audio scale. Some frequencies will be suppressed, others will be accentuated.

This inequality of the amplification leads to turning up the volume so that the output on the body-carrying notes will be satisfactory. This in turn results in overloading on those frequencies where the system accentuates. Overloading and amplitude distortion on these frequencies follow of necessity. Of course, the push-pull system is such that the effect of this overloading is somewhat diminished, but it can be heard just the same, because that kind of distortion is the most easily recognized because it is the most unpleasant. Then why have push-pull just so that the distortion which transformer coupling introduces may be minimized a little? Why not use resistance coupling and get the best quality there is? Why not avoid distortion entirely?

Tolerable Distortion

The maximum undistorted output of a tube is taken arbitrarily as that which, when the tube is properly loaded, gives a second harmonic distortion of 5 per cent. This does not mean that a greater volume than this cannot be obtained from the tubes without a great deal of distortion. The output may be raised until the second harmonic distortion is as high as 15 per cent before the distortion can be appreciated. The reason for this is probably that the distortion is harmonic, that is, not dissonant.

Since distortion of even this amount is only likely on the extremely low notes, which are only sounded at rare intervals, there does not seem to be ony valid reason for providing an amplifying system for the home that will handle all the notes with concert-hall volume.

Much more serious distortion can be introduced into the signal by improper grid bias and plate voltage and filament current than by using single-sided amplification in the output stage, and it is more than likely that when noticeable distortion is present one or more of the voltages cited are improperly adjusted. A push-pull stage will not help in this case at all.

Push-pull Effectiveness

The effectiveness of push-pull is in eliminating even order harmonics is only so good as the balance of the circuit, that is equality of the tubes and tube adjustments and the correct division of the voltage impressed on the grids and the loading of the tubes. It is a well-known fact that no two tubes are alike even if they do have the same code number on them. For this reason the push-pull action is not complete, and it may be that advantage of push-pull is entirely imaginary.

Not only are the tubes disimilar but the signal voltages impressed on the grids are different. The so-called center tap on the secondary of the input transformer may be displaced from the center by a considerable percentage. This adds unbalance at all frequencies. Then, again, the capacity between one grid terminal and ground may be different from that between the other grid terminal and ground. This adds unbalance at the high frequencies. Very few push-pull transformers are balanced with respect to capacity between its grid terminals and ground. The action of a single-sided amplifier does not depend on exact balance. It is simply operated within limits where balance is of no importance.

What holds true of the push-pull input transformer also holds true for the output transformer, although the effects may be relatively less.

Distortion by Transients

Time Constant of Circuit Determines Interference Duration

By Edgar B. Barter

REFERENCE is frequently made in radio to transients and to time constants. What are they? A transient is a current or voltage which lasts only a short time. For example, a crash of static gives the tuned circuits an impulse and a current flow as a result of it for a very short time. It starts with a high value and dies out quickly. While this current lasts the tuned circuit oscillates freely at its natural frequency. When a current is stopped or started transients also appear. Also, when the signal strength varies suddenly either because of a change in the carrier power or because of a change in the degree of modulation, transients appear in the same way. Again, when either the carrier or the modulation frequency changes the effect occurs.

Nature is replete with transient effects. Pluck or strike a piano string and the string vibrates for a while. Strike the pan of a spring balance or suddenly remove a weight that has lain on it and the pan vibrates up and down a few moments. Strike almost anything rigid a sharp blow and that object vibrates, as is evidenced by the sound that is heard. All these are transient effects, for the vibration starts with a large amplitude and quickly dies out. These vibrations are all at the free natural period of the vibrator.

Free and Forced Vibrations

The sound from a violin produced by the bow, or that from an organ, is not a transient, but is forced, and is due to a "steady state" condition. However, in these and similar cases transients occur at the beginning and the end of the continuous vibration, or when the intensity of the vibration is changed either up or down by an increase or a decrease in the force causing the continuous vibration.

There is a difference between the free and forced natural frequencies of vibration of any resonant body or circuit, the free vibration having the slightly lower frequency. The difference between these two natural frequencies of vibration is greater the larger the resistance in the electrical circuit, or the friction in the mechanical vibrator. In nearly all practical electrical tuners the resistance is so small that the difference between the two frequencies is negligible.

Spark telegraphy was carried on with transients. In the primary quenched spark was released and this induced a current in the secondary. The quenched spark simply means a spark which died out in a few vibrations. The current in the secondary was not damped nearly so much and therefore continued a comparatively long time.

The existence of transients in tuned circuits in radio receivers and transmitters leads to a certain amount of distortion. And here is where the time constant comes in, to which we referred in the opening sentence. The time constant of a circuit or other vibrator is a measure of the length of time required for a transient to down out. In terms of the resistance and the inductance in the tuning coil the time constant is $2L/R$, which is given in seconds if L is measured in henries and R in ohms.

Exponential Decrease

The decay of the transient follows all exponential law, well known in radio because of the use of exponential horns for loudspeakers. It will be noted from the above expression for the time constant that it is greater the larger the inductance of the coil and also the greater the smaller the resistance. Thus a transient lasts much longer in a tuned circuit of low resistance, or of high selectivity, than it does in a circuit of high resistance, that is, than in a broad circuit. Also it lasts longer in a circuit of high inductance than in one of low inductance.

We can easily determine from the value of the time constant how long it will take for a transient to die down to a given fraction of its original intensity. For example, how long does it take for the transient to die down to one per cent. of its initial value when the inductance of the tuned circuit is 160 microhenries and the resistance is 5 ohms? In this case the value of the time constant is 64 micro-seconds. The exponential formula for solving this problem is $\exp(-t/T) = .01$, where T is the time constant, just given for one particular circuit, and t is the time required. To simplify this equation we invert it and then take the natural logarithm of both sides. Inverting it we get $\exp(t/T) = 100$. The natural logarithm of the left hand member is just t/T and that of 100 is 4.606. Thus we obtain t by multiplying 4.606 by 64 microseconds. Hence the time required for the transient to die down to one per cent. of its initial value is 295 microseconds.

