RADIO'S LIVEST MAGAZINE

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Radio-Craft

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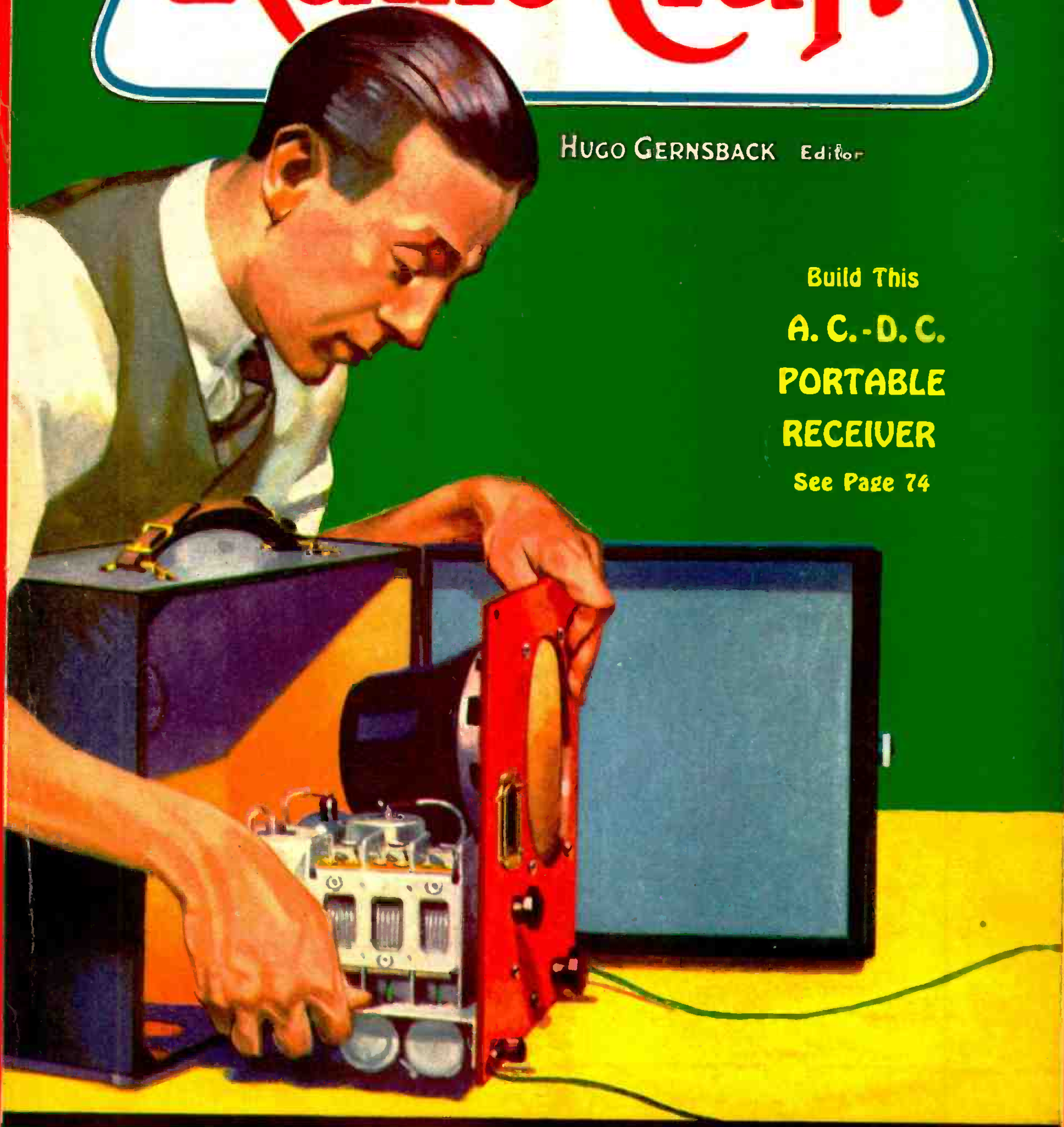

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A. C.-D. C.
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See Page 74

Eddy Current Speakers — An Ohm- and Output Meter — A "B" Tube Superheterodyne Developments — Non-Regenerative Amplification

Radio-Craft
FOR THE
SERVICE MAN · DEALER · RADIOTRICIAN

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CONTENTS OF THE AUGUST, 1932, ISSUE

VOLUME IV Number 2

IN OUR NEXT FEW ISSUES:

A UNIVERSAL SET ANALYZER to be truly "universal" must, in the light of present-day circuit arrangements, be extremely flexible in control. Read the description of the manner in which such an instrument may be constructed at low cost.

SUPER-SELECTIVE T.R.F. RADIO SETS are of particular interest when they are associated with circuits of high-gain type. The author furnishes complete construction details for a radio receiver of this nature.

TUNING METERS AND CIRCUITS to many technicians are a bit of a mystery. In this interesting article the reader is enlightened on a subject of increasing importance.

ELECTROLYTIC CONDENSERS have been perfected to an extent not realized by many Service Men and instrument designers; these advancements are discussed in an authoritative article.

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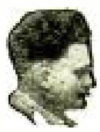

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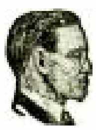

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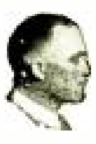

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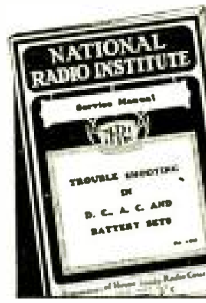

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The manufacturers of the nationally-known line of Philco radio receivers have recently taken one of the most progressive steps in the tangled history of radio servicing, and in the interests of all Service Men we wish to give the matter prominent attention in this department. We quote directly from a letter written to RADIO-CRAFT by Robert F. Herr, service engineer for the Philco Radio & Television Corporation:

"Attached to this letter you will find a copy of the new Philco Parts Replacement Catalog.

"During the past few years more and more of the radio service work has been passing from the radio dealers to individual radio Service Men and radio service companies employing a number of men. We also realize that most of the radio set manufacturers have limited the sale of their parts to their authorized dealers and also most of the radio manufacturers have priced all their parts entirely too high. Philco is starting an aggressive sales campaign on replacement parts for Philco radios and also on the sale of those parts which can be used for other radio work. This Parts Catalog supplies the necessary information on part numbers and dealer net prices. All of the prices in this catalog have been greatly reduced so that today a genuine Philco replacement part costs less in most cases than a substitute part.

"*This parts catalog is being distributed to radio Service Men in every country of the world. The sale of these parts is not limited to authorized Philco dealers; any Service Man capable of repairing a radio can secure a copy of this catalog.* We believe that this catalog will be of great help to radio Service Men because it contains the only official, complete list of the more common replacement parts in every Philco radio from the very beginning up to and including the models shown at the R.M.A. show in Chicago in June."

Considering the large number of Philco receivers that have been sold during the past several years, this liberal attitude is sure to have beneficial results for everyone concerned. We congratulate the Philco company on its wisdom and hold it up as an example to certain other radio receiver manufacturers who keep the values of resistors and condensers a deep, dark secret—and wonder why they are so unpopular among people in the trade.

Readers of RADIO-CRAFT may secure copies of the Philco Parts Catalog by using the usual Readers' Bureau coupon on this page.

56. THE GENERAL RADIO EXPERIMENTER

"The General Radio Experimenter" is a monthly house organ of the General Radio Company. It is devoted to electrical communications technique and its applications in allied fields, and contains a great deal of accurate, well-written, technical information. The May issue, of sixteen pages, has articles on a vacuum-tube bridge, an output-power meter; a beat-frequency oscillator, a standard signal generator, and a sweep circuit for the cathode-ray oscillograph. The last-named article is particularly good, and explains the need for and operation of "saw tooth" oscillators, which are regarded as complicated and mysterious by many radio men. The "Experimenter" is mailed free of charge to interested persons. *General Radio Company.*

57. EXPERIMENTS WITH THE PHOTRONIC RELAY

The experimenter who has gotten the idea that photoelectric cells require a lot of amplifiers and associated apparatus for successful operation will be surprised at the number and variety of practical stunts that can be performed with the Photronic cell without amplifiers of any kind. This cell has sufficient output to actuate a small relay directly, this relay in turn operating a slightly heavier one for control purposes. The following interesting devices are described in the booklet of the above name: a sunrise alarm to waken a sleeper; a sunset switch to turn on light; a light-beam burglar alarm; a smoke detector; an automatic alarm to announce visitors; and an automatic parking light. The ingenious constructor can readily think up numerous other applications for this versatile device. *Weston Electrical Instrument Corp.*

58. CONCOURSE ELECTROLYTIC CONDENSERS

This new catalog of electrolytic condensers will be of interest to all users of condensers, and particularly to Service Men because it describes a number of very convenient replacement units that will solve difficult service problems in some types of sets. The mounting of the replacement blocks has been simplified considerably by the adoption of a single-hole, metal strap bracket, which eliminates the large holes formerly required for many condensers of the inverted type. *Concourse Electric Company.*

59. PRACTICAL RADIO ENGINEERING

This handsomely prepared 24-page brochure describes in great detail the home-study courses in radio engineering offered by the school mentioned below. These are intended for the more advanced type of student who is interested in actual radio engineering, as they include mathematics running up to vector analysis, use of the slide rule, and even the operation of 50-kilowatt broadcasting stations. The instruction is intended to bridge the gap between college study which emphasizes the theoretical side and the "practical" courses which end with service work. The serious radio man who is looking ahead will find this booklet worth reading. *Capitol Radio Engineering Institute.*

RADIO-CRAFT 55-59
Readers Bureau
96-98 Park Place, New York, N. Y.

Please send me *free of charge* the following booklets indicated by numbers in the published list above:

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Radio-Craft
FOR THE SERVICE MAN · DEALER · RADIOTRICIAN
"Takes the Resistance Out of Radio"

Editorial Offices: 96-98 Park Place, New York, N. Y. HUGO GERNSBACK, Editor Vol. IV, No. 2, August, 1932

"TRICK" AMPLIFIER APPLICATIONS

An Editorial by HUGO GERNSBACK

LAST year, in one of my editorials, I suggested that Service Men and others connected with the radio industry can not only earn money but even a good living by installing A.F. amplifiers. I suggested that there is a great and ever increasing demand for this type of radio installation at the present time.

Besides public address and similar amplifying systems, there are many uses for amplifiers that have hardly been considered. Every day we receive letters suggesting new and useful purposes where amplifiers may be employed; and, strangely enough, we hear from laymen who have found uses for amplifiers that the radio man himself has overlooked. This clearly demonstrates that radio Service Men and others in the industry are not alive to the money-making opportunities that are now knocking at their doors.

A case in point: The recent deplorable Lindbergh case brought the fact home to many parents that additional safeguards are required for their children. Mrs. Godfrey Ludlow, wife of the well-known violinist, became so engrossed in thought on this subject that she turned inventor herself. She bought a microphone and placed it in the corner of the baby's crib and attached it to a commercial audio amplifier. This amplifier was then connected to a loudspeaker placed in her own bedroom which was some distance from the children's bedroom. This simple device worked so well that the child's breathing could be heard loud and clear through the loudspeaker in the parent's room, and the slightest noise in the children's room, such as footsteps, the opening of a window or creaking shoes would create a sufficient commotion in the loudspeaker to bring the parents instantly into the nursery.

Here, then, is a ridiculously simple device that could be sold to many families with young children. The cost is low, and the amount of current used is negligible. Why cannot Service Men and other radio people sell such a simple device at a good profit?

There are, of course, many other trick amplifier applications, and thousands of new and hitherto unthought of uses will be commonplace in a few years. Of the long list, I will only mention a few:

Every large organization, whether factory or office, has uses for amplifiers. The busy executive and general manager cannot be everywhere. He can, however, have microphones scattered all over the plant, and by pressing a button, get in touch with any part of the plant through the medium of his loudspeaker, and he will be enabled to listen-in to the various activities of his employees. The mere fact that the employees would know that their activities may be noted would often have a salutary effect, and would certainly help to raise the efficiency of the plant. It would do away with much useless talking and time wasting by employees, which in these days of efficiency is not tolerated by real executives.

Motion picture houses can bid for the patronage of the near-deaf or hard of hearing by installing a very simple device which, in some cases, does not even require a separate amplifier. If one or two rows in the auditorium are wired, and pin jacks are attached to the back of the chairs, it would be possible to plug in a pair of headphones which can be given, or loaned for a deposit to the hard of hearing; the other end of the connection going to the amplifier. Thus, the hard of hearing who never get much satisfaction from the talkies would be able, by means of headphones, to enjoy the programs as well as their more fortunate brethren.

In most dining rooms of the better apartments and private houses, there is usually a foot push-botton used to summon the maid or cook, whichever the case may be. Very often an order is to be given, and this results in much useless running about and delay. A microphone can be effectively concealed in the chandelier in such a way as to enhance the decorative effect. An artistic cord is suspended from the microphone; by pulling the cord, the microphone is put in the circuit. You talk in your natural voice, giving your order to the kitchen, where an amplifier and loudspeaker are installed. Instead of ringing a bell, therefore, the order is given orally, directly to the kitchen. This is a little innovation that will appeal particularly to many householders.

In the nursery, it is often necessary to admonish the children and keep them from talking when they do not wish to go to sleep, or to give other orders to them. At the present time, it means that the father, mother or nurse must go to the nursery in person, and close the door, etc.; thus creating further disturbance which is not always wanted. A microphone amplifier and loudspeaker is a simple solution of the problem and the scheme has actually been found to work exceedingly well in practice, because if the children hear their parent's voice, they pay attention, and the mystery of the unseen voice generally has an arresting effect upon most children.

In most apartment and private houses, there is a push-button in the master's bedroom to the servant's room or quarters. It is usually used to summon the maid or other servant. A microphone at the head of the bed, with a pull cord to make contact and a loudspeaker in the servant's quarters is a much better idea, and saves useless running around. The order can thus be given directly to the servant's room or servant's quarters. Of course, the microphone is only placed in use when the cord is pulled, making contact.

In busy restaurants, waiters and waitresses, nowadays, are apt to shout their orders to the kitchen if it is not too far away; and where the kitchen is downstairs, there is usually a good deal of useless running about. A microphone at a strategical position solves this problem to a nicety. The waiter or waitress approaches the microphone and by means of his or her foot closes a circuit, and the order is received instantly on the loudspeaker in the kitchen, much louder and clearer than it could be heard through intervening doors or other obstructions.

These are only a few of the more obvious applications of audio amplifiers. It should be a relatively simple matter for a Service Man or a radiotrician to make up a portable amplifier and give a spot demonstration. Talking about it, as a rule, means little to the prospect, but if the device can be demonstrated to him and the advantages shown, a sale can be made in most instances, and usually at a good profit.

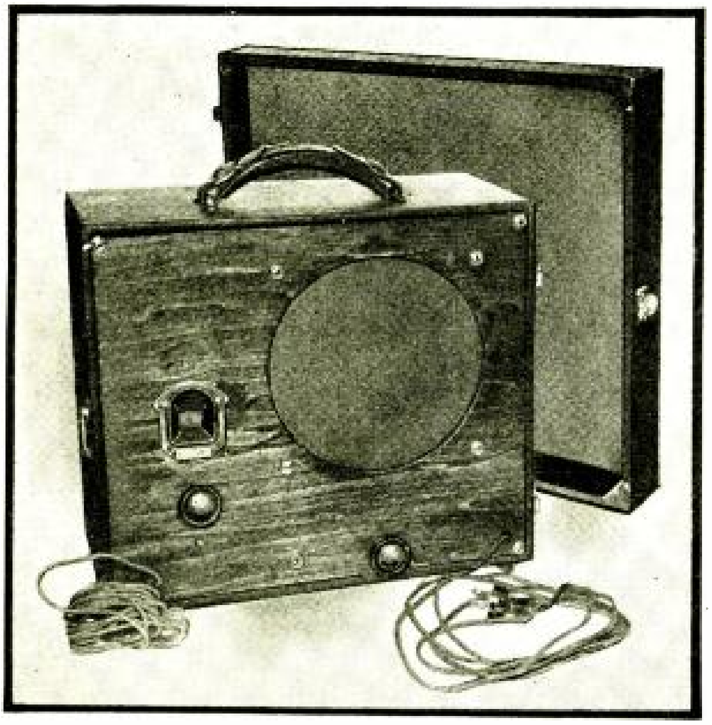


Fig. A

AN A.C.-D.C. PORTABLE RECEIVER

Construction details of a portable receiver using the latest tubes and operating from either 110 or 220-volts A.C. or D.C. without anv circuit changes.

By J. BURGESS DAVIS

THE portable receiver illustrated in Figs. A, B and C will be a boon to many radio enthusiasts who have felt the need of a compact, lightweight receiver, capable of operating from A.C. or D.C. service, with dynamic speaker quality. A ten-foot antenna provides ample pickup for good speaker volume on locals, and many distant stations have been logged with an antenna of this length. No exterior ground connection is required, as the receiver circuit is directly coupled with the lighting circuit, which in most cases is grounded at the meter and/or the pole transformer. The sensitivity of the receiver is largely due to the use of two pentodes in the R.F. amplifier. A screen-grid power detector, feeding into two A.F. pentodes with grids and plates connected in parallel, provides the audio amplification. The remaining two of the seven tubes employed are so connected as to constitute a half-wave rectifier. The tubes are all of the six-volt heater, automobile-type. Because of their rugged construction and the fact that the heaters are not critical to voltage variations over a comparatively wide range, these tubes are admirably suited for use in a receiver of this type.

The Circuit

The circuit, like most good things when properly developed, is extremely simple, as reference to the schematic drawing of Fig. 1 will prove. Due to the universal feature, the circuit is treated as though the receiver were to be operated from direct current only and the line polarity indicated accordingly. When the receiver is operated from an A.C. line, the indicated polarity holds true, since only that half of the wave which corresponds in direction to the polarity indications is used. All the heaters as well as the flashlight lamp (which is used as a pilot light) and the filament resistor R9, are connected in series across the 110-volt line. Resistor R8 is shunted across the pilot lamp to protect it from overload but is not of sufficient current rating to make it safe to operate the receiver without the pilot lamp.

In order to reduce the number of controls and to economize in space, the line-switch and volume-control are mounted on the same shaft. The side of the line connecting with the heater of the first R.F. tube is grounded to the chassis. This is effective in maintaining the same relative potential difference between cathode and heater at all times, as well as keeping this potential difference lowest at the input of the amplifier so that the possibility of amplifying hum is lessened.

The primary of the antenna-coil L1, is grounded through condenser C8 in order to prevent burning out the coil should the antenna accidently become grounded.

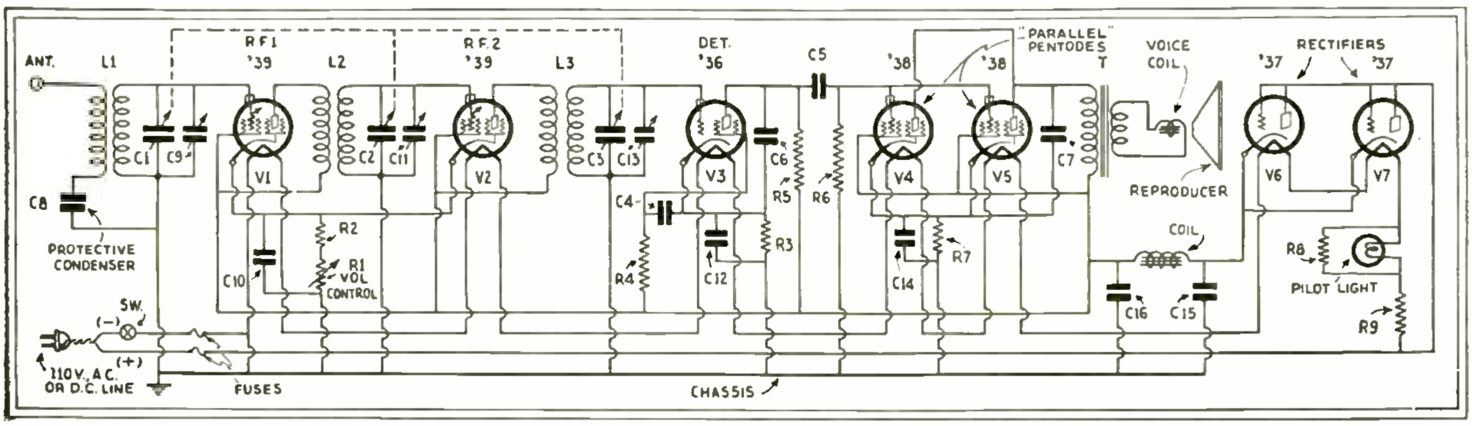


Fig. 1
Schematic circuit of the receiver designed by Mr. Davis. Note that the line plug may be inserted into either A.C. or D.C.

All grid biases are obtained in the usual manner through resistors R2, R3, and R7. Volume is controlled by means of a 10,000-ohm variable resistor R1 in series with the biasing resistor R2. The latter provides a minimum required bias of three volts on the grids of the R.F. tubes. By increasing the value of resistance in this circuit we increase the voltage drop across it and consequently the bias on the grids with a resultant decrease in volume.

Bypass condensers C10, C12 and C4 are of the .1-mf. tubular type, while C14 is a 10-mf. dry electrolytic, low voltage condenser.

Due to the universal feature of this receiver it is impossible to use an electro-dynamic speaker without adding to the cost, weight and bulk of a separate rectifying unit. If the plate-current drain were sufficient to excite the field, the speaker field coil could be used to replace the filter choke but since this is not the case a permanent magnet type was chosen. The center tap of the primary of the output transformer is taped up and only the two outside leads used. In order to provide sufficient power to operate the speaker, two of the '38-type pentodes were connected with their grids and plates in parallel.

Condenser C7 is used as a permanent tone adjustment. By the use of other values of capacity, any tone adjustment may be obtained. Increasing the capacity of C7 will reduce the high-frequency range and give the receiver a lower tone, and vice versa.

The Filter System

We now come to the rectifying and filtering system. This system has been made practicable by the advent of the six-volt, heater-type tube. A '37-type tube, when used as a rectifier, is capable of delivering about 14-ma. of rectified current. Two of these tubes with their elements connected in parallel constitute a rectifier of sufficient capacity to operate the receiver. The plate element is connected to the most positive point in the circuit (which is the side of the line opposite that grounded to the chassis). The cathode element is connected to the point of lowest potential or ground through the amplifier and detector tubes, and the current flowing through the circuit thus formed, produces the voltage drop across it.

The potential difference between any two points is proportional to the resistance of that portion of the circuit. By multiplying the total plate current by the resistance of the five amplifier and detector tubes in parallel we can arrive at the difference in potential between the cathode and plates according to Ohm's Law.

The choke in the rectifier circuit helps to smooth out the A.C. ripple while the two filter condensers also add their bit to this operation and aid in maintaining a higher plate voltage. Owing to the small amount of current flowing through the filter, the secondary of an audio transformer having a D.C. resistance of not more than 1,200 ohms can be used as a filter choke. The primary leads should be cut off or taped up. Condenser C15 is an 8-mf. electrolytic, and C16 is a 50-mf. dry-type electrolytic, rated to operate at a maximum of 100-volts D.C. and serves to reduce A.C. hum to a minimum.

Constructing the Receiver

The cabinet is constructed of one-quarter inch, three-ply veneer, nailed and glued at the joints and reinforced with hardwood corner blocks which also serve as mounting brackets for the panel. An 1/8-in. groove on either side of the cabinet, near the bottom, serves as a track for the chassis. The outside of the cabinet should be sandpapered smooth and the corners slightly rounded. It can then be finished with Duco or covered with imitation leather. Four rubber feet should be located on the bottom near the corners, and a suitable carrying handle bolted on the top. The handle should be located in the center of the top with the cover in place; that is, the handle should be mounted in the center of the cabinet and cover assembly. The inside of the cover may be lined with colored paper or cloth glued in place.

Hinges that can be separated at the joint should be used for mounting the cover and so mounted that the cover hangs on the cabinet, otherwise the cover will drop off the hinges when it is unlocked. A small spring lock mounted at the end, opposite that on which the hinges are mounted, completes the cabinet equipment.

The panel illustrated in Fig. 2 is cut from quarter inch three-ply stock. After cutting and drilling, it should be sandpapered smooth, and given a coat of walnut oil stain. The surplus stain should be wiped off with a dry cloth and the

(Continued on page 108)

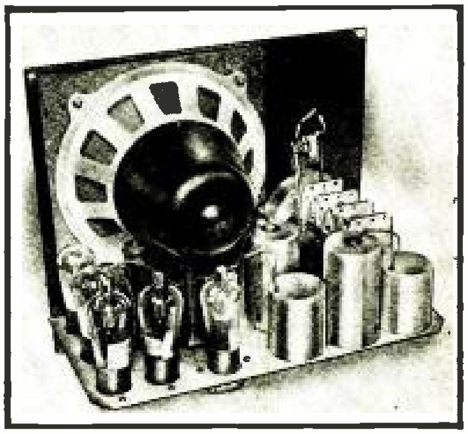


Fig. B
Rear view of the receiver.

