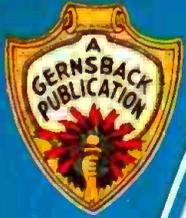


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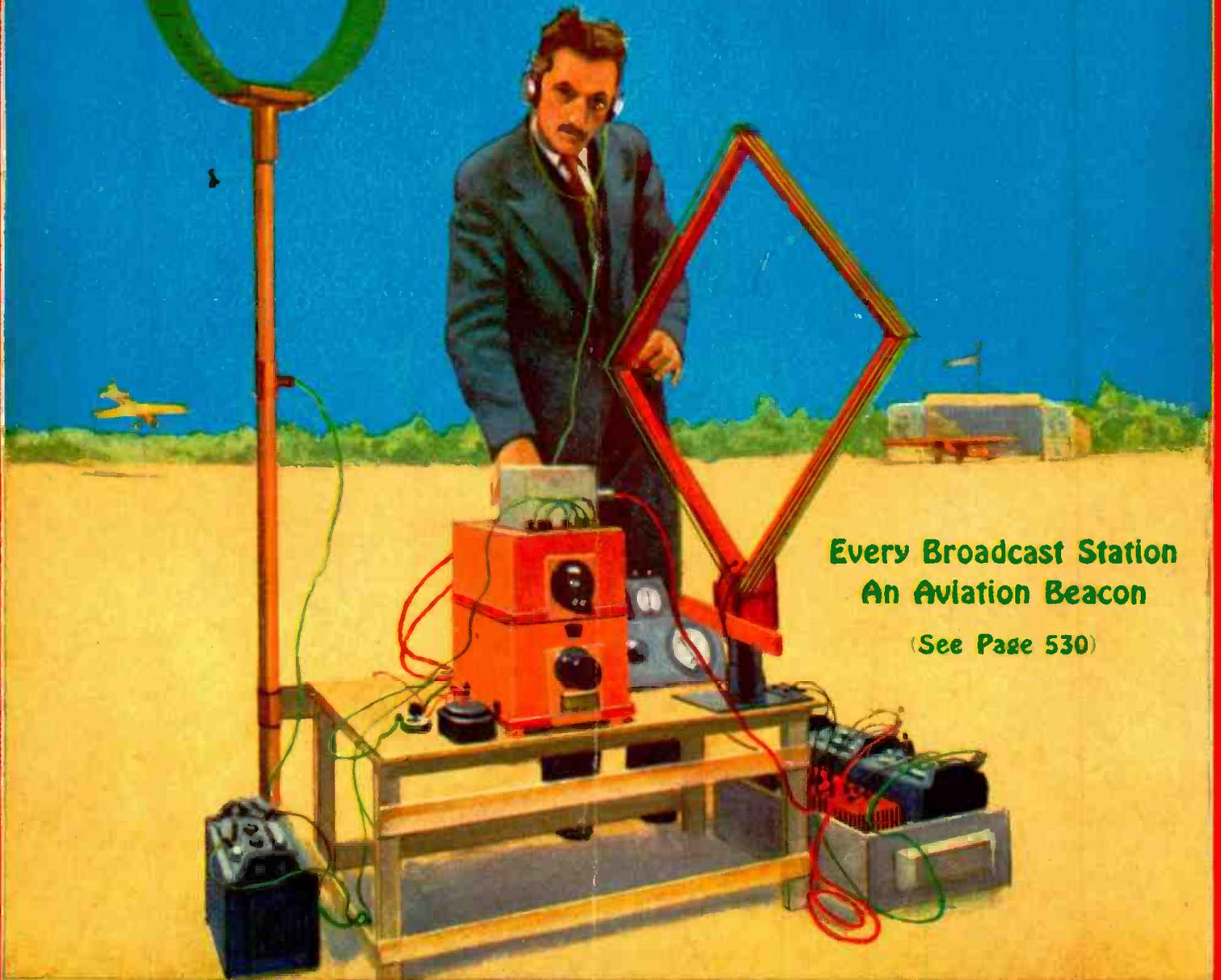


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FOR THE
SERVING MAN - DEALER - RADIOTRICIAN

HUGO GERNSBACK Editor



Every Broadcast Station
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(See Page 530)

Tracing and Curing Hum

Band-Selector Design

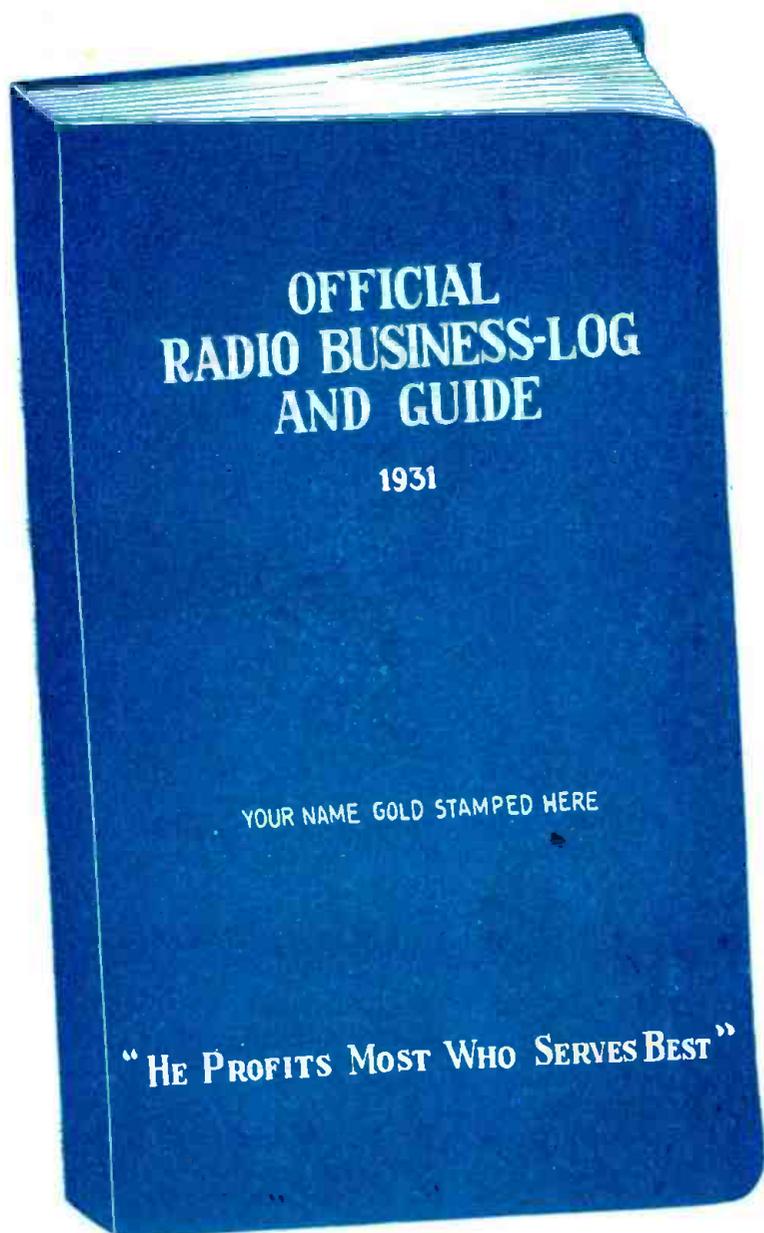
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VOLUME II
 NUMBER 9

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TWO-VOLT TUBES FOR SET OPERATION: A discussion of tube, receiver and battery problems and methods. These new tubes have given new efficiency and economy to battery-operated sets.

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TESTING APPARATUS: Set analyzers, tube checkers, modulated oscillators, meter multipliers, and other apparatus for the shop and the service kit.

A HOME-PRACTICE SET. This ingenious apparatus lends itself to bell signaling and telephone use, as well as code practice. With the aid of a wire line, it gives radio practice without requiring a wire line.

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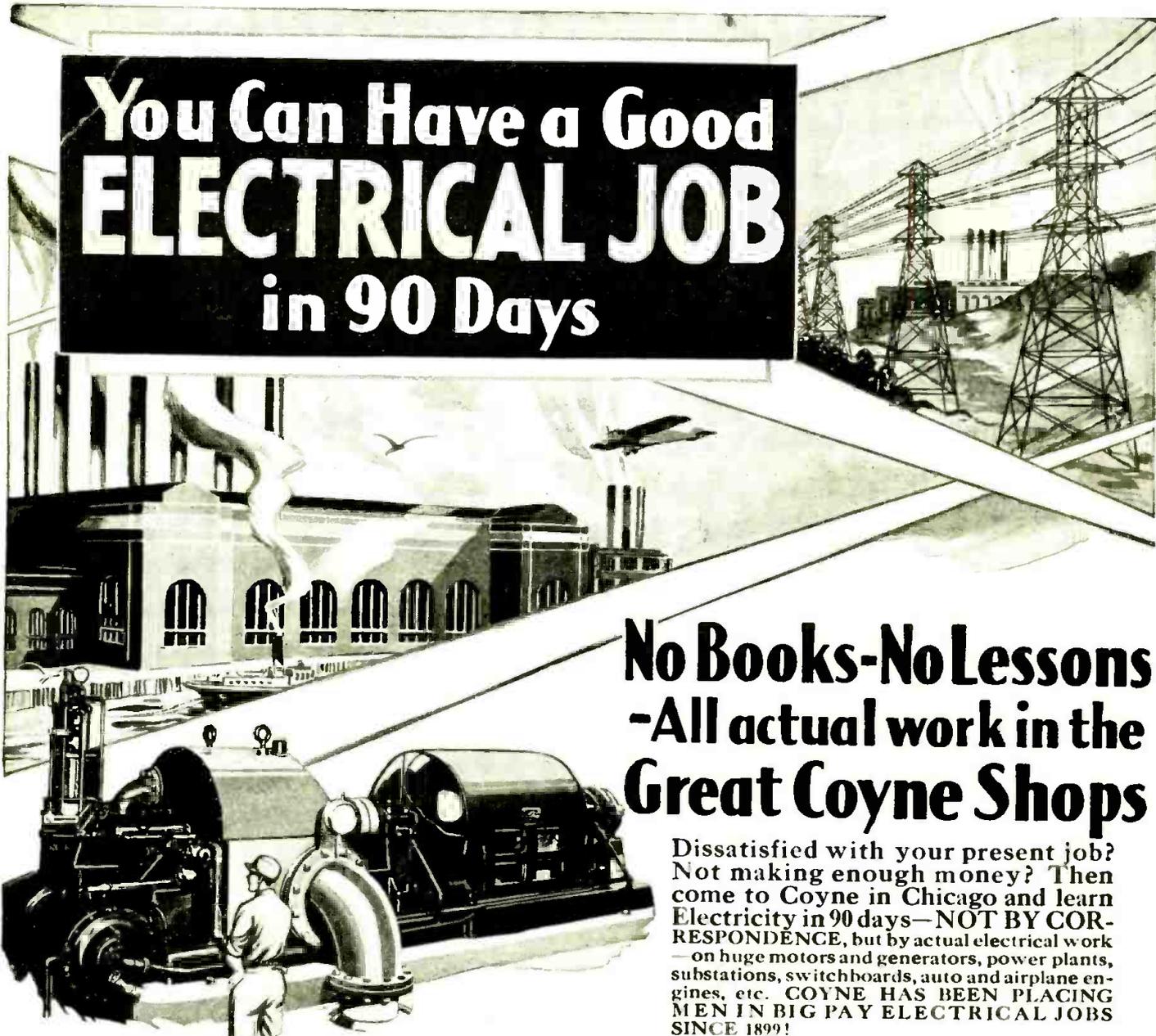
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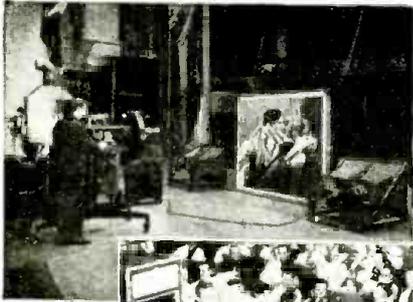
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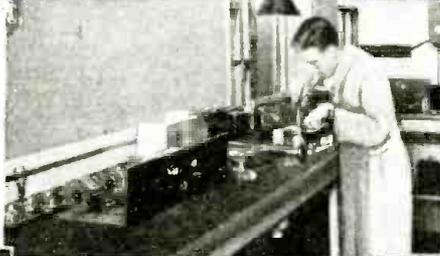
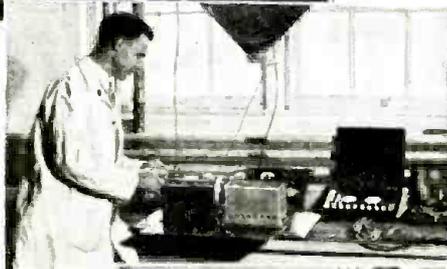
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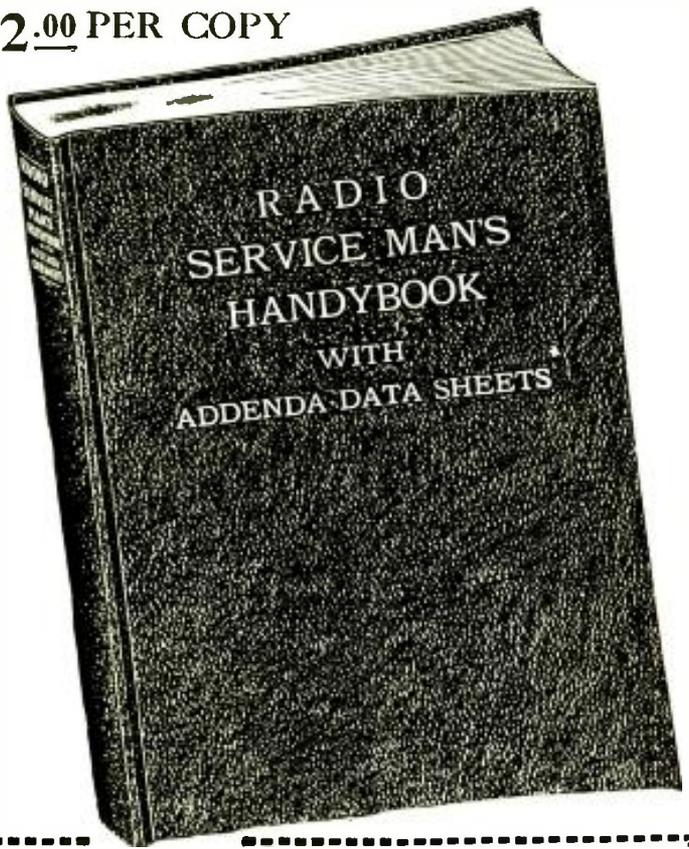
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MARCH
1931
VOL. II—No. 9



HUGO GERNSBACK
Editor

“Takes the Resistance Out of Radio”

Editorial Offices, 96-98 Park Place, New York, N. Y.

Tomorrow's Radio Set

By Hugo Gernsback

THOSE interested in the radio art have constantly wondered what the future radio set will look like, what its efficiency will be and, particularly, what progress there will be made as far as the radio tubes are concerned.

Before the questions can be answered, let us look into the principles underlying radio reception. Take the ordinary aerial atop your roof. Surprising as the statement may seem, nevertheless it is perfectly true that every radio station in the entire world which is broadcasting (or transmitting code, for that matter) is represented there, right in your own aerial. It makes no difference how far away that station is: Not only theoretically, but practically, the waves from a five-watt station located 12,000 miles away are impinging on your aerial. Of course, you can not hear all these stations, for a simple reason only; and that is, the sensitivity of your present set is not sufficiently great though the energy is in your aerial, just the same.

When we started out with a crystal detector, its range was limited, purely because its sensitivity, as reckoned today, was exceedingly small. Next we had the vacuum tube and, when it first came out, its sensitivity, though much greater than that of the crystal detector, was still comparatively poor. With the newer tubes (such as, for instance, the screen-grid and the thyatron) the sensitivity has been stepped up tremendously. It may be said that a good modern midget set using only four receiving tubes (the fifth tube being simply a rectifying device) easily replaces a ten-tube set of four or five years ago; that is, as far as sensitivity is concerned. And, indeed, our present little four-tube midget set gives a power which was undreamed of even three years ago. All of this is due to the tremendous amplifying powers of the modern tubes.

When I use the word “tremendously” I do so only in a comparative manner. Certainly, ten years after this is written, the present radio tubes with their “tremendous” amplifying power will be laughed at. It is conceivable that, ten years hence, we will have a single tube which will do all the work of the four or five tubes used today. It will probably be a combination of a detector and an amplifier, as well as a rectifier; the entire tube probably being no larger than an '80-type tube of today.

Incidentally, if we measure the future by the past, that single tube will be far more sensitive than anything we have now. And, with a set containing such a tube, coast-to-coast reception will be a common everyday affair.

What the future tube will look like, and exactly how it is going to operate, no one knows. The chances are that it will be a “cold” tube; that is, no heated filament, such as we have today, will be used to give us electron emission.

The present tubes are, after all, only a makeshift. The introduction inside the tube of the heater element always gives rise to hum (created by the current supply) which, I am quite certain, will not prevail in the future. An interesting patent has just been granted to a well-known radio worker, who uses the photoelectric principle in a vacuum tube for use in a radio set; here a small and entirely separate electric-light bulb, which may be quite small, throws light, which gives rise to the electronic emission, upon a cathode in the new vacuum tube. All the hum, and many other difficulties, are done away with by means of such a tube. Three or more tubes, when placed around a light-source, are thus energized at a considerable saving of current; and better reception is had all around.

It would appear that the “cold” vacuum tube, which I had predicted as much as ten years ago, is now about to become a reality; it certainly seems to be a step in the right direction.

The important work of the radio-tube scientists, now, is to successfully step up the sensitivity of the radio tube. This will, of course, make our radio sets less complicated and cheaper to operate; and they will therefore also not get out of order so easily.

From a service point, this is important. When you have to service a set that has ten tubes, when something has gone wrong with the set, naturally the difficulties are twofold in such a set when compared to one of five tubes.

The problems under discussion here are of course still largely in the future; but the thoughtful radio worker, I am sure, would like to know with a reasonable degree of certainty what lies ahead of us.

Service Men's Department

This department is about the Service Man, for the Service Man, and largely by the Service Man. Its contributors are practical men, and we invite every Service Man in the country to tell about his own experiences of all kinds.

Edited by JOHN F. RIDER

CHECKING INACCESSIBLE UNITS

By John F. Rider

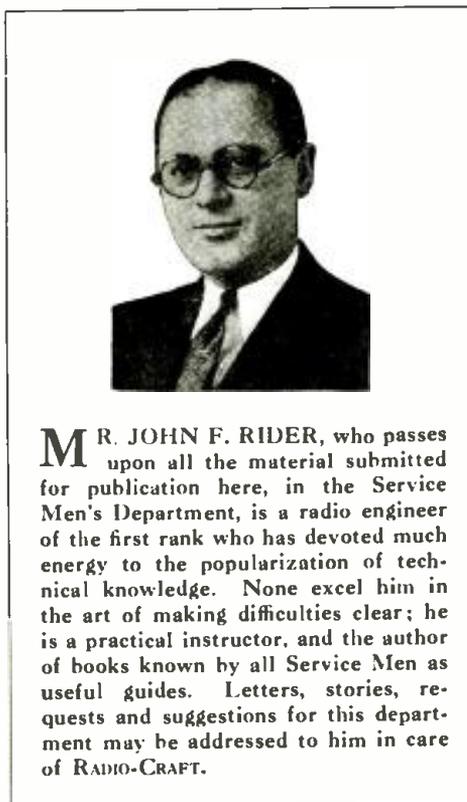
A RADIO receiver is nothing more than a coordinated arrangement of electrical units. The electric receiver of today approaches, most closely, what may be classed as a wholly-interlocked system, wherein every part is tied in with the next. This condition makes possible the testing of inaccessible units; perhaps we should not use the word "testing," instead say "checking." Time and again, it is found difficult to reach one or more units which are located in the innermost recesses of the receiver. But, by suitable analysis of the receiver wiring diagram, it is possible to locate a circuit whereof the unit to be checked is a part. Just how effectively he can check such units, depends upon the Service Man and his knowledge of wiring diagrams.

If we examine a wiring diagram, particularly that of an electric receiver of modern date, we cannot help but note that the ground terminal is common to all parts of the circuit (at least, the "B—" terminal is common to all circuits). In this connection we except just one part of the receiver, the voice coil of the dynamic speaker. In very rare cases, it is also necessary to except the aerial circuit; but, in the majority of instances, the ground end of the aerial circuit terminates at "B—."

Starting at the "B—" terminal, we can trace continuity to every part of the system other than the two mentioned. The number of electrical elements present in the system between "B—" and the extreme end of the circuit is a matter of design. Thus, in the detector circuit of the conventional receiver, we may find the sections of the voltage divider, perhaps a filter resistor, the plate coupling unit and, mayhap, the radio-frequency choke in the plate circuit between the detector plate and the plate end of the coupling unit.

Of these units, one or more may be located in the power pack, and thus separated from the receiver proper. However, with the receiver wiring diagram as a guide, and the electrical values of the parts marked upon the diagram, we can check not only continuity to the "B—" terminal, but also the electrical values of the different sections in the divider. This is possible in the following manner:

If the plate coupling unit located in the detector plate circuit is a resistor, its electrical value is marked upon the diagram. If the plate coupling unit is a transformer, its resistance may be approximated or determined by a D.C. voltage test across the terminals of the unit. The plate current flowing in the detector plate circuit may



MR. JOHN F. RIDER, who passes upon all the material submitted for publication here, in the Service Men's Department, is a radio engineer of the first rank who has devoted much energy to the popularization of technical knowledge. None excel him in the art of making difficulties clear; he is a practical instructor, and the author of books known by all Service Men as useful guides. Letters, stories, requests and suggestions for this department may be addressed to him in care of RADIO-CRAFT.

be determined without much trouble. Applying Ohm's law for resistance, and substituting the voltage measured across the primary and the current in the plate circuit, will determine the resistance of the winding. Assuming a fairly low value of resistance for the detector R.F. choke (about 25 to 30 ohms if it is of the low-pass filter-system variety, and about 200 ohms if it is used as an ordinary choke) we find that the resistance measurement between "B—" and the plate of the tube indicates the electrical values of the total divider. If the total resistance of the divider as recorded does not check with the measurement, individual measurement of the various sections is possible by checking between "B—" (which usually is ground) and the various radio-frequency plate circuits.

It is, of course, impossible to quote every test which may be carried out in this fashion. Each receiver presents its own problems. Take for example, the measurement of the circuit through the grid-bias volume-control unit. One end of this resistance is ground and "B—"; the other the cathode of one or more tubes. To check the resistance of this control unit, the measuring instrument need not be placed directly across the control unit, which is usually located upon the panel and there-

fore difficult of access. Check between the ground and the cathode.

With "B—" terminal as the common terminal, we can check every part of a "B—" eliminator system. If the "B—" terminal is the most negative upon the eliminator, contact between "B—" and the plate terminal of the rectifier tube (with the tube out of the socket) provides a resistance check upon the power transformer's plate winding. If the system employs two half-wave rectifier tubes, switching from one plate to the other permits checking each half of the winding. In cases of this nature, it is not necessary to measure the resistance. Both halves of the plate winding should show the same value of resistance when measured upon a continuity tester.

With "B—" as the common terminal, it is possible to check each ground connection to the chassis by checking between the grid of each tube and "B—." In work of this type, it is necessary to refer to the diagram to locate any possible variation from the conventional tuned grid system, in order to properly locate the circuit prongs for the resistance measurement.

Investigation of a large number of wiring diagrams shows that the method of resistance measurement is preferable to ordinary continuity testing. This is particularly true when high-resistance units are located in many circuits; the ordinary continuity test, when applied to a high resistance, does not serve well to determine the approximate resistance in the circuit. In many instances, the difference between 50,000 and 100,000 ohms is appreciable, and manifests an effect upon the operation of the receiver. When it is checked for resistance, the variation is immediately evident; when it is checked only for continuity, the presence of a fairly high resistance is indicated, but it means very little.

The proper application of short-circuiting links across various parts of a system enables determination of the condition of the unit which has been short-circuited. Naturally such short-circuiting links should not be applied across voltage-reducing resistances, where this would tend to greatly increase the voltage applied to the tube. The sole exception to this statement is the grid-bias resistance in the radio-frequency end of the receiver, or the bias resistance in the detector circuit. A momentary increase in plate current, in order to find out whether or not the grid-bias resistance is open, will not injure the tube. Based upon the conventional tube circuit, such short-circuiting links may consist of a resistance of about 500 to 1,000 ohms, connected between the cathode and ground or

(Continued on page 555)

Operating Notes for Service Men

Much of the knack of servicing comes from familiarity with certain receiver models. An old-timer communicates his professional experiences for the benefit of the craft.

By BERTRAM M. FREED

RECENTLY, an Earl "Model 21" D.C. receiver was checked by a Service Man; the complaint being, no reception. Use of a set analyzer disclosed but one defect; namely, reversed plate reading on the first audio and R.F. stages; others received proper plate voltages. This fact alone vetoed the suggestion of a punctured filter condenser. However, when the set was taken apart, it was discovered that the condenser connected to the set side of the "B" choke was shorted. The condenser block in this model has colored wires emerging from the block. The condenser in question has a blue lead, which was clipped at the block; and a replacement unit of 2 mf. capacity was inserted (Fig. 1). The return or common lead is colored black.

While neutralizing this model, some Service Men make a practice of utilizing a Stevens No. 4 "Spintite." This procedure will work, although allowance must be made for the capacity of this metal tool. However, care should be taken not to short the wrench against the metal chassis; as this may blow one of the '01A tubes. Incidentally, the '71A tubes are in a separate filament circuit, and removal of an '01A will not cut off or break the series circuit of the power tubes.

Many Kolster "K20" sets on the market today are slightly different from their predecessors. As many know, this model employs grid condensers shunted across the grid suppressors. On the later model, a small aperture will be noticed at the left of the

first R.F. tube socket (facing rear of set). This opening is to allow insertion of a non-metallic screwdriver to adjust a variable condenser, which is connected across the grid suppressor, instead of the former fixed condenser. Adjustment of this condenser is not critical, but the DX ability of the set depends upon the correct setting. The condenser should be varied, for maximum response at 650 meters, by means of a local oscillator or some powerful broadcaster at a frequency or wave near this figure.

Atwater Kent has made it a simple task to line up the condenser gang in the new "Model 70" series A.C. and D.C. receivers. While heretofore, it was necessary to release the rotors of the condensers to line up the gang, it is now sufficient to adjust the screws of the compensating condensers to accomplish the same job. These screws

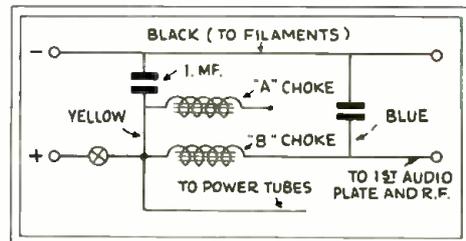


Fig. 1
The shorting of the condenser at the right, in a "Model 21" D.C. Earl filter block, reversed plate voltage polarities. External replacement is easy.

However, replacement has since been found unnecessary. The phono-pickup feeds into an input transformer which couples the pickup to the detector grid circuit by means of the peculiar throw-over switch. One side, of both primary and secondary windings of this transformer, is grounded already. In an effort to determine the cause of grounding, of the other side of the secondary winding, one of these units was taken apart. The metal housing of the transformer folds over at the bottom and holds the cardboard terminal strip. Leads from the transformer come through small holes in the cardboard and are soldered to lugs; which are fastened to the cardboard by means of two flanges which pass through and are bent over to hold the lugs in place. Too many times has the Service Man found that one of these flanges had not been bent over, and was shorting to the core of the transformer. This has been remedied, by either bending over the flange or clipping it. Some dispense entirely with the lugs, by lengthening the transformer leads and bringing these up through the holes in the cardboard. The latter should be replaced, and the ends of the can should be bent over into place.

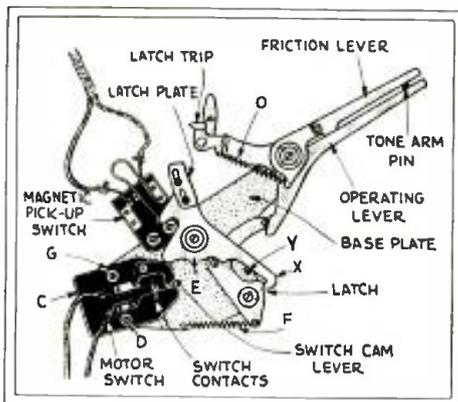


Fig. 3
Details of the automatic switch controlling the phonograph motor in Radiola and Victor combinations. It is discussed in the text on page 554 and necessary adjustments described.

are located at the top of each section in the bathtub gang. The proper screw can be identified by the sealing wax over it.

It seems that manufacturers are now taking into consideration the fact that their sets must eventually be serviced. The Brunswick No. 22 A.C. "Unicontrol" shows this. Removal of the bottom plate reveals all circuits and connections. However, unless the Service Man knows how, locating the line fuses is another matter. The shield can of the power transformer must be loosened, by the removal of the four screws holding it; and the fuses will be found cleverly concealed behind some insulating paper. There are two cartridge-type fuses, one in either side of the line.

Intermittent reproduction in Majestic combination receivers was cured, in nine instances out of ten, by replacing the "phono" input transformer. The Majestic "100B" incorporates this unit in the receiver chassis.

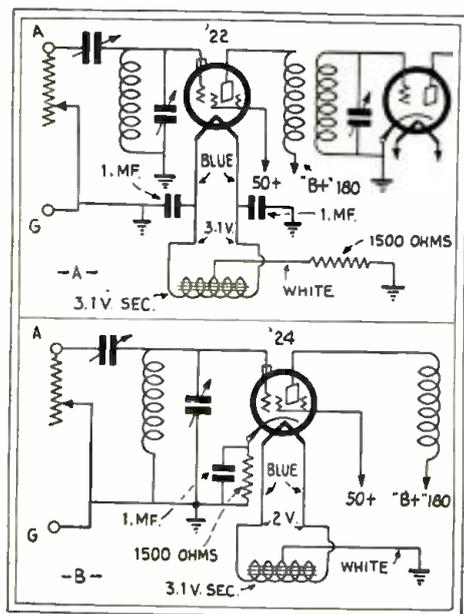


Fig. 2
On replacing a '22 by a '24 in the Freshman "Q-16" and similar models (see also RADIO-CRAFT for March, 1930) the increased drain of filament current will cut down the voltage to the proper value.

Early Screen-Grid Models

It seems that the only way to remedy the complaints of hum on resonance and short-lived '22 screen-grid tubes, is to rewire the Freshman "Q-16" set to use an A.C. '24 tube. The first step, of course, is to tear out the UX socket and replace it with a UY type; the procedure will vary with the type of socket employed. The same filament leads may be used, though this is a 3.1 volt winding (the '22 screen-grid tube is rated at 3.3 volts at .132-ampere), for the '24 will get approximately 2 volts in most instances (See Fig. 2). In cases where the filament voltage under load is lower than 2 volts, the '24 filament may be placed in parallel with the '27 tube. This will deliver about 1.9 volts in most cases to the '24.

(Continued on page 554)

Leaves from Service Men's Note Books

The "Meat" of what our professionals have learned by their own practical experiences of many years

By RADIO-CRAFT READERS

HANDY CONNECTIONS

By John D. Hayden, Jr.

THE usual run of test plugs, furnished with test sets and other equipment, are soldered to the wires and there must always be four or five wires always attached to it. If an old four-, and another old five-prong tube base, are cleaned out and then four or five stiff wires (about No. 16) are soldered to four or five phone-tip jacks, and then soldered into the tube base, we have a changeable plug. After the jacks are soldered the base should be filled with hot sealing wax. Yaxley jacks should be used as they are practically all enclosed, except for two small holes at the bottom which should be plugged with a little solder; be careful not to get the jack full of solder. With this plug, two wires with phone tips soldered to their ends can be used, to connect to the plate, grid or filament leads at will.

Volume and tone of the Silver Marshall "750" chassis can be greatly improved by the addition of a 1-mf. bypass condenser across the detector "B+" lead; there is room on the top of the chassis for this extra condenser. This also lowers the hum level of the set, especially when using a dynamic speaker.

A 110-volt D.C. dynamic speaker is sometimes hard to connect to a set; the Service Man may want to use it with a battery set where there is 110-volt A.C. but no eliminator to supply the field of the speaker. The hook-up shown in Fig. 1 will often solve the problem; some speakers require a big filter, and others one of lesser capacity. Either an '80, with the plates wired together or an '81 rectifier may be used.

Since the A.C. line gives 110 volts, the rectified voltage will be somewhere within the limits of suitability; the average speaker takes about 40 mills; the rectifier will deliver it easily. If this arrangement can be used, no other transformer is necessary.

There are many radio sets of the familiar neutralized type on the market today; I recently worked on a Silver-Marshall of this type and experimented a little to find the best setting.

The set was neutralized at the factory

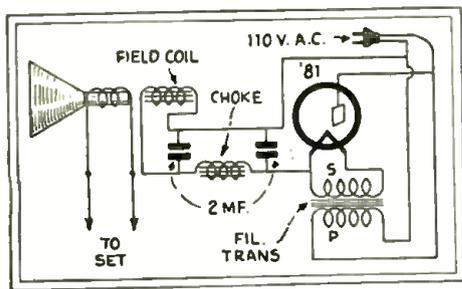


Fig. 1

A convenient means of operating a 110-volt D.C. dynamic speaker from the A.C. line.

and, so far as oscillation was concerned, it was perfect; but the volume was very low in the daytime. The neutralizing screws were so set that each could be turned about half-way around before it would oscillate. This caused the set to oscillate very easily at the lower end of the broadcast band; it would not whistle at the upper end at all. I finally adjusted the screws so that it oscillated at the middle of the band before it did at the lower end. When this was done, one of the screws could be turned about a quarter round in either direction before it would oscillate; but the other could be turned only the fraction of an inch either way. After this, the stations all over the dial came in with very good volume and tone.

A PILOT-LAMP ADAPTER

By Audie Robertson

FOR the Service Man, the device shown in Fig. 2 is very convenient when working in the dark corners of the set. A miniature socket, to fit a dial-light bulb, and a burnt-out bulb, the base of which forms the plug, with two flexible insulated wires are the only requisites.

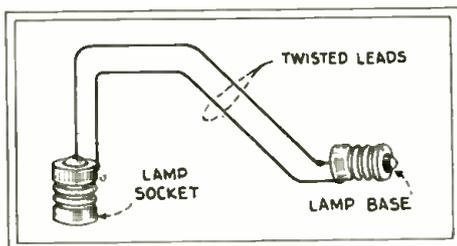


Fig. 2

The dial-light is converted into a trouble-shooting lamp by the use of this simple adapter.

Take the pilot lamp out of the set, put it in the socket of the extension lead; and screw the plug of the latter into the pilot lamp's socket. The lamp continues to operate from the set's current. Two-foot leads are usually enough.

VICTOR SERVICE NOTES

By John D. Hayden, Jr.

ONE of the most constant sources of trouble, that I have found in the old-model Victors, is the breaking of leads to the voice coil on the dynamic. The diaphragm of this speaker is held around the edges with very thin rubber, and the diaphragm moves farther than in other speakers of this type. This trouble can be located very easily; there is no sound whatever from the speaker, although the tubes light. If these leads are lengthened with some flexible wire, the trouble will not occur again for some while.

One of my customers, who owned a Victor, complained that, while in the daytime he could not get the stations he used to,

at night he could hear hardly at all. Upon examination I found a weak '80. In the daytime the light-line voltage was high and, though the tube was weak, it gave some

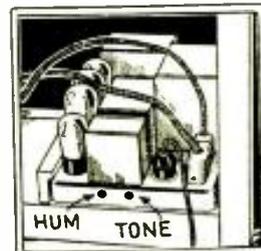


Fig. 3

In recent Victor models, a tone control is mounted in the pack, so that the Service Man can adjust the set to his customer's ears.

current; but at night, when the load on the line increased, there was not enough voltage to work the set properly, causing the trouble mentioned.

On this model, there is a tone control on the power pack. I find that many of my customers do not know this, and I instruct them in the method of using it; this helps to get their service call.

The Victors that are equipped with phonograph often need servicing. If the reproduction sounds low and faint, the trouble may be located in the pickup. The armature, which is supposed to move freely, sometimes gets out of line, and sticks to the side of the magnet or touches it frequently. By resetting the screws, found in the head of the pickup, this trouble can be cured. In one other case, where there was no sound at all, the trouble was located in the volume control; the operator had turned the control too far, and it had lodged between the two stops and remained there.

RECEIVER COMPARISON PANEL

By Fred Lichtgarn

DEMONSTRATING various radio sets on the dealer's floor is made more convenient by the very simple idea illustrated in Fig. 4, which I have found practical and useful. Any receiver may be played at will; so that a quick switch from (Continued on page 562)

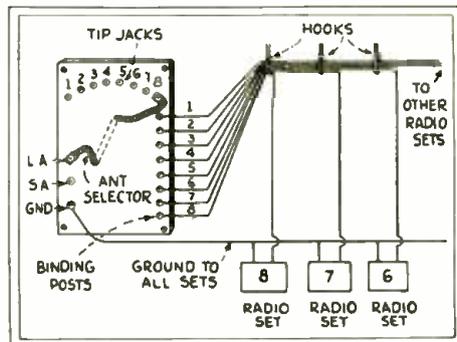


Fig. 4

An inexpensive arrangement for the display room, permitting the demonstrator to turn from one set to another to show quality differences.

PHILCO "SCREEN-GRID PLUS" RECEIVERS MODELS 92, 95, 95E, 96, 96A, 96E, 296, 296A, 296E.

Perhaps the best known type of radio receiver made by the Philadelphia Storage Battery Company, Philadelphia, Pa., is found in the line of "Screen-Grid Plus" chassis. The circuits used in the various models differ as follows: "Model 92" is a 25-cycle model; the "Model 95," the standard 60-cycle, 110-volt chassis, which is illustrated below; the "95E" is a 210-270-volt model, of the "95"; "Model 96" adds a tone control; the "96 A" is designed for 25-cycle operation; "96 E" is the "96" for 210-270-volt line supply; "Model 296" is the "96" in combination with a phonograph; "296A," the same for 25-cycle supply; and "296E" is equipped to use a 210-270-volt power supply.

Automatic volume control and the "Multiplex" linear power detector V4, which has two element or "diode" connection of the type '27 tube giving exceptionally fine audio quality characterize these "Screen-Grid Plus" Philco models.

Since the "95" is the foundation circuit, and is illustrated in the figure, data directly applicable to it will be first considered.

The parts indicated in the diagram have the following values: Condensers C are the aligning condensers; C1, C2, C3, C4, the tuning capacities; C5, C6, C7, C8, C9, C10, C11, C17, C22, C29, 0.15-mf.; C12, .0005-mf.; C13, C19, 0.5-mf.; C14, C18, .05 mf.; C15, C20, C27, 1.0-mf.; C16, C28, .0025-mf.; C21, .01-mf. (each); C23, 0.25-mf.; C24, C26, 2-mf.; C25, 0.15-mf.

The resistors measure as follows: R1, 5,000 ohms; R2, 20 ohms; R3, R16, R18, 70,000 ohms; R4, R5, R7, R12, 250 ohms; R6, R11, R13, R14, 1/2-meg.; R8, R19, 13,000 ohms; R9, R10, R21, 1/10-meg.; R15, R25, 1/4-meg.; R17, 25,000 ohms; R20, 8,300 ohms; R22, R23, 70 ohms each side; R24, 800 ohms. Choke Ch measures 200 ohms.

Early models of the "95" did not have resistors R7 and R12; these units having been added shortly after production started. Their inclusion in the circuit prevents oscillation when using the "Loc." terminal.

Following are the readings indicated for the average set analyzer: filament potentials; V1, V2, V3, V4, V5, V6, 2.15 volts; V7, V8, 2.2 volts; V9, 4.5 volts. Plate potentials; V1, V2, V3, 155 volts; V4, zero; V5, 27 volts; V6, 85

volts; V7, V8, 250 volts. Control-grid potentials, V1, V2, V3, zero; V4, V5, 0.5-volt; V6; 0.2-volt to 2.0 volts; V7, V8, 41 volts. Screen-Grid potentials, V1, V2, V3, 95 volts. Cathode potentials, V1, V2, V3, 5.3 volts; V4, 0.7-volt; V5, V6, 5.5 volts. Plate current, V1, V2, V3, 4 ma.; V4, V5, zero; V6, 2.5 ma.; V7, V8, 28 ma.; V9, 43 ma. per plate. The current drain of the screen-grids of V1, V2, V3, is 0.8-ma.

The color code, or other identification, of the resistors is as follows: R1, golden yellow; R2, flat wire-wound; R3, R16, R18, jade green; R4, combined with C7; R5, combined with C8; R6, R11, R13, battleship gray; R7, combined with C11; R8, R19 Belgian blue; R9, R10, R21, silver gray; R15, R25, white; R17, auto buff; R20, wire-wound tube, 6 in. long; R22, R23, flat wire-wound, center-tapped; R24, wire-wound tube, 2 in. long.

The power transformer's connections may be determined by referring to the diagram; observe the lugs of this unit with the chassis inverted and the power transformer at the right. Counting from left to right, the top two are, 1, 2; second row, 3, 4, 5, 6; third row, 7, 8, 9, 10. Two leads are primary connections; instead in the "96," two lugs at the left of 1 and 2 are provided.

In the 25-cycle models, condensers C24 and C26 rate 3 mf.; and condenser C25, 0.3-mf.

In the Models "96" and "296," resistor R2 and switch Sw. 1 are not used; see the smaller diagram (detail A) at the lower left. Also, the dynamic reproducer plugs into the circuit at X1, X2, X3, X4. The tone control C21-Sw4 is found in the "96" and "296." Condensers C23 are not used in the "Model 96"; but they are retained in the "296." Condenser C22 is not found in the "96" and "296" chassis.

In these last, the pilot light V10 may be replaced without removing the chassis from the cabinet; merely remove the screw fastening the lamp bracket to the condenser housing, and bring the bracket out over the condenser.

When taking voltage readings, keep the R.F. shields on; and tune to eliminate circuit oscillation. The two condensers C23 are provided to reduce the tendency toward circuit oscillation.

In the diagram, the standard pick-up con-

nection is shown, using a high-impedance pick-up. In a few early models of the "296" there will be found a low-impedance pick-up and a special matching transformer; the latter is part "No. 4145." The lubricant of its turntable motor's worm-gear is clear petroleum jelly; and of the motor, a few drops of clear, thin oil.