If the circuit is tuned to 1,000,000 cycles the duration of the transient would be 295 cycles. In terms of cycles at this frequency the transient lasts quite a while, but in terms of time it dies out practically instantaneously.

Suppose the transient is a change in the modulation of a carrier wave. A 10,000 cycle frequency is suddenly started with a given amplitude. The question is, how many modulation cycles will the transient last, or how many cycles will it take before the modulation is up to its final value within one per cent.¼ We just found that it lasts 295 microseconds. One cycle of the 10,000 cycle modulation lasts 100 microseconds. Thus the modulation will be complete within one per cent. in 2.95 cycles of the modulation frequency.

If the modulation frequency is only 1,000 cycles per second the transient lasts only .295 of a cycle, and if the modulation frequency is as low as 100 cycles per second the transient lasts only .0295 of a cycle of the 100 cycle frequency. Yet in all these cases, if the carrier is one megacycle per second, the transient lasts 295 cycles of the carrier.

Will transients have any marked effect on the quality? Obviously if the modulation frequency is sustained for a considerable fraction of a second there is no appreciable effect even on modulation frequencies as high as 10,000 cycles per second. If, however, it lasts only a very short time there will be some distortion at the higher modulation frequencies. This is on the assumption that the time constant is no greater than that given above. If it is much higher, as it may be in highly resonant or selective circuits, there may be considerable distortion at the higher modulation frequencies. It will also be considerable when the modulation frequencies are much higher. It is for this reason that in television transmitters and receivers broad circuits must be used, for in television the signals may be composed of sudden jumps from one intensity to another.

At every change from one intensity there is a transient, or hang-over, effect which renders changes less sudden and which obliterates detail, unless the time constant is so small that the transient effect is killed almost instantly.

Effect on Speed

The time constant is closely related to the possible speed of signaling with dots and dashes. These signals are made by making and breaking the circuit, and if they are to be reproduced as sharply as made, the time constant must be such that the currents can build up and die down almost instantaneously. If the currents persist after the circuit is broken, and if they require a long time to build up after the circuit has been made the dots will be indistinct. It becomes difficult to tell a dot from a dash. For this reason it is necessary to decrease the speed of signaling so that both the dots and the dashes will be longer. The other alternative is to make the resonant circuits less selective so that the transients lasts only a short time.

Transients do not play an important role in broadcasting because none of the resonant circuits is excessively selective. Moreover, there are not many sudden changes from one state to another. The carrier amplitude remains constant. So does the carrier frequency. Hence no transients arise from these sources. The modulation frequency may change by large amounts, but the change is usually gradual. For example, the volume may increase in the ratio of 100 to one, but not instantaneously, even though the time may be short. There are transients in the original source of sounds as well as in the electrical vibrators, and these transients are as much a part of the sound as the steady state vibration. A sound builds up, it does not jump up. There may be exceptions, of course.

Likewise the frequency of modulation may change, giving rise to transients. Music consists of systematic changes of frequency. But since the highest modulation frequency that is likely to be met will build up in a few cycles, and since frequencies of this value are of relatively little importance, transients cannot affect the quality appreciably, unless the receiver is super-selective. No doubt some of the suppression of the high notes in low IF superheterodynes of high selectivity and some of that in highly selective regenerative circuits is due to transients.

