OCT. 26TH 1929 | MOST POPULAR POWER AMPLIFIER | 15 CENTS

RADIO WORLD
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The First and Only National Radio Weekly
396th Consecutive Issue—EIGHTH YEAR

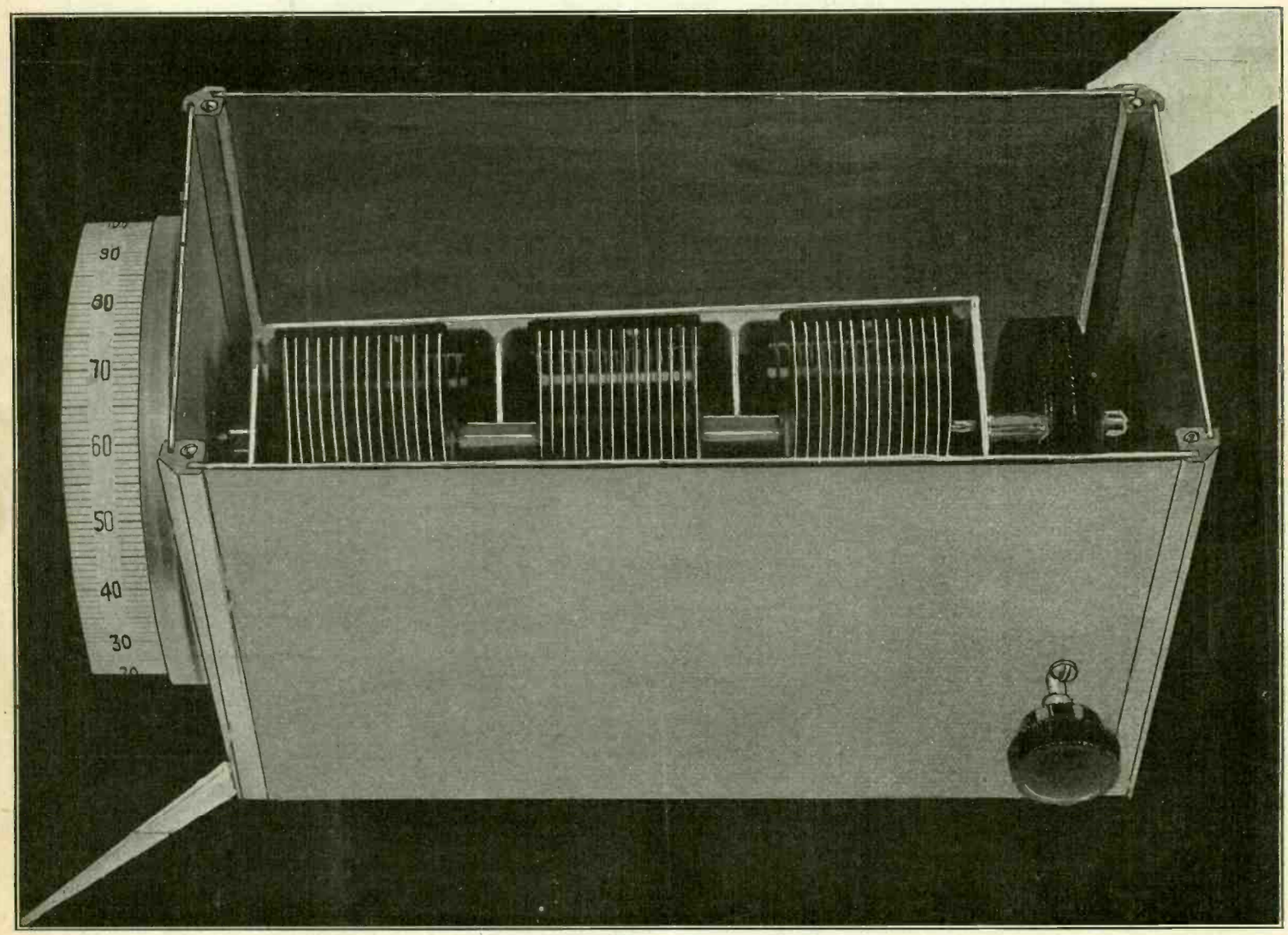
HOW ETHER MUSIC MAKER WORKS

INDUCTION EXPLAINED

PUSH-PULL DIAMOND, FOR BATTERIES OR AC

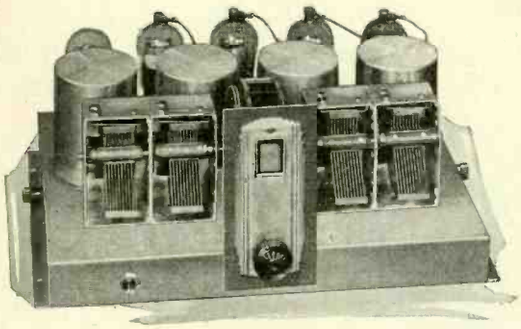
RADIO THEORY FOR SCHOOLBOYS

COMPARTMENT FOR CONDENSER AND DRIVE



A shield, such as ordinarily houses a coil, socket and tube, is used in this instance as a container for a three-gang condenser, with drive mechanism as part of the assembly. **See page 6.**

NATIONAL SCREEN GRID TUNER MB-29



The most sensitive tuned radio frequency tuner so far developed, the MB-29 is long on distant reception, and penetrates seemingly unsurmountable barriers to reception. On the MB-29 the stations come in no matter where you are. The MB-29, designed by James Millen and Prof Glen H. Browning, is the choice of the most discriminating. It is designed only for AC operation, uses four stages of screen grid RF and a power detector (227). Use 135 to 180 volts on the detector. Testimonials from radio's hardest-boiled experts prove this is the circuit of circuits. Buy the parts and find fullest radio delight. You will be sure nobody else has a tuner as good as yours, unless he too has an MB-29. Complete component parts for National Screen Grid Tuner MB-29, mounted on frosted aluminum chassis, including rainbow modernistic drum dial HC. Order catalog No. MB-29-K. list price, less tubes, $69.50. Your price .....

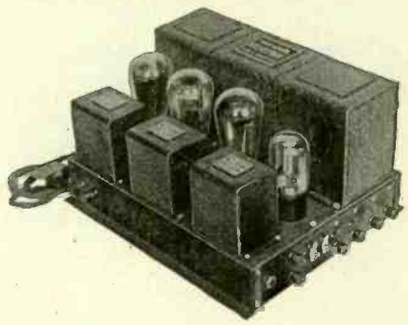
$40.00

Push-Pull Amplifier

The National Velvetone Push-Pull Power Amplifier (shown at right) consists of an AC-operated filament-plate supply, with two stage transformer audio amplifier and output transformer built in. Made only for 110-V., 50-60 cycles. Sold only in completely wired form, licensed under RCA patents.

The new Power Amplifier has been developed and built to get the very most out of the MB-29. It is a combination power supply and audio amplifier, using a 280 tube for a rectifier, one stage of transformer audio with a 227 tube and a stage of push pull amlification with two 245s. It furnishes all power for itself and for the MB-29, as well as the audio channel. Order catalog PPPA, list price, completely wired and equipped with phonograph jack, (less tubes) $97.50. Your price.

$55.00



View of National Velvetone Push-Pull Power Amplifier, an expertly made A. B and C supply and audio amplifier, producing marvelous tone quality.

PEERLESS Super Dynamic Console Speaker

Peerless Super Dynamic 12" AC-operated spoaker, built into a Sonora console, with 2.000 mfd. filter condenser to kill hum; equipped with special rectifier and switch. Speaker by United Rep. Corp. List. $155.00. Your price.....

$37.50

The famous Peerless AC dynamic speaker, with Kuprox rectifier and 2,000 mfd. hum-killing condenser built-in, all housed in this 40" high Sonora cabinet of fascinating ply-walnut. The cabinet is all one piece—carved legs, marqueterie panel and grille pillars. Sliding back is made of caned steel, acoustically open to present boominess. This imposing floor model speaker, exactly as illustrated, in original factory packing case, shipping weight 100 lbs. Never in your life did you hear of such an amazing bargain—highest class, perfect, guaranteed merchandise at more than 75% off list price! Look at that beautiful console cabinet, its graceful legs, with archer's bow tiepiece; its rosetted side panels at front, its shapely grille pillars, all in two-tone effect, with high-polish surface of ply-walnut. The speaker sets against a golden grille, with ample baffle board concealed. Order catalog PSHB @ $37.50. The console, which has removable back, is 40" high, 19" wide, 16" front to back.
Speaker only, with 2,000 mfd. and Kuprox rectifier, all built up at factory. Order Cat. SO @ $23.50.
Cabinet only, Order Cat. CO @ $15.00.

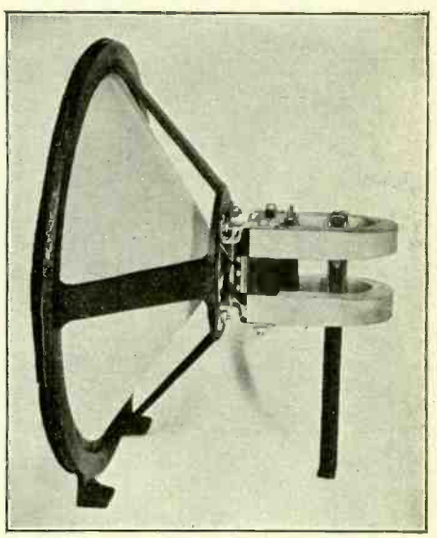
Farrand Inductor

Absolutely unexcelled tone quality, with amazing sensitivity, is assured when you use Farrand Inductor Speaker and a fine audio amplifier. The chassis is sold completely erected with unit and supporting brace mounted. The unit, cone spider, and ring are sturdily put together. Use a baffle board or box of your own choice.
A new principle is involved in the Inductor Chassis. The armature moves up and down, in a wide gap, instead of from side to side in a tiny gap. Hence the armature does not strike the pole pieces.

The chassis is offered at professional discounts, the prices quoted being net. The outside diameters of the two different sized models are 9" and 12" respectively. The speaker should be selected, no matter what size, that matches the impedance of the output tube or tubes. See list below. The larger size gives better low-note response.
For single 112, 112A or 210 output tube, 9" diameter, order Cat. N9R @ $11.95.

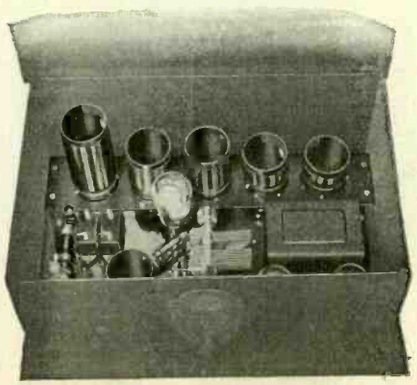
For 171, 171A, 245 or 250 single output, or ANY push-pull output where you have an output transformer or midtapped impedance, order Cat. N9G @ $11.95.

Same as above, only 12" outside diameter, order N12R for single 112, 112A, or 210 tube, @ $12.95.
For single 171, 171A, 245, 250, or for ANY push-pull, order Cat. N12G for 12" size, @ $12.95.



Farrand Inductor Speaker (12" size illustrated), list price, $22.50. Your price $12.95.
Consult information at left as to suitable type speaker for your output tube. The 12" is preferable if you have room.

Short Wave Circuit



National Thrill Box, 4-tube short wave circuit, 15 to 535 meters, battery-operation of filaments; B supply, either batteries or eliminator.

Get a real kick out of listening to foreign stations on a real short-wave circuit, the National Thrill Box. Uses one 222 screen grid RF amplifier, one 200A detector, one 240 first audio and one 171A or 112A output. Single control. Buy the parts and build the circuit in two hours. Data sheet shows dial settings where foreign stations come in. Cat. SW4EF, all parts, including decorative brown steel cabinet, all six plug-in coils, list price $51.90 (less tubes). Your price $31.00.

NO C. O. D. ORDERS

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

Please ship at once on 5-day money-back guaranty the parts checked off below for which $.....is enclosed.

Cat. MB29K @ $40 net	Cat. N12R @ $11.95 net
Cat. PS HB @ $37.50 net	Cat. PPPA @ $55 net
Cat. SO @ $23.50 net	Cat. SW4EF @ $31 net
Cat. CO @ $15 net	Cat. N9G @ $12.95 net
Cat. N9R @ $11.95 net	Cat. N12G @ $12.95 net

NAME .....

ADDRESS .....

CITY..... STATE.....

Component Parts for PUSH-PULL AC DIAMOND

Check off parts you want. Each part is sold separately.

☐ L1, L2—RF3, antenna coil	$ .80
☐ L3, L4, L5—SGT3, screen grid, 3-circuit coil	1.30
☐ C1, C2—two .00035 mfd., extended shafts; brackets	2.06
☐ CT—80 mmfd. equalizer	.35
☐ C3—Grid condenser with clips	.21
☐ C4, C5—Two .01 mfd.	.70
☐ R1—One 0.1 meg.	.30
☐ R2, R4—Two 5.0 meg.	.60
☐ R3—Potentiometer, 25,000 obms or more; knob	1.50
☐ T1—Push-pull input transformer	3.41
☐ PPOC—Special push-pull output choke	3.41
☐ Ant., gnd., Sp. (—), Sp. (+)—4 posts	.40
☐ Polo 245 power transformer, 110 v. 50-60c.	10.00
☐ C5—Filter condenser 2 mfd., 550 v. AC.	2.94
☐ C7, C8, C9, C10—Mershon Q 2-8, 2-18, bracket	5.75
☐ C10, C11, C12—Three 1 mfd. 200 v. DC	1.50
☐ R5, R6, R7, R8, R9, R10—Voltage divider, 13,850 ohms, 50 watts, 14 taps, bracket	3.95
☐ F—1 amp. fuse with base	.50
☐ SW—Through pendant switch AC	.40
☐ CO—One convenience outlet	.20
☐ CD—12 ft. AC cable, male plug	.70
☐ Socketed, drilled metal subpanel	3.80
☐ National type HC new modernistic rainbow dial, pilot bracket, 2.5 v. AC lamp	3.13
☐ 7x21" drilled front panel	1.95
☐ Two flexible links, insulating ¼" shaft	.76
☐ Knob for tickler	.18
☐ Screen grid clip	.06
☐ All parts	$48.86
☐ Kelly tubes, one 224, one 228, one 227, one 280, two 245	$13.25

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Enclosed please find $..... for which please express at once the parts for the Push-Pull AC Diamond of the Air as checked off above.

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Component Parts for PUSH-PULL BATTERY DIAMOND

[Check off parts you want. Each part is sold separately.]

☐ L1L2—Antenna coil RF3 @	$ 0.80
☐ L3L4L5—3-circuit SG coil SGT3 @	1.30
☐ L6—Push-pull output impedance	2.83
☐ T1—Push-pull input transformer	3.41
☐ CT—80 mfd. equalizer	.35
☐ C1, C2—Two .00035 mfd. ext. shafts @ 98c	1.96
☐ C3, C5—Two .01 mfd. mica condensers	.70
☐ R—One 6.5 ohm filament resistor	.25
☐ R1, Sw—One 75 ohm switched rheostat	.80
☐ R2, C4—2 meg. Lynch leak, grid clip condenser	.51
☐ R3—One .25 meg.	.30
☐ R4—One 5.0 meg.	.30
☐ R5—One 1.3 ohm filament resistor	.20
☐ Ant., Gind, Sp. (+) (Sp. (—)—Four posts @ .10	.40
☐ One drilled front panel 7x18"	1.85
☐ One socketed, self-bracketing metal sub-panel, all holes drilled	3.50
☐ One National new modernistic drum dial with color wheel, pilot bracket, 6v. lamp, hardware, knob	3.13
☐ Two matched knobs for rheo. and tickler @ .18	.36
☐ Five vari-colored cable leads @ .07	.35
☐ Flexible link and insulated shaft	.55
☐ One screen grid clip	.06
☐ All parts	$23.91

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Enclosed please find $..... for which please mail at once the parts for the Push-Pull Battery Model Diamond of the Air as checked off above.

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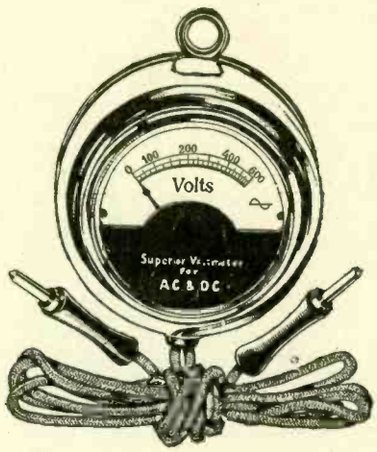
High Resistance Meter

ACCURATE TO 1%!



O-600 AC and DC Voltmeter—same meter reads both —with 32" long flexible cords built in, and equipped with hanger. Extreme diameter (less hanger) 2¾".

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Here is a meter that serves an abundance of uses, because it has a wide voltage range, 0 to 600 volts, and measures voltage of alternating current and direct current, and is accurate to 1%. In a meter it's accuracy that counts.

You can measure not only the DC voltages of B eliminators, power packs and B batteries, with easily legible readings of 20 volts per division of the scale, with wide divisions between 100 and 400 volts, so that you can easily see to within 5 volts, but you can also measure the AC voltage across high-voltage power transformer secondaries. If full-wave rectification is used, you measure each of the two sections of the transformer secondary and add the voltages. Thus up to 1,200 total volts across the secondary may be read. For half-wave rectification, a secondary up to 600 volts is read across the total winding. You find out at once whether this winding is open or shorted, since no reading then would be obtained, or find out whether the voltage is right, or too high or too low. In all instances the AC voltage across the secondary should read higher than the desired DC output, due to the voltage drop in the tube and to the current in the entire voltage divider and its sections. The normal deduction from the AC voltage, to obtain the DC voltage, is at least 10%.

A REQUISITE FOR SERVICING!

Often service men, experimenters and students must know not only the transformer high voltage, but also whether the AC line voltage is the rated 110 volts or not. This meter tells you. Connect it across the 110-volt line. By reading this voltage and the voltage of the high-voltage secondary you can also determine the step-up ratio, by dividing the smaller reading into the larger.

Because this is a high-resistance meter you can rely on the accuracy of the readings.

Only a high-resistance meter can accurately measure the DC voltage of a B eliminator. Other meters draw so much current that the reading may be 50 volts less than what it should be, or still more inaccurate, and you could almost guess the voltage more accurately than a low-resistance meter would read.

MONEY-BACK GUARANTY!

This meter is sold on a 5-day money-back guaranty. Buy one, try it, test it thoroughly, compare it with other meters in performance and appearance. If not fully satisfied, send it back and your money will be promptly refunded.

The meter is full nickel plated, highest possible polish, has green cords, with red (positive) and black (negative) moulded bakelite tip-holders, and sturdy tips. The positive and negative indications are for DC measurements. For AC the meter may be connected at random.

This meter, which is of the moving vane type, is made in Germany and represents finest workmanship.

Cat. M600 AC-DC $6.00

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Cat. M600, price $6.00

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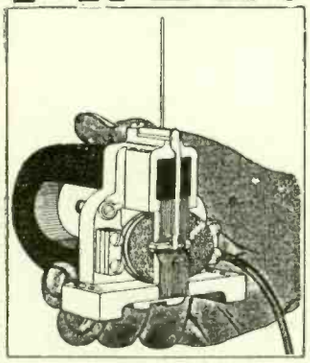

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The Multi-Tap Voltage Divider has a total resistance value of 13,850 ohms, in the following steps: 3,000, 4,500, 2,000, 800, 700, 600, 550, 500, 450, 400, 200, 100 and 50 ohms. With the zero voltage lug the total number of useful lugs is fourteen. The resistances stated are those between respective lugs and are to be added together to constitute 13,850 ohms total.

Rated at 50 Watts

A conservative rating of the Multi-Tap Voltage Divider is 50 watts, continuous use. The unit is serviceable in all installations where the total current drain does not exceed 125 milliamperes.

Extreme care has been exercised in the manufacture of the Multi-Tap Voltage Divider. It is mounted on brackets insulated from the resistance wire and that afford horizontal mounting of the unit on baseboards and subpanels.

There long has been a need for obtaining any necessary intermediate voltage, including all biasing voltages, from a Multi-Tap Voltage Divider, but each lug has to be put on individually by hand, and soldered, so that manufacturing difficulties have left the market barren of such a device until now.

The Multi-Tap Voltage Divider is useful in all circuits, including push-pull and single-sided one, where the current rating of 125 milliamperes is not seriously exceeded and the maximum voltage is not more than 300 volts. If good ventilation is provided, this rating may be exceeded 15 per cent.

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. If a B supply feeds a receiver with two-stage audio amplifier, the last stage a single-sided 245, then the voltages would be 250 maximum for the power tube, 180, 135, 75, 50, 40, 35, 30, 25, 16, 10, 6, 3, 1, and 0.5. By suitable connection of grid returns the lower voltages may be used for negative bias or even for positive voltage on the plates. Even 0.5 volt is provided for negative bias of a space charge detector (224 tube) in resistance-coupled audio.

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.

You do not need to calculate the voltage from current and resistance values, but can measure the voltage with a high resistance voltmeter, so you will know just which tap to use, or simply use the taps that give best results as determined by ear test.

Order Cat. MTVD at $3.75

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Gentlemen: Enclosed please find $3.75 for which please send at once one Multi-Tap Voltage Divider, 13,850 ohms, 14 taps, mounted on brackets, 50 watt rating; Cat. MTVD.

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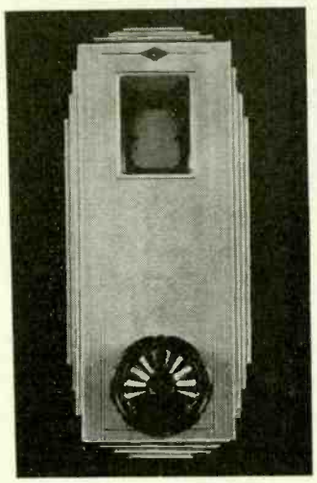
A BRILLIANT MODERN DIAL



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Roland Burke Hennessy, editor; Herman Bernard, business manager and managing editor; J. E. Anderson, technical editor.

First in Popularity

Push-Pull 245 Power Amplifier Leads the Rest

By Neal Fitzalan

STANDARD design for a power amplifier is shown in Fig. 1, the only novelty being a multi-tap voltage divider, which affords fourteen different voltages which may be apportioned for bias and plate voltages, as needed.

The audio amplifier consists of one stage of resistance coupling, worked out of the detector, and one stage of push-pull transformer-coupled audio feeding a pair of 245 tubes.

Besides providing the filament, plate and biasing voltages for the audio amplifier, the device furnishes filament voltages for the 224, 227 or 228 tubes in an independent tuner as well as grid and plate voltages for the radio frequency tubes and the detector. The usual 227 detector may be retained, or the 228 may be used to somewhat better advantage, since the first audio stage is resistance coupled, and the 228 is a high mu tube for AC operation, having the same heater voltage and current requirements as the 227.

Besides the 227 first audio tube, six other tubes may be heated from the 12 ampere 2.5 volt winding.

PROVISION FOR PHONOGRAPH PICKUP

The power amplifier may be fed by a phonograph pickup instead of by a radio receiver, a switch enabling one to change from one to the other. This switch is in the grid circuit of the first audio amplifier, and its purpose is to change the load from the grid leak to pickup, while an extra switch, actuated by the same operation, turns off the filament current and voltage supplied to the tuner. Therefore it is impossible to hear both radio and phonograph together.

The voltage divider has fourteen useful taps, a total of 13,850 ohms being used, so that the bleeder current is around 20 milliamperes, which tends to stablize the voltages.

The power tube bias is 50 volts, obtained through the drop between one of the taps and ground. As the power tube filaments are an independent circuit, the negative bias on the power tubes may be used as a positive plate voltage on any of the other tubes, or on screen grids, especially valuable in radio circuits where the standard 75 volts for the screen grids of 224 tubes proves too high and causes squealing.

Biasing voltages for power detection are available, too, and, depending on the plate voltage, they may be 16 or 25 or even more.

10 VOLTS BIAS ON FIRST AUDIO

It will be noticed that the plate voltage on the first audio tube is the limit for a 227, that is, 180 volts. Hence a negative bias of 10 volts is used. This permits the first audio tube to receive the full load from a power detector handling an enormously high signal amplitude, and without overloading the 227 first audio, or the push-pull pair, for the output has an undistorted maximum power of about 6,400 milliwatts.

The bias for heater type tubes—and all the tubes except the 280 rectifier and the push-pull 245s are of that type—is the voltage drop in that part of the divider between the cathode connection and grid return. Usually grid return is made to ground. So by "lifting" or "lowering" the cathode connection on the voltage divider, by using taps nearer the maximum potential or nearer grounded zero potential, the biases may be arranged as desired.

In tuners that have independent biasing resistors for the tubes used, connection of cathodes to the voltage divider for bias should not be made.