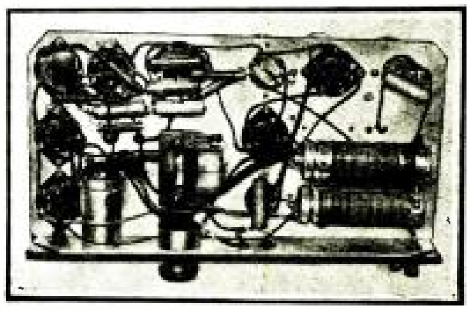


Fig. C
Under-chassis view showing the location of the parts.

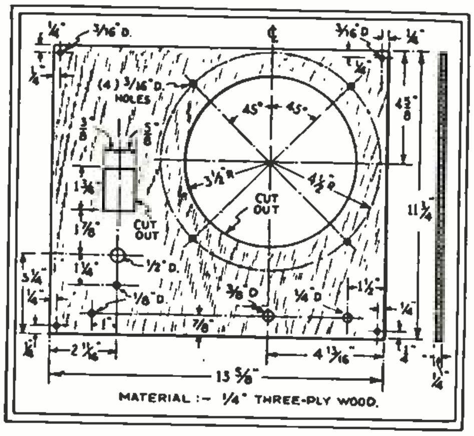


Fig. 2, above
Complete details of the panel. If the apparatus specified by the author are used, no trouble should be experienced in laying out the panel.

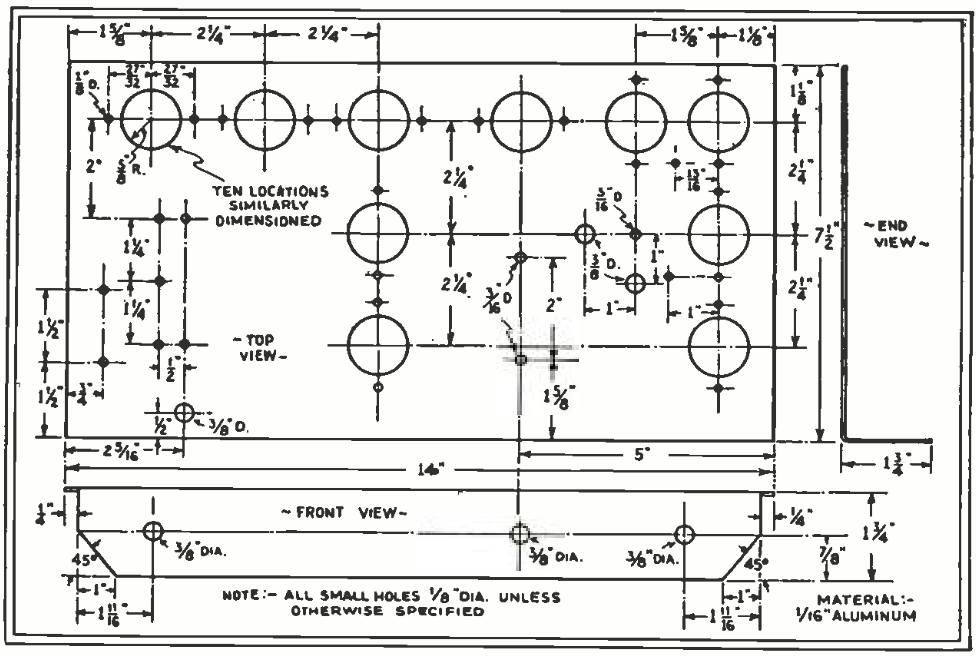
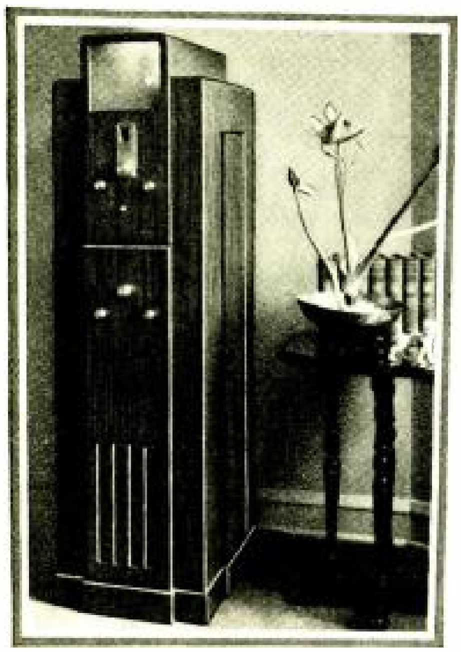


Fig. 3, right
The mechanical layout of the chassis is shown here.

THE LATEST RADIO EQUIPMENT

NEW TELEVISION RECEIVER



The Western Television Receiver.

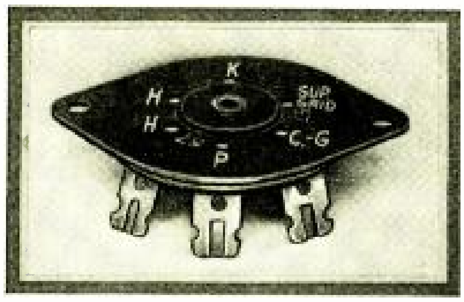
THE Western Television Corp. presents a new television receiver, incorporating two sets—one for the reception of pictures and the other for the accompanying sound transmitted in the broadcast band. A modernistic cabinet, shown above, together with a neat ground-glass screen are attractive features.

A SIX PRONG SOCKET

THE advent of the new tubes, such as the 46, 57 and 58 demands new six-prong sockets in order to properly house them. To effect this, the H. H. Eby Manufacturing Co. announces the new socket illustrated above. The socket holes are arranged in a circle, the heater prongs being of slightly greater diameter than the remainder so that the tube may be placed in the socket in only one way.

The six-prong wafer-type socket manufactured by the Eby Mfg. Co.

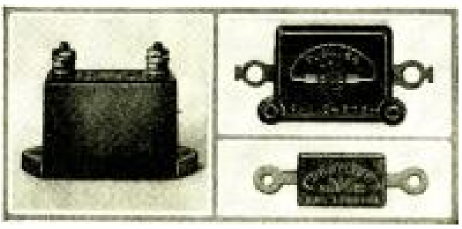
ANOTHER SOCKET



The six-prong socket by Cinch

ABOVE is illustrated another six-prong socket designed to accommodate the new tubes. As may be seen, it is of the wafer type, suitable for chassis mounting. The top of the socket is marked according to the type of tube. It is a product of the Cinch Mfg. Co.

NEW REPLACEMENT UNITS



Dubilier Condensers for replacement.

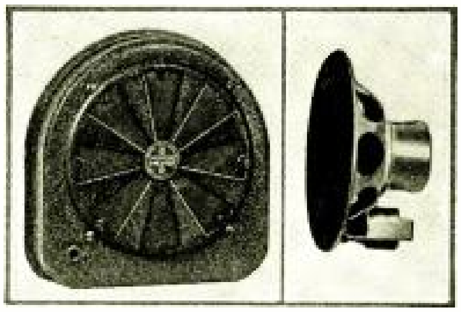
REPLACEMENT condensers suitable for nearly all types of radio replacement work have been announced by the Dubilier Condenser Corp., manufacturers of radio condensers. The illustration above depicts three of the many types available to the radio Service Man. They are made in various shapes and sizes.

SPARTON AUTOMOTIVE SET

THE new Sparton model 40 automotive receiver, illustrated here, is a typical example of what the modern auto receiver will be like. Incorporating four type '36 tubes, a '37 as the A.V.C. and a '38 output pentode in a T.R.F. connection, it represents the latest advances made in this field by the Sparks-Withington Co., manufacturers. A significant feature is the use of the Lafoy system of automatic volume control described in the July issue of this magazine.

Sparton Receiver.

VEHICLE SPEAKER



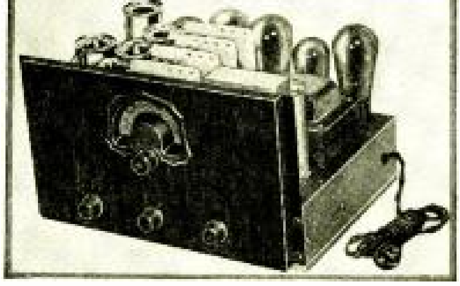
The Wright DeCoster Speaker

AUTOMOTIVE radio is in full swing, and a speaker specially designed for this purpose has been announced by Wright-DeCoster, Inc. Containing all of the features such as dust-proof cover, mounting screws, etc., it should prove a boon to set builders.

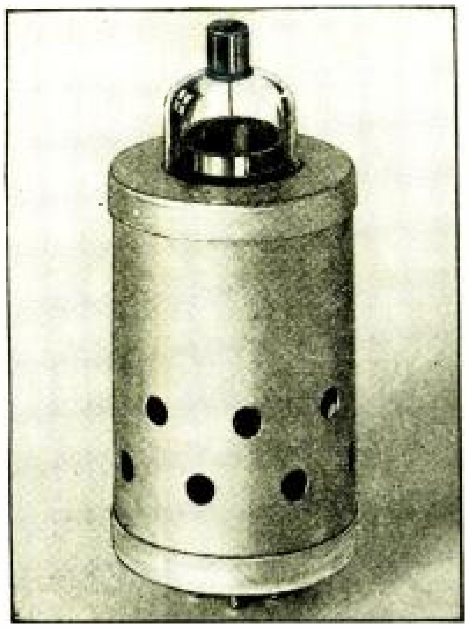
REPLACEMENT CHASSIS

THE July issue of this publication contained a data sheet of a replacement chassis manufactured by the Transformer Corporation of America, a photograph of which appears below. Statistics compiled by the above firm indicates that of the 17,000,000 radio sets now in use in this country, the apparatus in approximately 11,000,000 is obsolete!

This chassis is designed to replace existing sets and at the same time retain expensive cabinets.



A replacement chassis designed to be used in existing cabinets. A product of the Transformer Corp. of America.



The new National tube shield.

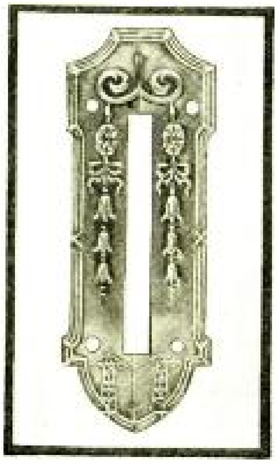
NEW TUBE SHIELDS

THE new tubes announced in past issues of RADIO-CRAFT demand an entirely new type of shield can if effective shielding is to be secured. These tubes, types 57 and 58, are equipped with a dome-shaped glass bulb which has been especially built to reduce inter-electrode capacity to a minimum.

In order to derive the best possible results from the use of these tubes, the shield can must be placed as close as possible to the internal shield in the tube. This has been admirably accomplished by the National Company, Inc., makers of the tube shield illustrated here. The tube shield inside the glass may be seen at the top while the holes at the bottom are for ventilation purposes.

TUNE-A-LITE ESCUTCHEON

IN the November, 1931 issue of this publication, there was described a new type of tuning indicator which depended for its operation upon the ionization of neon gas in a vacuum. This device was unique in the sense that the height of the neon flare was proportional to the strength of the received signal.



A Tune-A-Lite escutcheon

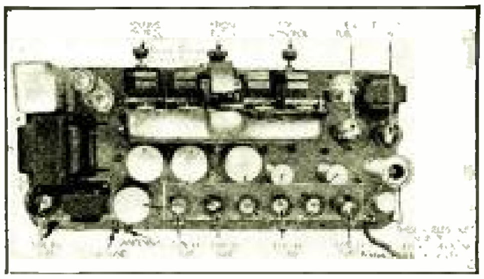
While this device has been incorporated in several commercial sets, it may also be purchased by individuals for use in home-built receivers. One of the major disadvantages of its use has been the lack of a proper escutcheon which now may be secured from Blan the Radio Man.

IMPROVED ELECTROLYTIC CONDENSER

Concourse condenser.

AN improved type of electrolytic condenser with a ribbed aluminum case has been brought out by the Concourse Electric Company. The new container is more rigid than the old smooth type, is less susceptible to denting, and has greatly increased heat radiating surface. The latter feature is important in crowded midget receivers. In the 8-mf. size this condenser measures only 3⅜ inches long and 1⅜ inches in diameter. The voltage rating has been increased from 450 to 600 volts. The instrument is intended for inverted one hole mounting.

NEW PHILCO SET



Philco 15 chassis.

THE Philadelphia Storage Battery Co. announces a new receiver chassis illustrated above, known as the "15" chassis designed for use with their models 15X and 15DX receivers.

It is an eleven-tube set incorporating four type '44 tubes in the R.F. first-detector and two I.F. stages; four type '37 tubes in the second-detector, first and second audio stages and as the oscillator; two type '42 tubes in a push-pull pentode output stage; and an '80 rectifier.

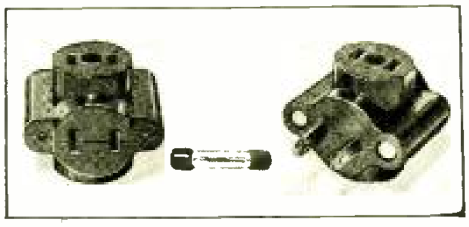
This receiver also incorporates such features as twin reproducers, tone control, automatic volume control, visual tuning and a local distance switch.

CRYSTAL DETECTOR

Crystal detector.

"HISTORY repeats itself." This well - known adage seems to prevail in the radio as well as in other fields. The amount of correspondence that we have received warrants the announcement of the device shown here.

FUSED ATTACHMENT PLUG

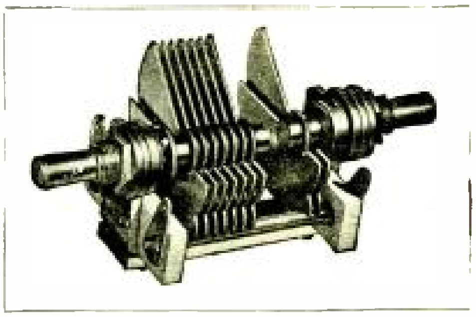


A fused attachment plug.

THIS new fused attachment plug is designed to protect radio receivers against overloads. It is made of molded bakelite, and holds two standard automobile type cartridge fuses, which are quickly replaceable. It fits in any electric fixture and provides three outlets which take the regular two-prong plugs fitted to the cords of radio and electrical appliances. This plug should be a profitable item for the Service Man, as it has good selling points and can be installed in two seconds. It is made by the Electro-Motive Engineering Corporation.

NEW "BAND SPREAD" CONDENSER

TO assist amateurs in constructing short wave receivers having the much desired band spread tuning characteristic, the Hammarlund Manufacturing Company, Inc., has designed a new type "band spread" midget condenser.



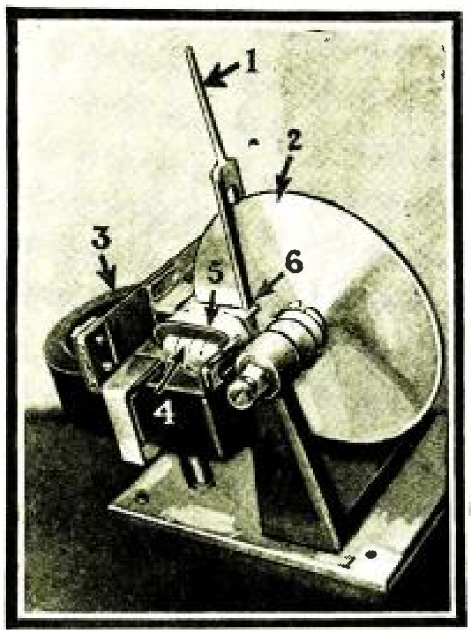
New band-spread condenser.

Two sections are provided in the condenser, one having a capacity of 100 mmf. and the other a capacity of 35 mmf. Each section may be individually tuned by its own shaft. Tuning to the center of the desired band is accomplished by the high capacity section, the low capacity section then being used for "spreading the band" and so greatly simplifying tuning within the limits of the band.

The condenser is specially designed for efficiency on high and ultra high frequencies. Isolantite is used for insulation, bearings are heavy and accurately fitted, plates are of brass, and no nuts or screws are used, all joints being securely soldered. Adapted for either base mounting or single hole panel mounting.

As may be seen by reference to the photograph above, the shaft of the condenser protrudes at both ends. The main condenser is set for the best position on any particular band and the three-plate variable unit is then used as the tuning unit.

In this manner, the tuning is spread over the entire band you are working on—hence the name.



Photograph of the Eddy Current reproducer. The numbers are discussed in the text.

EDDY CURRENT LOUDSPEAKERS

Keen interest has been shown recently in new loudspeakers. The Eddy Current Types, described herewith, offer great possibilities.

By DR. FRITZ NOACK*

THE application of amplification to all radio circuits involves the use of some form of valve action whereby a small amount of energy is used to control a much larger amount. Crudely explained, the small amount of energy required to operate an electric switch manually may produce thousands of kilowatts of power. In the same way, the small amount of energy fed into the grid circuit of a vacuum tube controls a much greater amount supplied from a "B" battery or other source.

For many years engineers have been trying to apply this same principle to the operation of loudspeakers—so that a virtually unlimited external source of mechanical energy could be controlled by a relatively small amount of energy obtained from the output of a radio set or other device. The object was to either make the loudspeaker so sensitive and efficient that audio amplifiers could be eliminated; or, with their use, enormous volume could be obtained, depending upon the design of the speaker.

The eddy current promises to attain this object! Its use allows tremendous mechanical energy stored in a rotating disc driven by an electric motor to be harnessed and controlled by an electromagnet connected to the output of a radio set in such a way that the controlled energy is translated into sound waves. Before describing the speaker it may be well to explain briefly how eddy currents may be generated in a rotating disc and their effect demonstrated.

How Eddy Currents Are Produced

Faraday showed that when a metal bar is moved between the poles of a magnet so as to cut the lines of force, an E.M.F. will be established between the ends of the bar and a continuous current will flow through an external circuit connected to the ends of the bar.

Likewise, when a metal disc is rotated between the poles of a magnet, a continuous current will be generated—but it will flow through the metal of the disc which is cutting the lines of force in one direction and in its return path will circle through the disc outside the range of the lines of force. This is clearly illustrated in Fig. 1. A is a side view and the magnetic pole, N, is on the side of the disc towards the observer as shown in the end view at B. Both poles of the magnet are shown at N and S in Fig. 1 B.

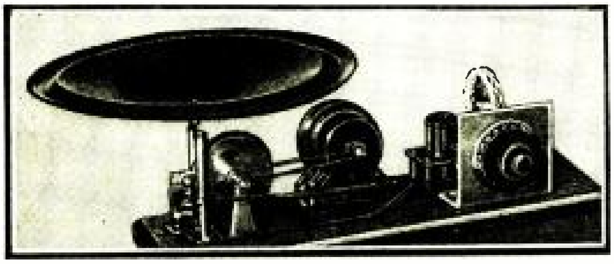
As the disc rotates in the direction of the arrows, and since the magnetic lines of force are passing through the disc from N to S, a current will be generated which will flow in the disc in the direction indicated by the arrows marked E. This current, in Fig. 1 A, flows from left to right through that part of the disc between the magnet poles, and circles around in the direction shown. If either the poles of the magnet or the direction of rotation of the disc is reversed, the direction of the generated current will also reverse. This current, because of its circular path, is called an "eddy" current.

It is obvious that the eddy current, flowing in a closed loop, will act as a single-turn electromagnet and will set up a magnetic field of its own. Since there are two eddy current loops, two fields will be created, as shown at N'—S' and N"—S" in the sketch at B. The polarities will be as indicated. It is also apparent that the eddy field N'—S' will repel the permanent field N—S, and the eddy field N"—S" will attract the main field N—S, causing a strong magnetic pull *opposite* in direction to the direction of rotation of the disc. In other words, rotating a metal disc in a magnetic field caused an appreciable drag, and such a system is used to place a load on small motors used in watt-hour meters.

The drag, of course is, proportional to the strength of the eddy current generated which in turn is proportional to the speed of the disc. The greater the speed, the greater the drag. If a pulsating external magnetic field is employed, the eddy currents will aso be pulsating and the mechanical drag on the disc will likewise pulsate or vibrate in unison. This will cause actual mechanical motion or vibration of the disc (which will increase and decrease in speed in unison with the magnetic pulsations) or the external magnet poles may be so mounted that they will vibrate under the influence of the pulsating drag, the speed remaining constant. It is this effect that is made use of in eddy current speakers. The mechanical vibrations are harnessed to a diaphragm or cone to produce sound waves and their strength varies in proportion to the speed of the disc. Therefore, to increase the volume of sound, simply rotate the disc at a higher speed.

The German graduate-engineer, Friedrich Gladenbeck of Berlin, has perfected an eddy current speaker which is likely to replace, to a certain extent, the audio amplifier. The inventor actually claims that this new loudspeaker if hooked up to the detector will give good loudspeaker reception.

The illustrations show what the speaker is like. The principle is shown in Fig. 2; it provides for an electromagnet, 1, around which is wound the coil, 2, which conducts the audio frequency current. The pole pieces of the electromagnet are marked 3. One lamination, 4, is solidly attached to each pole shoe. These laminations are made of iron and are exceedingly flexible. Their free ends, 5, are bent upward, so that two parallel end surfaces are formed. Between these two end surfaces



Another view of the Eddy Current reproducer showing the connection to the cone.

* Berlin Correspondent.

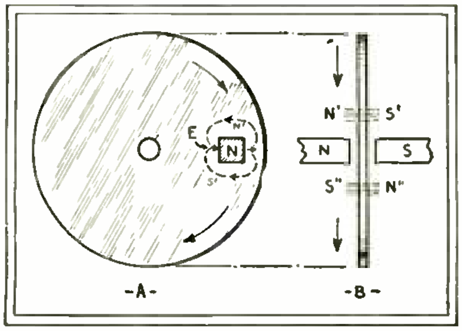


Fig. 1

The rotating disc cuts lines of force, developing an E.M.F. which causes a current to flow as shown at A; the field generated, at B.

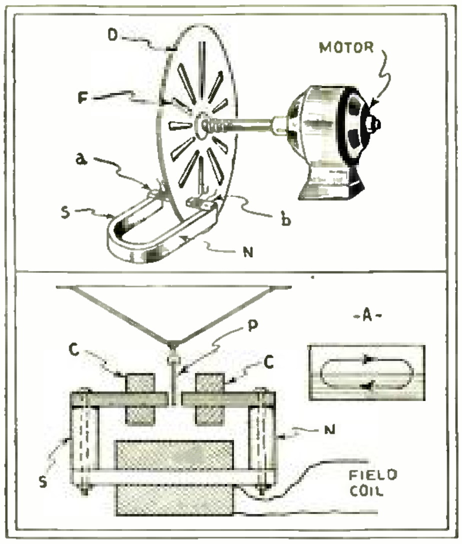


Fig. 3, above. Details of the speaker, designed by Mr. Clyde Fitch using the eddy current idea. Fig. 4, below. Still another type of speaker.

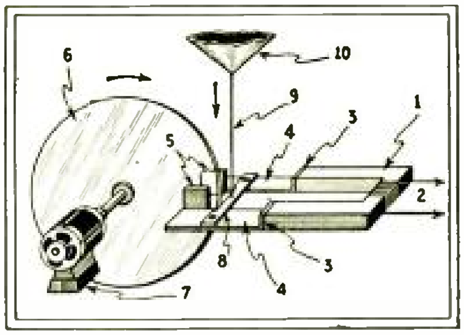


Fig. 2

Details of the Eddy Current reproducer. The theory is given in the text. In constructing this speaker, be sure that the speed is steady.

a disc, 6, rotates; which is operated by a motor, 7.

When the electromagnet, 1, is magnetized by the audio current in the coil, the two end surfaces, 5, are likewise magnetized. The end surfaces, 5, would have a tendency to swing against each other which is avoided by a bridge, 8. A connecting wire, 9, ties the cone diaphragm to the bridge, 8. If the springs, 4, are moved parallel to each other, either up or down, because of the magnetic drag, the cone, 10, through the connecting wire, 9, is also set in swinging motion.

Due to the fact that the two end surfaces, 5, are magnetized differently (one north and the other south) in accordance with the audio frequency current, eddy currents are generated in the disc, 6, setting up a field of force as previously explained. If the disc, 6, revolves, and its speed is held constant by motor, 7, then the bridge, 8, must move up and down at a frequency determined by the A.F. signal applied. Obviously, there is a certain relation between the magnetism of the cup springs, 5, their distance from each other, the material from which the disc, 6, is made, its thickness and the speed of 6.

The rotating disc has a diameter of about 3¼ inches. The diameter does not matter much but the thickness of the disc and the material from which it is made, are of importance. All sorts of discs have been tried out made of various materials, magnetic and non-magnetic. No one knows which material is really the best. The disc revolves at about 2,000 R.P.M. though it is not certain that this speed will be necessary. The distance of the end surfaces of the two springs from the rotating disc must be as short as possible.

A total degree of efficiency has already been reached which is almost double that attained by standard types of magnetic loudspeakers. However, further improvement may be necessary before going into production so as to decide what material is best suited for the disc, how thick it should be and the number of revolutions necessary for satisfactory operation. Only a small amount of power is required by the starter motor.