The "Screen-Grid Plus" receivers are to be aligned at some frequency between 1200 and 1400 kilocycles; first adjusting the aligning condenser of C4. If it is desired to use the meter method of aligning, a convenient manner of making the test is to connect the negative side of a 250-volt (1000-ohms-per-volt) meter to the chassis; and its positive side, by means of an adapter plug, to the cathode of V3. Align for maximum deflection.

In detail B (lower left) is shown the arrangement of the condensers in the filter block "No. 3754"; at C, the tube layout.

Reception may be improved if the position of the line plug is reversed; this change will be particularly noticeable when the receiver is being operated with the connection "LOC" (to which may be attached any short wire, or a lead to metallic wall lathing). Do not operate the receiver without a good ground connection.

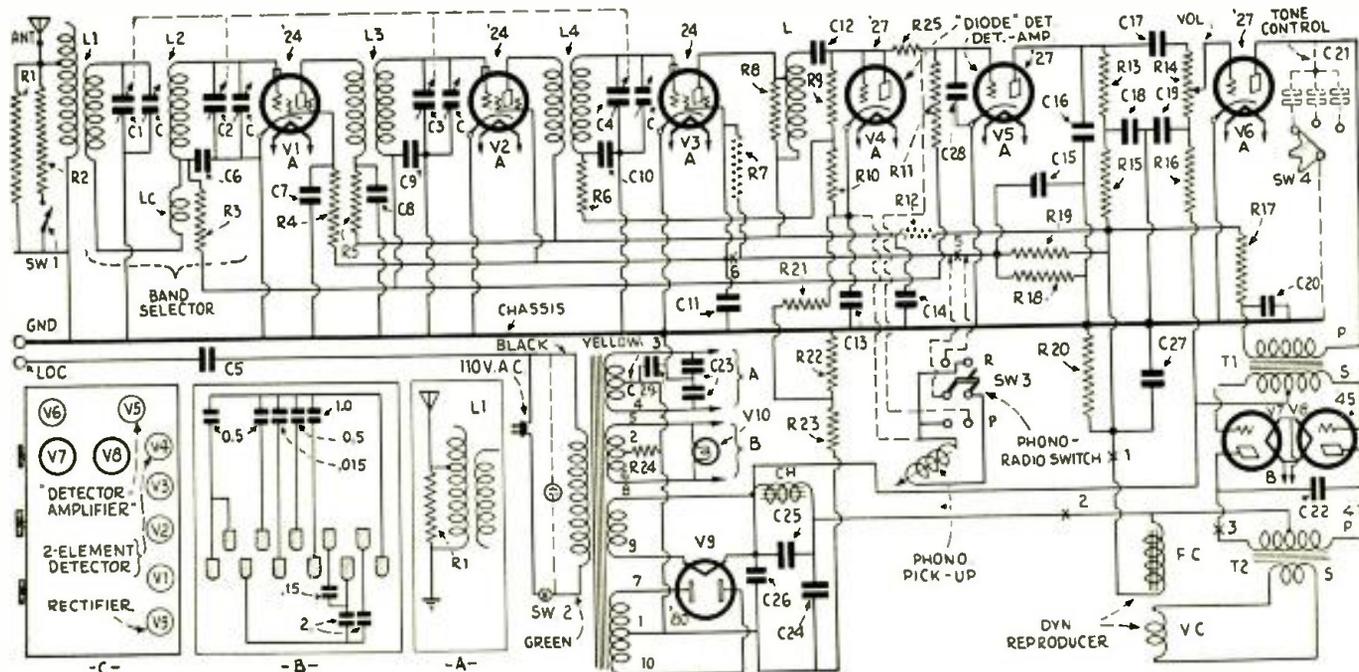
The light-line connection for the turntable motor and its switch is in shunt with the primary of the power transformer; and is shown dotted.

In some receivers of the "296" model, the motor's speed control will be found below the motor-board; it is to be reached from the back by a screw-driver.

"Fuzzy," distorted, or noisy reproduction in this model may be due to the motor-board's holding screws being too tight to permit the motor to "float" in the gum-rubber washers provided. Lack of lubrication may cause the same effect.

Chemically-pure vaseline may be used to eliminate noise due to the contact arm's rubbing on the wire of the volume control, R14.

In locations where it is impossible to get a low-resistance ground connection, it is advisable to detune slightly the first aligning condenser shunted across C1; about one-eighth of a turn is usually sufficient. This will reduce the tendency toward circuit oscillation.



Schematic circuit of the Philco "Model 95" receiver, including the variations which distinguish several other models of the "Screen-Grid Plus" series. At the lower left, additional details of the sets are: A, the input connections of the "96" and the "296"; B, terminal connections of filter condenser block "No. 3754"; C, tube layout. Since V4 does not amplify, it is supplemented by V5.

BRUNSWICK MODEL B-15 "UNI-SELECTOR" RECEIVER

This screen-grid receiver, a product of the Brunswick Radio Corp., New York City, incorporates four of the 2-volt type-'32 screen-grid tubes (three R.F. stages and a screen-grid detector, to obtain high amplification); a type '30 A.F. amplifier; and two type '31 power tubes in push-pull. The completed receiver is designed to operate three "B" batteries, a "C" battery, and 2-volt "A" battery, particularly the Eveready type A-600 "Air-Cell."

The values of the various construction units are itemized in the following list:

Resistor R1, 750,000 ohms; R2, 250,000 ohms; R3, 500,000 ohms; R4 (tone-control variable resistor), 0.50,000 ohms; R5, 2 megs.; R6, filament current limiting resistor, 0.6-ohm.

The condensers in the "B-15" have the fol-

lowing designations and respective capacities: C, 10 mmf.; C1, tuning condensers, C2, C3, C4, .000425-mf.; C5 (volume control) variable dual condenser, 10 mmf.; C6, C7, 10 mmf.; C8, .0002-mf.; C9 ("A +") bypass to chassis) C10 and C12 1/2-mf.; C11, 0.14-mf.; C13, .0002-mf.; C14, .02-mf.; C15, .03-mf.; C16 and C17, 1 mf. The A.F. transformer T has a ratio of 2:1.

From consideration of these figures it will be noted that the total plate current consumption is only slightly over 18 ma.

The color code of the resistors used in the "B-15" is as follows: R1, purple; R2, blue; R3, black; R5, green.

The reproducer is special; this "inductor dynamic" unit reproduces low notes with more efficiency than the ordinary magnetic reproducers, while it does not require the field-current supply used by the regular dynamic reproducers.

The moving voice-coils of the inductor dynamic reproducer, like the coils in an ordinary magnetic reproducer, are of the high-impedance type. The small tone-control knob is located directly

The reason for this is, that if the current output of the air-cell "A" battery exceeds the value of 0.75-amp., the carbon electrodes of the battery will become filled with the electrolyte in the cells, and cannot again be made to function. Service Men accustomed to shorting the "A" circuit (as when a storage battery is used for the "A" supply) cannot use the same test procedure in connection with the air-cell battery without permanently damaging the latter.

Another point to be observed is that this characteristic of the air-cell requires that no more tubes than are shown here be employed in the circuit; consequently, a pilot light must not be placed in the set as an additional convenience, since these lamps usually consume at least 1/4-amp.

At the present moment, there is no convenient way of determining the life remaining in an air-cell battery; except by making a rough estimation on the basis of its normal life. This will be about 1,000 operating hours, when operating a receiver of the type exemplified in the Brunswick "Model B-15," for three hours per day. A voltmeter of the low-resistance type will draw too much current, and will endanger the air-cell battery. Also, it probably will lack the accuracy required to determine the output voltage of the battery at a particular point on its discharge curve; although, with a high-resistance voltmeter, a certain approximation of the "life-expectation" of the air-cell may be obtained in this manner.

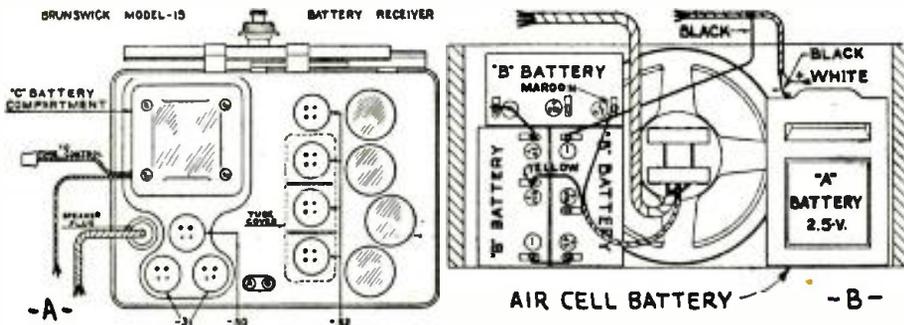
It is a common practice among service men, in an effort to speed the testing of receivers, to successively tap the tubes in a receiver. In the "B-15" this is inadvisable, because the danger of shorting the elements of a tube, and thus destroying the air-cell "A" battery through the added current drain.

About six quarts of water will be required to fill the air-cell battery. It is not necessary to use distilled water; ordinary drinking water being satisfactory.

This current-supply unit is of the "primary" type; that is, it generates its own current. Consequently, it cannot be charged like a storage or "secondary" battery. Also, unlike other primary batteries having a liquid electrolyte, this is not designed to permit replenishing the elements or the solution after the useful life of the battery has ended.

Care should be taken to use only the correct tubes in this set, as any change probably would cause an overload of the "A" supply. For this reason only tested tubes of rated characteristics should be used.

Unlike the average modern radio set, this receiver was designed for the use of a long outdoor aerial, up to a hundred feet, well elevated; though its location, and distance from the nearest broadcast station, must be controlling. It is intended for a distance-getter, having a rated sensitivity of 5 microvolts per meter, on the standard antenna.



At left, top view of the Brunswick "Model B-15," designed to work with 2-volt tubes, an "inductor dynamic" reproducer, and an air-cell "A" battery; the last unit, approximately the size of a storage battery, will be noted in the sketch at the right.

below the "Uni-Selector" control, which is, really, a combination of two knobs; one of these governs the tuning condensers; the others is a multiple control. Pushed in, it operates switch Sw1 for "local" station reception; pushed out, for distant reception. When turned to the extreme left, switch Sw2 is placed in its "off" position; turning it to the right puts it "on," and continuing to turn this knob to the right increases the volume.

The arrangement of the tubes in their sockets, and the location of the "C" battery, are shown in the detail sketch. It will be noted that the "A" battery's terminal reading is 2.5 volts; in the set this is reduced to the required 2 volts by the drop through resistor R6.

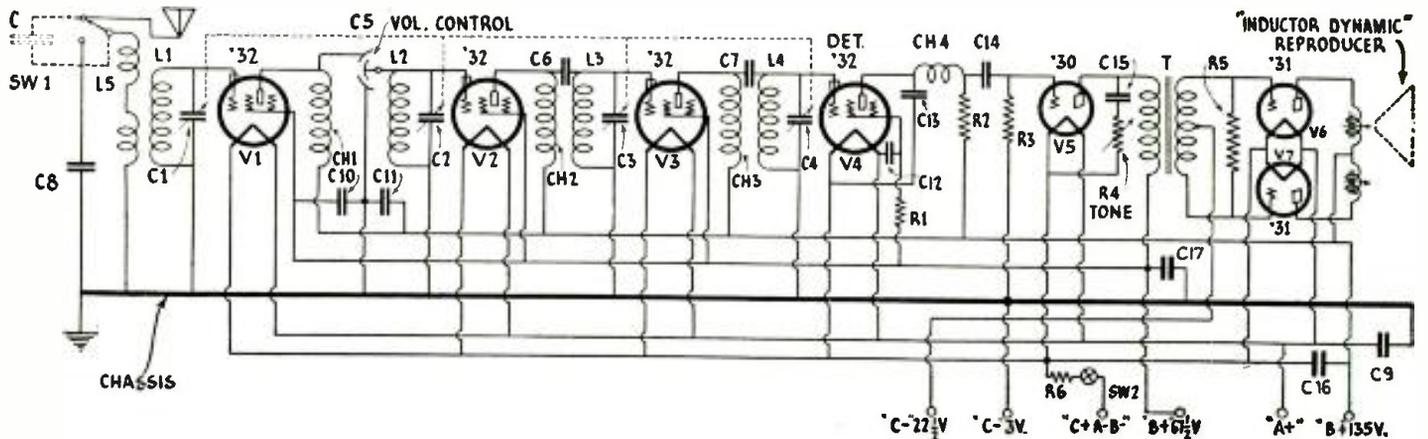
The accessories are specially recommended for use in the Model B-15. The color code for the battery leads is as follows: "A-," "B-," and "C +" black; "A +," white; "B + 67 1/2," yellow; "B + 135," maroon; "C - 3" (and chassis), brown; "C - 2 1/2," yellow.

There are a few precautions to be observed when checking this receiver; probably the most important is not to use any method of testing which will put a short circuit across the tube filaments, or the "A" supply.

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How to Use the Service Oscillator

A Time-Saver for the Service Man, and Means of Better Work

By K. T. VEDDER and E. C. HUGHES, Jr.*

THE details of the construction of this oscillator were described in the December, 1930, issue of *RADIO-CRAFT* (page 336). To increase the flexibility of the test equipment, it has been so designed that it may be operated from either the alternating-current house supply lines or from batteries.

When the oscillator is to be operated from the 110-volt alternating current house supply, the selector-switch on the right-hand side is turned to the "A.C. on Filament" position. Before placing the tube in the socket, the "A.C. Filament Voltage" switch is turned to the proper position to give the correct filament voltage for the type of tube that is to be used.

To use a direct-current filament supply, the selector-switch is turned to the other position, marked "External Filament Supply." Batteries, or other suitable source of direct current, are then connected to the binding posts marked "External Filament Supply."

Care must be taken that the correct voltage for the tube being used is applied to the filament. This is very important.

Either A.C. or D.C. for Plate Supply

Either alternating or direct current may be used on the plate of the oscillator tube, by turning the selector switch on the left to the proper position. In the "A.C. on Plate" position, 110-volt alternating current is applied to the plate; and in the other position, "D.C. on Plate," the supply is from the two small 22½-volt batteries enclosed in the carrying case.

It is, of course, possible to use alternating current on the filament and direct current on the plate, or *vice versa*; as well as either direct or alternating current on both the filament and the plate. Both the filament and the plate selector-switches are so arranged that it is impossible to put both alternating and direct current on the same circuit at the same time.

Coupling to Make Test

In coupling the oscillator to a set for test, a lead is taken from the binding post marked "Coupling" to the antenna binding post on the receiver. In some cases, it will be found that the oscillator gives too strong a signal when directly coupled to the set.

Sufficient signal strength may then be obtained by merely placing the oscillator near the set. The strength of the signal can be varied by varying the distance between the set and the oscillator.

It will be noted that, on complete alternating current operation, the oscillator gives a much stronger signal than on direct-current operation, due to the radio-frequency coupling through the 10-volt power supply lines.

By changing the resistance of the grid leak and the capacity of the grid condenser, the pitch of the modulated signal can be adjusted.

Increasing the resistance of the grid leak or the capacity of the condenser will lower the pitch of the modulated note very readily.

The milliammeter indicates the plate current drawn by the oscillator tube. Thus the test set indicates whether the plate and filament connections of a tube are in an operating condition. (*Functioning, to a limited extent, as a tube checker.*—Editor.)

When the oscillator is coupled to a set, the milliammeter will show an increased reading when the oscillator is brought into resonance with the set under test. This is due to the fact that the oscillator oscillates less strongly, causing the plate current to rise.

Using Oscillator as Wavemeter

To use the oscillator as a wavemeter, it will first be necessary to calibrate the condenser scale of the oscillator. This can be done by tuning a receiving set to various stations in the broadcast band whose frequencies are accurately known. Then tune the oscillator until maximum signal strength is heard in the receiver at the same point at which maximum signal strength was obtained from a broadcast station; care being taken that the receiving set is carefully adjusted to the peak of the broadcast station's wave. The dial setting of the oscillator is then noted, together with the frequency of that particular broadcast station.

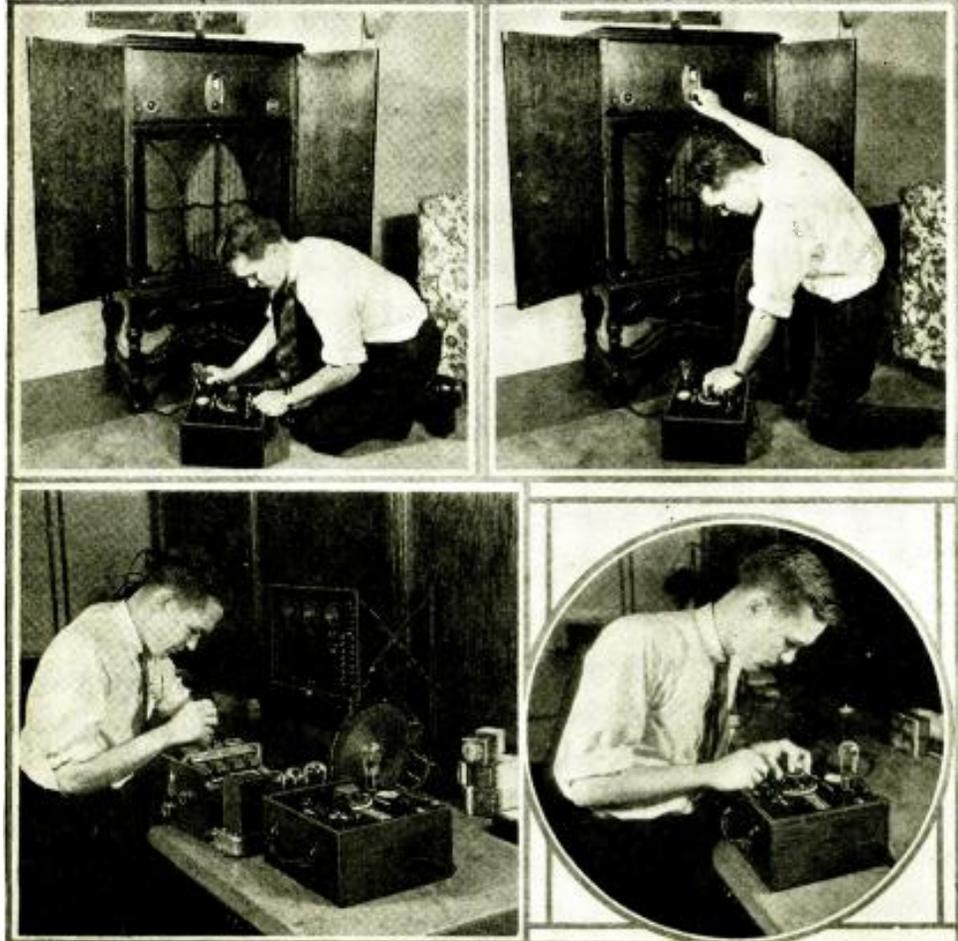
By taking several points in this manner, a curve of frequency (or wavelength) against dial setting on the oscillator can be plotted. It is essential that the same tube be used at all times for this purpose; as different tubes will cause a change in the calibration.

If so desired, the frequencies can be lettered directly on the dial, or a newly calibrated dial substituted for the old one on the oscillator.

In the absence of broadcast stations the oscillator will supply a signal suitable for testing at any desired frequency in the broadcast band. This band extends from 500 to 1500 kilocycles.

It will be found that the steady signal of the oscillator, used in conjunction with the service notes of the set manufacturer, is of great assistance in adjusting compensating condensers to obtain maximum signal strength. In addition, the oscillator can be

(Continued on page 564)



Upper left, adjusting the filament voltage before starting; upper right, the oscillator used as a wavemeter. Lower left, adjusting the trimming condensers of a set; lower right, calibrating the wavemeter.

*R.C.A. Radiotron Co.

Favorite Testing Equipment of Service Men

And methods for its use to the best advantage in and out of the shop

A DUPLEX TEST PROD

By Alvin C. Porter

THIS device was made by the writer while set-testing in a factory, and proved itself to be practical, making voltage readings much less troublesome. Ordinarily two prods were used; one for bias voltages, and one for screen and plate voltages. By incorporating a switch in a suitable handle, these voltages may be taken with one prod.

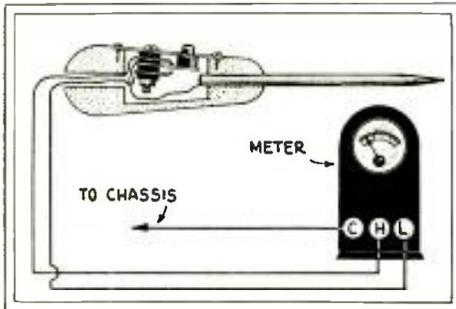


Fig. 1

With this prod, readings can be taken on either scale of a meter for quick testing work.

The switch assembly consists of three phosphor-bronze springs mounted to a strip of brass, $\frac{3}{4}$ -inch wide and $2\frac{3}{8}$ inches long, with a $\frac{6}{32}$ machine-screw; they are insulated from one another and the screw with fiber washers. A hole is drilled in the brass plate to take a push-button as shown in the drawing. The button is turned on a lathe, or built up from a bakelite rod and a thick washer. The handle is hollowed out and the switch fastened to it with two small wood-screws. The hollowing may be done by roughing out with a large drill and finishing with a pocket knife. The center contact of the switch is connected by a short length of insulated wire, to a brass rod which is driven into the handle. One wire of a two-wire cable, about four feet in length, is soldered to the upper contact; the other end goes to the high-voltage post of the meter. The lower contact is connected by the other wire to the low-voltage side of the meter. A knot is tied in the cable, to prevent it from pulling out of the handle.

In practice, the upper and middle contacts are always in contact giving high voltages. By pressing the button, a low voltage reading is obtained. The negative terminal of the meter is connected to the chassis with a small clip.

A SIMPLE TUBE TESTER

By Vincent Campbell

FOR the Service Man who cannot afford much for his testing equipment—and I think there are quite a few of us—I think this simple and very effective tube tester will be of considerable interest. It combines ideas from many sources with a few original ones; and with proper use, will justify its trifling cost—a very few dollars. The meters may be incorporated into the tester or, if the Service Man has instruments

of the same type, he may use open-circuit jacks where the meters are indicated, and employ his own.

This circuit will test screen-grid tubes, by using the flexible cap lead for grid connection. The D.P.D.T. switch Sw does away with any need for two extra sockets; thus reducing cost and increasing the simplicity. The tester may be mounted in any form that pleases the builder and, since all of us have our own ideas in this regard, I hesitate to suggest any specific mounting.

The tube to be tested is inserted in the proper socket, the resistance R4 being turned completely into circuit with the filament; Sw is set in position 2, and Sw1 is turned on. R4 is then turned until the tube receives the proper voltage, as read on the 0-15-volt meter V. The first reading is then taken on the 0-25-scale milliammeter MA.

Then press the push-button K, and take the second reading; compare with the table reproduced here. (With low-priced, low-resistance meters, it would be well for the

for which the parts were picked up around New York City. I am sure that this idea will come pleasantly to Service Men who have been called upon to test tubes, but lacked apparatus.

Tube Chart

Type	Volts		Milliamperes	
	Filament	K Open	K Closed	
'11-'12	1.1	1-1.5	2-2.5	
'26	1.5	1.5	4	
'45	2.5	3	11	
'24	2.5	1	2.5	
'27	2.5	1.5-2	3-5.5	
'99	3.3	1.5	3	
'20	3.3	2.5-3	5.5-6	
'22	3.3	2	4-6	
'01A	5.0	1.7	4.5-5	
'12A	5.0	2	6.5-7	
'12	5.0	2	4-6	
'10	5.0	.7	1.7	
'71	5.0	3.5-4	12-13	
'71A				
'00A	5.0	1.5	3.5	
'10	7.5	2	6	
'50	7.5	3	10.5	

I have not data on the new two-volt tubes; but those who come in contact with them, or other special types, can quickly determine with the aid of a few good tubes the proper readings.

AN EXCELLENT OUTPUT METER

By Roy E. Jessup

AN output meter which I greatly favor over the vacuum-tube voltmeter is made by the use of an output transformer, a 15-ohm potentiometer, one double-pole double-throw switch, and a Weston "Model 425" thermogalvanometer. The device can be built into a very small case; it requires no batteries, or power supply.

(Continued on page 563)

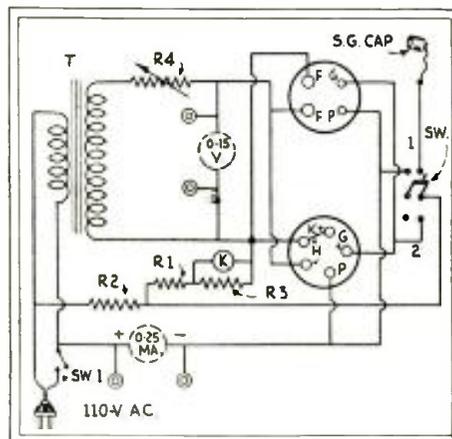


Fig. 2

An inexpensive home-built tube checker which will serve many purposes of the Service Man.

builder to prepare his own chart; using tubes of known rating.—*Editor.*)

For screen-grid tubes, switch Sw is set at position 1; and the cap of the flexible lead is connected to the cap of the tube being tested.

The parts purchased by me for the tester were as follows:

- One 7 $\frac{1}{2}$ -volt, 2-amp., filament transformer, T (\$1.25);
- Three Electrad "Type B" resistors: R1, 400 ohms; R2, 1000 ohms; R3, 2250 ohms (\$1.50);
- One Centralab 250-ohm power rheostat, R4, type "PR250" (75c);
- Two sockets, UX and UY type (50c);
- One D.P.D.T. switch Sw (25c);
- One line switch Sw1, on-off type, 110-volt (25c);
- One push-button K (15c);
- One "Readrite" 0-15-volt A.C. voltmeter V (\$1.50);
- One Readrite 0-25-ma. D.C. milliammeter A, (85c).

The prices quoted (total \$7.00) are those

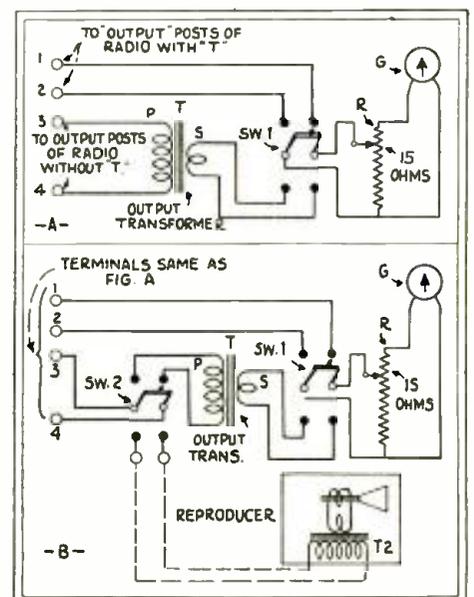


Fig. 3

Instead of a vacuum tube and milliammeter, a thermogalvanometer, which reads very low A.C. currents, is here used to measure the output of a receiver.

Location and Reduction of Hum in Electric Receivers

Some causes of this elusive complaint, and trouble-shooting methods

By C. W. PALMER

THERE are a great many possible causes of hum in every electric receiver. Any engineer who has designed or assisted in the design of a set of this type will appreciate this fact; and it is surprising to the writer that more information has not been published on the subject.

A certain amount of hum, present in every electric set, is due to the tubes themselves; and the engineer who designs the set, of course, has no means of reducing this hum voltage. However, the use of heater-type tubes, in all stages except the last, has contributed much toward the elimination of this trouble; and it is hoped that in the future, tube design will be improved considerably, in the reduction of hum and also in the matters of length of life and efficiency.

The hum which is produced by induction, in electric receivers of present design, is an important item, and due mainly to the fact that standard design requires that the power supply unit be incorporated in the same chassis as the set. Yet, suppose we have a receiver with a separate power unit; in the installation, it is unwisely mounted in the top of a console cabinet with the power unit directly below it. The chances of a strong inductive pick-up from such an arrangement are much greater than in a correctly-designed set with the power unit enclosed.

Induction pick-ups may be divided into two general classes—magnetic and electrostatic. Since each requires a different mode of elimination, we will consider them separately.

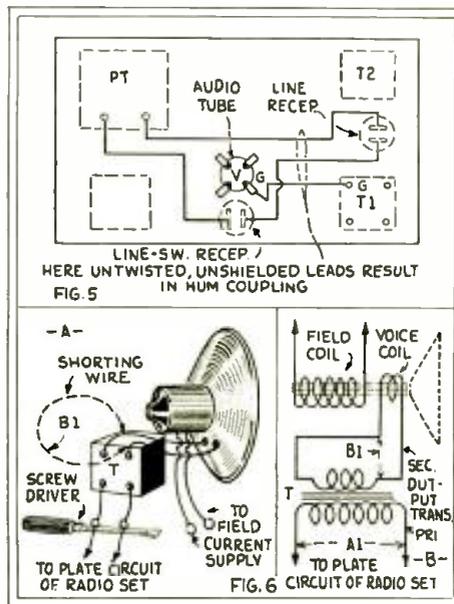
Magnetic Induction

The leakage currents built up in the core of the power transformer (particularly if a single transformer is used for the filament, plate and grid supply) are undoubtedly the worst offenders in the matter of induction pick-up. The filter chokes must not be neglected; especially if an air-gap is employed to maintain a high inductance. (The average air-gap is equivalent to the thickness of a calling card.) Naturally, the first choke, carrying the greater percentage of A.C. component in the current, must be watched most carefully.

It is easily understood that the first audio transformer is the most susceptible target for magnetic leakage currents. (See Figs. 2 and 3). Any hum picked up at this point is amplified several hundred times, in a good audio amplifier; and a comparatively small hum voltage may be increased to tremendous proportions in the speaker.

By the first audio transformer, is meant, not only the transformer, but the associated wiring and—last but not least—the tube itself. This point is often neglected, even in some sets well designed in other respects. The electron stream in the tube is affected as readily by magnetic fields outside the tube envelope as by those within it; and a hum may be introduced from outside sources as well as by a field set up in the filament or cathode of the tube. This brings to mind an experience of the writer, some time ago, in designing a receiver. The dies for stamping the chassis were all made before it was discovered that a strong hum was introduced, under certain conditions, through the fact that the rectifier and detector tubes were only a few inches apart,

although separated by a wall of aluminum (A, in Fig. 4.) It was necessary to enclose the detector tube completely, as at B, before the hum was finally eliminated.



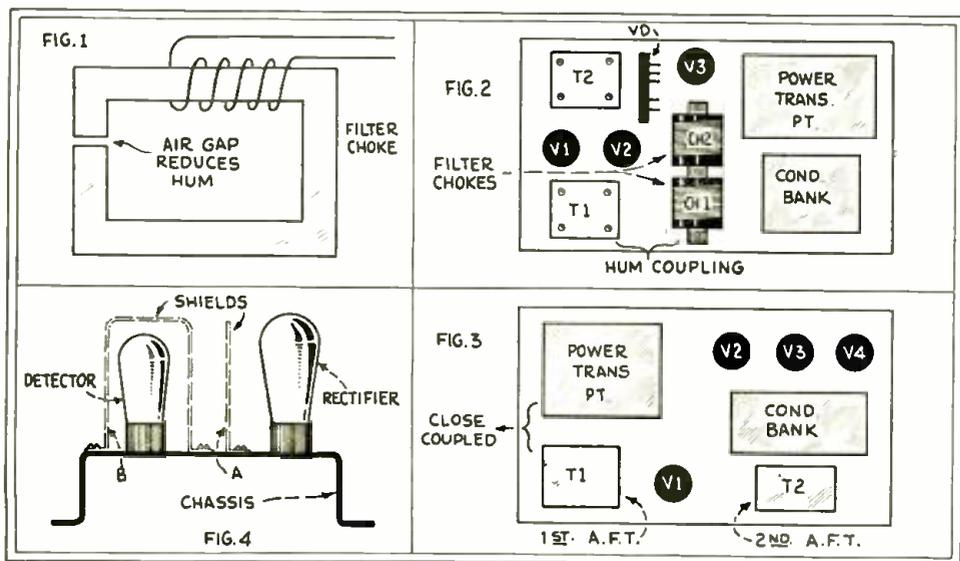
Above, we see a cause of hum, in the nearness of the power-tube's grid to an A.C. lead. Below, shorting tests, to determine the location of feedbacks.

High-quality amplifiers require very great care in shielding and isolation, to prevent magnetic pickups. A poor amplifier, with little or no amplification at frequencies below 150 or 200 cycles, is not nearly as critical in this respect; because of the poor amplification at the frequencies of the supply current and its first few harmonics.

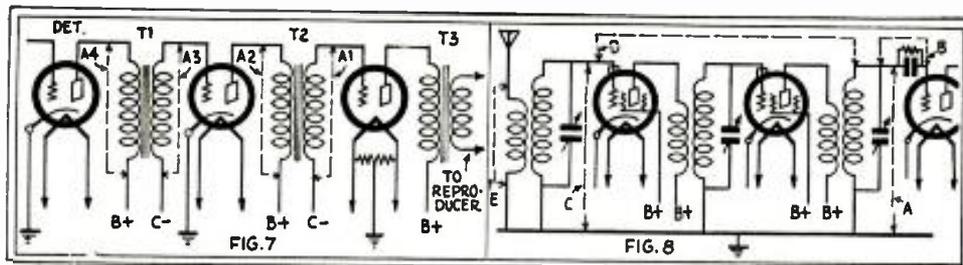
Trouble with Dynamic Speakers

Another source of considerable trouble with inductive pickup is the dynamic type of speaker, used so universally in modern sets. The fact that the field winding of such a speaker is supplied with poorly filtered or unfiltered current is not serious in itself. This will cause a low hum, due to the induction in the voice coil or coupling transformer. The main trouble is caused by induction between the field winding and other circuits in the set; especially the detector or first audio circuits. When this occurs, the hum voltage becomes very annoying.

Also, the usual methods of reducing hum in these speakers are comparatively poor. The shading rings and hum-bucking coils have an efficiency seldom more than 50% and usually much lower; while the 2000-mf. condenser, so much trusted, does not reduce the hum more than 30%. These statements are based on actual tests made by the writer, as well as on several reliable authorities. There is a very definite field for improvement in the dynamic speaker when used with a separate power supply.



Causes of hum and places where it is likely to occur, are illustrated in the diagrams above. If the gap, shown in Fig. 1, has been shorted, hum occurs. In Fig. 2, interchange of T1 and T2 might reduce hum amplification; in Fig. 3, another cause of feedback is shown; while Fig. 4 shows ineffective shielding at A, remedied as at B.



The shorting method of "hum-shooting" is carried back stage by stage, from speaker to aerial: at the left, the steps from output transformer to the detector: right, working from detector through R.F.

Electrostatic Pickups

Because the audio-frequency impedance between the grids and plates and the grounded circuits of a radio-frequency amplifier is very low, the electrostatic pickups are limited almost entirely to the detector and audio systems of a receiver.

Unlike magnetic pickups, the electrostatic pickup occurs mostly at the higher audio frequencies; because the degree of coupling commonly found in an amplifier favors those higher frequencies. Thus it is the higher harmonics of the supply current which are heard from an electrostatic coupling and, since these harmonics have a much lower voltage than the fundamental and the first few harmonics, the difficulties from this source of hum are comparatively small.

Any unshielded conductors carrying a high alternating potential (such as the leads from the power transformer to the rectifier tube, the leads from the rectifier to the first filter choke, and any 110-volt leads from the power line) are possible sources of such trouble (Fig. 5). As in the case of magnetic pickups, the detector and first audio circuits are the most susceptible; although others should not be entirely neglected.

With a set employing grid-current detection, the detector grid is an extremely susceptible point. However, with the general acceptance of plate-current detection, this trouble is not so prevalent in the later electric sets. One source of trouble in this respect is between the various filament windings of a power transformer, particularly if the detector grid is at a potential far removed from ground. Although the writer has not tried the following scheme, it is believed that an electrostatic shield of brass or copper placed between each pair of the filament windings and between the high-voltage winding and the primary and filament windings, would be a solution of this problem.

Types of Hum Tones

While the audible characteristics of the three general classes of hum (i.e., magnetic induction, electrostatic induction and insufficient or incorrect filtering) cannot be described exactly, they are sufficiently individual so that, with a little experience, almost anyone can tell the differences.

The first (magnetic induction pickup) has a low tone, sometimes accompanied by a peculiar singing sound. In poorly-designed sets, which have little amplification on the very low tones, the singing noise may be all that is heard. This singing is the note of the higher harmonics of the 60-cycle frequency. As already explained, this type of

hum is usually caused by magnetic coupling, between the power transformer or filter chokes and a circuit in the set. A very similar hum is heard when the filament potentiometers are incorrectly adjusted, or when the center tap of a transformer's filament winding is not at the true electrical center.

The second type (electrostatic induction), while not as common as the first, is more easily described. It is higher in tone than the magnetic type, and has been compared to the buzzing of a bee close to your ear. This buzzing hum is caused by electrostatic coupling between the rectifier or input leads and the detector or audio amplifier in the set. A similar noise is sometimes caused by a noisy detector tube; although these are not as common as they were some time ago.

The third type (poor filtering) is the sonorous steady 120-cycle hum, higher than the note for magnetic coupling, and without the singing sound which often accompanies the latter. This may be caused by insufficient filtering in the power unit, or incorrect by-passing in the circuits of the set; it is much more musical and resonant than the other two types.

Some Simple Tests

Many hum problems can be solved merely by listening to determine the type of audible note. However, some simple tests on the wiring of the set will disclose the source of the sound, regardless of its type; these are made with several pieces of wire, and no instruments are required. Later, some more thorough tests will be explained.

If the speaker, or the "output" trans-

former which couples it to the set, is short-circuited (Fig. 6), the hum which remains is due to the speaker itself; this may be caused by insufficient filtering of the current supplied to the field winding. Next, if the wire is connected across the secondary of the transformer between the first and second audio stages, in such a way that the "C" bias on the last tube or tubes is not disturbed, (A1, Fig. 7) the hum originating in the last stage will be added to that in the speaker; and comparison by ear will tell how much hum is originated in this amplifier circuit. If the first audio transformer's secondary is shorted in the same way (as at A3), the hum in the first audio stage will be added. (Shorts A2 and A4 also are convenient in locating hum.)

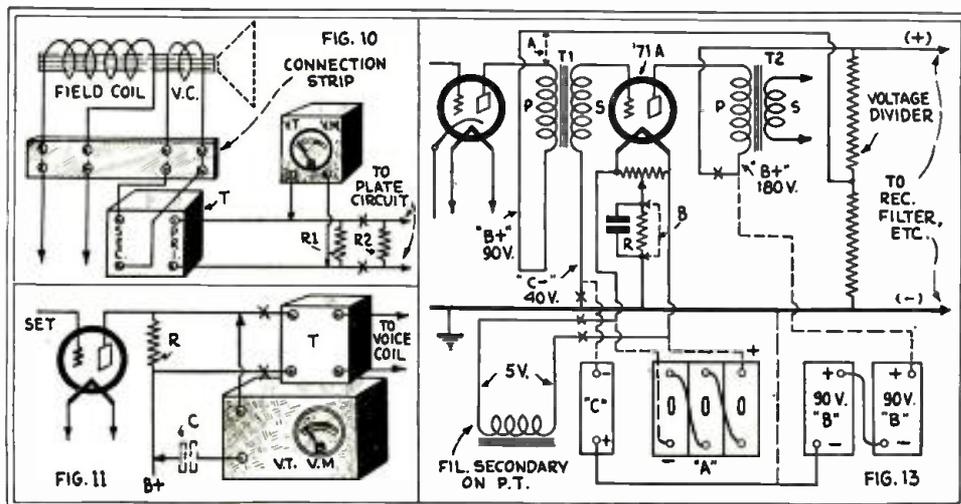
If the hum comes in class one of the above definition, the detector and its R.F. coil can be shorted in the same manner (see Fig. 8) to show the hum in the detector. Then, if the hum increases when this short-circuit is removed, the difference is due to the radio-frequency section of the set. In the latter case, the hum may be heard only when a station's carrier wave is tuned in. If grid detection is employed, and the grid leak is short-circuited, most of the electrostatic hum in the detector grid will be removed. (Hum voltages due to antenna pick-up disappear when a jumper is applied as at E.)

By localizing the hum in this way, the exact cause can be found quite readily. In using this system, it may be found that, with certain parts shorted out, the hum *increases* rather than decreases. This is due to what might be called a hum-feedback, which reduces the over-all hum voltage.

Complete Hum Analysis

While the above simple methods will often tell quickly just where the source of hum may be found, it is advisable, in some cases, to use measuring instruments to make a more detailed study of the various susceptible points of the set. The following tests are based on the use of a vacuum-tube voltmeter connected across the speaker's input leads.

If a speaker of the magnetic or inductive (Continued on page 558)



Upper left, measuring the hum voltage in the dynamic, with an output vacuum-tube volt meter; below, a similar test on the set's output. R must equal the impedance of the primary of T, which it replaces; C may be needed to keep the proper D.C. bias on the tube of the meter. At the right, batteries substituted for the power pack, to obtain hum-free current for testing.

Radio Programs Guide Planes in Flight

By GERHARD FISHER

TO satisfy an urgent need, Geoffrey G. Kruesi, research engineer of the Western Air Express, working in collaboration with the writer as consulting research engineer for that corporation, has designed a new directional receiver for airplane use. In its use, a pilot is not limited to the bearings furnished by the radio beacon system which

has been developed by the Bureau of Standards; but he is enabled to determine his position with reference to any radio station in operation, whether a beacon, a broadcaster of programs, or a transmitter of any other type. The system may be utilized in the reception of any continuous-wave or I.C.W. (telegraph) signals.

The beacon system hitherto used employs a directional transmitter on the ground, communicating with an open antenna on the plane; it is designed to keep the ship on a straight course in a certain radio lane (approximately two miles wide) regardless of wind-drift. But, with the new system, the pilot may leave his narrow airplane, to



Upper left, Mr. Kruesi making the first demonstration; the square loop is only experimental. Upper right, the standard loop, mounted on the cabin of a plane. Lower left, the course indicator, on the plane's instrument board; lower right, the supplemental equipment, which weighs but ten pounds, with a standard airplane receiver. In the small panels, large and small radio receiving equipment for planes. First photo © Wide World.

fly round a stormy area, for instance; and then he may safely approach his destination from any direction he chooses. The combination of the two methods means an enormous aid to aerial navigation.

We have developed two types of direction-finders; one as an attachment to the standard W. E. aircraft receiver; and the other as a small unit in which the receiver and the radio compass are combined. The latter uses the new two-volt tubes, operated from the "air-cell" type of battery recently introduced for that purpose, which delivers a constant voltage of 2.1 for several hundred hours.