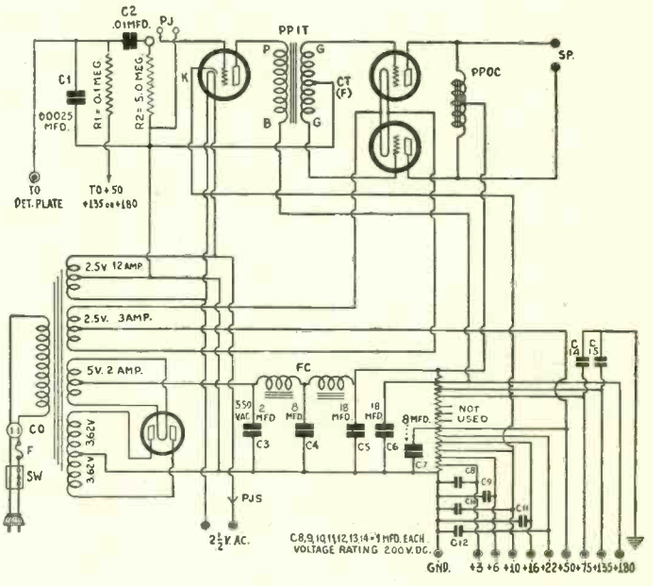


FIG. 1.
A POWER AMPLIFIER AND ABC SUPPLY, WITH A 245 PUSH-PULL OUTPUT, USING A MULTI-TAP VOLTAGE DIVIDER THAT AFFORDS ALL NECESSARY VOLTAGES FOR BIASING, INCLUDING THE BIASING OF POWER DETECTORS, AND ALL NECESSARY PLATE AND SCREEN GRID VOLTAGES FOR TUNER AND AMPLIFIER

The B supply power transformer is fused and has a convenience outlet into which you may insert the AC cable of a dynamic speaker, so the pendant follow-through switch that governs the power amplifier and tuner also will act upon the speaker at the same time. The same switch turns all three on or off.

This is a standard hookup of a circuit enjoying great popularity at present. It may be built on a cadmium-plated steel subpanel, which has 2" flanges at right angles all around, serving as a self-bracketing feature, and the voltage divider may be fastened to one of these flanges on the inside, thus taking up no room on top of subpanel.

Such a layout actually has been effected on such a steel subpanel that has sockets built in.

Within two weeks these subpanels will be available, but meanwhile the preliminary details of the circuit and constants are given herewith.

The, intermediate plate voltages are indicative only, as diagrammed, as the actual voltages may be obtained simply by using a high resistance voltmeter.

(*Continued on page* 18)

Experimental Circuits

How Faraday Laid the Foun

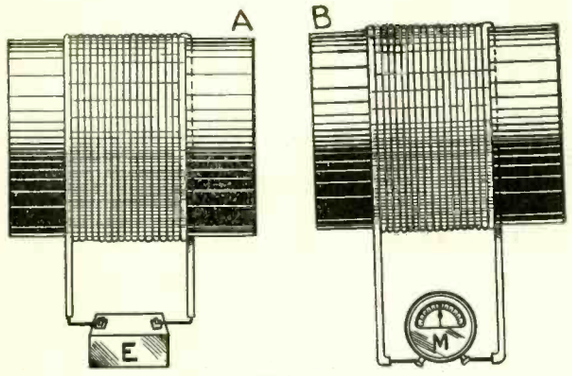


FIG. 1
A SIMPLE ARRANGEMENT OF COILS FOR DEMONSTRATING THE PROPERTIES OF INDUCED CURRENTS.

INDUCED currents and voltages play an important role in radio, and the subject cannot really be understood until induction has been mastered. In order to gain a good understanding of how currents and voltages are induced in a circuit it is necessary to repeat some of the simpler experiments of Faraday, the English physicist who worked out the basic principles of the subject. These experiments can be performed by anyone who has the necessary simple equipment.

Let us start experimenting by forming a circuit composed of some kind of sensitive current meter in series with a coil of wire. The circuit is shown in Fig. 1, in which B is the coil, which may be called the secondary, and M is the indicator. The meter may be a sensitive galvanometer or any other sensitive current meter so arranged that the pointer can move in either direction from its position of rest. In case no such meter is available, one can be improvised by using an ordinary pocket compass and placing this inside another coil, the terminals of which should be connected in series with the secondary coil.

Now let us form a primary circuit by connecting a battery E across the terminals of a coil A. A steady current flows through the primary coil, and this current makes the coil a magnet, or more precisely, an electromagnet.

Grasp the primary coil and thrust it toward the secondary coil with a quick movement. Note the behavior of the pointer on the indicator M. It will be found that the pointer kicks in one direction or the other, but quickly comes to rest at its old position. Now jerk the primary coil away from the secondary and watch the pointer. This time the pointer will kick in the same way as before, but in the opposite direction. Again it will quickly come to rest at its old position.

NO CURRENT, NO KICK

Repeat this experiment when there is no current flowing in the primary coil, both when the terminals are open and when they are joined together. The meter will not show any deflection either when the primary is thrust toward the secondary or when it is jerked away. It is clear then that in some way the needle kicked because there was current flowing in the primary circuit when the two rapid motions of the primary took place.

Repeat the experiment once more with current flowing in the primary, but this time move the primary coil up to the secondary very slowly and also remove it very slowly. Observe the pointer of the meter carefully. There is either no motion at all observable, or it is very small. Hence it is clear that the intensity of the kick of the pointer depends on the rapidity of the motion with which the primary moves toward or away from the secondary.

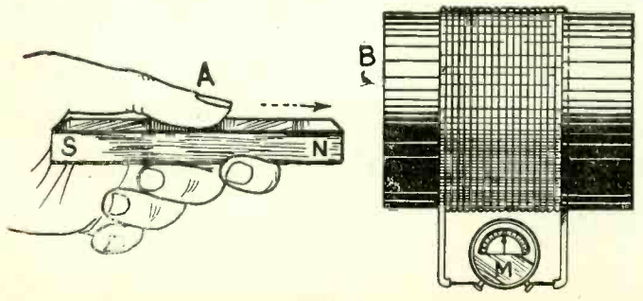


FIG. 2
A PERMANENT MAGNET CAN BE USED FOR INDUCING CURRENTS IN A COIL IN THIS MANNER.

DEPENDS ON MOTION

Repeat the experiment once more, with current flowing in the primary coil, but this time move the secondary coil toward and away from the primary. If the motion is rapid it will be found that the pointer kicks. This shows that it is the relative motion between the two coils which counts. This can be verified further by moving both coils at the same time, both toward and away from each other, and also by moving the two coils in the same direction, keeping the distance between them the same. It is only when the relative motion is rapid that the effect on the pointer is appreciable, and it is only when a current is flowing in the primary that there is any effect at all. Moreover, there is no effect at all except when there is relative motion between the two coils.

The effect that takes place is due to *induced* voltage in the secondary coil, and this voltage is induced because the magnetism from the first coil that flows through the second coil *changes*. The magnetism itself has no effect, for if it did the needle of the meter would not come to rest after the primary coil has been brought up close to the secondary. It is the change that is essential. From the facts that the pointer kicks in one direction when the primary is brought up to the secondary and in the opposite direction when it is jerked away, it is clear that the direction of the induced voltage depends on the direction in which the magnetism changes, that is, whether it is increasing or decreasing.

COIL HAS POLARITY

Note carefully in which direction the pointer kicks when the primary is brought up and when it is jerked away. Now reverse the primary coil, that is, turn it end for end, and repeat the experiment, with current, of course, flowing in the primary. Note that the directions of the kicks also have reversed. Again reverse the connection of the battery in the primary circuit and repeat the experiment. This also reverses the directions of the kicks. The primary coil evidently has polarity.

Now if the effect in the secondary circuit is due to changing magnetism, it should be possible to substitute a permanent magnet for the primary circuit, as illustrated in Fig. 2. Grasp a permanent bar magnet, SN, and thrust it suddenly into the secondary coil. The needle kicks up just as it did when the primary coil carrying current was brought up. Jerk the magnet out of the secondary circuit with a quick movement. Again the needle kicks, but this time in the opposite direction. Note that the amount of kick depends on the rapidity with which the magnet is moved away from or toward the secondary circuit, B. Now, it is clear that the effect is due to changing magnetism, since a permanent magnet acts the same way as a coil carrying current.

To test further the similarity between the coil and the permanent magnet, turn this end for end and repeat the experiment. The directions of the kicks have been reversed, just as they were reversed by either turning the primary coil around, or by reversing the battery connections.

The experiment might also be repeated with an unmagnetized bar of iron. It will be found that there is no effect, just as there was no effect when the primary carrying no current was moved. There can be no doubt that the effect is due to changing magnetism in the secondary circuit and that the intensity of the effect depends on the *rate* at which the magnetism changes.

In order to prove that the primary coil carrying current is a magnet, a pocket compass or any magnetized needle might be placed inside the coil. Place it so that when no current is flowing in the circuit the needle points in a direction of about 45 degrees with the axis of the coil. Then turn the current on. The needle turns. It acts about the same as when a permanent magnet is brought near it.

CHANGING MAGNETISM INDUCES VOLTAGE

The changing magnetism through the secondary coil induces a voltage, or emf, in the winding, and this emf forces a current through the circuit. The indicator responds to the current. The current due to induced emf is called induced current.

Instead of using a current indicator in these experiments a voltage indicator can be used, and this shows directly that it is voltage that is induced. The best voltage indicator is an ordinary vacuum tube. The secondary terminals of the coil are connected to the grid and the filament of the tube, and a milliameter is connected in the plate circuit to act as indicator. If the voltage on the grid changes the current in the plate

for Studying Induction

dation of the Entire Subject

circuit also changes. No current can flow in the secondary coil, for there is no circuit. In other words, the coil is open. Therefore any effect that is observed in the plate circuit is due to a change in the voltage in the coil. If the experiments outlined above are repeated it will be found that the needle of the milliammeter in the plate circuit will kick just as the needle did when the meter was connected directly in series with the coil.

It is not to be expected, however, that the magnitude of the kicks will be the same in both instances. It may be much greater in the second case, or it may be less. If the effect is too small to be observed it is only necessary to increase the number of turns on the coils involved, to increase the strength of the magnet, or change the tube used as voltage indicator. The magnitude of the effect largely depends on the mutual conductance of the tube used, being proportional to it. Fig. 3 gives an idea how to perform the experiment with a vacuum tube as voltage indicator.

If a really great effect is desired, let the secondary coil be the secondary winding of an old audio transformer. For a smaller effect, use the winding primary. Of course, in order to be able to thrust the permanent magnet into the coil, the core of the transformer should have been removed. By moving the magnet back and forth at a regular rate, the voltage induced will alternate, and this will be indicated by a swinging of the pointer of the meter about its mean position. Whenever an alternating voltage is induced in a coil it is due to a periodic changing of the magnetism threading the turns of that coil. It may be due to a mechanical movement of a permanent magnet, as in the case illustrated in Fig. 3, or to the movement of an electromagnet, as in the case of certain alternators. Or again, it may be due to the movement of another coil carrying a steady current, as in the case of Fig. 1.

ANOTHER EXPERIMENT

Another simple experiment throwing light on the induction of voltages can be performed easily. Suppose a battery be connected in series with the primary of an audio transformer, the secondary of which is connected as in Fig. 3, or as in Fig. 1. Without moving either coil with respect to the other, make and break the primary circuit. Whenever the circuit is made, thus starting the current, there will be an indication of induced voltage in one direction, and whenever the circuit is broken, stopping the current, there will be an indication in the opposite direction. The greater the current that is started and stopped, the greater is the effect. The induced voltage will be greater when the current is stopped, because the magnetism decreases much more rapidly when the circuit is opened than it builds up when the circuit is made, and it will be remembered that the effect depends on the rate at which the magnetism through the secondary changes. This experiment is best performed with an ordinary audio transformer without removing its core, but it can also be performed with an air core transformer.

It is not necessary to stop the primary current completely in order to get an induced voltage in the secondary. Suppose a resistance, say equal to the resistance of the primary winding, be inserted in the primary circuit. Put a short circuit wire across this resistor and arrange it so that one end of this wire can be connected and disconnected quickly. Thus when the wire is connected the resistance in the circuit is equal to the resistance of the primary winding, and when the connection is removed the resistance is doubled. The current changes accordingly. The needle of the indicating meter kicks both when the connection is made and when it is broken, but in opposite directions. Thus voltages are induced in the secondary both when the current in the primary is increased and when it is decreased.

HAS BEARING ON OPERATION

This has a direct bearing on the operation of a transformer coupled amplifier, for in this case the current in the primary rises and falls because the plate resistance of the tube varies. The only difference between the two cases is that in one the changes are sudden while in the other they are gradual.

Fig. 4 illustrates a circuit suitable for observing the effect on the induced voltage in the secondary of changes in the current in the primary. By means of key K1 the current can be started and stopped completely. When this key is manipulated the other key K2 should be closed. To study the effect of cutting in and out of a resistance K1 should be closed and K2 should be manipulated. The voltages on the tube should be adjusted so that the milliammeter will normally read about 20 milliamperes. The values given happen to be those required in a special case, but ordinarily the bias should be greater than

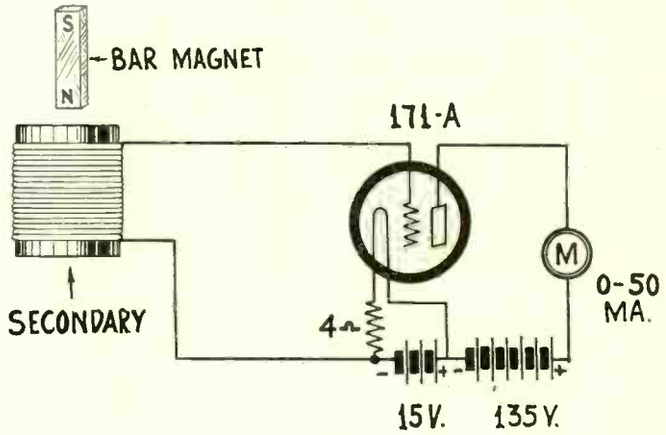


FIG. 3

WHEN NO SENSITIVE CURRENT INDICATOR IS AVAILABLE A VACUUM TUBE CAN BE USED FOR INDICATING THE PRESENCE OF INDUCED VOLTAGES.

15 volts. It is inadvisable to use a higher voltage in the primary than 4.5 volts, because the induced voltage in the secondary when the current is stopped may be so high as to break down the insulation in the transformer.

INDUCTION BY ALTERNATING CURRENT

We have not yet mentioned specifically the most important case of induced voltages, namely, that when alternating current flows in the primary circuit. An alterating current is characterized by the fact that it continually changes in magnitude and in direction. It starts at zero and rises to a certain value, called the amplitude. Then it decreases to zero, reverses direction and increases to the maximum in the new direction. Then it decreases again to zero, completing a cycle. The number of such cycles per second is the frequency of the current.

The magnetism associated with any coil is directly proportional to the intensity of the current flowing at any instant. Therefore when an alterating current is flowing through a coil the intensity and direction of the associated magnetism changes. The magnetism goes through maxima at the same time as the current goes through maxima. Both also go through zero at the same time and reverse in direction simultaneously. A coil carrying alternating current, therefore, is a magnet the polarity and intensity of which change continually. In fact such a coil is, as far as its effect at a given point is concerned, as if it were a rotating permanent magnet.

If, then, there is a second coil near the coil carrying alternating current, that coil will be subjected to a continually changing magnetism and consequently an emf or voltage is induced in the second coil.

CLOSENESS GOVERNS EFFECT

The secondary coil may surround the primary, or the primary may surround it, or again the two coils may be placed

(*Continued on page* 16)

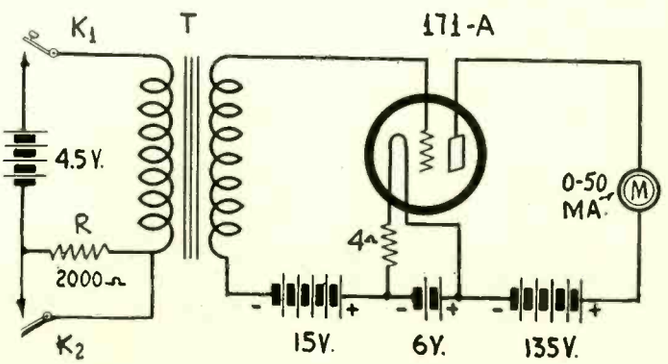
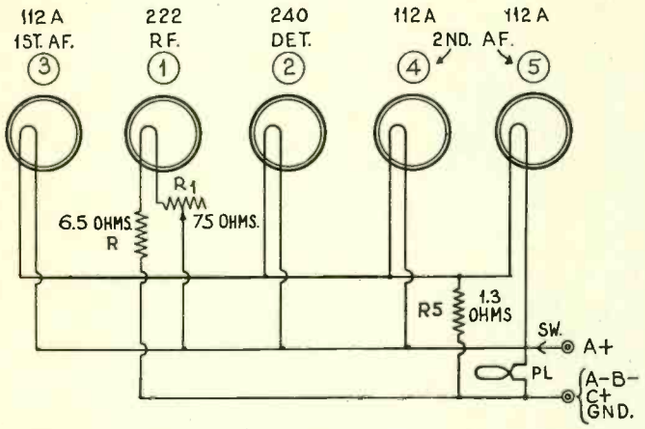


FIG. 4

CURRENTS CAN BE INDUCED IN A COIL BY STARTING AND STOPPING A CURRENT IN A COIL COUPLED TO IT, OR BY SIMPLY VARYING THE CURRENT IN THE PRIMARY.

The Push-Pull Diamond

Same Fundamental Circuit Used for Batteries and AC



HOW THE FILAMENTS ARE WIRED IN THE BATTERY MODEL PUSH-PULL DIAMOND OF THE AIR. A MINUS, B MINUS, C PLUS AND GROUND ARE UNITED. ONE RESISTOR DROPS THE BATTERY VOLTAGE TO THE FILAMENT VOLTAGE FOR THREE TUBES, AND TWO RESISTORS DO THE SAME FOR ONE TUBE, THE 222. THE TUBES ARE SHOWN IN THE PHYSICAL ORDER OF ARRANGEMENT IN THE CIRCUIT.

[*In the October 13th and 19th issues the Battery Model Push-Pull Diamond of the Air was described. Herewith is the final instalment. Next week the construction of the AC Model Push-Pull Diamond will be discussed. A foreword on the AC subject is also published in the accompanying article, and the schematic diagram of the wiring appears on the opposite page.*—Editor.]

THE physical arrangement of the tubes used in the Battery Model Push-Pull Diamond of the Air is illustrated this week. As the front panel faces you, this arrangement is: 112A first audio tube at extreme left, 222 radio frequency amplifier in second position; 240 high mu detector in third place, and the 112A push-pull pair at right, one next to the other in the same line as the rest.

For assistance to novices the diagram shows also the filament wiring. The 222 tube alone has two filament resistors, one 6.5 ohms, which serves a limiting object, so that prohibitive filament voltage will not be applied to this tube from the storage battery, the other, 75 ohms, a rheostat used as volume control. The switch SW is built into this rheostat.

C5 IS .01 MFD. CAPACITY

The storage battery voltage is dropped to 4.7 volts through the 1.3 ohms resistor, R5, which will get a little hot, but is so constructed that nothing can happen in consequence. This resistor is placed underneath the subpanel, as was illustrated last week.

LIST OF PARTS

For the Battery Model

L1L2—Antenna coil RF3.
L3L4L5—Three circuit SG Coil, SGT3.
T1—Push-pull input transformer.
T2—Push-pull output device.
CE—Equalizing condenser 80 mmfd.
C3, C5—Two .01 mfd. condensers.
R—One 6.5 ohm filament resistor.
R1SW—75 ohm switch rheostat.
R2—One 0.25 meg. Lynch resistor.
R3—One 5.0 meg. Lynch resistor.
C1, C2—Two .00035 mfd. tuning condensers, extended shafts.
R4—One 13 ohm filament resistor.
Ant., Gnd., Sp. (+), Sp. (—)—Four posts.
One 7x18" drilled front panel.
One self-bracketing subpanel 7x17½", sockets affixed; already drilled, cut out in two places; hardware; insulating washers.
Two resistor mountings.
One National type HC modernistic dial with color wheel, pilot bracket, 6-volt lamp, hardware.
Two matched knobs.
Flexible link, insulating shaft.
One screen grid clip.
Five vari-colored cable leads.

Also under the subpanel are the 6.5 ohm filament resistor, the audio resistors and their mountings, and the two .01 mfd. condensers, C3 and C5. In a previously published list of parts C5 was omitted inadvertently.

The lugs of the resistor mountings have fixtures that would come in contact with the metal subpanel, hence cause short circuits, were not the mountings elevated to prevent this. Flat type bakelite insulators furnished with the official cadmium-plated steel subpanel are used for this purpose. Three such washers are placed between each mounting and the under part of the subpanel, so that when the mounting screw is passed through the subpanel from the top, and thence through the holes in the washers and the hole in the mounting, and the nut tightened down, the lug hardware rides free and clear of the subpanel, and is immune from any possibility of shorting.

The recommended output tubes are 112A because they will stand enough input to satisfy any home requirements, but there is no objection to using a pair of 171As as the output, leaving the first audio tube a 112A. For the 171A push-pull pair the plate voltage on these alone should be 180 volts, the negative bias 40.5 volts, but the handier 45 volts obtained from a pair of batteries, or a single battery, may be used for bias, if desired.

WATCH OUT FOR CURRENT DRAIN

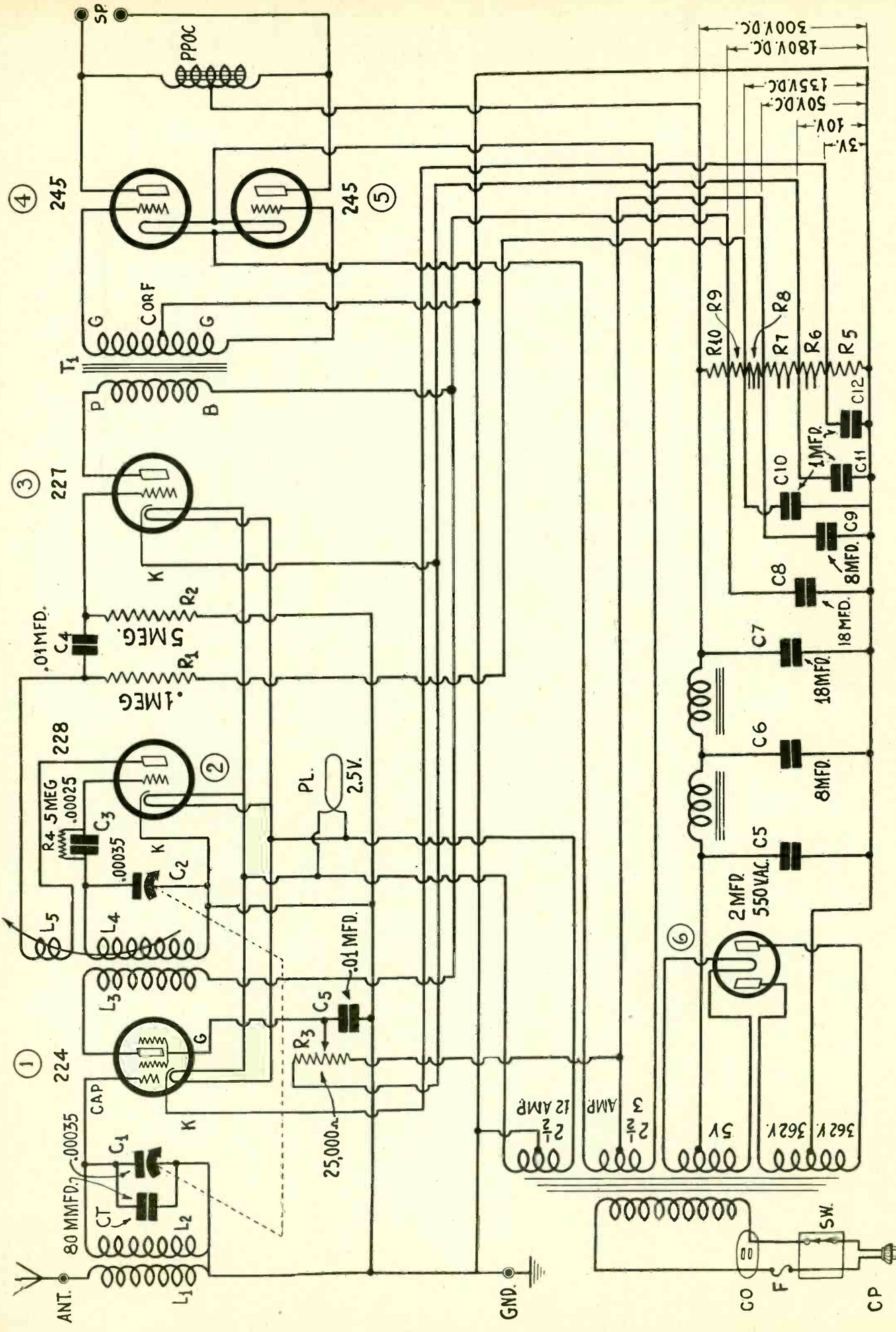
The maximum plate voltage for the circuit, applied to the last stage only, the push-pull pair, where 180 volts produces a drain of nearly 40 milliamperes for the push-pull pair alone, which would make the total drain of the circuit a little more than 50 milliamperes, or too much for economical operation if B batteries are used. But a B eliminator, if it will handle 50 milliamperes without

(*Continued on page* 18)

LIST OF PARTS

For the AC Model

L1L2—One antenna coil, RF3, for .00035 mfd. tuning.
L3L4L5—One three-circuit screen grid coil, SGT3, for .00035 mfd.
C1, C2—Two .00035 mfd. tuning condensers, with shaft extending at both ends; two brackets.
CT—One 80 mmfd. equalizing condenser.
C3—One .00025 mfd. grid condenser with clips.
C4, C5—Two .01 mfd. mica condensers.
R1—One 0.1 meg. Lynch metallized resistor.
R2, R4—Two Lynch 5.0 meg. metallized grid leaks.
R3—One potentiometer, 25,000 ohms or more; knob.
T1—One push-pull input transformer.
PPOC—One push-pull output choke.
Ant., Gnd., Speaker (—), Speaker (+)—Four engraved binding posts.
One Polo 245 power supply transformer, primary, 110 v., 50-60 cycles, with secondaries: 2.5 volts, 12 amps., 2.5 volts, 3 amps.; 5 volts, 2 amps.; 724 volts; all secondaries center-tapped; two 50 henry chokes built in; Cat. No. P245PS. (Note: for 40 cycles, 110 volts, use Cat. P245S40; for 25 cycles, 110 volts, use P245S25.)
C5—One 2 mfd. 550 volt AC working voltage (rms.) filter condenser.
C7, C8, C9, C10—On Four Mershon condensers: two of 8 mfd., two of 18 mfd., all in one copper case; with bracket. Cat. Q 2-8, 2-18B.
C10, C11, C12—Three 1.0 mfd. bypass condensers, 200 volt DC working voltage.
R5, R6, R7, R8, R9, R10—One bracketed voltage divider, 13,850 ohms, 50-watt continuous duty rating; 14 taps, 7 taps not used separately in this circuit.
F—One 1-ampere fuse with base.
SW—One pendant through switch, AC type.
CO—One convenience outlet.
CP—One AC cable, 12 ft. long, with male plug.
One metal subpanel, with three five-prong (UY) and three four-prong (UX) sockets built in, and holes drilled for parts.
One National type HC drum dial with new modernistic escutch. eon and rainbow feature; pilot bracket and 2.5 AC volt lamp, PL.
One 7x21" front panel.
Two flexible links, insulating ¼" shaft.
One extra knob for tickler.