Toy motors may be run by storage batteries to drive the disc. If a battery-operated radio set is available, its battery may be used to run the motor. Inasmuch as the loudspeaker is supposed to have a much greater degree of efficiency, the radio receiver may be equipped with fewer tubes and the extra power made available for the motor. If electric lighting circuit is available, this current would, of course, be used to run the motor. Inasmuch as many electrodynamic loudspeakers need an exciting current, the special current supply would not present any difficulties.

Commercial Application

An eddy current speaker developed by Clyde Fitch in this country makes use of a rotating disc in a somewhat different manner. The principle is illustrated in Fig. 3. In this case the external magnetic field is rigidly fixed so that it will not vibrate, and the disc is made of very light material, such as aluminum, and attached to the motor shaft through a spring so that the vibrations will take effect *in the disc*, and the *speed of the disc will vary at an audible frequency*.

This variation in speed is transformed into sound waves by means of small fins F placed on the disc. These fins continually stir up the surrounding air due to the steady rotation of the disc; when the rotation wanes in speed, the vibrations are transferred to the surrounding air by means of the fins. Experimental work is still being done on this unit and definite data on its construction and operation cannot be given out at this time.

Another type of speaker that has been thoroughly tested and has proved equal to the average dynamic speaker is shown in Fig. 4. This is also an eddy current speaker but has no rotating or moving parts other than the motion of the armature and cone.

This speaker consists of an electromagnet connected to a D.C. source so as to magnetize the poles N—S. Laminated ends are placed on these poles forming a narrow gap in which the aluminum plate P is suspended. The coils C carry the audio frequency currents from the output of the radio set. These currents cause a fluctuation of the magnetic lines of force that pass through the plate P and hence induce similar currents in P. Since one half of P is exposed to the magnetic field, the induced currents will flow through this half and return through the unexposed half, as shown in the sketch at A, Fig. 4. The shaded area of this sketch indicates that part of the plate which is exposed to the magnetic field.

Since there is a permanent D.C. field passing through the plate, and an alternating eddy current flowing through the plate between the pole tips, the plate will be set in vibration for the same reason that the voice coil of a dynamic speaker is set in vibration when carrying audio currents. The plate is attached to a cone, as shown, to which the vibrations are applied.

The moving parts of this speaker can be made very light, and in this way the frequency characteristics can be controlled so as to give faithful reproduction.

Conclusion

This article only attempts to outline some of the work which has been done along these lines. From the results obtained to date, it appears that in the not too far future, commercial loudspeakers will be available using the ideas outlined in this article.

The experimenter finds here a very fruitful and virgin field for experimentation. It is but a simple matter to construct a speaker as suggested in the article, and after noting the results obtained at first, change the constants of the units one at a time until best results are secured.

In the photograph shown on page 78, the numerals have the following significance: (1) connecting pin to the cone; (2) rotating disc; (3) permanent magnet for supplying the constant magnetic field; (4) transformer for applying the audio signal; (5) transformer core; and (6) pole face.

The photograph in the lower part of the same page shows an eddy current speaker connected to an R.F. tuner. As stated previously, no audio amplifier is necessary as the speaker is sensitive enough as it is.

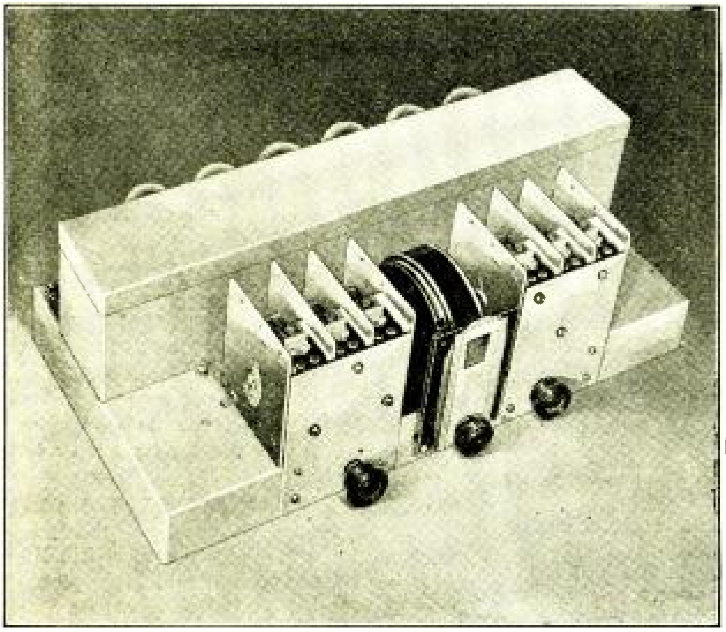


Fig. A
Photograph of a laboratory model of the six-tube "Plerophone."

Non—Regenerative

By WALTER M. CUSICK

AT a recent demonstration in Fordham University, a distinctly new method of circuit connection which makes possible a degree of amplification, from a given tube, heretofore considered impossible with all but high-mu tubes, was announced. The novel feature of this connection lies in the fact that the receiver is free from all forms of oscillation, thus reducing the noise level to a minimum.

Laboratory models of receivers incorporating this new principle have been given the name "Plerophone" and patents for same have been granted to its inventor, Prof. Joseph J. Daley of Boston College. Photographs of two types of receivers using the new system are shown in Figs. A and B. A schematic circuit of a six-stage set is in Fig. 1 and of the four-stage in Fig. 2.

Theoretical Considerations

Receivers in general use today have inherent characteristics which tend to increase the distortion in the output. In the first place, the amount of amplification obtainable from a given tube is limited primarily by oscillation. If the impedance of the load of an R.F. stage is increased in order to secure a reasonable gain, oscillation will result, and the impedance must be decreased in order to secure stable operation. If the impedance is maintained constant, then some external means such as suppressor resistors, neutralization and balancing methods etc. must be employed in order to prevent this oscillation. The latter only tends to prevent oscillation *after it is generated* and does not get at the *source* of the evil—the load impedance. The Daley system overcomes this difficulty.

Secondly, most receivers have the primary of the R.F. transformer connected directly in the plate circuit of the tube and, consequently, the current through the primary, and hence the magnetic field generated, varies above and below the value determined by the D.C. plate current flowing when no signal is impressed. Thus, slight variations in modulation (due to the audio signal to be heard) are obliterated. The Daley system eliminates this.

A third fault that arises in connection with most commercial receivers is the non-uniform amplification over the broadcast band (or short-wave band). This has been corrected in present-day receivers to some extent by the addition of a small amount of capacity between the primary and secondary of the R.F. transformer in the form of a loop of wire from the plate to the grid-end of the transformer. However, much of what is to be desired is included in the system to be described.

Each of the above items will be discussed in turn.

Elimination of Regeneration

Theory indicates that when an inductance, capacity and resistance are connected in series and the terminals connected across a source of alternating current of variable frequency, there will exist one frequency at which the current through the circuit is a maximum, and furthermore, the *value* of this maximum current is determined solely by the resistance of the circuit. This frequency at which maximum current flows is called the *resonant* frequency of the circuit, and the circuit is said to be in *resonance*. Now, with a given E.M.F. applied and the current a maximum, the impedance of the circuit must be *low*, else maximum current could not flow, the current is in phase with the voltage and the circuit acts as though it were resistive only.

This principle is the basis of operation of all radio receivers, with the exception that the coil and condenser are connected in parallel, and at resonance, a *minimum* current flows. If a minimum current flows, the impedance of the circuit is a *maximum*, else minimum current could not flow.

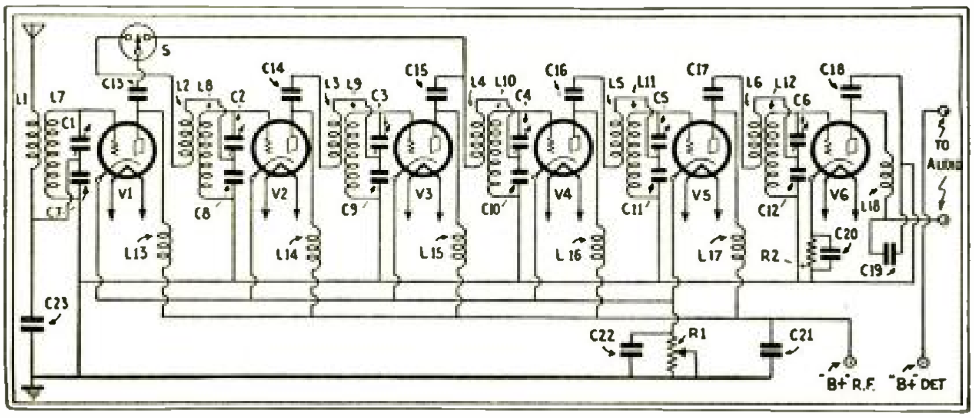


Fig. 1
Schematic circuit of the six-tube Daley receiver using the new system of tuning. The switch S is used so that either six or four tuned stages may be employed at will. In view of the fact that the receiver has been made for battery operation, no power pack has been shown.

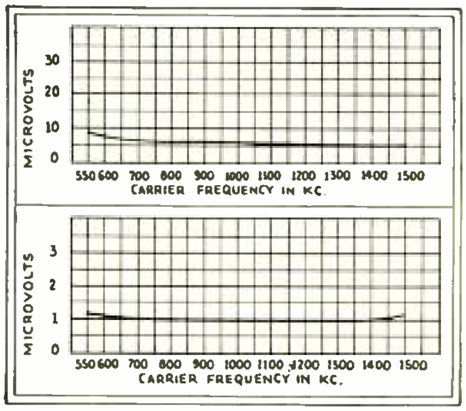


Fig. 4
Sensitivity curve of the six-tube receiver is given above, and of the four-tube receiver, below.

Amplification

A description of a new type of receiver in which the tuning system is so arranged that oscillation is impossible.

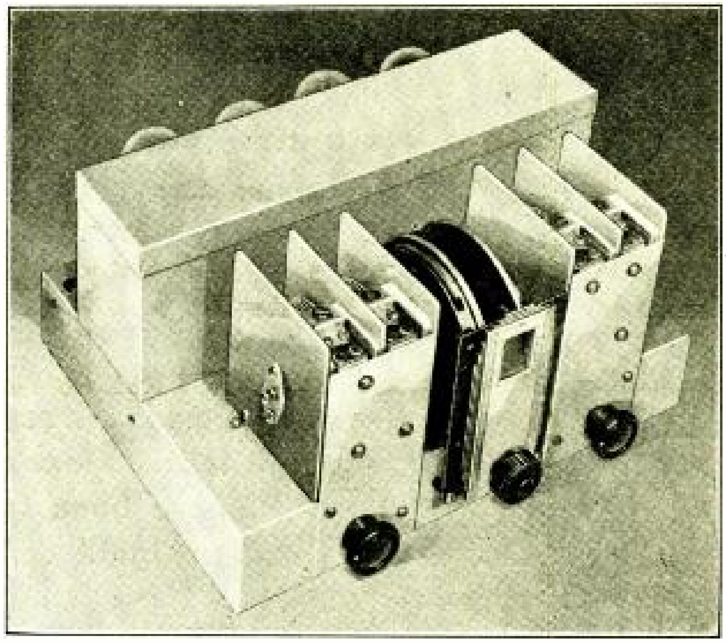


Fig. B
Photograph of the Daley four-tube receiver.

With this latter method of connection, which is used substantially in all present-day radio sets, the load impedance of the tube is a maximum and oscillation results, with the aforementioned limited amplification.

Figure 3 is a schematic circuit of the Daley system in its essential form. As may be seen, the plate P of a tube connects to the grid of the succeeding tube through a complex circuit arrangement. L1 is the primary of the R.F. transformer; L2, the secondary of the transformer; C3, a tuning condenser; C2, a fixed condenser G, the grid of a tube; C1, a fixed condenser; and R.F.C., an R.F. choke.

The primary L1 is coupled to the secondary as shown, the mutual inductance being indicated by M. The plate voltage for the first tube is conveyed via the choke R.F.C. in order to eliminate the D.C. from the primary of the transformer (this will be discussed later), and the condenser C1 is inserted in order to isolate the high voltage from the grid of the second tube; thus R.F.C. and C1 may be temporarily disregarded as far as circuit operation is concerned.

The signal from the plate of the tube V1 in order to reach the grid of V2 must pass through L1 and the complex tuned circuit consisting of L2, C2 and C3. The transfer of energy occurs in two different ways: First, because of the coupling between L1 and L2 (due to M) and second, because of the capacity coupling (due to the combination of C2 and C3). *In other words, C2 and C3, in series not only tune the coil L2 to the desired frequency, but transfer energy from L1 to L2.* When C3 has a low value, the combined capacity (of C2 and C3) is low and when turned to maximum value, the combined capacity is high. In any event, since the tuned circuit is in resonance with the signal to be received and *connected in series with the plate of V1 and the grid of V2, the net reactance of the circuit is zero* and the load of the tube V1 is purely resistive. Therefore, since the load is resistive, the tube *cannot* break into oscillation.

Uniform Response

The energy induced in the secondary of the transformer by the primary increases as the frequency increases. This means that, ordinarily, the response of the set would be greater at the high-frequency end. But in this receiver, the energy transfer is not only due to electromagnetic coupling but also to capacitative coupling, and since the tuning condensers are so arranged that they constitute a coupling medium as well as a tun-

(*Continued on page 109*)

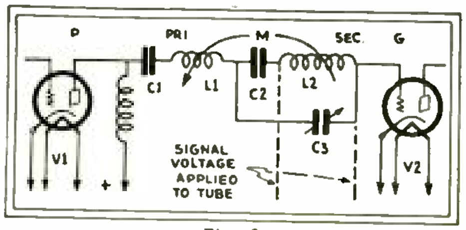


Fig. 3

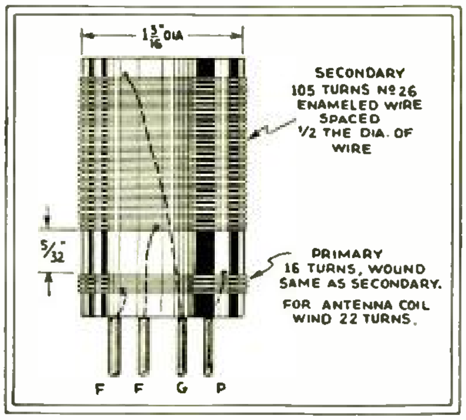


Fig. 7

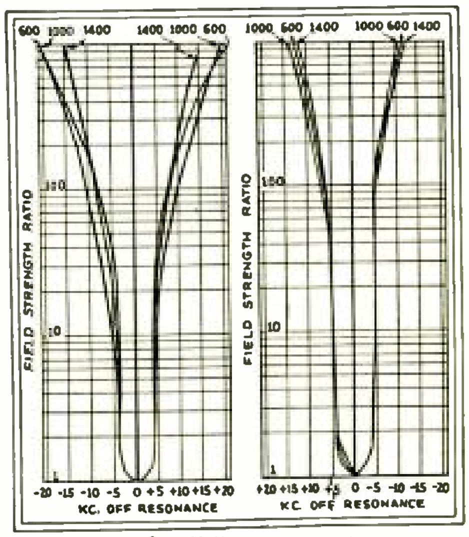


Fig. 5, left. Selectivity curves of the six-tube receiver.
Fig. 6, right. Selectivity curves of the four-tube receiver.

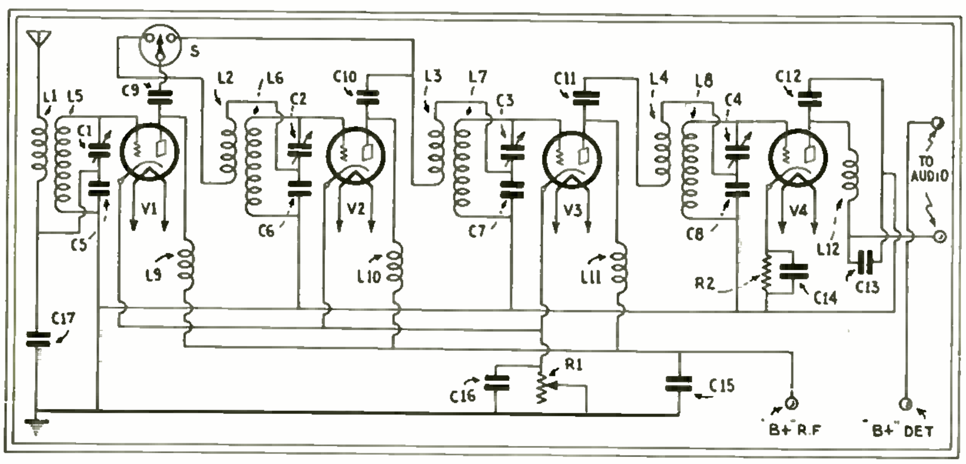


Fig. 2
Schematic circuit of the four-tube "Plerophone," designed by Prof. Daley. The switch S is thrown to the left when four tuned stages are to be used and to the right when three are to be used. Thus the sensitivity of the set may be varied for individual conditions.

A TINY-TUBE A.C. LOUDSPEAKER SET

A midget receiver that truly deserves its name. Not only is the speaker diaphragm of unusual design but the tubes have been specially built for the set, they, too, being of "midget" construction. Here is something for set manufacturers to shoot at.

By J. V. CAPICOTTO*

A 6-TUBE radio set which might well be termed a "depression special" has just made its appearance on the market. The entire receiver has outside dimensions of only 10x10½x6½ ins. and includes an electric clock which operates independently of the receiver; the list price is less than twenty dollars. The Model 8 set, used as the basis of this article, weighs only 14 lbs.

Perhaps the most interesting of several features which have not been incorporated in previous instrument designs is the use of the Rochelle-salt crystal reproducer unit and its method of driving the unique diaphragm. Since a limitation imposed by the dimensions of the cabinet precluded the use of a standard cone diaphragm and motor, the diaphragm material has been designed to fit inside of the cabinet in the form of an inverted-U, as illustrated in Figs. B and C. The two extending arms are driven at the two extremities through the medium of leverage bars, one on either side, which are set in motion by a crystal reproducer unit of double-action type, illustrated in Fig. B.

Tone Quality

As described in the article, "The Rochelle Salt Crystal Reproducer," which appeared in the July, 1932, issue of RADIO-CRAFT, the crystal element *without a load* is responsive from 0-500,000 cycles! Consequently, the resulting tone quality of a reproducer incorporating this motor element is almost entirely a function of the diaphragm material and its method of mounting.

In Fig. F is shown the manner in which an aperture is made into each side of the cabinet to enhance the tonal effect; the illusion of reality is completed by making openings in the base and raising the cabinet about ½-inch, on rubber feet.

Since the reproducer diaphragm thus fits almost snugly against the inside wall of the cabinet, there is ample room for the compact chassis which is shown in position in Fig. A.

As illustrated in Fig. 1, the circuit of this receiver varies but little from standard design. However, it is interesting to note that since the crystal reproducer is strictly a voltage operated device, it is convenient to use *a resistance load* in place of the regular output transformer; and as the tubes are connected in push-pull, this resistor is center-tapped. In this manner the tone quality is enhanced; and also there is effected a considerable reduction in the space required for the output coupling unit.

Dwarfed Tubes

It would be quite impossible to achieve the remarkable small dimensions of the chassis illustrated in Fig. E were it not that there has been developed for use in this chassis *an A.C.-type tube having di-*

* Radio Products Corp.

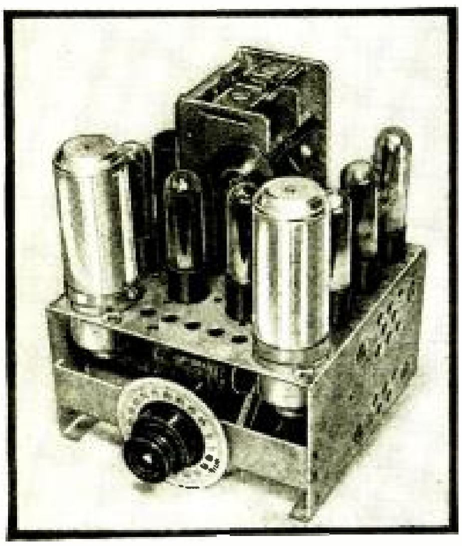


Fig. E
An excellent chassis view.

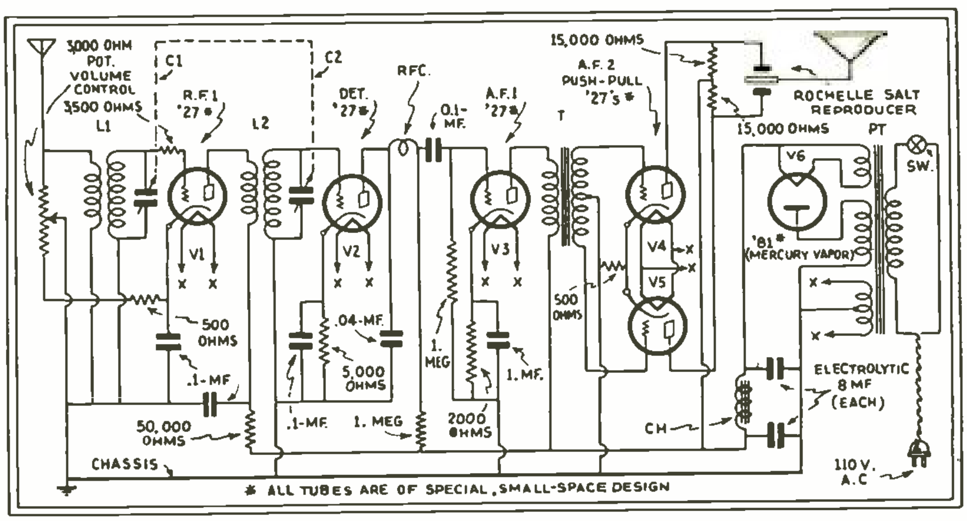
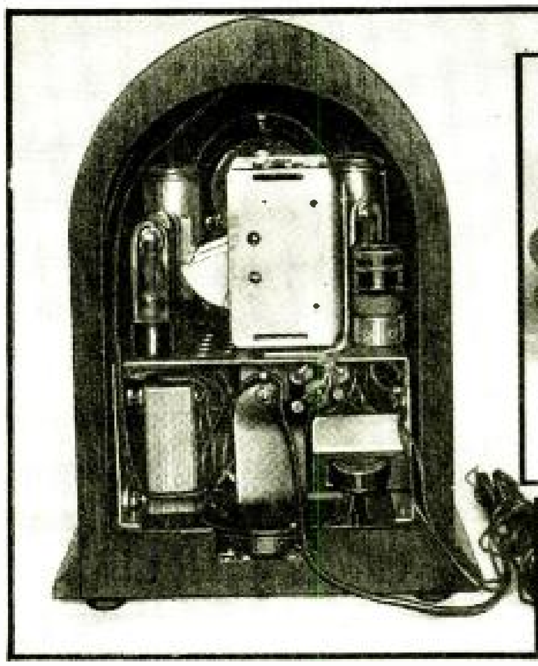
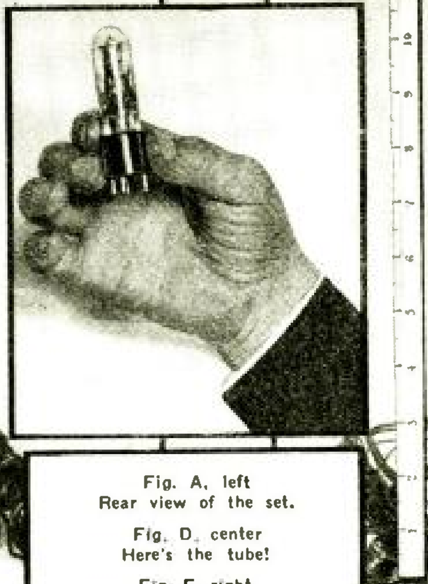


Fig. 1
Schematic diagram of the receiver using the small tubes.





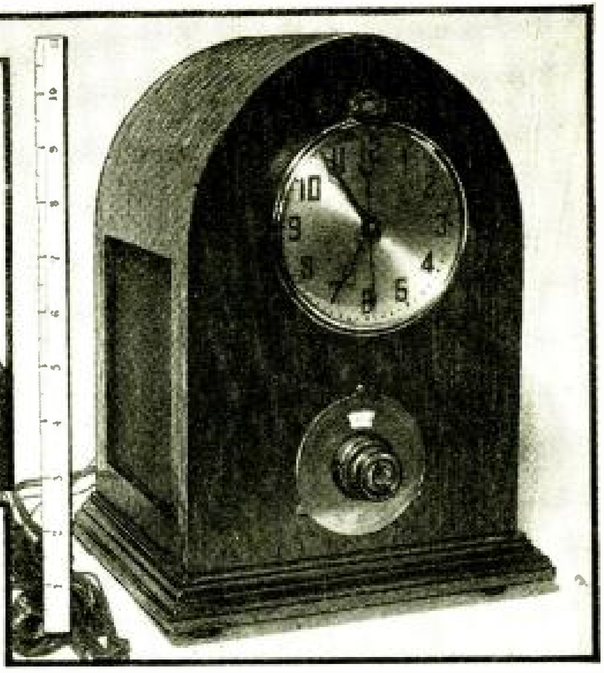


Fig. A, left
Rear view of the set.

Fig. D, center
Here's the tube!