Operation is Automatic

The lighter apparatus, especially designed for smaller aircraft, is absolutely self-con-

tained; a loop, mounted either inside or outside the fuselage, is used in connection with this. The new system incorporates the method of comparing two rather strong signals (*instead of sighting at right angles to minimum signal; as in marine radio-compass work*) and matching them against each other; the resulting currents are translated by the course indicator shown in the illustration at the lower left. The indicating device consists of a meter similar to the ammeter on the dashboard of an automobile; but, instead of "Charge" and "Discharge," it is engraved "Right" and "Left" with a zero reading in the center.

In practice the indicator needle remains on zero, if the plane's nose is pointed toward the radio transmitter. If the ship is turned

to the right, the indicator needle will point to the left, indicating that the pilot has to make a left turn to bring the ship back on its course; the opposite movement will reverse the indication on the instrument.

By purposely swinging the plane to right or left, the pilot can determine whether or not the station is located in front or behind him. For instance, on turning the plane to the right, the indicator needle might move to the left; this would give an infallible indication that the station is ahead. By a movement of the indicator needle to the right, it would positively indicate that the plane had passed that particular radio station.

For convenience, there is provided a small
(Continued on page 571)

The "Martenot"--A New Radio Musical Instrument



The scale of the "Martenot," corresponding to a pianoforte: the right hand of the performer is on the fingerpiece controlling the tone, and his left on the rheostat-switch, which controls the timbre and the succession of notes.

"ETHER MUSIC," as it has been called, for many years has offered strong attractions for those who are endeavoring to realize the possibilities, evident in modern vacuum-tube circuits and loud speakers, for the production of harmonies beyond the mechanical limitations of wind and string instruments.

We have had fixed-tone instruments, such as the "Pianorad," which gave forth pure, fixed musical notes; and others, such as the "Theremin," in which varying the capacity in a tuned circuit enabled the performer to run the gamut. However, the purity of tone which would seem theoretically desirable is far from satisfying to the musical ear.

A French musician, M. Maurice Martenot, who is also a radio expert, has devised a particularly ingenious apparatus, with which he is touring the United States; and his recitals have exhibited a musical quality which exceeds that of previous radio-acoustic instruments. In his system, that tube action which is commonly called "distortion" is converted into an asset; through the production of electrical harmonics which give a rich timbre to the notes which are lacking in color when produced by circuits of higher electrical fidelity.

As in its predecessor, the Theremin, the Martenot apparatus depends upon a change

of capacity in a tuned radio-frequency oscillator, which beats against a fixed-tune oscillator and thereby produces audio frequencies. The fundamental circuit is shown in the accompanying diagram.

However, a more exact regulation of the audible difference-frequency is obtained by the method shown. The front of the instrument is built like a standard pianoforte; along the front is a brass strip, into which

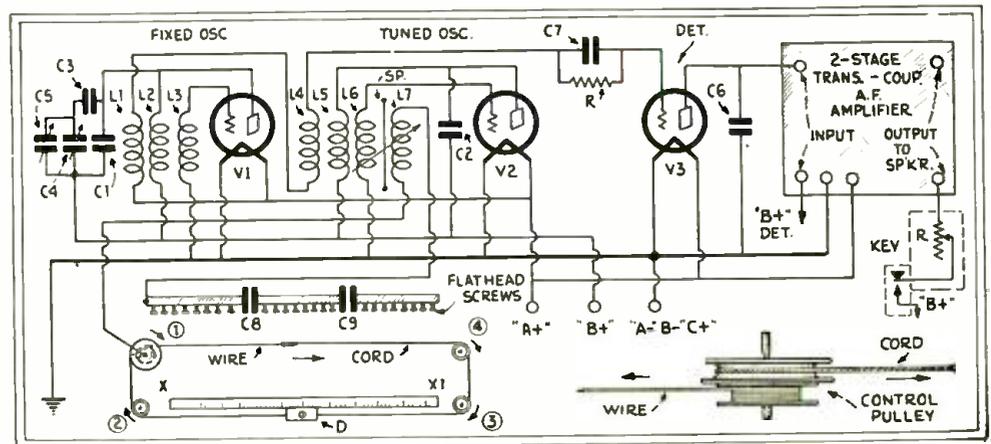
are turned a number of screws. These are connected to one terminal of the inductance L7; the other lead of which is connected to the metal spindle of the spool L. On this, as shown in the detail at the lower right, is wound a metallic wire; by unreeling the latter, a varying capacity between the wire and the screw-heads is created across the ends of the coil, thus changing the frequency of the oscillator V2 and, thereby, the output tone of the apparatus.

Attached to the spool, in a separate slot, is a rubber cord, which is wound up as the wire is drawn out, and *vice versa*; a finger-piece D joins this to a second cord, which in turn is connected to the free end of the wire. The result is a composite endless cable, which runs around the pulleys 1-2-3-4 (lower left); and the position of the finger-piece D at any moment indicates the tone to which the "Martenot" is tuned.

It is possible also to release one end of the cord; the performer then stands at a distance from the instrument, and plays it by pulling out and releasing the control cord. An additional control, attached to the fingerpiece, permits him to run trills as he desires.

The first oscillator V1 is adjusted to a fixed frequency by the use of the numerous trimming condensers; the spade Sp between the coils L6 and L7 of the second oscillator

(Continued on page 564)



The electrical circuit of the "Martenot"; the capacity between the wire and the screwheads at the lower left governs the heterodyned audio note, the pitch of which is indicated by the position of the fingerpiece D on the scale. Lower right, arrangement of wire and control cord on the metal pulley (1).

Automatic Radio Alarm for Ships

The "Night Watchman" of the Sea Never Sleeps

By J. A. DOWIE, M.I.R.E.*

ON British vessels, automatic apparatus is used which responds only to a single specific signal, called the "alarm signal," used in addition to the universal distress signal, "SOS," for summoning aid in emergencies. This auto alarm is a mechanical device for attracting the attention of ships, on board of which no radio watch is being kept, should some other vessel in that neighborhood be in distress.

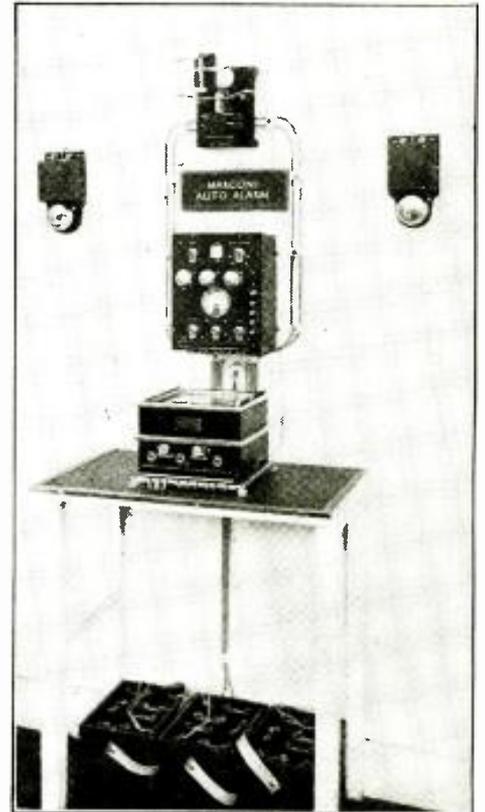
Before this equipment was installed on British ships, the most elaborate inspection tests showed that no device can be produced, which is simple enough to stand up to sea conditions, and will record with certainty the "SOS" signal without also responding a large number of times a day to accidental combinations of "longs" and "shorts," which may happen to resemble the distress signal. Such an arrangement is also liable to failure in recognizing calls, due to comparatively light interferences.

Therefore, it is necessary to use some form of signal which can be identified by a simple and strong selector system, without risk of any material number of false calls, and in spite of considerable interference. It is also necessary that the form of signal chosen, and the design of the selector, should be such that a reasonable amount of inaccuracy in the transmission of the signal is permissible; that is to say, the selector must be devised so that it will accept the chosen signal, or something reasonably like it, without failure and without answering false calls, even in the presence of considerable interference.

Both practice and theory have shown that a signal composed of prolonged dashes, with brief periods of silence between, gives the best prospect of satisfying the above requirement; and further trials have shown that a signal composed of dashes of four seconds duration, separated by spaces of one second duration, gives the requisite degree of certainty of operation, coupled with ease of sending, no more assistance being required than that of a watch with a second hand. This form of signal has the further advantage of being fairly rapid in its action. Twelve such dashes with their spaces can be sent in one minute, and any longer dashes or spaces make the signal too slow in operation.

This group of twelve four-second dashes, separated by spaces of one second, has been adopted for the alarm signal; and ships in distress send this signal (on a wavelength between 585 and 615 meters) as a preliminary to the universal "SOS" signal. The selector will then set alarm bells ringing in all nearby ships which carry the apparatus, consisting of the receiver and selector.

The receiver, a regenerative detector with two A.F. stages, the last a double-grid tube (Fig. 1) is connected directly to the ship's aerial, when required, by a switch; all other apparatus being disconnected; its filament and plate supplies are put on by the same movement of the switch. The receiving circuit is so arranged that it shall be up to the required standard of sensitivity, on all waves between 585 and 615 meters; between these limits the sensitivity is practically the same.



This receiver and automatic selector is operated by a radio alarm system, on ships' calling wave; and only by a special signal. (Illustrations courtesy The Marconi Company.)

Operation of the Receiver

The function of the receiver is as follows: in the absence of any incoming signal, a steady current of about 0.7-ma. flows in the outer grid circuit of V3 and thence, via the last audio transformer, through the main relay coils (Fig. 2) thus holding the relay's tongue in contact with the front stop, against the bias of the relay.

The arrival of an incoming signal makes the grid of V3 more negative, and thus cuts down the plate current, permitting the relay tongue to be released; the tongue is pulled back by its bias.

Any steady reduction in the relay-coil current will set up a momentary voltage across the ends of the high-resistance winding of the last audio transformer; the connections of the windings are such that the change tends to make the grid still more negative, and thus sharpens and intensifies the action of the incoming signal.

It will be noticed that there is no grid leak for V3; if there were, the relay would be operated by the beginning of an incoming signal, and the tube would then remain paralyzed by the accumulated charge on the grid. This trouble is avoided by connecting the grid through the "G" terminal to the back contact of the relay; so that the grid is discharged when the tongue of the relay falls. The resulting "C" voltage prevents a surging current through the last audio-transformer winding, which might cause the relay to chatter.

The filament potential is 24 volts; connection is made through the "No-Volt" relay in the selector, which acts as a tell-tale should the filament current fall below the minimum value necessary to obtain proper

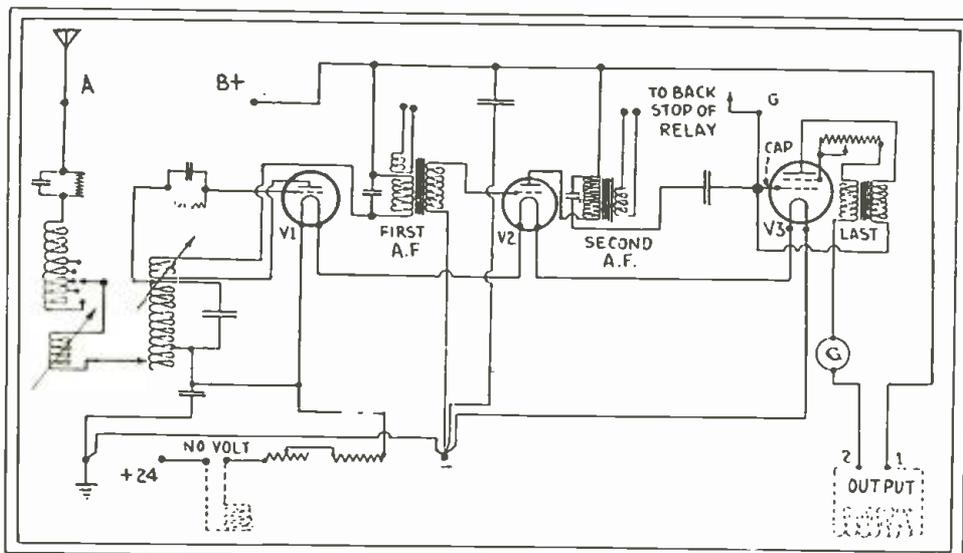


Fig. 1

This receiver designed for the special purpose of working with the relay of Fig. 2, uses tubes of a special British type. Values of parts are not available.

* Chief Instructor, National Radio Institute.

emission in each tube. All three tubes are supplied from the same plate source (36 volts above the negative point; 24 volts being derived from the "A" battery and 12 volts being provided by an additional storage battery).

Operation of the Selector

The primary movement of the selector is governed by the movement of the relay tongue. In the state of rest, the relay tongue is held against its front stop, as explained before, and the circuit is completed through the first magnet, thus holding down the primary arm against the action of its spring. When a signal of sufficient strength arrives, the relay tongue falls away from the front stop; the current through the first magnet is broken, and the selector begins to work. If the incoming signal is too feeble, the relay tongue will fall back to the front contact, the current through the first magnet will recommence, and the selector action will be stopped.

All is now ready for another signal. If the signal is of proper working strength, the relay tongue will go right across to the back stop, and the grid of V3 will be discharged. The plate (outer grid) current will begin again to go through the relay coils, and the tongue of the relay will start its return journey to the front stop. If the signal continues, the current in the main relay coil will be again reduced, and the tongue will be pulled back to the back stop. Therefore, during the continuance of an incoming signal of sufficient strength, the relay tongue chatters against its back stop; and, all the time, the circuit through the first magnet is open and the selector continues in operation.

The primary movement of the selector consists of an arm having a spring at one end and an air dashpot fitted for quick recovery at the other. The first magnet pulls this arm down against the action of the spring; when the current to the first magnet is stopped, the spring pulls the arm up against the drag of the dashpot. If this movement continues long, the arm will close the first working contact, known as the "D" contact. If the movement continues, the arm will also close the second working contact, known as the "C" contact. The dashpot adjustments are permanent and the position of the "D" contact cannot be adjusted; but the time the arm takes to close the "D" contact can be varied by altering the tension of the spring. This is set at three seconds. The "C" contact can be moved bodily, so that the time elapsing between the closing of the "D" and "C" contacts can be varied. This should be two seconds or, in other words, the "C" contact should be closed five seconds after the commencement of operation of the selector.

When the "D" contact is closed, a simple pawl and pawl-wheel movement is operating, which rotates by one tooth of the pawl wheel a shaft carrying the ringing contact.

If the primary arm closes the contact "C," both the holding and driving pawls are drawn back out of engagement with the pawl wheel by the re-setting magnet; and the shaft flies back to its starting position due to the action of the spring.

The circuit through the windings of these re-setting magnets also closes through a contact held by the shaft, known as the "Q" contact, which opens when the shaft is in the starting position; and it is closed as soon as the shaft is turned.

Were it not for this arrangement, the circuit through the re-setting magnet would be completed through the "G" contact when the connector was in the ready position, and the pawls would be unable to start the rotation of the shaft.

Four-Second Timing

Thus, it is clear, if the movement of the primary arm is governed by the movement of the tongue of the main relay (which in

turn is controlled by the incoming signal) the shaft will be advanced by one tooth of the pawl wheel if the signal consists of an unbroken dash lasting for three seconds; and if this dash continues through a total of five seconds, the shaft will be returned to its starting position. Hence, a five-second dash will cause the shaft to advance one tooth of the pawl wheel; while an allowance of practically one second each way is made to cover bad sending.

As soon as this contact "D" closes, it also starts the secondary action of the selector by energizing the magnet of a secondary arm (which is similar to the primary arm) and so pulling it down against the action
(Continued on page 560)

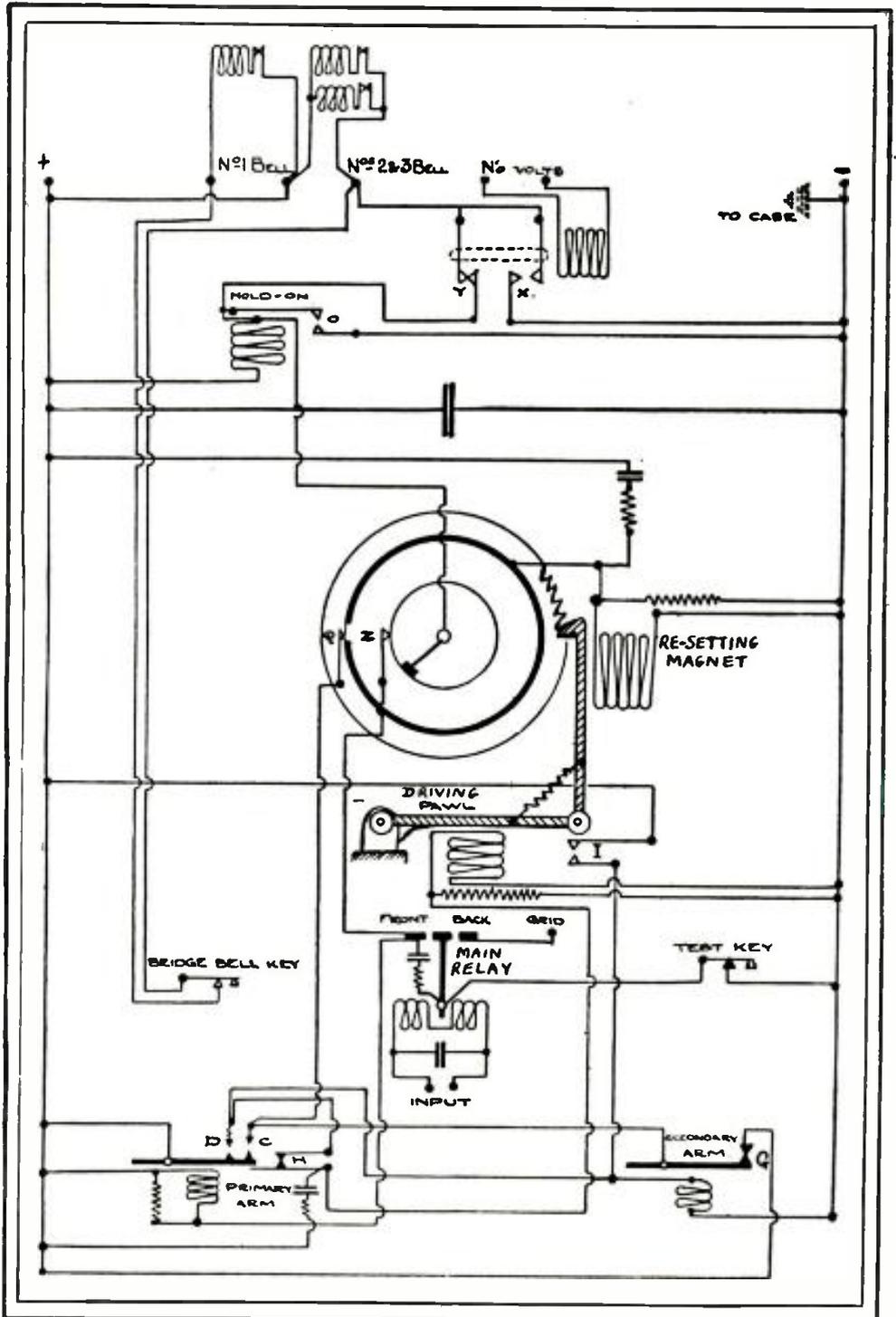


Fig. 2

This ingenious selective relay distinguishes the four-dash "alarm signal," from all other code reception, and sets off the alarm system automatically.

New Radio Devices for Shop and Home

In this department are reviewed commercial products of most recent interest. Manufacturers are requested to submit descriptions of forthcoming developments.

DIRECT-COUPLED AMPLIFIERS

AFTER many months of laboratory research there finally has been developed by Electrad, Inc., a direct-coupled amplifier designed to deliver an undistorted output of 10 watts. In addition to this number, the "C-250," illustrated in Fig. A, and shown in schematic form in Fig. 1, there are now available "Model A-250" and "Model A-245."

The "A-250" puts out 4.6 watts. Other characteristics are: input voltage for above power output, 0.28-volt; power consumption, 85 watts; tubes, one '24, one '50, and one '81. All are assembled on a metal sub-panel.

The "A-245" has an undistorted power output rating of 1.6 watts; input potential, 0.25-volt; power consumption, 40 watts; tubes, one '24, one '45, one '80. This amplifier is available either in kit form or completely assembled and ready for operation.

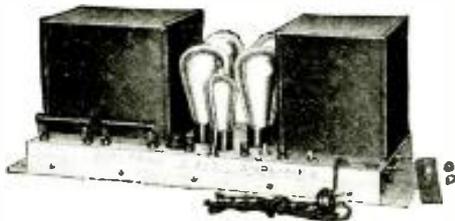


Fig. A

The largest of the Electrad Loftin White direct-coupled amplifiers, designed for high output and quality.

The "Model C-250" is the most outstanding of the three; since it incorporates tone control in addition to the built-in power; a hunt compensator is part of the circuit design. The tube requirements are one '24, two '50s, and two '81s. It is an ideal instrument for many services, and the technician and radio Service Man will do well to consider this instrument for many purposes requiring exceptionally true audio reproduction at high levels of volume, while good quality is a prime requisite at lesser volumes.

The gain at 50 cycles is 56 db.; at 1,000 cycles, 60 db.; at 10,000 cycles, 56 db. There is provision for the field current of two

dynamic reproducers; if this is not utilized, the circuit may be closed through resistors of 2,500 ohms. The power consumption is 160 watts. The line supply is fused. A single or double button microphone, or the output of a radio set may be connected through a transformer to the input of the power amplifier, the input circuit of which is shunted by a tone control. Net weight of the "C-250," 38 lbs.; dimensions, over all, 21½ x 7¾ x 8⅞ inches high.

The same considerations are true of this unit as of the older direct-coupled amplifiers having lesser power output; to wit: resistors, power transformer, and fixed condensers must be accurate in rating and construction. The slightest deviation from the rated constants would be magnified in the associated circuits, and poor performance result. The answer lies in obtaining either the specific parts or the completely-assembled unit (as the case may be) carrying the guarantee of the manufacturer.

Of course, these amplifiers may be used wherever audio systems having these characteristics are specified.

"BUDDY" TEST PRODS

SOMETHING a bit "different" in test prods is offered by Blan the Radio Man, Inc.; it is the "Buddy" prod, illustrated in Fig. B.

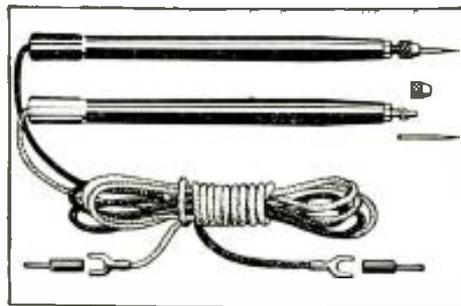


Fig. B

"Buddy" test prods come in several combinations.

The four-foot flexible leads terminate in little "clucks," similar to those on cone-type magnetic reproducers. These will grip



Fig. C

The compact "Companion" is a real portable, for use wherever an A.C. light socket is available.

any length or kind of wire or other material of the right diameter; and phonograph needles are supplied with them. These readily pierce, without difficulty, the insulation of heavy "weather-proof" wires, for the purposes of taking current readings, testing for continuity, etc. Because of their small diameter, the insulation is not damaged by their use.

The handles are made of insulating Ebonite and measure approximately ¾ in. x 6 in. long; and are distinguished by the colors; four of which are available. The leads, too, are differently colored, and thus facilitate ready identification.

By having available several different types of points, blades, etc., great versatility is obtained with the tool. For carrying, the phonograph needle is turned end-for-end when not in use, thus eliminating the danger of scratches. The cards are furnished with either spade or phone tips.

TWO-TUBE ELECTRIC SET

A NOVELTY recently put on the market by the Insuline Corporation is the "Companion" receiver, illustrated in Figs. C and D, and consisting of a regenerative detector, a current-supply unit, headphones, and carrying case (tubes extra); with a circuit designed for a 110-volt A.C. lighting main. As its name implies, it is a "companion" for the traveling man, the bed-ridden, and the experimenter; and boys take to it like ducks to water.

That there is a distinct demand for just such a receiver; and that this market of exceptionally low-priced radio sets is only now being scratched by the progressive dealer, has been evidenced by the influx of orders shortly after the release of the first publicity.

Use of the instrument is the acme of ease. The first step is to plug the 8-foot cord into the light-line outlet, with the receiver's switch in the "off" position. Next, the headphones are to be plugged into the tip-jacks provided and indicated by the

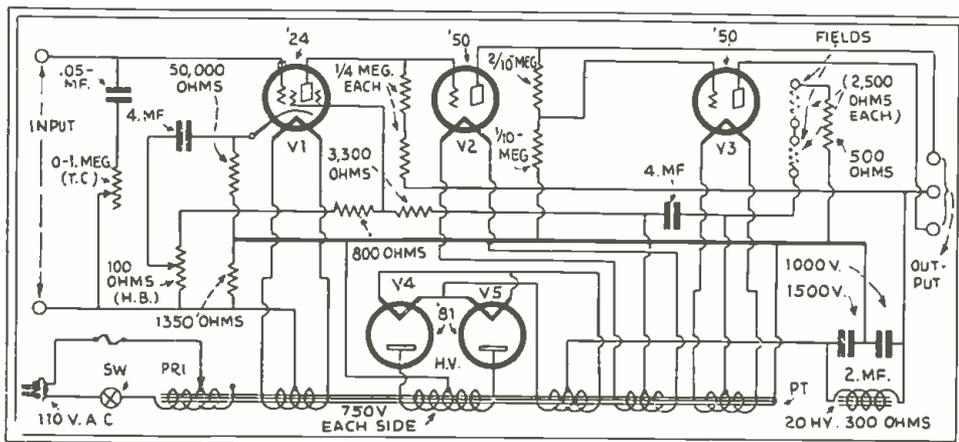


Fig. 1

The schematic circuit of the direct-coupled push-pull '50-type audio amplifier illustrated above, which has a conservative rating of 10 watts undistorted output; it works from microphone, pickup, or radio tuner input.

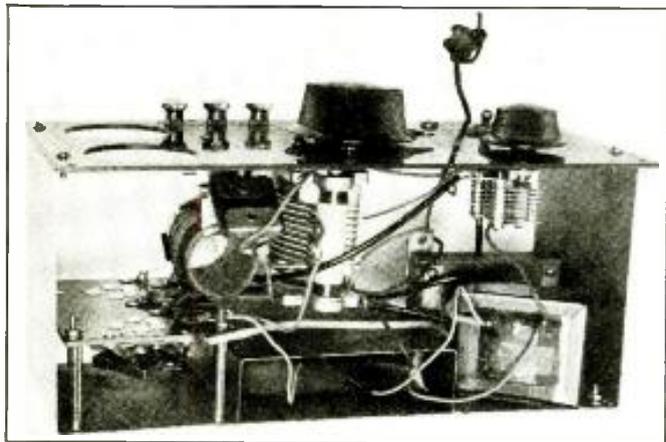


Fig. D
The "Companion's" chassis, removed from its case; the tubes, when in use, are inserted through the large round holes at the left of the panel. The center knob is the tuning dial, that at the left the regeneration control. The power transformer is mounted at the lower right.

Fig. 2
(below)
The simple and ingenious circuit of the receiver illustrated above and its built-in power supply.

often eliminates excessive hum. One of the '27s functions as a detector, and the other as a rectifier. The former, in the circuit used, is really an R.F. and an A.F. amplifier, as well as a detector. The rectifier changes the 110 A.C. to hum-free D.C., to supply the plate of the detector.

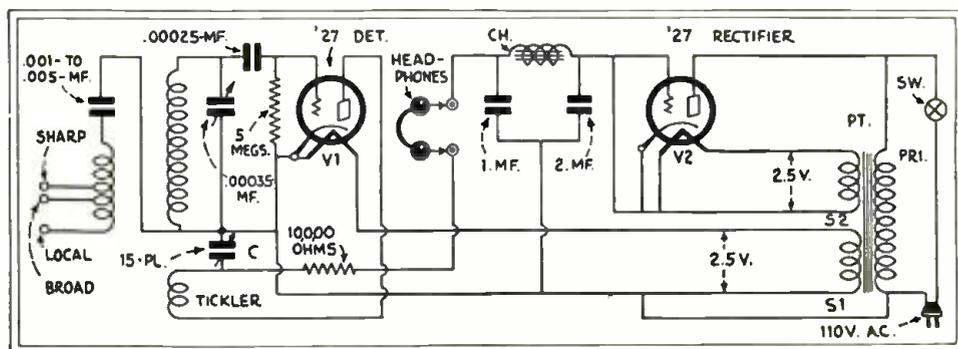
(The experimenter may be interested to read the constructional details of the original A.C. portable receiver, which was described and illustrated in the December, 1930, issue of *Everyday Mechanics*, in the article, "A One-Tube Portable Electric Set."—Editor.)

The sturdy chassis construction of the "Companion" is worthy of note (Fig. D).

(Continued on page 563)

panel engraving, "phones." Only then, with the two '27s (heater tubes) in the sockets, is the switch to be turned "on."

The connections, those of the super-sensitive "three-circuit tuner," are shown in Fig. 2. The regeneration control, "C" in the schematic circuit, is the small knob at the right in Fig. C, which shows the exterior of the "Companion." The center knob indicates the tuning over the engraved scale. Three binding posts are provided for adapting the receiver to any convenient antenna and ground arrangement. Reversing the light-line plug in the receptacle



Practical Hints to Radio Manufacturers

By Radio Users and Service Men

ADDITIONS OF PHONOGRAPH EQUIPMENT—SERVICE CALL RECORDS

THE field for installing phonograph attachments to the radio, which the customer has already bought, widens every day. Most of the time the customer would rather have the phonograph installed in the top of the radio cabinet; but the average radio cabinet does not have enough clearance between the set and the top of the cabinet for a motor with a turntable and reproducer. Why does not the manufacturer hinge his lid and leave room in the top for the installation of phonograph equipment at a later date? This would in no way hinder the sale of combinations; for the customer who wants a combination when he first buys his radio will buy one any way; while the set owner who later decides to convert his set to a combination would, most likely, buy the attachments from the manufacturer of the set, if that manufacturer would market a motor-board and reproducer ready to slip into the top of his cabinet.

For the set owner, who has already purchased a radio with little room at the top, why does not some manufacturer make a motor with an extension shaft and turntable mount, which would allow the turntable to be mounted in the customary position with the motor at the side or in the bottom of the cabinet?

Another article which would find a good market is an electric pickup, constructed to lie flat on the record and but a fraction of an inch thick. This would permit installation in a small space.

HINTS TO RADIO MANUFACTURERS

Until further notice, each "What the Public Wants" suggestion published here will be paid for at the rate of \$1.00; and their practical value, rather than their ingenuity or curiosity, will determine the selection, since this feature is intended to be of educational value to the radio industry. This means that we ask ideas from our readers, not for new inventions, but for simple details, often very small ones, which they have observed.

Then, too, an article which would encourage the tabulation of data on a manufacturer's machine would be a card tacked to the inside of the cabinet, with blank spaces to be filled in by the Service Man at each call. With these complete data of the cost of upkeep and times a set gave trouble could be obtained by the manufacturer by calling for the card. A metal slot, tacked to the inside of a cabinet, would encourage the Service Man to keep an index of his own calls.

MARCUS A. MCCOY,
3213 Blackburn St., Dallas, Texas.

AN INTERFERENCE SET-UP

A HINT, for some manufacturer of A chokes and condensers, is to put out an interference eliminator; whereby the inductances and capacities could be hooked up in series, parallel or series-parallel by an easy switching arrangement, for quick

determination of the best circuit to use in each case.

After the proper values were ascertained, a suitable unit could be constructed in the Service Man's laboratory. This would eliminate a good share of the guesswork and experimentation now generally necessary on such jobs; and save the Service Man considerable time, trouble and expense.

Reduction of interference would boost the sales of radio and increase the popularity of Service Men who are instrumental in accomplishing the work.

STANLEY I. HOUGH,
Route 7, Spokane, Washington.

TROUBLE-LAMP SOCKET

HAVE a place in the rear of the set where the Service Man can plug in a trouble lamp, to see the hard-to-get-at places.

IRVING FILDERMAN,
8528 118th Street, Richmond Hill, N. Y.

(Service Men have shown much ingenuity in devising attachments to light miniature lamps from the set's filament circuit; perhaps a socket of this kind would find additional uses.—Editor.)

A TWO-VOLT ADAPTER

A N adapter socket, containing the proper resistor in the filament circuit, would make it possible to test the '30-'31-'32 tube series with an analyzer or tube tester which does not supply 2-volt current.

REX CALLAHAN,
Honea Path, So. Carolina.
(In the meantime, Service Men and Kink-crafters can undoubtedly get busy.—Editor.)

The Dynatron Oscillator for Testing

An explanation of this interesting circuit, and purposes for which it may be employed

By C. H. W. NASON

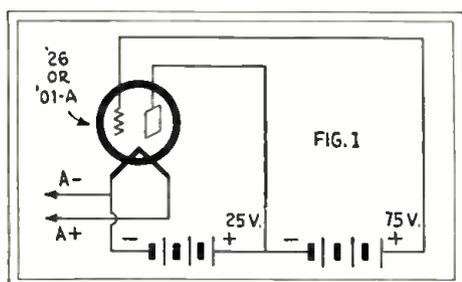
ALTHOUGH such knowledge is not essential to the understanding of the practical side of radio, most of us are familiar with the characteristic curves of vacuum tubes. A knowledge of the meaning of the various curves is highly desirable if the student is seriously inclined; since it is only by a thorough understanding of the principles of vacuum-tube operation that the circuits involved may be correctly designed.

never be permitted the doubtful liberty of excursions into the negative-resistance or "dynatron" region. This region is found to begin at any point where the plate's potential (purposely or otherwise) becomes *less* than that of the screen-grid by an amount sufficient to cause a secondary emission of electrons from the plate. It is easy to understand this fact, by reference to the operation of a three-electrode tube as a dynatron.

by the quantity L/CR ; from which it may be seen that the R.F. resistance of the coil may readily be determined by a simple equation when the values of L , C , and the negative resistance of the tube at the point where oscillation begins, are known.

This is but one of the many ways in which the dynatron proves itself a useful device, both as a measuring instrument and as a new bit of radio equipment. So great are the possibilities of the device as an amplifier that the writer hesitates to predict its future, lest he under-estimate the value of the device.

A few years ago, J. J. Dowling described the use of a screen-grid tube as an audio amplifier in the dynatron range of operation. At that time, the writer obtained excellent results with the tube as an amplifier at extremely low input levels; the gain obtainable is astounding. *The difficulty exists*



Dynatron action is possible with even a single-grid tube, when the voltage on the grid is strong enough to draw back electrons from the plate.

All who have examined the curves of the screen-grid tubes must have noted the little twist which each takes in its course; and, perhaps, noted also how, in that "dip," the plate current actually decreases with increasing plate voltage. This effect amounts to "negative resistance." It must not be thought that this mode of operation is peculiar to the comparatively new screen-grid tubes; for it was noted and very carefully investigated in connection with three-electrode devices many years ago. The first mention which came to the writer's attention was that in Dr. Alfred N. Goldsmith's monumental work on radio telephony, published in 1916.

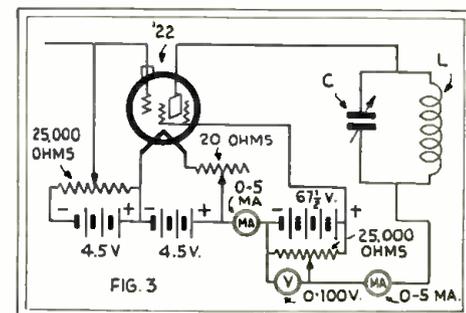
Electrons emitted from a hot cathode or filament, as shown in Fig. 1, are accelerated toward the grid by virtue of the positive potential on the latter. Because of the open construction of the grid, some of these electrons pass through the grid and each strikes against the plate with enough force to knock loose one or more of the electrons lodged on the surface of the plate. Normally, these "secondary electrons" would be permitted only a brief excursion from the surface of the plate; and would then return thereto, by reason of the positive potential of that electrode.

In the condition of the dynatron, however, the grid is more highly positive; and these dislodged "secondary electrons" are therefore accelerated toward the grid. This results in two currents in opposing directions; if the electrons leaving the plate predominate, the current will be negative; and the tube can be said to be operating on its dynatron characteristic, and is a negative-resistance device.

A typical curve of the dynatron range of a '24 tube is shown in Fig. 2. The negative resistance under these conditions can be readily determined by means of Ohm's law from the data in the figure.

Utility of the Dynatron

If a tuned circuit is placed in the plate lead of the dynatron, oscillation will result when the impedance of the tuned circuit is greater than, or equal to, the negative resistance of the tube. The impedance is given



A dynatron testing unit which will find many uses in the laboratory of the radio experimenter; as for the measurement of R.F. resistance.

in the fact that tubes designed for other purposes are not uniform in their operation in the dynatron range.

There is a particular advantage in operating a tube in this manner which seems to escape the notice of most investigators. The writer claims no credit for the idea, which was privately communicated to him by Mr. Philo T. Farnsworth of the Television Laboratories, Inc.

It is well known—or should be well known—that the effective input capacity of a tube depends upon the grid-filament capacity; to which is added a complex quantity involving the grid-plate capacity; to which is added a complex quantity involving the grid-plate capacity and the effective gain through the tube. In the case of the dynatron there is no phase reversal of 180°, such as the signal encounters in passing through a normal tube; and the complex capacity mentioned above is subtractive from the grid-filament capacity rather than added to it. If by some trick in design the complex value is greater than the simple grid-filament capacity, a *negative capacity* obtains in the grid circuit of the tube. Now it is fairly plain that a negative capacity can be visualized only as a *positive*

Reversed Plate Current

In the normal operation of the screen-grid tube, it is quite essential that the tube

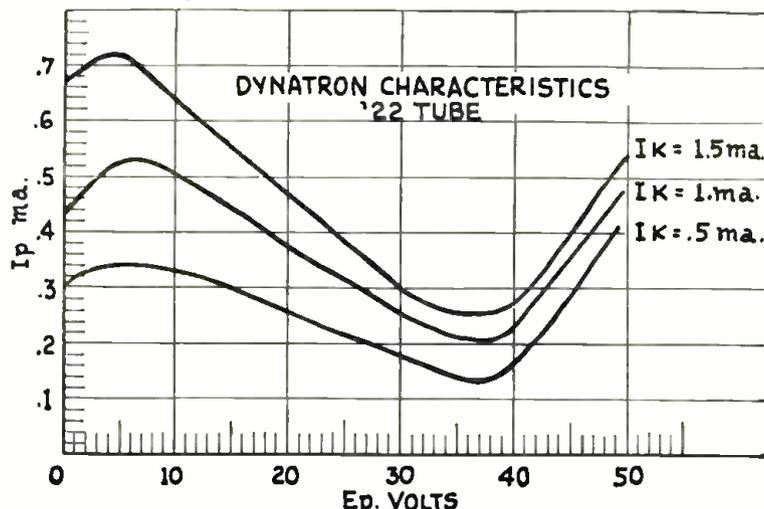


Fig. 4
By plotting the characteristic curves of a screen-grid tube, in the manner shown, and averaging the value of the constant K for the particular tube, as explained in the text, it is possible to calculate the resistance of a circuit, whose capacity is known, at the high frequency which the dynatron oscillator is generating.

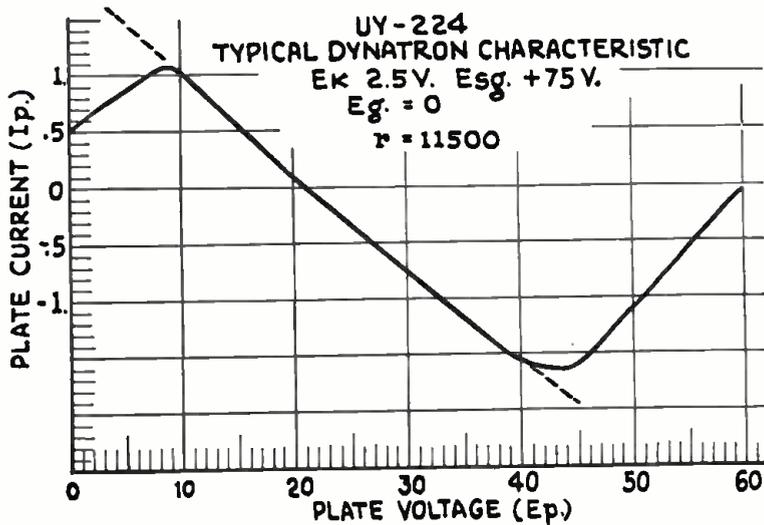


Fig. 2
The curve of a screen-grid tube, over a range where the screen-grid voltage exceeds the plate voltage, showing the dynatron characteristic—that is, the reversal of the flow of plate current with increased plate voltage. This is a negative slope of the characteristic; corresponding to a negative resistance.

inductance—strange as the mental image of a fictitious inductance may seem. Moreover, this inductance will increase with the frequency of the signal. This seems to indicate that a resistance-coupled amplifier may be made, not only to operate over a wide band of frequencies, but to have a gain-frequency characteristic rising toward the high-frequency end—where the gain normally falls off, because of the circuit and tube capacities which slant the resistance elements. (For further data on resistance-coupled amplifiers, the writer refers you to his own paper on "Amplifying the Television Signal," in the March 1930 issue of *RADIO-CRAFT*.)

The above data deal mainly with suppositions and hopes which may never materialize. There is, however, a little unit which the writer has built which will readily become the most useful instrument in the radio enthusiast's laboratory. It will operate as a heterodyne oscillator or wavemeter, or it may be used below the point of oscil-

lation to neutralize the inherent resistance of any wavemeter and thus sharpen the setting and accuracy of the tuned circuit.

Measuring R.F. Resistance

The most useful purpose, for the serious experimenter, will be in the measurement of the R.F. resistance of coils.

The figure of merit "Q" for a coil at any particular frequency is determined by the value of $6.2832f L/R$, when L and R are taken in ohms and henries. The procedure in measuring the resistance of a coil is as follows:

We know by definition that oscillation starts when "r" (the negative resistance of the tube) is equal to L/CR —the impedance of the tuned circuit. A number of '22 tubes should be tried in the circuit, and their curves of I_p against E_p plotted as in Fig. 2, to determine the particular tube of most sharply-defined dynatron range.

The circuit arrangement for the testing device, shown in Fig. 3, is due to Paul D.

Zottu, and is chosen for its simplicity as compared with the method of Linna. For purposes of accuracy, three curves have been plotted in Fig. 4, for three different values of the total space current, I_k , as adjusted by varying the filament voltage.