ADVANCE SHOWING OF THE CIRCUIT DIAGRAM OF THE AC MODEL PUSH-PULL DIAMOND OF THE AIR, COMPLETELY SELF-POWERED,

Principles of Inter

High and Low Frequencies Comp

By Knollys

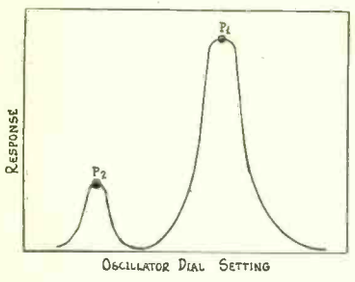


FIG. 15

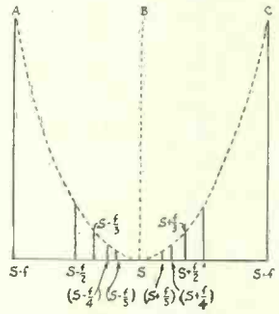


FIG. 14

TWO RESPONSE PEAKS ARE SOMETIMES OBSERVED IN A SUPERHETERODYNE, P1, DUE TO THE FUNDAMENTALS AND P2 DUE TO THE SECOND HARMONICS. THE DISTRIBUTION OF THE RESPONSES IN A SUPERHETERODYNE DUE TO THE PRESENCE OF HARMONICS IN BOTH THE OSCILLATOR AND THE CARRIER.

[*The following is one of the weekly instalments dealing with the Superheterodyne circuit. The series was begun in the October 12th issue, and there was an instalment last week, October 19th. Another will be published next week, November 2d.—Editor.*]

ONLY those repeat points due to the beating of harmonics for which $m=n$ lie within the limits indicated in Fig. 15. Repeat points due to other combinations of harmonics may be distributed throughout the dial range. There is one important combination, namely, when $m=1$ and $n=2$. The fundamental of the signal frequency beats with the second harmonic of the oscillator. A commercial receiver operating on this principle is called the Second Harmonic Superheterodyne. In this receiver the oscillator inductance was made so large that the second harmonic of the generated frequency was of the same order of magnitude as the signal so that when the oscillator was set to bring in a given station the dial reading was approximately the same as that for the radio frequency tuner.

Even in the ordinary Superheterodyne in which the oscillator can be set independently of the radio frequency tuner many of the high frequency broadcast channels can be tuned in on the second harmonic. Let us illustrate by assigning values to our symbols. In the first place m equals unity and n equals 2. Hence our formulas become $H=(S-f)/2$ and $H=(S+f)/2$, which give the two settings for bringing in signal S. Now let the intermediate frequency be 50,000 cycles per second and let the desired signal have a frequency of 1,200. Substituting these values in the above formulas we obtain two values for H, namely, $H=575$ and $H=625$ kc. Both are within the tuning range of the oscillator when this has the same inductance and capacity as the radio frequency tuner. Frequencies much lower than 1,200 could not be received on the second harmonic settings but all higher could.

LIMITED SECOND HARMONICS

When the intermediate frequency is higher and when the oscillator has been designed to receive on only one setting not many broadcast stations can be received on the second harmonic. For example, if the intermediate frequency is 400 kc the lowest frequency of the oscillator is 950 kc. If these values be substituted in the formulas and we solve for S we get $S=2{,}300$ and $S=1{,}500$ kc. One of these is above the tuning range of the oscillator and the other is just on the edge. Hence the 1,500 kc frequency is the only one that can be received on the second harmonic, and this on only one of the possible settings. Thus it would appear that 400 kc is a suitable intermediate frequency from this point of view.

If we make the intermediate frequency 200 kc the oscillator range should be from 750 to 1,700 kc. Putting 200 and 750 in the formulas for f and H respectively and solving for S, we get 1,300 and 1,700 kc. Thus we can receive all stations above 1,300 kc on the second harmonic, provided that the oscillator can be tuned independently of the radio frequency tuner.

The second harmonic of the oscillator is not important enough to exert any influence on the choice of the intermediate frequency. The subject was brought up simply to explain the appearance of certain repeat points. If the circuit has been designed properly repeat points will not cause any interference even if a station could be received with some intensity on the second harmonic.

SAME SIGNAL AT TWO CLOSE POINTS

Sometimes a certain signal can be received at two points close together as illustrated in Fig. 14. The main point may be at P_1 and the other at P_2. The height of P_2 is much exaggerated as compared with that of P_1. The second maximum, P_2, is due to the second harmonics of both the signal and the oscillator and corresponds with $S-f/2$ in Fig. 15, when $S-f$ is the main setting. $S+f/2$ gives another maximum corresponding to $S+f$, but this is usually weaker because $S+f$ is weaker.

These secondary maxima are sometimes confused with similar responses due to close coupling between two tuned circuits in the filter because when two tuned circuits are coupled very closely the rsponse has exactly the shape of the curve in Fig. 14. In some circuits the lower maximum, as P_2, may be due to the combined effect of the two.

If the intermediate frequency is high, the coupling between the oscillator and the modulator loose, and the radio frequency tuner is reasonably sharp, there is no reason for worrying about the multiplicity of repeat points indicated by the formulas just given. The receiver can be arranged mechanically so that only one of the normal settings of the oscillator is utilized without fear that the many repeat points will cause interference.

IMAGE INTERFERENCE

The most perplexing problem that arises in connection with the design of Superheterodynes is that of minimizing the so-called *image interference*. This type of interference is peculiar to the Superheterodyne and arises from the fact that a signal of any given frequency comes in at two normal settings of the oscillator, namely, that at which the oscillator frequency is greater than the signal frequency by the amount of the intermediate frequency and that at which the oscillator frequency is less than the signal frequency by the same amount. For example, if the signal frequency is S and the intermediate frequency is f, then if the oscillator is set at either $S+f$ or $S-F$, the signal comes through the filter, because in either case the frequency f acceptable to the filter is produced with the signal carrier S.

Now suppose there is another signal carrier of frequency S' which has not been tuned out completely at the modulator. This will likewise come through if the oscillator is set at either $S'+f$ or at $S'-f$, for again the frequency f acceptable to the filter is produced in the modulator. Now if the two signal frequencies are related so that $S+2f=S'$, that is to say, so that $S+f=S'-f$, the two signals S and S' will get through at the same setting of the oscillator. Interference results unless one of the carriers has been tuned out completely before it gets to the modulator.

WHY WORD "IMAGE" IS USED

The use of the term *image* to describe the interference is due to the fact that the two normal settings of the oscillator are symmetrically located in the frequency scale about the signal carrier frequency, just as the image and object are symmetrically located with respect to a plane mirror. For example, let S, Fig. 16A, be a plane mirror and let some object be located at $S+f$. The image of this object will appear to be located at $S-f$, the image and object distances being equal. Now suppose there is another plane mirror S', parallel to the first and located a distance $2f$ to the right of S. Let there be another object at the point $S'+f$ to the right of S'. Since the object distances are the same for the two mirrors, and the mirrors are a distance $2f$ apart, it is clear that the image in the second mirror appears to be in the same position as the object in front of the first mirror. That is to say, the image $S'-f$ coincides with the object $S+f$. Of course there is no real coincidence for the image is virtual, not real.

In the electrical case, however, there is real coincidence, for real beat frequencies are produced both with S and S' when the oscillator is set half way between.

LACK OF EXACT COINCIDENCE

In most instances the intermediate frequency of the filter is such that the image of one frequency does not exactly coincide with the object of the other, for this can only happen when the intermediate frequency is an integral multiple of the spacing of broadcast channels, which is usually 10 kilocycles. Even if the intermediate frequency is nominally an integral multiple of this spacing, say 50 kilocycles, the frequency may actually be 49 kilocycles, for example. Moreover, the broadcast stations are not separated by exactly 10 kilocycles, since a deviation of 500 cycles in either direction from the assigned frequency is permitted. Hence, in general there is never exact coincidence between the image and the object.

The case where there is only approximate coincidence is illustrated in Fig. 16B. The two normal settings of the oscillator for bringing in signal S are $S-f$ and $S+f$. Those for bringing in the signal S' are $S'-f$ and $S'+f$. The oscillator, of course, can only be set at

mediate Amplifiers

ared, Image Interference Analyzed

Satterwhite

one point at a time. If the circuit is tuned exactly for bringing in S the oscillator is set at $S+f$ and if it is tuned for bringing in S' it is set at $S'-f$. If the oscillator is set at either point it will beat with both S and S', and two different beat frequencies will be produced. One of these will be that to which the intermediate frequency filter has been tuned and the other will be slightly different, depending on the separation between $S+f$ and $S'-f$. Let us call these two beat frequencies f and f'. These two frequencies will beat in the second detector and produce a squeal, and it is this squeal which is usually called image interference.

It is possible to detune the oscillator so that this squeal disappears, which is done by setting it exactly half way between S and S'. The receiver will then not be tuned to either signal but it may be that one of them can be received with practically no interference, especially if one of the signals has been suppressed considerably before it reaches the modulator. However, since the station frequencies S and S' and the local oscillator frequency all may vary, it is usually not possible to hold this adjustment for more than a second at a time. It is, therefore, impractical to employ this zero beat method of reception, because no sooner has the proper adjustment been made than one of the three frequencies involved will change, thus restoring the squeal.

CAN NOT TUNE OUT SQUEAL

It should be emphasized that this squeal cannot be tuned out by increasing the selectivity of the intermediate frequency filter. In order to do this the selectivity would have to be so great as to tune out the lowest audible tone, and that, of course, would tune out all the desired signals as well as the interference.

The only practical method of minimizing image interference is to tune out the carrier of the undesired signal before it reaches the modulator. That means that the radio frequency tuner ahead of the modulator must be very selective. Ordinarily, a single radio frequency tuner is not sufficient to suppress the unwanted carrier to the point where image interference is not a nuisance. The higher the intermediate frequency the less need the pre-modulator selectivity be for a given suppression of any signal which might cause image interference.

The intensity of the squeal is proportional to the intensities of the two sub-carriers f and f' and these in turn are proportional to the intensities of the two carriers S and S' at the modulator. If the radio frequency tuner ahead of the modulator is so sharp that when it is set for the frequency S, the suppression of S' is practically complete, the sub-carrier frequency f' will be so weak that the audio beat between f and f' will not be of audible intensity. But if S' is not thoroughly suppressed, f' will have considerable intensity. Yet the beat produced between f and f' may be so feeble that it cannot be heard except during moments when the signal carrier S is unmodulated, that is, when no sound impinges on the microphone associated with S.

WHEN BOTH ARE EQUAL

If the heights of the vertical lines erected at S and S' in Fig. 16 represent the intensities of the two signals at the modulator, the case represented is that when both are equal. The radio frequency tuner must suppress one of these, say S', so that its intensity could be represented by only a dot above the horizontal line.

So far we have considered only the beats between the two sub-carriers f and f'. But each of these is associated with two sidebands extending about 10,000 cycles above and below each sub-carrier. It is clear that when the sub-carriers themselves are so close together that they produce an audible beat the sidebands will overlap. The frequencies in one group would beat with those in the other. These beats, however, would not be sustained like the beats between the two sub-carriers, since any given note that impinges on either microphone is not sustained. If one of these notes were sustained for a moment, it is not likely that a sustained note from the other microphone would be sounded at the same time. But just the same, there is room for much clashing and momentary beating.

It is easy to imagine what would occur if the two interfering signals were equal at the modulator and the oscillator were set so that both came through. The result would be about the same as if two orchestras were playing different selections in the same room, the one giving no attention to the other. Indeed, the result would be much worse, for the heterodyne squeal and many other beat frequencies would be present which would not be there if the orchestras were playing in the same room.

Fig. 17 illustrates image interference and the clashing of sidebands. S is the desired carrier and S' that of the interfering signal. The oscillator setting is represented by H, the value of which is such that the beat f is that of the intermediate frequency filter. H

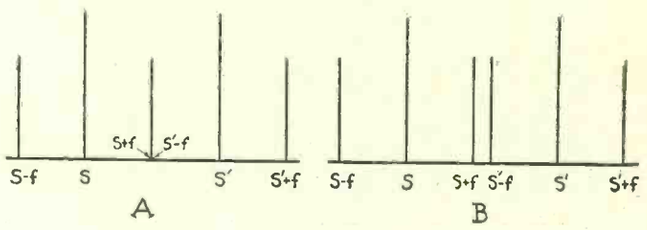


FIG. 16
GRAPHICAL ILLUSTRATION OF THE MEANING OF IMAGE INTERFERENCE

also produces a beat frequency f' with S'. These two beat frequencies are placed lower down the frequency scale to the left in approximately their proper relation. The squeal heard in the loudspeaker is represented by the distance $f'-f$. The short dotted lines symmetrically placed about f' are the outside limits of the sidebands of f', and the short solid lines about f are the outside limits of the sidebands of f. The region of clashing of sidebands is ab.

For illustration let $S'=1{,}000{,}000$ and $S=900{,}000$ cycles per second. Also let the intermediate frequency f be 47,500 cycles per second. The $H=S+f=S'-f'=947{,}500$. Since the difference between S' and S is 100,000 cycles and f is 47,500, f' is 52,500 cycles. The squeal between f and f' will be 5,000 cycles.

As the oscillator dial is turned, the point H moves and both f and f' change in value, and so does the squeal produced by the beating between the two sub-carriers. The volume of sound from either signal also changes, the maximum occurring when a sub-carrier is equal to the frequency to which the filter is tuned.

CHOICE OF INTERMEDIATE FREQUENCY

When the intermediate frequency is very low, for example, 30,000 cycles per second, the radio frequency tuner has to be exceptionally selective in order that a signal carrier causing image interference may be tuned out effectively. For example, suppose the two signals are 1,500 and 1,440 kilocycles and the second of these is desired without any interference from the first. When the oscillator is set at 1,470 kc both signals will come through the filter unless one of them has been tuned out completely before it reaches the modulator. If we wish to receive the 1,440 kc signal we tune the radio frequency circuit to this frequency.

But the other signal is only 60 kc away, and therefore it requires a high selectivity to cut it out. Even in many ordinary receivers the 1,500 kc signal would interfere considerably with the desired signal.

In a Superheterodyne the interference from the beating of the two sub-carriers would be much more severe than the direct interference between the two signals in the ordinary receiver. Hence the selectivity in the radio frequency level would have to be greater in order to reduce the squeal to a value below audibility.

ARGUMENTS AGAINST LOW INTERMEDIATE FREQUENCY

This is one reason for not using a low intermediate frequency. Another reason we have already stated, namely, that if the IF is low the selectivity of the filter is likely to be too great. There are other reasons. For example, if the intermediate frequency is low it is difficult to separate it from the audio frequencies in the plate circuit of the detector by means of the usual by-pass condenser and radio frequency choke. If the intermediate carrier is suppressed thoroughly by these devices, the higher audio frequencies are also suppressed. The effect of this is the same as excessive selectivity in the tuned filter, namely, absence of high notes and excessive bass in the loudspeaker. Music would lack brilliancy, speech would be muffled, and consonants would be indistinguishable. Still another reason for avoiding a low intermediate frequency is the tendency of the oscillator frequency to be pulled over to the natural frequency of the radio frequency tuner. This effect was discussed under modulating circuits.

As the intermediate frequency is increased these difficulties become less and less important. Suppose, for example, we use an intermediate frequency of 200 kc. If now we want to receive a signal on 1,440 kc the oscillator can be set at 1,640 or 1,240 kc. The 1,500 kc signal will no longer interfere. There are two possible signals which could interfere, namely, 1,840 and 1,040 kilocycles. Each one of these differs from the frequency of the desired signal by 400 kc, twice the value of the intermediate frequency. It does

Image Interference

How It Arises and What Remedies Apply

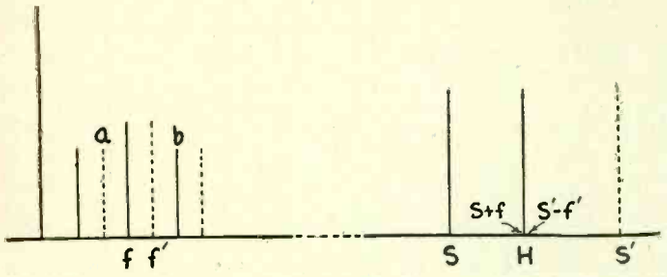


FIG. 17
THIS ILLUSTRATES HOW THE SIDEBANDS CLASH IN A RECEIVER IN WHICH THERE IS IMAGE INTERFERENCE

not require a very selective circuit to tune out a signal differing by such a high value.

It is also relatively simple to separate in the plate circuit of the detector by means of RF chokes and by-pass condensers a frequency of 200 kc from one of 10 kc without appreciably suppressing the lower frequency. Also with a 200 kc difference between the tuned circuits there will be no tendency for the two to "pull together." The selectivity in the IF level need not be so great that it would suppress the sidebands, because the RF selectivity is effectively much greater.

It is possible to use a still higher intermediate frequency, and, indeed, some circuits have been built with a frequency as high as 400 kc.

BAD EFFECTS OF HIGH INTERMEDIATE FREQUENCY

There are, however, certain undesirable effects that enter when the frequency is high. For example, it is not possible with a simple tuner in the oscillator to cover the necessary frequency band to bring in all the signals in the broadcast band on both the possible settings of the oscillator. Suppose the intermediate frequency is 400 kc. To bring in 550 kc, the lowest channel in the broadcast band, the oscillator could be set at either 150 or 950 kc. To bring in the highest broadcast frequency, 1,500 kc, the oscillator could be set at either 1,900 or 1,100 kc. In order, then, to bring in all the broadcast frequencies on both the possible settings, the tuning range of the oscillator would have to be from 150 to 1,900 kc. Such a range is not practical, for it would require plug-in coils or an equivalent arrangement for extending the range, such as taps on the oscillating coil.

However, when the intermediate frequency is of this order of magnitude, there is little need for covering this wide range, for the only reason for doing so would be to provide an alternative setting in case there is image interference on one of the normal settings; and when the intermediate frequency is as high as that assumed above, the radio frequency tuner is quite effective in eliminating image interference. Therefore the oscillator may be designed to receive on either the lower or the higher setting, but not on both. There are two reasons why the higher setting is ordinarily selected. First, the signals are louder on this setting; second, oscillator need not cover as wide relative frequency range.

SOME AT BOTH SETTINGS

When the higher setting is used the oscillator is designed so that the range is from $550+f$ to $1{,}500+f$, in which f is the intermediate frequency employed. Therefore if f equals 400 kc, the frequency range of the oscillator is from 950 kc to 1,900 kc. If the intermediate frequency is 200 kc, the range of the oscillator should be 750 to 1,700 kc.

It is clear that if the oscillator can be adjusted independently of the radio frequency tuner, some of the broadcast stations can be received on both settings even when it has been designed to receive on only one. For example, suppose the intermediate frequency is 400 kc. The lowest frequency of the oscillator is 950 kc, as we found above. Since 1,350—400 equals 950 kc, it is clear that any station having a frequency of 1,350 kc or higher can be received on the lower setting as well as on the higher.

When a Superheterodyne is designed to receive on the higher oscillator setting only, the tuning mechanism is usually arranged so that only one setting is possible and so that the oscillator is set at this automatically when the radio freguency tuner is set for the signal carrier. A Superheterodyne so arranged is usually called a "one-spot," but as we have found above, a true "one-spot" is not possible. Arranging the tuning mechanism in any way does not alter the electrical features of the circuit; it merely makes it impossible to select one of the points. If there should happen to be image interference on the only available setting, that would be unfortunate. But, as we have emphasized, when the intermediate frequency is high and the pre-modulator tuner is selective, there is little likelihood that the image interference will be of nuisance intensity.

Thirteen Unlucky Causes of Hum

The following are thirteen causes of hum in power amplifiers:

(1)—Excessively large capacity in the B suppy filter next to the rectifier tube. When an electrolytic condenser of large capacity is used in this place the hum is frequently very great. At other points in the filter large capacity is advantageous.

(2)—Saturated filter chokes. If the current drawn from the B supply is greater than that for which they have been designed hum results, because the inductance of the chokes is too low. Sometimes chokes are rated so optimistically that even when the current is less than rated value there is considerable hum due to saturation.

(3)—Unbalance of the filament circuit of a three-element tube heated with AC. The center tap of the filament winding may not be in the center or tapped resistor used in place of a center tap on the winding may not be accurately center tapped. The grid or plate return leads, or both, may be made to one side of the filament winding.

(4)—No connection of the heater winding of a 227 tube and the cathode or equivalent point. When the heater winding midtap is left unconnected there is usually a pronounced hum. This tap should be connected directly to the cathode or to a positive or negative point on voltage divider, or equivalent point. The connection of least hum in any particular case can be found by trial in a few minutes.

(5)—Improper bias on an amplifier tube sometimes results in hum, especially when the grid goes positive.

(6)—In some instances hum results when the plate current for any reason is lower than a certain value depending on the tube.

(7)—An open grid circuit on the low potential side often gives rise to hum. The open does not necessarily make the circuit inoperative.

(8)—Close proximity of a wire carrying alternating current to a grid lead in an amplifier. The hum is carried over by capacity coupling between the grid and the AC wire.

(9)—Sometimes hum results from lack of grounding cases and cores of audio and power transformers.

(10)—Oscillation in the amplifier or in the radio portion of a receiver. The oscillation may be at any frequency whatever. For example, it may be a very high, parasitic radio frequency oscillation, or an oscillation in the tuning range of the receiver. Again, it may be an oscillation at audio frequency due to feed back through the B supply. This oscillation may even be above audibility, or again, below the audible limit. Regeneration is also a possible source of hum since it is the same thing as oscillation. If the regeneration or weak oscillation occurs near the hum frequencies, that is to say, 60 or 120 cycles, the hum is likely to be very severe.

(11)—Inadequate filtration of the field current in a dynamic speaker. This is often a source of strong hum when the speaker is exceptionally efficient on the low notes, as most dynamic speakers are.

(12)—Overemphasis on the low notes in the receiving system. This may be due to excessive selectivity, by-passing or choking of the higher audio frequencies, intentional regeneration or resonance effects at a low frequency, or to any effect which accentuates the low notes in comparison with the high notes. This is purely a relative effect. Since the hum frequencies are low, whenever the bass is accentuated the hum is brought out prominently.

(13)—Defective parts. In some instances the hum can be traced to a defective part in the B supply or in the amplifier, such as a punctured condenser, a burnt-out resistor or an open coil.

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CONDENSER NEXT TO RECTIFIER

SOMETIMES I see a 1 mfd. filter condenser specified for placement next to the rectifier in a B supply, sometimes 2 mfd., once in a while 8 mfd. Which is correct?—G. F. U.

All are correct. The higher the capacity, the higher the effective voltage at the output, due to the lower impedance of the higher capacities. Also, the higher capacities reduce the hum more, up to a certain capacity value, although they cause a heavier strain on the rectifier tube's filament due to high charging at starting.

* * *

WHICH TUBES CAN BE REACTIVATED

WHICH tubes can be reactivated?—F. J. V.

Those with thoriated tungsten filaments, not to those with oxide coated filaments. Hence reactivation may be applied to the 199, 120, 220A, 201A, 222, 240, 112, 171 and 210, but not to the 11, 12, 112A, 171A, 200, 226, 227, 228,, 280 and 281. See the issue of September 7th for data on reactivation.

* * *

ACTION OF LEAK AND CONDENSER

IN using a grid leak-condenser detector, are electrons caused to accumulate on the grid, or do all of them flow away through the grid leak?—V. O'T.

With positive grid return, and grid leak-condenser detection, the grid voltage becomes positive in respect to the filament, and electrons accumulate on the grid. The condenser prevents most of the electrons from escaping the grid, so the grid leak is used. A few tubes do not require the leak, e.g., the 200A, as there is leakage enough through the conducting path inside the tube. The value of the grid leak is determined by the period of the audio frequency variations, and usual values are from 2 to 10 meg., with a preference for a medium value. This supposes the use of a .00025 mfd. grid condenser. The capacity of the condenser affects the value of leak resistance, as some of the electron charge on the grid can leak off through the condenser.