Fig. F, right
Front view of the set.

mensions smaller than those of any tube of similar type at present available; its minuteness is realized by the comparison exhibited in Fig. D: the outside diameter of the tube is only ¾-in. and its total length is slightly less than 3 in. The electrical characteristics are the same as those of standard '27-type tubes. In fact, by special design of the elements, even the same inter-electrode capacities have been obtained; thus it may be used as replacement for present '27-tube tubes by the use of an adapter.

These "Lilliputian" tubes are of the quick-heater type and although they have a cathode they do not use the customary insulating material such as a ceramic, between the cathode and heater; the latter is automatically located in the center of the cathode sleeve by means of two insulating bushings and spring tension on the heater absorbing expansion and contraction to prevent the heater shorting to the cathode.

As indicated in the schematic circuit and the photographs, a two-gang tuning condenser is used, one section tuning the R.F. amplifier circuit and the other the detector. The latter is resistance-capacity coupled to a single stage of A.F. amplification which drives two of the midget tubes connected in push-pull.

The rectifier in this receiver is a mercury-vapor tube of the half-wave type; its envelope, in size, matches the other tubes in the set. Since the voltage drop within a rectifier of this design is only about 15 volts, it is unnecessary to apply an external A.C. potential of more than 230 volts. Note that the filament of this tube consumes 2 amperes at 1.5 volts.

By an ingenious arrangement of the drive-cable, it has been found convenient to spread the dial readings of 0-100 over a full 360-*degree* scale, as shown in Fig. E.

The author believes that in this receiver has been achieved a design which will enable the public to have a radio receiver in more than one room—for instance, in sun-parlors, bed-rooms, etc. The color schemes which these various services demand will be met by the various finishes of the cabinets.

Experimental models incorporating the features described in this article have performed so well it is contemplated to extend the design to include several other circuit arrangements.

Increasing Sensitivity

For instance, it has been found that many people would like to have a set in which the same reproducer arrangement is followed, and in which the same type of tubes are used, but with a much greater sensitivity to power ratio than is possible in the present design. Naturally, this will take the set out of the "dwarf" class, since the additional stages of amplification will require considerably more space for the added tubes and associated equipment.

Nevertheless, by following the original design, and merely enlarging it to include the additional components, it still is possible to produce a set which, point for point, will have considerably smaller dimensions than could be obtained by following previous instrument designs.

Even in the planning of a portable set for battery operation, in which might be used earlier types of tubes, such as those generally classed by filament rating as "2-volt" or "6.3-volt," it still will be of considerable advantage to incorporate the inverted-U diaphragm and crystal motor type of reproducer. In the first place, this type of reproducer consumes practically no current; in the second, it is exceedingly compact. Tone quality is exceptionally fine on the higher frequencies; the quality of reproduction in the lower register is mainly a matter of obtaining a large baffle area.

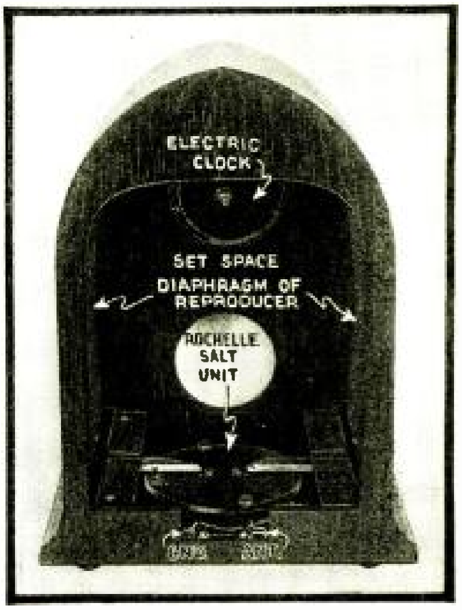


Fig. B
View showing the location of the diaphragm.

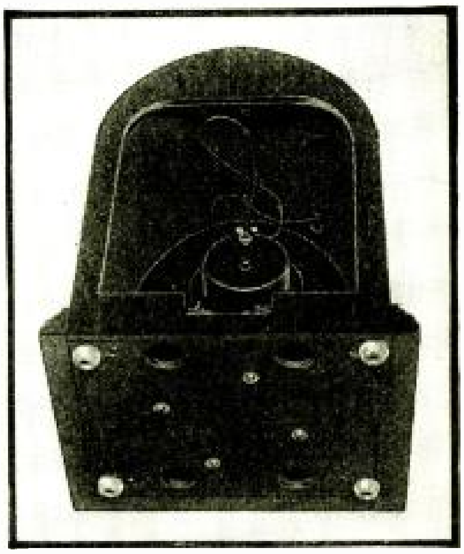


Fig. C
Bottom of the set showing the location of the "air holes."

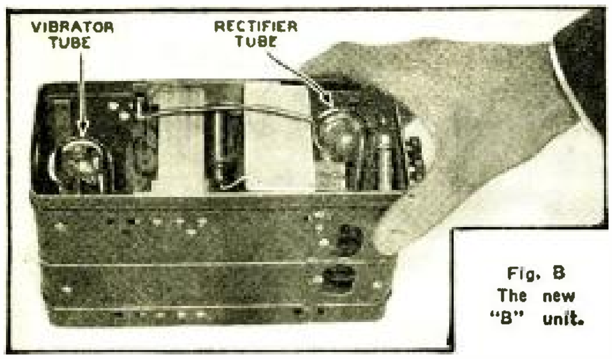


Fig. B
The new "B" unit.

THE "B" TUBE

Here, at last, is a tube designed to convert D.C. into A.C. at all standard voltages. It is especially recommended for auto use.

By ALVIN B. BEDROSSYAN

AUTOMOTIVE radio "B" eliminators may be classed under two main groups,—

1—Rotating types, and,

2—Vibrating types.

The first group may again be subdivided into three types:

I. A small D.C. motor with an extra winding on the armature for generating high potentials in the order of 150-200 volts, pulsating D.C. A rectifier is not necessary, but a suitable filter is required.

II. Converters having a D.C. input and an A.C. output. Both rectification and filtering are required.

III. Devices that have a D.C. input which is chopped or broken up by the brush and commutators, and then fed into a transformer which delivers a high voltage ready for rectification and filtering.

Brush and commutator trouble, cost, and sales resistance to purchase of rotating equipment, are reasons for making general acceptance of these units rather difficult; although undeniably they serve the designated purpose.

Fundamentally, all vibrator-type "B" eliminators consist of a breaker or interrupter, step-up transformer, rectifier, filter system and, for best results, a voltage divider. By far, the most troublesome factor is the breaker or interrupter; the contacts stick rather frequently and although this may be cured to a large extent by employing suitable magnetic and ballistic means, another snag is encountered. The electrical arc or sparking at these points soon causes the contacts to oxidize, pit and, finally, become destroyed.

Vacuum Contacts

Numerous metals and alloys were tried in an effort to overcome this latter difficulty, but in general, the desired results were not forthcoming when operating in open air; therefore, the writer resorted to the logical expedient of enclosing the interrupter mechanism in an evacuated bulb.

Immediately, long life, stable operation with no fear of sticking (due to the lack of oxygen which plays havoc with the best of contacts) and permanence of adjust-

(*Continued on page* 110)

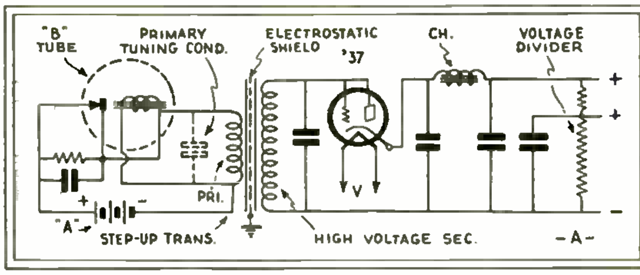


Fig. 1

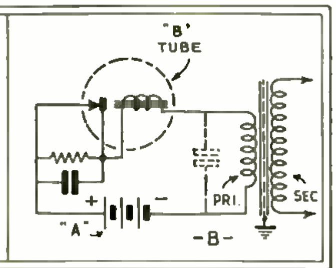


Fig. 2

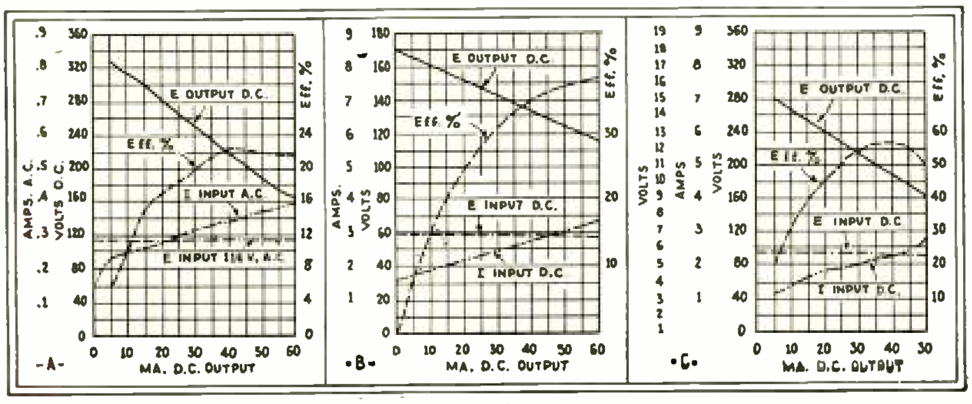


Fig. 3

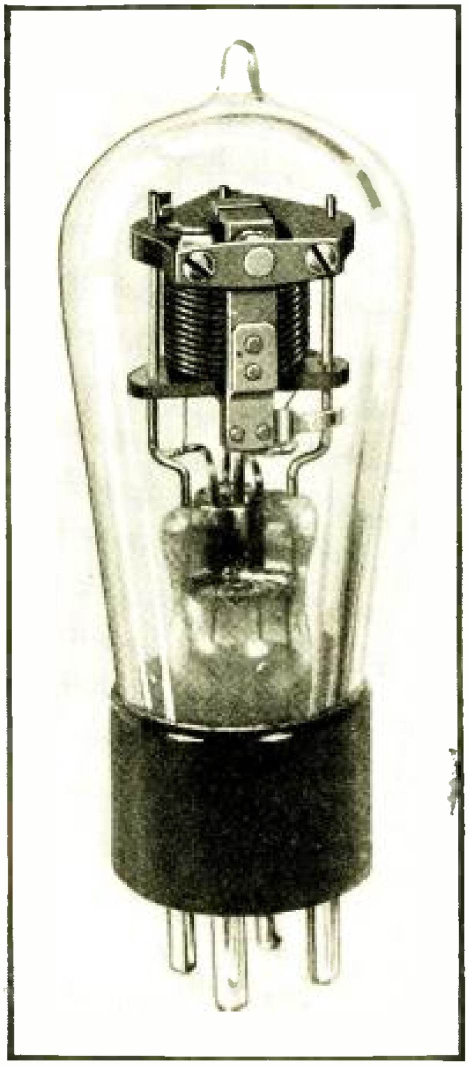


Fig. A

ELECTRIFYING THE "MEGADYNE"

The now famous "Megadyne," described in the July issue of this magazine, may be electrified by the addition of this simple power unit.

By HUGO GERNSBACK

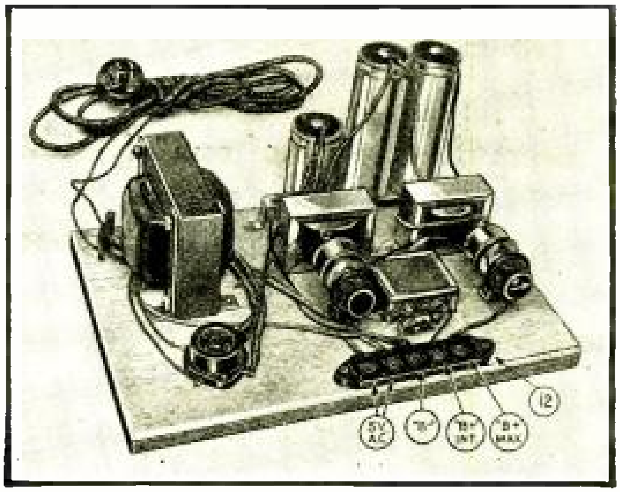


Fig. A. Photograph of the Megadyne's power unit.

IN the July, 1932 issue of RADIO-CRAFT I described a battery-model "Megadyne," the loudspeaker set that requires only one tube—a pentode, and a crystal. In the following description will be found all the details for operating this remarkable receiver from the house current, thus entirely eliminating batteries.

The only fundamental difference between the battery set and the electric set, is the use of a simple "B" eliminator. The original set was designed to use a "uni-potential cathode" type of tube, the '38, which possesses two outstanding advantages: First, the rugged filament may be operated with full efficiency under wide fluctuation in the D.C. voltage supply. Second: the thermal lag of the heater, and the uni-potential characteristic of the cathode, prevent the reproduction of hum when the filament is supplied with raw A.C. at approximately the rated operating potential of 6.3 volts.

This essential unit for electrifying the Megadyne, the "B" eliminator, is illustrated photographically in Fig. A; Fig. 1 gives a pictorial diagram of connections and the schematic circuit is shown in Fig. 2.

Although this unit has been built up in "breadboard" style, for convenience in illustrating, the experienced constructor will have no difficulty in making a more compact arrangement. Inexperienced constructors are cautioned to observe a few fundamental rules, should they desire to revamp the parts layout to suit a particular condition.

If a metal chassis is desired, the builder is urged to use *only* the parts specified in order to obviate, so far as possible, inoperation due to faulty units, grounds, and shorts; for the "Megadyne" receiver, in wiring and electrical action, is like no other, and trouble-shooting may present some difficulty to inexperienced technicians.

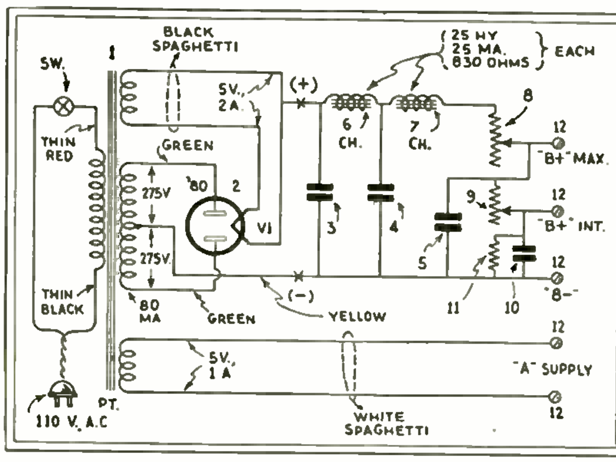
An important point, and the one to which particular attention *must* be paid, is the adjustment of variable resistor 9 which controls the voltage at terminal B-PLUS INT.—the potential for the control-grid (cap lead) of the '38. *If this potential is permitted to exceed a certain critical value the grid will be seen, in a darkened room, to glow cherry-red, and continued application of this voltage*, which is considerably beyond the setting for best operation, *will result in the destruction of the pentode.*

For maximum bass response it was found best to use a type '80 tube as the rectifier 2; the power transformer must be designed to deliver secondary potentials of 5 volts; 5 volts and 275 volts on each side of the center tap of the secondary.

Residents of D.C. districts may be interested to note that by breaking the leads of this power unit at X, to eliminate the power transformer and rectifier, and connecting the two wires to the 110 V., D.C. power-line leads having the polarities indicated (reversing the plug in the socket will check this condition), D.C. plate supply will then be available; the final step, to obtain filament current from the power circuit, is to connect the filament terminals to the light-line, with a 35- or 40-watt lamp in series. Suitable fuses *must* be connected in both sides of the power line; a ground is not necessary, a .01-mf. fixed condenser should be connected in series with the aerial.

Due to the design of this power unit, it is possible, whether operated from 110 volts D.C. or A.C., to secure very flexible control of the output potentials, by adjustment of resistors 8 and 9. Electrolytic bypass condenser 5 is particularly effective as resistor 8, in addition to act-

(*Continued on page* 109)



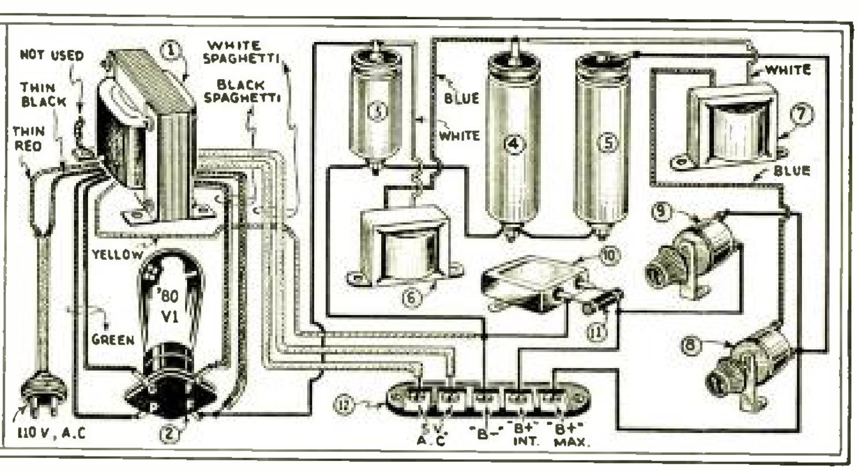
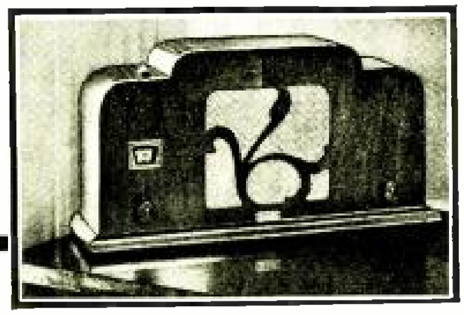


Fig. 1, right. Pictorial layout of the parts of the Megadyne. The numerals correspond to those in the diagram at the left, Fig. 2.

THE "3-TUBE" AUTODYNE SUPERHETERODYNE

A description of one of the first commercial receivers to use the new 57, 58 and Triple-Twin tubes.



A photograph of an early model receiver using the principles discussed in this article.

By R. H. G. MATHEWS*

IN an effort to produce a radio receiver economical in cost and small in size, but with enough sensitivity to allow good distance reception without sacrificing one-channel selectivity, the "3-tube" (4 tubes with the rectifier tube) autodyne superheterodyne described in this article was produced.

While many thousands of 4-tube tuned-radio-frequency sets have been sold, their primary appeal was that of size and cost, but their performance was fit only for local reception in metropolitan areas; while all attempts to improve their sensitivity were made at a sacrifice of selectivity. Although sufficiently sensitive to give distance reception, a set of this type is unable to do so because of broad tuning.

The superheterodyne obviously should be the ideal "3-tube" receiver circuit because sensitivity can be secured without sacrificing selectivity; and also because with this circuit, it is very easy to obtain equal sensitivity, i.e., equal performance from one end of the tuning band to the other.

Until the advent of the modern version of the autodyne circuit, a "3-tube" superheterodyne was at best a makeshift; since prior to this the only available detector-oscillator was the dynatron.

The dynatron oscillator depends on the "secondary emission" from a non-carbonized plate for its operation. Consequently, *the introduction of carbonized elements in modern tubes has completely eliminated the dynatron from practical consideration.* Moreover, the dynatron possesses no gain in itself, whereas with an efficient autodyne oscillator, a gain in this stage of close to 100 may be accomplished!

The advent of the new type 57 and 58 tubes makes the "3-tube" autodyne superheterodyne an ideal small radio because of the tremendous gain secured by the use of these tubes. The additional use of the triple-twin output tube, type 295, avoids the use of an ordinary combination detector-output tube, which is highly satisfactory.

* R. H. G. Mathews & Associates.

The Receiver

Complete circuit diagram, parts identification table and parts list are shown in accompanying illustrations. In building a set employing this circuit, special care should be taken to place inter-connected parts as closely together as possible and to avoid long or closely coupled leads. Because of the high gain, complete shielding of the first two tubes is essential. The use of the new type metal shield, especially designed for use with the peculiar shaped envelope of the 57 tubes, is recommended.

In this design, use is made of one of the harmonics of the autodyne oscillator to provide, through a S.P.S.T. toggle switch, short-wave reception in addition to the regular broadcast reception. This part of the circuit is made up of the adjustable condenser C15, the inductance L4 and the switch SW.1 and should cover a band of from 90 to 200 meters.

An intermediate frequency of 262.5 kc. is used to avoid too many image repeats and the necessity of an additional tuned stage, which not only adds to the cost of the receiver, but also increases its size.

Properly built and adjusted, this "3-tube" receiver should have an overall sensitivity of approximately 10 microvolts absolute, and a band width of approximately 7 kilocycles at fifty times standard signal strength. The tone quality is exceptionally good through the elimination of second harmonic distortion, this being accomplished through the use of the triple-twin output tube.

By careful assembly and the use of reliable and accurate parts, this radio set should compare favorably with ordinary receivers of six or more tubes. Inquiries, questions and comments on the set or design which may be forwarded to the author through this magazine will be welcomed and given prompt attention.

Description of Apparatus

One DeJur 2-gang type 3502 condenser, trimmers on short side, capacity increasing counter clockwise, shaft 3/8 x 1 inch long, low shields, C1, C2;

One Crowe dial, numbers to run clockwise, for 3/8-inch shaft with escutcheon plate;

One speaker, 2,500-ohm field, transformer to match a single type 295 (4,000-ohm primary impedance);

One socket marked "57";

One socket marked "58";

One socket marked "295";

One socket marked "280";

One Eby antenna-ground strip;

One Carter power transformer 3562, P.T.;

One Carter choke 4073 mounted on transformer shell, (10 hy. at 10 ma., resistance less than 200 ohms);

One Meissner, 262½ kc. output I.F. transformer with trimmer, I.F.T.2;

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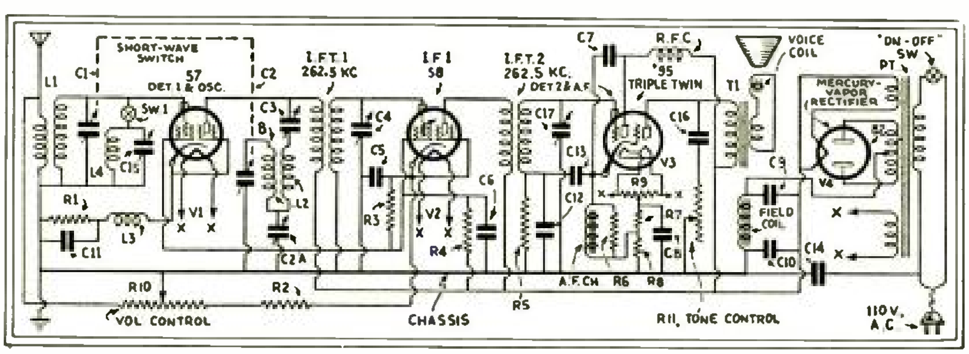


A complete schematic circuit of the "Autodyne Triplex." Observe the use of the combined oscillator-detector.

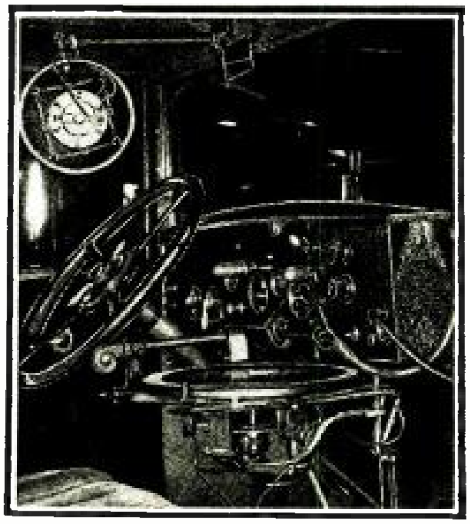


Fig. A

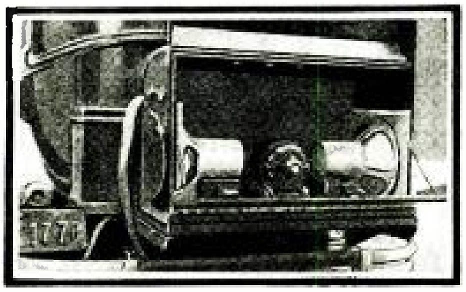


Fig. B

A MOBILE P.A. SYSTEM

A mobile P.A. system, not installed in a truck but in a passenger car, and so arranged that the seating capacity is not reduced. It is completely described by the author in this interesting article.

By H. A. BLAIR

HERE is something new in a motorized sound amplification system. Through the application of advanced design and the utilization of waste space, the motor car sound system described and illustrated in this article does not interfere with the use of the car for other purposes. None of the passenger space is utilized, nor is the car cluttered up with loudspeakers and other equipment.

Discussion of System

A traveling public address system of this kind offers numerous possibilities of profit to its owner. At election time, political candidates will use it for campaigning. At summer resorts, airports, church festivals, bazaars and other places where crowds gather, this sound system will be in demand; for it is inexpensive and easy to install.