Data for the curves should be taken with the grid bias, screen-grid potential and cathode current held constant. The slopes of the straight portions of the curves are rarely parallel, and it is necessary to secure an average value in order to simplify calculations. This is done by employing the equation $r = K/I_k$ and calculating K (a "constant" for the tube) for each curve as shown in Fig. 4.

The slope of the curve "r," is ascertained by dividing a given change in plate voltage by the corresponding change in plate current. Thus, if a change of ten volts resulted in a change of 0.8-ma. (.0008-amp.), the negative resistance or slope of the curve would be 12,500, and if the cathode current (I_k) for that particular curve were 1.5 ma., K would be 18.75. Calculate K for all three curves; add the results together; and divide by three to obtain an average value for the tube.

Now, with a tuned circuit connected in for measurement, we vary the rheostat until oscillation is indicated by a sudden change in plate current; read the value of I_k at the point where oscillation takes place; and substitute it in the equation $r = K/I_k$, in order to obtain the value of r at the oscillating point. The R.F. resistance R of the coil, at that frequency, is now obtained readily by substituting the known values of C, L, and r, in the equation $r = L/RC$.

The approximate value of L is known by calculation. That of C at different dial readings may be obtained from the manufacturer of any high-quality condenser, in the calibration curve of his product. The

(Continued on page 560)

Improving the Hammarlund-Roberts "Hi-Q 29"

By GUS JACOBSON

AN extremely popular receiver, the Hammarlund-Roberts "Hi-Q 29," was the first of the "band-selector" T.R.F. kits on the market for the custom set builder and, at the time of its introduction, was without a doubt a leader in the custom-built field.

Subsequent developments in circuit design and practical improvements which, if incorporated in this set, will make it the equal in many ways of the receivers on the market today; and that is a tribute to the soundness of the fundamental engineering of the design. The circuit of the tuner, after alteration, is shown schematically herewith.

Problems of Band-Selector Construction

Many constructors of this receiver experienced difficulty in balancing the tuning condensers to the proper band width. If the adjustments had been properly made for ten-kilocycle band selection (say at the center of the broadcast spectrum) the set would, at the ends of the tuning dial, either tune so broadly as to give a signal at two

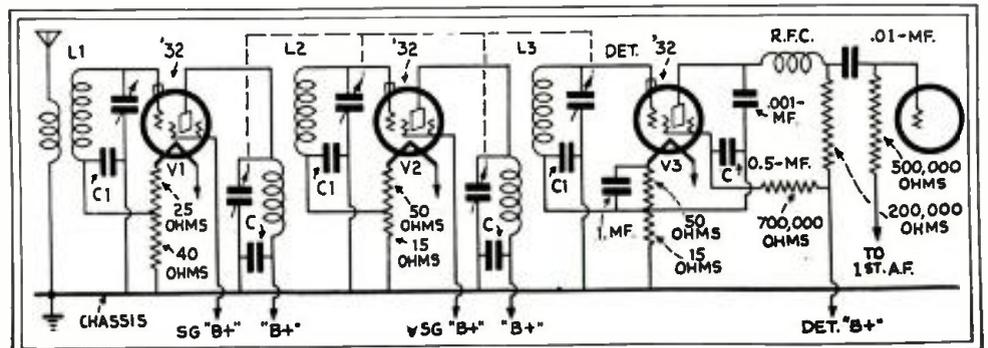
positions on the tuning dial (as much as four to five divisions apart) or tune so sharply as to cut the sidebands and cause attenuation of the high audio frequency response.

The latter was very noticeable in its effect on the audio quality; causing a marked thinness or even absence of the higher audio

frequencies which are so necessary, when clear voice and music reproduction is desired.

In this design, both the grid and plate circuits are tuned and, since the R.F. plate coil's "B+" terminal goes to the "B" supply unit, and its tuning condenser's rotor

(Continued on page 567)



The tuning circuit of the Hammarlund-Roberts "Hi-Q 29" battery model altered to improve the band-pass selectivity and to use the new 2-volt screen-grid tubes in the R.F. and detector stages. It may also be advantageous to couple the tuned grid and plate coils by very slight capacities.

How to Build a Midget Radio Receiver

Constructional data for an electric set of the mantel type now popular

By H. G. CISIN, M.E.

THE widespread popularity of the "midget" receiver is readily explained. A set of this type takes up little space, is economical, and gives remarkably fine performance, obtained through the application of modern design and, particularly, by the utilization of certain recent radio engineering developments. The use of fewer tubes reduces the number of parts required and, therefore, the cost of the set; it naturally follows that less space is required.

This description of how to make a midget all-electric radio set includes in its design practically all the latest radio developments. The set builder is often able to apply new ideas and developments, as in this instance, months before they become available through the regular factory-built sets.

Reference to the circuit diagram discloses two tuned stages of screen-grid R.F. amplification, a screen-grid detector, and a type 345 power tube; the latter is resistance-capacity coupled to the detector.

Exact dimensions for the cabinet are included, for the benefit of the set builder in a position to make his own.

The mechanical construction of the chassis is noteworthy; it is of sheet aluminum, and furnishes adequate structural support, as well as added finish of the completed appearance.

The shielded R.F. coils are tuned by .00035-mf. condensers, gauged to an illuminated drum dial, and trimmed by small equalizers in shunt with each. Volume is controlled by a potentiometer, regulating the screen-grid voltages, which is combined in the same unit with the power switch.

Constant operating conditions are obtained by an Amperite of the line-voltage control type; the control of tube voltages insures more even volume and tone quality, and lengthens also the life of the tubes.

Provision is made for the use of a D.C. dynamic reproducer, supplied with field-

excitation current from the power pack; the instrument specified in the parts list is of a small type, though highly efficient, which is readily housed in a midget cabinet.

Assembly of the Receiver

To save time, it is suggested that the aluminum chassis be procured already cut and bent to the desired dimensions. A

deck. The two fixed midgets are also mounted as shown.

The combination potentiometer and power switch should be mounted on the front vertical wall of the chassis, which is then turned right-side up. The drum dial is mounted at the front center; the single condenser (12) at its right, while the dual condenser (1, 8) goes at the left. (If the dual type is

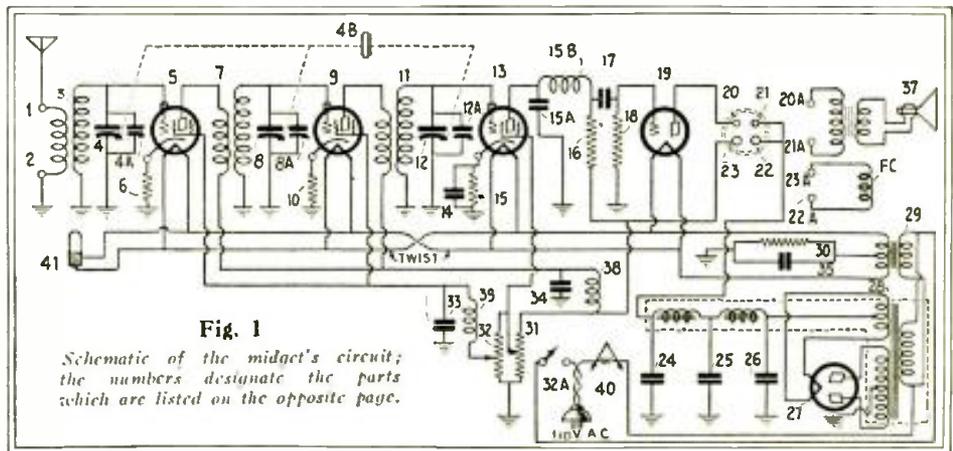


Fig. 1

Schematic of the midget's circuit; the numbers designate the parts which are listed on the opposite page.

number of concerns, which specialize in work of this sort, will also supply the chassis with the sockets riveted in place, provided specific directions are given; in fact, if so desired, all necessary mounting holes may be drilled at the time the chassis is bent.

After the sockets are mounted, the chassis should be turned face downward, and the parts shown in the underside view should be fastened in place. The heavier resistors may be mounted at right angles to the chassis, using fiber washers to insulate them from the aluminum. For greater facility in making adjustments, the three trimming condensers may be mounted on the top of the chassis, instead of below the

not available, two single condensers may be substituted, using a small coupling between them; there is room enough on the chassis to permit this.) The condenser shafts may be shortened to save space. Since the height of the drum-dial shaft is greater than that of the condenser shaft, it will be necessary to raise the condensers on suitable washers to the correct elevation.

The three shielded coils (3), (7) and (11) are mounted as shown; large holes should be drilled in the chassis below them, to prevent short-circuiting coil terminals.

The filament transformer (29) is next mounted at the right front corner of the chassis, and the power compact (28) directly behind this, with the condenser block (11, 33, 34, 35, 24, 25, 26) alongside as shown. The antenna and ground binding posts (1, 2) complete the assembly.

Test Wiring Procedure

It is desirable to wire in the switch (32A) and the Amperite (40) first. Break one of the connections leading to the power transformer's primary, wiring in the switch and Amperite socket in series. An ordinary UX-type socket may be used at (40) for the Amperite; although a special two-prong socket is available, if it is desired to improve the appearance somewhat.

The next step is to remove the plug from the wires leading to the primary of the filament transformer (29); shorten the leads, and connect them to the primary wires coming out of the pack. Be sure to make the connections at the points nearest the pack; so that operation of the switch will turn "on" or "off" both transformers.

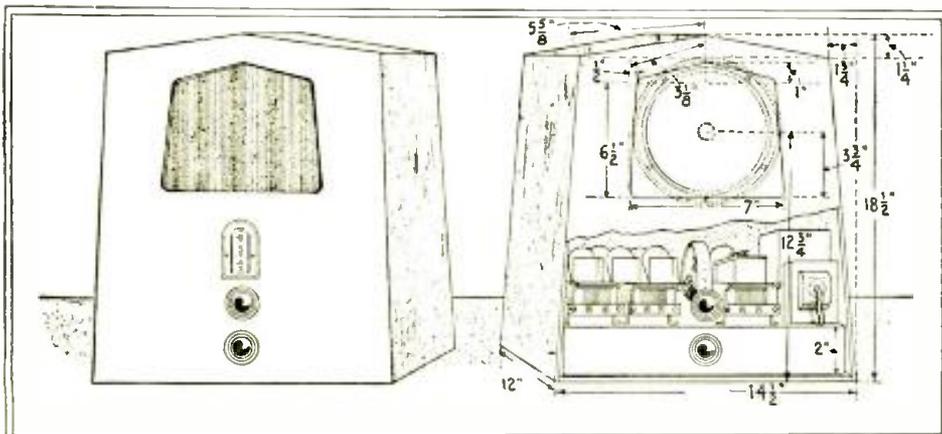


Fig. A

At the left a simple and readily-constructed cabinet design, suitable for housing the midget described above. It presents no difficulty to the builder who has a few tools; and its lines are distinctly modern. At the right, the dimensions are detailed.

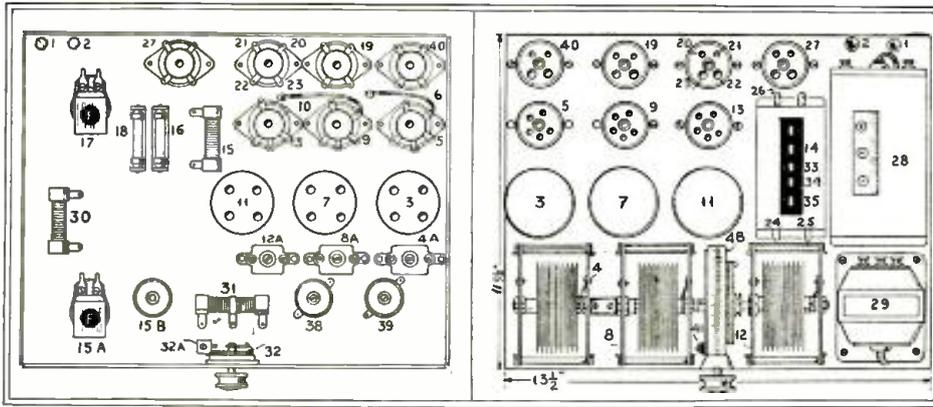


Fig. 2

Left, the underside of the midget chassis; right, the upper side of the sub-panel after mounting the parts which may be identified by the corresponding numbers in Fig. 1 and in the list below.

- One Thordarson Power Compact (28), type "R-480";
- One Thordarson filament transformer (29) type "T-3660";
- One Amperite (40) line-voltage control type "5-A-5";
- One Jensen "Midget" electrodynamic reproducer (37) model "D-11";
- One 15 1/2 x 17 1/2-inch sheet, 14- or 16-gauge aluminum, for 11 1/2 x 13 1/2-inch chassis, two inches high;
- Two binding posts (1, 2); three UY 5-prong sockets (5, 9, 13); four UX 4-prong sockets (19, 27, 40 and 21-21-22-23); and a roll of Corwico armored hook-up wire with stranded core;
- Three "Hyvac" self-shielded "UY-224" screen-grid tubes (5, 9, 13); one '45 power tube (19) and one '80 rectifier (27);
- Wood (three-ply) for cabinet (optional); base 12 x 13 3/4 x 1/2-inch; two sides, 12 x 17 3/8 x 3/8-inch; two top pieces, 5 5/8 x 12 x 5/8-inch; one front, 14 1/2 wide at base by 18 inches high (shaped as illustrated; sides 17 3/8 inches, tops 5 5/8 inches).

The wiring to the power switch and the Amperite socket, as well as all filament wiring, should be twisted. All four tubes and the pilot light utilize a 2 1/2-volt filament supply. The center-tap of the filament transformer is connected to the 1500-ohm biasing resistor (30) and thence to ground. The resistor is shunted by the 4-mf. condenser (35, which is part of the block.)

The various grid circuits are wired next; these connections should be shielded with armored wire and the armor shielding should be grounded. Small bell-shaped grounded shields should also be used over the caps of the tubes; the '24 type listed is otherwise self-shielded.

The volume control (32) is wired in at this time; the plate circuits should be completed next, and then the cathode circuits.

The aluminum chassis itself serves as a common negative return. The ground binding post is grounded directly to the chassis, whereas the antenna post is carefully insulated from the chassis. The primary of coil (3) is tapped at 13 turns; and a connection should be made at this point, instead of at the end of the winding, if the set is to be used with a long aerial. If desired, the tap may be connected to an additional "long" post, while post (1) may be used for a short aerial.

The by-pass condensers should be wired in and also the filter condensers (24, 25, 26); the last designated, being nearest the rectifier tube, must be rated to withstand the terrific punishment imposed upon it by the pulsating D.C. output. (In the condenser block specified, the first 2-mf. unit on the left, facing the label, is made especially for this purpose.) The rectifier filament and plates are connected, and the remaining wiring of the power supply is completed. Nearly all the wiring is run beneath the deck of the chassis.

A UX socket and tube-base plug are used for making rapid connections to the dynamic reproducer. As shown in the schematic diagram, the transformer's primary lugs (20A) and (21A) are soldered to the leads going to the plate and grid prongs of the tube base; while the field terminals (22A) and (23A) are soldered to the leads connected to the filament prongs. The socket (20, 21, 22, 23) is wired in the set as indicated; so that, when the plug is inserted in the socket, the transformer primary of the speaker will be in series with

the plate of the power tube and "B+", and the field coil of the dynamic reproducer will be connected in series between "B+" and the plates of the R.F. and detector tubes (13).

It is highly desirable to check up the completely-wired receiver with a good set tester. First of all, read the filament voltages. These should all be 2.5 volts (no load), with the exception of socket (27), where there should be 5 volts across the filaments. The tubes should then be put in place and the set fully tested under operating conditions. The plate voltage at (19) should be 250, with a drop of 50 across resistor (30). The detector screen-grid voltage should be about 90, with a cathode-voltage reading of 9; while the cathode voltage reading on the screen-grid tubes (5) and (9) should be about 2 1/2 volts. The screen-grid voltage on these tubes should be 75 volts (max.), with a plate voltage of 180. The detector's plate current will be approximately one-half to one-quarter of a milliamperere—much less than that of the amplifiers, as its plate voltage is lower.

List of Parts

- One dual .00035-mf. Cardwell variable condenser (4, 8), type "217-CL," and
- One single .00035-mf. Cardwell variable condenser (12), type "171-CR";
- Three Muter or X-L. midget variable condensers, 3- to 50-mmf. (4A, 8A, 12A);
- One Silver-Marshall illuminated drum dial (4B), type "810 R," and pilot light (41);
- Three Silver-Marshall shielded R.F. coils: two (7, 11) type "121"; and one (3) type "124";
- Three Silver-Marshall R.F. chokes (15B, 38, 39);
- Two 400-ohm Electrad wire grid resistors (6, 10);
- One 1500-ohm Electrad "Truvolt" resistor (30), type "B-15";
- Two Electrad "Truvolt" resistors (15, 31), type "B-70";
- One Electrad "Royalty" potentiometer (32), type "11" with power switch (32A);
- Two Durham metallized resistors: one 1/4-meg. (16); one 1-meg. (18);
- One Flechtheim condenser block, type "JN-45"; three 2-mf. capacities (24, 25, 26); three 1-mf. (14, 33, 34); one 4-mf. (35);
- Two Flechtheim "Midget" fixed condensers: one .001-mf. (15A) type "M-F"; one .01-mf. (17), type "M-K";

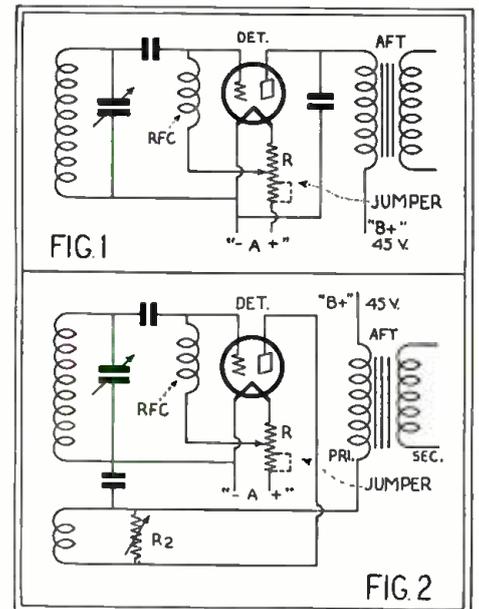
INCREASING DETECTOR EFFICIENCY

By R. Wm. Tanner

In nearly all receivers which employ the grid-leak method of detection, the operation may be improved in the following simple manner; this is especially true in the case of home-constructed sets, where any combination of grid condenser-leak that was available has been used.

It is possible to replace the grid leak with a radio-frequency choke, having an inductance of the correct value for the wavelength range of the receiver. This offers a comparatively low resistance to the negative charge on the grid, but a very high impedance to the R. F. currents.

The choke should be connected directly between the grid and filament, *not across the grid condenser*. But, if the low side is connected direct to the positive side of the filament (as generally is the case with a grid leak), operation will be poor. This is
(Continued on page 565)



The use of an R.F. impedance instead of a high-resistance grid leak, will usually improve detector efficiency; but the bias should be carefully adjusted by using a potentiometer.

RADIO CRAFT KINKS

ELIMINATING PLUG-IN-COILS

By M. D. Rubin

MOST short-wave radio fans dislike plugging coils in and pulling them out, every time they wish to change to a different waveband. Several complicated arrangements have already been devised to obviate this; but, as a rule, they are too difficult for the average set constructor to build. These complications are usually in the switching arrangements; but here is a switching method which is not complicated.

Get two miniature four-pole double-throw switches, either knife or jack. Mount these on the panel near the bottom; then mount four sockets for the coils directly behind the panel, and the detector tube socket directly behind these. When this is done connect as shown in the diagram (Fig. 1) which is self-explanatory. It would be a good idea to label each side of each switch with the waveband of the coil that side controls. Also, label the neutral position, as in the diagram.

To operate, close switch to side wanted, leaving other switch at neutral; i.e., if the 15-25 meter band is wanted, turn switch 1 to that side, and leave switch 2 at neutral. If a jack switch is used, no condenser effect should be present; because there is always a disconnected plate between any two sections of the jack switch. In addition, the leads should not be lengthened much; for the switch is quite close to the coil sockets.

EDISON "B" BATTERIES

By Chester Rector, W9BFW

REBUILDING a storage "B" battery of the Edison type has several advantages: first, the investment is small; second, no destructive acid to spill; third, the nickel steel elements are non-sulphating and last indefinitely; and, fourth, the Edison type is lighter than most others. These batteries hold the charge for a long time when not

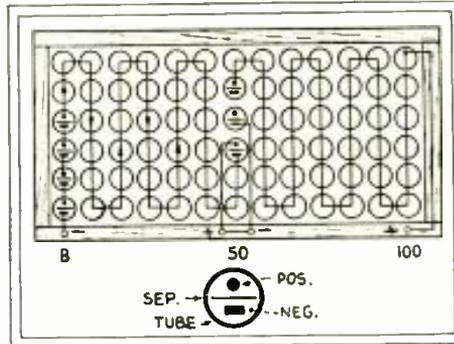


Fig. 2

The storage "B" battery is much favored in Europe still. Many old ones may be picked up here.

in use. If one is not at hand, it can be obtained from a radio store very cheap; and can be made to give very good service by the following method:

Carefully remove all of the elements and test tubes from the rack, and clean thoroughly. After they are completely cleaned, lay them out to dry. From the drug store purchase two pounds of potassium hydroxide, 5 lbs. distilled water, and 1 oz. mineral oil.

Mix in an earthenware or glass bowl the distilled water and potassium hydroxide until there is a reading of 1,250 in a clean hydrometer, one that has not been used for testing acid batteries. At this stage the solution will become quite warm; so it should sit until cool, being tested again for correct reading. If the reading is higher or lower than 1,250, distilled water or potassium hydroxide should be added as required. Leave the solution to settle, and then filter.

Next assemble the battery, as in Fig. 2. Fill each cell to within one inch of the top, by using the hydrometer. The plates will soak up some of the solution; so the process should be repeated. With a clean medicine dropper, place about three to four

drops of the mineral oil (liquid paraffin) upon the top of the solution in each cell.

The charging can be done from a 110-volt A.C. line, by the use of a trickle charger. However, if a 32-volt D.C. lighting system is available, the battery can be charged this way, after it is divided into 25-volt sections; of course, no rectifier is necessary.

The battery must be tested with a voltmeter since the specific gravity remains the same whether it is charged or discharged. The solution should be changed about once every year when in use; and the level should be kept up by adding distilled water.

Two of these units make a very good plate supply for the beginner's amateur transmitter. Also, this type of battery works very well on any radio receiver.

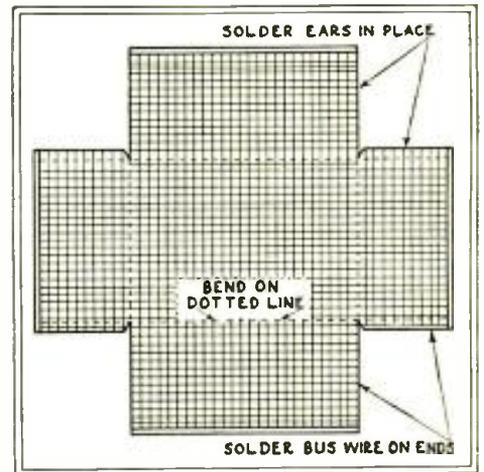


Fig. 3

Copper screening, of the type used for doors and windows, is very easy to handle, and often serves the purpose of shielding.

A CONVENIENT SHIELDING

By George H. Haby

WHERE I live it is difficult to get sheet metal of any kind for shielding radio sets. So I bought some copper window screen, which was the best that could be done, until I could get hold of some aluminum sheeting. This copper window screen was used in shielding a screen-grid Pilot "Super Wasp" receiver, and it was very successful.

In comparing it with other sets, identically the same except for the solid shielding, it was found that the "screened" set was the sharpest-tuning, and had the best control of oscillation. The principle of that type of shielding is that the condenser capacity between the screen shielding and the coils, is reduced to a minimum; making it possible to build the parts close together, and saving weight. Any one who can handle a soldering iron well will find that copper window screen will be much easier to install than to fit up solid plates. Fig. 3

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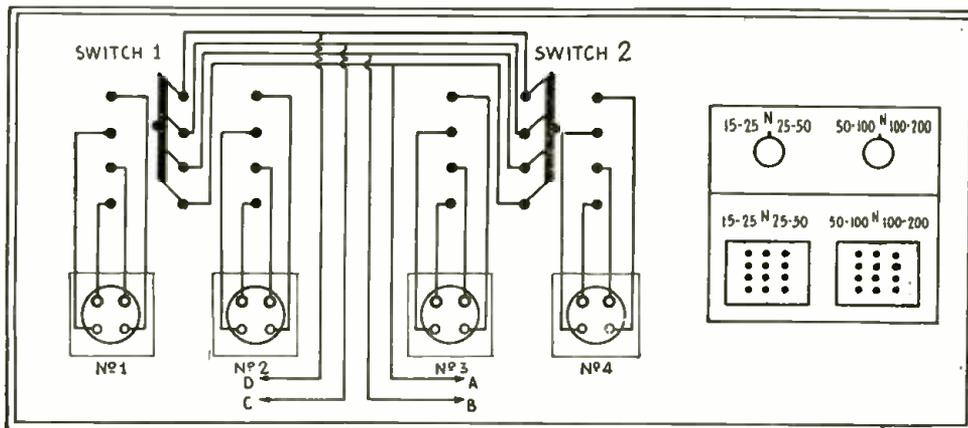


Fig. 1

The switching system shown makes possible fixed K.F. coils for short-wave work. The switches may be arranged on the panel as shown at the right; jacks as above, or blades as below.

The Hammarlund "Hawk" Short-Wave Set

A very efficient two-tuber, using the new 2-volt tubes

By LEWIS W. MARTIN

THE striking tempo of castanets amid the strains of a swinging tango, the vibrant music of a native reb'ab orchestra, the boom of Big Ben, intriguing code messages from the four corners of the earth, speech in every tongue—all are at your finger tips, direct from their points of transmission—thanks to short waves. The realm of 1001 thrills, the short-wave region, is truly a revelation in its fascinating features.

With the advent of the '30 type, two-volt tubes, simplicity and efficiency are merged with economy of operation. Since only 120 milliamperes, total current, is drawn by two tubes, the "Hawk" receiver illustrated here can be operated from two ordinary dry cells.

As will be noted (Fig. 1), the detector V1 is regenerative, using the condenser parallel-feed method, the most effective system for real results. The tickler, L3, is a fixed winding; a 100-mmf. midget variable condenser C2 controlling the plate circuit. With this system, exceptionally smooth tuning, gradual over the entire scale, is afforded; thus there are no "dead spots" or "tuning dips." The audio stage is coupled in by a special transformer T of low ratio.

The Components

A word about the equipment used in this circuit. "Parmica," a new insulating material, closely approximating the efficiency of dry air, is used exclusively in the specified short-wave components, reducing dielectric losses to less than 10 per cent. of that with usual insulations.

For easy and accurate tuning, a special 125-mmf. tuning condenser C1 is used; its "midline"-shaped brass plates are 1/32-inch thick and double-spaced, and soldered in place with special tie bars. With a full-floating rotor, mounted in adjustable cone bearings, there is assurance of exact capacity values at every given setting. Plate vibration is prevented; and there is also a constant-impedance double-wiping contact which eliminates the objectionable inductive reactance of the conventional pigtail. The brass plates of the midget condenser are also non-corrosive, well spaced and soldered in place, to provide accurate capacity settings.

In the coils illustrated a thin continuous film of rigid dielectric is fastened to the inside edge of the wire, where there is the minimum field. Heavy wire is also used, to reduce the resistance of the wire itself. The space between successive turns is slightly more than the diameter of the wire itself; not only is the distributed capacity reduced in this manner, but also the high-frequency resistance of the coil.

The set comprises four plug-in inductors covering the 14- to 110-meter range. These coils (described roundly as the 20-, 30-, 40- and 80-meter coils) are all built around the design just mentioned. The variable pri-

mary is a part of the base, and accordingly remains unchanged for all wavelengths, maximum energy transfer being maintained by varying its coupling position.

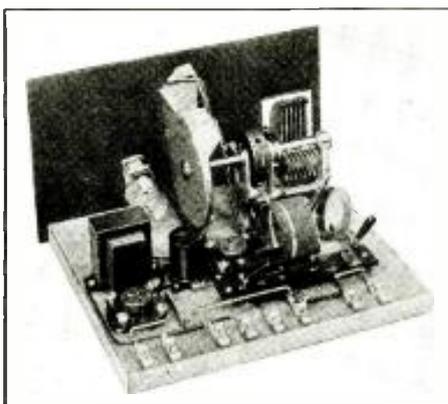


Fig. A

The "Hawk's" layout: the condenser at the right is shielded from the panel, to prevent hand-capacity.

With the exception of the 80-meter coil, all are wound on two-inch forms with No. 16 D.S.C. wire, 11 turns to the inch. On the 80-meter coil, No. 18 D.S.C. wire is wound on the same diameter form with 17 turns to the inch. Between the tickler L3 and the secondary L2, there is a space equal to one turn.

To provide steady grid control, a special grid condenser (C3) with a capacity variable from 20 to 100 mmf., is used in conjunction with a 3-megohm grid leak, R1.

The radio-frequency choke used has an exceptionally low distributed capacitance—only 3 mmf.—due to its patented helical winding. In short-wave work, it is imperative that the distributed capacity be at a minimum; since the frequency range is great and the choke is usually operated below its resonant frequency.

The New Tubes

The '30 is a general-purpose tube; excellent as a detector and as a first-stage audio amplifier. At its rated filament voltage of 2, the filament uses only 0.12-watt; the economy is apparent. It has an amplification factor of 8.8, and a grid-plate capacity of only 6 mmf. With its extremely low plate drain, and stable and non-microphonic construction, this tube is ideal for short-wave work, especially where flexibility and ease of operation are concerned.

When it is used in the detector circuit, from 45 to 67½ volts should be applied to the plate. As an amplifier, the voltage should be 90, with a 4½-volt "C" bias. At these plate and grid voltages, the "B" consumption is only 2 milliamperes.

If two dry cells, in series (3.0 v.) are used, the filament resistors R2 and R4 should be 15 ohms each. If a 6-volt storage battery is used, they should each have a value of 50 ohms, with a rheostat to reduce the battery voltage to 5.

Mounting of Parts

The panel should be first laid out, as shown in Fig. 2. The panel should then be fastened to a plywood baseboard, and the other parts are mounted as shown in the photograph.

Constructors with spare binding posts about can use them instead of the clips, mounting them on a suitable insulating strip. To facilitate connection, the terminals should be marked in this manner (reading from left to right, and looking at the set from the rear): "Ant.," "Ground"; "A—," "B—," "C+"; "A+"; "B+45"; "B+90" and "Phones." The "C-4½" volt terminal is in the form of a flexible lead, coming from the transformer.

No. 18 insulated wire should be used; (Continued on page 559)

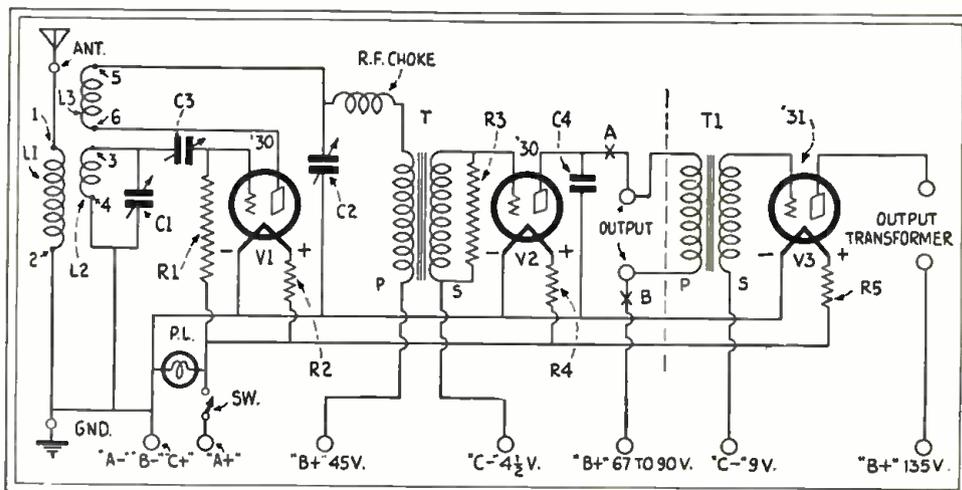


Fig. 1

At the left, the "Hawk's" circuit as a two-tuber, suitable for phones; the addition of a power stage, as at the right, gives suitable amplification for a speaker. Both construction and operation are extremely simple and, in a suitable location, remarkable effects are often obtained from a small set.

Short-Wave Broadcast Listening Grows

Some characteristics of radio's most wonderful development

By ARTHUR J. GREEN*

SHORT WAVE broadcasting is not new; for years amateurs in all parts of the world have been sending out music and talking to their friends over the short-wave channels. However, it is only recently that the general public has taken an interest in this wavelength band, which comes far below that which the ordinary broadcast receiver tunes. This delay has been due, partly to the slow progress made in the short-wave field, and partly to activity concentrated on the broadcast band. Until recently, most radio engineers ignored the short-wave field, because they looked upon it as a playground for the amateur, and put forth all their efforts toward improving broadcast receivers and transmitters.

Slowly, very slowly, the idea began to circulate that extreme long-distant reception is possible by utilizing the short wave channels. A few progressive commercial engineers decided to investigate, and put short-wave stations on the air, waiting further development in this field. Reports coming in from great distances proved their theory and, almost immediately, there was a rush of applications for stations on both code and voice. Large, powerful transmitters were supplanted by medium-powered and less expensive ones, and found to be more reliable for the transmission and reception of messages over long distances. Still the public was not awakened to short-wave development.

As an experiment, several of the world's leading manufacturers decided to put short-wave stations on the air. Programs were irregular, the transmitters were of poor design, and listeners were few and far between. But the fact that short-wave broadcasting was a possibility was soon established.

Although history is somewhat blank on the matter, station G2NM at Caterham, England, was picked up and rebroadcast in Ceylon in 1924. Later, CFCA at Toronto, Canada, relayed the English station G5SW. The first United States rebroadcast was made by a station in Lockport, New York. The idea stuck, and soon the different claims were trying to outdo each other in point of relays of overseas stations. Then, and not till then, did the public become "short-wave minded."

"Junk-Box" Sets

In the first rush of short-wave fans, there was little choice in the way of receivers, and therefore short-wave receiver design was much in the same class as that for the broadcast band in 1921 and 1922. Thousands of listeners tried building their sets from old discarded odds and ends, that had

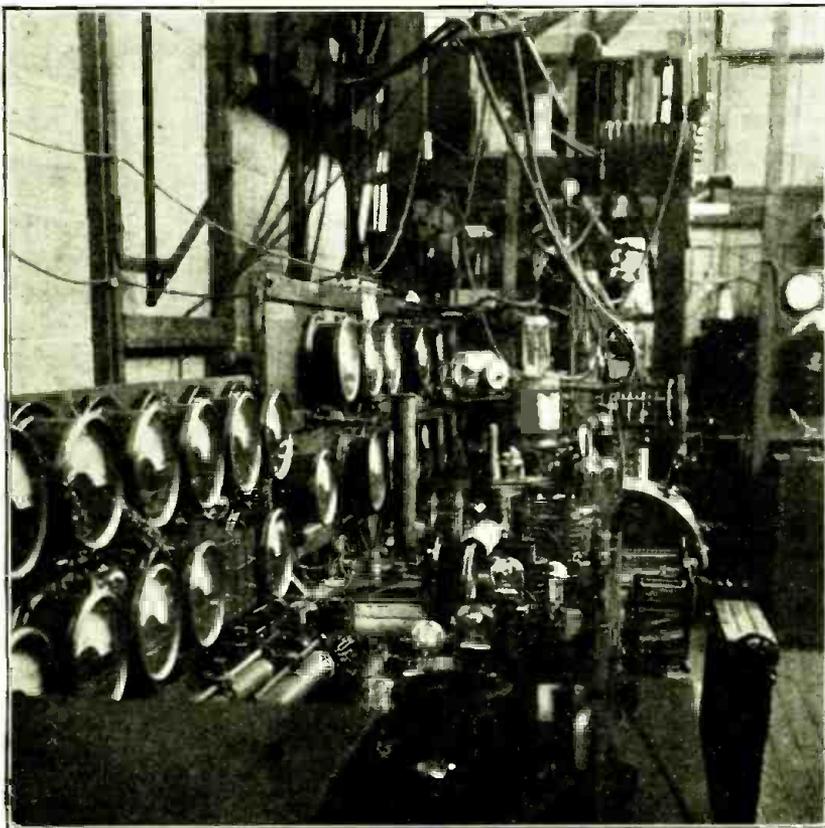
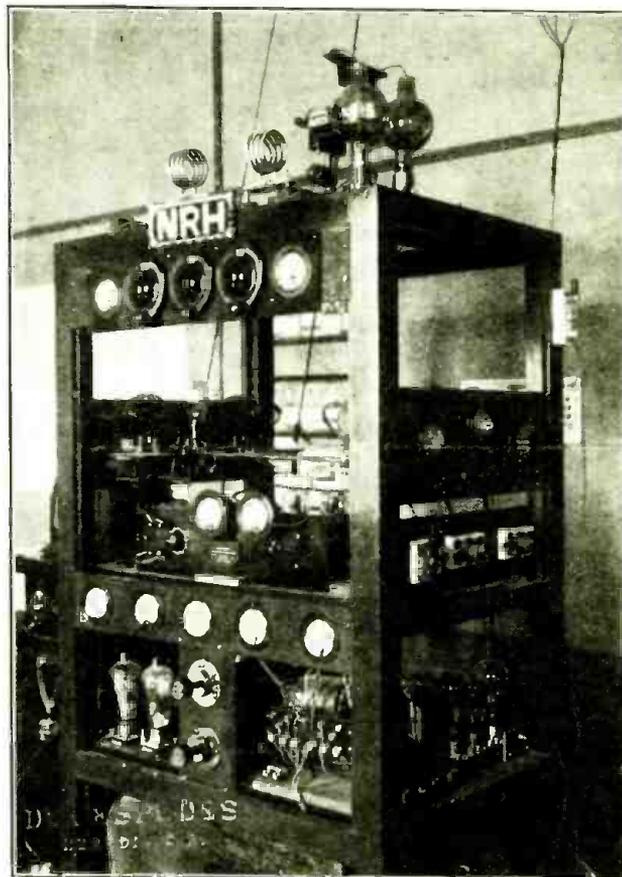
been put aside years before as poor equipment.

The surprising part of this was that many achieved a certain degree of success in picking up stations all over the world. Thousands of others, after weeks and even months of effort, gave up short waves; and their unfavorable experience and disappointment has ever since been a drawback to the sale of short-wave receivers.

There were three great drawbacks to short-wave broadcasting at that time: first, the lack of stations and entertainment; secondly, the poor quality of receivers; and thirdly, the lack of information on all phases of short-wave reception—including how, when and where to tune, what stations to tune for, and such things as effects of light, etc. Each of these handicaps has been greatly overcome during the past year.

All the broadcasters of the world have awakened to this new field. Short-wave stations are becoming more and more numerous each month. In the tropical and subtropical regions, where reception on the broadcast band has been confined to a few months out of the year, because of heavy static, the listener has taken to short waves

Right, the smallest S.W. broadcast transmitter, internationally famous for its remarkable distance work on 10 watts, as well as the personality of its operator, Sr. Amando Cespedes Marin, of Heredia, Costa Rica.



Left, the huge transmitter of PCJ, Hilversum, which rivals Pittsburgh and Schenectady as the home of international broadcasting. This station, operated by the N. V. Philips Radio Co., of Eindhoven, Holland, is inferior to none in power and is heard almost everywhere in the world.

* President, I. S. W. C.

with great interest. To supply these listeners with entertainment, many stations are going on the air with regular programs. It is no longer necessary to depend on one or two foreign stations for entertainment on a short-wave receiver. Ships at sea talking to shore stations, airplanes and airport stations, telephone stations in all parts of the world, police stations, and amateurs on phone add to the variety of entertainment.

Modern Short-Wave Receivers

There are now on the market, six types of short-wave receivers, each with its advantages and disadvantages. The first, and perhaps the best in the hands of a skilled operator, is the superheterodyne. Up to the present, there has been little interest in this circuit.

The second is the tuned radio-frequency circuit. This utilizes the screen-grid type tubes (the '32s, '22s, '21s or a pentode) in a stage of tuned radio-frequency preceding the detector. This circuit is perhaps the ultimate in receiver design for the layman.

The third type is the untuned radio-frequency circuit. Although practical for most purposes, it does not compare with the tuned circuit.

The fourth is the regenerative circuit, commonly called the three-circuit tuner. This is still a favorite with thousands; but, as more and more short-wave fans are born, this type of receiver must be eliminated, as it has been from the broadcast band. Its fundamental fault is the oscillation it sets up and transmits to other receivers nearby.

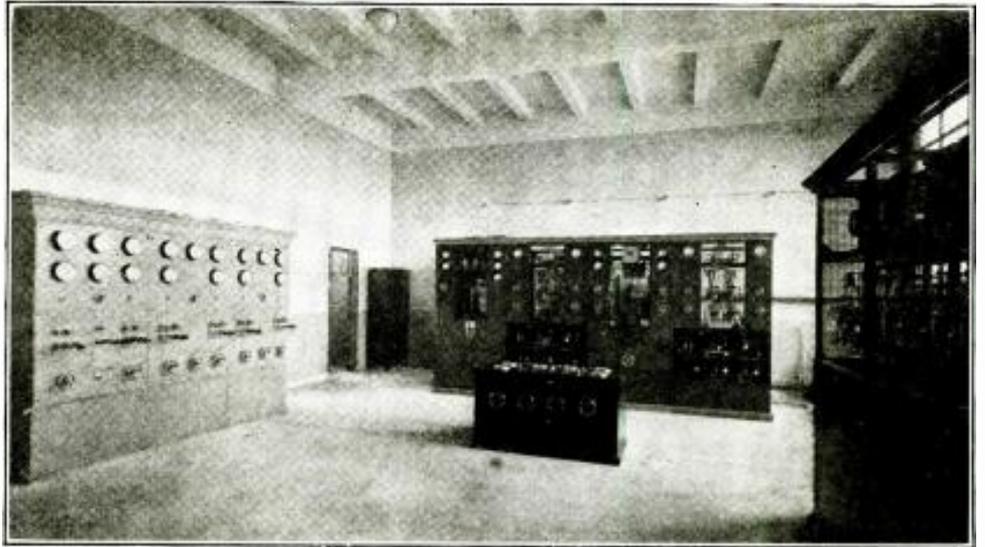
The fifth, although not a distinct circuit, is the converter, which is used to pick up a short-wave signal and transmit it through a regular broadcast receiver, utilizing the radio-frequency stages.