* * *

THE CIRCUIT HE WANTS

ONE circuit I have a fancy for is a four tube design with shielded one stage of radio frequency amplification, shielded detector input, and two stages of high-class audio. It seems to me this circuit is abundantly useful, and sensitive and selective enough, if properly designed. Has such a circuit been published recently in your columns, and if not, why not?—T. F.

Such a circuit is attractive, and meets the requirements that you set forth. It has not been published recently in these columns. Design work is now under way on such a circuit, embodying the HB compact, battery model, in shielded form, and also a four-tuned-circuit screen grid radio frequency amplifier and detector. First the four tube design will be published in a few weeks, then the other, in about two months.

* * *

USE OF AN ARRESTOR IS ADVISABLE

IS it necessary to install a lightning arrestor in connection with a radio receiver? Is not the aerial itself a lightning arrestor?—D. W.

It is advisable to instal an approved lightning arrestor. This means one approved by the National Board of Fire Underwriters, which require it. An aerial does not serve as a lightning arrestor, even if it is grounded.

* * *

HE HAS HIS DOUBTS

I HAVE assembled a receiver of the best parts that I could obtain, judging the quality by price, reputation and available engineering data, as well as by the claims of the manufacturers. But judging by the sound the darn thing produces I suspect that I attached too much importance to these factors. It needs no acoustic expert or a skilled musician to tell that the quality is rotten. May be you can suggest where the trouble might be.—E. L.

Not knowing what parts you did use, it is impossible for us to sav whether you attached too much weight to the price, the reputation of the parts, or the claims of the manufacturers. It may be that you did not get the original engineering data but only what was left after a commercial artist had retouched the curves.

Then, again, it may be that every part you have is as good as could be expected and that it is the combination of these parts which is at fault. It is no trick at all to take the best parts and make a terrible receiver out of them. You may not have attached enough weight to warnings and suggestions to use by-pass condensers and filters in the p'ate circuits. Possibly you used a condenser here and one there and thought that one of 2 mfd. would work as well as 50 mfd. If you skimped on the little things after you had bought a good set of parts, you deserve all the rotten quality you are getting. Fortunately, omissions of this nature can be rectified without much trouble and expense.

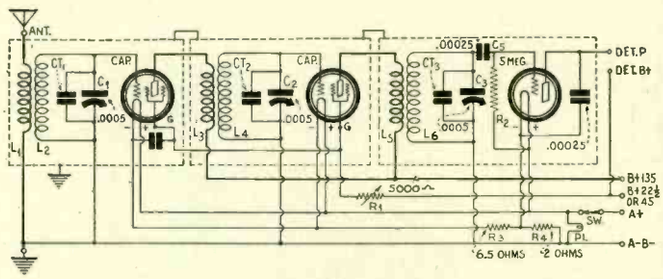


FIG. 802
WHEN SCREEN GRID TUBES ARE USED SHIELDING SHOULD BE DONE THOROUGHLY AS ILLUSTRATED HERE.

RECEIVER STOPS PLAYING SUDDENLY

MOST of the time my receiver, which is well rated, works satisfactorily, but once in a while it stops playing with a plop or a click. Can you tell why it behaves that way?—C. F. W.

There are many conditions in a receiver any one of which might account for the stoppage of the signals. The most likely condition is that of oscillation. The set plays all right until the circuit breaks into oscillation, when the signals either stop entirely or become weak. Too much feedback in the radio frequency amplifier is the cause.

There is also the possibility of a defective part, such as a by-pass condenser, choke or transformer. The insulation may be all right when the set is cool, or when moderate signals are being received, but it may not be able to withstand the stress when the receiver has warmed up or when there is a sudden burst of static or similar disturbance.

* * *

TUBE FOR POWER DETECTION

I HAVE an AC receiver equipped with a detector of the grid condenser and leak type and I want to change over to power detection. What tube do you recommend for detector? I understand that to make power detection successful it is necessary to increase the radio frequency amplification. Is that correct?—A. J. B.

The 227 type heater tube is about as good as any other. If you use that type of tube now there is no reason for changing. Just change the circuit to conform with the requirements of power detection. Yes, you should increase the radio frequency amplification considerably.

* * *

REPLACING CONDENSERS

THE by-pass condensers across the B supply leads in my receiver have been punctured. Is it safe to use condensers designed for 600 volt DC service when the highest normal voltage applied to the amplifier is 300 volts?—E. A. J.

A safety factor of 300 volts ought to be enough, especially in view of the fact that the 600 volt condensers are rated with a high safety factor in the first place.

* * *

SHIELDING STAGES IS ADVISABLE

I AM contemplating building a sensitive radio frequency amplifier and detector employing screen grid tubes. If I use no more than two screen grid tubes ahead of the detector do you think that shielding of the stages is necessary? If you do, please show, or tell, how it should be done. Is it necessary to shield each screen grid tube if it is inclosed inside a shielding can containing the coil and the condenser?—E. B. W.

It is highly advisable to shield thoroughly, and a good way of doing it is shown in Fig. 802. The dotted lines are the outlines of aluminum or steel boxes. These boxes should be connected together and grounded. It is unnecessary to shield each tube separately although it may be of some value to do it.

* * *

DOESN'T KNOW BATTERY POLARITY

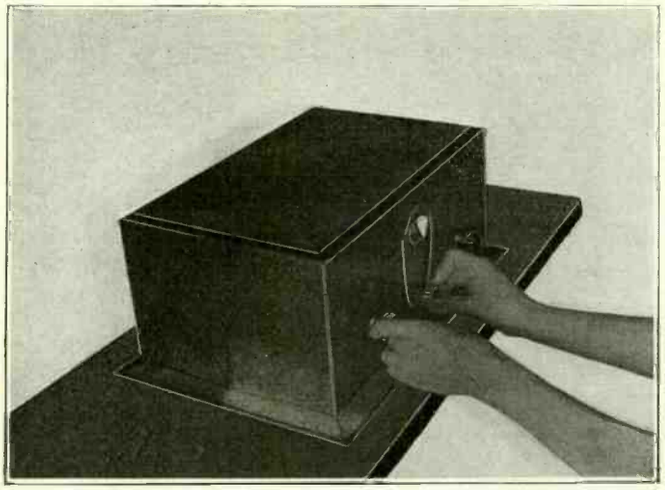
I DO not know offhand what the respective posts are on my storage battery, but one of them accumulates some corrosion. Which one is this?—D. Z.

The corrosion usually is greater at the positive post. You can determine the polarity of the battery with a DC voltmeter. When the side of the meter marked (+) is connected to positive of the battery the other meter lost to negative, you get a reading. Otherwise the needle kicks back, that is, goes below zero. Be careful not to leave the meter in circuit in reversed fashion or you might injure the meter.

Radio for

The Creation and Transmiss

By J. E. Anderson and



WHEN TUNING IN A SELECTIVE, SHORTWAVE RECEIVER LET THE HANDS REST ON SOMETHING FIRM, LIKE THE TABLE TOP.

[*This is the first instalment of the book, "Radio for Schoolboys," never before published. Read* RADIO WORLD *each week so that you will not miss a single instalment of this interesting and important contribution to radio literature.—Editor.*]

CHAPTER I
The Origin of the Wave

BETWEEN the antenna of a broadcasting station and the receiving antenna of your home radio waves travel, and they can be tuned in with your receiver. They do not travel this distance on or through wires. They travel instead through air. They go up as high as a negatively charged layer of atmosphere, called the Kennelly-Heavyside layer, and penetrate to some extent into the earth itself.

Something moves when these waves of high frequencies travel. It is not the air, for the air at the sending point may never reach the receiving point. It is not the ground, or otherwise there would be miniature earthquakes as radio waves are sent out.

When a wave is radiated the surrounding medium, in this instance air particularly, conducts the electrical agitation. You can imagine a pipe conducting water. The water moves, the pipe is still. The air, however, is not a confined conductor, but carries the wave in all directions, as if some impulse were started from the center of a circle and conducted away from its point of origin on an infinite number of infinitely long radii of the circle. On the basis of this idea of infinite radii the wave when transmitted is said to be radiated.

SOUND WAVES AND RADIO WAVES

Sound waves are of lower frequencies than radio waves, but have some points of similarity with radio waves. If a string of a violin is plucked, a note will be heard, because the string has been set into vibration, and the surrounding air is made to conduct this vibration. You hear the note because the vibration has been communicated through the air to the diaphragm of your ear, which vibrates at the same frequency, hence you hear the note.

There are many differences between sound waves and radio waves.

Sound waves travel at the rate of about 1,100 feet a second. Radio waves travel at the speed of light waves, about 186,000 miles a second. Hence radio waves travel about 900,000 times as fast as sound waves and at a speed that would carry radio waves around the 25,000 mile circumference of the earth about 7½ times in one second.

Sound waves are audible, but radio waves, because too high in frequency to gain any response in the human ear, can not be heard. Thus is the difference in frequencies made obvious.

A radio wave is produced electrically, by use of voltages and currents. A sound wave is produced mechanically, as by striking or otherwise vibrating something by impact. Sounds also may be produced electrically, as by uniting two inaudibly high frequencies that differ from each other by some audible frequency. The audible result is called a beat note.

A door bell, the armature of which is caused to strike against the bell when current passes through a coil of wire, so that the armature is attracted and repelled and causes the ringing, is an example of physically produced sound. The blow of the armature or hammering rod against the bell produces the sound. The fact that electricity was used to cause the movement does not change the aspect from mechanical to electrical.

WORK PERFORMED BY THE STATION

So, at the broadcasting studio, physical vibrations, produced by air actuating vocal chords, saxophones or cornets, or by direct impacts, as sticks beaten against drums, are created. These are sounds.

The problem is to enable the possessor of a radio receiver to hear a faithful copy of these sounds from his loudspeaker.

To produce this result, the station performs the following tasks:

The station furnishes the program.

The station provides a microphone, or several microphones, at the point of origin of the program, which is usually at the studio. The microphones, sensitive to the sound, are charged with voltage, and the variations in frequencies and intensities of the sounds picked up by the microphone, cause corresponding variations in current and voltage in the microphone circuit. These variations are conducted by wire to a circuit, consisting of vacuum tubes, which amplifies them. The circuit in which this magnification takes place is known as an audio frequency amplifier because it amplifies frequencies that are in the audible range. The volume of amplification is controlled by an operator at the control board. The product in its present state can not be heard, because of the conversion that has taken place, whereby the sounds themselves, with the aid of the voltage-operated microphone, have been transformed into corresponding variations in electric current and voltage. But a reproducing device connected in the circuit, such as earphones or loudspeaker, would render them audible, in the same way as in a home radio receiver.

The station operates also a radio frequency circuit, tuned to the frequency officially assigned to it, and which has a corresponding value of wavelength. This radio circuit is so arranged that a vacuum tube is caused to generate a wave of the assigned frequency. As a variation of more than 500 cycles from assigned frequency limits is forbidden, a steadying device is used to maintain the station's frequency constant.

Elementary Fact

(*Continued from page* 9)

end-to-end or side by side. The closer the two coils are associated geometrically the greater the effect of the primary on the secondary because the more of the magnetism of the first will thread the second. When much of the magnetism of the first threads the second, the two coils are said to be coupled closely, or tightly, and when little of the magnetism of the first threads the second, they are said to be coupled loosely.

When the axis of one of the coils is at right angles to that of the other the coupling is zero, even when one is inside the other, because in this case there is as much magnetism threading the secondary in one direction as in the other, and the net effect is zero. When one coil is outside the other there are certain other positions, when the axes are not at right angles, which give zero coupling because the magnetism threads the secondary in such manner that the emf induced in some of the turns cancels that induced in the other turns. The coils are then said to be electrically at right angles.

The simplest alterating current is the simple harmonic, or sinusoidal, illustrated in Fig. 5. The curve is called a sinusoid, or simply a sine curve, and in this case it illustrates how an alternating current of this type varies with time. The current intensity at any given instant t is given by i. The value of i varies from zero up to Io, the maximum in the positive direction, then it goes down to zero again, thus completing the positive half of the cycle. The same sequence takes place in the negative direction, attaining a maximum negative value of Io. At T the cycle is completed and a new cycle starts.

INTENSITY PROPORTIONAL TO RATE OF CHANGE

The magnetism associated with the first coil in which i is flowing can be represented by the same curve as the current

Schoolboys

ion of the Modulated Wave

Herman Bernard

The station unites the audio frequency pulsations, as received from the microphone line, with the radio frequency generated by the radio circuit. The tube that finally handles the audio frequencies is called the modulator, and the tube that generates the radio frequency is called the oscillator. The output of this combination—audio frequencies of varying frequencies and strength, mixed with a radio frequency of steady frequency and strength—is fed to the antenna, and this combination is the radiated radio wave. It is always changing considerably in strength, and slightly in frequency, to the extent determined by the modulator.

SILENCE UNDER THE ANTENNA

Just as two inaudible frequencies, differing from each other by a frequency that is audible, may be united to produce a beat note, so may an audio frequency be united with a radio frequency, but the result will not be a note. It is possible to have a note only when something can be heard. If a product of two frequencies is still too high to be heard, it is in the region of radio frequencies.

Therefore if you stand under the antenna at a transmitting station, you hear nothing, for nothing that can be heard is impressed on the antenna. The fact that the station's assigned frequency was generated by the oscillator, and that the output of the modulator was mixed wih this generated radio frequency, left the products still inaudible.

The reason is apparent when you consider that the audio frequencies picked up by the microphone range from about 25 cycles to 5,000 cycles, while the radio frequencies used in broadcasting range from 550,000 cycles to 1,500,000. So if the highest audio frequency were added to or subtracted from the lowest broadcast frequency, then

550,000—5,000=545,000
550,000+5,000=555,000

This is a total difference of 10,000 cycles, and is the frequency width allowed to broadcasting stations, and is called a channel.

Different persons, as well as the same person at different ages in his life, have different upper limits of hearing, but it is not to be expected that anybody, except by special training of the ear, will hear a frequency as high as 20,000 cycles. Therefore 545,000 cycles is enormously beyond the range of hearing.

CARRIER AND SIDEBANDS

The mixing of the audio part, or component, with the radio part therefore leaves only radio remaining. But this radiated wave is not of one frequency or intensity. It is changing in frequency as affected by the audible frequencies emanating from the modulator tube.

If the frequency of the transmission wave is 1,000,000 cycles (300 meters) and a 2,000 cycle note is played before the microphone, the frequencies sent out are 1,000,000—2,000 or 998,000, and 1,000,000+2,000, or 1,002,000 cycles. Besides these the originally generated wave, the so-called carrier, is transmitted. Therefore there are three frequencies, all of them radio frequencies:

(1) The carrier frequency. (2) The frequency equal to the sum of the carrier and the modulation frequencies, called the upper sideband. (3) The frequency equal to the difference between the carrier and the modulation frequencies, called the lower sideband.

Besides there are other frequencies, resulting from complex combinations of the two resultant frequencies with the carrier and with each other, but these are of very slight intensity, and means are usually employed to prevent the radiation of unwanted combinations.

The result is referred to a wave and it is fed to an additionally charged transmitting aerial. The wave travels back and forth between antenna and ground as many times a second as the frequency of the wave.

Thus the transmitting antenna is said to be oscillating, because of these almost unbelievably rapid reversals of current and voltage taking place in it. The surrounding media conduct this periodic agitation. At many points along the infinite route receiving aerials are charged by the same frequency of voltage and current. All the stations on earth produce an effect upon all the aerials on earth, but receivers to which these aerials are attached are only sensitive enough to make something intelligible out of the strongest of the impulses.

It has been said that the air conducts the radio waves. It is true. But it has become popular to refer to the conducting medium as the "ether," although a scientific definition of what the "ether" is has yet to be advanced. It is convenient to use the term, however, as referring to the conducting medium, as then one need not consider whether it be air, ground, rock, salt, water, or what-not. The fact is that the air is not a selected agency but an inevitable one.

(*Continued next week*)

s About Induction

curve. But the emf in the secondary cannot. It will be recalled that the insensity of the induced voltage is proportional to the **rate of change** of the magnetism threading the secondary coil. This rate of change is greatest when the current is zero, and is zero when the current is maximum. Therefore the emf curve starts with the maximum value *Eo*, and as the current increases to *Io* the emf decreases to zero. As the current decreases to zero, the emf increases to *Eo* in the negative direction, and so on.

The emf curve is also a sinusoid, but it is displaced one quarter of a cycle with respect to the current curve, or what amounts to the same thing, 90 electrical degrees. The simple shape of the emf curve assumes that the transformer is air core. When there is iron present a simple current curve does not produce a simple emf curve.

The term emf is an abbreviation of **electromotive force,** which means a force that drives current around a circuit whenever a circuit is completed. When the circuit is open the emf can be regarded simply as an electrical pressure. If emf is measured in volts, as is usual, it can also be called voltage. Hence the terms emf and voltage may be used interchangeably.

Whenever induced current flows work must be done on the circuit. When one coil carrying current is brought up or pulled away from the secondary, or when a permanent magnet is moved similarly, the work is done by the person, or the machine doing the moving. There is no exception to this statement. The direction of the induced current is always such as to oppose the motion producing it, and since the current is in the same direction as the induced emf, the electromotive force is also in the direction which tends to oppose the motion. This is known as Lenz law, which is only the electrical phase of Newton's general law that "to every action there is an equal and opposite reaction."

IS AN ANTENNA NEEDED?

I HAVE AN MB-29 receiver and it is enormously sensitive. I use no ground and for an antenna is used only a few feet of wire. If I use my old outdoor antenna the signals are not as good when I use only the few feet of wire. Does not this prove that an antenna is not needed for radio reception?—H. C.

You may not have run a wire to a cold water pipe for a ground but that does not say you are not using a ground, or its equivalent, a counterpoise. The fact that you get better signals with the short wire than with the long antenna simply proves that the set is too sensitive for use with the outdoor antenna. It does not prove that you don't need an antenna, for you are using one. That short wire is all the antenna you need.

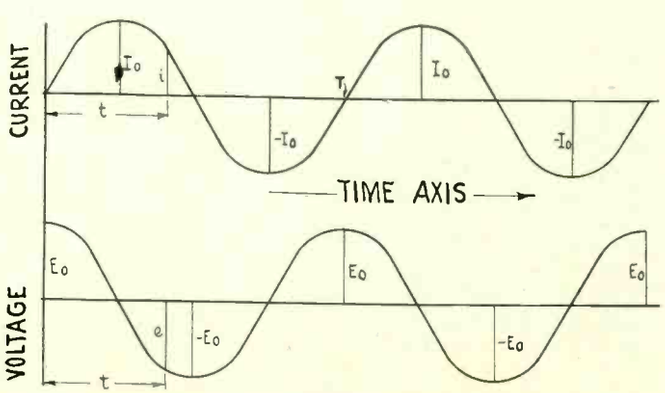


FIG. 5

CURVES ILLUSTRATING THE RELATION BETWEEN INDUCING CURRENT AND THE INDUCED VOLTAGE.

Right or Wrong?

[Here are ten more questions. They are based on material published in last week's issue of Radio World. *If you read that issue carefully you should be able to answer the questions. Verify your efforts by consulting the answers herewith. Next week's questions will be based on material published in this week's article.—Editor.]*

QUESTIONS

(1)—A by-pass capacity is not necessary in the plate circuit of a detector to secure good detection efficiency.

(2)—The squeal that once was the curse of radio is about to be harnessed and put to use in a musical instrument.

(3)—In order to operate successfully a receiver on the power detection principle it is necessary to increase the radio frequency amplification considerably.

(4)—In every normal Superheterodyne there is at least two settings of the oscillator at which any signal of given frequency comes in.

(5)—In a Superheterodyne it is not possible to make use of the harmonics of the oscillator frequency for receiving.

(6)—A vacuum tube voltmeter can be calibrated in terms of effective AC voltages by means of an AC milliameter and a known resistance.

(7)—The best oscillator for a Superheterodyne is one in which neither side of the oscillator condenser can be grounded.

(8)—The best modulator, or first detector, in a Superheterodyne is one in which the oscillator is coupled very closely to the modulator, because this gives the greatest response.

(9)—A given note on a musical instrument has always the same frequency of vibration. For example, A always has a frequency of 435 cycles per second.

(10)—A Superheterodyne will work even if the oscillator stops.

ANSWERS

(1)—Wrong. If the capacity across the audio load in the plate circuit were zero, there would be practically no detection. This does not mean that good detection cannot be obtained when no condenser is put in the circuit. There is usually enough stray capacity, or plate to filament capacity, to make the circuit operative.

(2)—Right. The Theremin ether music instrument is based on this squeal and it is about to be placed on the market by a large radio corporation.

(3)—Right. If a large radio signal voltage is not impressed on the detector, it is not a power detector, simply a grid bias detector.

(4)—Right. One setting is obtained when the oscillator frequency is the difference between the signal frequency and the intermediate frequency and the other when the oscillator frequency is the sum of the signal frequency and the intermediate frequency. These settings are twice the intermediate frequency apart on the oscillator dial.

(5)—Wrong. If the oscillator frequency is made low enough the second, third or any other harmonic could be used for mixing with the signal frequency. But it is not advisable because the harmonics are weak compared with the fundamental. Yet one commercial Superheterodyne was made that employed the second harmonic.

(6)—Right. That is how such a meter is calibrated. The milliammeter gives the effective value of the current and when this is multiplied by the known resistance, the effective voltage drop in the resistance is known.

(7)—Wrong. The best oscillator is one in which one side of the condenser, the rotor, can be grounded. The only reason it is better is that grounding prevents body capacity.

(8)—Wrong. This is the worst kind of modulator because it generates many repeat points. It is true that it is sensitive.

(9)—Wrong. The frequency of any note depends on what pitch is used. The frequency of A varies from 400 cycles per second to almost 500 cycles. In the international pitch the frequency is 435 cycles per second.

(10)—Wrong. When the oscillator stops, the Superheterodyne is dead, for it is the heart of the circuit. But it is only dead up to the first detector. If a lead be run from the plate of that tube to the plate of the second detector the receiver is an ordinary receiver.

A THOUGHT FOR THE WEEK

PERHAPS you've been wondering why the names of RCA and other big concerns have been linked up with those of music publishers. The explanation is simple. Radio, motion picture and theatrical interests are paying vast sums in royalties annually to the music publishers through the American Society of Composers, Authors and Publishers. If the R.C.A. or others interested could control the royalty situation it would mean they would be paying large sums into their own treasuries. A small matter of only a few millions of dollars is involved.

Diamond Circuits

(Continued from page 11)

current drain overload, may be used. Overloaded B supplies hum badly.

The battery model is highly recommended to those persons who have no alternating current supply in their homes, for it will give abundant service, plenty of volume, an unusual wealth of distance reception, and good tone. The sensitivity is high. The parts cost $23.88.

The same fundamental circuit has been arranged for AC operation, only such changes being made as the A, B and C supply demanded, except that the volume control is a potentiometer varying the voltage to the screen grid of the radio frequency amplifier. This was done because it is objectionable to tamper with the heater or filament voltages of AC tubes.

THE AC MODEL PUSH-PULL DIAMOND

On the opposite page is published the schematic diagram of the AC model. The same coils and tuning condensers, the same front panel appearance, including National modernistic drum dial with color wheel, and the AC equivalent of the tubes used in the battery model, are used, except for the push-pull output stage, where two 245s are inserted. It is not practical to use the 245 with filament or plate batteries, because of the heavy drain, but in an AC circuit they make an exceptionally fine push-pull output pair. They provide a maximum undistorted power output considerably in excess of any signal possibility in this receiver, but that is a precaution taken wholesomely.

A special output choke for push-pull is required, one that will pass 100 milliamperes without heating, and handle a heavy signal without saturation of the core. The push-pull output device in the battery model is designed for and used with a considerably lighter load.

Both the push-pull output impedance and the voltage divider were specially designed for this circuit, although of course useful in other circuits where heavy current flows. The coil and core are as husky as you would expect for filtration in a B supply, which shows that special pains were taken to assure an instrument that would not yield under the strain.

MULTI-TAP VOLTAGE DIVIDER

The voltage divider has fourteen taps over a total resistance of 13,850 ohms. The 180-volt tap is 1½" away from the high end, the 135-volt tap is 2¼" away from the 180-volt tap, while the 75-volt tap (not used in this circuit) is 1¼" away from its predecessor.

The voltage divider consists of two separate resistors, one atop the other, mounted on a bracket and joined together by a wire connecting two lugs, so there are fifteen taps, only fourteen of them effective, as two represent one voltage. This is normally the 50-volt tap, in single-sided circuits, but for push-pull a tap lower down is used, on the other resistor tubing that has ten taps on it, all about equi-distant.

The object of a multi-tap resistor is to give the versatility of a group of variable resistors, without the expense and uncertainties of operation that might attach to an adjustable resistor that carries so much current.

The voltage divider brackets are insulated from the resistance wire. The divider is 7½" long and 3¾" high.

[The article on the construction of the AC Model Push-Pull Diamond of the Air will be begun next week, in the November 2nd issue of Radio World.—Editor.]

Popular Power Amplifier

(Continued from page 5)

If the tuner uses grid leak and condenser detector, use 50 or 90 or 135 volts on the plate, which ever works best, and that fact will be determined largely by the type of tube used. For the 227 the plate voltage may be 50 or 90, but for the 228 it should be 135. For power detection, meaning high plate voltage and high negative bias without leak and condenser, the plate voltage should be 135 to 180 and the negative bias whatever affords best detection. For the 227 tube, at 135 plate volts, the 16 volt negative bias often is superior, but if for any special reason better results are obtained with 22 volts bias or 10 volts, use this.