The amplifier used is a special Blair Loftin-White two-stage job, using a single '24 screen-grid tube in the first stage and two '50-type tubes in push-pull in the output stage. Two '81 half-wave rectifier tubes are employed. It has $11\frac{1}{2}$ watts output. The amplifier is mounted on a metal chassis, which is located below the instrument panel (dashboard) of the car at the right of the driver. It is bracketed to the floor board, standing on one end at an angle, out of the way of the passenger riding with the driver. Leads from the amplifier are brought from standard A.C. extension plug outlets which are screwed to the floor board. This method of construction permits the amplifier to be removed readily at any time. The amplifier is energized by means of a 110-volt alternating current system, described later.

A phonograph and microphone mixer is fastened on the dashboard at the right, as shown in Fig. A. This device is extremely compact. It contains a combination switch and microphone gain control; a phonograph gain control; a small toggle switch for changing over from phonograph to microphone or vice versa and a starting switch, mounted on one side, for switching the battery current "on" or "off." There is also a compartment within the mixer for two small $1\frac{1}{2}$-volt dry cells for microphone current supply. An efficient phonograph scratch filter is also built into the mixer box. All leads are brought to external binding posts, permitting easy checking when trouble shooting.

A standard G.E. induction motor is mounted beneath the phonograph turntable. This complete unit is mounted on a special metal plate which slides on

(*Continued on page* 111)

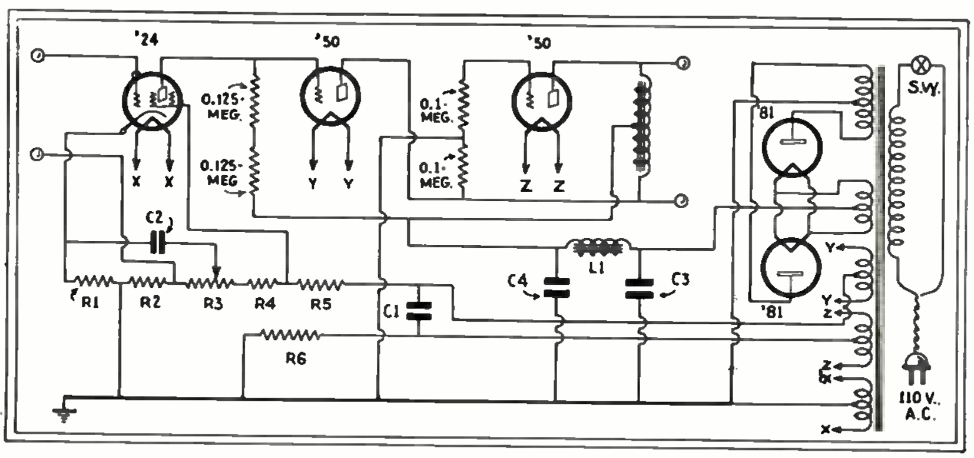


Fig. 1
Schematic circuit of the Loftin-White two-stage amplifier used by Mr. Blair.

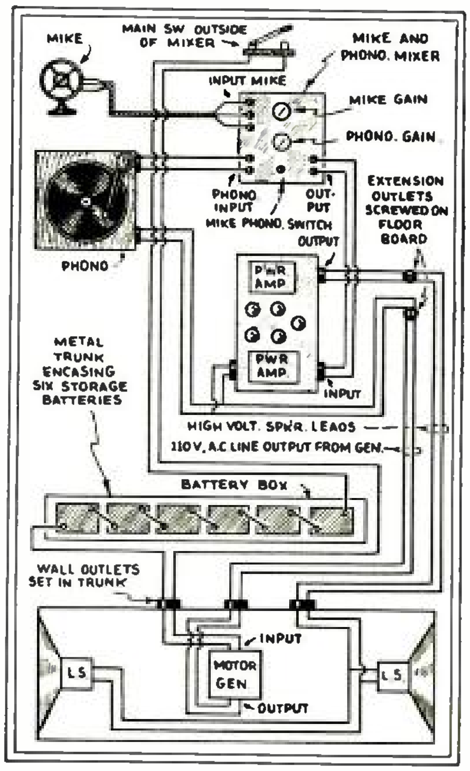


Fig. 2
Block diagram of the P.A. system.

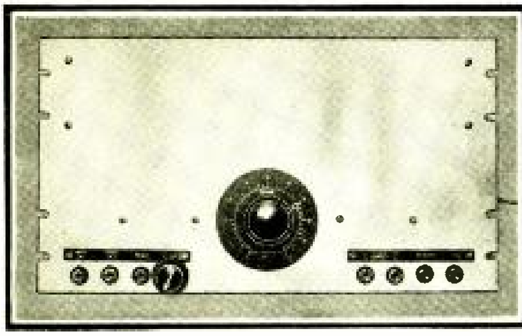


Fig. A
A typical commercial mixer panel.

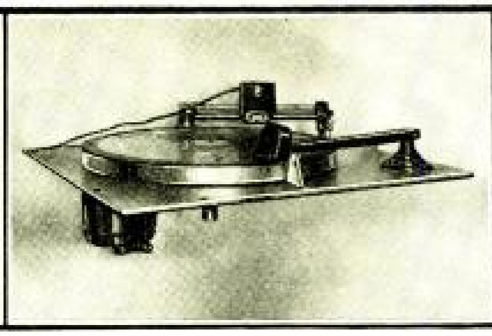


Fig. B
A commercial recording turntable.

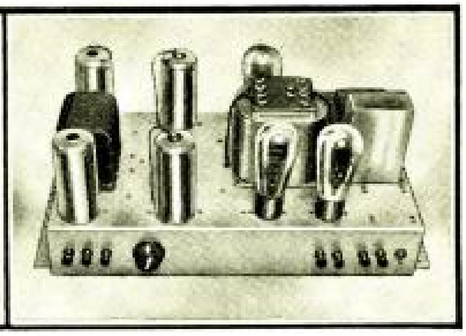


Fig. C
An amplifier suitable for recording.

SOUND RECORDING AT 33-1/3 R.P.M.

By GEORGE J. SALIBA, S.B.

RECENTLY, a great deal of experimental work has been done in instantaneous recording on 33-1/3 R.P.M. or *slow speed* records. These slow speed records have many practical applications, especially in the recording of radio programs, and a number of radio stations are now using this method.

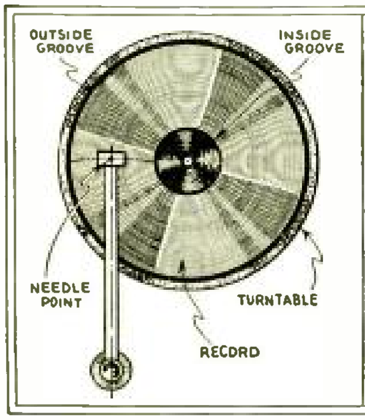
In the past, the station had no comeback if the sponsor claimed that his program was not put over as agreed upon, but now, the station takes the recorded program from its files, plays it back and so settles the disagreement.

Comparative Playing Time

Commercial types of sound recording equipment now available to the home recordist and designed for 33-1/3 R.P.M. operation are illustrated in Figs. A, B and C.

One 16-inch, 33-1/3 R.P.M. disc plays for 15 minutes; it contains a half hour's program if both sides are used. This long playing time appeals to those artists who keep their own files. Heretofore, it has been the custom to use 12-inch, 78 R.P.M. records, but since these play for only four minutes, three of them are required for a fifteen minute program. Continuity is maintained by fading from one record to another, and often this fading is necessary at a vital part of the program much to the chagrin of the artist. The 16-inch record overcomes this objection.

Recording at 33-1/3 R.P.M. entails more problems than at 78 R.P.M. In Table I are given the tangential velocities of 78 R.P.M. and 33-1/3 R.P.M. records.



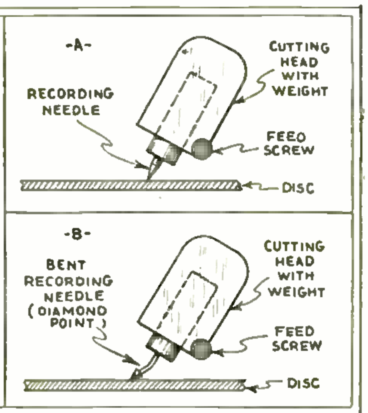


Fig. 1, left. Arrangement of record on a turntable.
Fig. 2, right. Two types of recording needles.

TABLE I

Location of Groove	Tang. Velocity—Ins. per Sec. (78 R.P.M.)	(33-1/3 R.P.M.)
Inside	16.25	13.5
Middle	31.5	20.5
Outside	46.5	27.5

Since the needle speed is much lower on the slower speed records, the recording and reproducing problems are increased; consequently, as the speed of the needle is lower, the track available for recording will be shorter. It is difficult to make good recordings on the inside of the record because of decreased velocity. This is especially true in reproducing high frequency modulations; for the lower the frequency, the greater will be the amplitude—the frequency varying in inverse proportion to the amplitude. Therefore, high frequencies are recorded with very little amplitude, but this small amplitude represents considerable energy, and no difficulty is experienced in reproducing these modulations if the needle is sharp.

When a needle is new, it does its best work, and for this reason the 33-1/3 R.P.M. records are always started from the inside. The diameter of the inside or starting groove should not be less than 7½ inches; a smaller diameter would be detrimental to good quality.

Position of Pickup

The proper placing of the pickup is also very important to good reproduction. Heretofore in 78 R.P.M. recording, it has been the custom to place the pickup so that the needle hits the exact center of the turntable. Because of the comparatively short radius of the record, this is considered the correct position, but for 16-inch records, *this rule does not hold.*

In recording, the cutting-head is guided in a straight line across the face of the record. Obviously, the correct way to reproduce such a record is to have the reproducer travel straight across the face of the record. This would necessitate the use of a feed screw, which is not practicable for commercial purposes. In the placing of the 78 R.P.M. pickup so that the needle hits the center of the turntable, straight-line reproduction is approximated because the arc obtained is almost equal to its chord. If we now take a 16-inch record and place the pickup in the same location, we note that from the start to the end, the arc described has a comparatively short radius and therefore is not equal to the chord, i.e., the plane of the

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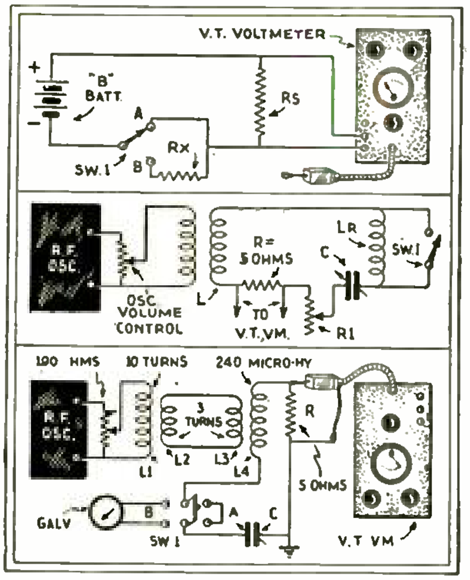


Fig. 1, above. Fig. 2, center. Fig. 3, below.

USING THE V.T. VOLTMETER

The third of a series dealing with the use of the vacuum-tube voltmeter, described in the February issue of RADIO-CRAFT.

By BERYL B. BRYANT

RESISTORS of *all sizes* may be measured by the use of the setup given in Fig. 1. If desired, a permanent setup as an ohmmeter may be made; the accuracy of measurement is very close to that obtainable by the Wheatstone Bridge method. Should the experimenter desire a permanent setup as an ohmmeter, the scale of the V.T. voltmeter indicating meter may be calibrated. (See February issue of RADIO-CRAFT for a description of the voltmeter.—*Editor.*)

The procedure of measurement is to insert the resistor to be measured at RX. With SW. 1 placed on point "A," the voltage drop across the resistor RS is determined. Resistor RS may be of any value, although the lower its value, the lower the resistance that may be measured. It is recommended that two values one of 100 and a second of 10,000 ohms be used in order to have an ohmmeter reading from a low range to several thousand ohms.

After the voltage drop across RS, with the switch in position "A," has been determined, S.W.1 is thrown to position "B" and the voltage drop again measured. With the voltage drop measured across RS with the switch in position "A" known as Es, and the voltage drop across RS with the switch in position "B" known as Er, the value of the unknown resistance may be determined from the following formula:

$$\text{Resistance in ohms} = \frac{Es - Er}{Er} \times RS$$

Coil Resistance Measurement

It is sometimes necessary that the engineer know the resistance of an R.F. inductance. This is especially necessary in modern receiver design because the value of the inductance may be decreased; it is also desirable to know the power factor of a coil when it is enclosed within its shield.

The setup given in Fig. 2, provides a means whereby the operator may determine the resistance and then the power factor of a coil very quickly. The pickup coil L should have an inductance of approximately one-half that of the coil to be measured. The resistor R has a value of 5 ohms. The variable resistor R1 should have a range of 0 to 2,000 ohms and should be non-inductive. The condenser C should be of the precision type in which the change of resistance for capacity variations is a minimum, although any other variable condenser may be used and its resistance measured for particular capacity settings.

The circuit is tuned to resonance with the R.F. oscillator. The variable resistor R1 should be set at its zero position. The reading of the V.T. voltmeter when connected across the resistor R is noted. The S.P.S.T. switch across Lr is then closed. The circuit is now retuned to resonance. Care should be taken that the deflection of the V.T. voltmeter microammeter is not off-scale, as otherwise the meter will be damaged. The resistor R1 is adjusted until the same V.T. voltmeter reading is obtained as before closing S.W.1. The resistance setting of R1 will now be the resistance of the coil at the particular frequency employed. If the resistor R1 is of the decade calibrated type, it will not be necessary to measure the resistance to determine the correct value.

In order to determine the power factor of the coil, its inductive reactance is determined by the formula:

$$X_L = 6.28 \times F \times L$$

Where X_L is inductive reactance in ohms; F the frequency in cycles per second, and L is the inductance in henries. Having determined the reactance of the coil, the power factor may be determined from the formula:

$$P.F. = \frac{R}{XL}$$

where P.F. is the power factor, R the resistance of the coil, and XL is the inductive reactance of the coil.

The decrement of the coil in a circuit may be determined from the formula:

$$\text{Logarithmic decrement} = 3.1416 \times R\sqrt{\frac{C}{L}}$$

where R is the R.F. resistance of the circuit, C is the capacity in microfarads and L is inductance in microhenries.

Measuring the Inductance of Thermo-Galvanometers

The setup for the measurement of inductance of thermo-galvanometers is given in Fig. 3. L1, the radiating coil of the oscillator, should consist of 10 turns of wire on any convenient diameter tube; L2 and L3 are 3-turn pickup coils in a link circuit, L4 may be a standard broadcast inductance of 240 microhenries; the variable R should be a non-inductive 5-ohm resistor, across which is measured the voltage drop of the circuit for resonance indication.

The procedure of measurement is to first set the condenser C at approximately half its capacity; the frequency of the oscillator is brought into resonance with the circuit; the D.P.D.T. switch S.W. 1 should be in the "A" position. The accuracy of the measurement will depend upon the care in obtaining the maximum resonance indication on the V.T. voltmeter.

When the maximum resonance has been obtained, the capacity of the condenser C is determined. (If possible, the condenser should previously have been calibrated.) The thermo-galvanometer is now placed in the circuit by setting the switch to the "B" position. The circuit is again brought into resonance with the condenser C, and its capacity determined.

The inductance in microhenries of the thermo-galvanometer may be determined by subtracting the inductance of the circuit without the meter from the inductance of the circuit with the meter; the inductance being computed.

HOW TO MAKE AND CALIBRATE

AN I.F.-R.F. OSCILLATOR

Because the service oscillator is of such vital importance in radio work, the author has consented to build and describe this compact and much-needed device. Details of construction and calibration without the aid of external oscillators are included.

By CLYDE J. FITCH

VARIOUS commercial oscillators have been described in the pages of this magazine, but until now no complete constructional details of an oscillator that can be *built and calibrated* by the average Service-Man have been described. The oscillator described here was designed, built and calibrated so that *exact* data could be given in answer to the many requests from our readers.

To expedite servicing, the instrument was made as simple and compact as possible; a simple oscillating circuit was used employing a type '30 tube operated by dry cells. No attempt was made to design the instrument for line-voltage operation; the tube draws so little current that small-size batteries will run it for a long time. Furthermore, calibration is simplified and more accurate. Tip-jack connectors, mounted on the panel, (see accompanying photographs) provide ready means for measuring filament and plate voltages with an external voltmeter, so that a check on the condition of the batteries can be quickly made. Once calibrated with fresh batteries, it is important for maintaining accuracy that the voltages remain practically constant.

The fundamental oscillator circuit is designed to cover nearly all the I.F. frequencies used in commercial superheterodynes. The circuit is self-modulated at an audio frequency by means of a grid condenser and grid-leak of the proper values. This produces rich harmonics of higher frequencies that are used to cover the broadcast range as well as some of the higher intermediate frequencies.

The instrument is calibrated by comparing it with an accurately calibrated radio receiver. Any good receiver can be used, calibrated by tuning-in broadcast stations of known frequencies.

Construction of the Oscillator

The first procedure is to select the parts necessary for the complete instrument. While other makes of parts than those used in this oscillator may be employed it is recommended that *the parts specified should be as closely adhered to as possible.*

List of Parts

1—Blan, new type shield 10 x 6 x 5 inches deep;
1—National, .0005-mf. variable condenser, type EC;
1—National, precision dial. type M;
1—Clarostat. 3,000-ohm volume control, type P185;
1—Aerovox, .0005-mf. fixed condenser;
1—Durham, 1¼-megohm pig-tail grid leak;
1—Benjamin, four-prong cushion socket;
1—Filament switch;
4—Tip-jack connectors;
2—Eby binding posts;
2—Small Burgess 1½-volt dry cells, 4 x 1¾ inches;
1—Small Burgess 22½-volt "B" battery;
1—Type '30 vacuum tube;
1—15-ohm fixed resistor;
1—Bakelite tube 2 inches in dia., 4 inches long;
¼ lb. No. 30 D.C.C. magnet wire.

The aluminum shield box is of a new type with rugged corner posts that makes an excellent case for an instrument of this kind. Any of the sides can be quickly removed for replacing batteries or for other purposes. In the instrument illustrated, a bakelite-cloth covering was placed over the front panel for the sake of appearance. We recommend, however, that the panel be sprayed a dull black.

The tuning condenser is of the straight-line-frequency type; it proved its value when the oscillator was calibrated as the calibration curves obtained were virtually straight lines.

Construction of Coil

The coil used in this oscillator was purposely wound by hand so that it could be duplicated by anyone; otherwise the builder might be handicapped by difficulty in obtaining a commercial coil if such a coil were specified.

The coil was first calculated by using well-known inductance formulas so that the circuit would tune to approximately 100 kc. with the condenser set at maximum or .0005-mf. From these calculations the coil illustrated in Fig. 1 was made. It has approximately 400 turns of No. 30 D.C.C. wire (the exact number

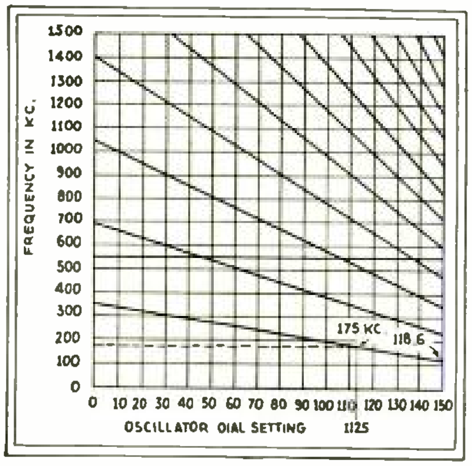
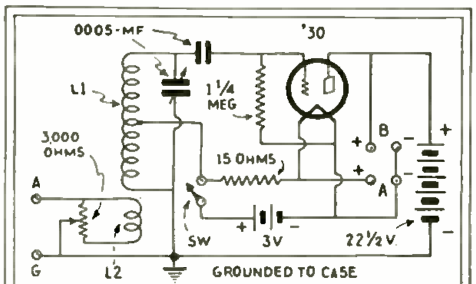


Fig. 5
Calibration curve of the oscillator. Each line is a harmonic of the one below it; in this manner both the I.F. and R.F. ranges are covered with one coil and one dial.



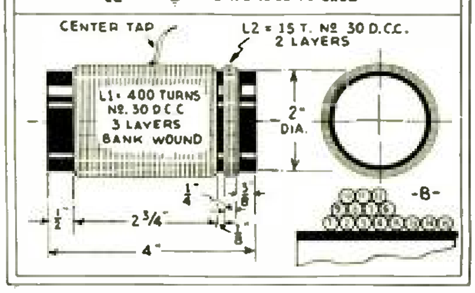
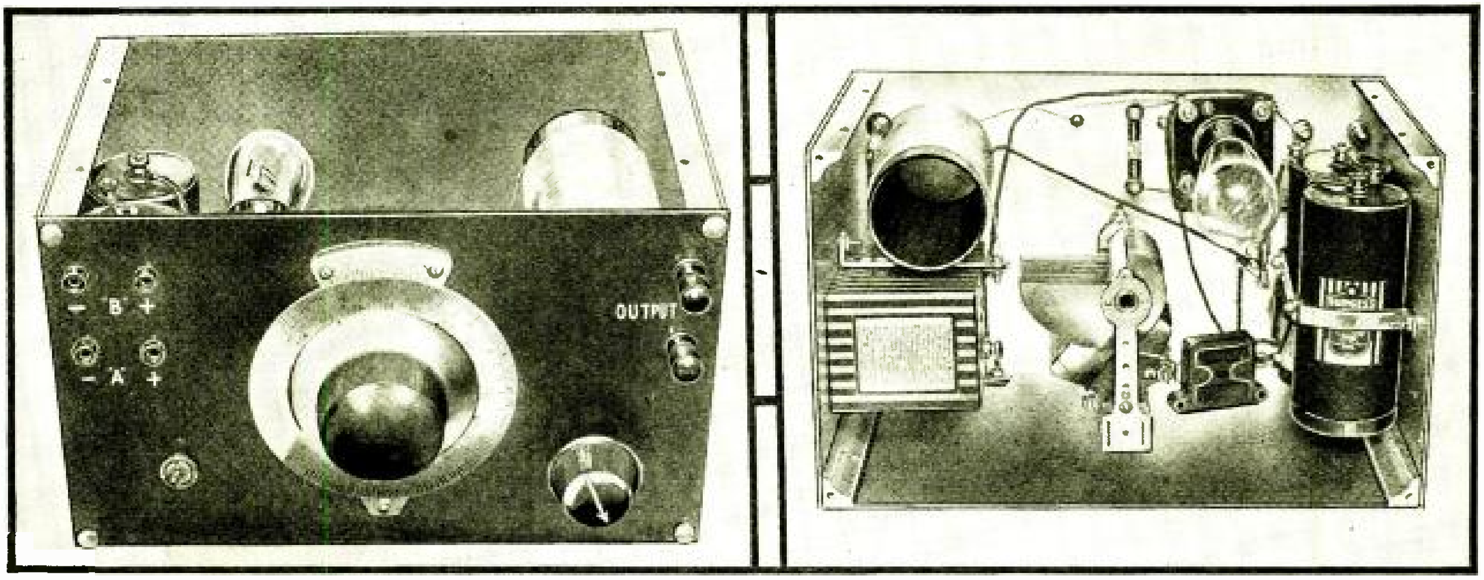


Fig. 3, above. Schematic circuit of this simple and efficient unit.
Fig. 1, below. Winding details of the coil used in the oscillator.



Left, the front and right, the internal view of the all-range oscillator. Its utter simplicity is only too apparent.

of turns is not important). The center tap was made at the approximate center of the winding after the coil was wound.

The wire was bank-wound in three layers. The manner of winding, which was found to be the simplest and best suited to this purpose, is illustrated in Fig. 1B. The turns are numbered in this sketch in the sequence in which they were wound; the process is continued in the same manner until the winding is complete.

The pick-up coil connected to the output posts consists of 15 turns of the same size wire. Both coils should be impregnated with boiling paraffine.

After the coil was finished and the circuit calibrated the lowest frequency which could be generated with the condenser set at maximum was 118.6 kc. Shielding, no doubt, caused the effect of a loss of inductance, which accounts for the higher frequency of the circuit than that on which the calculations were

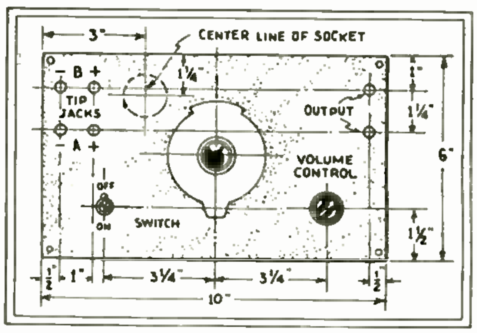


Fig. 2. Complete panel details.

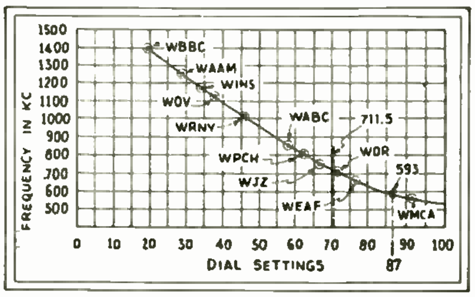


Fig. 4. Calibration curve of the broadcast receiver used by Mr. Fitch.

based. Since the lowest I.F. used in commercial supers is about 130 kc., the range covered by this instrument is ample and the coil was left as originally wound.