The sixth is the adapter, which plugs into the detector socket of a broadcast receiver, and uses only the audio end.

Guides to Distant Reception

The short-wave listener is fast becoming familiar with short-wave tuning, and no longer gropes in the dark for entertainment. He no longer "fishes" for stations, but tunes his dials to the setting where he knows a certain station may be found. If that particular station is not good enough to give him entertainment, he then tunes to another. Many of the older theories have been exploded, in regards to skip-distance and such matters. Perhaps the hardest lesson to learn was the operation of what was commonly called "skip-distance," but which is really the effect of light on certain waves. Some are strengthened in carrying range by light, and others by darkness. The lower the wave or the higher the frequency, the greater is the range; but, at the same time, daylight *increases* this value below 20 meters and *decreases* it above that wave.

A good guide to tuning is as follows: below 20 meters, tune from daybreak until dusk. From 20 to 33 meters, stations in the direction of darkness (east) are best from noon until about 10 P. M. Stations in this band to the direction of light (west) are best from midnight until shortly after daybreak. From 33 meters upward, darkness aids the signal and, the greater the amount of darkness between the listener and the station, the greater the volume received. Almost all distant stations are to



The short-wave listeners who have heard French conversations radiating to South America, to the French possessions, and to ships at sea, will be interested in this view of the short-wave transmitting room at Ste. Assise. Several transmitters, working through directional acrials, are grouped at this suburb of Paris, and operated by the Compagnie Radio-France.

be received below 50 meters. The time directions given above apply to standard time at the receiving end.

Harmonics, once considered a detriment to short-wave tuning, are now used as guides to picking up distant stations on certain points on the dial. It is easy to calibrate a short-wave receiver by picking up a harmonic, dividing the true wave of the station and learning the exact wavelength of the harmonic.

Skip-distance holds no more terrors for the average short-wave listener. If a listener has been enjoying a fair degree of success in the broadcast band, there is no reason to expect short waves to be different.

Listeners Increase in Number

Short-wave broadcasting is here to stay. It opens an entirely new field of frequencies, *twenty-five times as wide as the present broadcast band*, and each of which is particularly adapted to some purpose. The writer predicts that, in time to come, there will be stations broadcasting on several short-wave channels simultaneously to cover the entire world in one broadcast. Not that the signal will go around the world (that is being done today) but it will reach every section of the world at one time.

For example a station may be on 150 meters for local reception, and not be subject to "skip-distance" weakening in that area. Then on 75 meters for slightly further distance; 50 meters for the next area; 25 meters for the next; and 15 for sections where daylight is still effective. Perhaps even higher frequencies could be utilized. In this manner, the listeners in every part of the earth would have the program at their fingertips. This is not only a possibility but a probability in the near future.

The International Short Wave Club was organized to help overcome the third drawback to short-wave broadcast reception. Through the interchange of information and ideas, it has brought short-wave station schedules and such matters up to the highest standard possible at the present time. Started one year ago, with three members, it has grown to the point where its membership covers 39 countries and possessions.

Fifty per cent of its members are acting as reporters in securing information which is printed and mailed out to members. The club has sponsored test programs from transmitters all over the world, at times best fitted for reception; among them stations located in Honduras, Spain, Holland, England, Colombia, Madeira and others. At this time it is arranging a chain of short-wave stations which will broadcast regular programs dedicated to the members of this club. Every reputable person is welcome to membership; a fee of one dollar a year being necessary to cover the printing and mailing out of the club magazine. The only other requirement is an interest in short-wave broadcasting.

SHORT-WAVE BROADCAST

PIONEERING

By H. P. Davis

Vice-President, Westinghouse Elec. & Mfg. Co.

MOST advances in applied science or art have had to create their own field of usefulness and seldom win immediate public approval. The story of steel exemplifies this. The introduction of the telephone and the electric light had much difficulty at the beginning, and the public was generally slow to accept them as universal facilities.

Radio-telephone communication, however, almost overnight was acclaimed and rapidly assumed a dominating position in domestic life. It is an interesting fact that it took more than forty years for the same number of American homes to be equipped with telephones and electric lights as are now equipped with radio receiving sets.

In the early part of 1923 Westinghouse engineers plunged into a line of research work that was as much a pioneering effort as that of establishing the first broadcaster, and eventually in the development of broadcasting and radio communication may have even greater importance.

I refer to the pioneering work that was done in developing the so-called short radio waves. This part of the frequency spectrum had been looked upon as useless; and

(Continued on page 565)

More About the "Roll-Your-Own"

By W. E. SMITH

IN the November, 1930, issue of *RADIO-CRAFT* appeared an article by the writer, entitled "A Roll-Your-Own Super." It is not my purpose to comment here further on the merits of this design; but I do suggest that, if you are a DX fan, you will find this set's distance-getting qualities limited only by the noise level.

In answer to the invitation at the close of the previous article, many readers sent to me letters with questions about the construction of this superheterodyne. Some of them were plainly apologetic for the limited experience of beginners; some asked where parts could be purchased ready-made; and others wished more information on points which were not as fully explained, perhaps, as they should have been in the original article. These few words have been written, therefore, to supplement the first story, and answer the principal questions which have been brought up.

There seems to have been most perplexity about the intermediate-frequency coils. I described bunch-wound coils, although those in the illustration appeared more like the spider-web variety. Either will do; but in this article I have described another type which may be even more convenient to wind than the original. The forms can be made in any wood-turning shop.

Many inquiries were directed to me by owners of condensers which they wished to use. It should seem hardly necessary to say that any set of condensers may be used with proper coils; and that any sizes of coil forms and wire may be used, by regulating the number of the turns used, to match the capacity. The larger the condenser, the fewer the turns; the larger the coil form, the fewer turns, etc. If the insulation changes the actual spacing of the wire, this must be taken into account also.

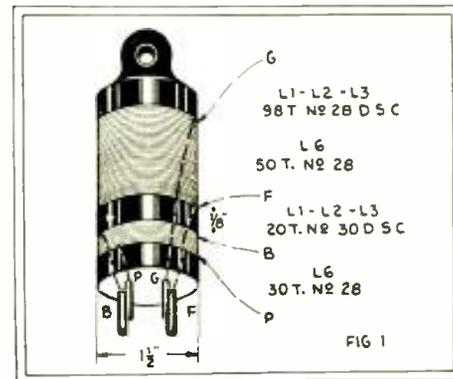
The coils used in the original receiver were of the Pilot plug-in type (No. 176) fitting UX sockets. The three R.F. were used without change; but it was necessary to alter the oscillator coil, to comply with the following specifications (See Fig. 1).

Diameter of coils, 1½ inches; R.F. coils, 98-turn secondary of No. 28 D.S.C. wire (for .00035-mf. condensers) separated by ¼-inch from a 20-turn primary of No. 30 D.S.C. wire. The oscillator coil L6 has 50

turns of No. 28 enamelled wire on the grid (tuned) winding, for a .0005-mf. condenser; and 30 turns of the same wire on the plate. In each case, the top of the secondary coil goes to the grid, its bottom lead to "F-"; the top of the primary to "B+" and the lower end to the plate of the proper tube. The connections of the tube-base prongs are shown in Fig. 1.

While C6 is not of the same capacity as the others, it has the same cut of plates and frequency-variation characteristic; otherwise the dials would not track. Make all adjustments of the circuit at about 50 on both dials; tune in a broadcast station at about 325 meters, and adjust all tuning condensers until the signal is loudest. Take off or add windings to your tuning and oscillator coils until the dials match. After this, do not readjust C5 and C10, which tune the I.F. couplers; or the setting of the oscillator dial will be altered.

These stages may be very easily shielded, by the use of Pilot shielded condensers and



The R.F. coils must be suited to the condensers used. Those in the original set-up are as shown.

crs, who thought that the dowels illustrated were the forms. More turns, of course, would be needed on ½-inch forms than on the larger ones. The wire used was No. 36 S.S.C.; bunch-wound No. 36 enamelled wire coils would have served.

The first I.F. coil L4 has two resonated windings; one tuned by a fixed condenser C4 and one by a Variodenser C5; the illustration showed both components as variables, which might have been used. Only one winding of L5 is tuned in this manner.

I suggest that the constructor may find the construction shown here easier. Fig. 2 gives the details of two coil forms, and Fig. 3 the turns of wire and the connections for the two I.F. couplers. Fig. 4 shows dimensions for shields, which may be used. A shield should not be less than an inch from the windings, all around, and preferably separated further.

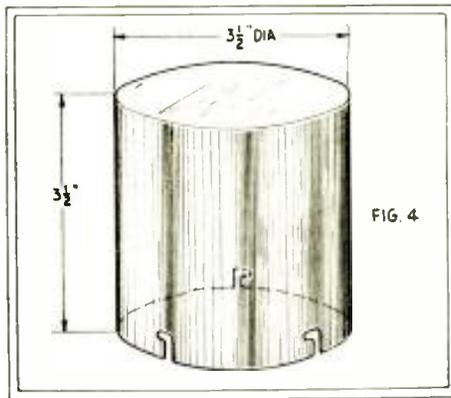
The writer has been asked by more than one correspondent if he could supply intermediate-frequency transformers. I cannot undertake to do this; but believe that these directions should enable anyone to make his own, or have them made for him by a local Service Man. Those described here will peak at about 1400 kilocycles. Some have suggested solenoid coils for the purpose; this is not impossible, but I do not recommend it.

I consider it preferable to buy R.F. chokes, rather than wind them. The commercial parts are just as cheap.

The bypass condensers C7, C8 and C11 may be larger than the 0.5-mf. value specified, if the constructor finds it more convenient to use the larger size. The grid leak condenser C13 is standard—.00025-mf.

The tubes used are '01As, except the oscillator V8, which is a '12A, and the power tube. For the latter, of course, a constructor may use any type he desires, or a push-pull stage; if the proper transformers and "B" supply, as well as grid bias, are provided. The set may also be electrified, by using a filament transformer with A.C. tubes, and suitable grid-bias resistors in the cathode returns. Follow the directions which come with the tubes.

Many readers have asked me: "Can I use the new two-volt tubes?" Yes! It is necessary—
(Continued on page 570)

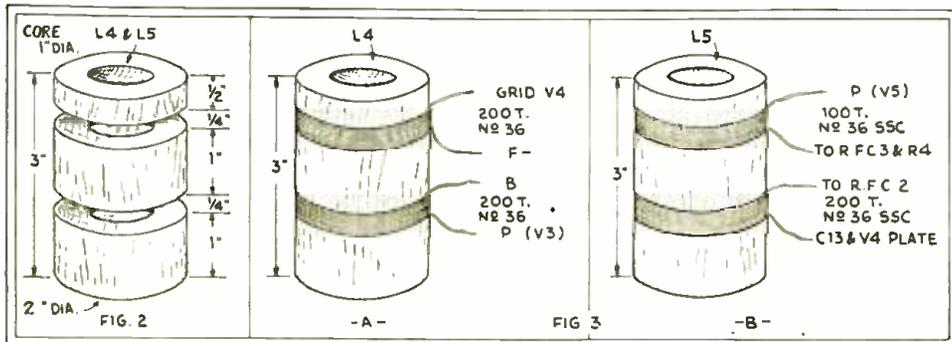


The I.F. coils must be shielded; the can dimensions given are the minimum for those illustrated below.

shielded coils, instead of using cans. The condensers shown in parallel with C1, C2 and C3 are, of course, the trimming condensers provided with the gang; these could be dispensed with, if the coils were sufficiently well matched.

Intermediate-Frequency Couplers

The I.F. coils described were bunch-wound, on a 1-inch form, and mounted on ½-inch dowels. This perplexed some read-



The intermediate transformers shown here are perhaps the easiest to make. These forms may be turned out of wood; or even paper spools might be used to give the same relative positions. The "B" of L4 actually leads to the grid of the oscillator V8; see the receiver diagram on page 286 of November, 1930, *RADIO-CRAFT*.

The Radio Craftsman's Own Page

What our experimental readers have found out for themselves

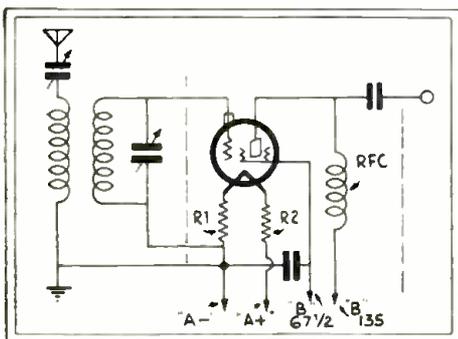
Letters concerning hookups asking further details, etc., should be addressed to the writers of these letters, directly

ANOTHER BOOSTER UNIT

Editor, RADIO-CRAFT:

In the November issue, Mr. Henning described his screen-grid "Better Booster;" I have had such good luck with one of a similar nature that I feel it should be passed along to the next fan.

I could not use the diagram as it appeared originally, because of local stations near by. Accordingly, I used a primary connected to aerial and ground in the regular manner, replacing the aerial condenser with a 7-plate variable. For wavetrap, I have a



A booster unit using a two-volt screen grid tube, ahead of an old regenerative circuit.

hundred feet of Litz wire in a loop, in series with the antenna; it is unnecessary to shield this. I bypassed the screen-grid lead to ground with an 0.25-mf. capacity, and placed one aluminum wing partition between the tube and the R. F. transformer and another between the booster and the old set—a Reinartz four-tuber (detector, single audio and a pair of push-pull '71As).

For the tube, I use one of the new screen-grid '32s, with filament resistors suitable for a 6-volt battery; R1, 25 ohms, R2, 30 ohms.

With this booster and set, I can pull in WTIC with plenty of volume at 7 p.m.; at noon WLW and KFI are my most distant points. I believe another stage of untuned R. F. ahead of this would bring them all in. I want to thank you for this article in RADIO-CRAFT, and hope you will have something even better in the near future.

R. J. BROYLES,
Amarillo, Texas.

(The sketch fails to show the Litz coil. As the resonance of the aerial is an important matter, in getting distance, this point will probably be of interest to many readers. We would like to have further particulars.—Editor.)

SECURES SUDDEN SELECTIVITY

Editor, RADIO-CRAFT:

I would like to tell you of my experience with the "Better Booster;" I built it as described, and used it with a Parmak seven-tube battery set. When I tried it out, I found great volume, but no selectivity. So I took a length of 1 1/4-inch tubing, 31 1/2 inches long, and wound 130 turns of No. 28 D.C.C. wire on it at one end, and 38 turns of the same wire, in the same direction, and in-

duced from the first. I then hooked the antenna to one end and grounded the other. When I tried it out, I found super-selectivity; I can separate Vancouver and Mexico City, supposedly on the same wavelength, and have brought in stations from Mexico to Alaska, and coast to coast. Without it, nothing but ordinary Pacific Coast reception.

ELMER WEBSTER,
Bend, Oregon.

(Mr. Webster does not give the connections he used; but it is quite possible that the same combination would not work for anyone else. No two locations and antennas are alike. It is a question of experimenting until the best results are obtained in your own location; which is helped by using variable condensers and coils.—Editor.)

A SHORT-WAVE TUNER

Editor, RADIO-CRAFT:

I have had such good luck with all A.C.-operated tuners that I thought I would pass one along for what it is worth. I have received WGY every day for months, held W3XAL for four hours twenty minutes, straight through; and the set has no body capacity whatever. I use the circuit shown, followed by two stages of transformer-coupled audio; the last a '45 tube with 250 volts on the plate. Have had W2XAF, W1XAZ, HKC, W9XAA, W3XAL, W9XAL, W8NK and VE9CF, with volume for dancing, and others with lesser strength.

C is a Hammarlund midjet; C1, .00012-mf.; C2, a Pilot 23-plate midjet; C3, .006-mf.; C4, C5 and C8, 0.25-mf.; C6 is .0001-mf. (C7 not given). R1 is 3 megohms; R2, 400 ohms; R3, 1/4-meg.; R4, 1 meg.; R5, 2000 ohms. L1 is a National high impedance choke; L2, L3 and L4 are short-wave R.F. chokes; and L represents Dresner plug-in coils.

I shall be glad to have your comment if any.

DAN McNEES,
666 Fulton Street, San Francisco, Calif.

(The first glimpse gives the idea that the circuit is standard; but it has special features. Care should be used in the choice of condensers; for there is 180 volts across the plates of C1.—Editor.)

UNINTENTIONAL SHORT-WAVE WORK

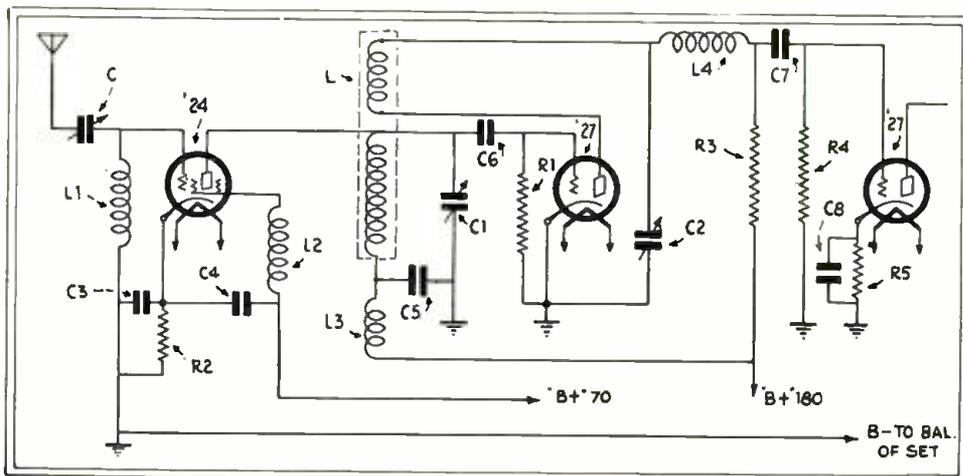
Editor, RADIO-CRAFT:

I had an ordinary three-circuit set using one C-11 tube in a cabinet. It wasn't working so "hot"; so I took it out and set it up on a breadboard, where it worked about the same. I changed the position of some of the parts, but (as I thought) left the wiring the same. I was surprised to find that I couldn't get WGY any longer, but could get code. By careful tuning, I later heard W2COJ at Irvington, N. J. Since then I have had about forty stations near here, and have been able to log some of them quite accurately.

When I changed the parts around, I had connected the aerial and ground to the secondary, and the condenser across the primary; this had the effect of lowering the wavelength to about 80 meters. This had a good result for me; I had never been interested in short-wave work, thinking it was too expensive; but when I first heard W2COJ as loud as WGY ever came in, I got the "bug." I now have a short-wave set made and will try it as soon as I get the batteries. It isn't much, but I will have a lot of fun trying it.

One morning before school I heard a station in Alabama, but couldn't get the call; a few minutes later I heard W1BCR, Providence, calling the fifth-district station which was CQing a few minutes before. I have heard a station in Iowa, Fairmount, W. Va., one in Detroit, one in Elgin, Ill., and many others nearer to me. I have heard

(Continued on page 571)



Here is a short-wave circuit, with a tuned-plate R.F. amplifier which, like the detector, is fed from an 180-volt tap. Some of the values differ slightly from the usual. C7 may be around .01-mf.

Band Selectors and Their Applications

With data for the construction of a band selector for a screen-grid A.C. receiver

By C. H. W. NASON

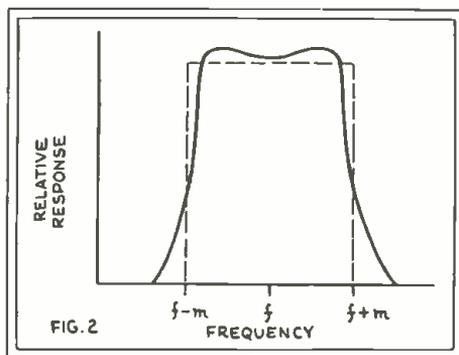
SINCE the earliest days of broadcasting, the bogey of sideband cutting has menaced every move toward better selectivity. The term "side-band cutting" refers to the fact that a modulated wave is considered as consisting of three components of the following nature: the carrier frequency minus the frequency of modulation (known as the lower sideband); the carrier frequency proper; and the carrier frequency plus the modulating frequency (termed the upper sideband). If this modulated wave is to pass through a tuned circuit without loss of the higher modulation-frequencies, the tuned circuit must be capable of responding simultaneously to all three of the components noted, at the highest frequency of modulation desired. In the case of broadcasting, this is 5,000 cycles; so that the tuned circuits must be capable of passing a band 10,000 cycles wide over the entire tuning range.

As an illustration of this point, refer to the response curve *a-a* in Fig. 1. Here we have an indication of how poorly a "low-loss" coil, having excellent gain at the carrier frequency, will fulfill the requirements of a high-quality system. Curve *b-b* in the same figure is that of a very poor coil; i.e., one with a high R.F. resistance. Here we have achieved excellent results, so far as we are concerned with the transmission of the side frequencies; but, in order to secure this result, we have sacrificed all traces of selectivity. The response for other stations, close to the frequency of the desired carrier, is too high. It is quite obvious that the ideal lies some where between the two. The dotted characteristic *e-e* represents the ideal and, presumably, unattainable response for a radio receiver. Here the transmission is one hundred per cent. for all desired frequencies and zero for all others.

The Band-Selector Curve

There is nothing new about band selection, since it carries us back to some of the earliest circuits known to the art. The fact exists that, if two identical circuits tuned to the same frequency are coupled together, their response will no longer be as shown in curve *a-a* of Fig. 1. They will react upon

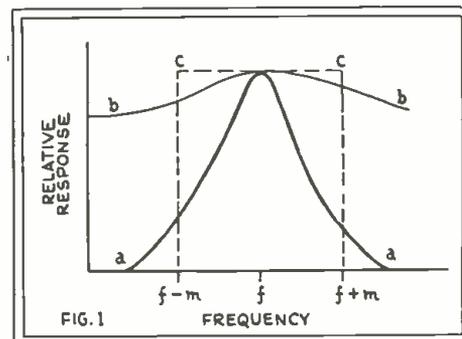
each other in such fashion as to produce a response-characteristic of the type indicated in Fig. 2. Comparing this curve (the heavy line) with the ideal (dotted line) superimposed upon it, we may readily see why band-selector circuits are attracting so much attention. The curve exhibits two peaks, equally removed from the resonant frequency of the two circuits. The distance between these two peaks and, consequently, the width of the band passed is a function of the coupling between the two circuits and of their radio-frequency resistance. The steepness of the slope away from the peaks—in other words the selectivity of the circuit with regard to adjacent broadcast channels—is determined by the R.F. resistance of the coils. It is essential that the coils employed be of "low-loss" nature, if the maximum approximation to the ideal response-curve is to be attained. The curve of Fig. 2 is that



The double-humped curve of a modern band-selector's signal acceptance comes very close to the lines of the ideal curve in Fig. 1.

of a system for which we will later write accurate specifications. Note again how closely this conforms to the ideal.

There are many methods by which we may couple two circuits but, with each method, we encounter a great many reasons for not doing it just that way. Radio is a compromise from start to finish; and we will attempt to crowd into this article just as many of the whys and wherefores as will fit into a non-technical discussion. Three common methods of coupling are shown in

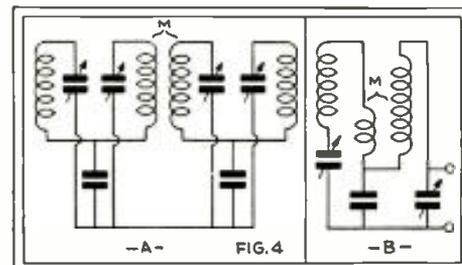
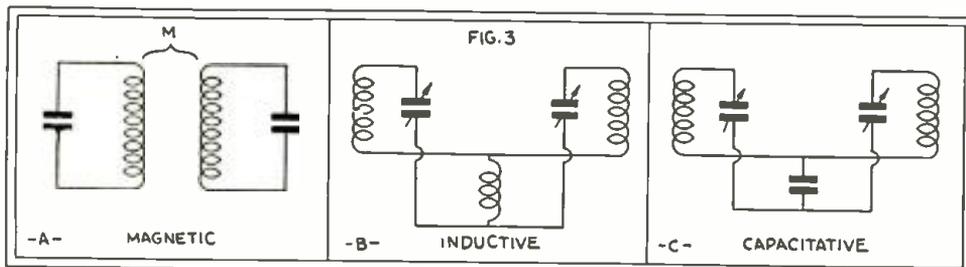


The selective curve *a-a*, showing sacrifice of sidebands, and that of broad tuning, *b-b*, where stations on each side ride in, are on opposite sides of the ideal *e-e*.

Fig. 3; in each of the three, the coupling represents an impedance common to both circuits. This "common impedance" is our old enemy who caused motorboating in resistance-coupled amplifiers, and who has now returned in a more friendly guise.

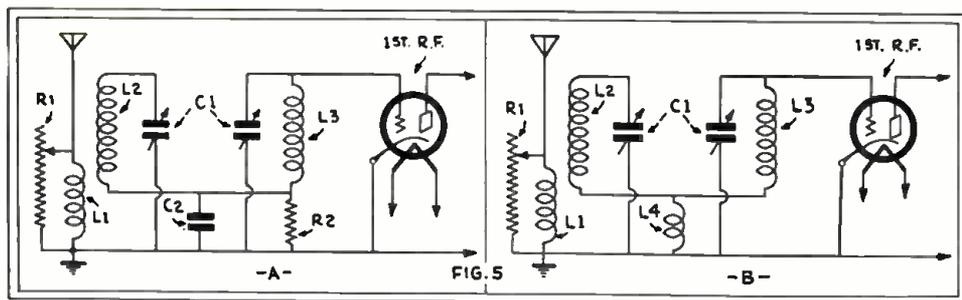
Choice of Coupling Methods

If by calculations we fix upon certain constants for a coupled-circuit system, to give a desired tuning range with a desired band width at some particular frequency, we shall find that our band width is not constant over the entire tuning range. The reason for this is fairly obvious; the impedance of the coupling varies with the frequency in such a fashion that, with capacitive coupling, the band will be widest at the low-frequency end of the scale while, with inductive coupling, the reverse is true. If we employ untuned R.F. transformers in our interstage circuits, and thus isolate the function of selectivity from the function of amplification (as in several commercial receivers) we can overcome this by employing four tuned circuits in a single coupled-circuit system employing differing methods of coupling, as shown in Fig. 4A. This circuit is admirably suited to the untuned transformers now on the market. Where we employ tuned interstage circuits, an arrangement of a complex nature, such as that shown in Fig. 4B, would accomplish equalization of the band width over the entire range.

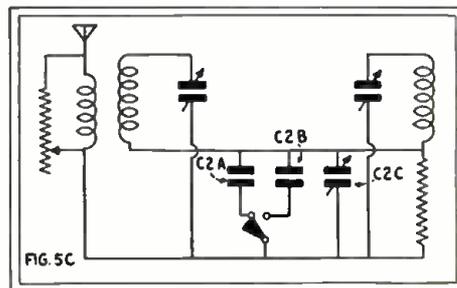


We have three types of band-pass coupling: A, where the mutual inductance governs the band's width; B, where the two circuits have series inductance in common; and C, where there is a series capacity in common. The characteristics of the three are explained in the text.

Left, an application of both mutual inductance and capacity, for coupling. Right, an interstage coupler to maintain uniform band width.



The two band-selectors shown above differ, in the method of coupling the tuned circuits: in A the capacity C2 is used, and the resistance R2 is necessary to furnish a grid bias. In B, coupling is inductive; constants for both designs are given.



For the purpose of maintaining a uniform width of band passed through the tuning range, the method shown above may be used.

The inherent qualities of R.F. circuits come to our rescue, however, and it is not necessary to go to such lengths. The radio-frequency resistance of an ordinary coil increases rapidly toward the high frequencies, with a consequent broadening of tuning at that end. If we employ capacitive coupling—with the desired band-width determined at the low-frequency end of the tuning range—the increasing resistance as the tuning is changed will serve to equalize the width of the tuning band.

In order to derive the full benefits accruing from the use of coupled-circuit systems, it is not essential to employ double circuits throughout our receiver. Normal circuits at several points in the receiver, together with a single coupled-circuit unit, will suffice to give the desired effect. The transmission-characteristics of band-selectors are such that the voltage at their output is but half that available at the input; and they, naturally, entail a considerable loss in gain. This fact brings us to another of the many compromises necessary in engineering practice. If we intend to use a single coupled circuit system or band-selector in our receiver, shall we place this circuit in the antenna stage ahead of the first tube, or in some other portion of the receiver? Remember that the over-all response of the receiver will not be affected by this choice. This is rather an unfair question; and the writer will answer it quickly, without asking for replies from his readers.

The sensitivity of a commercial receiver of today is far greater than that of receivers in general a few years ago. In their most sensitive condition the new receivers get right down into the incurable tube noise which is due to the motion of electrons in the first tube. For this reason, any measures for enhancing selectivity which tend to reduce the level of the available signal, at the grid of the first tube, are undesirable.

Cross-Talk and Beat Notes

It stands to reason that, if we are going in for a combination of selectivity and high quality, we must make certain concessions with regard to other factors in a receiver's performance; and a bit of sensitivity can be well sacrificed in the interests of finer reproduction. Although the factors of sensitivity and tube noise point to the inclusion of our band-selector circuit at some point following the first tube there are two sources of interference which have been given slight publicity in the press. These are "cross-talk" or cross-modulation, and "beat-note" interference.

When the screen-grid tube first appeared it was condemned as lacking in "selectivity." The truth of the matter is that the screen-grid tube is inherently more selective than its predecessors; but a lack of complete understanding on the part of designing engineers led us up many by-paths and blind alleys. Because of its high gain the screen-grid tube is prone to the effects of cross-modulation; that is to say, the voltage developed across the antenna by an exceedingly powerful local (though far removed in frequency from the desired signal) is often sufficient to operate the tube on an unfavorable portion of its characteristic curve, and thus allow the modulation of the interfering signal to become superimposed upon or to modulate the desired signal. The only way in which this type of interference can be done away with is by the use in the antenna stage of some sort of tuning circuit which will attenuate all undesired signals to a harmless level. In the band selector we find the answer to this problem. It is this cross-talk effect which rendered rapidly obsolete those receivers which achieved single control by means of an untuned antenna stage. In the case of the untuned antenna, unsought-for rectification caused harmonics to appear at most embarrassing points on the dial.

About the "beat-note" interference noted above, there is little to be said other than to refer the reader to the fact that two carriers producing an undesirably high voltage across the antenna will create two sets of beats, having frequencies respectively equal to the sum of the frequencies of the interfering carriers and to their difference. Thus, two carriers having frequencies of 900 kc. and of 550 kc. will produce beats at 350 and at 1450 kc. The latter will appear in the output of the receiver as a strong signal carrying the modulation of both original carriers intermingled.

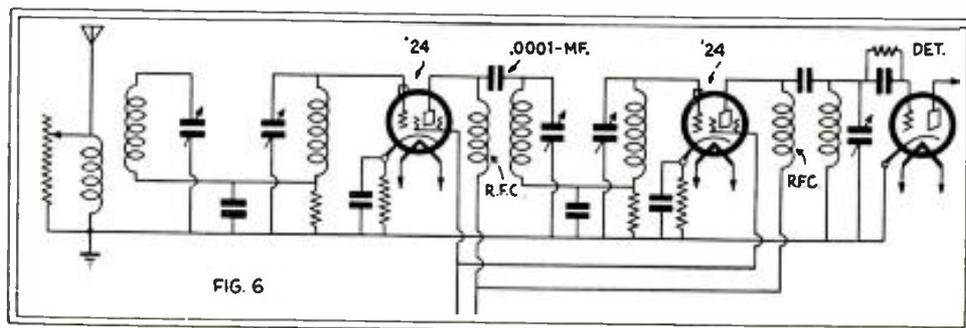
This effect occurs only when the voltage of the undesired signal is sufficient to operate the tube at a point where rectification can occur; and the trouble can be cured through the use of a band-selector circuit before the first tube. The argument, therefore, seems greatly in favor of the inclusion of the coupled-circuit system ahead of the first R.F. stage, except in locations far removed from broadcast stations and where sensitivity is the major consideration.

Design of Band Selector

The writer will specify two coupled-circuit systems for use in the antenna stage, and another for use in interstage coupling. Where the maximum quality is desired, and where a multiplicity of tuned circuits is not an undesirable feature, a total of five tuned circuits would enable us to employ both systems in conjunction with a normally-tuned detector input. This feature is not necessary, however, in locations where the interference is of a normal character. In writing specifications for the antenna coupling the writer asks your forbearance as far as explanations are concerned; for the antenna circuit is of an unusual nature, and this leaves an opening for another article devoted entirely to antenna-coupling systems.

In Figs. 5A and 5B there appear antenna tuning circuits, readily distinguished by the use of capacitive and inductive coupling. You will remember that we decided upon capacitive coupling because of the fact, that while the band-width decreased with the frequency, this decrease was compensated for by the increased apparent broadness, due to increase in the R.F. resistance of the coils, as we approach the high-frequency end of the tuning range. For educational purposes the specifications for inductive coupling also are included.

(Continued on page 561)



Here we have a diagram of an R.F. tuner, with band selectors for the aerial and interstage couplers. It is possible to substitute this in any receiver diagram where there are two R.F. stages. If preferred, the inductive coupling of Fig. 5B may be substituted in the antenna coupler.

The Hows and Whys of the Push-Pull Circuit

(PART III)

The push-pull circuit, it is generally known, gives more power than tubes in parallel; and it gives better quality. The reasons will be explained in a series of articles of which this is the third.

By EDGAR MESSING

SO far in this series, we have studied how and why tubes distort, and what happens to these distortions when tubes are connected in push-pull. Using simple equivalent diagrams, we found that the true signal outputs of these tubes complete their circuits by passing through the output transformer and the common filament connections. Distortion currents, caused by second-harmonic production, however, balance out in the output transformer and, in completing their circuits return to the tubes via the grid-biasing resistor. These conclusions, it must be pointed out, depend on the assumptions that the tubes had equal mutual conductances and that the input and output transformers are correctly center-tapped.

remarkable results; which few of the fans whom we have met have ever bothered to trace.

Since there is no signal current through the grid resistor of a push-pull circuit, no bypass condenser across it is required—a notable saving in commercial production. Some very curious things result when the bypass condenser is left out.

Effect of Harmonics on Grid Bias

We have seen that the even-harmonic distortion currents, in the course of their adventures, have gone through the biasing resistor. Let us recapitulate. The curves of Fig. 8 are self explanatory.

For simplest analysis we may consider that the distortion in the plate currents A

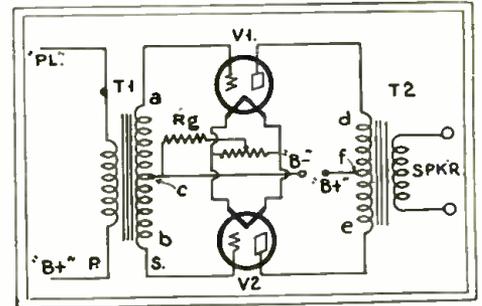
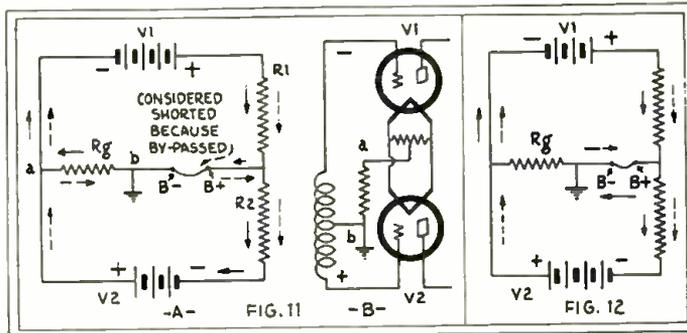


Fig. 1

The standard push-pull circuit; we shall see why it is advisable not to bypass Rg.

These circuits analyze the effect of unmatched tubes in a push pull stage. In Fig. 11, the stronger tube V1 sends its surplus of plate current component through Rg, building up a positive voltage which weakens the bias of V1 and strengthens that of V2. The effect in Fig. 12 is that when V2 is stronger,



Our path-tracing expedition through the push-pull circuit (in January RADIO-CRAFT) brought out one very interesting fact: that the true signal current—the undistorted component in the plate circuit—completes its path through the output transformer and the filament connections without going through the "C"—bias resistor. This apparently insignificant fact leads to some very

and B in the lower panels is not caused by tube action, but that each tube acts as a perfect amplifier with a distorted input signal. We analyze these signals A and B and find that tube V1 of Fig. 1 has impressed on it a voltage C representing the fundamental or true signal. This is equal and opposite to C, which is impressed on tube V2. At the same time, each tube has another voltage, simultaneously impressed; these last, the distortion voltages D and D1, are of equal magnitude and similar polarity. The currents produced by these distortion voltages, we find, add up and go through Rg.

Since Rg is not bypassed, there is across it a drop which acts *degeneratively* on the producing grid voltages. For example, if both grids are positive (second harmonic voltages)—the plate currents increase; which really means that the alternating component, introduced by the grid biasing voltages, aids the currents produced by the plate supply. This component then increases the biasing voltage drop across Rg.

The grid is thus made more negative, and this opposes the positive potential producing the distortion currents. (Such an effect is called "degeneration," as opposed to regeneration in which the voltage reimpressed on the grid aids the original.) Further, since the current through Rg consists of the currents through both tubes, the degenerative action is relatively strong. The re-

sult is that distortion components have tended to nullify themselves.

These effects are highly encouraging. We have eliminated a large condenser and, while so doing, have automatically converted a nuisance and a bogey—degeneration—into a benefit; in this manner exhibiting the true genius of engineering. But this is not all. That unbiased grid resistor not only provides a cure for natural troubles such as tube distortion, as we have just proven, but it also goes on to take care of extraneous faults that man in his foolishness may introduce.

Effect of Unmatched Tubes

The push-pull circuit seems to be a balanced affair. Distortion balances out; hum caused by A.C. operation of filaments, (a topic we will dispose of in a few words later), balances out; but there are, as we see, three places where unbalance may take place. It may be caused by an off-center tap on the input transformer; by tubes with different mutual conductances (which means tubes with different amplification factors but with equal plate impedances, or *vice versa*); or by an off-center tap on the output transformer or choke.

The most common of these cases is that of unbalanced tubes; rarely indeed do they have the same mutual conductance. But those gentlemen who insist that the salesman test twenty or thirty tubes, in order to match a pair, are wasting time. As we shall see.

Let us draw our equivalent instantaneous condition as in Fig. 11, wherein we consider tube V1 to have a higher mutual conductance than tube V2; which is the same as saying that V1 places a higher voltage across the load circuit than V2. Then V1 tends to produce the currents shown by the full lines, and V2 those shown by the dotted lines. (We are assuming, of course, that the output and input transformers are really center-tapped; which means, so far as our diagram is concerned, that R1 equals R2.)

As in the condition discussed in the previous installment, the currents through R1 and R2, the two halves of the transformer, add,

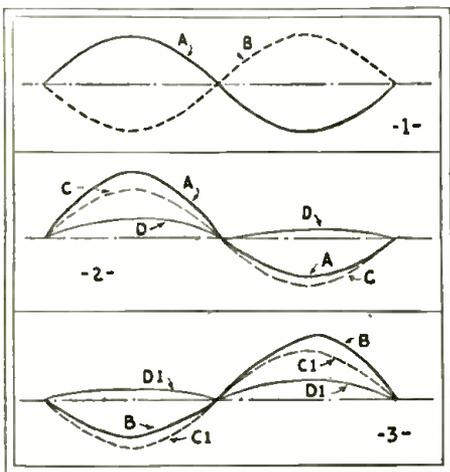


Fig. 8

In this diagram (redrawn) at 1 the grid inputs are A and B; in the lower figures, A and B are plate outputs, C-C1 the true signal, and D-D1 harmonic distortion components.

But the currents through R_g do not cancel out, because the current produced by V_1 is larger than that produced by V_2 . The current that does go through R_g is equal to the difference. Furthermore, the current through R_1 is greater than that through R_2 ; and it is equal to the current through R_2 plus the current through R_g .

Now, from Fig. 1, we see a negative potential on the grid of V_1 , by decreasing the plate current, will have the effect of sending through the output transformer a current opposed to that produced by the "B" battery. But V_2 , having a positive potential on its grid, has the opposite effect on its load. These are the conditions of Fig. 11; because the batteries indicated represent the equivalent voltage producing current bucking the "B" supply.

And, praises be to this noble circuit, the direction of the current component through

R_g is such that its ground side becomes more positive with respect to the cathode, tending to put a positive potential on V_2 and a negative potential on V_1 . In other words, V_1 is degenerated and does not amplify as much as it would if a bypass condenser were across R_g ; while V_2 is regenerated and amplifies more than it would have with R_g bypassed.

On the other hand, if the potential on the grid of V_1 had been positive, then the batteries in our equivalent circuit would have been reversed; and the unbalanced current through this arm would have been in the opposite direction. The end of R_g near the ground would have been made more negative; and the positive potential on V_1 would have been lessened, while the negative on V_2 would have been boosted.

If V_2 had the higher mutual conductance, the resulting situation would be as in Fig.

12; the dotted arrows, as before, showing the current produced by V_2 and the full arrows those produced by V_1 , under the conditions of a negative potential on the grid of V_1 and a positive potential on the grid of V_2 . The net current through R_g would produce a condition the reverse of that in Fig. 11; with the result that the voltage on the grid of V_2 would be opposed and that on the grid of V_1 would be aided.

So the tube with the greatest mutual conductance acts regeneratively so far as its partner is concerned and degeneratively with regard to itself. In other words, the push-pull circuit automatically compensates for its unbalanced tubes. This is a rather revolutionary statement for some of us, but absolutely true. The degree of compensation, unfortunately cannot be 100% for reasons that will appear in the next installment.

Finding Polarity in Transformer Windings

By VICTOR L. OSGOOD

AN audio transformer may be used as a coupling impedance with the screen-grid tube by connecting the primary and secondary in series so that their respective fields are aiding each other. The resulting impedance is a great many times higher than that of the primary alone and, consequently, allows advantage to be taken of the high amplifying qualities of the tube; thus saving the cost of a new impedance designed for this purpose, or of a resistor.