The recommendations made herein are indicative only. Results themselves are the best ultimate guide. Experience will show the way readily.

A push-pull input transformer is used to feed the power tubes, a center-tapped output impedance to couple the speaker to the push-pull pair. The connection diagrammed is corr
Signal current alone flows through the speaker, so no additional output device is needed for any type speaker. The direct current flows through the two sections of the center-tapped impedance coil.

Forum

A FRIEND SPEAKS HIS MIND

FOR some time I have been a subscriber for RADIO WORLD, and a reader for considerably longer.

Probably I am representative of a large class of readers interested in radio largely for recreation, combined with an occasional opportunity to turn a dollar or two profit. In fact I believe that fully 90% of your readers are in this category. Engineers are not likely to be much interested and mere listeners are more likely to buy a magazine devoting more space to broadcast gossip.

Why do you publish a complete list of United States stations practically every week, and ignore the Canadian stations, many of which are regularly received over broad territory in the United States? Toronto stations are heard everywhere in the Middle West, North of the Ohio River, and give access to the excellent chain programs of the Trans-Canadian Broadcasting Co. CKGW, of Toronto (now on 690 kc) and CFRB of Toronto (960 kc) are powerful and have good local programs in addition.

Why do you publish the whole list every week, anyway? We all have our logs. We know where the stations have been. What we want is the *changes*. Why not publish a list of changes?

Another thing I would like to see changed is the arrangement of copy. Frequently I want to save an article but find that it is backed up by another article which I also want to paste in my scrapbook, but find myself faced by the necessity of scrapping either one article or the other, as the issue is usually off the stands before I get around to cutting out the articles worth saving.

Cannot it be so arranged that the magazine be so paged that a good article can be segregated in this way? So that two good articles can both be saved without being mixed together?

I have greatly appreciated the series of articles by Mr. Anderson and Mr. Bernard on audio amplification, a subject in which I am particularly interested.

Another interesting article was one entitled "The Curse of Zero Beat," which cleared up several points which had long been troubling me. Also the various articles on push-pull resistance coupling have been worth reading. One thing I have not quite been able to understand is why you have published, several times, resistance coupled push-pull circuits, but explained that none of them will work, as the circuit is bound to be one-sided, either one side dead or else in similar phase. I cannot see where the circuits suggested in Mr. Anderson's article of October 5th are of any help, as the difficulty of balancing the circuits would be virtually prohibitive, apart from the complication of the circuit.

I should like to open up a field of discussion. Essentially, impedance coupled amplifiers (ignoring problems of hysteresis and direct current supply) should follow the same rules as resistance coupling, and therefore, I should conclude that an impedance-coupled push-pull amplifier would be equally impossible. Am I right? An article on this subject, repeating and amplifying the theory of operation of push-pull, would be interesting reading.

Granting that I am right about the impracticability of impedance couple push-pull, then how about autoformer coupling suggested by Kendall Clough? Silver-Marshall have thought well enough of this circuit to manufacture special transformers (257 and 227) to make use of it. I have myself built an amplifier using these Clough push-pull units. The quality is exceptional. But I cannot see how the two circuits can possibly balance, though no doubt they would be out of phase, one being actuated by the primary while the other was actuated by the secondary. The claim is that both even and odd harmonics introduced in the detector are eliminated. The theory of this is not by any means clear to me. Will you explain that an engineer of Mr. Clough's eminence would commit himself in print unless he were sure of his ground, yet I am from Missouri, and would like to be shown. In any event the amplifier is a peach.

Would your readers not like to have the opportunity of learning Mr. Anderson's or Mr. Bernard's views on this interesting circuit, about which you have thus far published nothing, though you gave considerable space to the Clough system as applied to straight cascade amplification.

Also would not a comparison of the Clough autoformers with Remler's similar ones be in order?

Another subject for discussion profitably could be the operation of loudspeaker directly from the detector plate circuit. I myself have successfully operated a Western Electric cone without audio amplification, using a 240 tube as detector with grid bias. The speaker was isolated from the direct current plate circuit by means of a large capacity condenser with a Samson audio choke in the B lead. The RF component was by-passed to ground and choked out of the B circuit as usual. Very satisfactory room volume was easily obtained on local stations, and I rather fancy that with plenty of RF amplification some distance reception might be expected, though I did not attempt it. The experiment was made with only two RF stages ahead of the detector.

I like your paper, as it gives me a lot of food for thought, even if I cannot digest all of it.

PHILIP M. C. ARMSTRONG,
1444 Burns Ave., Detroit, Mich.

* * *

THE INSPECTOR'S REPORT

KEEP up the good work. Your magazine certainly deserves the full support of every person interested in radio. For the fans who make radio a "hobby" as well as those who make it a business, you now have no rival in the field.

FRANK J. BAIN,
Inspector, Bureau of Pensions, U. S.
Department of the Interior.

* * *

A WHACK AT SLEEPYHEADS

HOW about something for us down this way? You seem to steer clear of more than one tube ahead of the detector. Why? I refer particularly to AC circuits.

I am building the HB Compact, AC Model, but I am not touching my present set—yet.

Another pet of yours is resistance coupling. Why not develop something like the factory sets? I get better tone on my home-built sets than is produced on the other sets, but I don't get all the stations some factory-made sets do, because we never get dope on more than four tube or five tube sets.

Wake up! I am not the only kicker. See what you can do. Perhaps I shall find the Compact equal to the big sets, but it doesn't seem reasonable.

A. W. YEAST, Halifax, N. S.

* * *

HOW HE IMPROVED COMPACT

I HAVE missed very few copies of your magazine for the last two years. I find that the HB Compact is certainly the most efficient circuit I have ever built.

It is also interesting to note the increasing space you are devoting to the "Forum," as many interesting topics can be discussed.

Perhaps my experience with the HB Battery Model Compact would be of some help to those not as lucky as others in obtaining results.

Oscillation was present at the start. A slight movement of the rheostat was enough to throw the set out of balance. Turning it back, nothing could be heard. Bringing my hand near the long lead from the coupler to plate of first screen grid tube I noticed the frequency changed accordingly. Shortening this lead, I was sure would improve results so I moved the first screen grid tube forward midway between the dynamic coils. This shortened the plate lead nearly five inches, also preventing any stray capacities between this and other wires. The results were all that you claimed.

More than average volume is obtained and of course the quality is fine.

As a final suggestion anyone not getting the results expected will do well to make this simple change.

MAURICE BILL, Binghamton, N. Y.

* * *

BIG VOID TO FILL

THIS is meant to be "constructive." The trouble with a weekly paper is partly due to the fact that it is run by highly trained engineers. It is hard to look at the problem from the ordinary fan's viewpoint. I am an engineer myself, but not electrical. I build about a dozen radios a year for the "kick of it." I have made a number of power transformers and filter chokes, also the DC Dynamic I am now using.

Where will you find information on the design? Not in RADIO WORLD. I had hard work getting the dope, but I know now. For the benefit of those who don't, but would like a try at it, I would be pleased to make proper drawings for cuts if I thought you would publish them, only I must know the size of sheets you use, also if you want black drawing ink on white paper.

Again what is in an RF choke, 85 milli henries? What is in an audio frequency choke? Is it any good on an AC set? I never heard that subject discussed at all.

Again start a trouble series. State symptoms and where to look for cures. I have a case on hand now. Listen to this. Transformer coupled audio AF3 Ferranti. First audio will work with a 240 high mu tube, but with some distortion. Take tube out and replace with the tube meant for here, a 201A, and the music clears up, but the set won't stop whistling (Everyman Four, battery model).

I have just built the Everyman Five AC, with dynamic and 250 tube. That set is worth a write up. The lack of interest down here is in a measure due to the fact that radio is not good early in the night and when it is good nothing but jazz and cheap talk. The good music seems to be early. Sunday night I heard the vilest stuff that I ever heard in my life either on radio or otherwise.

W. A. WEST,
Dept. Works and Mines,
Halifax, N. S.

* * *

THEN WHERE'D THIS GO?

BEFORE I forget it, kill that Forum column. You do not have to furnish a playfield for so many chumps.

I am growing young on the mental food I get from articles by Anderson and Bernard. But you don't need that Forum.

I have a lot of old trash about the house that I am dumping into the garbage barrel, stuff that the gyps got off on me. That is not going to occur again.

Seattle, Wash. A. C. CLARK.

KENT DENIES MERGER RUMOR

Rumors that Atwater Kent, Crosley and Majestic were to merge have been afloat recently. A. Atwater Kent positively denied he is contemplating a merger with anyone.

$10,000,000 IN GENERAL MOTOR RADIO COMBINE

Alfred P. Sloan, Jr., president of General Motors Corporation, and David Sarnoff, executive vice-president of the Radio Corporation of America, made the following announcement today:

"As a result of negotiations during the past few weeks, General Motors Corporation has just concluded an agreement with the Radio Corporation of America, General Electric Company and Westinghouse Electric & Mfg. Co., under which it proposes to enter the radio business in a large way.

"A new corporation to be called General Motors Radio Corporation has been organized with a capital stock of $10,000,000 preferred and 1,000,000 common shares of no par value. The Radio group is to contribute $4,900,000 in cash and to grant licenses under all their patents covering radio sound and picture receiving and reproducing sets for use in homes and automotive vehicles. General Motors Corporation is to subscribe $5,100,000 in cash and to assume the management of the new enterprise.

G. M. TO OWN 51 PER CENT

"The Radio Group, consisting of Radio Corporation of America, General Electric Co. and Westinghouse Electric & Mfg. Co., will own 49 per cent and General Motors 51 per cent of the total stock.

"Not only do we believe that there is a great opportunity for the development of the radio business as an adjunct to the automobile, but the radio field in general is one that is closely related to the automobile and electric appliance business in which the General Motors in engaged.

"The Radio Corporation of America will continue independently, as heretofore, both as to the manufacture and distribution of its products, and the General Motors Radio Corporation will develop its business along separate lines. The Radio Corporation and the General Motors Corporation will cooperate to make the new arrangement a success."

CARS TO BE RADIO EQUIPPED

Speaking for the General Motors Corporation, Mr. Sloan said:

"New Cadillac and LaSalle cars have been designed for radio installation and thousands of installations have already been contracted for by dealers. As quickly as possible the same facilities will be available for other makes of General Motors cars."

The Board of Directors of the General Motors Radio Corporation follows: John Thomas Smith, vice-president and general counsel of General Motors Corporation, chairman; R. J. Emmert, president, General Motors Radio Corporation; General James G. Harbord, president, Radio Corporation of America; John L. Pratt, vice-president General Motors Corporation; Andrew W. Robertson, chairman of the board, Westinghouse Electric & Mfg. Co.; David Sarnoff, executive vice-president Radio Corporation of America; Alfred P. Sloan, Jr., president General Motors Corporation; Gerard Swope, president, General Electric Company; C. E. Wilson, vice-president, General Motors Corporation.

KGO Wants Power of 50,000 Watts

Washington.

An application for authority to employ the maximum broadcasting power of 50,000 watts was filed with the Federal Radio Commission by KGO, Oakland, Calif. The station, owned by the General Electric Company but recently turned over to the National Broadcasting Company for program management, now employs 7,500 watts.

In its application, the station requested authority to change its location from Oakland to a point near Belmont, Calif., and to install new equipment designed to a 50,000-watt output.

KGO, under the reallocation of last November, was assigned the 790-kilocycle channel on a cleared channel basis, but by virtue of the decision of the Court of Appeals of the District of Columbia, WGY, also owned by the General Electric Company and located at Schenectady, N. Y., was authorized to utilize this channel jointly with KGO during night hours.

NEW ALLIANCE UNDER ATTACK

Washington.

In a telegram to Attorney General Mitchell, Oswald F. Schutte, executive secretary of the Radio Protective Association of Chicago, attacked the association of interests of the General Motors and Radio Corporation of America as a violation of the Sherman anti-trust law and demanded an investigation. General Motors is to sell sets, including automobile receivers, of RCA design. His telegram set forth:

"This alliance of General Motors with Radio Corporation, General Electric and Westinghouse interests, emphasized by interlocking directorates, violates Sherman anti-trust law. It adds to $5,000,000,000 radio trust more than $1,000,000,000 resources of Du Pont General Motors interest.

"When alliance of General Motors with United States Steel Corporation was announced a year ago Congress demanded investigation and that merger was dropped. Present combination is far more flagrant violation of anti-trust laws.

"Under reciprocal patent agreement General Motors interests acquiesce in alleged validity of illegal patent pool of Radio Corporation of America, General Electric Company, Westinghouse Electric and Manufacturing Company, United Fruit Company and American Telephone and Telegraph Company, thus eliminating the one powerful technical organization that would be in position to oppose patent claims of Radio trust."

The recent United States court decision in the oil-cracking patent pool case declared that such an organization violated the Sherman law and held that parties to it "purchased immunity from attack on their patents," according to the telegram.

"Eight years ago radio trust obtained letter of immunity from Attorney General Daugherty," the telegram concluded. "If General Motors-Radio Corporation has asked Department of Justice for similar immunity for newest merger, we demand a public hearing and ask the right to be heard."

New Corporations

Silver King Radio Co., Inc., Garfield, N. J.—Atty. Irving Cohen, Passaic, N. J.

Ariel Radio, Rochester—Attys. Hubbell, Taylor, Goodwin, Nixon & Hargrave, Rochester, N. Y.

Wheland Radio Corp.—Atty. Teitelbaum & Jay, 165 Broadway, N. Y.

Ocean Radio Co.—Teitelbaum & Jay, 165 Broadway New York, N. Y.

BOARD CHANGES STATION LIST; TWO QUIT AIR

Washington.

The following list of changes and corrections to the broadcast station list were announced by the Federal Radio Commission:

WCCO, Anoka, Minn.; studio, Minneapolis; new owner, Northwestern Broadcasting, Inc.

WCKY, Villa Madonna, Ky.; studio, Covington; licensed to operate. Frequency, 1,480 kc. Shares with WSOA, WJAZ and WORD; power, 5,000 watts.

WHAS, Jeffersontown, Ky., granted increased power to 10,000 watts.

WJAS, new transmitter location licensed, North Fayette Township, Pa.

WKRC, Cincinnati; new owner, J. S. Boyd.

WLBW, Oil City, Pa., new owner, Radio-Wired Program Corp. of America.

WMC, Memphis, Tenn, construction permit issued to move to Bartlett, Tenn.

WMBC, Detroit, Mich., construction permit issued to increase power to 250 watts.

WNAT, Philadelphia, Pa., new; shares WFKD, 100 watts, 1,310 kc.

WRBL, Columbus, Ga., David Parmer, new owner.

WTOC (formerly WSGP), Savannah, Ga., 500 watts, 1,410 kc.

KFBB, Great Falls, Mont., new location.

KFJI, Astoria, Oreg., new owner, KFJI Broadcasters, Inc.

KFPL, Dublin, Tex., permit issued to increase power from 15 to 100 watts.

KFQD, Anchorage, Alaska, Anchorage Radio Club, 1,230 kc.; station deleted.

KFWM, Oakland, Calif., permit issued to move to Richmond, Calif., and increase power from 500 to 1,000 watts.

KFXM (formerly KFWC), Ontario, Calif; studio, Pomona; 1,200 kc.; permit issued to move to San Bernardino, Calif.

KGA, Spokane, Wash., Ralph A. Horr, receiver, supplants Northwest Radio Service Co. as owner.

KGCX, Wolf Point, Mont.; licensed to operate at Wolf Point.

KGDR, San Antonio, Tex., Milan Radio Co., Inc., new owner

KGHI, Little Rock, Ark., First Baptist Church (O. A. Cook, agent); 1,200 kc., new frequency.

KGU, Honolulu, Hawaii, permit to use 1,000 watts instead of 500.

KJR, Seattle, Wash., Ralph A. Horr, receiver, replaces Northwest Radio Service Co.

KMJ, Fresno, Calif., 1,210 kc., new frequency.

KNX, Los Angeles, Calif., permit issued to increase power from 5,000 to 50,000 watts.

KOAC, Corvallis, Ore., 550 kc., new frequency.

KREG (formerly KWTC), Santa Ana, Calif., 100 watts, 1,500 kc.

KTAB, Oakland, Calif., Associated Broadcasters, 1,000 watts, 560 kc.; new power, new frequency.

KWYO, Laramie, Wyo., 600 kc., station deleted.

KYA, San Francisco, Calif., F. C. Dahlquist, receiver, listed as new owner.

Privy Council Upholds Alexanderson Patent

A radiogram from London stated that a decision had been handed down by the Privy Council, the highest appellate tribunal in the British Empire, upholding the Alexanderson tuned radio frequency patent as against the Schloemilch and von Brönk patent.

The case went to the Privy Council in London on appeal from the decision of the Supreme Court in Canada. In the Canadian litigation, the Alexanderson patent was sustained by the lower court. This decision was reversed by the Supreme Court of Canada after which jurisdication of the controversy was taken by the Privy Council.

The two patents had already been considered by two Federal District Courts of the United States both of which had decided in favor of the Alexanderson patent.

The validity of the Alexanderson patent was the subject of testimony offered before the Senate Interstate Commerce Committee last May during its hearings on the Couzens bill for the creation of a Federal Communications Commission.

BOARD STARTS NEW POLICY OF ROUTING WORK

Washington.

The "zone system" of radio administration, under which particular Commissioners cared for the primary regulation of the geographical zones from which they were appointed, has been abolished by the Federal Radio Commission.

On recommendation of the Bureau of Efficiency, the Commission has adopted a system of distributing the regulatory work so that the Nation as a whole, rather than the individual five radio zones, will come under the jurisdiction of the particular Commissioner to whom is to be delegated a specific regulatory function or functions.

As in the past, however, it was stated, final decision on all matters will be taken by majority vote of the Commission membership.

Under the new procedure, it was pointed out, an application from a broadcasting station for modification of its license first will go to the engineering division for determination as to whether it will fit in with the existing broadcasting set up. Then the legal division will pass upon its legal aspects, and the qualifications of the applicant. It then will be sent to the Commissioner or Commissioners in charge of engineering, and finally to the full Commission for action.

Applications of all kinds and all Commission business, it was explained, first will be handled by the expert or clerical forces, and then routed through the particular Commissioner charged with the jurisdiction of the specific type of business, to the full Commission.

NO MORE ZONED WORK

Thus, it was pointed out, the Commission will have the benefit of the studies of its subordinates along with their recommendations before it finally acts on an application.

In the past the procedure has been for all matters affecting a particular radio zone, whether broadcasting, short wave, or general policy, to go directly to the Commissioner representing the zone. He would decide the course to be pursued and supervise the investigation, and himself bring the matter before the Commission with his own recommendation as the Commissioner of the zone in which the particular applicant is located.

McMurdo Silver Hurt As His Car Overturns

McMurdo Silver, president of Silver-Marshall, Inc., Chicago, was injured in an accident when his car overturned, hut soon was pronounced out of danger. The youthful manufacturer's mother, in constant attendance at his bedside, was assured there was no possibility of bad after-effects, and that her son should be able to leave the hospital in about three weeks.

At Mr. Silver's request his executive duties were handled during his absence by a committee of three, consisting of G. A. Norton, H. C. Bodman and W. J. Frisbee.

New Phone Cable Cuts Out Static

A new telephone cable which is said practically to eliminate static has been perfected by the engineers of the Bell Telephone Laboratories, said J. S. McCulloh, president of the New York Telephone Company, and will be used in transatlantic communication inside a year. Mr. McCulloh said:

"With the aid of these cables, which will practically relegate static to the scrapheap the entire field of transatlantic cable communication will be revolutionized. It is no exaggeration to predict that within a few years telephone communication with every foreign country and intercommunication between these countries will be a reality.

"Such wonders as telephone communication with ships at sea and with aircraft is already an established fact. Only a few days ago engineers of the Bell Laboratories established telephone communication between a plane at Whippany, N. J., and London. There can be little question that communication by wire will link every nation of the world before many years have passed."

STANDARD LINE VOLTAGE ASKED

Chicago.

Many sections of the United States have non-standard electric current and voltages. One of the major undertakings of the Radio Manufacturers' Association will be a campaign to bring about uniform current and voltage throughout the country. The association held executive session here.

The fact that the most up-to-date radio receiving sets, which operate on 110 volts, 60 cycle alternating current, are useless in those sections of the United States which are served with other current and voltages, spurred the association.

Two types of current are used in this country, the announcement said: alternating and direct, with the voltages ranging from 100 volts to 225 volts. Twenty different voltages are in use in as many parts of the country.

New England, for instance, has 70,000 homes using 104 volt AC, and about 300,000 homes with 115 or 120 volt AC, according to "Electrical World." In New York City there are almost 360,000 DC homes to which the perfection of AC reception is wholly denied.

In the Middle West also there are large areas still using direct current with voltages ranging from 110 to 220 and these, too, are denied the benefits of modern radio.

PEOPLE APPEAR FULL LENGTH TELEVISED RAY

Washington.

The Federal Radio Commission heard testimony from William S. Hedges, radio editor of "The Chicago Daily News" and president of the National Association of Broadcasters, on that newspaper's applications for a television experimental broadcasting station and for a rebroadcasting channel for international use. All applications were taken under advisement by the presiding Commissioner, E. O. Sykes.

Mr. Hedges said he regarded television as being in the experimental stage. His organization, he said, wishes to further other experiments with visual broadcasting.

FULL-LENGTH PICTURES

A new television system, which he called the "microvisor," would be used by the new station, said Mr. Hedges. This system, he declared, gives "full-length" pictures, whereas the existing television experimenters have been transmitting only "bust" pictures.

"The Chicago Daily News," Mr. Hedges declared, has operated WMAQ at Chicago seven and one-half years.

Mr. Hedges also testified in connection with the application of "The Chicago Daily News" for a rebroadcasting channel. He explained that such a channel is sought primarily in connection with the holding of the World's Fair in Chicago in 1933, for the international rebroadcasting of the proceedings and other events. In the meantime, however, he said, the channel is sought for intermittent rebroadcasting both of its own programs and those of the Columbia Broadcasting System, with which it is affiliated.

WILL SEEK OTHER WAVE

It was brought out by Commission engineers that the 5,900-kilocycle channel asked by "The Chicago Daily News" for rebroadcasting is assigned exclusively to the Universal Wireless Communications Co. for point-to-point communications. Thomas L. Marshall, attorney for the newspaper, asked leave to file an amended application for a different frequency and to increase the power request from 5,000 watts to 10,000 watts.

LIGHT CONTROL FROM PLANE

A device connected up to a short wave transmitter which will permit the controlling of airport lights, landing lights, beacon lights and emergency lights from a plane in flight has been invented by William Earle Stillwell, Jr., of Cincinnati.

Many European Programs Are Due

Impetus has been given to the plan to exchange regularly radio programs of the United States and England since the visit of Premier Ramsay MacDonald to this country, said Dr. Alfred N. Goldsmith, chief consulting engineer of the National Broadcasting Company.

The addresses of the Premier in New York and Washington were carried to British listeners on pre-arranged schedules for the first time in broadcasting history.

"Reports from abroad show tremendous interest in this new type of broadcasting by short waves," said Dr. Goldsmith. "As a result the coming Winter will see a remarkable increase in the number of programs from Europe carried ove rour radio chains."

ONE WAVE SOON TO EACH CHAIN, SAYS TERRELL

Washington.

Broadcasting stations transmitting a particular chain program will be linked on a single radio channel, synchronized by wires between the stations, within the next few years, William D. Terrell, chief of the radio division of the Department of Commerce, predicted.

Wire synchronization of broadcasting stations on a limited scale, said Mr. Terrell, already has been found feasible. By controlling the signal emitted from the key station through a parallel land wire, he stated, it is technically possible for a group of stations transmitting the same program to operate on the same channel.

JUST QUESTION OF TIME

"To me," he continued, "it is just a question of time before the chains begin using only a single frequency for their entire network. It would solve the problem of duplication of chain programs, since all the chain stations broadcasting one program would be on the same channel."

Mr. Terrell, who, before the Federal Radio Commission came into being in 1927, was directly in charge of radio regulation, declared that if the chains adopt the wire synchronization plan, an entirely new allocation of stations will be necessary.

DIVERSIFICATION POSSIBLE

At present, he pointed out, stations subscribing for chain programs broadcast on individual frequencies assigned to them, either on a cleared channel or time-sharing basis. These stations, he said, could have two transmitters, one broadcasting the chain program, and the other operating as an "independent" station, offering original programs, and diversifying the program matter now available to listeners.

Engineers of the National Broadcasting Co. and of the Westinghouse Electric & Manufacturing Co. have been experimenting with wire synchronization for some time, said Mr. Terrell. The Westinghouse company, he explained, for several years has been maintaining such a system between WBZ at Springfield, Mass., and WBZA at Boston, a distance of 60 miles.

The wires now used by the chains and leased from the American Telephone & Telegraph Co., according to engineers, may be employed in the wire synchronization. These land lines now are employed to transmit programs from the key stations to the subscribing stations on the chain. There are two sets of wires of the improved telephone type, adapted for the control of the radio signals which are transmitted by the key station, he told "The United States Daily."

"We would have much more variety of programs if the chains confined themselves to a single frequency," continued Mr. Terrell. "The independent stations could broadcast original material, and the listener would not be bothered with picking up the same program at a number of places on his dial."

WCDA BACK IN CERVICE

The broadcasting station of the Italian Educational Company, WCDA, in New York City, was recently reopened. A new transmitter has been installed and the studio has been reconditioned. The station is sponsored by the Italian Historical Society of America.

Heising Nominated To Head Institute

Raymond A. Heising, engineer of the Bell Telephone Laboratories in New York, has been nominated for president of the Institute of Radio Engineers for 1930.