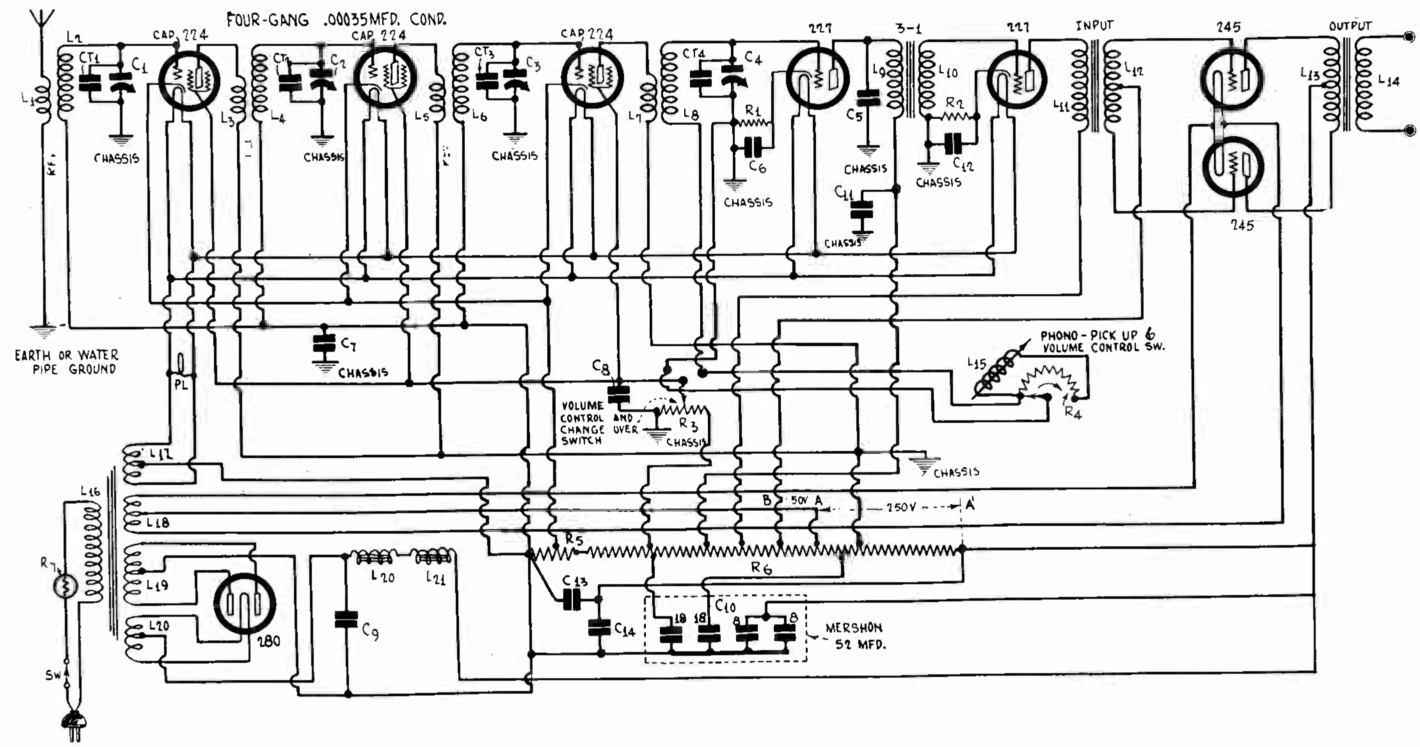
Three Types of Suppression

This suppression must not be confused with that due to the fact that the modulated wave really consists of the carrier and its side frequencies. There are in fact three sources of suppression of the high frequencies, namely, the transient effect, the side frequency suppression by detuning, and the capacity effect across the line. Of these three the first is negligible except in certain instances. The side frequency effect is usually the greatest, and is frequently the only one considered. The capacity effect may be quite great but in nearly all cases this effect can be made negligible. The first two are effects in resonant circuits and both are closely related to the resistance in the circuits. The capacity effect is mainly in the audio end of the receiver, beginning with the grid circuit of the detector.

AC Circuit Layouts

How Transformers are Located for Minimum Hum

By Manfred Kliest



THE writer has been engaged during the past three weeks at developing an improved form of four-tuned circuit receiving set. The wiring diagram herewith is the result of my desire to make the successful construction of this circuit as simple as possible, although at first blush the diagram may look complicated.

Set-builders seem prone to try to interpret a schematic diagram too literally. When such a degree of literalness is indulged in the inevitable result is that a complaint is made that the builder can't make his set work or has rebuilt the set twice or three times without improvement. On investigation of these cases which concern all varieties of receiving sets it is found that wiring errors were made all the way from wrong coil connections to upside-down connections throughout the whole set. It is hardly to be wondered at when sets, not matter how simply or otherwise laid out, won't operate when full of construction errors. Perhaps out of a total of 200 connections and 100 wires there are only two wrong connections. It is generally true that on these very two connections will hang the difference between success and failure.

The wiring of a simple radio receiver of the three circuit tuner type can serve as a sort of preliminary model, and I want to begin by saying that one of the fundamental radio receiving circuits evolved (using a triode) is this circuit and it is capable of innumerable comparative illustrations. One of these is that of two men laying out and wiring up a similar three-circuit tuner,—one will try to hurry to get his assembly complete, while the other will sit down and plan first, then lay out the parts and finally get them arranged in the manner he thinks best, then test all parts, next start to wire up the filaments, then the detector circuit, the amplifier stages (if there are to be any) and finally the RF wiring, closing with antenna-ground circuit and testing out all the way through.

Tip on Location of Parts

This general mode of procedure is to be followed also when setting up a more complicated receiver, except that after the filament circuits have been laid in the audio amplifier is best completed next in order that it may receive a preliminary test for operation and checking for excess-hum. This applies to all-electric (AC) receivers.

When you are trying to decide upon the probable location of parts in your all-electric set bear in mind that all power transformers, no matter how covered, passes an external magnetic field, and as this field is not likely to be symmetrical it is a very excellent plan to place this transformer on the steel chassis and connect it to the 110-volt line, and then with the transformer excited, try placing one of the audio transformers near it in various positions (with earphones connected to the secondary) and explore around until you find the planes in which the hum heard in the earphones ceases or is very low. This will be the best location for the audio transformers and chokes, though audio transformers are preferably located in as weak a part of the external field as possible.

In the case of the de luxe receiver diagrammed herewith, patterned after the HB44, this point for the audio input and output push-pull transformer was found right at underneath center of the sub panel and directly beneath the four-gang variable condenser. The first (3—1) audio transformer—L9—L10 is located directly under the detector socket, and its base is mounted directly at right angles to the chassis, underneath side. All constructors are merely warned not to place this transformer near any wiring that has a strong AC field.

In the de luxe chassis, two 30 henry chokes are used, and if they are correctly mounted and connected in opposing series, or mounted in opposing similar parts of the external field of the power transformer, there will be negligible pick-up hum from this source, but all these observational tests must be carefully carried out. If you build one set carefully it may be all right to rush through the next ten jobs, but I'm not saying so.

Pointers on Connections

It is on this account mainly that I have chosen to install the inductively wound 17,000 ohm voltage divider (R6) directly under the subpanel,—R_5, the variable mid-tap radio frequency cathode resistor, a humdinger, is securely soldered to the negative end as shown, and there is just enough room between the mid connection end of R_6 and the front side wall of the sub panel for the two 1 mfd. condensers C13 and C14. One is grounded directly to the wall of the chassis and the other in series goes to the common ground on the resistor R5, while the mid-tap goes directly to the high potential end of the voltage divider.

I cannot over-emphasize the importance of braiding the AC lead wires from the power transformer to points where the connections are to be made. Neat and very close braiding means that the extent of the external field around these conductors will be limited to a small area resulting in a minimum of hum pick-up, and if the builder has no circuit wire of gauge larger than 16 B&S the best way to obtain uniform voltage drop along the filament circuit is to run a separate but twisted-in feeder to the far end of the filament circuit that is fed by the 16 ampere 2.5 volt winding L17 and connect one end of the secondary to the feeder and the other secondary wire to the opposite side of the filament winding at the point of attachment closest to the transformer.

The filaments of the 245 tubes are connected in parallel by means of well-twisted leads, and are fed by transformer secondary winding L18 with mid-tap to a point A, which position is determined later. The connection to L18 is likewise made as close to the transformer as convenient.