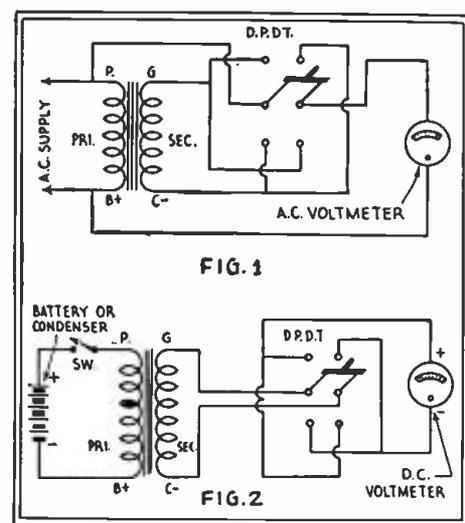
The cost of the latter is quite small if the grid-leak type is used, but the instability of resistor compounds in circuits where appreciable current is flowing is well known, as is also the cost of high-value wire-wound resistors; so that using the old audio transformers is a distinct saving, or trouble insurance, either way it is regarded.

It is very important that the primary and secondary be connected together with the proper polarity to get the right results; the method of determining which two of the four terminals should be connected together is described below. It requires the use of either an A.C. or D.C. voltmeter; but one of the two instruments is usually available to the set-builder.

Let us consider first the use of the A.C. meter. If it be the low-range type, used for measuring potentials on A.C. tube filaments, then the source of A.C. voltage may be the filament voltage on the power output tube. If the meter will read higher voltages, (up to 120) then the voltage source may be the 110-volt supply line.

Fig. 1 shows a D.P.D.T. switch used in the polarity determination; but, of course, this switch is not really necessary. It is shown merely for the sake of clearness in explanation. The experimenter may connect up the circuit, first one way and then the other, without the use of any switch at all.

With the switch, meter, transformer and voltage supply connected as shown, note the meter reading. Then throw the switch to the reverse position, and again note the reading. The higher of the two readings is the one obtained when the two windings are aiding; and the two transformer terminals that are then connected together



The two methods shown above may be used to determine the proper connections of transformer windings so that they will be in "series aiding." The choice depends on the meter used.

through the switch are to be permanently connected together. Use "B+" and the one remaining terminal for the two impedance connections.

Use of a D.C. Meter

The procedure is different if the meter be the D.C. type. A source of D.C. voltage which may either be a 4.5-volt "C" battery or a 1-microfarad condenser, is then required. The condenser may be charged from the detector "B+" supply and must be used before this charge has had time to leak off.

Connect the several parts as shown in Fig. 2 (remembering that the switches are not indispensable; because the leads may merely be twisted together temporarily for the test). Leave the primary circuit open until ready for the test. With the D.P.D.T. switch in one position, close the primary switch, keeping your eye on the needle of the meter. If the deflection of the needle (which will be only a momentary flick) is in the positive direction on the scale, the test is completed; if it be negative, throw the D.P.D.T. switch to the opposite position and again close the primary switch. Pay no attention to the needle movements when the

primary switch is opened; as you are likely to become confused in the test.

When the meter reads positive on the closing of the primary switch, connect the primary terminal marked "P" to that secondary terminal which is connected (through the D.P.D.T. switch) to the negative side of the meter. The two windings are now in series and aiding.

As a matter of precaution, it is well to warn the reader against leaving the primary switch closed when a battery is used, even though the drain is pretty small. But there is no need of allowing the current to flow; and so, as soon as the direction of needle deflection is noted, open the primary switch again.

If a charged condenser is used, this precaution is unnecessary, because the condenser discharges immediately anyway. A condenser larger than one microfarad may be used when the battery is not available; but it is not advisable to go down to smaller capacities, since oscillatory conditions become more troublesome and less energy is available for operating the needle.

WINDING TUBE-BASE COILS

By Nels Sahli

THIS is just another coil-winding jig; but it is handy for tube-base coils, and is so cheap and simple that it should help short-wave experimenters.

First, obtain a cushion socket that will hold the prongs of the tube base firmly.

(Continued on page 568)

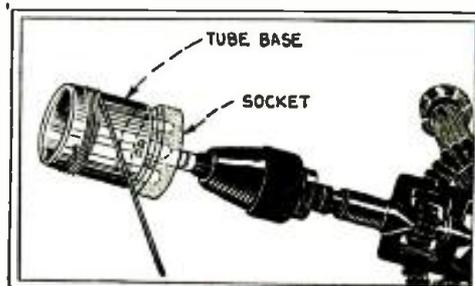


Fig. 3

The simple device shown, with a hand-drill, provides a simple winder for tube-base coils, much in favor for short-wave experiments.

Mutual Conductance and Its Associates

An introduction to Mr. and Mrs. Mho and all the little Micro-mhos, with some comment on the respective merits of tubes

By C. P. MASON

WHAT is the most unfamiliar word in the radio vocabulary? It would seem that the prize should be awarded to "Micromho," to judge from the difficulty which most people find in getting it straight. The micromho, it will be observed, is found in a list of tube characteristics, and has no other habitat.

"Well, Mr. Bones, what is a micromho?" "A micromho, Mr. Interlocutor, is a megohm which has changed its name, to keep from being caught and chopped into decimal fractions."

Cutting the comedy at this point, our readers may be interested in an explanation of the mho and the micromho, as a preface to a few remarks about vacuum tubes and their action.

Conductance or Resistance?

In ordinary radio computation, it is usual to talk only of the *resistance* of an electrical conductor. Some of our readers have protested against "taking the *resistance* out of radio;" but conductance seems to have no friends except in the tube tables. Yet conductivity is the most essential property of any electrical circuit.

We say that a wire has a resistance of one ohm, if one ampere of current flowing through it causes a potential difference of one volt between its ends. As the textbooks say:

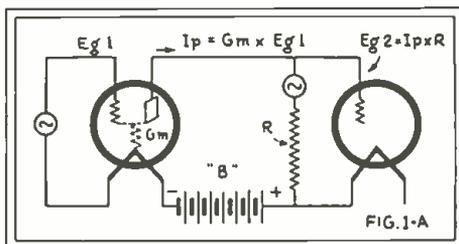
$$R = \frac{E}{I}$$

But, if we look at the matter in another way, a wire must have the property of conducting current, as well as that of resisting it. We use copper, instead of quartz, for

leads because (among other reasons) copper conducts an electrical current with the minimum of loss. And the case may be stated by saying that a wire has an internal *conductance* of one MHO if a potential difference of a volt across its ends causes a current of one ampere to flow through it. (The *mho*, you have probably guessed, is simply *ohm* spelled backward.) If we turn Ohm's law into Mho's Law, it will read:

$$G = \frac{I}{E}$$

That is, the conductance (G) equals the current in amperes divided by the voltage. The value of the conductance is always equal numerically to 1 divided by the resistance, and *vice versa*: so that multiplying by the conductance is the same thing as dividing by the resistance. ($G \times R = 1 = E/R$.)



The tube is a device to cause a large current to flow on the application of a small voltage. The property which enables it to do so is the "mutual conductance" created by its three elements.

By simple arithmetic, we shall find that one megohm (1,000,000 ohms) corresponds to one micromho (1/1,000,000 of a mho.) One volt of electrical pressure will force a current of one microampere (1/1,000,000 of an ampere) through either.

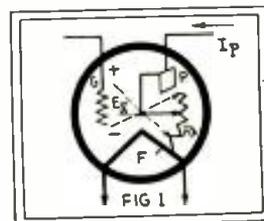
Conductance of a Tube

While a vacuum tube is a device more complicated electrically than it seems from the outside, we may simplify the discussion of its nature by considering it for a moment merely as a resistance connected between the filament and the plate leads. This resistance is not uniform: it varies with the applied voltage on the plate; and it varies also with the voltage applied to the grid; which is here acting something like the arm of a rheostat to turn in or out additional plate resistance. (Fig. 1.)

But, having set our tube to a certain plate resistance by the use of the proper direct voltages on grid and plate, if we apply an alternating-current or signal voltage to the grid, the arm of our electrical rheostat swings up and down; increasing the plate resistance and decreasing it, alternately. When the resistance is decreased, more current flows through the tube's output circuit from the "B" supply; just as when the resistance is increased, less current flows. The result is, that there is created in the plate current a pulsating component which we

can separate (say, by a transformer) in the form of an alternating current. This, if we have chosen the right values for an amplifying circuit, will create an output voltage which corresponds almost exactly in its

The grid voltage may be considered as working the arm of a rheostat connected between the filament and plate of a tube and, accordingly, changing the plate current at every swing of the signal.



"shape" to the input voltage applied to the grid, but is much greater in value.

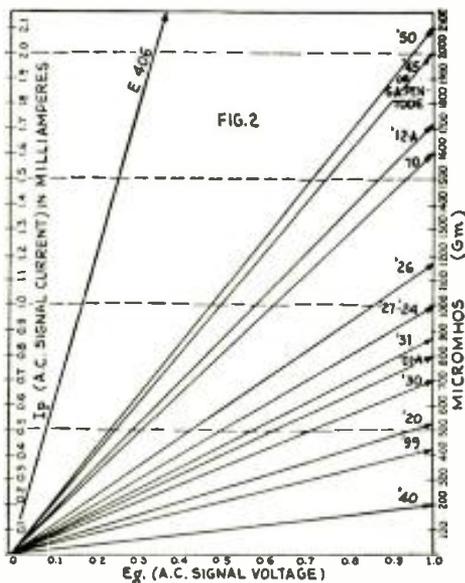
Considering the tube, therefore, only as a resistance in its plate circuit, we find that it has a value in ohms which may be determined from the voltage applied and the current passed. But, when we consider the tube as a unit, in which alternating-current flow in its plate circuit is produced by alternating voltages on its grid, we are coming around to the idea of conductivity rather than resistivity.

If an A.C. voltage is applied to the ends of a metallic resistor, we measure the conductance of the latter by the current that flows through it. If an input A.C. signal of the effective value of one volt should produce an effective A.C. output of one ampere from a tube, we would be justified in saying that, from this standpoint, the tube has a conductance of one mho. If the same input produced an effective A.C. output of only one microampere, we would rate the tube at one micromho instead.

Neither unit, however, gives a very practical value for ordinary radio receiving tubes. Practically all such tubes have a conductance between 400 and 2000 micromhos; as will be seen from Figs. 2 and 3.

The higher the conductance (called mutual because we must take into consideration the interaction between input and output circuits), the steeper the slope of plate current against grid voltage (Fig. 2). The number of microamperes change in the plate current corresponding to a change of one volt on the grid gives the rating of the tube's mutual conductance in micromhos. (Our British cousins make up for their extra trouble in spelling such words as labour with additional letters, by rating their tubes simply according to the "slope." This, as the diagram indicates, is simple and quite as satisfactory for most purposes.)

It is customary to say that a tube's "Gm," or mutual conductance, is equal to its voltage-amplification factor, or "mu," divided by the A.C. plate resistance (Rp). However, the answer, found in this manner from a table of tube characteristics, would be in mhos; and it is easier to avoid fractions by first multiplying the "mu" by one million. The answer is then in micromhos; and a



While the mutual-conductance characteristic is really a curve of varying slope, the lines here are drawn straight for the purpose of comparing various tube types. The highest is that of a European tube not available here.



The heavy lines at the right are the ratios between the heavy lines at the left and their associated shaded lines. The shaded lines at the right show plate current, and the mutual conductances must be interpreted with due regard to these.

result of 1750 micromhos is easier to handle, and looks bigger than .00175-mho, though it is the same thing. Either means that an alternating potential of one volt on the grid produces an pulsation of 1.75 milliamperes (alternating) in the plate current.

(It is necessary to recall that an alternating voltage differs from a direct voltage; in passing through a series of values, the effective value of which is only .707 times the highest voltage reached. In other words, an alternating voltage of 1.0 reaches the points of 1.414 volts positive and 1.414 volts negative during each cycle.)

Advantages of High Gm

The leading textbook on vacuum tubes, written ten years ago, covered their principles so thoroughly that it is still a classic. The author of "Thermionic Vacuum Tubes," I. H. J. van der Bijl, observes broadly: "It is always desirable to have the mutual conductance as high as possible." With the usual number of reservations, this is true; but there are several reasons why the owner of a set wired for '99s should not dash out and buy '50s to replace them.

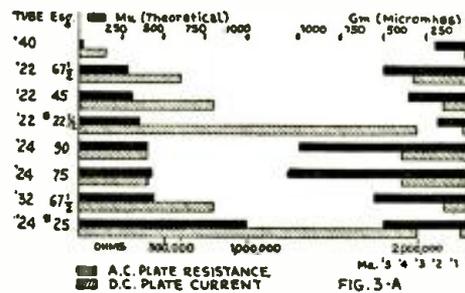
Yet, as between two tubes, of comparable character, the fact that one has a higher mutual conductance than the other means that it gives a higher current output from the same signal. The drawback in using the tube of higher conductance may be financial (as with the '50; although '10s have been used liberally for the R.F. receiving amplifiers by communication companies to whom smooth, reliable working was a matter of dollars) or, on the other hand, it may be electrical (as in a circuit where the tube of high mutual conductance will oscillate when it is not intended to do so).

Fig. 3 shows graphically the average characteristics of the principal receiving tubes, and their outstanding characteristics at different plate voltages (when the grid voltages are those specified by the makers for the corresponding plate voltages. For other combinations, it will be necessary to consult the curves issued by the tube manufacturers.) It will be seen that, the higher

the plate voltage used on a given tube, the greater the mutual conductance; and, therefore, the greater will be the useful variation or signal in the plate current.

The less the resistance of the tube, also, the greater the plate current for any given voltage; but it must be remembered that the vacuum tube is only part of the circuit. Unless the tube is in the last stage, so that its output passes through the windings of a reproducer, it will be necessary to convert the variation of the plate current into a voltage fluctuation which may be applied to the grid circuit of another tube as its input signal.

Therefore, we must put between the tube and its plate supply an impedance or a resistance; and this alters the characteristics of the circuit and, thereby, the effective mutual conductance of the tube. This is especially noticeable in the case of the screen-grid tubes of Fig. 3A. Their internal resistance is so enormous (it is necessary to show this on a different scale) that it is a good deal of a problem to utilize their voltage amplification with any degree of efficiency.



* Special A.F. connection.

The screen-grid tubes have characteristics so different from those of the three-element tubes that the scale is altered here. The low mutual conductances require high-impedance plate circuits.

High Amplification

A tube of high mutual conductance is a good amplifier—in its own class. Now we have screen-grid tubes which, with low mutual conductance, give high amplification in special circuits. The problem is the conversion of the output signal current into the maximum voltage which can be saved for application to the grid of the next tube. To do this, the output circuit must contain impedance, or resistance, which is in the same order as that of the screen-grid tube.

It must be remarked that, after all, high mutual conductance does not take the place of high voltage amplification. Modern circuits, in these days of automatic volume controls, tone controls, untuned antennas, and other sources of loss, must have a considerable margin of amplification in reserve.

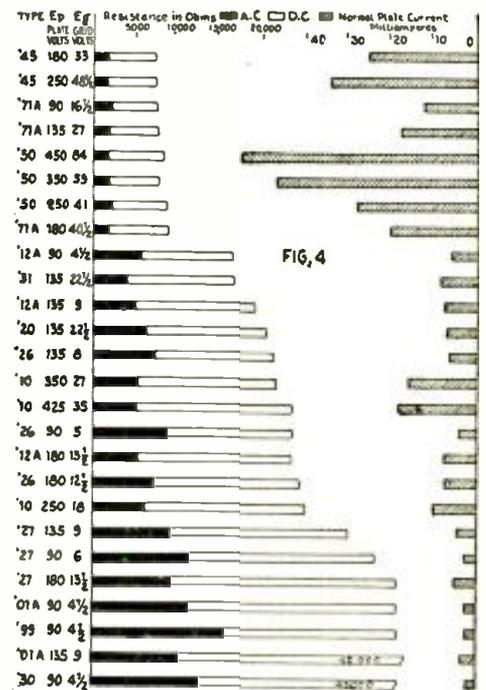
But, as between tubes of similar amplification factor ("mu"), the higher mutual conductance is a sign of superiority; as when the '12A is compared with the '01A, or the '24 with the '22. The only point is that the tube of higher mutual conductance also draws more plate current; and this is a point which must still be considered in battery operation. Yet, as the diagrams shown, the latest tubes are of better characteristics than the older types, some of which are already practically obsolete.

Low A.C. Resistance

In connection with the facts just remarked upon, it is necessary to comment again upon the fact that a tube is much more complicated than it seems at first sight. Between the filament and the plate, there is not a simple resistance, such as we find in a grid leak. There is a space in which electrons are moving at high velocity through a "hard" vacuum; and each electron is carrying with it a magnetic field. There are electrons forming a "space charge," that is to say, they are loafing along the first-base line, getting in the way of the runners. There is not a uniform potential on the filament, in the case of a direct-heating tube. The rate at which electrons boil out of the cathode or filament affects the "dynamic" characteristics of the tube. For these and other reasons, tubes have curves—not straight lines—for "characteristics," as any article on tubes will show; but the problem in amplification (as opposed to detection) is to find the point on the characteristic where the line is most nearly straight. The curves, in the tube's characteristic, mean distortion in the output.

It will be noticed that Fig. 4 shows the D.C. plate resistance, as well as the A.C. plate resistance; it is the latter which figures in tube tables, and in the computation of mutual conductance. The D.C. plate resistance, for our purpose, is taken as the resistance through which the given plate voltage will force a current equal to that drawn by the tube, at the specified plate and grid voltages.

For instance, it will be seen that the '01A tube passes 3 milliamperes when it has 135 volts on the plate and 9 volts negative bias on the grid; a 45,000-ohm resistor would do the same. But, at the voltages given, the A.C. resistance of the tube is only (Continued on page 569)



The grid voltages are so adjusted to the plate voltages that tubes are very sensitive to signal variations. The ratio of the solid lines to the lighter ones is an index of economy.



SPECIAL NOTICE TO CORRESPONDENTS: Ask as many questions as you like, but please observe these rules:

Furnish sufficient information, and draw a careful diagram when needed, to explain your meaning; use only one side of the paper. List each question.
 Those questions which are found to represent the greatest general interest will be published here, to the extent that space permits. At least five weeks must elapse between the receipt of a question and the appearance of its answer here.
 Replies, magazines, etc., cannot be sent C. O. D.
 Inquiries can be answered by mail only when accompanied by 25 cents (stamps) for each separate question. Other inquiries should be marked "For Publication," to avoid misunderstanding.

AIREX "ABC" ELIMINATOR

(108) Mr. J. E. Veigh, Dolhs Ferry, N. Y.

(Q.) I have an Airex "ABC" eliminator, from which the leads have been removed. The power transformer is not marked, and I find it almost impossible to determine the original connections in this unit. Please show the wiring diagram, and any additional available data on the connections, in the Information Bureau.

(A.) The schematic circuit of the Airex "ABC" eliminator is shown in Fig. Q108 at A, and the connections of the Earl power transformer, used in this unit, in the same figure at B.

It will be noted that the "A" portion of this eliminator will operate the filaments of the average all-electric set. Of course, the indicated voltages are alternating and not direct-current.

If any further difficulty is encountered in connecting up this eliminator, the trouble should readily be located by testing the circuits with an accurate voltmeter.

"IMPERFECT CONTACT" PHONO. PICK-UP

(109) Mr. Albert A. Pietro, Battle Creek, Mich.

(Q.) Is it possible for me to use my "Model L" phonograph pick-up for home recording as described in the December, 1930, issue of RADIO-CRAFT? I note in this story that an electromagnetic pick-up is used. My unit is a Bristolphone, made by the Bristol Recording Co., and operates on the principle of the carbon microphone. Would there be any danger to the pick-up, using it in this manner?

(A.) The Bristol "Model L" phonograph pick-up cannot be used reversibly, as the standard electromagnetic pick-ups can. That is, it cannot be

"driven" by the audio output of the associated power amplifier.

However this unit is very sensitive, operates like a regular carbon-button microphone, and is capable of many interesting tricks in the hands of the experimenter.

For instance, Fig. Q109A illustrates the manner in which the pick-up may be "worked" directly into the voice-coil of a dynamic reproducer. The milliammeter MA indicates the current in the circuit; which should not exceed 6 or 8 milliamps, in most instances.

This pick-up, which is nothing but a carbon-button microphone, is classed technically as an "imperfect-contact" device.

To obtain more perfect matching between some voice coils and this pick-up, it may be desirable to use a matching transformer; the connections are shown in Fig. Q109B. Reversing the connections to the 4½-volt battery may improve the operation of the unit; also, changing the tap on the battery may help.

OPEN BY-PASS CONDENSERS

(110) Mr. P. T. Faulkner, Muskogee, Okla.

(Q.) Most descriptions of test apparatus tell how to determine whether a filter condenser in sizes down to ½-mf., is open, shorted, or leaky; but there

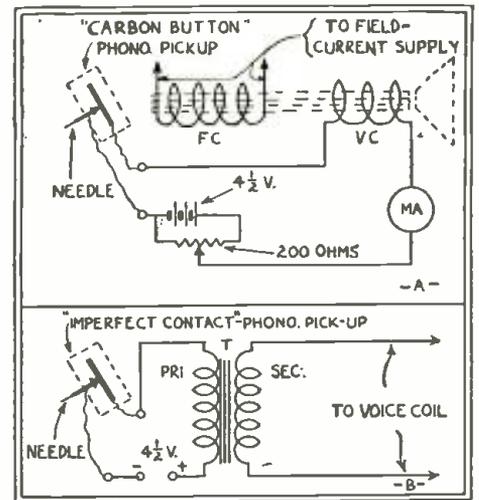


Fig. Q.109

The Bristol pick-up is of the microphone type, not magnetic. "Imperfect" relates to the principle only, not the design.

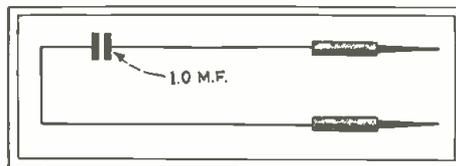


Fig. Q.110

A handy tester for condensers open internally.

does not seem to be any simple test for determining whether the smaller by-pass condensers are open; a short, of course, is obvious. Is there a simple test which will disclose an open in by-pass condensers of small size?

(A.) In Fig. Q110 is shown a simple arrangement, of two test prods and a fixed condenser, which is used in many service stations to isolate the cause of hum, circuit oscillation, broad tuning, weak reception, noisy operation, and other faults. If placed in shunt across an open by-pass condenser, it will usually cause the circuit to function more nearly normal; and thus indicate that the fixed condenser, across which it is shunted, is open.

This condenser should be of high voltage-test rating, to preclude the possibility of its breaking down on high-voltage circuits.

SERVICING VICTOR RADIOS

(111) Mr. Byron G. Lindquist, Akron, Ohio:

(Q.1) What is the explanation for an increase in signal volume when the ground wire is disconnected from a Victor T.R.F. set? Aerial and ground have been inspected, and both seem to be in perfect condition; all tubes test up to par.

(A.) When the ground wire is removed from a radio set, the chassis no longer serves as a radio-frequency shield since it is ungrounded. Regeneration now takes place in the circuit, thus causing increased sensitivity; and perhaps the circuit may become so highly regenerative as to slip easily into

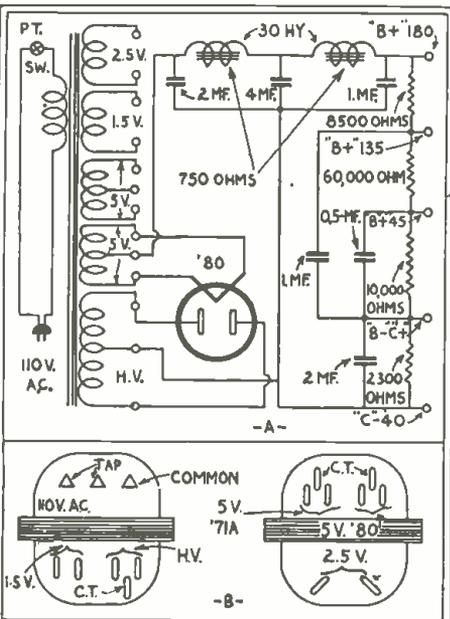


Fig. Q.108

Connections of the "Airex ABC" eliminator; and detail (below) of the power transformer used.

MICROPHONE — MICROPHONE TRANSFORMER

(112) Mr. Calvin Bostwick, Elgin, Ill.:

(Q.1) Are there any convenient corrective measures that may be applied to packed carbon-button microphones? The one in question is noisy and, though sensitive, it is difficult to keep at the best operating point.

(A.1) If buttons become packed because of moisture, or long standing in one position, it will often be possible to loosen the carbon granules by

(Continued on page 572)

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Operating Notes for Service Men

(Continued from page 521)



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Of the two, the first method is best; as this will not cause delay of several minutes in starting because of the lower filament or heater voltage.

In this set, bias is obtained by means of a resistor of 1500 ohms value, connected from the center tap of the '22 winding to negative or chassis. This resistor should be used to obtain bias for the '24 by connecting it from cathode to chassis; the center tap is then connected to chassis. If the '27 filament winding is used for heater voltage, the center tap of the winding already is connected to negative. The '22 filament leads from the power transformer are colored blue, the center tap white.

When the voltages are too low, it is not detrimental to place the fuse in the 110-volt position; for, even though the line-voltage is 125, the filament voltages on the tubes will be only normal. If the '27 filament winding is used for the '24 also, the blue filament leads intended for the '22 should be well taped and isolated from one another. The plate and screen-grid voltage leads are connected in the usual manner without any change. The increased sensitivity and almost humless reception resulting from this rewiring will pay for the time and trouble spent.

Replacements and Changes

Noisy and unstable operation in the Colonial "32AC" receiver has often been traced to a defective carbon resistor (orange-colored) connected from one terminal of the Mershon condenser to the audio transformer. The only remedy is replacement; when this is done, it is good policy to tighten terminal nuts and resolder the connections on the Mershon condenser. On this same set, when it is necessary to switch the phono-radio switch to "phono" on radio reception in order to obtain more volume and clear reproduction, it is a sign of an open detector-cathode biasing resistor.

The new Zenith "10.A.C." makes use of a three-point switch for proper antenna setting. On the first lot shipped out, an inferior component is the cause of intermittent and noisy reception. A new type of switch is now being used; and it is advisable to make the change to prevent possible future service calls.

On the Zenith "12 A.C." an ordinary toggle switch is used for an antenna switch, shorting or placing into the aerial circuit a condenser of approximately .00025-mf. capacity. This switch is often the cause of noisy and fading reception, when it becomes defective with use. Remedy is replacement. The defect can easily be found by moving the switch arm slightly, without throwing it over.

Very often, it becomes necessary to remove the Radiola "30A" chassis from its cabinet. When this is done, all cables and connections must be disconnected from the tuner chassis. Many Service Men, when placing the chassis back into the cabinet, do not hook up the antenna coupler properly. This coil has three secondary leads which connect to the terminal strip on the

catacomb. The black lead connects to No. 9 terminal (counting from right to left, as you face the rear of the set). The two black and green leads are connected to Nos. 6 and 7, respectively; these two may be interchanged. Lack of sensitivity and off-scale tuning will result from a mistake in replacing the coupler wires.

Complaints of fading on this model always gave a great deal of trouble, until all joints and connections were re-soldered and heated. Most frequently, however, the trouble can be traced directly to the multi-tapped voltage divider in the pack. Re-heating and sweating all soldered connections to this resistor will clear up the trouble. Symptoms of this defect are fluctuating voltages.

The automatic phonograph motor switch on Radiola and Victor combinations are

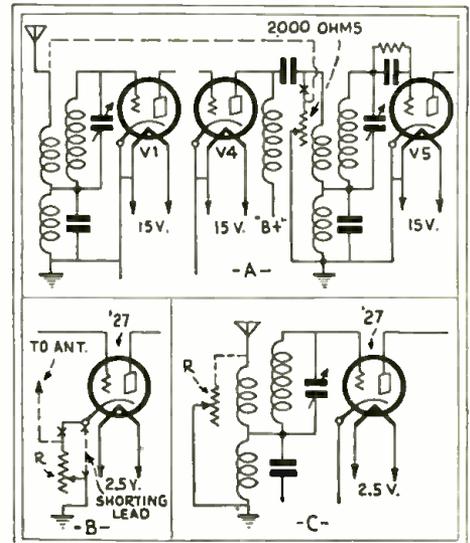
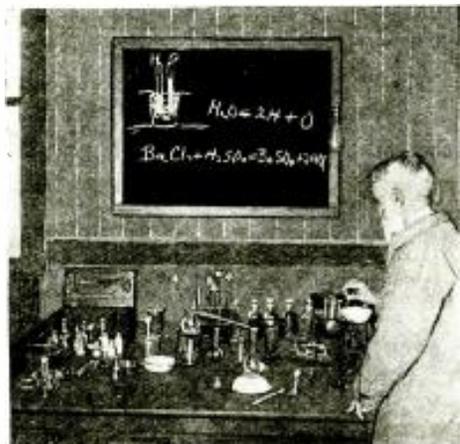


Fig. 4

Above, volume control in 15-volt Sonora "144" models, which may be connected across aerial; B and C, 2½-volt models before and after change.

often the cause of much labor and wasteful effort. Usually, the trouble lies in either premature tripping or failure of the switch to function. Referring to the illustration (Fig. 3) it can be seen that the surfaces at "X" must be squared; or we will have premature tripping. With use, these surfaces become rounded, or the latch spring loses its tension; all of which will cause this trouble. A small file diligently used, and increasing the tension of spring "F," will be the remedy. When the switch does not function, it is best to determine whether the contact springs within the switch have not lost their tension or that the contacts are corroded. The switch should be adjusted so that there is at least 1/16-inch clearance between the switch-cam lever and the latch-plate cam (this clearance point is denoted by "E"). This is done by loosening the screws "D" and "G," so that the switch mechanism can be adjusted. The screws should then be tightened. Failure of the switch to trip is caused usually by weakening of the latch-plate spring "O." If the teeth on the latch plate become worn, the same trouble may result. A file that is sharp, and small enough



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Service Men's Notes

(Continued from page 522)

one to the other permits a comparison of tone. All of the receivers to be compared must, of course, be "on" and tuned to the same station before starting the test.

I find the use of Carter "Imp" or Yaxley "Pup" jacks and plugs is more convenient than that of a standard inductance switch; because the former permit one to make a jump directly to any receiver desired. The indoor-outdoor taps are also handy.

WHERE LOCALS ARE WEAKER

By J. J. Brewster

SOME "Model 15" Brunswicks have for a volume control, a coupling condenser across the second variable condenser. On loud signals, this control will not cut down the signal sufficiently; and, when the receiver is switched to "local," the volume is insufficient.

The "local-distance" switch shown in Fig. 3A does not employ the usual arrangement; practically no signal can be received on the local side, unless within a hundred miles

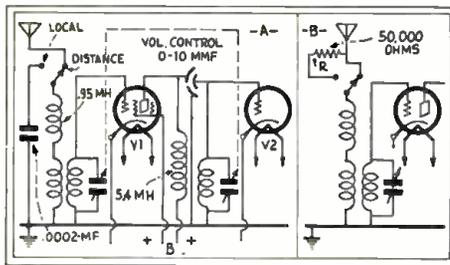


Fig. 5

Some sets cut out the aerial for "local" reception; where locals are less overpowering, the connection may be altered as shown at the right.

of a powerful transmitter. I have accordingly changed the system to that shown in Fig. B, and the "local" switch makes reception powerful enough to listen to locals without excessive volume. It is evident that this model was designed for locations in cities where there are several high-power locals. (See Data Sheet No. 38, on page 525.—Editor.)

PHILCO "95" DETECTORS

By Arch L. Campbell

SERVICE MEN would do well to make a note that, according to the factory's service manual, there is not supposed to be any "B" voltage on the plate of the first detector in the Philco "Screen-Grid Plus, Model 95" chassis. Since this would cause trouble unnecessarily if it were overlooked, I thought it well to call attention to this fact.

(The expression "first detector" is almost inseparately associated with superheterodynes; but, in the model mentioned, there are two 27 tubes, with the plate and grid of the first connected directly to the grid of the second. The manual quoted explains: "the first is the detector proper, which simply acts as a rectifier; it is not an amplifier. The second is the detector amplifier; the work is divided so that the first tube does the rectifying and the second tube does the amplifying." The first of these tubes, also, serves as an automatic volume control. The circuit of the set described is shown in Data Sheet No. 37, on page 524.—Editor.)

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starting position. On the other hand, if the space is too short to allow the selector mechanism to operate, the two dashes will be run into one, and the shaft will fly back after a total of five seconds dash. Thus, an allowance of nearly one second each way is made in the permissible length of the space; which can be anything less than two seconds and more than about a fifth of a second.

Dash No. 3, of the correct length, separated by the proper space (both within the allowances mentioned above), will cause the shaft to advance one more tooth (making three teeth in all) and, at the termination of this dash, the ringing circuit will be completed by the contact known as "Z." If the last dash exceeds 5 seconds, the ringing circuit cannot be completed, because the pawl will have been drawn back before the dash is finished.

The Automatic Alarm

The action of the ringing circuit is as follows: when the shaft has advanced three teeth, the "Z" contact is closed; this is in series with a "hold-on" relay and the connection made by the tongue of the main relay when it touches its front stop. When both the "Z" contact and the front-stop contact are closed, the hold-on relay is energized and, once it closes, it will not open again.

The "Z" contact is closed as soon as the third dash has lasted three seconds, but

the contact of tongue and front stop is not made until dash No. 3 ends; and, therefore, the bells ring only on the completion of dash No. 3, if this is of the proper length.

When dash No. 3 has lasted three seconds, the shaft is moved for the third time, and the "Z" contact is closed. But the tongue of the relay is away from the front stop, so that no current will flow through the ringing circuit until the tongue of the main relay returns to its front stop; which will take place on the termination of dash No. 3. If this carries on over the limit of five seconds, the shaft will have returned to its starting position because the re-setting magnet has been energized on the closing of the "C" contact; and there will then be no continuity through the ringing circuit because the shaft has returned to its starting position, and the "Z" contact is open.

The hold-on relay contact is in parallel with the combination of the "Z" contact and the tongue of the relay against the front stop. Once it has been closed, these two contacts are short-circuited, and the bells will go on ringing.

The arrangement of the bell-ringing circuit is as follows: three bells are set up; No. 1 on the ship's bridge, No. 2 in the radio office, and No. 3 in the operator's cabin. As it is undesirable that the bell on the bridge shall ring when the auto-alarm is being tested, there is arranged on the selector a push button which, while it is held in, switches off No. 1 bell; this is called the "bridge bell key."

Band-Selector Applications

(Continued from page 517)

The antenna coupling coil L1 is a small wooden hobbin to fit inside 1 1/4-in. bakelite tubing. It has a 3/16-inch slot wound with 200 turns of No. 36 double-silk-covered wire, over a 1/2-inch core.

As to L2 and L3, the tuning inductances (L1 is placed inside low potential—or ground—side of L2) each has 100 turns No. 28 enamelled wire on a 1 1/4-inch bakelite form. The length of the winding is 1.35 inches and the inductance is slightly over 200 microhenries; this covers the broadcast band when used with .00035-mf. condensers.

The coupling inductance L4 has 9 turns of No. 22 double-cotton-covered wire on a 1-inch form.

The sensitivity control is a 7000-ohm variable resistor, R1.

A 3-megohm leak R2 across the capacity-coupled circuit provides the grid return for the tube.

The tuning condensers C1 are .00035-mf. Trimmer condensers are not shown, but they are necessary for the correct alignment of the circuits.

The coupling capacitance C2 is a .01-mf mica condenser.

The tuning inductances L2 and L3 should be placed in separate shields; the coupling device, whether coil or condenser (C2 or L4) may be placed beneath the sub-panel between them.

Fig. 6 does not pretend to give complete design details for a receiver; since the circuits shown may be substituted in any receiver employing two screen-grid R.F. stages without making any other changes in the

receiver structure. It is not desirable to employ mutual-inductance coupling between the circuits; for the degree of coupling obtained by the builder is not likely to match closely that obtained by the designer.

Capacitive coupling has been shown in both circuits but, if desired, inductive coupling may be substituted in the antenna circuit. This should give a uniform band-width throughout the tuning range, with the usual apparent broadness at the highest frequencies. The R.F. chokes, shown feeding the plates of the tubes, are Hammarlund "RFC-85" with .0001-mf. mica coupling condensers. Grid-leak detection is assumed in the diagram, because of the need for sensitivity with the two band-selectors.

The writer will be pleased to answer any letters concerning these circuits. Remember that the tuning circuit shown above may be substituted for that shown in any receiver diagram calling for two R.F. stages, while still retaining the original specifications as to audio amplifiers, power supply, etc. It is unnecessary to call the attention of the dyed-in-the-wool experimenter to the fact that much opportunity for experiment is offered along these lines. Fig. 5C indicates a method of changing the band-width, during operation, by means of a bank of fixed condensers operating in connection with a tapped switch. Here the values would be as follows: C2A would be .01-mf.; C2B, .005-mf.; and C2C a .0005-mf. variable. Where inductive coupling is used, a tapped winding will afford the same opportunity for varying the band.

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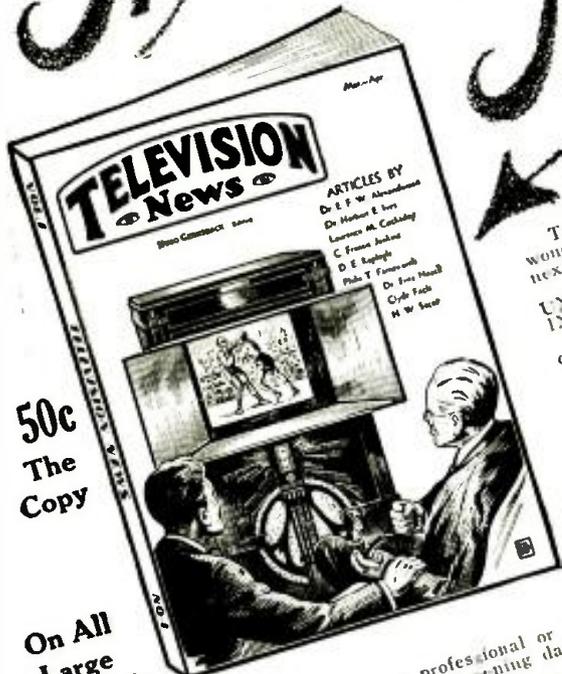
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- The Newest Television Developments, by D. E. Replogle, of the Jenkins Television Corp.
- Television Transmission—1931 Style, by C. H. W. Nason, E.E., National Authority on Television
- Television Course, by Fritz Noack, Berlin
- Complete Television Scanning System Without Discs, Herlin
- A New Electrical Scanning System, by Clyde J. Fitch, Well-Known Radio and Television Writer
- Television in Twelve Problems, by H. Winfield Serot, Radio and Television Specialist
- Solving Some Television Problems, by C. H. W. Nason, E.E.
- Practical Television Hints, by H. Winfield Serot, Radio and Television Specialist
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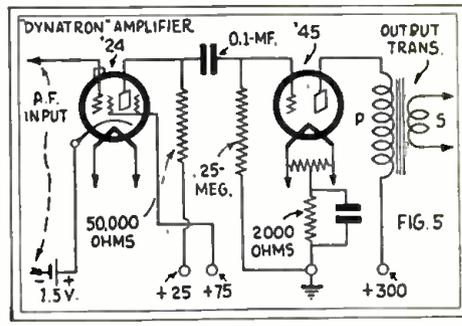
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The Dynatron

(Continued from page 537)

capacity added by the tube is about 18.5 mmf.

For those who desire to experiment with the dynatron as an amplifier, a circuit suitable for A.F. work is shown in Fig. 5. If the tremendous gain obtainable results in overloading the final stage, this will be indicated by the plate-current meter.



A dynatron A.F. amplifier, for A.C. operation, is offered here for the experimenters' benefit. It will be of interest to many who are working on problems of quality.

Ships' Radio Alarm

(Continued from page 533)

of its spring. As soon as this circuit is open, the secondary arm will begin to rise again; its rate of movement being adjusted so that it closes its working contact, called the "G" contact, five seconds after the circuit is broken.

Thus, suppose a correctly made four-second dash is received, the primary arm rises and, at the end of the three seconds, the "D" contact closes, and the secondary arm comes down. At the end of the four-second dash, the primary arm flies back to its second position and the "D" contact is opened. The secondary arm now begins to rise, and will close the "D" contact in five seconds if nothing intervenes to stop it.

But suppose that, after a one-second space, another four-second dash is started; when it has lasted three seconds, the "D" contact will again close, and the secondary arm will be pulled down again before it has reached the "G" contact. It takes five seconds to climb up to the "G" contact and, when working as described, it has been allowed only four seconds; one during the space and three seconds of four-second dash No. 2. Had the space lasted two or more seconds, time would have been allowed for the "G" contact to be closed; and, as the "G" contact is in parallel with the "C" contact, the pawls would have been pulled back and the shaft would have been released and would have returned to its starting position.

Thus, you see, a dash of less than three seconds has no effect on the shaft; a dash of three seconds or over allows the shaft to advance one tooth.

A dash of five seconds sends the shaft back to its starting position.

Dash No. 2, of not less than three seconds, following No. 1 at an interval of less than two seconds will allow the shaft to advance another tooth; but, if the space exceeds two seconds, the shaft will fly back to its

the first audio) has a marked effect on this type of trouble.

Hum "at resonance" often may be eliminated by reversing the position of the line-plug in the receptacle, or by-passing to ground, through fixed condensers of 0.1- to 2-mf. capacity, one or both sides of the light-line.

The Service Man and the set constructor often may check the grid-bias resistors, their by-pass condensers, the hum-balancing resistors, and perhaps their by-pass condensers, for opens, shorts, and grounds, by carefully and quickly applying a short-circuit, as shown in Fig. 11.

The only satisfactory remedy for poor filtering is more efficient apparatus, or higher values of inductance and capacity at the correct points.

Hammarlund "Hawk"

(Continued from page 541)

solder all joints, be sure that the ends of the leads are clean, and use a hot iron with as little flux as possible.

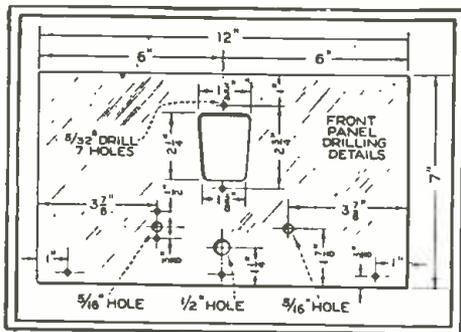


Fig. 2

The standard panel layout for the "Hawk."