Mr. Heising has been prominently associated with radio telephony since 1925, when he took part in the epoch-making experiments between Washington and Honolulu. He has also been closely associated with the IRE for a number of years and invented the Heising system of modulation.

Colonel A. G. Lee of the engineering department, General Post Office, London, has been named for vice-president of the Institute.

For managers John V. L. Hogan and Robert H. Marriott, both consulting radio engineers of New York, have been designated. Both are past presidents of the institute.

CURBING NOISE TOLD IN BOOK

The elimination of unnecessary noises that mar good radio reception has become a serious problem, not only for radio set owners and broadcasting stations, but also for manufacturers of radio receivers.

The problem became particularly acute for the radio manufacturing industry when the public at large blamed the set for giving audibility to all sorts of noises that had no connection whatever with entertainment.

The set itself is not responsible, and it is to inform set owners that many of these noises can be eliminated that the Radio Manufacturers' Association has published its latest book on radio interferences—"Home-made Static and How to Avoid It."

There are two major types of interference, the book relates: natural and "man-made." Natural static, caused by lightning and other atmospheric disturbances, cannot be entirely eliminated, although it can be reduced.

"Man-made static," however, being caused by man, can be eliminated by man. It usually comes from faulty electrical appliances located in or near the home that contains the noisy radio set.

To aid harassed set owners in finding and eradicating interference, the Radio Manufacturers' Association enlisted the aid of more than 200 leading radio and electrical engineers. Under the supervision of H. B. Richmond, president of the RMA, these engineers reported their fullest knowledge and latest information as to the causes of static and the procedure necessary to find and eradicate them.

Copies of the manual may be obtained from the Radio Manufacturers' Association, 32 West Randolph St., Chicago, Ill.

NEW TELEPHONE LINK

Radio telephone communication was opened between Argentina and Spain on Columbus Day. It is now possible for any telephone user south of Brazil to call up any telephone user in Europe by way of the Buenos Aires-Seville radio telephone link. Nearly all countries in Europe are also connected with the United States by means of radio telephones. A service between North and South America will be opened next Spring.

CBS IS SEEKING WAY TO REACH ALL THE WORLD

Washington.

The Columbia Broadcasting System wants more short waves, so its entertainment can be heard in "every part of the civilized world."

Paul M. Greene, chief engineer of the CBS, and Sam Pickard, vice-president, made oral arguments before the Federal Radio Commission.

Mr. Greene said his company desired assignments on 11,800 and 15,290 kilocycle channels, and renewal of its existing license on 6,120 kilocycles. The system now is rebroadcasting over W2XE at New York, but its coverage is limited because of these conditions, he said.

Discussing the quality of Columbia programs, Mr. Greene said:

"Assuredly the international reception of these programs would create a favorable impression of American broadcasting standards. We believe that there is no better way to create friendship and respect for American culture than by presenting programs such as these which reflect that culture.

WOULD OVERCOME OBSTACLES

"In order to overcome skip-distances and atmospheric conditions and to meet all the varying conditions arising in Summer and Winter, day and night, broadcasting on short-wave frequencies, it is necessary to have several widely separated channels."

Mr. Greene said that arrangements have been made tentatively with European broadcasting companies for the interchange of programs. Dr. Leon Levy, an officer of the Columbia system, he said, recently made a trip to Europe for this express purpose. All negotiations already have been completed with the agency at Oslo, Norway, and others now are in process with agencies in France and other European countries, he said.

TALENT $3,750,000 YEARLY

"The Columbia," continued Mr. Greene, "is the largest independent broadcasting company. The programs of Columbia are on the air a minimum of 16 hours each day and it is the intention of the applicant to broadcast these programs over the short-wave frequencies requested. The yearly expenditure for talent charges on Columbia programs is, conservatively, in the neighborhood of $3,750,000."

Paul D. P. Spearman, assistant general counsel of the Commission, in cross-examining Mr. Greene, brought out that WCAU, at Philadelphia, is affiliated with the Columbia system. This station, he brought out, recently was awarded the rebroadcasting channel of 9,590 kilocycles for rebroadcasting Columbia programs in part.

Plane in Bell Labs For Full Radio Tests

The latest addition to the extensive laboratory facilities of the Bell Telephone Laboratories is a Ford tri-motored all-metal airplane, fully equipped with instruments to enable the development of radio apparatus for aircraft communication from the earliest experimental stages right through to the final testing of the finished apparatus under actual flying conditions.

TIME-SHARING KSTP, AND WLS GET 50KW TOO

Washington.

Construction permits authorizing the installation of transmitting systems employing the maximum allowable broadcasting power of 50,000 watts have been issued to stations WLS, Chicago, and KSTP, St. Paul, Minn., the Federal Radio Commission announced.

In the case of the Chicago station, owned by "The Prairie Farmer," an agricultural publication, the authorization was without restriction. The station now uses 5,000 watts power and operates five-seventh of full time on the 870 kilocycle channel.

SIMULTANEOUS WITH WJSV

KSTP is owned by the National Battery Broadcasting Company. It operates on the 1,460 kilocycle channel with 10,000 watts of power, broadcasting on the channel simultaneously with station WJSV, Mt. Vernon Hills, Virginia.

In granting the construction permit to WJSV, it was explained at the Commissioner's office that no commitment was made to increase the power of the station to 50,000 watts once the new equipment has been installed.

KSTP FIRST EXCEPTION

At present, it was pointed out, those stations authorized to use 50,000 watts power operate on cleared channels. The grant of a construction permit to KSTP for this maximum power is the first instance in which a station not assigned to an exclusive channel has been so authorized.

Literature Wanted

George H. Ohmer, 36 Spirea Drive, Oakwood, Dayton, Ohio.
Ascorra Hnos, P. O. Box No. 2334, Calle San Pedro No. 339, Lima, Peru.
Max Joseph, 1815 Gauthier St., Montreal, Canada.
Leslie A. Taylor, c/o Hamilton Hotel, Hamilton, Bermuda.
Radiocraft Laboratory, P. O. Box 276, Hudson, Mass.
Radio Repair Shop, Box 174, Knoxville, Tenn.
Carl Peden, 724 Hiddeson Ave., Greenville, Ohio.
W. Pollmann, P. O. Box 744, Mairobi, Kenya-Colony, Africa.
Francisco Bou, Jr., 4625 James Street, Philadelphia, Penna.
S. Stubbs, P. O. Box 420, Waycross, Ga.
A. L. Reynold, Box 73, Newbern, Tenn.
George E. Levey, 135 Caton Ave., Mt. Ida, Alexandria, Va.
E. R. Jamison, 1092 Walnut, Long Beach. Calif.
C. J. Weiland, 1020 Walton Ave., New York City.
Edward Lindberg, R. F. D. 2, Sherman, New York.
Milton C. Roth, 17214—91st Ave., Jamaica, New York.
L. W. Moran, Plato, Sask., Canada.
L. Trevarrow, L, Box 21, Mohawk, Michigan.
William Goldstein, 347 Snediker Ave., Brooklyn, N. Y.
Ellis Watson, 2667 Mayhole Ave., Chicago, Illinois.
Mr. John Stab, 2152 5th (Ave.) St., Philadelphia, Penn.
Chas. F. Morris, Box 852, Albuquerque, New Mexico.
J. A. Denekas, 706 N. Howell, Davenport, Iowa.
Chas H. Dozier, 2014 Lumbard St., Philadelphia, Pa.
J. J. Morrissey, 59 Chandler St., Boston, Mass.
R. T. Ayres, 248-A Warren St., Roxbury, Mass.
Billy Crawford, 107 Church St., Hertford, N. C.
W. B. Garner, Hergira, Ky.

WGY to See What 200,000 Watts Do

Washington.

The advantages of high power in broadcasting will be determined in tests at 200,000 watts by the General Electric Co. of Schenectady, N. Y., it was announced by the Federal Radio Commission.

The Commission has renewed the experimental license held by the General Electric Co. for the power tests. The experimental station, with the call letters W2XAG, operates on broadcast as well as short-wave channels. The test station is associated with WGY.

The license authorizes the tests between midnight and morning, subject to conditions which will prevent interference with regular broadcasting and reception.

CANADIANS ASK 13,000,000

In a recent report made by the Royal Commission of the Dominion Government, consisting of John Aird, chairman of the board of directors of the Canadian Bank of Commerce, C. A. Bowman and A. P. Frigon, to the Hon. J. A. Cardin, Minister of Marine, the construction of seven national stations, costing $13,000,000, strategically located throughout the country, each with an antenna input of 50,000 watts, was recommended.

Chain broadcasting was also proposed. The first step toward the successful operation of this plan, according to the report, required that one private broadcasting station be acquired until the new government stations were ready, all other private stations to be closed in the meantime.

A recommendation for the increase of the license fee from the present $1 to $3 also was made.

Indirect advertising would be permitted on the programs, the report also states.

New Big Clarostat Handles Heavy Loads

The Super-power Clarostat, with a current handling capacity of 250 watts, was specially designed for real power application. It is a variable resistance when it is necessary to try different values, and a fixed resistance when left at a given setting.

The Super-power Clarostat may be used as a line voltage control for power amplifiers and heavy drain receivers operating on socket power for adjusting the primary voltage to any desired value. It may be used to control the filaments of a group of moderate power transmitter tubes and as a plate voltage control in transmitter circuits. It also affords motor speed control, heat control and electric plating control. Further facts upon this invaluable accessory may be had on application to the Clarostat Manufacturing Co., Inc., 291 North Sixth Street, Brooklyn, N. Y. Mention RADIO WORLD.

OPERADIO APPOINTS FERNALD

P. R. Fernald of the H. & F. Radio Laboratories, 72 Cortlandt Street, New York City, has been appointed Eastern Representative for the Operadio Mfg. Co., St. Charles, Ill. The line includes speakers, magnetic and dynamic, and power equipment.

BOARD INVADED BASIC LAW, SAY TWO STATIONS

Washington.

Contending that the Federal Radio Commission has deprived it of its property without due process of law and in violation of the Fifth Amendment, the Great Lakes Broadcasting Company (WENR), presented its appeal from a decision of the Commission.

Acting under the authority granted by the Davis amendment, the Radio Commission issued its reallocation order of November 11th, 1928, whereby WENR received two-sevenths of full time on a frequency of 870 kilocycles.

On a hearing of an application by that station for an increase of time, after the order reducing time had gone into effect, the application was refused by reason of an evenly divided court. This decision was in effect, counsel for the appellant declared, a decision without a hearing, since by the divided court the Commission held the reallocation order proper.

WENR'S SERVICE CLAIM

A further contention of station WENR is that being a 50,000-watt station, it can give wider service than a 5,000-watt station (WLS) which shares four-sevenths time on the 870 kilocycle frequency as compared with the two-sevenths allowed WENR.

Joined in this case before the Court of Appeals, District of Columbia, also are Wilbur Glenn Voliva (WCBD), which has one-seventh of the time, and the Agricultural Broadcasting Co. (WLS), which has four-sevenths.

An increase of time is sought for station WCBD in that it was prior in time to any of the other stations concerned and hence had the prior right to the channel. Its counsel set up violation of the Fifth Amendment as well as claiming that the station had been discriminated against because it is owned, operated by, and broadcasts the programs of the religious community at Zion City, Ill.

THE LAW OF THE LOUD VOICE

WLS denied the priority in time of WENR over WLS and insisted that the mere fact of greater power should not entitle it to greater allotment of time over WLS, insisting that such a proposition would amount to saying that "the man with the loudest voice had the paramount right to talk."

The Commission denied that there had been any invasion of property rights without due process of law, that the procedure employed to effectuate the Davis amendment was reasonable as a regulation of interstate commerce, and that the appellant's privileges were not curtailed without an adequate hearing.

The Commission's counsel described the chaos which existed in the field of broadcasting and the subsequent order which the Commission has been able to establish under General Order No. 40, reallocating, limiting, and otherwise regulating broadcasting stations throughout the Nation generally and in the Chicago area in particular.

The Commission's attitude, he explained, in its reallocation under the Davis amendment, has been to give the listening public the best radio service possible without unreasonably invading the property rights of the various station owners.

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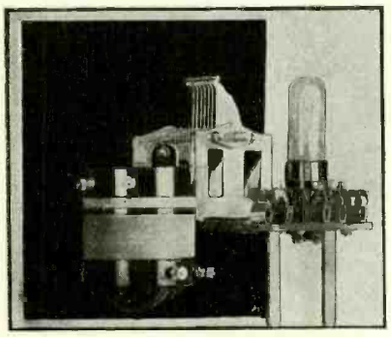
Can Build a Broadcast Receiver for Only $4.28

Using Component Parts for the Schoolboy 1-Tube DX Circuit

as described by Jack Tully



Side view of the Schoolboy's One-Tube Receiver

COMPONENT PARTS

[Check those you want.]

	Price
L1, L2, L3—3 circuit .00035 tuner knob	$1.30
C1—Tuning condenser, .00035 mfd.	.30
C2—Grid condenser, .00025 with clips	.21
C3—Fixed condenser, .0005 mfd.	.19
R1—One 2-meg. leak	.30
R2—One 30-ohm rheostat, knob	.32
One 7 x 10" front panel	.59
One 3 x 6" subpanel	.42
One dial with pointer	.43
Six supporting brackets at .04	.24
☐ All parts	$4.28

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New York, N. Y.

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RADIO FANS—Would you like to purchase the latest electric Coast to Coast Screen Grid Radio for less than the cost of a battery set? If so address Economy Sales Co., Pa. Ave. Sta., Wash., D. C.

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L1L2—One antenna coupler, RF3	$ .90
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C1C2—One double condenser, .00035 mfd. ea.	1.80
CT—One Hammarlund 80 mfd. equalizer	.35
C3—One .00025 mfd. mica grid cond. clips	.21
C4, C5—Two, .01 mfd. mica fixed cond. (both)	.70
C6—One .0025 mfd. mica fixed condenser	.21
R1, R4, R7—Three 5.0 meg. grid leaks (all 3)	1.05
R2, Sw—One 75-ohm rheostat with switch	.80
R3—One 1.0 meg. metallized resistor	.35
R5—One 6.5-ohm fixed filament resistor	.25
R6—One 0.25 meg. metallized resistor	.21
R8—One 1.3-ohm fixed filament resistor	.20
Ant., Gnd., Sp. —, Sp. +,—All 4 binding posts	.40
1, 2, 3—Three UX sockets (all 3)	.90
One seven-lead battery cable	.50
Four resistor mountings (all four)	.84
One dial	.33
Hardware as prescribed by Jack Tully	.40
All Parts	$11.10
Three Kelly tubes: one 222, 240, 112a	$5.70

All prices are strictly net and represent extreme discount already deducted.

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Component Parts for SCHOOLBOY'S 2-Stage Audio Amplifier

Two 3-to-1 audio transformers, $1.25 each	$2.50
One .00025 mfd. condenser	.21
Two UV sockets at .26	.52
One binding post strip with 10 posts	1.50
Four brackets at .05 each	.20
One 2-ohm filament resistor	.30
	$5.23

[*Order what parts you want. You do not need to order all of them.*]

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☐ Two RF3 RF transformers @ 0.80	$ 1.60
☐ Two .00035 mfd. tuning cond. @ 0.30	.60
☐ One .00025 mfd. grid cond., clips	.21
☐ One .00025 mfd.	.21
☐ One 4 ohm filament resistor	.20
☐ One switched rheostat 30 ohms	.60
☐ One 5 meg. leak	.30
☐ One 1.3 ohm filament resistor	.20
☐ Two 3-to-1 AF transformers @ $1.25	2.50
☐ Four sockets @ 0.24	.96
☐ Speaker (+) (—) posts @ 0.10	.20
☐ Nine wires in cable @ .07	.63
☐ Two dials @ 0.33	.66
☐ 7 x 14" front panel	1.85
☐ One 8½ x 13½" baseboard	1.00
☐ All parts	$11.72

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One Tube?
Two Tubes?
Three Tubes?
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Circuits for Schoolboys—Easy to Build, Very, Very Inexpensive!

A One Tube Receiver, parts costing $4.28!
A Two Tube Audio Amplifier, parts costing $5.23!
A Three Tube Speaker—Operating Circuit, parts costing $11.10!
A Four Tube Speaker—Operating Circuit, parts costing $12.72!

The construction of these circuits, with a pictorial diagram as one of the illustrations, was described by Jack Tully, himself a schoolboy, in RADIO WORLD. See list below.

☐ Sept. 21st and 28th issues, One-Tube DX Set, by Jack Tully; two-part article.
☐ Oct. 5th, Three-Tube Single Dial Speaker Set, by Jack Tully.
☐ Oct. 12th, Two Stage Transformer, Coupled Audio Amplifier, by Jack Tully.
☐ Oct. 19th, Four-Tube DX Speaker Set, by Jack Tully.

15 cents a copy. Order at once while these copies are available.

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EVERY WEEK in RADIO WORLD appears a feature article of intense interest to schoolboys. Parents and other relatives will bring great delight to youngsters by sending $3 for a 6 months' subscription for RADIO WORLD (26 issues) in the youngster's name.—RADIO WORLD, 145 West 45th Street, New York City.

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ARTISTS and Art Students are printing 250 signs or pictures an hour without machinery. Sample and particulars, 10c. Straco, 1014 Mulberry, Springfield, Ohio.

BARBECUE, Broil, Grill all meats, fowl, fish with electric table appliance size chafing dish. Chrome finish $20, nickel, $15. Also bakes waffles and cooks like stove. Cleveland Neaco Products, 2012 West 83rd St., Cleveland, O.

DIAMOND OF THE AIR, SCREEN GRID MODEL, battery operation, four tubes described in February 9th, 16th, 23d and March 2d issues, 1929 Send 50c for these four copies. Blueprint free with 8 weeks' subscription to RADIO WORLD at $1.

AC DIAMOND, screen grid, 4 tubes, published in March 23d and 30th issues. Send 25c for these two numbers. Blueprint free with 8 weeks subscription for RADIO WORLD at $1. Circuit to be used with separate B eliminator.

If you are renewing a present subscription please so state.

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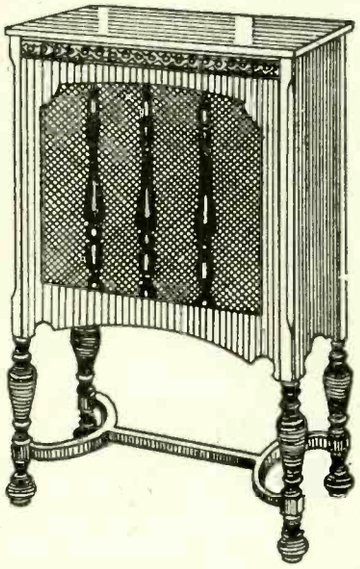

The speaker cabinet is walnut finish, 33" high, 24½". wide,. 17½". deep,. with. carved. legs. Golden cloth grille covers front opening. Built inside is No. 595 molded wood horn with baffle and No. 203 driving motor unit that stands 250 volts without filtration. Horn and motor removable. Table alone is worth price asked. Remit with order and we pay cartage on Aristocrat Floor Speaker.

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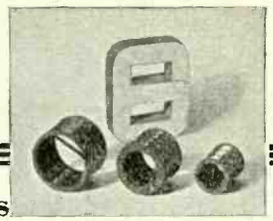

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R. C. A.
60, 62, 20, 64, 30 105, 51, 16, 32, 50, 25 A.C., 28 A.C., 41, Receptor S.P.U., 17, 18, 33.

FEDERAL
Type F series filament, type E series filament, type D series filament, Model K, Model H.

ATWATER-KENT
10B, 12, 20, 30, 35, 48, 32, 33, 49, 38, 36, 37, 40 42, 52, 50, 44, 43, 41 power units for 37, 38, 44, 43, 41.

CROSLEY
XJ Trirdyn 3R3, 601, 401, 401A, 608, 704, B and C supply for 704, 704A, 704B, 705, 706.

ZENITH
39, 39A, 392, 392A, 40A, 35PX, 35APX, 352PX, 352APX, 37A, 35P, 35AP, 352P, 352AP, 34P, 342P, 33, 34, 35, 35A, 342, 352, 352A, 362, 31, 32, 333, 353A, power supply ZE17, power supply ZE12.

MAJESTIC
70, 70B, 180, power pack 7BP3, 7P6, 7P3 (old wiring) 8P3, 8P6, 7BP6.

FRESHMAN
Masterpiece, equaphase, G, G-60-S power supply, L and LS, Q15, K, K-60-S power supply.

FADA
50/80A receivers, 460A Fada 10, 11, 30, 31, 10Z, 11Z, 30Z, 31Z, 16, 17, 32, 16Z, 32Z, 18, special, 192A-192S and 192B8 units, R80A, 480A, and SP 50/80A receivers, 460A receiver and R60 unit, 7 A.C. receiver, 475 UA or CA and SF45-75 UA or CA, 50, 70, 71, 72, C electric unit for special and 7 A.C. receivers, ABC 6 volt tube supply, 86V and 82W, E180Z power plant and E 420 power plant.

FREED-EISEMANN
NR5, FE18, NR70, 470, NR57, 457, NR11, NR80 DC.

STEWART-WARNER
300, 305, 310, 315, 320, 325, 500, 520, 525, 700, 705, 710, 715, 720, 530, 535, 750, 801, 802, 806.

GREBE
MU1, MU2, synchrophase 5, synchrophase AC6, synchrophase AC7, Deluxe 428.

PHILCO
Philco-electric, 82, 86.

KOLSTER
4-tube chassis used in 6 tube sets, tuning chassis for 7 tube sets, power amplifier, 7 tube power pack and amplifier, 6 tube power pack and amplifier, rectifier unit K23.

STROMBERG-CARLSON
1A, 2B, 501, 502, 523, 524, 635, 636, 403AA power plant, 404 RA power plant.

ALL-AMERICAN
6 tube electric, 8 tube 80, 83, 84, 85, 86, 88, 6 tube 60, 61, 62, 65, 66, 6 and 8 tube A.C. power pack.

DAY FAN
OEM7, 4 tube, 5-5 tube 1925 model, Day Fan 8 A.C., power supply for 6 tube A.C., B power supply 5524 and 5525, motor generator and filter, 6 tube motor generator set, 6 tube 110 volt D.C. set, 6 tube 32 volt D.C. set.

COLONIAL
26, 31 A.C., 31 D.C.

WORKRITE
8 tube chassis, 6 tube chassis.

AMRAD
70, 7100, 7191 power unit.

SPARTON
A.C. 89.

MISCELLANEOUS
DeForest F5, D10, D17, Super Zenith Magnavox dial, Thermyodyne, Grimes 4DL inverse duplex, Garod neutrodyne, Garod EA, Ware 7 tube, Ware type T, Federal 102 special, Federal 59, Kennedy 220, Operadio portable, Sleeper RX1, Armad inductrol.

Here are the 22 chapter headings:

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VACUUM TUBES
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TROUBLE SHOOTING IN "A" ELIMINATORS
"B" BATTERY ELIMINATORS
TROUBLES IN "B" BATTERY ELIMINATORS
TROUBLE SHOOTING IN "B" BATTERY ELIMINATORS
SPEAKERS AND TYPES
AUDIO AMPLIFIERS
TROUBLE SHOOTING IN AUDIO AMPLIFIERS
TROUBLES IN DETECTOR SYSTEMS
RADIO FREQUENCY AMPLIFIERS
TROUBLE SHOOTING IN RF AMPLIFIERS
SERIES FILAMENT RECEIVERS
TESTING, AND TESTING DEVICES
TROUBLES IN DC SETS
TROUBLES IN AC SETS

Some of the Questions Settled in Book:

Securing information from the receiver owner, list of questions, practical chart system of repairs, circuits and operating conditions.

Repairs in the home, method of operation, spare tubes, the process of elimination, recognizing symptoms, examples of practical application, tracing distortion, tracing electrical disturbances; vacuum tube tests; neutralizing systems, filament circuits, grid circuits, methods of securing grid bias, plate circuits; long aerials, short aerials, selectivity, imperfect contact, directional qualities, grounds; "A" battery eliminator types, design, operating limitations, requirements for perfect operation. AC eliminators, DC eliminators; "A" eliminator hum, reasons, voltage, reasons, noise; full wave, half wave, B battery eliminators, filament rectifiers, gaseous rectifier, dry disc rectifier, wiring, parts used, design, voltage regulation, operating limitations, requirements for perfect operation, combination filament and plate voltage eliminators, AC and DC types; B battery eliminator output current and voltage, excessive hum, dead eliminator, poor design, reasons for defects, motorboating, punctured condensers, shorted chokes, voltage regulator tubes, function of filter system, C bias voltages, voltage divider systems, filter condensers, by-pass condensers, voltages in the system; determining voltages in B eliminators, AC DC, voltage drop, effect of shorted filter system, defective rectifiers, defective transformer, defective chokes, defective by-pass condenser, design of filter system, defective voltage divider network, relation between hum and output voltage, isolation of troubles, external filters, noise filters; cone, dynamic, exponential speakers, troubles, dead, weak output, distorted output, rattle, continuity testing, windings, magnets, frequency filters, testing, chokes, condensers, hum elimination; audio amplifier types, transformer, resistance, impedance, auto-transformer, combinations, requirements for perfect operation, operating limitations, tubes, forms of coupling, plate voltage, grid voltage, filament voltage, isolating condensers, voltage reducing resistances, noises, analysis of trouble, plate current, grid current.