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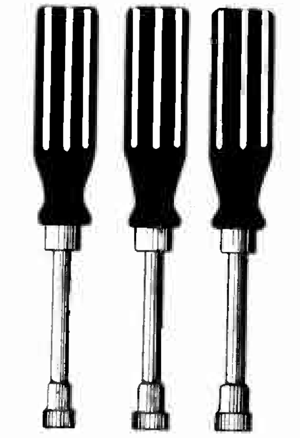

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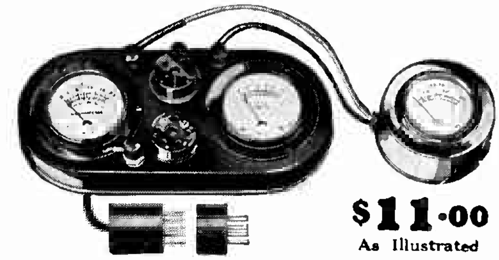

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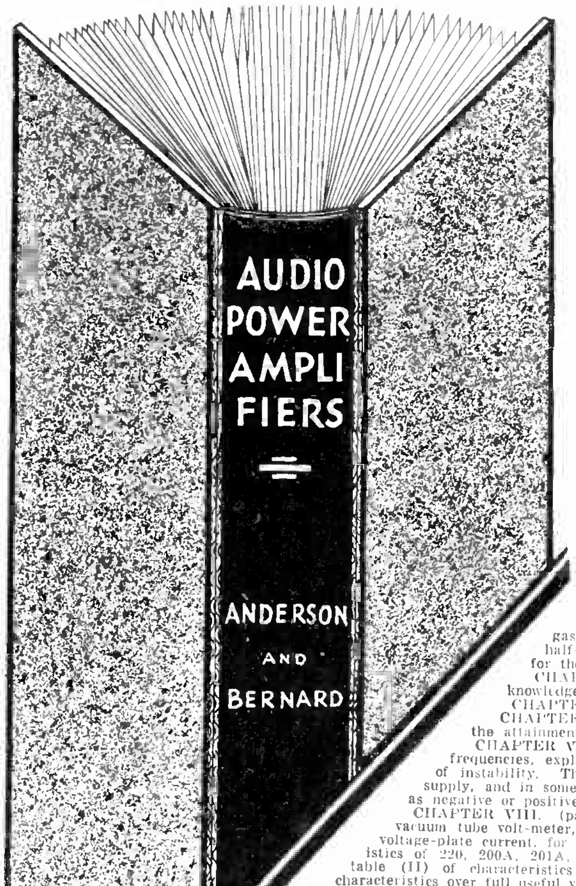

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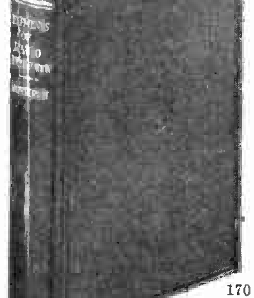

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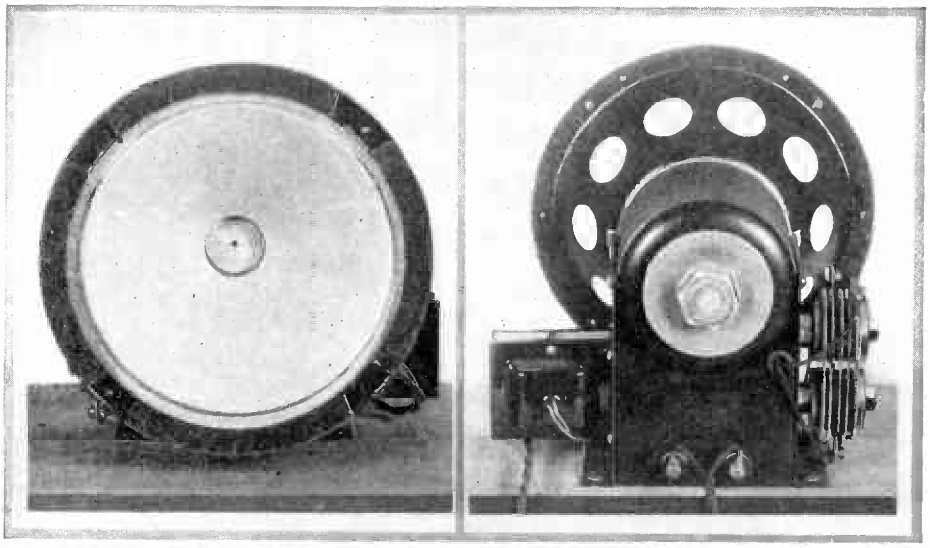

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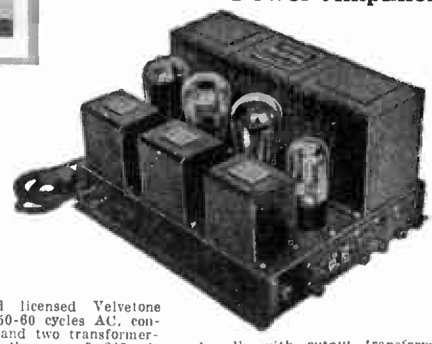

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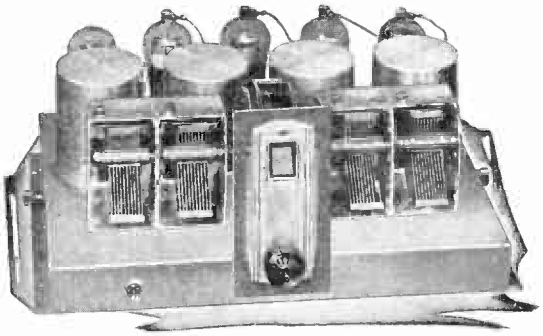

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Cigar-cigarette stand, with imitation microphone pedestal, into which is built a lighter. Press button at top and light up. 10-ft AC cable and plug. Works on AC or DC, 110 v. Order Cat. MIK-L-S, list price $2.75; net price.................. **$1.49**

O-1 milliammeter, 99% accurate; panel mount type; internal resistance, 88 ohms; used as voltmeter, with 1,000 series ohms for each volt to be read, has resistance of 1,000 ohms per volt. Order Cat. F-O-1, list price $12; net price **$5.95**

220-v Kodel "B" Supply

Kuprox B eliminator, Model 316, 220 volts DC, utilizing 280 tube, for 110 v. AC, 50-60 cycles, to deliver positive voltages of 45, 90, 135 and 180 and negative voltage of 40 for biasing 171 or 171A, also delivers 4 volts negative for other receiver tubes.