Tuning the Set

After connecting the antenna and ground leads, and turning on the tubes, the primary winding, which is attached to a hinge, should be so placed that it is practically vertical. Now, insert any coil and turn the midget condenser knob, so that the plates are in mesh. Tighten up the screw on the grid condenser, C3, and place the variable primary so that it dips inside the fixed winding. A slight hiss will be heard; this shows that the detector is just beginning to oscillate. Now turn the tuning condenser's knob; the presence of a station will be detected by a whistle. The regeneration condenser should then be turned slowly, until only the signal itself remains. A slight re-adjustment of the tuning condenser will now be necessary, because regeneration affects the tuning.

To be sure that the set is oscillating, touch the stator plates of the tuning condenser; a sharp click should be heard. If no click is heard, increase the regeneration condenser setting, and vary the position of the primary, until the click is heard.

The results will vary considerably with different operators. A little experience is necessary to tune in distant stations; to facilitate tuning, a complete list of short-wave stations should be at hand.

The shield plate in front of the variable tuning condenser is used to reduce body capacity. The special placement of the parts further helps to eliminate this annoyance.

Adding an Audio Stage

This set can also be built as a three-tuber. To do this, add on another audio-frequency transformer T1, a socket, a 6.5-ohm resistance (R5) and of course, another tube; here we may use the new type '31 power tube with an extra 45-volt "B" battery, and the 22½-volt "C" battery. The "P" and "B+" terminals of the second audio transformer then connect at terminals A and B as indicated in the diagram. When placing these extra components on the baseboard, move up the first-stage transformer and socket, to allow room for the second transformer and socket. The transformers should be so placed that their cores are at right angles.

For this receiver, an aerial length of about 75 feet, including the lead-in, should be used; the wire should be free and clear of other antennas or obstructions.

A set builder desiring to use 5-volt tubes (such as the '01A) can do so; it being necessary only to substitute 10-ohm resistors. If the set is to contain three storage-battery tubes, a '12A can be used advantageously in the last stage.

This receiver, when built in strict accordance with the instructions, diagrams, and specified parts, will afford ample volume on distant stations. It must be remembered that careful tuning plays a very important part in bringing in distant programs.

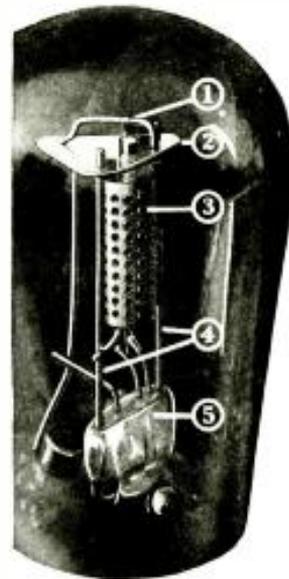
List of Parts

- One Hammarlund 125-mmf. short-wave condenser, type "MLW-125" (C1);
- One Hammarlund 100-mmf. midget condenser, type "MC-23" (C2);
- One Hammarlund 20-100-mmf. condenser, type "EC-80" (C3);
- One Hammarlund LWT-4 short-wave coil set (L1, L2, L3); consisting of an "LWT-B" base, with adjustable primary; and one each "LWT-20," "LWT-30," "LWT-40," and "LWT-80" coils, to cover the 14- to 110-meter range.
- The turns on the 14-24 meter coil are: grid 3, plate 3; 22-40 meters, grid 7, plate 3; 36-65 meters, grid 15, plate 6; 60-110 meters, grid 24, plate 12. The aerial winding L1 has 6 two inch turns for all ranges.
- One Hammarlund radio-frequency choke, type "RPC-85";
- One Hammarlund audio transformer, type "HL-15" (T);
- One 3-megohm grid leak (R1);
- Two 15-ohm filament resistors (R2, R4);
- One 100,000-ohm resistor (R3);
- One .001-mf. fixed condenser (C4);
- One Hammarlund drum dial and knob, type "SDW-1";
- One bakelite panel, 7 x 12 x 3/16-inches;
- One plywood baseboard, 11¼ x 10 x 7/8-inch;
- One aluminum condenser shield, 4 x 5 x 1/32-inch;
- Two four-prong cushion-type sockets;
- One filament switch;
- One set of eight Fahnestock clips;
- Wood-screws, hookup wire, solder, grid-leak mounting and clips.

Accessories

- One pair of 1½-volt dry cells, or one 6-volt storage battery;
- Two 45-volt "B" batteries, small size;
- One 4½-volt "C" battery;
- Two '30 type (two-volt) tubes;
- One pair of good phones.

IT'S EASY TO IDENTIFY 1931 TUBES



①

Positive Characteristics

TUBES must do more than light, or ride on testimonials. From factory to ultimate socket, they must provide definite electrical characteristics precisely matched to radio set requirements at all times.

And that is the function of ultra-sturdy De Forest construction:

1. Nickel support wires of twice the normal diameter.
2. Heavy, accurately punched mica spacer positively positioning elements at top.
3. Perforated metal plate in place of wire mesh.
4. Heavier side supports providing ample rigidity four ways.
5. Special tempered glass press produced on unique De Forest automatic units, accurately mounting support wires.

These and other advanced features, found in fresh De Forest Audions—tubes produced a month or two ahead of sale—insure the 1931 performance of the 1931 radio set.

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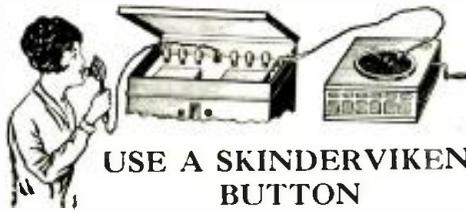
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TUBES



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MAKE Your Own Home-Recording Outfit



USE A SKINDERVIKEN BUTTON

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With a SKINDERVIKEN microphone button you can make a powerful HAND-MICROPHONE — one of the essential parts in any home-recording outfit.

The HAND-MICROPHONE will faithfully pick up your voice and translate it into electrical current variations.

These variations may be amplified — simply by connecting the HAND-MICROPHONE, through a plug-in adapter to the detector or first audio circuit of a radio set.

The amplified currents will powerfully vibrate the recording needle in a phonograph pick-up connected to the "loud speaker" binding posts of the set, and thus may be made to register on any pre-grooved phonograph record.

The "play back" is accomplished by connecting the pick-up in place of the HAND-MICROPHONE, and attaching a loud speaker to the proper binding posts.

If you wish to dispense with the radio set amplifier, you may connect the SKINDERVIKEN HAND - MICROPHONE direct to the recorder (the "pick-up" with a recording needle) through a transformer.

Full details supplied with every SKINDERVIKEN button, including diagrams, drawings and instructions.

These wonderful little SKINDERVIKEN microphone buttons may be used for hundreds of uses, such as:

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WE PAY \$5.00 IN CASH for every new use developed for this unit and accepted and published by us.

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Please mail me at once as many of the following items as I have indicated.
Skinderviken Transmitter Units at 95c. for 1 \$1.75 for 2; \$2.50 for 3; \$3.20 for 4.

When delivered I will pay the postman the cost of the items specified plus postage.

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

Location and Reduction of Hum

(Continued from page 529)

type, with a permanent magnet, is employed, the speaker hum can be neglected. If, however, a dynamic speaker with an electromagnetic field is used, the hum due to the speaker must be accounted for. Such hum is due mainly to coupling between the field coil and the voice coil (Fig. 9) as mentioned before. In measuring hum of this type, the speaker's input transformer (T, Fig. 10) should be disconnected from the set, and a resistance R1, equal to the plate resistance of the output tube or tubes, should be substituted, in shunt with the measuring device (the vacuum-tube voltmeter V.T.V.M.)

The field winding should be supplied with the normal amount of current; to do so, in case the current is obtained from the "B" power unit of the set, a resistance R2 (equal to that of the primary of the speaker's coupling transformer) should be connected in the lead to the power tube or tubes. In this way, the current consumed by the set will remain normal.

If a power transformer, input transformer or any other source of a strong field is close to the speaker, it should be removed temporarily to a point far removed from the speaker; then returned individually to the former position and a comparison made.

When making further tests, if the speaker hums, it should be removed from the circuit, and a resistance, (R, in Fig. 11) equal to that of the primary of the transformer should be placed in the plate circuit of the power tube.

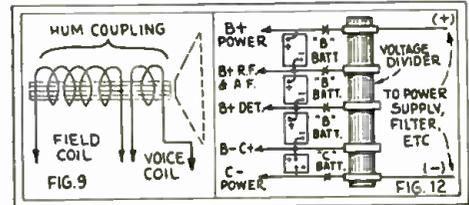
Substituting Various Units

In order to measure the hum produced by any one of the power supplies, the others should be replaced by batteries (Fig. 12). For example, if we wish to measure the hum produced by the "B" power unit, the "C" biasing resistors and the filament transformer should be replaced by batteries of the same voltage and with sufficient current capacity. The hum is then measured in the plate circuit of the power tube.

The same system is used for the filament. The correct filament current can be obtained by placing a resistor in series with a 6-volt storage battery.

In the case of plate and grid voltages, the supply for the individual tube should be tested. As an example, we could measure the hum introduced by the "C" bias in the power tube's circuit by replacing the plate and filament supplies by batteries for the power tube alone; and then test each of the other stages in turn, thus comparing the increase on the hum for each addition. (This, however, cannot be done for the "C" bias test when the power unit is tapped for this bias; except as indicated in the figure.)

In measuring the hum introduced by induction, the power supply for the plate, grid and filament of the power tube should be replaced by batteries (Fig. 13); and the primary of the coupling transformer, between the first and second stages, should be short-circuited with a wire, A. The grid bias resistor R is to be shorted by a wire, B. The hum developed in this manner is



Left, the dynamic reproducer as a source of hum. Right, replacing the voltage divider by batteries, as a hum proof current supply for testing.

then due to induction; and a speaker in the power tube's plate circuit will reveal to which type it belongs.

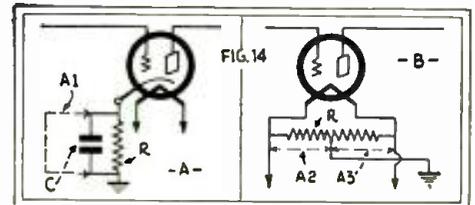
The same system may be used for the first stage; by replacing the power supply with batteries in this stage, shorting the primary of the first audio-frequency transformer, and comparing the hum with that measured for the power tubes. This system may be applied also to the detector.

To measure the hum introduced in the radio-frequency amplifier by modulation of the carrier wave, the detector and audio amplifier should be operated entirely from batteries, and a strong signal should be tuned in. Because of the possibility of the transmitter's having a carrier hum, the signal should be produced preferably by a battery-operated local oscillator or generator, and be about "10 microvolts per meter."

In all the above tests, whenever the power supply for a tube is removed from a power supply unit, a "dummy" load or resistor should be substituted, in order to keep the remaining currents at their correct values.

When the actual source of hum has been located, measures may be taken to remove or reduce it. In the case of magnetic coupling, for instance, the usual interaction is between the wiring in the detector or first audio circuit, and either the power transformer or the first filter choke. Shielding the grid leads will often help.

Rearrangement of the parts is sometimes necessary and, in extreme cases, special shielding of the offending part is essential. Ordinary sheet iron, while a good shield for electrostatic action, is not very good against magnetic fields. "Soft" iron and special transformer steel (such as silicon steel, Permalloy and Permivar) are much more effective.



Left, a test for hum due to a faulty grid-biasing circuit; right, a similar test of the center-tapped filament circuit.

Electrostatic coupling may, usually, be prevented by shielding the offending high-voltage leads, and carefully grounding the shields. Rearrangement of the parts is sometimes essential; although the writer has found that shielding the tubes (especially

mount the "cat" close to the dash with the tuning condensers directly on the dash; and have another satisfied customer and a nice little profit. I have absolutely no use whatever for the ground capacitor aerial. The first time the customer takes to a muddy road, there is trouble. In closed cars I mount a coil with sixty turns of wire on a three-inch (diameter) tube inside the top near the center, and get excellent results with the aforesaid super.

I designed a ten-tube super, using five '24's, three '27's, and two '45's, with an automatic volume control, for my own car. One of my helpers is constructing it now and I will inform you more about it later.

I would not give two whoops for all the patented aerials, lightning arrestors (for home use), static eliminators, etc., on the market. Certain hookups, which have been previously published in this magazine, will greatly reduce local interference, however.

I have a prediction to make. The four-place switches in the new R.C.A. and Victor machines are going to give more trouble than all the rest of the machine.

MARCUS A. MCCOY,
3213 Blackburn Street, Dallas, Texas.

NOT TOO MUCH "PUSH"

Editor, RADIO-CRAFT:

I like your magazine very much, and have received many good ideas on receivers. But why all this bunk about getting business? Good radio Service Men don't have to advertise and send circulars telling how good they are. Give me recommendations of eight or ten satisfied customers, and I will get the business.

Too many people want to sell something right away to the customer, and destroy his confidence first thing. I always say: "Your tubes are bad. Have you an account at any electrical store? I can supply them, of course, but I will get them from your own dealer if you wish."

Nine times out of ten, they say: "You go ahead and supply them."

The days of gypping the public are over. You can't charge for repairing a radio that you have just fooled with, and expect to be recommended or called back.

LE ROY H. SMELTZER,
243 S. Washington Avenue,
Greensburg, Penna.

IT ISN'T THE 50 CENTS, IT'S THE—

Editor, RADIO-CRAFT:

I quote from a letter signed only "Shaker Heights, Ohio" (a suburb of this city) in your January issue: "We're no longer men of a profession, to have to accept so low a fee for our services." The reference is to advertisements of fifty-cent service charges.

I agree with "Shaker Heights," if we accept such a fee. Personally, I still have faith in human beings, and I still get my \$1.50. You can't fool all the people, etc.

As to parts discounts, why "Shaker Heights" can't get his discounts, I do not know; but I do know that I get regular discounts without any trouble.

A Service Man with any backbone does not have to accept a fifty-cent service fee. If I wanted to accept a fifty-cent charge,

I could do so and still make more money than I am making; but I won't do business that way.

To illustrate: A week ago I was called to repair a Majestic "71." While I was making my tests, the owners told me that they had had one of these "50-cent" companies look the set over and give them a price. They also admitted to me that they had dropped the power pack; and I suppose they told the other fellow the same thing.

Well, to make a long story short, I completed my tests, and found nothing wrong except an open filament lead in the R. F. circuit. I had been there exactly thirty minutes (unlike the Flying Service Man) and a little solder did the trick; my charge was \$1.50—my minimum.

Then it came out. The "50-cent" company had given them a price of \$35.00, and the set would have to go to the shop. I suppose this estimate came from the knowledge that the pack had been dropped; though, as the rectifier tube had not been damaged, it could not have been dropped very hard.

BLAINE MARTIN,
1933 East 73rd Street, Cleveland, Ohio

NEW COMPONENTS ARE SUSPECT

Editor, RADIO-CRAFT:

I quite agree with the letter of Mr. Hyde, in the December issue, entitled "Protection Against Lightning"; but I have been in the service for over two years, and found that very few sets have a D. P. D. T. switch and few have even an arrester. In that time I have only had one that I think had been hit by lightning; and all that happened was that the primary winding of the antenna coupler was burnt out. (It was an electric set.) I have not heard of any other set that could have been lightning-struck; and I have concluded that the danger of lightning is very low, whether one carries protection or not. I would just as soon be without a lightning arrester as have one.

I am also in favor of the "Hints to Manufacturers"; for, judging by the way some of them put their sets together, they think these will never need any service or that, if they do, the sets will be returned to the factory. Generally, the receivers that need the most service are those that are hardest to get at. I may add that receivers which stand up under the conditions found in the United States do not do so here as they should.

I do not like the practice of pulling out a chassis in the customer's home and fixing it there; even though the customer may almost forbid it to be taken from the house, a little bit of explanation will usually overcome this. Most customers watch the Service Man, as a cat does a mouse, with the idea that the radio will never work again. Then too, manufacturers change parts from time to time; and the customer sees that the new part is not the same as the one taken out, and fears that the set will never be the same. When a chassis has to come out, except for a minor repair, it is my principle that it should be taken to the shop.

HAROLD B. AULENBACH,
91 Augusta St., Hamilton, Ontario, Can.



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Gentlemen: Please send me your big FREE book which tells about the many opportunities in Radio and about your famous laboratory method of radio instruction at home.

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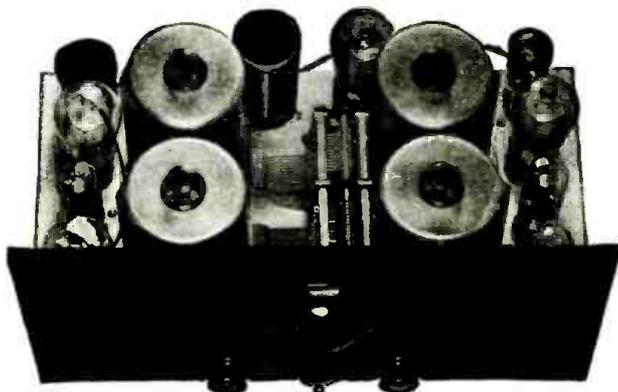
HERE'S THE FIRST RADIO THAT EVER DID IT!

Broadcast Band Every 10 K.C.

NO NOISE — CLEAR AS CRYSTAL
SNAP A SWITCH
80-METER SHORT-WAVE BAND

The Newest
Development
in Radio

The
LINCOLN
D.C.-8



Lincoln Engineering Again Startles the
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Just read and let your imagination do the rest.
Self-contained D.C. power. No A.C. power with its cracks and growls.

No storage batteries. No charging. Just assemble in console and forget for a year.

CRYSTAL CLEAR LONG DISTANCE RECEPTION

Perfect 10-K.C. separation from local made possible by Lincoln's famous original design.

Then by an amazing new development, by simply snapping a switch, get the interesting 80-meter phone band. Tunes over 80 degrees on the dial like broadcast. NO COILS TO PLUG IN OR SWITCH. Just think what this means — Air Mail, Police, and private phone from coast to coast.

New 2-volt low drain tubes. New "A" supply operates from oxygen in the air. New exquisitely designed console.

LINCOLN D.C.-8 CHASSIS (Less Tubes) \$80.00

AND WHAT'S MORE — SHORT-WAVE RECEPTION IS NOW STANDARD IN THE LINCOLN DE LUXE 31. Utilizing six screen-grid tubes in the most powerful selective receiver known today. Try this on your receiver — place your dials midway between your local station and a distant station 20 K.C. away, and open up your volume control. Lincoln equipment is doing this daily in the heart of Chicago with four times the power of any receiver without a background from a 50,000-watt local station.

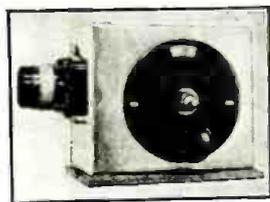
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SHORT-WAVE WAVEMETER

EVERY SERVICE MAN NEEDS ONE!!



This Fine Shielded Instrument finds Foreign Stations on dials of short-wave sets, makes tuning simple, calibrates oscillators, sets, coils, checks Receivers and Transmitters. Hundreds of Uses! Works on ANY set. Set it to wavelengths, then tune receiver to it. Range: 15 to 125 meters; gets any station. Complete (nothing else required to operate it) with extra, sturdy plug-in coils, calibration charts and Full Instructions, only \$6.95. Why pay \$12 and more? EASY to work and ACCURATE!! Send only \$1 in stamps, pay rest to postman when received.

DELFT RADIO

524 Fairbanks Ave.

Oakland, Calif.

ON Page 518 you will find an interesting announcement of the RADIO SERVICE MAN'S HANDYBOOK with addenda data sheets. It takes but a few minutes to read of the full particulars about this new book.

between the grid and the ground. Assuming that the grid circuit contains no units other than the secondary of the transformer, this test will show whether or not the lack of grid bias upon the tube is due to an open secondary.

Examine a modern diagram; check the various circuits, and you will find that you can make a very large number of tests by connecting a resistance-measuring equipment between the "B—" terminal and the socket contacts, and thus obviate the need for pulling the chassis.

Service Man's Forum

(Continued from page 523)

fications necessary to properly service receivers such as are distributed in music stores, drug and hardware stores and the like and why is it that when such a man requests information from a manufacturer regarding the latter's make of set that if he receives a reply to his request it may amount to no information at all? I believe this is common practice with a great many manufacturers and jobbers.

C. M. DELANO,
Box 663, Lincoln, Nebraska.

THE KIDS ARE CLEVER

Editor, RADIO-CRAFT:

Just a line, from one of your so-often berated "kid" service men. I am eighteen years old, and have seen only six years in the radio field; but I am frequently called on by local Service Men, much older than myself and with as much as ten years' experience in "our" field, who want advice on different questions. I have studying under me several "kids"; and I find they make much more efficient Service Men than most older persons. I am service manager for a local "chain," and I attend high school at the same time.

Recently I have installed several motors and turntables with electric pickups in the tops of Zenith "39 A's." The reproducer arm must be so constructed that it will fold down near the top of the set when not in use; since, even with the 1¼-inch motor, the lid of the machine will not clear the reproducer when it is on the record. The scratch from the record is very faint, however, and it permits the lid to be left up while the machine is playing. For use in some machines where there is a limited space in the top, I have designed a needle extension which allows the reproducer to be laid down flat near the record; it is made out of strong steel, and is just long enough to change the angle at which the reproducer must rest. This gives much better quality than I expected when I first conceived the idea and, because of the high amplification in the audio stages of the average set, there is no noticeable decrease in volume.

Why does not some manufacturer make an extension shaft for his phono-motor, so that the motor can be placed to the side or bottom of a cabinet, yet allowing the turntable to be placed at the customary position?

For use in the automobile, I prefer the old R.C.A. semi-portable super chassis. I change these to single-dial control and

to re-construct the teeth, will clear up this difficulty. (See Fig. 3).

Sonora made two "A44" models; the first employed 15-volt Arcturus tubes and the second, which was a converted job, '27 tubes in all R.F. stages. The former set used a volume control of about 2000 ohms, connected from negative chassis to plate circuit of the fourth R.F. stage (Fig. 4A). However, in the converted job, the volume control was used to control cathode bias on the R.F. amplifiers (Fig. 4B). This method, though a good one, was not effective in this set because of the value of the control used. Control of volume was not gradual and only about one-tenth the entire unit had any use.

Without disturbing the circuit, the cathode connection was removed and shorted to chassis; so that another method to control volume could be employed. After several experiments, it was determined that the variable resistance placed across the aerial and ground would give as good and smooth a control of volume as could be desired (Fig. 4C). Only one lead is necessary to make this change. One side of the control resistor is connected to the aerial lead. The frame of the control is fastened to the chassis by means of a nut thereby obviating any other connection to ground.

In the new Bosch sets the line, "local-distance" switches are not an integral part of the receiver chassis. They are controlled by a single knob on the tuning panel. The local-distance switch is connected to the set by three wires going to the three binding posts on the side of the chassis; the top being the aerial and the bottom, the ground. Lack of sensitivity can be traced to the omission of connecting the wire belonging on the center binding post.

The first R.F. tube in the Kennedy screen-grid receiver will often need replacement; for, as soon as this tube becomes weak, the selectivity of the receiver is impaired. Some tubes, even though testing perfect, were unsatisfactory for some unexplainable reason. Experiment and trial will quickly determine the proper tube to use for this stage.

Lack of sensitivity, in the Pada "42" series A.C. chassis, is a common complaint and may be caused by any of a number of defects; but one that has often been found is in the 50,000-ohm blue carbon resistor in the plate circuit of the detector stage. Usually, a drop in normal plate voltage will accompany this defect. If a resistor of 25,000-ohm value is used for replacement, there will be a slight increase in selectivity.

Inaccessible Units

(Continued from page 520)

between the filament and ground. The cathode or the filament may be reached without pulling the chassis, and the same is true of the ground; thus, it is possible to check the grid-bias resistance without pulling the chassis.

The same method of measurement is applicable to audio-frequency grid circuits. Suppose that it is necessary to check the continuity of the secondary of the audio-frequency transformer; a resistance unit, of about 5,000 to 10,000 ohms is connected



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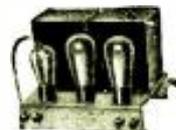
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New Radio Devices

(Continued from page 535)

The usual R.F. coil design, for a 1 1/4-in. form, is followed; the added tickler winding has fifteen turns over the center of the secondary. A miniature of the "condenser bank" of the big sets may be seen.

A black imitation-leather-covered carrying case, 7 x 11 x 8 1/2 in. high, completes the instrument; which weighs only 8 1/2 lbs.

"UNI-DIRECTIONAL" BOWL SPEAKER

THESE has been much ado about short-wave beam radio transmitters, but we have heard little about beam audio transmission. The "Uni-Directional Bowl Speaker," manufactured by Operadio Mfg. Co. and illustrated in Fig. E, is just such an instrument; combining the stature of Gargantua and the voice of Stentor. For the audio power of this instrument is concentrated, and thus affords complete coverage of large fields, such as motion-picture "lots," fairs, stadiums, racetracks and airports. At this point attention may be called to the fact that, up to distances of 500 feet, and even more, there is little diminution of the sound; it "carries."

Although a large model is shown in the illustration, the same principles of design are incorporated in smaller units, such as those designed for car radio installations. The model pictured is the "OT," weighing 575 lbs.; and with a bell-opening five feet in diameter. The advantage of the "bowl" dynamic is that penetration may be obtained without objectionable volume near the reproducer. The frequency-response is particularly satisfactory over the very wide audio range from 50 to 6,000 cycles.

The principle of operation is clearly shown in Fig. 3. Both the front and back of the dynamic reproducer unit are called into play; the high frequencies from one side are radiated by bowl A while the low notes expand through the gradually-increasing air column afforded by the facing surfaces of bowls A and B.

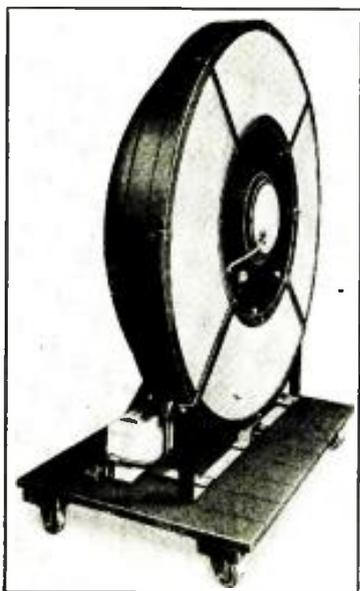


Fig. E

A powerful reproducer for open-air announcements.

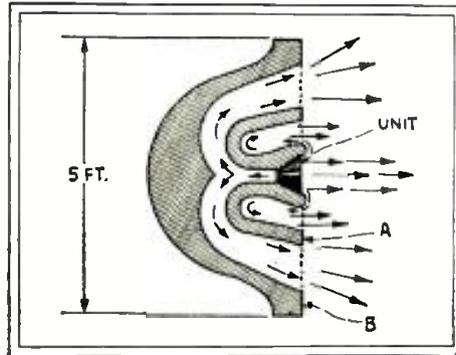


Fig. 3

The bowl speaker acts both as baffle and horn, delivering the output from both sides of the dynamic unit.

These reproducers are equipped with field-current supply leads, for 110-volt A.C. mains, and voice-coil input transformers.

HAND MICROPHONE

FOR the home-recorder, as well as for use in connection with industrial- and home-talkie picture equipment, there is available a new high-grade, although inexpensive hand microphone.

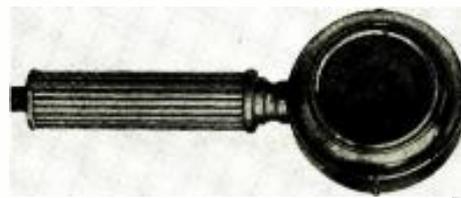


Fig. F

An attractive pattern of hand microphone with many uses.

This instrument, the "Model 12N" two-button hand microphone, manufactured by the Ellis Electrical Laboratory is illustrated in Fig. F.

The microphone is of the standard carbon-button type, and uses the same unit found in the makers' regular broadcast-type microphones. A three-conductor cable is available; although not part of the package.

The dimensions of the "Model 12N" are, diameter, 2 7/16 in.; thickness, 1 1/2 in.; total length, 6 1/2 in.

Testing Equipment

(Continued from page 527)

The output of the radio set is connected to the high-impedance, or primary winding of an output transformer. The low-impedance secondary winding is connected to the thermogalvanometer, through the 15-ohm potentiometer, which regulates the current.

Many radio receivers have built-in output transformers, the loud speaker having none. The D.P.D.T. switch is placed in the circuit, preceding the potentiometer; so that the meter and resistance can be switched to the output of this type of receiver.

A decided improvement can be made by inserting another double-pole, double-throw switch, preceding the output transformer, so that one can switch from output meter to loud speaker, whenever desired.

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THE first edition of my Radio Encyclopedia—39,000 copies—is completely sold out. The first printing of this famous **First Encyclopedia of Radio** ever published has been totally consumed. A new edition is now in preparation. It will be issued in February, 1931.

This new edition will represent not only a complete revision of all the material in the first, but much valuable new information has been added, making the new volume about twice the size of the former.

A vast amount of new material has been collected and arranged, and is incorporated in the forthcoming edition. This new data covers all the momentous innovations and improvements in radio construction and technique which have developed since the first edition came off the press.

Some of the new subjects are:

Short wave sets, circuits, coils, etc.

Receiving sets, all types; battery, A.C., D.C.; modern superheterodynes; home recording equipment.

Power supply systems; all types, including "B" eliminators and systems used in all types of A.C. and D.C. electric sets.

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And last but not least there has been added a section of important tables, indispensable to the radio constructor, serviceman, professional, designer, and amateur; among these tables will be found:

Complete vacuum tube characteristics.

Tables of voltages at different sockets in modern sets.

Resistors, and values employed in voltage dividers and how they are calculated.

Coil and condenser data, showing the size of coils required with different condensers for a given wave length band.

Voltage regulators—for fluctuating line voltages.

Wavelength and frequency conversion tables.

Power consumption of standard radio sets.

Sound absorption of different materials.

Condenser replacement table.

Wire tables.

Radio set table, listing all known receivers by makes, style numbers, types of sets, tubes used.

Etc., etc.

The new Radio Encyclopedia will be a book of the same size as the first edition—9 by 12 inches—printed on heavy durable paper. The number of pages is doubled. The binding will be in semi-flexible red morocco keratol, gold stamped, with marbled fly-leaves, and the text will be printed in large easily readable type.

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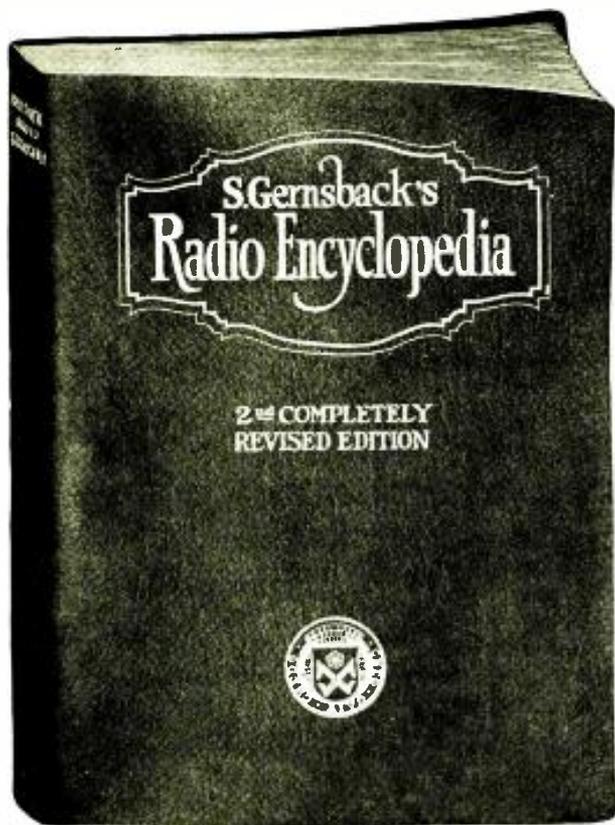
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with a low-impedance secondary, (the transformer being contained in the reproducer), the terminals 3 and 4 are directly connected to the output of that receiver. If the receiver under test contains its output transformer, then the output is connected to terminals 1 and 2. The reason is that the low-impedance winding of the output coil will not match the high impedance of the primary of the output transformer in the meter box. When the receiver is connected, a deflection will occur on the meter, proportional to the amount of current flowing. For comparing the output of one receiver with another, the potentiometer should be adjusted so that the meter will read a maximum current flow at one-half scale.

This thermogalvanometer is an A.C. meter and can not be used on D.C.; costs more than a V.P. voltmeter, but I like it better, and believe it more satisfactory.

Service Oscillator

(Continued from page 526)

tuned to any frequency, giving a check on the receiver's adjustment at any point on the scale.

The selectivity of a set can be checked comparatively, by making a small change in the condenser setting on the oscillator and noting the decrease in signal strength. When comparing the selectivity of two sets in this manner, it is essential that the test be made at the same frequency with both sets, as the selectivity usually varies with the frequency. This also gives a ready method of checking the selectivity of a set under different operating conditions.

With the oscillator calibrated as a wave-meter, dials on receiving sets which have changed their setting can be reset easily and accurately. All in all, it is a valuable addition to any service department.—*Courtesy of R.C.A.-Radiotron "Good News."*

The "Martenot"

(Continued from page 531)

further facilitates the adjustment of these to the proper inductance and coupling to give the desired notes.

Volume and Timbre Control

The details of the control Rh, shown in the illustration at the performer's left hand, are not given in full; it is described as a rheostat, but serves also as a switch, evidently, serving to cut off one note as the control is shifted to the following position. By this means, also, it is possible to produce a staccato effect; while the rheostat, acting as a volume control in the output circuit, permits change from fortissimo to pianissimo passages.

As said above, the characteristic feature of the design of the tube circuits is that it is considered desirable here to create harmonics, rather than prevent them; and the selection of these harmonics makes it possible to imitate instruments already known—even the voice—and to create entirely new timbres. For this purpose, the inventor suggests use of new types of tubes; varying the applied voltages; and saturating the A.F. transformer cores.

Detector Efficiency

(Continued from page 539)

because a positive bias far too high for maximum efficiency is being applied to the grid.

By employing in the positive filament lead a potentiometer with the slider connected to the choke, the bias may be adjusted to suit the operator. See Fig. 1 for diagram of connections.

For this purpose, the filament rheostat may be modified slightly. The exact resistance, necessary to lower the voltage to that specified by the tube manufacturer, is obtained by dividing the voltage drop by the filament current.

If an '01A tube is to be employed with a 6-volt battery, the resistance required is 4 ohms (1 volt drop divided by $\frac{1}{4}=4$). Since 4-ohm rheostats are not easy to obtain, a 6-ohm type may be used and a jumper provided with a clip serves to cut out 2 ohms. To adjust this to the correct resistance, shunt a D. C. voltmeter across the filament terminals of the socket, and set the clip at a point which gives a meter reading of 5 volts. The slider is varied until best operation is secured; which will mean a positive grid bias of approximately one-fifth of a volt.

This method is especially suitable for use in the first detector of a superheterodyne receiver; the sensitivity obtained is somewhat greater than that of the grid-leak method, and is due to the possibility of obtaining exactly the proper positive bias.

The operating point on the rheostat is more easily found when regeneration is used; as it becomes much sharper. However, if a resistance control is employed, it should be put *across* the tickler (*not in series*); because the series connection varies the plate voltage, making it necessary to change the rheostat setting with each change of the regeneration control. (This last statement is perhaps not quite as important as it may sound, being a "crank's" viewpoint. Nevertheless, it is correct theoretically, and the shunt connection of the resistor seems to be preferable.)

The schematic diagram for the use in a regenerative circuit is shown in Fig. 2. The control resistor R2 should have a maximum of 50,000 ohms. A grid condenser of .00025-mf. will do, if the receiver is of the broadcast type, but .00015-mf. is preferable for waves under 200 meters.

Short-Wave Pioneering

(Continued from page 543)

no one wanted to have anything to do with these high frequencies.

Necessity forced us into this. We then had four stations but, owing to limitations that were placed upon us for telephone wires to connect our several stations together, we were forced to develop other means to accomplish this and obviously our first thought was radio linkage.

The radio linkage had to be silent, so far as the broadcast radio receivers were concerned; so we were obliged to select frequencies above or below the broadcast band. There were no lower frequencies available,



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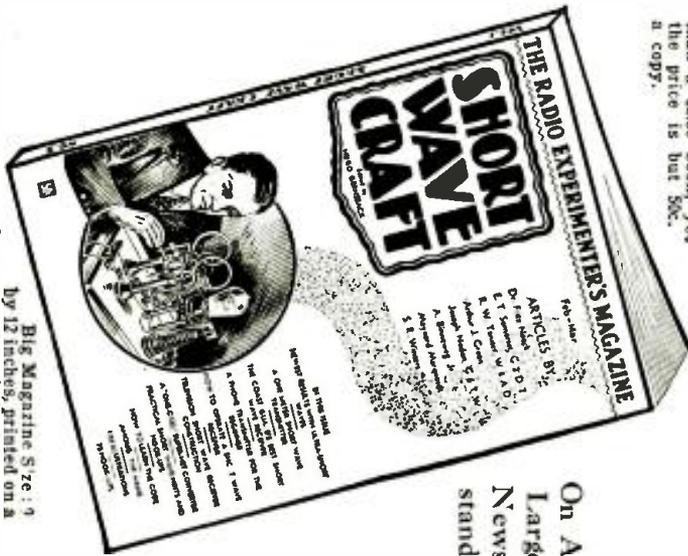
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Transmitters for Short Waves—How to build them

and we were therefore forced to the short-wave channels or higher frequencies.

Our experiments very quickly demonstrated the great value of these short wavelengths, and out of this work were created the possibilities of international broadcasting.

As early as 1923, the Westinghouse experimental station KDPM (located at Cleveland, Ohio) was repeating KDKA's program received there on short wavelengths from Pittsburgh. Some months later this method of station linking was used on a more elaborate and continuous plan; when the Westinghouse Company established at Hastings, Nebraska, a fifth station, KFKX, solely for radio repeating purposes.

Radio broadcasting and radio communication entered into a new era with the further use and development of these short waves. It furnished a method for station inter-linking and it also has proved to be a great step in the development of world communications.

As the experiments with short waves continued, we discovered that they were being heard in most unexpected places throughout the world. Particularly impressive was the efficiency of reception at long distances. As a result we decided to try to send a special program by this means across the Atlantic which could be received and repeated in England and Europe.

It happened that it was close to the New Year; and we therefore decided that this first international broadcast should be a New Year's greeting from the United States to England and Europe. It was my good fortune to speak this greeting.

On that night, December 31, 1923, across the Atlantic Ocean, covering a distance equal to one-eighth the circumference of the globe, the human voice was sped on these radio waves with the speed of light. At Manchester, England, this New Year's greeting was received and re-broadcast by the British Broadcasting Company, their whole system repeating it.

Here occurred an epoch in human history, for man had truly conquered space. The world's boundaries had been shifted. A human voice was heard simultaneously in North America and Europe—a greeting to millions of people spanning Nature's barriers, with no connecting media except the invisible and the unknown. Such was this pioneering achievement in voice transmission; probably in all the years of history no greater feat of science had been recorded.

Thus was the first step taken towards making international broadcasting and re-broadcasting an actual possibility, and it was undertaken with the definite purpose in view of eventually making it a reliable and everyday service.

The success of this pioneering attempt brought a realization to our dreams and hopes. Now it is simpler, and it is almost a matter-of-fact statement for me to say that international broadcasting is an established accomplishment, and eventually will be as reliable and as perfect as local broadcasting.

Imagine the possibilities that such a service portends and what a powerful agency it will be in bringing about a universal language, international good will and mutual understanding.

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"Hi-Q 29"

(Continued from page 537)

plates are grounded, it is necessary to couple the grounded rotor plates and the "B+" terminal of the plate coil by means of a 0.5-mf. fixed condenser, to complete the resonant R.F. circuit. These condensers are shown at "C" in the diagram.

Since this coupling capacity introduces into the circuit a reactance which varies with any change in the frequency to which the circuit is tuned, and because the grid circuit of the following tube (in the original design) did not include a similar capacity, it can be seen that the shapes of the resonance curves will not be symmetrical and proportionate when the gauged condensers are rotated; since the losses in both circuits will not be equal over the broadcast band.

Use of New Tubes

A simple way of keeping the same proportion of losses in both the plate and grid circuits, is to insert a similar 0.5-mf. capacity C1, in each grid circuit, as shown. This causes a marked improvement in the audio output and enables the operator to find more readily and accurately the best condition of "band width"—the more alike the two circuits look and function electrically.

Improvements in the design of screen-grid tubes are shown in the new two-volt, .06-ampere filament type, classed as "32." This tube, with its improved electrical characteristics, including low filament consumption, is very satisfactory and can be substituted in the battery model "Hi-Q29" by changing only the filament resistors; the correct new values of which are shown in the diagram.

It will be noted that a higher bias is placed on the screen-grid of the second R.F. tube V2, to prevent local signals setting up in it a state of "secondary emission"; for this would cause serious distortion in the second R.F. stage and be passed, amplified and distorted, to the detector.

In some instances, it has improved the amplification, at the lower wavelengths, to couple the plate and grid coils at their high-potential ends, by means of small capacities (C2) of about 5-nmf. value.

The trend in modern receiver design is to employ a "C"-bias detector; because of its ability to handle higher input signal voltages, and the absence of harmonic generation which is common in the old grid leak-condenser method of detection (as ordinarily used.—*Editor*.)

If so desired, a screen-grid detector may be employed; for this purpose, the first A.F. transformer should be removed, and a resistance-capacity-coupled stage substituted, in order to secure sufficient bass frequency response. It should be remembered that a screen-grid tube used as a detector has a high A.C. plate resistance. The "C"-bias voltage, on the control-grid of a screen-grid tube used as a bias-detector, should be about one-tenth of the voltage applied to the screen. A voltage of thirty on the screen-

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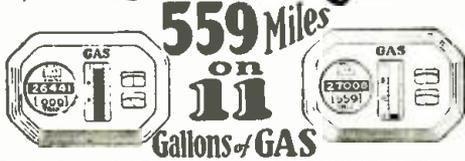
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grid requires a control-grid bias of three; and, with a type 32 tube, this voltage may be obtained by the drop across the filament-ballast resistor.

Of course, "C"-bias detection may be applied to an ordinary 701A- or 72A-type tube; by connecting the grid return lead to the "-" terminal of a "C" battery, the positive of which is led to the negative filament line. The proper biasing voltage for an 701A or 72A tube, used as a detector, should be about one-tenth of the effective plate voltage applied to the tube.