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Enclosed please find:

☐ $3.50 for which please send me postpaid "Trouble Shooter's Manual," by John F. Rider, being Part II of "Service Man's Manual." 240 pages, 8½x11", more than 200 illustrations, including wiring diagrams of commercial receivers as advertised; imitation leather cover, gold lettering.

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John F. Rider wrote two companion books grouped under the title "Service Man's Manual." The first was "Mathematics of Radio," the second "Trouble Shooter's Manual." The value of one of these books is more than doubled by the possession of the other.

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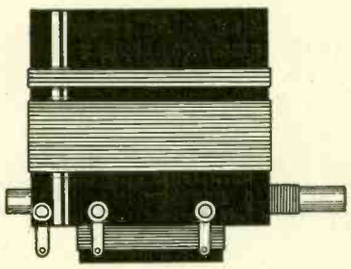
A NEW IDEA IN COILS!

The Bernard Tuner Works Screen Grid Tubes Up to the Hilt!

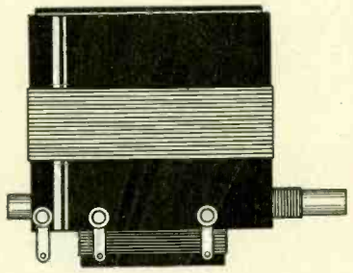


Cat. No. BT5A—$2.50
FOR .0005 MFD. CONDENSERS
Bernard Tuner for antenna coupling, the primary being fixed and the secondary tuned. This coil is used as input to the first screen grid radio frequency tube. The double-action tuning method invented by Herman Bernard is employed. Adjust an equalizing condenser across the tuning condenser so that exactly the same dial settings prevail through all circuits. This equalizer, 90 mmfd., once set, is left thus.
Cat. No. BT3A for .00035 mfd.....$2.25

FOR the first time in radio a coil has been designed that permits working the screen grid tube up to the enormous amplification level that theory long promised but practice long denied.

The secret lies in tuning the plate circuit of the screen grid tube, and still covering the entire broadcast band. Herman Bernard, noted radio engineer, invented the solution—a tuned coil consisting of a fixed and a rotating winding in series, the moving coil turned by the same dial that turns the tuning condenser. An insulated link physically unites condenser shaft and moving coil. Thus when the condenser plates are entirely in mesh the moving coil is set for maximum inductance, that is, it aids the other part of the tuned winding. As the condenser is turned to lower capacity setting the moving coil aids less and less, until at the middle of the dial it acts as if fixed. From then on the moving coil bucks the fixed winding, greatly reducing the total effective inductance, and thus nullifying the effect of the high starting capacity.

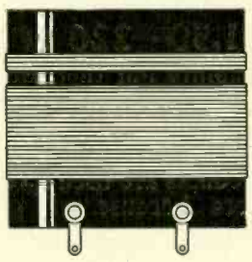
The Bernard Tuner is a two-winding coil for interstage coupling, working out of a screen grid tube, 222 or 224, and into any type tube. The tuned primary has coupled to it a still larger inductance, on separate inside form, for step-up, thus greatly increasing an already enormous amplification! This is Cat. No. BT5B for .0005 mfd., BT3B for .00035 mfd. Use BT5A or BT3A for antenna coupler, tuning the secondary, with an equalizing condenser across the antenna tuning condenser, so that the high minimum capacity of the tube's output will be duplicated at the input.



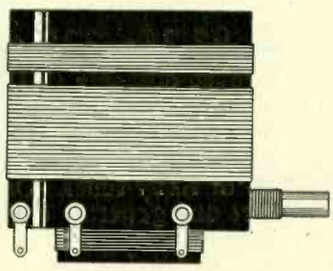
Cat. No. BT5B—$2.50
FOR .0005 MFD. CONDENSERS
Bernard Tuner for working out of a screen grid tube, consists of a rotary coil in series with a fixed coil, the two constituting a tuned primary, for tuning the combined rotary and fixed windings to exceed the broadcast band of wavelengths. The condenser shaft and rotary coil shaft are physically coupled so one motion turns both. Develops the highest possible amplification from the screen grid tube.
Cat. BT3B for .00035 mfd.....$2.55

The Diamond Pair

Since 1925 the Diamond of the Air has been an outstanding circuit. It has undergone few changes. When power tubes and screen grid tubes appeared these were included. When AC operation became practical, the model was described for such use. Whether battery-operated or AC-operated, the Diamond of the Air is a dependable and satisfactory circuit. It uses a screen grid RF stage, tickled detector and two stages of transformer coupled audio. The same coils are used for both models, battery or AC. The secondaries are tuned. They are matched with fine precision, to permit ganged tuning.



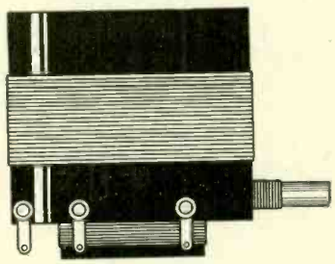
Cat. No. RF5—$0.75
FOR .0005 MFD. CONDENSER
Antenna coil for any standard circuit, and one of the two coils constituting the Diamond Pair. The secondary is carefully wound to match the inductance of the companion coil's secondary, so equality of tuning prevails.
Cat. No. RF3 for .00035...$0.80



Cat. No. SGT5—$1.25
FOR .0005 MFD. CONDENSER
Interstage 3-circuit coil for any hook-up where an untuned primary is in the plate circuit of a screen grid tube. This primary has a large impedance (generous number of turns), so as to afford good amplification. Used in the Diamond of the Air.
SGT3 for .00035 mfd.....$1.30

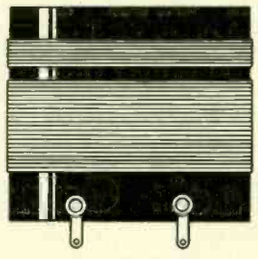
The Diamond Pair of coils for .0005 mfd. tuning are Cat. Nos. RF5 and SGT5. A circuit of excellent stability, extremely high selectivity and good sensitivity, the Diamond of the Air should be built with coils that permit full capitalization of the virtues of the circuit. Not only is the number of turns correct for this circuit on each coil, but the spacing between aperiodic primary and tuned secondary is exactly right. Note that the 3-circuit coil SGT5 (or SGT3) has a high impedance primary. This means good amplification from the screen grid tube, obtained in a manner that guarantees selectivity attainment.

ANTENNA COUPLER



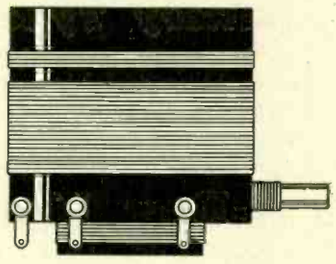
Cat. No. VA5—$1.10
FOR .0005 MFD. CONDENSER
Moving primary and fixed secondary, for antenna coupling, adjustable from a knob at the front panel, thus providing volume control.
Cat. No. VA3 for .00035 mfd.....$1.15

SG TRANSFORMER



Cat. No. SGS5—$0.75
FOR .0005 MFD. CONDENSER
Interstage radio frequency transformer, to work out of a screen grid tube, where the generous-sized primary is in the untuned plate circuit.
Cat. No. SGS3 for .00035 mfd.....$0.80

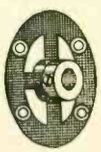
STANDARD TUNER



Cat. No. T5—$1.25
FOR .0005 MFD. CONDENSER
Standard three-circuit tuner, for antenna stage, or interstage coupling where primary is in the plate circuit of any tube except a screen grid. Provides abundant selectivity and gives smooth tickler action.
Cat. T3 for .00035 mfd.....$1.30

Insulated Link

A flexible coupling device to unite two independent ¼" shafts for single dial operation of a tuning condenser and a Bernard Tuner. If the condenser has shaft protruding from the rear, then the condenser may be panel-mounted and the coil shaft coupled by the link to either extension shaft of the condenser. If the condenser has no shaft protruding at rear, mount the Bernard Tuner on the front panel. It has shaft protruding at rear for coupling by the link to the condenser's front shaft. To make sure of insulated protection do not force the receptacles of the link together when mounting.



FL4..$0.35

Data on Construction

The coils are wound by machine on a bakelite form 2½" wide, and the tuned windings have identical inductance for a given capacity condenser, i. e., .0005 mfd. or .00035 mfd. Full coverage of the wave band is assured. The wire is silk insulated.

All coils with a moving coil have single hole panel mounting fixture. All others have base mounting provision. The coils should be used with connection lugs at bottom, to shorten leads.

Only the Bernard Tuners have a shaft extending from rear. This feature is necessary so that physical coupling to tuning condenser shaft may be accomplished by the insulated link.

[Note: Those desiring the 80 mmfd. equalizing condenser for use with the antenna model Bernard Tuner, BT5A or BT3A, should order EQ80 at $0.35.]

SCREEN GRID COIL COMPANY
143 West 45th Street, New York City

SCREEN GRID COIL COMPANY, 143 West 45th St., New York, N. Y.
Just East of Broadway

Enclosed please find $..... for which please ship at once, parcel post prepaid, the following coils:

Quantity	Cat. No.	Price	Quantity	Cat. No.	Price	Quantity	Cat. No.	Price	Quantity	Cat. No.	Price
☐	BT5A	$2.50	☐	RF5	$0.75	☐	VA5	$1.10	☐	SGSF	$0.75
☐	BT3A	$2.55	☐	RF3	$0.80	☐	VA3	$1.15	☐	SGS3	$0.80
☐	BT5B	$2.50	☐	SGT5	$1.25	☐	T5	$1.25	☐	FL4	$0.35
☐	BT3B	$2.55	☐	SGT3	$1.30	☐	T3	$1.30	☐	EQ80	$0.35

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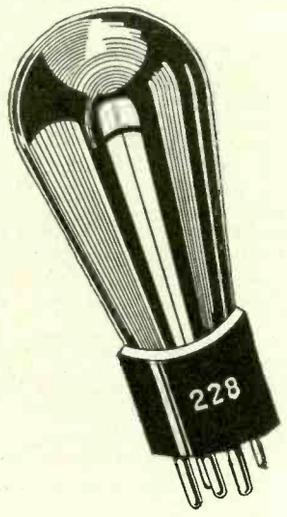
New High Mu AC Tube

228 Provides Higher Amplification and is an Excellent Power Detector



228 AC High Mu Tube, with an amplification factor of 45 is an exclusive contribution to tube science by Kelly laboratories.

WHEN signals are weak in an up-to-date AC receiver using *227* tube as detector or audio amplifier, replace the *227* with the new *228* high mu AC tube and be amazed at the difference in volume.

The up-to-date receivers have high impedance primary in the first audio transformer, or have a resistor in the plate circuit, so the high mu tube is a boon indeed.

As a detector the *228* can be used with leak and condenser, with grid returned to cathode, or as a negative bias (power) detector. See table, lower left corner.

Since the *228* has the same base, same prongs and same heater voltage as the *227*, it can be used for replacement and improvement, and without requiring any wiring changes or any other changes. Simply insert the *228* in the socket from which the *227* is removed.

228

$2.50

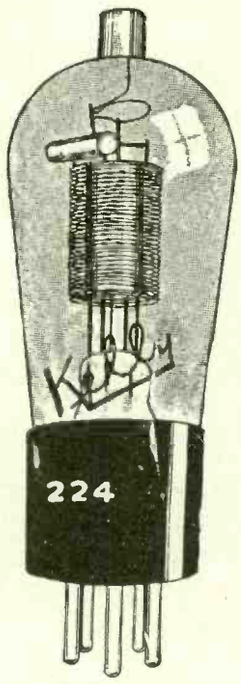
CHARACTERISTICS OF THE 228

Heater voltage 2.5 volts AC.
Heater current 1.75 amperes.
Amplification factor 45.
Mutual conductance 1,000.
Plate voltage 180 volts.
Grid bias, detector —6 volts.
Grid bias, amplifier —2.5 volts.
Load resistance, 0.1 to 0.5 meg.
Internal plate resistance 45,000 ohms.

The plate current under normal operation is less than one milliampere. Hence the 228 tube imposes minimum load on the B supply.

The 228 is not suitable as a radio frequency amplier.

224 at $3.00—245 at $2.25—227 at $1.50—226 at 95c



The screen grid tubes have proved not only their capability but their dependability, and in AC circuits the *224* AC screen grid tube is popularly used as amplifier and detector, with the *245* as output, singly or in push-pull. Safe and satisfactory, Kelly *224* tubes are made with the same expertness and precision that characterizes the entire line of Kelly tubes. Our products are used by laboratories, technicians, experimenters and general consumers because of proven merit.

The Kelly *224* screen grid tube is not only excellent as a radio frequency amplifier but as a detector, especially applicable as a space charge detector.

A suitable high impedance load should always be in the plate circuit of any screen gride tube. For RF a large untuned primary, or a tuned primary, for detection and AF a resistor of 50,000 ohms or higher, usually considerably higher, or a high impedance inductance. You will find Kelly 224 fully meets your most exacting requirements.

The *224* and *227* are 5-prong (UY) tubes, the *245* and *226* 4-prong (UX) tubes.

Battery Type Screen Grid 222 at $3.50

The battery operation the *222* screen grid tube is an important contribution, because enabling such high amplification that battery circuits are put on a par with AC circuits in performance. The *222* is the most popular battery-operated tube for up-to-date circuits and the Kelly model is made to produce clear reception and have exceptionally long life.

5-Day Money Back Guarantee!

You run no risk whatever when you purchase Kelly tubes. Not only are they expertly made but they are sold on a 5-day money-back guarantee. This exclusive form of protection enables you to be the ultimate judge in your own laboratory or your own home, with no appeal from your decision on our part. If you are not delighted with the performance of Kelly tubes, we are not even satisfied, and will promptly refund your money on the foregoing 5-day basis.

If at any time after the five days expire, after receipt of tubes by you, there should develop any adverse condition for which you deem the tube at fault, you may communicate directly with us, and we will give the matter prompt attention. Our aim is to render a real service and through such efforts have we built up our volume of business.

Kelly Tube Company. 143 West 45th St., N. Y. City

Enclosed please find $..... for which ship at once tubes marked below:

- ☐ 228 AC high mu. @.....$2.50
- ☐ 224 AC screen grid @.....$3.00
- ☐ 245 AC power tube @.....$2.25
- ☐ 226 AC amplifier @.....$0.95
- ☐ 227 AC det.-amp. @.....$1.50
- ☐ 171A AC power tube @.....$0.95
- ☐ 210 AC power tube @.....$4.50
- ☐ 250 AC power tube @.....$6.00
- ☐ 280 AC rectifier @.....$1.75
- ☐ 281 AC rectifier @.....$3.50
- ☐ 222 battery screen grid.....$3.50
- ☐ 240 battery high mu.....$1.25
- ☐ 112A battery power tube.....$0.95
- ☐ 171A battery power tube.....$0.95
- ☐ 201A battery tube.....$0.65
- ☐ UX199 battery tube.....$1.25
- ☐ Matched pair of 245s for push-pull (for both).....$4.50
- ☐ Matched pair 171As for AC Push-Pull (for both).....$1.90

ALL PRICES QUOTED ARE SELLING PRICES AND ARE NET

Name .....

Address .....

City ..... State.....

☐ Put cross here if C.O.D. shipment is desired.

Types of Tubes and Their Voltages

Tube	Fil. Volt	Amplifier Plate Volts	Amplifier Neg. Bias	Detector Plate Volts	Detector Neg. Bias	Remarks
228	2.5 AC	180	2.5	180	6	Heater type, 5 prongs.
224	2.5 AC	180	1.5	180	6	Heater type; SG volts, 75
245	2.5 AC	250	50.0	—	—	—
226	1.5 AC	135	9.0	—	—	—
227	2.5 AC	180	9.5	180	18-25	Heater type
171A	5ACorDC	180	40.5	—	—	—
210	7.5 AC	350	27.0	—	—	—
250	7.5 AC	450	84.0	—	—	—
280	5.0 AC	350AC	—	—	—	Full-wave rectifier
281	7.5 AC	700AC	—	—	—	Half-wave rectifier
222	3.3 DC	135	1.5	135-180	4-7	SG volts, 45
240	5.0 DC	135-180	3-4.5	135	1.5-3	—
112A	5.0 DC	135	9.0	135	Leak-cond.	—
UX199	3.3 DC	90	4.0	90	Leak-cond.	—

New J-245 Trouble-Shooting Jiffy Tester

Tests All Modern Circuits at Plate Voltages up to 300 Volts, Finds Shorts and Opens, Judges Tube Performance—All in a Neat, Small Steel Case with Crackle Finish in Brown

THE handiest, dandiest compact Jiffy Tester is the J-245, especially designed to test up-to-date receivers, particularly those using screen grid tubes and 245 single or push-pull, testing out-of-date receivers just as well. It has an extensive usefulness and brilliant eye appeal. It tests sets with 201A, 200A, UX199, UX120, 240, 171, 171A, 112, 112A, 245, 224, 222, 228, 280 and 281 tubes without extra adapters.

Into the case are built the following meters: one reading O-20 ma. and O-100 ma, for plate current, change-over switch included; one reading O-60, O-300 volts DC for plate voltages and DC house line voltages; and one reading O-10, O-140 volts AC and DC (though the meter is marked AC), thus O-140 may be used for DC line voltage.

Two switches and nine tip jacks are on the panel. The jacks are marked to receive the four-tipped leads which emerge from the plugged cable conector. These leads are colored red, blue, brown and white, and so are little rings around the tip jacks that the leads connect to. All nine jacks are marked besides.

The switches are for change-over on the milliammeter, and for connecting and disconnecting the grid return to note a tube's "liveliness." How this is noted is explained in the instruction sheet accompanying the J-245.

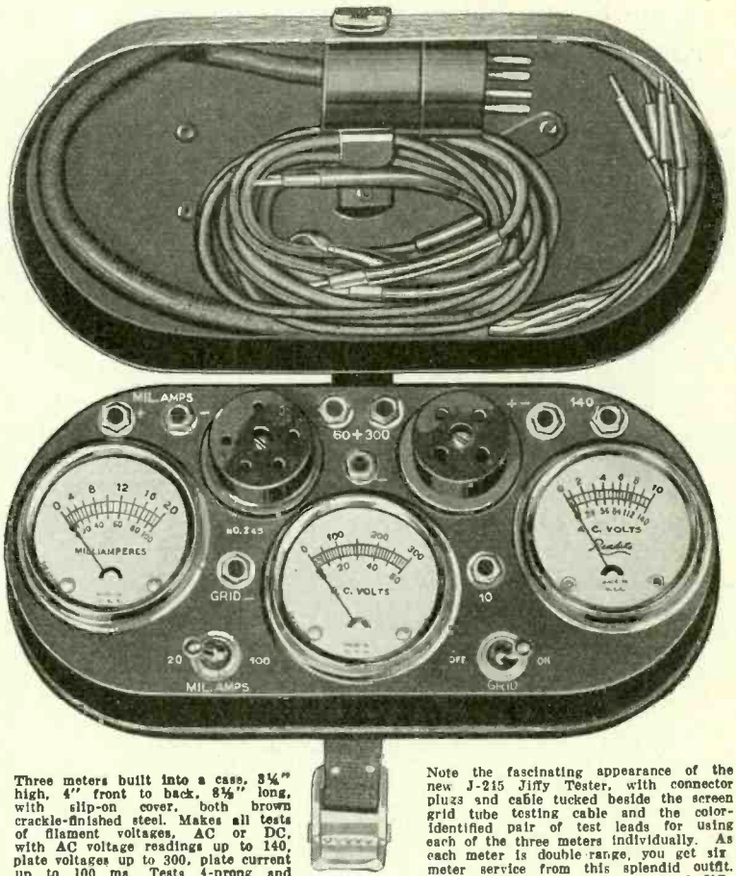
Two sockets are on the panel, one 5-prong, the other 4-prong, for holding the UX and UV tubes, including screen grid tubes, both AC and battery types. To enable full test of screen grid tubes, including AC 224 and DC 222, a screen grid cable is supplied.

The compact J-245 therefore tests all plate voltages up to 300 volts, including B eliminators; all filament voltages, DC or AC, up to 10 volts; all plate current up to 100 ma. Besides, it provides close readings for plate current of 20 ma. or less and for B voltages of 60 volts or less, and AC voltage readings up to 140, including AC line voltage. Besides, it reads screen grid voltage.

The base that contains the meters has four feet on it, is only 1¼" high, and snugly receives the cover. Inside the cover is a spring clip to hold the plugged cable, with a 4-prong adapter, as well as the red and black separate test leads for use of each meter independently, and the screen grid cable. You have three separate double-range meters independently accessible, in other words, six-meter service, besides the plug-in feature for joint use of all meters in testing receivers, tubes, continuity, shorts, opens, etc., as described in the instruction sheet.

This outfit has a genuine leather handle on the top for carrying, and a braided strap for keeping the cover from coming off accidentally. It is the very thing that the service man, experimenter, student and teacher have been looking for.

Order Cat. J-245 and you will be surely overjoyed at the possession of such a handy, dandy, reliable and rugged Jiffy Tester, the neatest one you ever saw, and one that abundantly answers the purposes of service work. You don't need to know in advance how to use it. The instruction sheet gives a simple but comprehensive explanation. Besides, a tube data sheet tells how to determine if tubes are O.K.



Three meters built into a case, 8¼" high, 4" front to back, 8½" long, with slip-on cover, both brown crackle-finished steel. Makes all tests of filament voltages, AC or DC, with AC voltage readings up to 140, plate voltages up to 300, plate current up to 100 ma. Tests 4-prong and 5-prong tubes, including screen grid tubes. Test leads and instruction sheet included.

$11.76

Note the fascinating appearance of the new J-245 Jiffy Tester, with connector plugs and cable tucked beside the screen grid tube testing cable and the color-identified pair of test leads for using each of the three meters individually. As each meter is double range, you get six meter service from this splendid outfit. This is the most popular type of Jiffy Tester and the most desirable in the low price range.

Remit $11.76 with order, and we pay cartage!

Successful Servicing Is Impossible Without Meters

IF you are a service man you are lost without meters. You may carry individual meters around with you and still remain perplexed, for lack of any means of obtaining access to the voltages or currents you desire to test. Therefore an analyzer like the J-245 is just the thing, and it is much more neatly made than you could possibly make a tester yourself, since, besides the engineering talent required to design such a device, thousands on thousands of dollars must be invested in dies. You reap the benefit of expert engineering design, quantity production and careful instruction as to use when you buy a J-245. It is unqualifiedly recommended as superior to any tester that is anywhere near so low in price. You could pay twice as much and get half as much value!

NEVER again need you be stumped for want of the necessary measuring equipment. Suppose you want to know the AC line voltage or DC line voltage—the right hand meter gives it to you. Simply plug the red test lead into the "140" tip jack, the black test lead into the "+" tip jack. If you desire to read the plate current of one tube, insert the tube in the proper socket of the J-245, connect the plug (with the aid of the 4-prong adapter, if necessary) into the emptied socket of the receiver, switch the milliammeter to "O-20" reading, insert the four-colored cable leads into the corresponding marked and colored tip jacks and turn on the set. These are only some of the fifteen tests you can make.

Independent Access to All Three Meters Insures Versatility

BESIDES fetching appearance, sturdiness, compactness and low cost, the J-245 affords versatility by rendering individual access to each meter. Use the red and black test leads for this purpose. Suppose you want to know the total plate current drain of all tubes of a receiver. Use the milliammeter at its "O-100" setting, connect the test leads to "milliamps +,—" and the other ends of the leads in the negative B line.

This accessibility of each meter—six-meter service, remember—heightens the value of the J-245 more than 100%, and is a new feature.

YOU are all set to go when you possess the J-245. The only limitations you will possibly encounter, and these are rare instances, apply to the testing of the B voltages on 210 and 250 tubes, and to testing the Kellogg tubes, which have filament emerging from a cap at top.

The plate voltage on a 210 is usually 350 volts while that on a 250 is usually 450 volts, and the B voltmeter reads up to 300 volts. But a series resistor will extend the range. This multiplier is an extra, and those deeming it necessary may order Cat. No. J-10; at 88c net, to increase scale to O-600 volts.

Likewise, a Kellogg tube adapter is available, Cat. No. J-24 at 60c net. If UV199 tubes are to be tested, a pair of adapters is necessary, as these tubes have a unique base. The UX199 tubes can be tested without adapters. For UV199 tubes order Cat. No. J-19 at 60c net, which changes the UV socket of the receiver to accommodate the UX plug of the J-245, and Cat. No. J-20 at 36c net, to change the 4-prong socket of the J-245 to receive the UV199 tube.

NET PRICES AT MORE THAN 40% OFF LIST PRICE!

J-245, consisting of the complete outfit, less multiplier, UV adapters and Kellogg tube adapter. Net price $11.76
J-106, resistor to be connected in series with O-300 voltmeter to increase reading to 600 volts. (Jack terminals optional. See coupon.) Net price ..... .88
J-106 only ..... .88
J-19 and J-20, pair of adapters for testing UV199 tubes. Net price for both.. .96
J--24, Adapter for testing, Kellogg and old Arcturus tubes. Net price..... .60

GUARANTY RADIO GOODS CO.
143 West 45th Street, (Just East of Broadway), New York, N. Y.

Gentlemen: Enclosed please find $..... Send me at once at your expense:

- ☐ One J-245 with instruction sheet, net price..... $11.76
- ☐ One J-106 multiplier, net price..... .88
- ☐ Jack Terminals optional for J-106, order JT, net price..... .30
- ☐ One pair of UV adapters, J-19 and J-20, price of both, net .96
- ☐ One adapter for testing Kellogg and old type Arcturus tubes, J-24, net price ..... .60

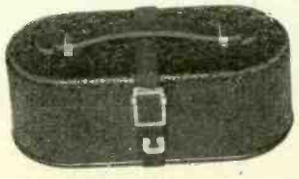
All prices are net and represent extreme professional discount already deducted.