Assembling the Apparatus

Figure 2 shows the drilling layout of the panel. The panel is 10 x 6 inches and the tuning condenser shaft passes directly through the center; templates for condenser and dial drilling are furnished with the instrument; the locations of the other parts are clearly indicated; the socket and the coil are mounted on the rear of the panel. The tip-jacks should be of the insulated type as they should not be in contact with the panel. One of the output posts is also insulated from the panel with bakelite washers; the other one is grounded.

The two dry cells are clamped to the left end of the case with standard brass angles and strips supplied by radio stores. The "B" battery is similarly clamped to the right end plate.

Figure 3 shows the complete wiring diagram. It will be noted that the negative terminal of the "B" battery is grounded to the case. The center terminal of the volume-control and the rotor plates of the condenser are also grounded. The values of the parts are clearly indicated on the diagram and agree with those called for in the list of parts. A study of the photographic illustrations will show more clearly how the apparatus is assembled.

Calibrating the Oscillator

By tuning-in various broadcast stations on a standard receiver of good design, accurate frequencies are available, especially from quartz crystal - controlled broadcast stations; these are used for calibrating the oscillator. The simplest procedure is to first plot an accurate calibration curve of the broadcast receiver. Such a curve is illustrated in Fig. 4. Frequency in kilocycles is plotted against tuning dial settings.

The next step is to disconnect the aerial from the broadcast receiver and connect the insulated output post of the oscillator to the aerial post of the receiver and connect the other post to the ground of the receiver. By switching on the oscillator, a series of harmonics may be heard by turning either the oscillator dial or the broadcast receiver dial. We are now prepared to make a very accurate set of calibration curves of the oscillator, after which the calibration can be further checked by heterodyning with crystal-controlled broadcast station waves.

The first step is to set the oscillator dial at its maximum or 150. Then tune in a harmonic of the oscillator at the highest dial setting heard on the broadcast receiver. Turn the volume-control of the oscillator until the harmonic signal is very weak and an accurate dial reading of the receiver is obtained. On this particular set a harmonic was heard at 87 on the receiver dial. This indicated, from Fig. 4, a frequency of 593 kc.

Now slowly decrease the tuning dial settings of the broadcast receiver (leaving the oscillator setting as it was) until another harmonic is heard. In this case one was heard at 70 on the receiver dial and from Fig. 4 indicated a frequency of 711.5 kc. The former figure subtracted from the latter, or 711.5 minus 593, equals 118.5. *This is the fundamental frequency of the oscillator because each harmonic differs from adjacent ones by an amount equal to the fundamental.*

We can check the accuracy by dividing 593 by 118.5, which gives 5 and a slight amount over indicating that our readings were not exact. Evidently we were working on the 5th and 6th harmonics. Dividing 593 by 5 gives 118.6 as the fundamental. Six times 118.6 would give a frequency of 711.6 for the 6th harmonic instead of 711.5, which was obtained from the curve.

Knowing that the fundamental frequency is 118.6 at the 150 degree setting of the oscillator dial, we can mark off on the calibration chart (Fig. 5) harmonics up to the 12th, spaced 118.6 kc. apart.

(*Continued on page* 121)

A COMPACT OHM-- AND OUTPUT METER

By JACK GRAND

THE ohm- and output meter described in this article is primarily meant for the Service Man who owns a good set tester and yet wants the improved features of the later types that he may not be able to afford at present.

The ohm- and output meter illustrated is a combination of instruments used to indicate resistance and A.C. output voltage on the same meter. This is accomplished by means of a copper-oxide rectifier and a 3-pole, 6-throw switch. This meter can be built at a nominal cost as all parts are standard and are easily obtained.

Some practical uses for this instrument are as follows: As an ohmmeter, it has three convenient ranges: 0-1,000, 0-10,000 and 0-100,000 ohms, and is used to find unknown values of resistors; for continuity testing; checking balanced conditions of tapped transformers; opens; shorts, etc.

The output-meter has three ranges as follows: 0-1, 0-10 and 0-100 volts A.C. It is used in conjunction with oscillators for aligning condensers and I.F. coils, for locating hum, level indicators, etc.

The parts used for the ohmmeter are a 100-ma. shunt for the 0-1,000-ohm range; (this range should be used as little as possible as the drain is quite heavy); a 10-ma. shunt for the 0-10,000-ohm range; and a 4,000-ohm resistor for the 100,000-ohm range.

By clever use of the 3-pole 6-throw switch the 1,000-ohm variable resistor is used to compensate for high or low battery variations on all ohmmeter ranges.

On the 0-1,000-ohm range, with the switch in position, a 50-ohm fixed-resistor is automatically placed in parallel with the 1,000-ohm variable resistor, serving a two-fold purpose—it will bypass current from the variable resistor as well as change its range to less than 50 ohms.

This low range is required to get full-scale deflection with a 4½-volt battery. With the switch in position for 0-10,000 ohms, only the 1,000-ohm variable resistor is in series with the meter. In this manner 450 ohms is obtained for full-scale deflection with 4½ volts applied. With the switch in position for 0-100,000 ohms, the 4,000-ohm resistor is automatically placed in series with the 1,000 ohm variable resistor thus obtaining 4,500 ohms for full-scale deflection with the 4½-volt battery.

All resistance readings are in multiples of 10. The scale on the meter is calibrated to 100,000 ohms. All that is necessary when using the 10,000-ohm scale is to leave one cipher off the indicated figures on the 100,000-ohm scale, i.e., when the reading of the scale shows 1,000 ohms, leaving a cipher off the end figure, gives us a value of 100 ohms. On the 1,000-ohm scale, two ciphers are left off for obtaining correct values.

For the output-meter ranges great care must be exercised in connecting the rectifier. The polarity must be correct and the D.C. side of the rectifier must go to the meter, otherwise—"it is just too bad."

The resistance of the rectifier at full-scale deflection of 1 ma. is about 460 ohms; therefore, a 500-ohm resistor is placed in series with the rectifier to get a 1-volt A.C. reading; on the 10-volt scale a 10,000 ohm resistor is connected in series and on the 100-volt range 100,000 ohms is used.

The Parts

Standard stock-type resistors of good makes may be used. The 1,000 ohm variable resistor will compensate for resistance error and also for high and low battery voltage. The A.C. voltages are only approximate. If greater accuracy is required, precision-type resistors are recommended. (A rectifier calibration-curve is shown on page 656, May, 1932 issue of RADIO-CRAFT.) By the use of a switch with more poles, additional voltage ranges can be added.

The ohm- and output meter can be built in a small compact unit with self-contained battery as shown in the photographs. There are only a few wires and they can be neatly arranged. Heavy spaghetti covered bus-bar is recommended in connecting the shunts as fine wire has a high resistance and will introduce errors in the readings.

The entire unit can be mounted in a box 4½ x 6¼ inches; the depth of the box is dependent on whether the builder desires to have the battery in or out of the box. If the battery is not wanted in the box it must be connected in series with one of the test leads and either of the ohm tip-jacks.

The list of parts used are as follows:

One Weston 301, 0-1-ma. meter;
One Tanrex rectifier, RX;
One Van 100-ma. shunt, R1;
One Van 10-ma. shunt, R2;
One Clarostat 50-ohm fixed-resistor, R4;
One Electrad resistor, type R1, 1000 ohms, R5;
One Lynch 4,000-ohm resistor, 1 watt, R3;
One Lynch 500-ohm resistor, 1 watt, R6;

(Continued on page 112)

Fig. A
Front view.

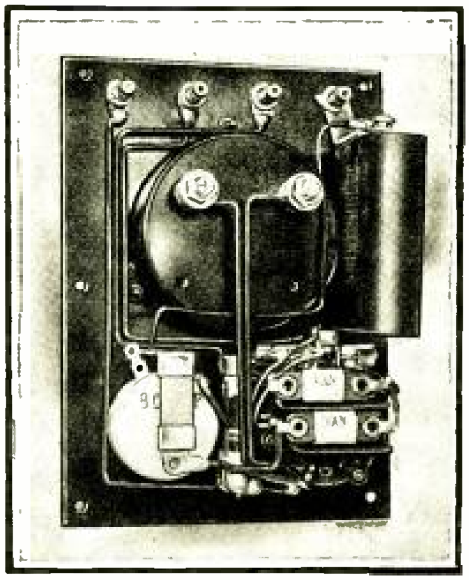


Fig. B
Interior view showing connections.

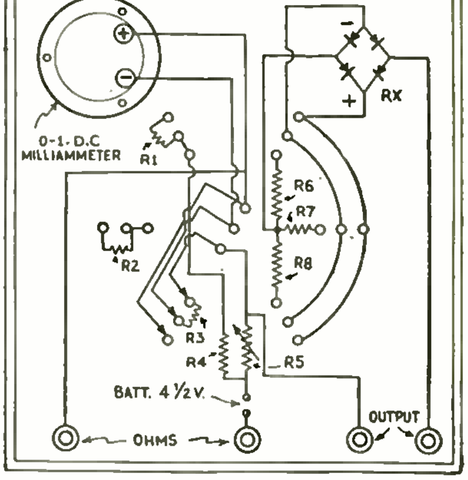
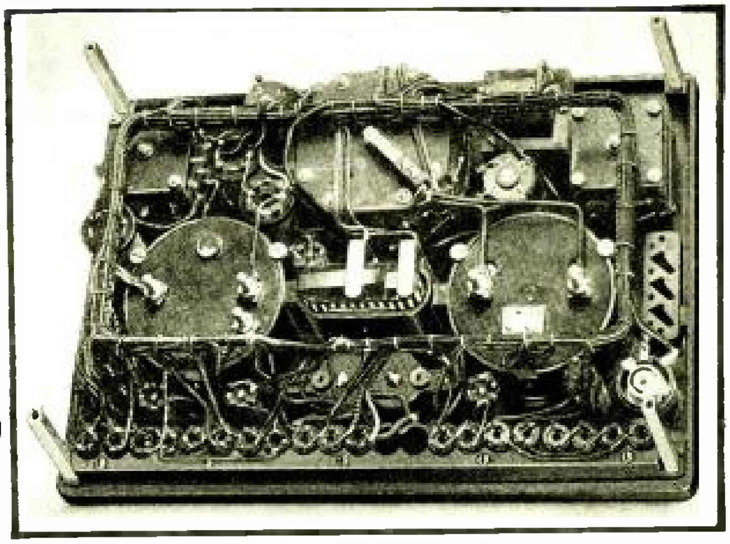


Fig. 1
Schematic circuit.

In a series of articles of which this is the second, the author describes the circuit arrangement used.



Photograph of the internal wiring of the Jewell 444 analyzer.

HOW TO USE A SET ANALYZER

By F. L. SPRAYBERRY

IN the July issue of this publication the fundamental connections underlying the principle of operation of all set analyzers were described. In this installment we will discuss the actual switching arrangements used in a typical analyzer.

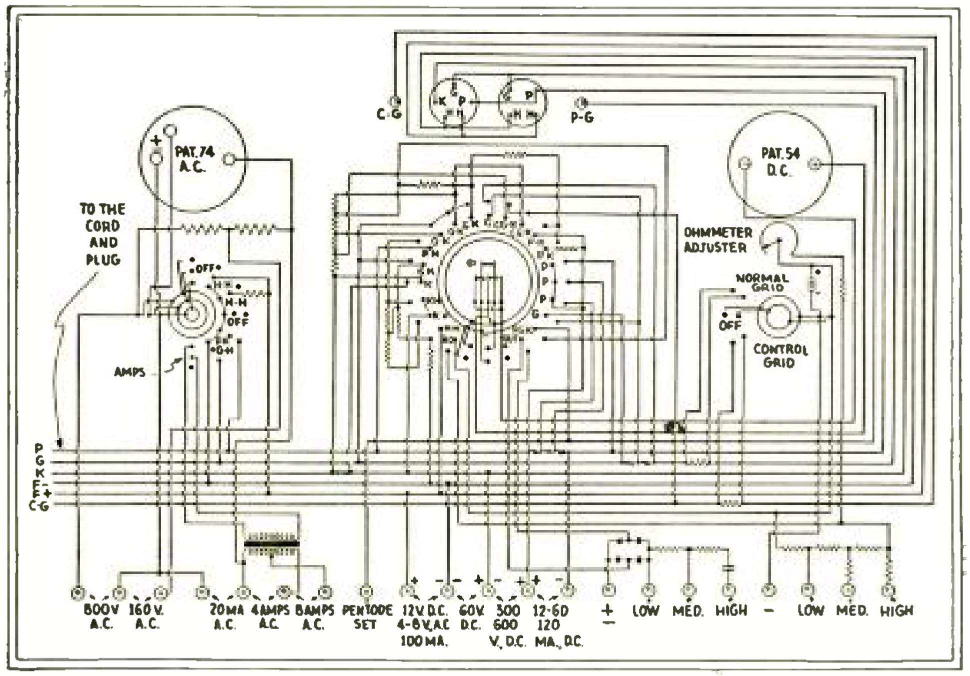
To enable you to understand how meters are connected to the circuits of four- and five-prong tubes in the Jewell 444, see Fig. 3, which shows the terminal designations for a four- and five-hole socket. The grid is indicated as "G," the plate as "P," the filament as "H" for negative and "H1" for positive, and the cathode as "K." These terminal designations are followed throughout in this analyzer.

The master selector switch is arranged for these designations, therefore, if you will keep these letters in mind you will always know how the meter is connected to the circuits.

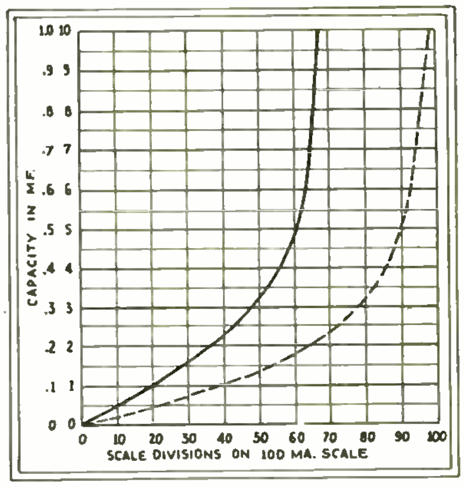
Master Selector Switch

There are twenty-two positions for the master selector switch including the "off" position. Counting from left to right beginning at the bottom, the first position is marked "R-C" meaning Resistance-Continuity (the function of this will be described later); No. 2 is "H-H-12V," signifying that the D.C. voltmeter is connected across the filament circuit using the 12-volt scale; No. 3 is "K-H-60V" meaning that the voltmeter is connected between cathode and heater using the 60-volt scale; No. 4 is "K-H-300V," meaning the voltmeter is between heater and cathode using the 300-volt scale; No. 5 is "K-12 MA." meaning the milliammeter is in series with the cathode circuit using the 12-ma. scale; No. 6 is "G-H-30V," meaning the voltmeter is between grid and filament using the 30-volt scale; No. 7 is "P-H-300V," meaning the 300-volt scale is between plate and filament; No. 8 is "G-K-12V," meaning the 12-volt scale is between grid and cathode; No. 9 is "G-K-60V," connected as No. 8 except that the 60-volt scale is used; No. 10 is "G-K-120V," and is the same as Nos. 8 and 9 using the 120-volt scale; No. 11 is "G-12 MA meaning the 12-ma. scale is in series with the grid circuit; No. 12 is "CG-K-6V" meaning the 12-volt scale is be-

(Continued on page 125)



Complete schematic circuit of the Jewell 444 set analyzer. The numbers on the rotary switch correspond to those discussed by the author. In reality, they refer to those circuits in which the meter is connected for a given measurement; for instance, with the switch set on the "G-K" terminal, the meter is connected between the grid and cathode of the tube. The three "G-K" points correspond to three different scales on the meter.



This instrument may also be used as a capacity meter. The solid line corresponds to the low range, and the dotted line to the high range.

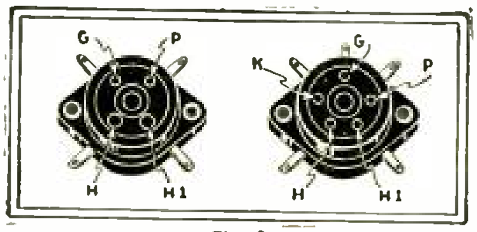


Fig. 3

I EQUALS E OVER R

By C. W. PALMER

The fact that current flow in an electrical circuit depends upon voltage and resistance means nothing unless one can visualize what is actually going on. In this extremely novel presentation, the author shows not only "how" but "why."

PEOPLE not familiar with electricity have the idea that little is known about this subject. This assumption is incorrect, as probably more is known about this science than about any other. Because mechanical motions and forces can be seen and felt, it is easy for the average person to understand and foretell their actions and the results ensuing. For example, few people would question the result of striking a piece of wood with the sharp edge of an axe or dropping an egg on a concrete floor; but when the problem is to visualize what is taking place in an electrical circuit, they are entirely at "sea."

If we remember that we cannot see or hear electricity directly, but can only observe its effects, the study of electricity—and its companion radio—will be much simplified.

Electricity (according to the electron theory) consists of extremely small moving particles, these particles have been named *electrons* and *protons*. These electrons and protons do not carry electricity, as some people think, *they constitute electricity*. In other words, an electron or proton is nothing but a small quantity of electricity. Electrons and protons are separated because they act differently; the electron is said to be a negative charge while the proton is a positive charge.

The average person usually believes an electron to be a very small particle of matter; beyond this elementary conception his ideas are vague and usually confused.

Let us first consider "Matter." Matter is any substance having weight and volume—the air, the earth, the water, are all forms of matter.

The Atomic Structure

Consider a bar of copper (an element) as shown in Fig. 1. This bar shows certain peculiarities which identify it as copper, and even a very small piece, such as B of Fig. 1, cut from this bar will be characteristic of the whole piece. If it were possible to keep cutting down the size of the piece of copper, we would arrive at a point where a further cut would result in changing its characteristics, and it would no longer be identified as the same material as the whole. This particle containing all the peculiarities of the whole piece is called a molecule of the element.

Since the molecule has the same characteristics as the whole, it, too, must be subdivided if we are to discriminate between one substance and another. Now, since all substances have different constituents, their molecules must be different, and science has been able to break down the molecule into still smaller particles called *atoms*. An atom of hydrogen is different from an atom of helium; an atom of copper is different from an atom of zinc, etc. Atoms cannot exist by themselves in a normal state—at least two atoms must be combined to form a molecule.

The atoms of every substance, regardless of its nature, are composed of *electrons*. This means that all substances contain electricity, which seems contradictory to our general knowledge, although it is apparently true as we shall soon see.

In its normal state, an atom contains a certain number of electrons and protons arranged in a particular manner. Each substance has a different combination and grouping of the charges. Hydrogen, for example, the lightest substance known, contains only one electron revolving

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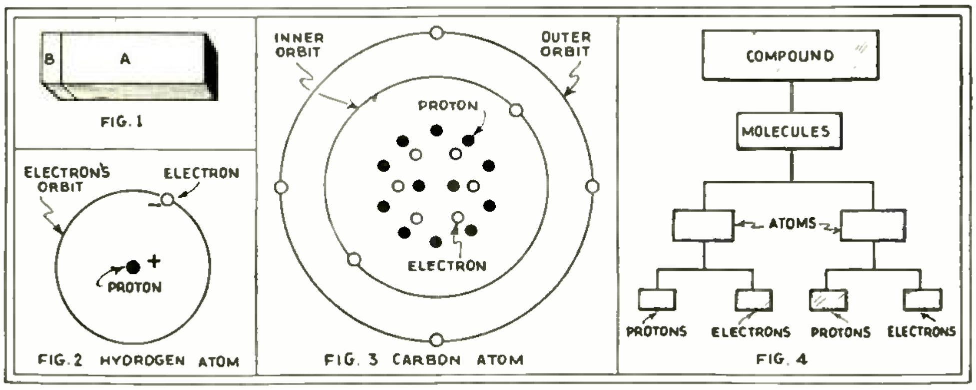
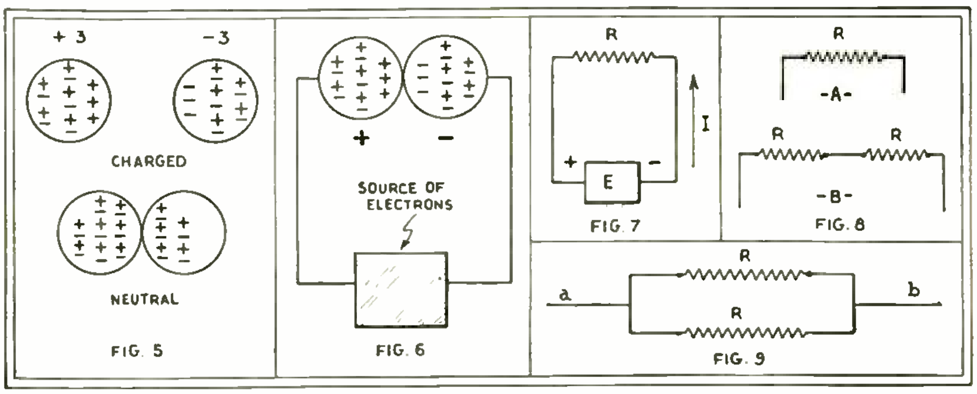


A molecule of a substance, say at B Fig. 1, is composed of positive and negative electrons such as illustrated at Fig. 2 or Fig. 3. Fig. 4 illustrates the logical sequence used in breaking down the substance.



The uncharged, separated molecules in Fig. 5 cause a flow of current as shown in the lower part of the same figure when touched. This flow ceases in a very short time, but may be caused to flow for a longer time by the application of an E.M.F. as shown in Fig. 6.

THE THEORY AND CONSTRUCTION OF ATTENUATORS AND LINE FILTERS

By HY LEVY

In the May and June issues of this publication, there was described the theory and operation of impedance matching. In this discussion, final calculations for "H"- and "T"-type pads are submitted by the author.

WE can now proceed with the design of an H-type pad to give us the desired 20 decibel loss as determined in our own problem under consideration. Assume we did not have Table 3 from which the values of Z_1 and Z_2 may be obtained, but that we wish to calculate our own values of Z_1 and Z_2 for the pad. To determine the constants of the pad, it is necessary to know the working formulas for an H-type network. The working formulas will not be derived in these papers, but it can be shown that the formulas for H-type networks are as follows:

"Z_1" the series element $= \frac{Z_0}{2}\left(\frac{A-1}{A+1}\right)$. (1)

"Z_2" the shunt element $= \frac{2 Z_0 A}{A^2 - 1}$ . . . . (2)

"Z_0" the characteristic impedance $= 2\sqrt{Z_1 (Z_2 + Z_1)}$ . . . . (3)

Examples of Design

We may now proceed with the application of these formulas to the design of the H-type pad to give us the desired 20 decibel loss as previously determined in our own problem under discussion.

TABLE 4

Decibels change	log. $\frac{V_1}{V_2}$ or $\frac{I_1}{I_2}$	$\frac{V_1}{V_2}$ or $\frac{I_1}{I_2}$	Zo = 200 Ohms		Zo = 500 Ohms		Zo = 600 Ohms	
			Z1	Z2 Ohms	Z1 Ohms	Z2 Ohms	Z1 Ohms	Z2 Ohms
1	.05	1.12	11.3	1760	29	4400	34	5280
2	.10	1.26	23.0	858	58	2150	69	2574
3	.15	1.41	34.0	571	86	1428	102	1714
4	.20	1.58	45.0	422	113	1066	136	1266
5	.25	1.78	56.0	328	140	820	169	984
10	.50	3.16	104.0	140.6	259	351.5	312	422
20	1.0	10.0	164.0	40.4	410	101	492	121.4
30	1.5	31.6	190.0	13.5	476	33.8	570	40.5
40	2.0	100.0	198.0	2.0	495	5.0	590	6.0
50	2.5	316.0	200.0	1.3	500	3.2	600	3.8

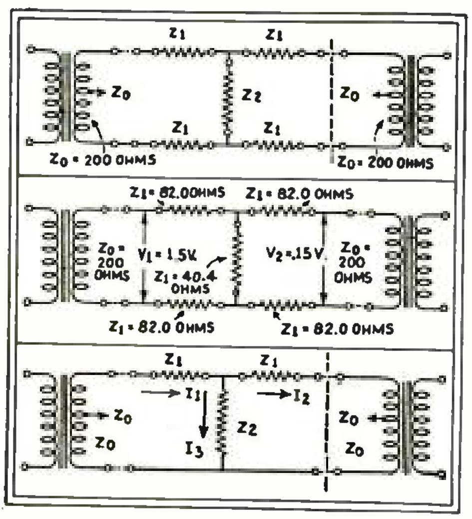


Fig. 10, above. H-type pad working between two 200-ohm impedances.
Fig. 11, center. A completed H-type pad causing a 20 db. loss.
Fig. 12, below. A typical T-type network.

Given: To design a 20 decibel pad to work between two 200-ohm impedances. (See Fig. 10.)

From Table 3, the value of "A," (see Fig. 9) the amplification constant, can be determined. The amplification constant $\frac{V_1}{V_2}$ at 20 decibels is given as 10.