One knob on the terminal panel controls the actual voltage on the 45-volt tap and another knob controls the voltage on the 180-volt tap.

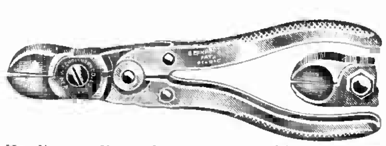
The terminal panel contains in addition to the two knobs seven binding posts for B minus, which is connected to the case, for the four positive and the two negative voltages.

It is provided with a standard plug and an 80-inch connecting cord.

The overall dimensions are: width 5⅛ inches; length, 13 inches; height, 8¼ inches. Order Cat. KO-B, list price $35, net price **$13.16**

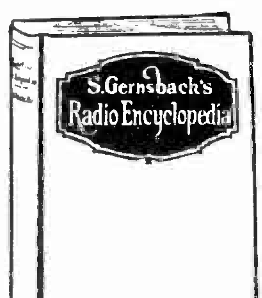
280 TUBE FREE WITH EACH KO-B

Spring Action Nipper



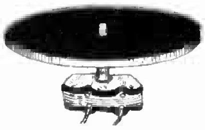
Handiest radio tool. Cuts even 8/32 machine screws. All wire, of course. Order Cat. NIP, list price $2.75; net price **$1.49**

Reference Book



Biggest bargain price of this famous encyclopedia, containing definitions of 1930 different terms. Classifies alphabetically and defines the terms used in radio. Pages 9x12 inches. 540 illustrations. Cross-indexed. Order Cat. GER-EN, list price $2.50, net price..........$1.49

Turntable Motor



Synchronous motor, for phonograph records. 80 revolutions per minute. Works on 60-cycle 110 v. AC. Smooth-running and lasts a lifetime. Fine for console installation. Turntable free with each synchronous motor order. Order Cat. SY-M, list price $20, net price...............$10.00

Service Book

The outstanding exposition of the solution of radio troubles. Just the thing for service men and experimenters. 328 pages 6x9 inches; 300 illustrations.. Order Cat. HA-TS @ $3.00

Guaranty Radio Goods Co., 143 W. 45th Street, New York, N. Y.
(Just east of Broadway)

Enclosed please find $.................... for which send me the following:

- ☐ Cat. ER-D-AC @ $12.50
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- ☐ Cat. PPPA @ $56.52
- ☐ Cat. MB-29-K @ $39.61
- ☐ Cat. MIK-L-S @ $1.49
- ☐ ER-6-V @ $9.25
- ☐ Cat. NIP, $1.49
- ☐ Cat. GER-EN, $1.49
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- ☐ Cat. HA-T-S, $3.00
- ☐ Cat. F-O-1, $5.95
- ☐ Cat. KO-B, $16.13

Canadian remittance must be by express or P. O. Money Order.
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☐ RADIO INDEX ((monthly, 12 issues) Stations, programs, etc.
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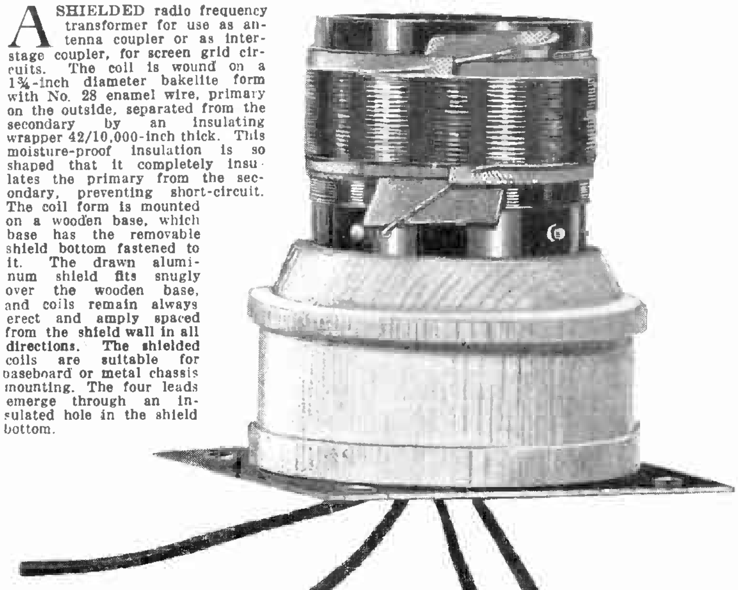
RADIO WORLD, 145 West 45th Street, New York, N. Y. (Just East of Broadway)

High-Gain Shielded Coils

A SHIELDED radio frequency transformer for use as antenna coupler or as interstage coupler, for screen grid circuits. The coil is wound on a 1¾-inch diameter bakelite form with No. 28 enamel wire, primary on the outside, separated from the secondary by an insulating wrapper 42/10,000-inch thick. This moisture-proof insulation is so shaped that it completely insulates the primary from the secondary, preventing short-circuit. The coil form is mounted on a wooden base, which base has the removable shield bottom fastened to it. The drawn aluminum shield fits snugly over the wooden base, and coils remain always erect and amply spaced from the shield wall in all directions. The shielded coils are suitable for baseboard or metal chassis mounting. The four leads emerge through an insulated hole in the shield bottom.

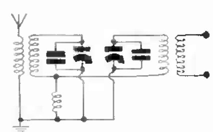


The coil comes already mounted on a shellacked wooden base, which is fastened at the factory to the shield bottom. Series A coil is illustrated.

The external appearance of the shield, with four 6/32 machine screws and nuts, which are supplied with each coil assembly.

Precisely Matched for Gang Tuning

ONE primary lead-out wire from the coil, for antenna or plate connection, has a braided tinned alloy covering over the insulation. This alloy braid shields the lead against stray pick-up when the braid alone is soldered to a ground connection. The outleads are 6 inches long and are color identified. The wire terminals of the windings themselves, and the outleads, are soldered to copper rivets. Each coil comes completely assembled inside the shield, which is 2¾ inches square at bottom (size of shield bottom) and 3¾ inches high. High impedance primaries of 40 turns are used. Secondaries have 80 turns for .00035 mfd. and 70 turns for .0005 mfd.