Your name ..... City.....

Your address ..... State.....

5-DAY MONEY-BACK GUARANTY

A Neat Carrying Case

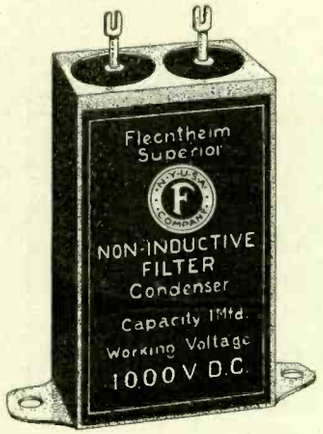


How the J-245 looks when the cover is slipped on and the strap is tightened. The handle is genuine leather.

Order a J-245 today. It is sold on a 5-day money-back guaranty, which nobody else offers. Try it out for five days after receipt. If not fully satisfied for any reason, or for no reason at all, send it back with a letter asking for refund of the money you paid. The refund will be made promptly. There are no strings to this guaranty!

FLECHTHEIM

1,000 v. DC
500 v. AC(rms)
Filter Condensers at Professional Discounts



Filter Condenser, Actual Size

Result of Years of Experimenting

UNBELIEVABLY compact, light in weight, made of the highest grade materials, these condensers are the result of many years of patient and constant research. The marvelous achievement is exemplified and substantiated by independent tests.

Types HV can be used to replace all types of condensers having a continuous working voltage up to 1,000 volts DC and will give utmost satisfaction and dependability for a rectified AC voltage up to and including 550 volts rms. Hence, it is just the filter condenser you want for 171A, 245 or 210 power packs, single or push-pull.

Twelve Telling Points

(1) Rated conservatively at voltages up to 1,000 volts DC (500 rms. AC.)
(2) Tested and re-tested at 1,500 volts DC.
(3) Breakdown voltage of 2,500 volts DC.
(4) Breakdown voltage, foil to case, 5,000 volts AC.
(5) Power factor (voltage loss) less than 1%.
(6) Resistance over 600 megohms per mfd.
(7) Negligible dielectric losses.
(8) Capacity is non-inductive and is accurate to within 5% of rating.
(9) Remarkably compact size; all capacities same height.
(10) Great saving in weight.
(11) Highly perfected terminal connectors and insulators.
(12) Proved by fatigue tests to have longer life.

THREE-IN-ONE

Type HV244 is a high-grade capacity bank to operate at voltages up to and including 750 rms AC. Just the unit to use for a B supply for the 250 tubes, single or push-pull. Consists of a bank of condensers tapped 0-2-4-4 mfd. The 2 mfd. section is made to withstand the terrific punishment of voltage surges, and sudden transient line voltages.

ACOUSTICAL ENGINEERING ASSOCIATES
143 West 45th Street, New York, N. Y.

Please send at once the Flechtheim condensers specified below. Quantity desired is marked in square.

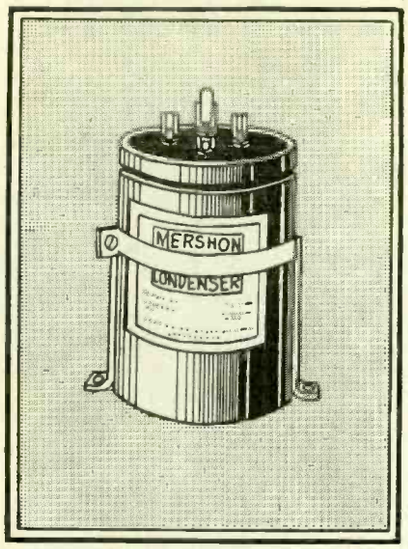
☐ Send C.O.D. (check off).
☐ Remittance enclosed. (check off).

	Type	Capacity Mfd.		Size	List Price	Net Price
☐	HV 5	.05	2	x1½x ⅝	$1.75	$1.03
☐	HV 10	.10	2	x1½x ⅝	2.00	1.18
☐	HV 25	.25	2	x1½x ⅝	2.25	1.32
☐	HV 50	.50	2	x1½x ⅝	2.50	1.47
☐	HV 100	1	2	x1½x ⅝	3.00	1.76
☐	HV 200	2	2	x1½x1¼	5.00	2.94
☐	HV 400	4	2	x1½x2⅝	9.60	5.29
☐	HV 244	0-2-4-4		3⅛x4 x2¾	25.00	

Name .....
Address .....
City ..... State .....

MERSHON

Electrolytic Condensers
at Professional Discounts



Mershon Electrolytic Condensers for Filtering Circuits of B supplies, rated at 400 volts D.C., or for by-pass condensers, give enormous capacities in compact form. We offer, at attractive discount, genuine Mershons made by the Amrad Corporation.

Cat. No. Q 8 — $4.67 NET

Consists of four Condensers of 8 mfd. each, all in one small copper case (less brackets). List Price, $7.95.....

[Cat. Q 8B same as above, but includes mounting bracket. No brackets sold separately..... $4.67]

Cat. Q 2-8, 2-18 — $5.55 NET

Consists of four Condensers, two of 8 mfd. each, and two of 18 mfd. each, all in one small copper case (less brackets), List Price, $9.45.....

[Cat. Q 2-8, 2-18B, same as above, but includes mounting bracket. No brackets sold separately..... $5.75]

Mershon electrolytic condensers are instantly self-healing. They will break down only under an applied voltage in excess of 415 volts D.C. (commercial rating; 400 volts D.C.) but even if they do break down because overvoltaged, no damage to them will result, unless the amount of leakage current and consequent heating of the electrodes and solution cause the solution to boil. Voltages as high as 1,000 volts will cause no particular harm to the condenser unless the current is high enough to cause heating, or the high voltage is applied constantly over a long period.

High capacity is valuable especially for the last condenser of a filter section, and in bypassing, from intermediate B + to ground or C + to C —, for enabling a good audio amplifier to deliver true reproduction of low notes. Suitably large capacities also stop motorboating.

Recent improvements in Mershons have reduced the leakage current to only 1.5 to 2 mils total per 10 mfd. at 300 volts, and less at lower voltages. This indicates a life of 20 years or more, barring heavy abuse.

How to connect: The copper case (the cathode) always is connected to negative. The lugs at top (anodes) are connected to positive. Where there are two different capacities the SMALLER capacity is closer to the copper case.

Mershons of equal capacity may be connected in series for doubling the voltage rating, or in parallel (any combination) to increase the capacity to the sum of the individual capacities, the rating remaining the same, 400 volts.

When series connection is used, the copper case of one condenser the anode of which goes to the high voltage should be connected to a lug or to lugs of the other condenser. The copper case of the second condenser goes to the negative.

In B supplies Mershons are always used "after" the rectifier tube or tubes, hence where the current is direct. They cannot be used on alternating current.

OTHER CAPACITIES OF MERSHONS

["S" stands for single condenser, "D" for double, "T" for triple and "Q" for quadruple. First figure between hyphens denotes quantity, second capacity per anode.]

Cat. No. S-8, list price $4.10; net, $2.41
Cat. No. S-9, list price $4.25; net, $2.49
Cat. No. S-18, list price $4.80; net, $2.82
Cat. No. S-40, list price $5.40; net, $3.17
Cat. No. S-72, list price $10.00; net, $5.88
Cat. No. D-8, list price $5.25; net, $3.08
Cat. No. D-9, list price $5.75; net, $3.38
Cat. No. D-18, list price, $6.15; net, $3.62
Cat. No. T-8 list price $6.30; net, $3.70
Cat. No. T-9, list price $6.45; net, $3.79
Cat. No. T 1-8, 2-18, list price $7.90; net, $4.65
Cat. No. 1-18, 2-9, list price $7.50; net, $4.41

[Note: Add 20c to above prices if bracket is desired. No brackets sold separately.]

No. C.O.D. orders on Mershon Condensers

GUARANTY RADIO GOODS CO.
143 West 45th Street, New York, N. Y.
(Just East of Broadway)

A Special Courtesy to all

A GERNSBACK PUBLICATION

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In order to make it possible for all Radio Technicians to read RADIO-CRAFT regularly, each month, we have put into effect a special subscription price.

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New York, N. Y.

Enclosed find $1.00 for which please enter my subscription to RADIO-CRAFT for eight months.

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City ..... State .....

Surpassing Results from HB Compact!

Screen Grid Circuit for AC or Batt ery Operation Is a Knockout!

THE screen grid tubes, both AC and battery types, 222 and 224, promised much. They could be used to provide actual amplification of 150 per stage, as compared with 8 per stage for a general purpose tube. If only the screen grid tube could be used at full practical amplification! Then a few tubes would do the work of many! At radio frequencies it was found that tuning the plate circuit put the mule kick into the set. But the whole wave band could not be tuned in. So Herman Bernard invented a coil—the Bernard dynamic tuner—that accomplished the trick. Full amplification plus full wave-band coverage! That's why his HB Compacts, only four tubes (plus a 280 in the AC model) perform like eight-tube sets! The sensitivity is incredibly high.

Sensitivity

It would be far short of an accomplishment to hook indifferent audio onto a grid leak-condenser detector. So in both models he used a power detector, two resistance audio stages producing undistorted volume exceeding that of any ordinary two-stage audio amplifier, amplification sufficient to load up the power tube in each instance. And in the case of the AC model HB Compact it is a 245, with 1,600 milliwatts maximum undistorted power output, standing enough gaff for a small hall! And what tone realism! Breath-taking! Nothing in radio ever excelled this tone quality! Nothing! Absolutely nothing!

Realism

As the prices quoted in the list of component parts show, these advantages may be obtained economically. The battery model draws only 21 milliamperes of plate current, .664 amperes of filament current. Large B batteries would last a year at that rate, for average use, and a small A battery require recharging only every two months to ten weeks!

Economy

And this amazingly sensitive, most thrilling and utterly economical circuit gives you all the selectivity you will require, unless you live close to a powerful broadcasting station. So you get a super-abundance of results, in an unusual but thoroughly tried and tested, positively proven circuit!

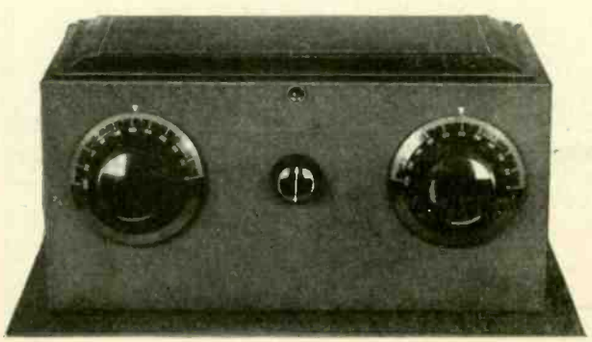
Selectivity

HB Compact, battery model, uses a 222 RF amplifier, a 240 (high mu) power detector, a 222 first audio and a 112A or 171A power tube. The RF tube's plate circuit is tuned by a new type coil that has a moving segment as part of the tuned inductance, with step-up ratio to untuned detector grid. The audio is resistance-coupled. A 7x14" front panel may be used, with baseboard, but the HB Compact Steel Cabinet, decorated brown, with satin aluminum subpanel, sockets affixed, is recommended.

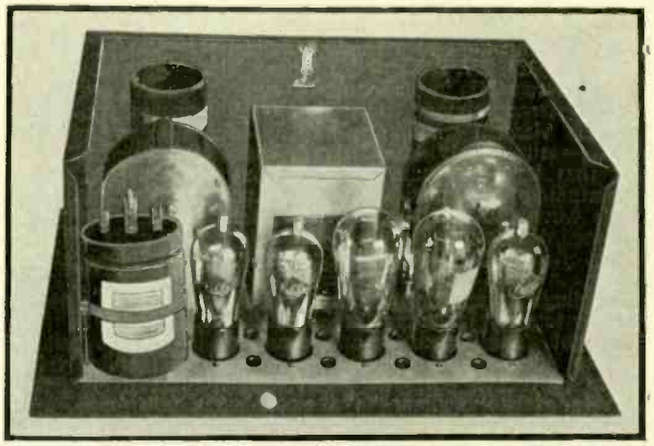
HB Compact, AC model, uses a 224 RF amplifier, a 224 space charge power detector, a 224 first audio and a 245 output tube, with 280 rectifier. Except for the space charge feature, not suitable in the battery model, and the larger power tube, not economically powered by batteries, the two models are fundamentally the same. The AC model is still more sensitive, however.

The same steel cabinet is recommended for the AC model, while the aluminum subpanel has the five sockets affixed and the type of each tube (except detector) printed on each socket.

Order what individual parts you want.



Front view of the HB Compact. The view is the same for AC or battery model. For batteries the switch is built in the rheostat. For AC a pendant switch is used at rear, in the AC cable.



View of the HB Compact AC Model, the tubes being, left to right, 224 detector, 224 first AF, 245 power tube, 280 rectifier and 224 RF. The subpanel is only 9½x14¼", yet everything save the speaker is in this small space!

Component Parts for HB Compacts

AC MODEL

L1L2L3—Bernard Antenna Tuner BT5A	$2.50
L4L5L6—Bernard Interstage Tuner BT5B	2.50
CT—One 80 mmfd. equalizer	.35
C1, C2—Two .0005 Dustproof @ $2.50	5.00
C3, C3, C4, C5—Four .01 mfd. @ .35	1.40
C7—One 1 mfd. 500V AC	.85
C8, C9, C10, C11—Mershon Q2-8, 2-18B	5.75
C12, C13—Two 1 mfd. 200 V. DC @ .50	1.00
R—One 25,000 ohm wire-wound pot.	1.50
R1, R2, R3, R4—.5, 1.0, .05 5.0 meg. @ .35	1.40
T1—Polo 245 Power Supply Cat. P245PS	10.00
2500, 4400, 774, 50, 8 (20 watt) Voltage Divider	1.75
PL—Bracket and 2.5 v. AC lamp	.70
OC, C6—Output choke, 2 mfd. 500 v. AC cond.	3.85
SP—, SP+—Two binding posts @ .10	.20
Three National grid clips @ .06	.18
F—One 1 amp. cart. fuse with base	.50
Aluminum socketed subpanel, 9½x14¼", 8 brackets	3.25
Steel cabinet, crackled brown finish, 7x15x9½	4.00
3 Insulating washers @ .03	.09
Two full-vision dials with pointers @ 75c	1.50
One AC pendant switch, double opening	.40
One 12 ft. length AC cable	.72
Two rolls Corwico braidite @ .35	.70
Two flexible couplers (links) @ .35	.70
	$50.79

Kelly tubes: Three 224 @ $3, one 245 @ $2.25, one 280 @ $1.75 ..... $13.00

[National Company's coils, soon to be released Cat. BTS5, BTP5 @ $5 each, may be used instead of BT5A and BT5B listed above @ $2.50 each. National Velvet Vernier full-vision dials, instead of plain dials listed above, counterclockwise, @ $1.75 each.]

BATTERY MODEL

L1L2L3—One Bernard Tuner for antenna circuit, for .0005 mfd. tuning (BT5A of Screen Grid Coil Co.)	$2.50
L4L5L6—One Bernard Tuner for screen grid interstage coupling, for .0005 mfd. tuning (BT5B of Screen Grid Coil Co.)	2.50
C1, C2—Two .0005 mfd. Dustproof tuning condensers @ $2.50	5.00
CT—One Hammarlund 80 mmfd. equalizing condenser	.35
C3, C4, C5—Three .01 mfd. mica fixed condensers @ .35	1.05
R1—One .25 meg. metallized resistors	.30
R2, R4—Two 5.0 meg. metallized resistors @ .30	.60
R3—One .075 meg. metallized resistor	.40
R5, SW—One 75-ohm rheostat with switch attached	.80
R6—Two resistors, one 1.3 ohms, the other 6.5 ohms (both)	.45
Ant., Gnd., Sp.—, Sp.+. Four binding posts (all)	.40
One drilled steel cabinet 7" high, 9½" front to back, 15" wide	4.00
Two dials with pointers (both)	1.50
One pilot light bracket with 6-volt DC lamp	.70
One 9½x14¼" satin finish aluminum subpanel with sockets affixed, and supplied with insulated bushings, supporting brackets, and resistor clips	2.00
Two insulated links (flexible couplers) (both)	.70
One 7-lead battery cable	.50
	$23.75

Kelly tubes: Two 222, one 240, one 112A or 171A, total, $9.20.

[National Coils for the battery model, vernier condensers, see note under AC Model.]

[The HB Compacts were designed and built by Herman Bernard. The battery model was described in the August 24th, 31st, September 7th and 14th issues of Radio World.]

[The AC Model is now being described. See pages 12 and 13 of this issue.]

Please Use This Coupon

GUARANTY RADIO GOODS CO.
143 West 45th St., N. Y. City, Just E. of B'way.

Enclosed please find $. ..... for which please send me component parts for the HB Compact as checked off above.

NAME .....

ADDRESS .....

CITY..... STATE.....

Polo 245 Power Supply

Scientifically Engineered, It Insures Superb Performance

THE Polo 245 Power Supply consists of a filament transformer, a high-voltage (plate) winding and two separate chokes, all built in a single cadmium-plated steel casing, for powering 224, 227, 228 and 245 tubes. The output may be a single 245 or two 245s in push-pull, because the chokes are large enough and strong enough to handle 100 milliamperes, while the power tube filament winding will easily take care of the two 245s. The entire supply is exceedingly compact and will fit in a cabinet that has the usual 7" high front panel. The high-voltage winding is of sufficiently high AC voltage to produce full 300 volts when the maximum direct current through any part of a voltage-dividing resistor is 80 ma. Of the 300 volts 250 are applied to the output tube's plate and 50 to its grid for negative bias.

All windings except the primary (110 volts, 50 to 60 cycles) are center-tapped, including the 5-volt winding for the 280 rectifier tube. The impedance bridge method is used for establishing the electrical center. Taking the positive rectifier voltage from the center of the 5-volt winding, instead of from either side of the filament, is a small extra advantage, but shows an extra stroke of careful workmanship to insure superb performance.

Another interesting point is that the high-current winding for all the 2.5-volt AC tubes to be used in a receiver or amplifier is rated at 12 amperes. This means that six heater type tubes may be worked well within the limits of the winding (total of 10.5 amperes used), while seven tubes may be used with the permissible excess of only .25 ampere over the rating (total 12.25 amperes). Of course the two or three other tubes (280, 245) are additionally supplied, from their individual windings. Hence a total of ten tubes may be worked (including 245 push-pull and 280 rectifier).

This is no mere estimate, but a scientific fact. The wire used on this 12-ampere winding is the equivalent of No. 9. Please read our chief engineer's report herewith.

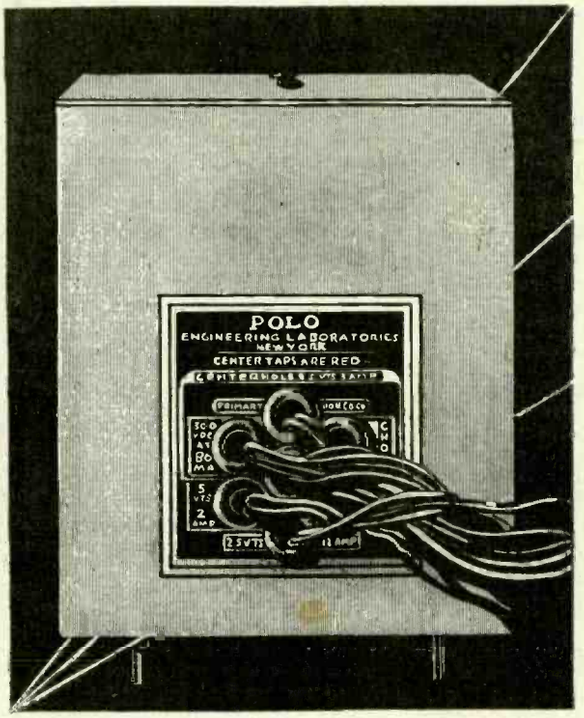
The two chokes are 50 henries each, and each choke is on a saparate core.

The 245 Power Supply weights 16 pounds. The shipping weight is 17 pounds.

For 40-cycle current, 110 volts, a special supply 2" higher, is made. Cat. P245, S40 (Code Cyclone). Price $13.50.

The 245 Power Supply, with chokes, is made also for 25 cycles, 110 volts. Only this particular combination is made for 25 cycles, although the filament-plate supply (less chokes) and the filament supply (less chokes and high-voltage winding) are made for 40 cycles.

For 25 cycles order Cat. No. P245 S 25 4⅝" wide x 5⅛" front to back x 9⅛" high. Shipping weight 25 lbs. (Code Cypress) at.....$14.50



Polo 245 Power Supply, including two chokes built in, size 4⅝" wide x 5⅛" front to back, 6⅛" high. Cat. No. P245 PS 110 volts, 50-60 cycles (code Cyclops).....$10.00
Cat. No. P245, S40, for 40 cycles, 110 volts; size 4⅝" wide x 5⅛" front to back, by 8⅛" high (code Cyclone).....$13.50

Chief Engineer's Report on Polo 245 Power Supply

By Walter J. McCord, Chief Engineer

Every precaution has been taken to produce a 245 power supply of superb performance, and in proof thereof I take pleasure in submitting for close study by engineering minds the specifications followed, with advice to novices.

(1)—Overall dimensions of the casing, 4⅝" wide x 5⅛" front to back x 6⅛" high.

(2)—Filament and plate secondary windings as follows: 724 volts at 100 mils, center tapped at 362; 5 volts at 2 amperes, center tapped; 2.5 volts at 3 amperes, center tapped; 2.5 volts at 12 amperes, center tapped.

(3)—Two 50-henry chokes, DC resistance of each, 420 ohms.

(4)—Primary draw with all secondaries worked at maximum, 88 watts.

(5)—One transformer core with 1" x 1¾" cross-section; window opening 2⅜" x ¾". Two choke cores with ⅞" x 1¾" cross-section; window opening ½" x 1¾"; .014" air gap. The laminations are stamped from high-grade Silicon sheet steel having 1.92 watts loss per pound. The joints in the transformer are all overlapping, holding the magnetic leakage to a minimum.

(6)—Size of wire and resistance of each winding as follows: Primary—No. 24 wire, DC resistance, 5.2 ohms. Plate Sec.—No. 30 wire, DC resistance, 104.5 ohms. 5 v.—No. 18 wire, DC resistance, .102 ohms. 2½ v., 3 a.—No. 18 wire, DC resistance, .051 ohm. 2½ v., 12 a.— .059 x .180 rectangular wire (equals approximately No. 9 wire), DC resistance, .008 ohm.

(7)—Total weight of block 16 lbs.

(8)—Casing is made of sheet steel and is cadmium plated. Four ¾" mounting screws are placed in the bottom, permitting the block to be mounted to the base, in a very small space, as no space is required for mounting flanges.

(9)—Care should be taken in connecting the leads so that none of the secondaries is shorted. A shorted secondary, either a direct short or through a defective condenser, soon will burn out a transformer. Care should be taken also in connecting the primary to the proper current. The primary should be connected to 110 v. 50-60 cycles AC, never to 220 volts, neither should it be operated on a line voltage of 130 or over.

NO C. O. D. ORDERS.

Polo Engineering Laboratories, 57 Dey St., N. Y. City. Enclosed please find $——, for which ship at once the following:

P245 PS (code Cyclops)	$10.00
P245 S40 (code Cyclone)	13.50
P245 S25 (Code Cypress)	14.50
PFT (code Cyclist)	4.25
P40 FT (code Cyanide)	6.25
PFPS (code Cymbal)	7.50
P40 FPS (code Cylinder)	10.00

In ordering by telegraph use code designations.

Name .....

Address .....

City..... State.....

ALL PRICES ARE NET

5-DAY MONEY-BACK GUARANTEE!

FILAMENT-PLATE SUPPLY

The Polo 245 Power Supply, less the two built-in chokes, is available to those desiring to utilize chokes they now have, and who do not find the compactness afforded by the consolidated unit absolutely necessary.

The Filament-Plate Supply has the same voltages on the secondaries, at the same ratings, as does the unit that includes the chokes.

Polo Filament-Plate Supply, consisting of five windings; primary 110 v., 50-60 cycles. Cat. No. PFPS (code Cymbal), $7.50.

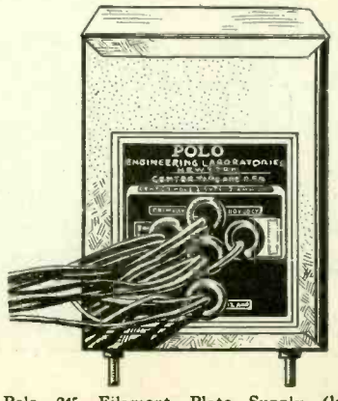
Same as above, except for 40 cycles 110 v. AC. and a little greater height. Cat. P40 FPS (code Cylinder), $10.00.

FILAMENT SUPPLY

A filament transformer only, in a smaller container than any of the others, but with the same voltage and current ratings, provides 2.5 v. at 3 amperes, 2.5 v. at 12 amperes, 5 v. at 2 amperes.

The Polo Filament Transformer, consisting of four windings as described; primary, 110 v. 50-60 cycles. Cat. No. PFT (code Cyclist) $4.25.

Same as above, except for 40 cycle, 110 v. AC. Cat. P40 FT (code Cyanide), $6.25.



Polo 245 Filament Plate Supply (less chokes) is 4½" wide, 5" high, 4" front to back. Weight 9 lbs.