Therefore "A" is equal to 10.

"Z_0" is equal to 200 ohms (given).

Then "Z_1" the series element from equation (1) is

$$Z_1 = \frac{Z_0}{2}\left(\frac{A-1}{A+1}\right)$$

$$Z_1 = \frac{200}{2}\left(\frac{10-1}{10+1}\right)$$

$$Z_1 = 100\left(\frac{9}{11}\right)$$

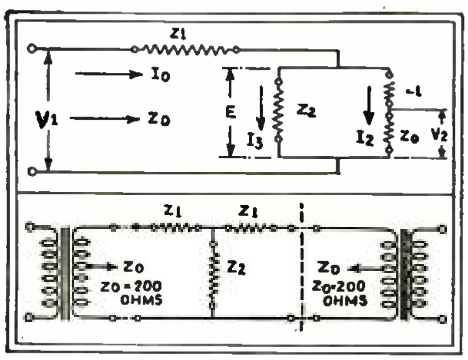


Fig. 13, above. Equivalent circuit of Fig. 12.
Fig. 14, below. A T-type network working between two 200-ohm impedances.

$$Z_1 = 100 \times .82$$

$$Z_1 = 82.0 \text{ ohms}$$

and "Z_2" the shunt element from equation (2).

$$Z_2 = \frac{2 Z_0 A}{A_2 - 1}$$

$$Z_2 = \frac{2 \times 200 \times 10}{10^2 - 1}$$

$$Z_2 = \frac{4000}{99}$$

$$Z_2 = 40.4 \text{ ohms.}$$

The completed network will look as shown in Fig. 11. As shown in this figure, the H-type pad having the series element equal to 82.0 ohms, and the shunt element equal to 40.4 ohms, will cause a 20 decibel loss to be introduced betwen V_1 the input terminals, and V_2 the output terminals, reducing the input voltage of 1.5 volts to the desired value of .15 volts across "Z_0" the load impedance, which was the problem under consideration. It will be noticed that the calculated values of "Z_1" and "Z_2" check with the values given in Table 3.

It was previously stated, that the image impedance must equal the characteristic impedance, in order to realize perfect impedance matching characteristics. This equality is shown below:

"Z_0" the image impedance = 200 ohms (given).

"Z_0" the characteristic impedance from equation (3).

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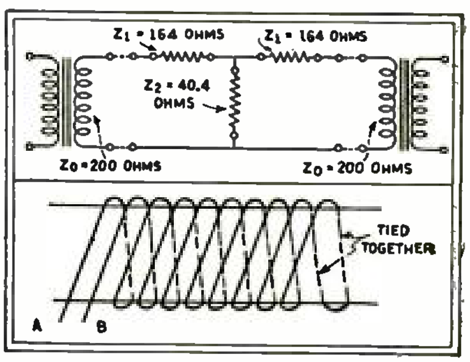


Fig. 15, above. A completed T-type network causing a 20 db. loss.
Fig. 16, below. Illustrating a bifilar winding. A and B are the ends of the winding.

THE ANALYSIS OF RADIO RECEIVER SYMPTOMS

OPERATING NOTES

By BERTRAM M. FREED

IT would seem that scarcely a week goes by without the radio Service Man meeting some serious problem, which in his opinion, is the most baffling and aggravating he has ever encountered. Yet, when once a difficult assignment is completed, never to be forgotten, subsequent failures of the same nature quickly recall the solution. Such a situation, recently, proved to be of such character, that mention of it must be made here.

Sparton Model 740

The complaint on a Sparton, model 740 receiver, similar to the model 301 (shown on page 459, of the February, 1931 issue of RADIO-CRAFT) except for the additional tuned R.F. stage and modification of the band-selector connections, was "very loud hum, accompanied by weak and distorted reception." Occasionally, one finds a shorted cathode filament 485 tube to be the direct cause of this same condition. (The 485 tube possesses the same characteristics as the 484 except for the fact that the 485 is a quick heater.) However, the tube checked satisfactorily.

Grid voltage on the '50 tubes, being normal, vetoed the presumption that the bias resistor was shorting at some point to the chassis. A careful socket analysis was made of the entire receiver with only a single clue, *the plate voltages were slightly below par.*

All this time, in order to complete the necessary tests, the set had been switched "on," and the terrific hum drove all within audible range almost to distraction. When the detector tube was removed, the hum decreased nearly 75 per-cent. As the power amplifier was functioning properly, this led to the conclusion that the fault lay in the power supply. Logically, the first thought was open-circuited filter condensers.

A 2 mf., 600-volt condenser was selected from the kit and connected from chassis to rectifier filament, red speaker lead and blue speaker lead, in turn. (The red and blue speaker leads connect to the speaker field which is used as a choke in the plate supply.) This move did not reduce the hum but the frequency of the note changed. Leaving the condenser connected from chassis to red speaker lead, another unit of like characteristics was connected from the blue speaker lead to chassis. The hum diminished considerably.

The condenser block in this receiver is composed of three 2 mf. sections. It appeared unlikely that two sections would open-circuit at one time. To definitely determine this fact, the three condenser leads were unsoldered from their respective positions in the circuit, and with the set switched "on," each lead was connected first to the high voltage and then to chassis to obtain a discharge. However, it was not possible to obtain a spark from any of the condenser sections.

The two nuts holding the block to the chassis were loosened and the block removed. A cursory examination disclosed the fact that the common lead which *should* have been soldered to the bottom of the can, and which is external to it, was not making contact; consequently, each section of the block was actually bypassing the hum voltage right around each choke, instead of to the ground. After connecting this lead and replacing the block the receiver performed in normal manner. The condition described is illustrated in Fig. 1.

Sparton 737

In the Sparton 737 ("gold" model, 600 series), one of the most frequently reported complaints is "fading." This may be caused by many defects, some of which have been previously described in these columns. Several months ago, such a complaint was followed up.

Aerial, tubes, the R.F. coil bobbins and the reproducer were all checked and they tested normal. Nevertheless, after about a half hour, the receiver commenced to fade, accompanied by an annoying sputtering and cackle, until finally, the set ceased to function.

The cackling and sputtering condition pointed definitely to some breakdown in the receiver; at the same time an arc was undoubtedly being produced.

With this in mind, different parts of the receiver and chassis were tapped with a light tack-hammer, care being exercised when the tubes were tapped, in an effort to locate the defective member by reproducing the arcing—and the resulting noise. This was made with the switch "on." When the push-pull audio input transformer was struck smartly, the set started to perform with a series of cackles.

(The above method of locating trouble might well be applied to the location of poor or unsoldered connections.)

After the receiver had operated normally for some time and again faded, striking the same unit restored reception to normal. A close persual of this unit disclosed the primary shorted to the core. A new transformer was installed and the job was done.

Since that time, eight transformers have been replaced on other service calls to remedy the same defect in the same model.

Two other common complaints have been found on the Sparton 737 receiver. In one case, the symptoms were weak reception and a loud howl as the volume control was turned down.

In such instances a socket analysis will show lack of plate voltage on one of the first three (untuned) R.F. tubes occasioned, generally, by a poor socket contact. In order to repair these sockets, it is necessary to remove the sub-panel assembly from the metal shield can. The two nuts holding the shield can to the shelf should be loosened and removed, and the shield can moved away from the dial to disengage the R.F. amplifier from the

(*Continued on page 117*)

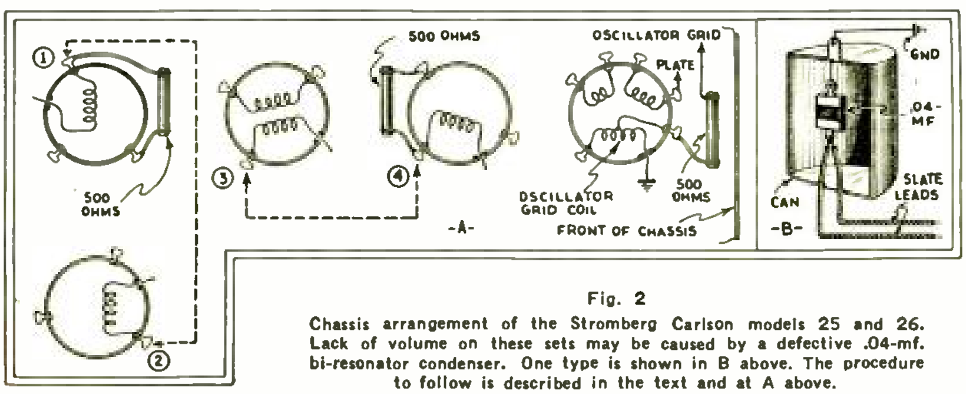


Fig. 2
Chassis arrangement of the Stromberg Carlson models 25 and 26. Lack of volume on these sets may be caused by a defective .04-mf. bi-resonator condenser. One type is shown in B above. The procedure to follow is described in the text and at A above.

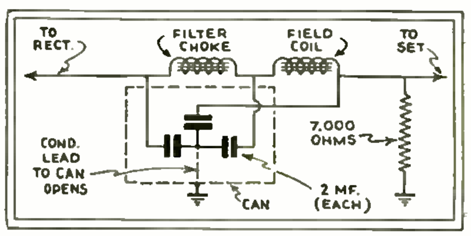


Fig. 1
Trouble was caused in a Sparton 740 because the lead which should connect to the can was not connected at all; each section of the unit was bypassing the hum around the filter chokes.

THE SERVICE MAN'S FORUM

Where His Findings May Benefit Other Radio Technicians

LASSOING BUSINESS

Editor, RADIO-CRAFT:

In Fig. A is illustrated our service shop. All of the equipment excepting the Jewell 199 set analyzer (which has been rewired) is home constructed. A description of the "lab." may be of general interest.

A standard large-size office desk covered with linoleum provides a working bench as well as eight drawers, one for each of the following: tools, hookups, condensers, resistors, volume controls, hardware and small parts, miscellaneous units. The test panel, at the rear of the desk, was constructed from veneer 38 in. x 58 in. x 1/4-in. thick, mounted on a heavy wooden frame.

On the panel at the lower right is an A.C. subpanel with "on-off" switches for all units as well as controlled outlets for a soldering iron and radio receivers under test; a master switch turns off everything. In the opposite lower corner is a complete power plant delivering "A," "B," and "C" voltages; and a Tungar battery charger.

A Jewell 199 analyzer rewired for quick socket voltage analysis and a complete set of adapters are handily arranged at the center. To the left of the Jewell instrument are the antenna and ground leads, brought to the panel on G. E. stand-off insulators. At the upper right is a broadcast-band shielded oscillator provided with a plug-in jack type of output connection.

On the subpanel in the upper left-hand corner of the panel is mounted a tube tester to indicate mutual conductance, filament emission, and shorted elements: a switching arrangement places the 8-scale Weston meter in series or shunt connection to any radio circuit; also, the meter may be used for external voltage and continuity tests. Provision is also made by means of tip-jacks to place any other meter in the circuit for adjustment or comparison. A line-filter reverse switch and control is built in.

In addition to the equipment on the panel there is one D.C.-type 90 to 1500 kc. oscillator; a two-button mike; and two dynamic and three magnetic test speakers. There also is available a Universal meter equipped with test prods and having four milliamp., three ampere, five voltage and three ohmmeter ranges; namely, a total of 15 ranges for one lone meter!

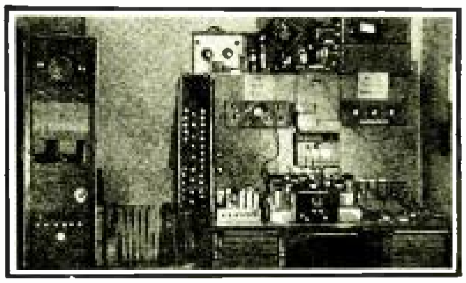


Fig. A
How's this for a Service Shop.

A card index is kept for changes on sets, and duplicate analysis blanks. In the tube rack at the left of the panel there is kept *a complete set of matched tubes*. A total of about 200 good hand tools are provided.

At the extreme left (under the big Peerless speaker) is under construction for a local publicity company, a rack-and-panel type of amplifier. Radio, phonograph and two mikes are switched by means of jacks and patch cords on the panel into two amplifiers; and from this combination, into five reproducers.

We are very proud of our radio library; a complete file of all radio publications is kept. Not shown in the photograph is another table for working tests; and long shelves provide for chasses, parts and tubes.

(Note—We may be radio men but we're not type-mill pushers!)

R. M. CASTE,
Dunbar Radio Co.,
Dunbar, W. Va.

("Mill pusher" or no mill pusher, our correspondent writes an interesting letter. We are sure that if more service organizations would follow a clean-cut plan in laying out a service shop, as have the members of this company, sales resistance would be greatly reduced.—*Technical Editor.*)

THE Official Radio Service Mens Association, sponsored by RADIO-CRAFT, *invites all Service Men who are not members of the Organization to write for an application blank. It is the official service organization of this magazine and is maintained solely for the interests of Service Men. Membership cards are issued upon passing a written examination which is forwarded by mail. Write for yours today. The O.R.S.M.A., 98 Park Place, N. Y.*

CONTROLLING THE PRICES OF TUBES

Editor, RADIO-CRAFT:

I wish that you would grant me a little space in "our" magazine for this letter; I say "our" because I feel that "It" belongs to the Service Man.

I hardly know just how to put it but anyway here goes. I am sure that there is not a Service Man that has not heard these words or something similar, "Why, I can order that tube from a mail order house for about half that price," and the smaller the town the more often he hears this plaintive refrain.

Consequently, I have a far fetched suggestion to make; I am confident that if the Service Men of the country at large would stick to it, it would work.

If the Service Men as a body would back the product of some reliable tube manufacturer, handle his line exclusively and talk quality; and if this manufacturer would refuse to sell these tubes to the gyp houses I think, in my way of seeing things, that the result would be a big step towards helping all concerned.

I would appreciate hearing what other Service Men have to say on this subject; in fact, the small radio dealer also might well benefit by subscribing to the same plan.

LEE F. SCHLOSSER,
Lee F. Schlosser Radio Service Co.,
Haleyville, Ala.

(There are two sides to this story, as there are to most, so let's hear what the "anti's" have to say.—*Technical Editor.*)

DANCE STATIC

Editor, RADIO-CRAFT:

The writer was called in to service a set in which there was interference.

The people danced quite a bit and when a couple passed (in the front room) a certain spot close to the front door the radio set seemed to want to fall apart due to the terrific noise it emanated. Well, I knew there was a loose connection but could not find it—so "Hawkshaw" went to work.

No loose connection in sockets or base plugs on the first floor, so up I went to the second. Nope, no luck. Nearly ready to give up, I went to asking questions.

I found out that Mr. Amateur a few years back had torn up a plank in the attic and done some wiring. Up comes the plank again and the mystery of a loose connection is solved—you know, resin joints.

T. E. DALY,
8 Brookfield, Beulah Park,
Cleveland, Ohio.

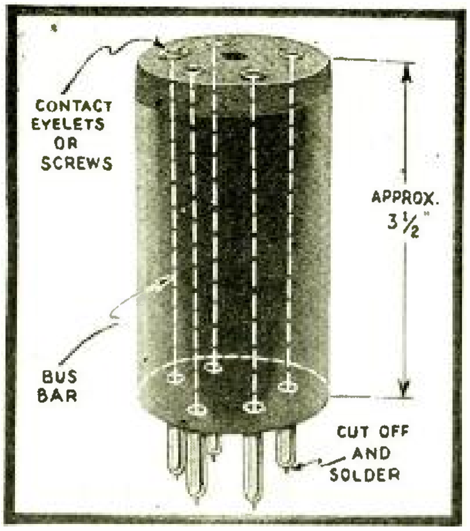


Fig. 1
Photograph of the new "resistance adapter."

SHORT CUTS IN RADIO SERVICE

$10 for Prize Service Wrinkles

Previous experience has indicated that many Service Men, during their daily work, have run across some very excellent Wrinkles, which would be of great interest to their fellow Service Men.

As an incentive toward obtaining information of this type, RADIO-CRAFT will pay $10.00 to the Service Man submitting the best all-around Radio Service Wrinkle each month. All checks are mailed upon publication.

The judges are the editors of RADIO-CRAFT, and their decisions are final. No unused manuscripts can be returned.

Follow these simple rules: Write, or preferably type, on one side of the sheet, giving a clear description of the best Radio Service Wrinkle you know of. Simple sketches in free-hand are satisfactory, as long as they explain the idea. You may send in as many Wrinkles as you please. Everyone is eligible for the prize except employees of RADIO-CRAFT and their families.

The contest closes the 15th of every month, by which time all the Wrinkles must be received for the next month.

Send all contributions to the Editor, Service Wrinkles, c/o RADIO-CRAFT, 98 Park Place, New York City.

PRIZE AWARD

ADAPTER FOR "RESISTANCE SERVICING"

By Robert Barton

WITH the coming of "resistance measurement" (prong of socket to chassis, etc.), as a basis of service procedure, the writer submits a description of a small unit which he has used for quite a while with satisfactory results. It speeds service work "like nobody's business!"

This device is a special plug adapter, illustrated in Fig. 1, which is cheaply and quickly constructed, its object being to provide a simple means of making electrical connection to the socket prongs when they are below the subpanel or surrounded by a non-removable shield. Contacts on the top plate are "straight through" connected to the prongs.

For its construction in UY-type, procure a 5-prong short-wave coil-form, such as the old Dresner, Octocoil, etc., and a flat piece of bakelite approximately the diameter of the coil form. Drill holes in the bakelite plate in the relative position of the tube prongs, and bolt short screws, to which are fastened lugs and lock washers, through these holes. To these lugs are soldered lengths of busbar which are then pushed through their respective holes in the prongs and drawn up snugly; soldering these pieces to the respective prongs ("grid" contact to grid prong, "plate" contact to plate prong, etc.) completes the job.

A unit of this type having low-resistance, convenient contacts to "jab up against" when making a resistance test instead of "fishing around" in a hidden socket, is something that I think will appeal to other Service Men.

Of course the same idea can be adapted for any type of socket; for instance in making such a device for a six-prong socket, procure a tube base with the required number of prongs in it, drill six holes in the top plate and then proceed as described for the 5-prong tube circuits.

By measuring the resistance between the chassis and each prong of each tube socket, with the current turned off, and comparing the resulting figures with previously prepared tables for sets of similar type resistor, opens, shorts and changes in value; condenser shorts and leakage; and instrument shorts; opens or grounds are readily detected.

Articles on the "chassis-to-tube-prong resistance" method of radio servicing for which this adapter is designed have appeared in contemporary publications, to wit: "The Resistance Measurement Method of Servicing," in the June 1932 issue of "Service" magazine, and; "Resistance Measurement," in the May 1932 issue of "Radio and Music Merchant" magazine.

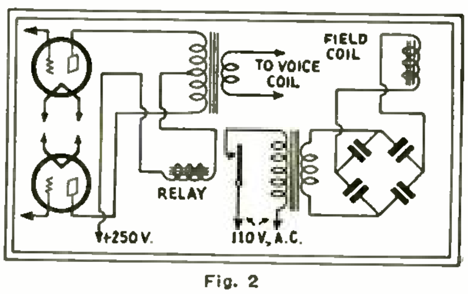


Fig. 2
Mr. Sager's remote control system.

REMOTE CONTROL OF A. C. DYNAMIC SPEAKER FIELD

By C. M. Sager

WHEN operating a dynamic reproducer with an A.C. field which is entirely remote from the set, it is necessary to turn the field supply to the speaker "on" and "off," *at the speaker*, with the result that the current is often left turned "on," when not in use.

A small relay, of the type formerly used to control "B" eliminators and battery chargers, can be used to turn the speaker on and off automatically.

Remove the winding from the relay magnet (this being about No. 18) and rewind with No. 32 enameled wire, random wound, to completely fill the spool. The rewound relay is connected in the center lead to the speaker input transformer, and operates on the plate current of the power tubes. Using two '45 or '47 tubes, with a plate current of 60 to 65 milliamperes, only about 4 or 5 volts drop across the magnet winding is required to operate the relay. See Fig. 2.

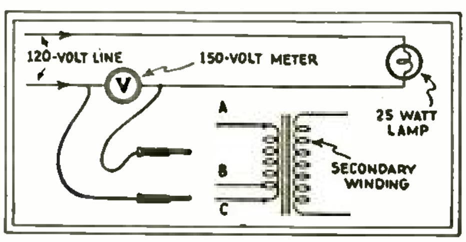


Fig. 3
Here's how to test those shorted turns.

A "SHORTED TURNS" TEST

By Clifton E. Wellman

I HAVE never seen described in any radio magazine the following method of testing for shorts in power transformers. It does not require elaborate or expensive equipment.

Many Service Men cannot tell when a power transformer is faulty, unless it has reached the point where it may be identi-

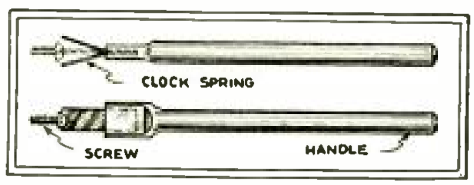


Fig. 4
The screw starter.

fied by the looks, the smell, or the open circuit condition of a secondary winding.

However, by utilizing the primary winding of the transformer to be tested as a shunt for an A.C. 150-volt meter, as shown in Fig. 3, shorts in the secondary windings are indicated by the drop in the meter readings. These should be checked against readings taken from transformers known to be O.K. A chart should be made up of these readings of the popular makes of radio sets that come into the shop; (the readings between different makes of transformers do not differ very greatly). Shorted turns in the primary windings may also be indicated in this test.

The following tests and readings, submitted as examples, were made upon a Victor model R-15 power transformer:

	Volts
Voltmeter readings, test prods open	110
Voltmeter readings, test prods shorted	0
Test prods connected to primary of trans., A to C. No. load	90
Test prods connected to primary of trans., A to B. No. load	86
Test prods connected to primary of trans., B to C. No. load	1
Test prods connected from A to C.	90
Add the following load—dial light.	89
2 power tubes	71
Rectifier	52
4 screen-grid tubes	32
Short rectifier plate to grid	1.5
Short rectifier filament	10.5
Short rectifier filament to plate	70
Short power tube filament	28
Short '24 tube filament	26

Therefore, readings that differ very much from the chart below would indicate that the transformer is not O.K.

	Volts
Victor R-15—Sec. free	90
Load 2 pr. tubes and rect.	52
Crosley 30S-31S-33S-34S—Sec. free	85
Load-rectifier	58
Radiola 41—Sec. free	96
Load-rectifier	62
Atwater Kent 44—Sec. free	78
Load-rectifier	56
Philco 77-77A—Sec. free	84
Load-rectifier—all tubes	30

A GOOD SCREW-STARTER

By Ray L. Mason

A SERVICE tool that I have found absolutely indispensable in my shop is made from a piece of copper tubing (such as refrigerator men or auto mechanics usually have around) about six inches long and with a diameter of about 1/4 in. or larger, (if copper tubing is not available an old curling iron will furnish the tubing) and, a piece of clock spring.

Pinch the end of the tube in a vise until almost closed, insert two pieces of clock spring about one inch long into the tube, leaving about a half inch protruding, then pinch tightly and you will have one of the best screw-starters you could ever find. The completed tool is illustrated in Fig. 4.

A SCREEN-GRID DETECTOR FOR THE A.K. 37

By George Stoneham

VOLUME and sensitivity were increased approximately three times, selectivity was improved and tone quality was unimpaired by making a few slight changes in an A.K. model 37 receiver. The changes made in this radio set may be made in any receiver where the type '27 detector operates with comparatively low plate voltage and R.F. input.

The original circuit of connections is shown in Fig. 5A; B, the completed diagram, incorporates a type '24 tube as the detector.

THE SERVICE MAN'S FRIEND

By Wilbert L. Misner

IN the life of every Service Man there comes a time when he will accidently mar the surface of a radio receiver cabinet. The writer takes care of such contingencies by always carrying along a small bottle containing clear varnish and capped by a rubber stopper. The procedure is illustrated in Figure 6.

The rubber stopper moistened with a little varnish is rubbed over the scratch until the varnish flakes have been dissolved and mixed with the fresh varnish and presto, the scratch will have disappeared!

Where the scratch has gone through the surface of the varnish and reached the wood, use a soft-lead pencil to darken the surface and then follow the procedure previously described.

REPAIRING A.K. POWER PACKS

By Herbert W. Jones

WE all know what a messy and tough job it is to repair A.K. Power Packs in which one of the condensers is "shot." However, there is one method which, inso-far as the writer is aware, has never before been proposed to the main body of Service Men. This is a simple and effective method of repairing such A.K. models as the 37 and 38—and without tearing the can to pieces or melting out the sealing compound; the principle is applicable to other makes of receivers having similar power pack design.

If either the detector bypass or the filter condensers are shot, remove the cover and loosen the clamp which holds down the two cans, raise the filter system can and then place under it a piece of insulating material. Then, cut the bare lead that connects from the filter can to the center hold-down, bolt and solder a piece of insulating wire to this bare wire from the can. Replace the can, place another piece of insulating material under the hold-down clamp (that is, over the filter can) and tighten. The filter can should now be *entirely* insulated from the chassis.