BP-6 is the coil at bottom.

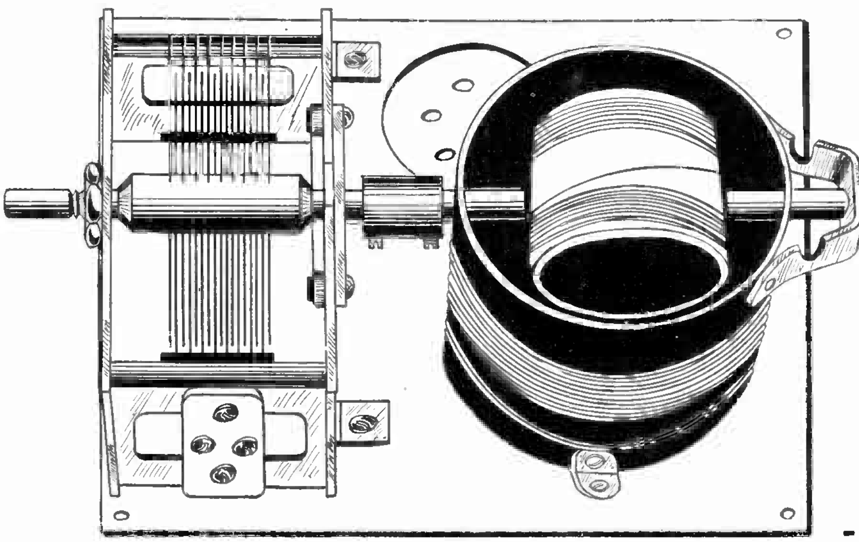
EXTREME accuracy in winding and spacing is essential for coils used in gang tuning. These coils are specially suited for gang condensers, because the inductances of all are identical for the stated size condenser. The coils are matched by a radio frequency oscillator. The color scheme is as follows: shielded wire outlead is for antenna or plate; red is for ground or B plus. (These options are due to use of the same coil for antenna coupling or interstage coupling.) Blue is for grid and yellow is for grid return. For .00035 mfd. the Cat. No. is A-40-80-S. For .0005 mfd. the Cat. No. is A-40-70-S.
Where a band pass filter circuit is used the small coupling coil to unite circuits is Cat. BP-6. The connection is illustrated herewith.

Junior Model Inductances

The Series B coils have the same inductance and the same shields as the series A coils, but the primary, instead of being wound over the secondary, with special insulation between, is wound adjoining the secondary, on the form, with ¼-inch separation, resulting in looser coupling. No wooden base is provided, as the bakelite coil form is longer, and is fastened to the shield bottom piece by means of two brackets. No outleads. Wire terminals are not soldered. Order Cat. B-SH-3 for .00035 mfd. and Cat. B-SH-5 for .0005 mfd.

Coils for Six-Circuit Tuner

Series C coils for use with six tuned circuits, as in Herman Bernard's six-circuit tuner, are wound the same as type A shielded coils, but the shields are a little larger (3 1/16-inch diameter, 3¾ inches high), and there are no shield bottoms, as a metal chassis must be used with such highly sensitive cricuits. Fasten the brackets to the shield and then, from underneath the chassis, fasten the other arm of the two brackets to the chassis. Order Cat. C-6-CT-5 for .0005 mfd. and Cat. C-6-CT-5 for .00035 mfd. Five needed for Bernard's circuit. If band pass filter coupling coil is desired order Cat. BP-6 extra.



For a stage of screen grid RF, either for battery type tube, 222, or AC, 224, followed by a grid-leak-condenser detector, no shielding is needed, and higher per-stage amplification is attainable and useful. This extra-high per-stage gain, not practical where more than one RF stage is used, is easily obtained by using dynamic tuners. Two assemblies are needed. These are furnished with condensers erected on a socketed aluminum base. Each coil has its tuned winding divided into a fixed and a moving segment. The moving coil, actuated by the condenser shaft itself, acts as a variometer, which bucks the fixed winding at the low wavelengths and aids it at the high wavelengths, thus being self-neutralizing and maintaining an even degree of extra-high amplification throughout the broadcast scale.

Two assemblies are needed. For AC operation (224 RF and 224 or 227 detector), use Cat. BT-L-AC and BT-R-AC. For battery or A eliminator operation (222 RF and any tube as detector), use Cat. BT-L-DC and BT-R-DC.

BT-L for the antenna stage and BT-R for the detector input. BT-L consists of a small primary, with suitable secondary for the .00035 mfd. condenser supplied. BT-R has two effective coils: the tuned combination winding in the RF plate circuit, the inside fixed winding in the detector grid circuit.
The moving coils must be "matched." This is done as follows: Turn the condensers until plates are fully enmeshed, and have the moving coils parallel with the fixed winding. Tune in the highest wavelength station receivable—above 450 meters surely. Now turn the moving coils half way round and retune to bring in the station. The setting that represents the use of lesser capacity of the condenser to bring in that station is the correct one. If gang tuning is used, put a 20-100 mmfd. equalizing condenser across the secondary in the antenna circuit and adjust the equalizer for a low wavelength (300 meters or less).

Screen Grid Coil Co., 143 West 45th Street, New York (Just East of Broadway):

Enclosed please find $........... (Canadian must be express or P. O. Money Order), for which send me prepaid the following:

☐ A-40-80-S, each .... $2.25 ☐ B-SH-3, each $1.00
☐ Matched set of four A-40-80-S........ 10.00 ☐ Matched set of four B-SH-3........... 4.00
☐ A-40-70-S, each .... 2.25 ☐ B-SH-5, each 1.00
☐ Matched set of four A-40-70-S........ 10.00 ☐ Matched set of four B-SH-5........... 4.00
☐ BT-L-AC and BT-R-AC, assembled, with condenser, link, socket and base, per pair....... 6.00
☐ BT-L-DC and BT-R-DC assembled, with condenser, link, socket, base, per pair.......... 6.00
☐ C-6-CT-5, .0005 mfd. shielded coil for six-circuit tuner.......................each $2.25
☐ C-6-CT-3, .00035 mfd. shielded coil for six-circuit tuner.......................each $2.25
☐ BP-6 .... .50
☐ EQ-100, equalizer of 20-100 mfd. capacity, made by Hammarlund........................ .35
(Note: All coils come with shields, except BP-6 and BT-L.)