These changes have been very satisfactory in reconditioning and modernizing the "Hi-Q29," and the ideas set forth should be not only useful in this case, but readily applicable, without further details, to other receivers of more or less similar design.

Tube-Base Coil Winder

(Continued from page 549)

Loosen the bolt that goes through the center, and discard the large outside framework that holds the soldering lugs. Then reassemble the center part; but replace the short bolt with a longer one that can be placed in the chuck of a small hand drill. Lock the hand drill into a vise, or otherwise secure it; plug the tube base into the socket; and it can be wound very handily and exactly.

(Another craftsman, Frank L. Dodd, has sent in a similar idea; but he uses, instead of a socket, another old tube base which has been filled with wax and drilled to receive the tube prongs like a socket.—Editor.)

SUPER-POWER IN EUROPE

"WORLD'S biggest broadcaster" is the term applied by the European press to the new Polish transmitter at Rasin, near Warsaw. Its power, 160 kw., while considerably less than that of KDKA's new transmitter, exceeds that which any American station is authorized to broadcast during regular evening hours. The masts are 600 feet high, and 750 feet apart, the largest in Europe.

According to an English correspondent of *Popular Wireless*, who viewed the apparatus at the Chelmsford works where it was made, the station is the first which has water-cooled filaments for its transmitting tubes! We are led to wonder about the truth of this, especially by reason of another inaccuracy. "The only other broadcasting station planned to provide power anywhere near this figure was at Bound Brook, N. J.; but the Americans admit that this station is a failure (hi) Poland, however, is going to be a success."

Incidentally, while it is necessary to construct special apparatus—say a long-wave frequency converter—to adapt an American set to receive this station on 1411 meters, the power of European stations has been increased enormously since the International Tests some years ago; and, in a quiet, favorable location not too near any local transmitter, it might be possible for an experimenter to bring in European broadcasts during the late afternoons this winter.

CLASSIFIED ADVERTISEMENTS

Advertisements in this section are inserted at the cost of ten cents per word for each insertion—name, initial and address each count as one word. Cash should accompany all classified advertisements unless placed by a recognized advertising agency. No less than ten words are accepted. Advertising for the April 1931 issue should be received not later than February 7th.

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See page 562 of this issue and read the special offer to those who are actively engaged in radio.

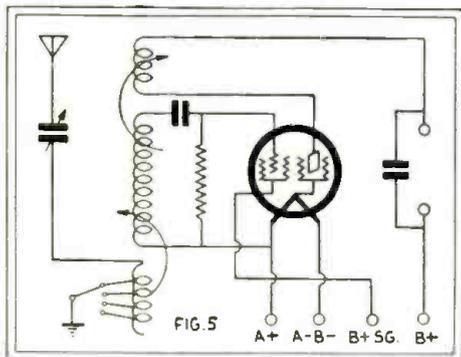
Mutual Conductance

(Continued from page 551)

10,000 ohms; and a signal input of one volt (A.C.) produces an alternating component of 0.8-milliamperes—one-fourth the value of the plate current.

Since the A.C. component is the only useful part of the plate current, for either amplification or loud-speaker reproduction, the efficiency of the tube is much higher than if it were no more responsive to alternating than it is to direct voltages. The reason of this differential action is the balancing of the influences of the grid and the plate voltages.

The endeavor to utilize mutual conductance more and more efficiently has caused, not merely new tube designs, but new circuit designs. The higher the "slope," the more sensitive is the tube; a condition reached just before oscillation, when the signal loses control entirely or partly. In the super-regenerative circuit, we have a very interesting attempt to apply critical grid biases to a tube, at such a frequency that cycles of extreme sensitivity will result, without losing control of the tube as an amplifier.



A single-tube circuit obtaining loud-speaker strength by the use of a pentode with its high amplification and powerful output.

The A.F. pentode, not yet in general use here, has practically become standard in European receivers of late date. It has resulted from the attempt to produce a power tube which shall draw as little current, yet give as much output as possible. With a large amplification, it feeds out of a detector; and the popular British "mid-get" is a two-tube set—a screen-grid detector and a pentode. The only American output pentode commercially produced has a mutual conductance of about 2000. We note the recent appearance of a European power tube which has a mutual conductance of 6000; the slope goes up almost perpendicularly (line "E106" in Fig. 2).

It may be of interest to our readers to show a recent experimental circuit, from an English magazine (Fig. 5) in which a pentode is shown in a single-tube receiver with loud-speaker output; regeneration adds to the pentode's high amplification, of sixty to eighty. Such a circuit, of course, could be used only in a suitable location.

(The reader who is interested in the measurement of mutual conductance in tubes will find the method described, and a suitable testing circuit shown, on page 322 of RADIO-CRAFT for January, 1930. A milliammeter and a calibrated resistor, with "A," "B," and "C" batteries, are the only apparatus required for the set-up.)

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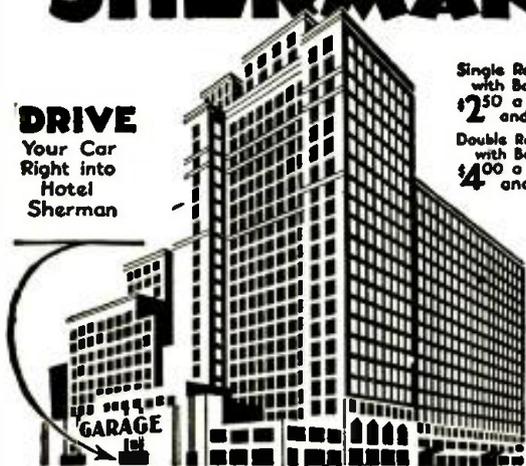
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CHICAGO

“Roll Your Own”

(Continued from page 514)

sary only to change the filament resistors specified for those which are made for use with the two-volt tubes and whatever battery you are using. (*Amperites 630 and 631 are designed for the '30 and '31 tubes, operating on 6 volts.*) It will be necessary, also, to change the grid return of V4 to provide 3 volts of negative “C” bias on this tube, when it is a '32 type.

If the filament temperatures of the R.F. tubes are automatically regulated, it will be necessary to introduce some control of oscillation and volume. The 500,000-ohm variable resistor, mentioned in the original article, should be connected in the plate lead common to the primaries of L2 and L3.

This set was designed for use with an aerial, and will give better results than with a loop. The writer prefers a bakelite sub-panel.

The layout given originally should present few difficulties. After you have procured the parts, lay them out as they were pictured in the original article. You may use components of different makes and constants, and find problems; but tackle them systematically, one at a time, and you will find it easier.

(We hope to have from Mr. Smith another article on developments which he is making along the lines of a modern home-built set. He has received, and answered patiently, a great number of letters from readers asking questions which were not of a nature confined to this particular set. Set constructors should not write to an author to ask him for information—say, about turns on a standard R.F. coil, or types of tubes—which has appeared often in print and which they should get from books, magazines, or manufacturer’s booklets, packages and advertising.—*Editor.*)

Radio-Craft Kinks

(Continued from page 540)

shows the method of construction which, when finished, is surprisingly stiff.

(In most parts of the world, the expression “screening” is used for what, in the United States, is called shielding.—*Editor.*)

A NEUTRALIZING TOOL

By Ralph L. Green

BAKELITE “screwdrivers,” used in neutralizing and making similar adjustments, become dull with a few minutes’ use and must be resharpened. After becoming



Fig. 4

Another tool which the Service Man or experimenter may convert from household uses.

bored with this, I hit upon using an ordinary bone knitting needle of large size (about 1/4-inch). After filing this to a screwdriver edge, I found that it held its edge fairly well. It will not break readily and is long enough to reach into comparatively inaccessible places.

Radio Guides Planes

(Continued from page 531)

signal light which will flash up when the plane reaches the vicinity of the radio station.

The receiver has been so arranged that telephone communication and weather broadcasts can be received at the same time that the radio compass is being used.

This new homing system is immune to error, even though the plane is banking or in a tailspin. Its range is rated as 200 miles; though it has operated successfully at greater distances.

While developed primarily for aviation purposes, the course finder may be applied equally well to the purposes of navigation; and will furnish the sea captain approaching a coast with not one, but many, bearings with which to correct his course. The extension of service from radio beacons and compass stations, therefore, need not be as costly as hitherto expected; although special services will be necessary for the guidance of increasing aerial traffic.

Tests of the System

With the apparatus illustrated, recent tests were made on the airplane between Los Angeles and San Francisco with one of the passenger planes of the Transcontinental and Western Air's Pacific division.

Pilot Harlan Hull tuned in on the government radio station at Oakland, immediately after taking off from Los Angeles. Throughout the 400-mile flight, the needle on his meter pointed to dead center when he was on the proper course, but wavered to one side whenever he deviated from his course. When he arrived directly over the radio station, the needle vibrated suddenly. (It is hoped to extend the operation of the principle shortly to give a correct angle for landing, even in blind flight.)

For the supplementary receiver illustrated, (lower right) plug-in coils make possible tuning over bands below the long-wave beacon signals and the broadcast range which falls below it. The lightness of the apparatus—some ten pounds—makes it especially suitable for airplane service.

Subsequent tests have been made before representatives of the U. S. Army; and negotiations for the commercial production of instruments of this type are announced.

The Radio Craftsmen

(Continued from page 545)

W8BXV at Old Forge, N. Y., several times in the daytime, and quite loudly.

The main disadvantage is that I have to control the regeneration by putting my finger on the variable grid leak; it is very hard to regulate, and that is the only reason I have not been able to log so many stations accurately.

HORACE EDDY,
Sidney, N. Y.

(Since the primary of a broadcast coil has fewer turns than the secondary, it will tune much lower with the same capacity across it; and this produces the effect noticed. The hookup, however, can hardly be as efficient as a regular short-wave circuit.—Editor.)

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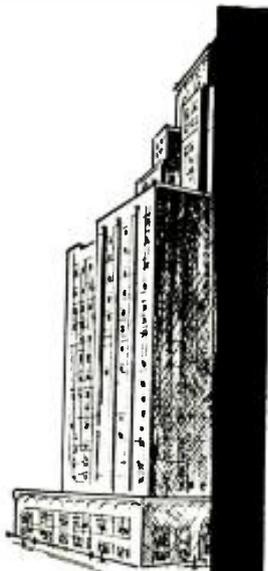
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SERVICE MEN — DEALERS

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HOTEL DIRECTORY of the Radio Trade

The Home Hotel of New York

Homelike in service, appointments and location . . . away from noise and congestion, yet but a few minutes from Times Square . . . garage facilities for tourists.

Room and Bath from
\$3 single \$4 double
500 Rooms

Home folks will
like this hotel

HOTEL

BRETTON HALL
BROADWAY at 86th ST.
NEW YORK

**WELCOME to
NEW YORK and**

The **HOTEL
GOVERNOR
CLINTON**

31ST. ST. AND 7TH. AVE.
opposite PENNA. R.R. STATION



1200 Rooms each
with Bath, Serv-
dor and Circulat-
ing Ice Water,
also Radio
Provisions



ROOM AND BATH · 3⁰⁰ UP

BACK ISSUES OF

RADIO-CRAFT can still be had at the regular price of 25 cents each. If you are in need of any copies for reference or servicing work, mail your order with remittance to RADIO-CRAFT, 98 Park Place, New York, N. Y.

New Uses of Radio Recording

PERMANENT TELEPHONE RECORDS

WHILE the telephone is the medium of increasingly long-distant and important business deals, now that international talks have been made possible by radio, the law has looked with suspicion for some hundreds of years on agreements of any importance, unless the terms were written down.

So the scheme of a firm in Melbourne, Australia, recorded in *Wireless Weekly* (Australia) may find many imitators in these days of electrical recording; though such service is not included in American telephone tariffs.

"An ingenious stratagem was adopted by a Melbourne firm to obtain a permanent record of a conversation conducted recently between Melbourne and Birmingham (England). Being advised that a call was coming through from Birmingham, the Melbourne firm arranged to have an electrical recording instrument tapped in their telephone circuit during the whole of the conversation.

"The telephone discussion concerned detailed figures and specifications, which were recorded, and constituted an accurate statement of the business which could be dealt with when the time factor did not involve the charge of £2 (\$10) a minute. Verbatim reports of the conversation have, it is understood, been sent from Melbourne to Birmingham, and the firm intends to place this and future recorded conversations on the office files for reference.

"This is believed to be the first occasion on which a long-distance call of this nature has been electrically recorded. Radio experts look forward to the time in the near future when such a record will prove in business dealings as binding as the written contract."

RECORDING CONVINCES SKEPTICS

Editor, RADIO-CRAFT:

In E. L. Smith's objections to the Stenode, I notice that he fears the shattering of the crystal from too high a signal strength. I take it that he is comparing the small power in the I.F. amplifier of the receiver with the immense power handled by a transmitter. I have no data on crystals immediately at hand, nor do I have the money to afford shattering one for such a test; but I do not believe the output of the strongest I.F. amplifier is sufficient to shatter a crystal with its natural period as low as even fifteen hundred kilocycles. However, I really can not conceive the idea that such a circuit as the Stenode uses could give reproduction with the same fidelity as an amplifier with a ten ke. band. Here's hoping, however, that the circuit is a success; as it will probably bring about the evolution of cheaper and better crystals.

A word or two about home recording: I think it is the best idea since screen-grid tubes. It makes it possible for the DX hound to *prove* to his friends that he got that certain station at that certain time. I have made several reproductions of code stations I have received; I lend these to my friends who are studying code, and

they find that a phonograph makes a nice code-practice machine.

I have played with short-wave receivers quite a bit but I have not had such great success. So far I have had only the following foreign broadcast stations; Nauen, Germany; Rugby, England; London, England; Madrid, Spain; Melbourne, Australia. I have tried nearly a hundred different circuits, including a superhet similar to the new R.C.A., with the inductance and capacity reduced.

I had one shortwaver, a T.R.F. with regenerative detector, which I could tune by standing three feet away and moving my hand. This was about ten meters. I find that as many as five stages of audio may be used on a S.W. set with much more volume than two or three will produce and with little howl, if the voltages are properly balanced. At present, I am experimenting with tuned audio systems and their application to the short waves.

MARCUS A. MCCOY.

3213 Blackburn Street, Dallas, Texas.

PERMANENT PROGRAM RECORDS

THE German listener misses very few worthwhile outside broadcasts, even if the programme is one which cannot be altered for the inclusion of such a relay.

Both Frankfurt and Stuttgart have their own recording plants, and if, as it happens, they cannot see their way to give their listeners the broadcast of an interesting event at the time it is taking place, they register the relay on wax and store it for future use.—*Wireless Magazine*.

BIGGER AND BIGGER

RUMORS have it that the Soviet republics, already possessor of more stations and higher power than other European countries, will erect 500-kw. broadcast transmitters in Leningrad and Moscow. Political, as well as radio interference, from these giant voices of the East is feared by neighboring countries.

Information Bureau

(Continued from page 552)

holding the "mike" with the diaphragm in a horizontal position, in one hand, and striking it gently against the other hand. Also, try gently striking the edge of the microphone against one hand. Note that damage may result if this procedure is followed with the current on; make certain that the microphone is disconnected from the battery circuit while undergoing this manipulation. Do not strike the diaphragm.

If the "mike" is located in an excessively moist place it may be advisable to place the unit under an electric light bulb, in front of an electric heater (at some distance), or in the rays of strong sunlight, to drive out the moisture that has caused the packing of the carbon. Most microphones are, after assembly, tested and balanced with meters; and they should not be opened or tampered with.

(Q.2) What are the average impedance values, of the primary and secondary windings of transformers designed to match a carbon-button microphone to a vacuum-tube grid circuit?

(A.2) The average values are: Primary, 200 ohms; secondary, 400,000 ohms. These values are for the usual 1,000-cycle standard.

RADIO'S GREATEST VALUES!

ALL merchandise listed is BRAND NEW and is shipped in the original, factory sealed cartons and carries the same guarantee of ABSOLUTE SATISFACTION! Due to the demand for this seasonable merchandise actually exceeding the available supply, ACT IMMEDIATELY! In most

instances, our SALE PRICES ARE LOWER THAN THE ACTUAL MANUFACTURER'S COST! Join the ever swelling ranks of our 100 per cent SATISFIED CUSTOMERS. ORDER DIRECT FROM THIS PAGE TODAY.

Dry Electrolytic Condensers

Mount in any position! Guaranteed never to blow out! Remarkably compact and very inexpensive, permitting generous use of filtering systems. The greater the mfd. capacity employed, the less A.C. hum remains. 500 volt peak rating. Ideal for all 171A - 215 power packs—use two of each capacity desired for 250 power packs (1,000 volt peak therefore assured).



No.	Mfd.	Diameter	Length	YOUR PRICE
1801	1	3/4 in.	2 1/2 in.	\$0.28
1802	2	1 in.	2 1/2 in.	.45
1804	4	1 1/4 in.	2 1/2 in.	.85
1808	8	1 3/4 in.	2 1/2 in.	1.35
1816	16	3 in.	4 1/4 in.	2.12
1824	24	3 in.	4 1/4 in.	2.75
1832	32	3 in.	4 1/4 in.	3.75

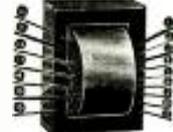
R.C.A. Double Filter Chokes

This heavy-duty, extremely strong, double filter choke can be used for all types of filter circuits, experimental work, power amplifiers, receivers, eliminators, power packs, converted sets, etc. Known as R.C.A. replacement part for all Radiola models, particularly Nos. 33, 17 and 18. Each choke D.C. resistance, 500 ohms. Connected in parallel, these double filter chokes have a rating of 15 Henries at 160 Mills; connected in series, 60 Henries at 80 Mills. Fully shielded in heavy metal case with special insulating compound. Size 5 1/4 x 3 3/4 x 2 3/4. Shipping weight 6 lbs. List Price \$10.05. YOUR SPECIAL PRICE..... **95c**



Earl Power Transformer

Make money revamping the old battery set. This power transformer used in Earl Model 22 receiver supplies "A," "B," and "C" potentials for: two '27's (or screen - grid '21's), three '26's, two '71A's and one '80 rectifier; total current output of high-voltage winding at maximum output (about 200 volts) is 80 ma. High-voltage secondary, filament winding for '27's, and for '71A's are center-tapped. May be used in any number of combinations. Suitable resistors, a couple of 4-mf. filter condensers, two 30-henry chokes and by-pass condensers complete line power pack. Size 3 3/4 x 3 x 2 3/4 inches. 16 long leads and full wiring directions. Shipping weight 5 lbs. List Price \$7.50. No. 1410—YOUR SPECIAL PRICE **\$1.75**



Utah Dynamic A.C. Power Speaker—Model 33A

110-volt, 60-cycle A.C. light socket supply for field excitation with Westinghouse dry rectifier. 9 in. high, 9 1/2 in. wide, 7 1/2 in. deep. Speaker cones packed in wooden crate. Weight 10 lbs. It is one of the most powerful as well as best reproducers in the market. 9-inch cone. List Price \$50.00. No. 1506—YOUR SPECIAL PRICE **\$7.50**



Cavalier Model 159 Console With Peerless Speaker



This beautiful and distinctive cabinet is sold with the built-in Peerless Speaker. It is designed to provide a maximum cabinet at a minimum price. Veneers of Flamed Walnut with attractive carvings and unusual turnings. Set compartment, 21 1/2 in. wide x 10 1/2 in. deep x 8 in. high. Height, 38 in. Shipping weight 65 lbs. Packed in original crate. Complete with Speaker. No. 159—YOUR SPECIAL PRICE **\$9.95**

"250" A.C. Power Transformer

This power transformer supplies currents for five 15-volt Arcturus tubes drawing 5 Ma. and 1/2 amp. on filaments; one 2.5 V. tube; two '50's, and two '81's. Two '27 or '22 (if suitable resistance is used) and 750 volts. Full wave "H" and "C". A line ballast resistor, such as the Amerlite, in conjunction with the special 85-volt primary, will maintain even voltage over 105 to 125 volts. Entirely shielded in metal. 1 1/2 x 1 1/2 x 6 1/2 inches high. Weight 15 lbs. For 110-120 volts, 50-60 cycles. List Price, \$20.00. No. 1412—YOUR PRICE..... **\$4.75**



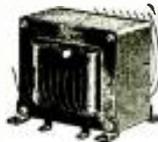
Shielded "A" Transformer

Modernize storage battery receivers by replacing '81A's with '26's and '27's heated by this filament transformer. Supplies 1.5, 2.5, and 5 volts; 2.5-volt winding center-tapped. Heats three '26's, two '27's, and two '12A's or '71A's. 3x3x1 inches. For 110-120 volts, 50-60 cycles. Weight 3 1/2 lbs. List Price, \$4.50. No. 1400—YOUR PRICE..... **\$1.75**



Kolster Jumbo A.C. Power Transformer

Will supply sufficient current and voltage for push-pull '10's, in conjunction with type '31 half-wave rectifiers. The 2.25-volt secondary output is just below the rated maximum for type '21 and '27 tubes; tubes will last much longer than when heated from a higher-voltage transformer. Four secondaries are rated as follows: Secondary S1, 7.5 V., 1.25 A.; S2, center-tapped, 7.5 V., 1.25 A.; S3, 1.5 V., 4.25 A.; S4, 2.25 V., 1.65 A.; S5, 725 V., 50 Ma. Primary is tapped for low line voltage. Has eight feet drilled for mounting to base of rack. Generous iron core assures cool performance under heavy load. For 110-120 Volts, 50-60 Cycles. Dimensions: 1 1/2 x 4 1/2 x 4 1/2 inches. Shipping weight, 12 lbs. List Price, \$19.50. No. 4336—YOUR PRICE..... **\$6.70**



Thordarson Standard Replacement Power Transformer

This transformer may be used in building up the sensitive chassis; or for replacement in such standard combinations as three '21's, two '27's, two '71A's or two '45's, and an '80 rectifier. Suitable for the home-built rack-and-panel public address amplifier, or cabinet-type photograph power amplifier. Just the foundation unit for an audio amplifier to be used as a standard of comparison. Well designed. Connections are made to soldering lugs on the two end plates. Dimensions: 3 1/4 x 3 1/2 x 1 inches. For 110-120 volts, 50-60 cycles. Shipping weight 5 1/2 lbs. List Price, \$12.50. No. 1405—YOUR PRICE..... **\$2.75**



2.5 Volt Filament Transformer

Has 2 center-tapped windings. Both deliver 2.5 volts. One winding gives 3 amperes; the other, 11 amperes. Pigtail leads. Heavy iron case, beautifully finished in brown crackle. 110 to 120 volts, 50 to 60 cycles. Dimensions: 3 1/2 x 5 x 4 1/2 inches. Shipping weight 9 lbs. List Price, \$6.00. No. 1414—YOUR PRICE..... **\$3.45**



A. K. 37-38 Filter Choke and Condenser Block

Contains two filter chokes, a speaker output choke, two high-voltage filter condensers, a detector by-pass condenser, and an R.F.-A.F. by-pass condenser, each connecting lead being identified by colors. To make up efficient power pack for a receiver using a Type '71A output tube you need only a rectifier tube socket, a voltage divider, a power transformer, and this filter block. 3 1/2 x 4 1/2 x 5 inches. Shipping weight 6 lbs. List Price, \$7.50. No. 1800-283—YOUR PRICE... **\$4.95**



The SONOLA 1931 A.C. Model Midget Receiver

This Midget Receiver will outperform many of its larger brothers. Uses 5 tubes: 3 screen grid, 215 power tube, 250 rectifier. Rola dynamic. Large capacity filter. Perfectly shielded. Selectivity obtained by use of three tuned stages. High amplification is assured by screen grid RF, screen grid power detector and '45 output. Rola Dynamic gives wonderful reproduction. So small you can put it anywhere yet it will fit. There may be cheaper midgets on the market. We are fully aware of this. That's exactly why you should have a SONOLA. There is NO GRIEF with this high grade set. For 50 to 60 cycle, 110 volts. Dimensions: 14 x 9 x 18 inches high. Shipping weight 30 lbs. List Price, \$59.50. No. 2500—Your Price (less tubes) **\$32.25**



Genuine Magnavox Microphone

Do Your Own Home Phonograph Recording Made by the world-famous Magnavox Co. While originally made to strap on the head, it is easy to screw a handle onto one of the side brackets. The side brackets are covered with soft rubber and place the microphone at the best speaking distance from the mouth. Comes with 6 feet of cord. The biggest mike bargain in America! Complete with straps and buckle to fit around head. Brand new, in original factory packing. Shipping weight 1 lb. List Price, \$10.75. No. 1610—YOUR SPECIAL PRICE **\$1.65**



"RTC" High-Voltage "Puncture Proof" Filter Condenser Units

We guarantee these condensers unconditionally. They are ideal for general replacement purposes and can be installed in any new power-pack. All condensers are furnished with 8-inch lengths of tinned "push-back" wire.

500 VOLTS			800 VOLTS		
Cat. No.	Mfd.	Your Price	Cat. No.	Mfd.	Your Price
1702	1/2	\$0.23	1706	1	\$0.45
1703	1	.30	1707	2	.75
1704	2	.40	1708	4	1.10
1705	4	.60			



FREE

We have just issued our new "RADIO SERVICE TREATISE," 114 red hot all the way through, 52 new hookups and circuit diagrams, 110 illustrations.

Partial contents: Modernizing old radio sets. How to convert battery to power sets. Selection of tubes. The detector tube. The power tube. Changes in grid or "C" bias circuits. Push pull amplifiers. Replacing audio transformers. Photo attachments. How to choose power transformers. Voltage dividers. Wattage of power transformers. Selecting and installing replacement parts in radio sets. Filter condensers. Renaming "B" eliminators. ALL BRAND NEW DOPE—NOT A REPRINT. Check full of REAL radio information all the way through. Even the catalog section has dozens of hookups—never found anywhere before. Treatise sent by return mail.

RADIO SERVICE TREATISE
AND
RADIO BARGAIN CATALOG
FOR RADIO SERVICE MEN—RADIO TECHNICIANS—RADIO DEALERS
RADIO TRADING CO.
25 WEST BROADWAY
NEW YORK CITY

Kolster Magnetic Cone Speaker Chassis



May be connected directly in the plate circuit of type '12A tubes; or to higher-power tubes through an output device. In push-pull circuits, speaker may be connected from plate to plate. "9-inch cone" type. Patented. Is prevented by a flannel damper; bass notes are well reproduced due to the "free-edge" effect. Its small dimensions make it eligible for use in home-constructed midget sets. Comes with 6 ft. cord. Dimensions: 10 x 5 1/2 x 4 1/2 inches. Shipping weight 6 1/2 lbs. List Price, \$18.00. No. 1500—YOUR PRICE..... **\$2.85**

Short-Wave Converter



Build a short-wave converter at lowest price on record, but with which excellent results are obtainable nevertheless. The voltage for the three 227 tubes used may be obtained from an external filament transformer or from a secondary winding of 2 1/2 volts in a power pack. Wavelengths from 30 to 110 meters. No plug-in coils; coil switch is used to cover wave bands. Single dial tuning, no grunting, no body capacity, no squeals. Leak-condenser modulation. Converter consisting of all parts (less filament transformer) including cabinet, panel, diagram and 1-page instruction sheet (less tubes). No. 1619—YOUR PRICE..... **\$4.85**
No. 1615—6-Volt Battery Model, same price.

GUARANTEED 6 MONTHS NEONTRON TUBES

Sold on a 6 MONTHS FREE REPLACEMENT GUARANTEE BASIS, PROVIDING TUBE LIGHTS! All tubes are carefully meter-tested before shipment, and carefully packed. Do not confuse these HIGH QUALITY tubes with any other "low priced" tubes—our low prices are possible because we do a VOLCME business!

Choice of	Choice of	Choice of	Choice of
226	112A	245	222
227	200-A-199UX	240	210
171A	199U-120	171	250
201A	224		281
63c each	70c each	80c each	\$1.60 each



WE ARE A WHOLESALE HOUSE AND CANNOT ACCEPT ORDERS FOR LESS THAN \$3.00. If C. O. D. shipment is desired, please remit 20% remittance, which must accompany all orders; balance on delivery. If the full cash amount accompanies the order, you may deduct 2% discount. Send money order—certified check—U. S. stamps (any denominations.)

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SERVICE MEN

At the tremendously low prices at which the merchandise below is offered, every radio dealer, service man or mechanic should equip himself with stock for future use. It is probable that such low prices will not prevail for long.



KOLSTER 245 POWER AMPLIFIER WITH MATCHED DYNAMIC SPEAKER

An Outfit of Proven Superiority

LIST, \$98.00
Less Tubes

Our Net Price \$24.50
Less Tubes

For radio, phonograph or public address systems. Reproduces speech and music with marvelous fidelity of tone. The amplifier has 2 stages, using a 227 in the first and two 245 tubes in the push-pull stage with a 280 rectifier. For 115-volt, 60-cycle alternating current. The Kolster Dynamic speaker chassis supplied with and included in the price of this outfit, is ACCURATELY MATCHED.

RADIART POWER TRANSFORMER

All Secondaries are Center-tapped

SUPPLIES VOLTAGES AS FOLLOWS:

Primary—110 volt, 50 to 60 cycles A.C.
Secondary—2.5 volt, supplies filament for five or more Screen-Grid or 227 type tubes.
Secondary—2.5 volt, supplies filament for two 245 Power tubes.
Secondary—5 volt, supplies filament for one 280 Rectifier.
Secondary—High Voltage, 375 volts each side of tap, supplies sufficient plate current for two 245 Power tubes.



Our Net Price \$3.75

245 POWER TRANSFORMER



For use with a 280 rectifier tube, to deliver 200 volts, 100 ma. (100 milliamperes), slightly higher voltage at lower draw from 105 - 125 - volt A.C. line (marked 110 v.), 50 - 60 cycles. The primary is tapped at 82½ volts in case a voltage regulator is used. The black primary lead is common. If no voltage regulator is used the other primary lead is the tap. If regulator is used, the red and black form the circuit. The secondary voltages are all center-tapped: 672 volts A.C. for 280 plates, 2½ v. 3 amps. for 245 output, single or push-pull; 5 v. 2 amps. for 227 tubes. Center taps are red and all leads are identified on name plate. Laminations are hidden except at bottom. Eight-inch leads emerge from the sides, but it preferred may be taken off through the bottom of the transformer by pushing them through the rubber grommets. Shipping weight, 12 lbs. Overall size: 5" extreme width x 1½" high.

Our Net Price \$7.35

No. 250 POWER TRANSFORMER

Same as above

Our Net Price \$8.50

No. 171 POWER TRANSFORMER

Same as above

Our Net Price \$5.50

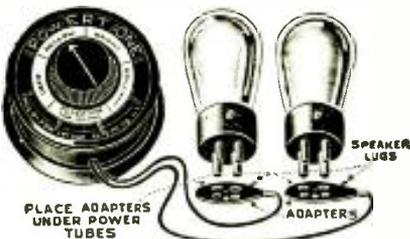
245 B SUPPLY CHOKE



100 m. choke coil for B filtration in 245 circuits; 200 ohms D.C. resistance, inductance 30 henrys. A continuous winding tapped in two places, giving three sections and four outleads, and permitting a "choke input" to filter. This method lengthens rectifier tube life and filter condenser life, yet filtration is splendid. The black lead goes to the rectifier filament center, the red, green and yellow leads are next in order. Capacities suggested: black, 1 mfd.; red, 1 mfd.; green, 8 mfd.; yellow, 8 mfd. In shielded polished aluminum case. Shipping weight, 4 lbs.

Our Net Price \$3.65

POWERTONE TONE CONTROL



A scientifically designed instrument for the regulation and control of tonal quality. Classical music, great speakers, famous artists can be heard the way you have always longed to hear them. The tone control is easily and quickly installed without the use of any tools. LIST PRICE, \$3.00.

Our Net Price \$2.55



EDISON AUDIO TRANSFORMER

Ratio 3½ : 1

Each 85c
Dozen \$9.00



BARGAINS IN TUBES

Regular SILVER SHIELD or PAR Vacuum Tubes—100 per cent. replacement within three months provided they still light

X201A	.....	\$0.35	X281	.....	\$1.05
X226	.....	.40	X250	.....	1.25
Y227	.....	.50	X210	.....	1.25
Y224	.....	.75	UX199	.....	.60
X245	.....	.50	UV199	.....	.65
X280	.....	.75	UX120	.....	.65
X171A	.....	.50	WD11	.....	.75
X112A	.....	.50	WD12	.....	.75

NO LESS THAN TEN TUBES SOLD AT ONE TIME



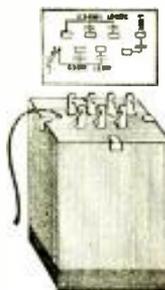
COMBINATION "A.B.C." POWER PACK

WIRED READY FOR USE

Built with high-grade parts. Supplies "A.B.C." Voltages for 5-220's, 2-227's, 2-171A's, 1-280, 105-120 Volts — 50-60 Cycle

Delivers over 125 Mills and up to 200 volts "B" power. The Power Transformer is designed to take care of a D.C. DYNAMIC SPEAKER, two connections being provided on the pack for same.

Price Now \$6.75



ACME 8.7 Mfd. REPLACEMENT BLOCK CONDENSER

Tapped at 2.7 600 Volts
1.8 600 "
2.1 300 "
1.8 300 "
.5 300 "

5" High, 4" Wide, 2¼" Deep. Ideal for replacements in "B" Eliminators — Power Packs — or the average Electric set.

Our Net Price \$1.75

NATHANIEL BALDWIN DYNAMIC D.C. SPEAKER



The ideal speaker for cabinet installation. Baldwin Quality — built to Baldwin high standards, which have been responsible for Baldwin world wide leadership—Superior tone quality. Diameter 9 inches, depth 7 inches. Field resistance of 2,500 ohms. This dynamic speaker can be used with A.C. Receivers that are equipped to supply the "B" current to speaker field.

Our Net Price \$4.95

Isn't This What You've Been Wanting? AT LAST A REAL NOISE AND HUM ELIMINATOR



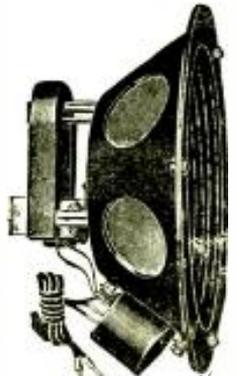
and your troubles are over. Works on all currents—Automatic—Requires no adjustments—Take advantage of this offer now. Special introductory offer for a limited time only. Heavy Duty.

LIST PRICE, \$7.50

Our Net Price \$2.65

R.C.A. MAGNETIC CHASSIS

This chassis is the identical one used in the R.C.A. Model 100A and 100B Speakers, which list for as high as \$35. Note built-in Output Transformer — this enables the speaker to be used with voltage applied to it as high as 600 volts, without any trace of distortion, rattling or blasting. Equipped with generous over-sized Magnets. The thick armature is accurately centered. The sturdy metal frame is lined with a special fabric, greatly improving the acoustic properties of this sensational speaker! Note the corrugated surface of the cone, an exclusive feature—enhances perfect tonal reproduction qualities considerably. Most compactly made: 9" outside diameter, 4½" deep overall.



Our Net Price \$3.25

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TERMS:—20% with order, balance C. O. D. 2% discount allowed for full remittance with order only.

Hudson Radio Co.

Carries a Full Line of Replacement Parts

WRITE FOR NEW CATALOGUE

The Robert Findlay Artistic Radio Consoles



Lowboy, Model 3
Height, 40 inches; width, 26 inches; depth, 14½ inches. Shipping weight, 50 pounds.

LIST PRICE, \$32.00
Our Price, \$3.95

A REAL BUY!



Highboy, Model 31 (left)
Height, 66 inches; width, 24 inches; depth, 11½ inches. With book shelf as shown.

LIST PRICE, \$50.00
Our Price, \$5.95

DESIGNED expressly for Crosley Jewelbox, Showbox and Gembox Receivers, but may be used with others. Finished with the beauty of fine, carefully matched veneers, with attractive speaker grille. Made entirely of metal. Console vibration and other unpreventable causes of distortion have been eliminated. The baffle construction is the last word for true dynamic reproduction.



Junior Lowboy, Model 3-J (right)
Height, 40 inches; width, 23½ inches; depth, 11½ inches. Shipping weight, 50 pounds.

LIST PRICE, \$30.00
Our Price, \$3.95

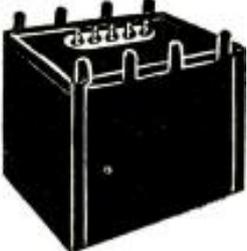
Peerless Courier or Transformer Corporation of America DYNAMIC SPEAKER CHASSIS



2500 Ohm D.C. Field
The latest and best Peerless Speaker Center-tapped voice coil
Equipped with output transformer 9-inch diaphragm
Cat. No. 175

Our Price, \$7.50

VICTOR REPLACEMENT CONDENSER BLOCK



10½ MFD., 600 VOLTS
For replacement in All Victor Sets
Total capacity 10½ Mfd., 600 working voltage.
Housed in metal can.
Size: 5½ in. long, 5 in. high and 4 in. wide.
Cat. No. 2709

Our Price, \$2.25

WESTERN ELECTRIC TYPE CW 930

HAND MICROPHONE WITH SWITCH

Cat. No. 3602

Our Price, \$8.50



CENTRALAB, FROST, CARTER, YAXLEY and CLAROSTAT

VOLUME CONTROLS and POTENTIOMETERS



Perfect slide contact
Standard ¼-in. shaft

R.C.A. VICTOR UNCASED CONDENSER



1000 VOLTS D.C. WORKING VOLTAGE
This genuine R.C.A. Victor uncased condenser is composed of the highest grade materials. They are compact and moisture proof, impregnated in special heat resisting compound.

100% REPLACEMENT GUARANTEED

Cat. No.	Size	Each	doz.
2927	½ Mfd.	25c.	\$2.50 doz.
2928	1 Mfd.	35c.	3.60 doz.
2929	2 Mfd.	50c.	5.50 doz.
2930	4 Mfd.	85c.	9.00 doz.

ROTOR SYNCHRONOUS MOTOR



Cat. No. 121

COMPLETE WITH TURNABLE
A modern, all-purpose A.C. direct electric phonograph motor equipped with turntable. Sturdy and compact, only 1½ inches thick. Starts and stops at the mere touch of a finger. A constant torque at exactly 80 revolutions a minute, regardless of voltage fluctuations. Assures an even quality reproduction without distortion. Truly a perfect synchronous electric motor. LIST, \$22.00.

Our Price, \$3.25

Cat. No.	Size	Description	Net Price
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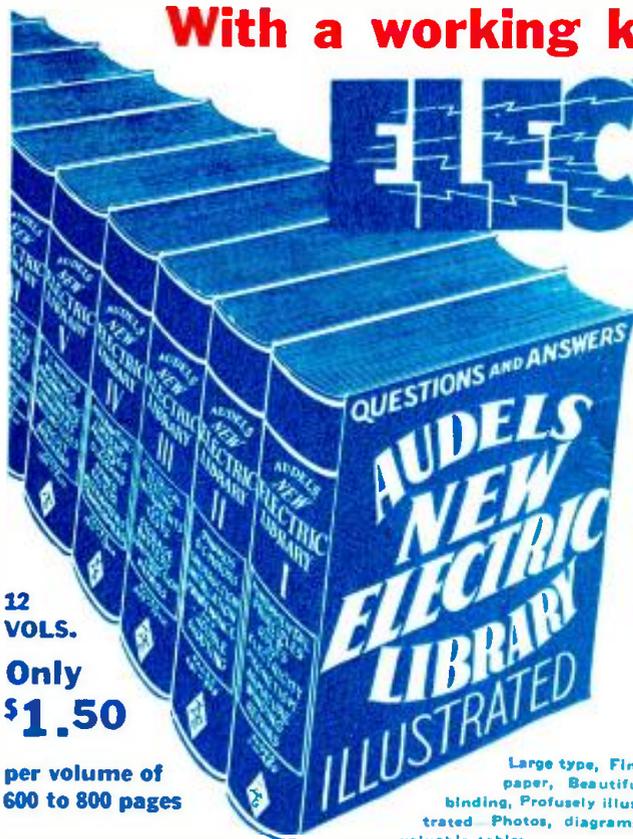
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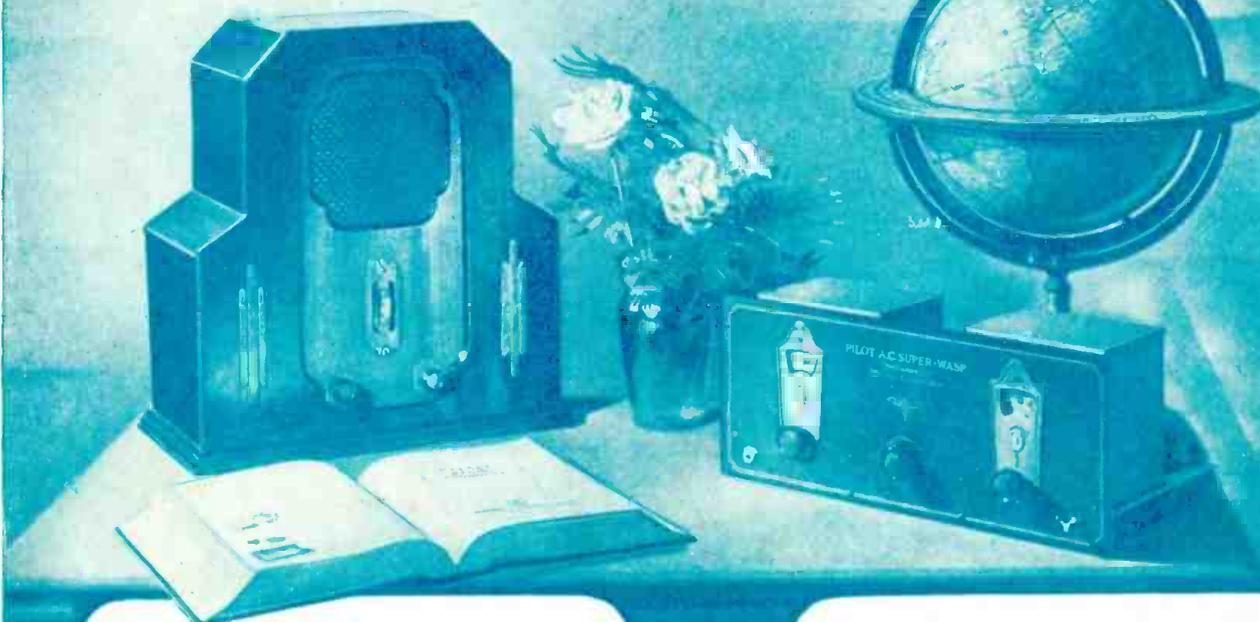
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