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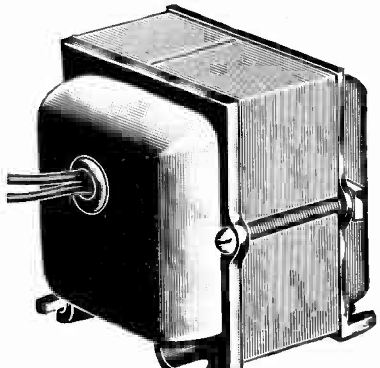
CITY.. STATE..

☐ If ordering C.O.D. put cross here. Post office fee will be added to prices quoted.

New Polo Power Transformers and Chokes

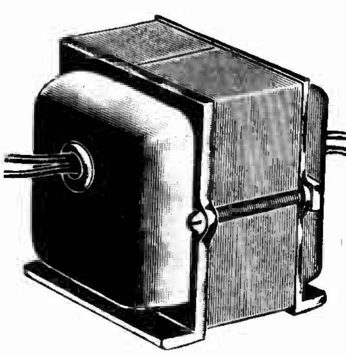


Shielded single choke, 200 ohms D.C. resistance, non-saturable at 100 milliamperes, with two black outleads, each 6 inches long. For filtration of B supplies. Inductance, 30 henrys.
Cat. SH-S-CH, price $5.00

The shielded single choke will pass 100 ma. One will suffice if the current is 100 ma. or less, for filtration of B supplies, provided the capacity at the filter output is 8 mfd. or more. Use two such shielded chokes if less than 8 mfd. is used at the filter output, Also, the shielded single choke may be used as in the power tube circuit for an output filter. In this connection use at least 2 mfd. for the capacity section of the filtered speaker output. Order Cat. SH-S-CH @ $5.00

The shielded double choke may be used for filtration where the B current is 60 ma. or less, with relatively small filter capacities, no less than 4 mfd. at the output, however. This choke consists of one winding, center-tapped. Its use is especially recommended for 171, 171A, 245 or 210 push-pull output. Connect the black leads (extremes of windings) to plates of the push-pull tubes, red center tap to B plus, and the speaker may be connected directly to plates without any direct current, but only signal current, flowing through the speaker. This system is applicable only to push-pull. Order Cat. SH-D-CH @ $6.00

In the same type of case a 20-volt secondary filament transformer, for 110 volts, 50-133 cycle, may be obtained for use in conjunction with dry rectifiers, such as Kuprox, Westinghouse, Benwood-Linze and Elkon, in dynamic speakers or A battery eliminators. Not made for 25 or 40 cycles. Order Cat. SH-F-20 @ $2.50



Twenty-volt filament transformer, 110 v. 50-133 cycle input, for use in conjunction with dry rectifiers. It will pass 2.25 amperes.

In a different type case, square, of cadmium plated steel with four mounting screws built in, size 4½ inches wide by 3¾ inches high by 4 inches front to back, a 50-60 cycle filament transformer is obtainable with the same windings as the 245 power transformer, except that the high voltage secondary is omitted. Order Cat. 245-FIL @ $4.50
For 40 cycles order Cat. 245-FIL-40 @ 7.00
For 25 cycles order Cat. 245-FIL-25 @ 8.50
[Any of the above three in the same case as the 245 power transformer, © $1.00 extra. Add PTC after the Cat. number.]

A single choke, unshielded, 65 ma rating, 30 henrys inductance, for B filtration or single output filter of speaker, is our Cat. US-S-CH @ $1.25

Polo Engineering Laboratories, 143 West 45th St., New York, N. Y.

Enclosed please find $——— for which ship at once:

☐ Cat. 245-PT @...$8.50	☐ Cat. 245-FIL @..$4.50
☐ Cat. 245-PT-40 @ 9.50	☐ Cat. 245-FIL-40 @ 7.00
☐ Cat. 245-PT-25 @ 12.00	☐ Cat. 245-FIL-25 @ 8.50
☐ Cat. SH-S-CH @ 5.00	☐ Cat. SH-F-20 @. 2.50
☐ Cat. SH-D-CH- @ 6.00	☐ Cat. UN-S-CH @. 1.25
☐ F-2.5-D @ 3.75	

Note: Canadian remittance must be by post office or express money order.

☐ If C.O.D. shipment is desired, put cross here. No C.O.D. on 25 and 40 cycle apparatus. For these full remittance must accompany order. The 25 and 40 cycle apparatus bears the 50-60-cycle label, but you will get actually what you order.

Name ....

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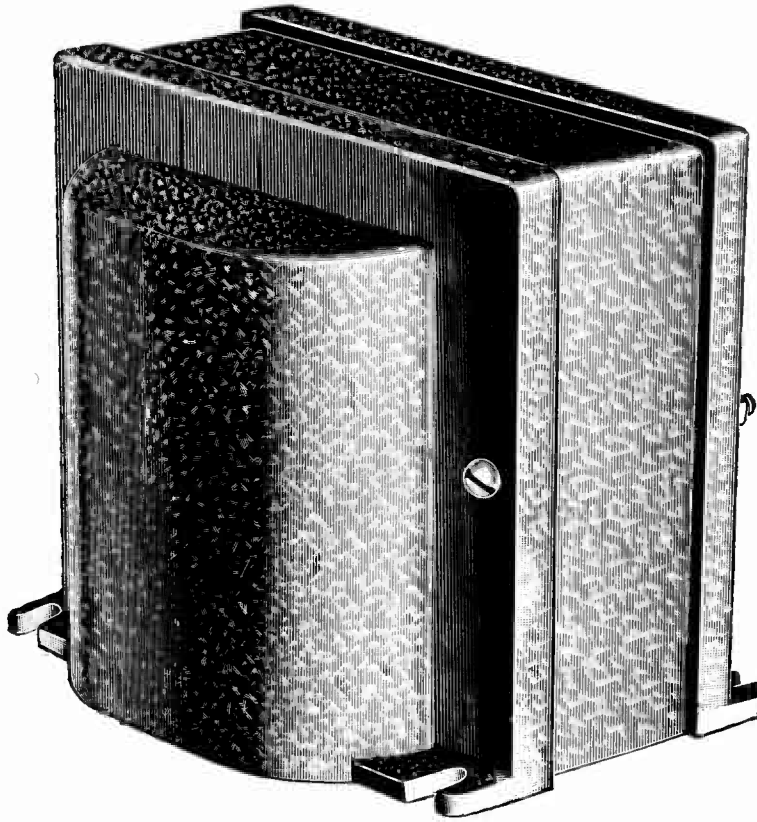
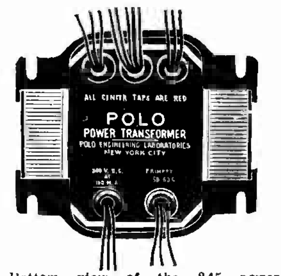
City .... State ....



245 Power Transformer for use with 280 rectifier, to deliver 300 volts D.C. at 100 milliamperes, slightly higher voltage at lower drain, and supply filament voltages.
Cat. 245-PT price $8.50

The Polo 245 power transformer is expertly designed and constructed, wire, silicon grade A steel core and air gap large enough to stand the full rated load. The primary is for 110v A.C., 50-60 cycles, tapped for 82.5 volts in case a voltage regulator, such as a Clarostat or Amperite, is used. The black primary lead is common. If no voltage regulator is used, connect black lead to one side of the A.C. line, green lead to the other side of the line, and ignore red lead, except to tape the end For use with a voltage regulator (82.5-volt primary) use red lead and ignore the green except to tape the end. The secondaries are: high voltage for 280 plates, with red center tap to ground; 2.5 volts, 3 amperes, red center tap to C plus, for 245 output, single or pushpull; 5 volts, 2 amperes, red center tap, as positive B lead, for filament of 280 tube; 2.5 volts, 16 amperes, red center tap to ground, for 224, 227 and pentode tubes, up to nine heater type tubes. Hence there are five windings.



Bottom view of the 245 power transformer. All leads are plainly marked on the nameplate, including the top row.

A special filament transformer, 110 v., 50-60 cycles, with two secondaries, one of 2.5 v. 3 amp. for 245s, single or push-pull, other 2.5 v. 12 amperes for 224, 227, etc., both secondaries center-tapped. Shielded case. 6 ft. AC cable, with plug. Order Cat. F-2.5-D @....... $3.75

The conservative rating of the Polo 245 power transformer insures superb results even at maximum rated draw, working up to twelve tubes, including rectifier, without saturation, or overheating due to any other cause. This ability to stand the gaff requires adequate size wire, core and air gap, all of which are carefully provided. At less than maximum draw the voltages will be slightly greater, including the filament voltages, hence the 16 ampere winding will give 2.25 volts at maximum draw, which is an entirely satisfactory operating voltage, increasing to 2.5 volts maximum as fewer than a total of nine RF, detector and preliminary audio tubes are used.

The avoidance of excessive heat aids in the efficient operation of the transformer and in the maintenance of good regulation, for excessive heat increases the resistance of the windings.

The transformer is equipped with four slotted mounting feet and a nameplate with all leads identified. It is one of the very finest instruments on the radio market.

Highest Capacity of Filament Secondary

SPECIAL pains were taken in the design and manufacture of the Polo 245 power transformer to meet the needs of experimenters. For instance, excellent regulation was provided, to effect minimum change of voltage with given change in current used. Also, the 2.5 volt winding for RF, detector and preliminary audio tubes, was specially designed for high current, to stand 16 amperes, the highest capacity of any 245 power transformer on the market. Hence you have the option of using nine heater type tubes. The shielded case is crinkle brown finished steel, and the assembly is perfectly tight, preventing mechanical vibration.

The power transformer weighs 11½ lbs., is 7 inches high, 4⅞ inches wide, and 4¼" front to back, overall.

Elevating washers may be used at the mounting feet to olear the outleads, or holes may be drilled in a chassis to pass these leads, and the transformer mounted flush.

Advice in Use of Chokes and Condensers in Filter

With the 245 power transformer either one or two single chokes should be used, or a shielded double choke, depending on the current drain and the capacity of filter condenser used. Where the capacity at the output is 8 mfd. or moro for a drain of 65 to 100 ma., a single choke will suffice (Cat. SH-S-CH), but where smaller output capacity than 8 mfd. is used on such drain, two such chokes should be used in series. Next to the rectifier, in either instance, use a 1 or 2 mfd., 550 A.C. working voltage rating condenser (D.C. rating, 1,000 volts). You may use your choice of capacity at the midsection.

If the drain is to be 65 milliamperes or less, the double choke, Cat. SH-D-CH, may be used for filtration, instead of two single shielded chokes.

The Polo 245 power transformer may be obtained for 25 cycles or 40 cycles on special order, as these are not stocked regularly, and remittance must accompany order. The same guaranty attaches to them as to all other Polo apparatus—money back if not satisfied after trial of five days. In these the primary and secondary voltages and taps are the same, only the case is deeper (front to back) because of larger core and wire for lower frequency.
For 40 cycles order Cat. 245-PT-40 .... @ $9.50
For 25 cycles order Cat. 245-PT-25 .... @ $12.50

[Note: The filter for 40 cycles should consist of two shielded single chokes, Cat. SH-S-CH, with 2 mfd. next to the rectifier and 4 mfd. minimum at the joint of the two chokes and at the end of the filter. For 25 cycles the same holds true, except that the output capacity at end of chokes should be 8 mfd. minimum.]

We Make Special Transformers to Order