The original connections of the filter system of an A.K. model 37 or 38 receiver pack are shown in Figure 7A; in 7B, the connections of the filter system are shown after being revamped in accordance with the above procedure.

Since the filter system is now connected to ground through condenser C6 the resulting effective capacities of the condensers in the can will be a function of the capacity of C6; in other words, we are bringing into use the law of condensers in series.

Therefore, to raise the effective capacity of C2, the condenser C7 connected to the outside of the can is added in parallel to C2 and C6.

Although the effective capacity of C3 is lowered, it is not possible to notice any difference in operation of the set. However, if desired, its capacity, too, may be increased by connecting an external condenser from the can to the detector positive terminal on the terminal board. Condenser C5 is added to aid in the filtering.

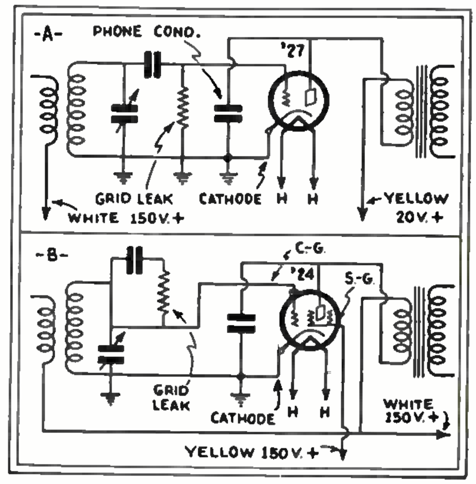


Fig. 5
Changing for the screen-grid detector.

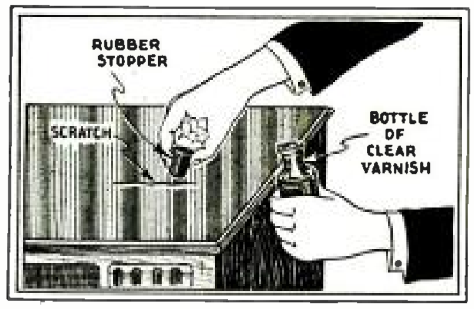


Fig. 6
At last, a scratch eliminator!

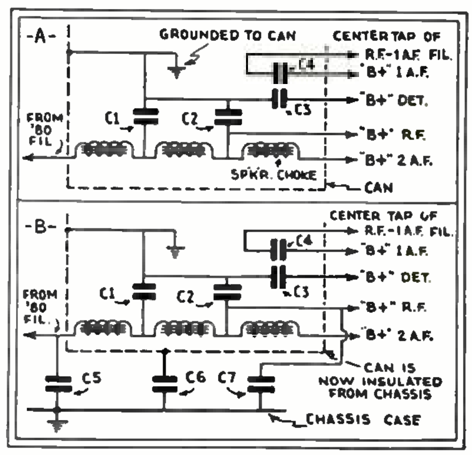


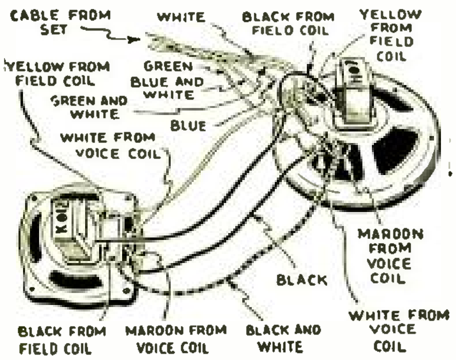
Fig. 7
And for repairing that A.K. power pack—

PHILCO MODEL 15 SERIES, 11-TUBE SUPERHETERODYNE CHASSIS

(Used in Models 15X and 15DX receivers; and includes inclined sounding board, twin reproducers, tone control, A.V.C., visual tuning, local-distance switch.)

A feature of this chassis design is the exceptionally fine quality of the reproduction. Note that tubes of the 6.3-volt or "automotive" type are used in this ultra-modern receiver, a product of the Philco Radio & Television Corp. The following quotation is of particular interest.

"In efficiency, in economy of current and space, in uniformity, in freedom from trouble and in all-around performance, the new Philco 6.3-volt universal-service tubes are superior to any tubes that we know of, past or present.



"We will standardize on 6.3-volt heater type tubes, since their use permits application to automotive receivers and D.C. sets, as well as to A.C. instruments; thus, all new developments in future Philco tubes will be immediately available for all these classes of service."

Following is a list of the features of this set, as furnished by the factory: Inclined sounding board, twin-reproducers, A.V.C., automatic tuning silencer, distance switch, illuminated grille, tone control, shadow tuning, glowing arrow station finder, station-recording type of dial.

The resistors in the Model 15 chassis should measure as follows: R2, R17, 10,000 ohms; R3, R5, R18, .49-meg.; R4, .16-meg.; R6, 51,000 ohms; R7, 200 ohms; R8, R14, R16, 1. meg.; R9, 13,000 ohms; R10, 1,000 ohms; R11, 99,000 ohms; R12, .25-meg. (dotted; see text); R13, R19, 5,000 ohms; R15, 25,000 ohms; R20, .24-meg.; R21, R22, 50 ohms; R23, 205 ohms.

Condensers C1 to C9, tuning or trimming condensers. Condensers C10, C22, C23, are 110 mmf. units; C11, C12, C13, C18, C19, .05-mf.; C14, C17, .09-mf.; C15, C24, C25, .25-mf.; C16, 35 mmf.; C20, 1. mf.; C21, C27, .01-mf.; C26, C31, C33, 0.5-mf.; C28, C29, C30, tone control condensers; C32, .002-mf. (dotted; see text); C34, C38, C39, .015-mf.; C35, .18-mf.; C36, C37, 6 mf. (electrolytic); C5A, 700 mmf.

The reproducer system of this receiver deserves special mention. Due to the fact that there are two separate dynamic reproducers operating from a single receiver output, it is absolutely essential that the instruments be correctly "poled"—that is, the field and voice coils must be connected so that the correct "phase" relation is maintained between the two units. (Both diaphragms moving in or out at the same time.) For this reason a detail illustration of the reproducer leads, showing their color code and connections, is reproduced in this Data Sheet.

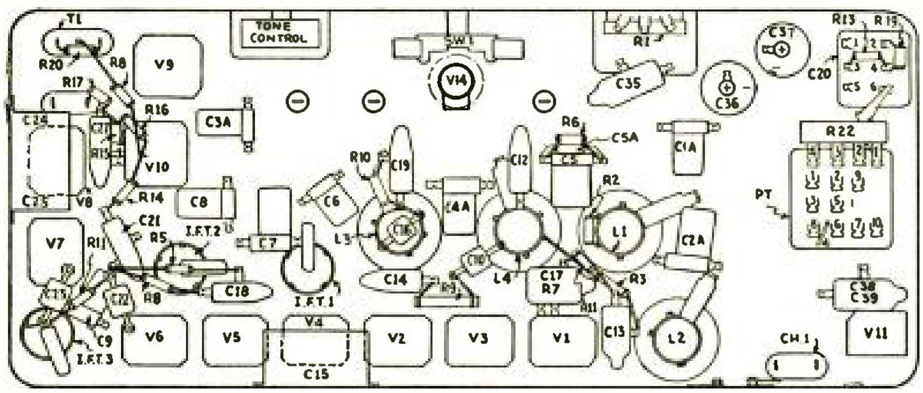
Chasses stamped at rear with a circle around Nos. 20 and 21 must have R12 and C32 added to reduce distortion due to powerful local stations; Nos. 22 and 23 have C32 but may require R12; subsequent chasses are equipped with both.

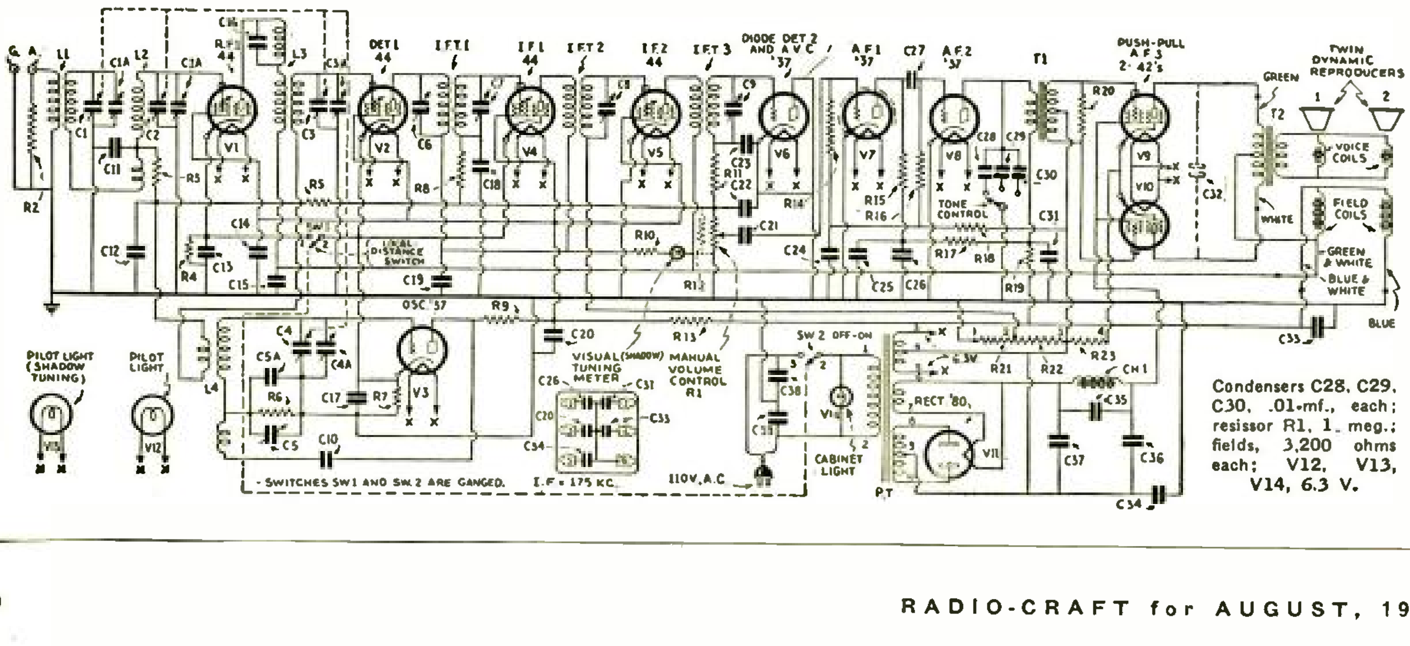
"Both speakers have identically the same frequency response characteristics," states the manufacturer. "The two reproducers are used to obtain more uniform sound distribution. An echo-absorbing screen at the rear of the cabinet prevents echo and blur—and tends to increase front-projected sound volume.

The power rating of the set is 115 watts.

The tubes in the Model 15 chassis are very economical in their filament-current requirements. The types '37 and 44 tubes consume only 0.3-A; the 42's (the output pentodes), 0.7-A.; the '80, 2. A. The filaments of all of these tubes, except the '80, are rated at 6.3 V.; the '80, 5 volts.

With an A.C. line potential of 115 volts, volume control at maximum, with the station selector turned to the low-frequency end and the power switch in the "middle" position, the following readings are normal: Plate potential (measured to cathode), V1, 165 volts; V2, V4, 250 volts; V3, 60 volts; V5, 275 volts; V6, zero; V7, 75 volts; V8, 100 volts; V9, V10, 255 volts; V11, 320 (per plate). Screen-grid (to cathode), V1, 55 volts; V2, V4, V5, 90 volts; V9, V10, 270 volts. Control-grid (to cathode), V1, V3, V9, V10, 15 volts; V2, V4, 0.85-volt; V5, 3.3 volts; V6, V8, 0.2-volt; V7, 0.4-volt. Cathode (to filament), V1, 30 volts; V2 to V9, 10 volts; V10, 15 volts; V2, V4, 0.85-volt; V5, 3.3 volts; V6, V8, 0.2-volt; V7, 0.4-volt. Cathode (to filament), V1, 30 volts; V2 to V9, 10 volts; V10, V11, 15 volts.





Condensers C28, C29, C30, .01-mf., each; resissor R1, 1. meg.; fields, 3,200 ohms each; V12, V13, V14, 6.3 V.

RCA VICTOR MODEL R-78 BI-ACOUSTIC 12-TUBE SUPERHETERODYNE

(Also, General Electric "Convention" Model J-125 Chassis.)

This is the first commercial receiver to incorporate the new "super-phonic" line of tubes which have recently made their appearance on the market. The tubes of this series incorporated in the R-78 (and J-125) chassis are the 58 R.F. pentode, 56 general-purpose, 46 Class B and 82 mercury-vapor rectifier. (The type 58 tubes are of 6-prong-base design.)

A feature of the receiver is the tone control, which is designed to maintain even reproduction of the low and high frequencies, regardless of the volume setting. Thus, bass reproduction at low volumes is not attenuated as when non-compensating circuits are used.

The resistance and capacity values of the respective units are indicated by figures within parentheses.

The following operating voltage and current readings are for a 120-volt line, the volume control set at "minimum," and no signal being received.

Filament potential, all tubes, 2.5 volts. Plate potential (to cathode or filament), V1, V2, V4, V6, V7, V10, 210 volts; V3, 70 volts; V5, 200 volts; V8, V9, 400 volts; V11, zero. Plate current, V1, V10, 3 ma.; V2, 1.5 ma.; V3, V6, V7, 5 ma.; V4, 2.5 ma.; V5, 1. ma.; V8, V9, 6 ma.; V11, zero. Control-grid potential (to cathode or filament), V1, V2, V3, V4, V8, V9, V10, V11, zero; V5, 12 volts; V6, V7, 8 volts. Screen-grid (to cathode or filament), V1, 100 volts; V2, V4, V10, 95 volts. Cathode (to heater) potential, V1, V3, V10, 7 volts; V2, 10 volts; V4, 8 volts; V5, 12 volts; V6, V7, 11 volts; V11, 15 volts.

The input signal potential for the I.F. amplifier is applied also to the A.V.C. amplifier tube due to the grids of both being coupled together by means of C32. The output of the I.F. amplifier V4 is applied to second-detector V5 through a sharply-tuned transformer I.F.T.2; however, the output of A.V.C. amplifier V10 is coupled to A.V.C. tube V11 through a broadly tuned unit

Although too much selectivity ahead of V11 is undesirable, since it introduces excessive distortion and overload as a station signal is tuned in, still, a certain amount is essential; otherwise, the A.V.C. will be caused to function by a local station when it is desired to tune in a weaker station on an adjacent channel.

The voltage developed across resistors R4, R21, R22, furnish control-grid bias for V1; the drop across R4, R22, is the control-grid bias for V2; and the drop across R4, control-grid bias for V4.

As the drop in these resistors is due to the signal potential applied to the A.V.C. tube and this voltage is in turn dependent upon the bias of the R.F., first detector, and I.F. amplifier, an automatic action is obtained; greater voltage is applied to the R.F. and first-detector than to the I.F. to prevent overloading of these tubes due to a strong, undesired adjacent carrier.

The undistorted power output of the R-78 is rated at 10 to 20 watts, depending upon the percentage of modulation of the incoming signal; consequently, to compensate for variations in sound intensity over the audio frequency band as the output is varied within these limits the volume control circuit is arranged to produce substantially flat response between the range of 35 and 5,000 cycles.

The trap circuit A.F.C.1, C11 tunes to approximately the middle of the A.F. response range and as the volume is reduced to one point, it causes greater attenuation of the middle register than at either end. From this point to the minimum position the volume control acts as a potentiometer across the trap circuit and reduces the volume without changing the frequency response to any greater degree.

This completes the description of the first half of the volume control; the second, which functions only over the last 20 degrees of the angular movement of the volume control, is resistor R1 connected between the R.F. and first-detector cathodes and varies the overall sensitivity

Push-pull voltage amplifier V6-V7 is the driver stage for push-push amplifier V8-V9.

Cabinet resonance has been nullified by means of two side chambers; the baffle area is large.

To prevent excessive hum and noise, it is essential that a good ground be connected to the yellow lead of the chassis; considerable hum also may be caused by insufficient twist in the volume control leads, due to pickup by A.F.C. 1.

In localities remote from strong stations it may be desirable to increase the A.V.C. action to obtain better than 100 mv. sensitivity. This is accomplished by shorting out R1, as indicated by the dotted line, "short."

To realign the chassis, an output meter will be necessary. (This may be a current-squared galvanometer connected to the secondary of T3 in place of the reproducer voice coil; an 0-5 ma. meter in the plate supply lead to V2; or a low-range A.C. voltmeter across the reproducer voice coil.)

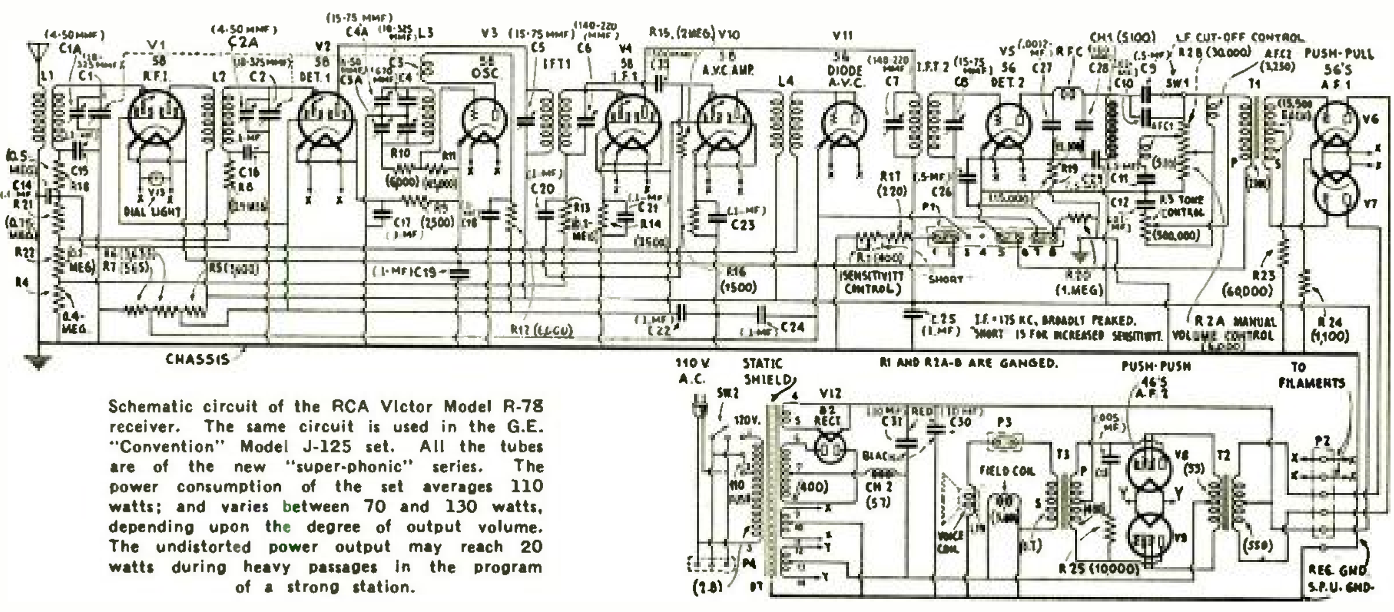
A "dummy" 56-type tube having an open heater circuit is required to replace V11; make certain that the dial pointer reads exactly at the short line on the scale when the gang condenser plates are fully meshed. Then, align the circuits at 1,400 kc., with the volume control in the "maximum" position.

Follow this with the alignment procedure at 600 kc., then repeat the procedure at 1,400 kc. Condenser C4A, the 600 kc. trimmer, is reached through a hole in the top of the chassis, and about half-way along a line drawn from the tuning dial to the socket of the first-detector.

To adjust the I.F. circuits, set the service oscillator at 175 kc., replace the regular type 56 tube with the dummy 56, as previously described, couple the oscillator to the control-grid of the first-detector, and set the volume control at "maximum"; adjust first I.F.T.2, then I.F.T.1. Repeat the procedure. Looking at the rear skirt of the chassis, and reading from left to right, the trimmers of the I.F. transformers are arranged in the following order: C8, C7, C6, C5. Terminal panel P1 is below these adjustments. At the left of P1 is the "fidelity" switch, SW.1.

It is a good plan after making the I.F. realignment adjustments to repeat the oscillator and R.F. adjustments.

Following is the color code of the power transformer: 1, black, red tracer; 2, black-red; 3, red; 4, 5, yellow; 6, 8, brown; 7, brown-black; 9, 11, blue; 10, blue-yellow; 12, 14, green; 13, green-yellow.

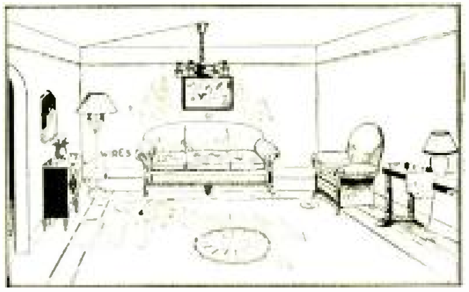


Schematic circuit of the RCA Victor Model R-78 receiver. The same circuit is used in the G.E. "Convention" Model J-125 set. All the tubes are of the new "super-phonic" series. The power consumption of the set averages 110 watts; and varies between 70 and 130 watts, depending upon the degree of output volume. The undistorted power output may reach 20 watts during heavy passages in the program of a strong station.

RADIO SERVICE AND THE ELECTRIC CODE

The third of a series in which the need for proper radio installations is emphasized.

By GUS JACOBSON



Radio installations may come and go but the good ones remain forever. This is well illustrated by the sketches above. The upper one shows how "the well-dressed installation will look," and the one below, how it will "not look."

IN a recently issued report of the New York Board of Fire Underwriters, the following excerpt may be of interest to radio Service Men, home owners, or other unauthorized persons doing electrical wiring. "The records of proven electrical fires compiled by the Electrical Bureau of the New York Board of Fire Underwriters show that the losses for uninspected and unapproved electrical devices, materials and wiring constitute 81 percent of the total electrical losses."—J. C. Forsyth, Chief of the New York Underwriters Inspection Bureau.

Chicago reports 650 electrical fires during 1931. Of these, W. A. Jackson, City Commissioner of Gas and Electricity reports that 400 occurred in residences *and 80 percent of these were due to faulty wiring installed by home owners and other persons untrained in the methods of installing electric wires.*

Other figures compiled by insurance officials, electrical contractor associations, and power company inspectors throughout the country, with a few insignificant exceptions, show similar trends. In all summaries, the majority of electrical fires are shown to have occurred in homes where comparatively small amounts of power is consumed. The exceptions are several communities where electrical authorities do more than shake an admonitory finger at householders where violations are discovered or where a fire has caused enough loss of life to awaken a temporary public conscience.

When a comparison is made between the current used in the average single-family residence or apartment, and the large amounts of power used in factories, and the inverse ratio of electrical fires that seem to occur with these large amounts of power, the inevitable conclusion is that such fires are caused, not so much by the presence of heavy currents, *as by the manner of confining these currents to their conductors and the prevention of arcs near combustible material.*

This is well known in the electrical industry, and the National Electrical Code devotes as much attention to the insulation and protection of current-carrying conductors as to the conductors themselves. The false economy of using 250-watt sockets to operate 600-watt irons has been proven time and again. The Association of Electragists, International, in 1931, inaugurated a campaign to bring the attention of landlords and small-home owners to the lack of sufficient convenience outlets in homes. Figures from member electrical contractors have been provided, proving that the cost of replacing burned-out sockets, accidents happening while the light was off due to fuses blowing from overloaded materials giving way, and mechanic's time lost travelling to and fro on these small blowout jobs, average in three years, more than the cost of installing convenience outlets.

Profits for the Service Man

The intelligent radio man should use these facts as a means of adding to his income. That nearly all this unapproved wiring takes the form of extensions from electric light fixtures is self evident for all power companies require that certificates from local insurance authorities and municipal electrical bureaus be registered with them before permitting current to be turned on.

When a Service Man is called in to install or repair a receiver and finds one of these scrap telephone or bell wire extensions, he can become a salesman of safety and explain the menace contained in this type of electrical installation. To a woman, what argument is more potent than that offered by the fact that 286 children, aged six and under, have perished in fires of proven electrical origin within a radius of twenty-five miles of Manhattan during 1931? *And 81 percent of these fires were due to uninspected and unapproved devices, materials, and wiring.*

Every radio Service Man has found that, after solving a baffling case of trouble (especially after others have failed or the owner has become involved in a hopeless mess after attempting to repair a receiver himself) radio set owners are apt to place confidence in every statement the Service Man makes. A time like this is an opportunity for the radio Service Man to bring out his array of facts regarding unapproved wiring and to sell the set owner the idea of electrical safety.

Even householders who do not care to go to the bother of having outlets installed at that particular time, may be so persuaded by the radio man's conversation that he will have such receptacles installed when the house or apartment is being painted. If contact is maintained with such a householder, as for example by means of free tube tests, this job should go to the Service Man or the electrical contractor he is associated with. In communities where licenses are required, or where Service Men have not been trained in methods of installing receptacles, radio men will save themselves plenty of grief if they contact electrical contractors and turn all possible jobs over to them, on a commission basis.

There is little reason why Service Men cannot utilize their continual contact with set owners to permit them to sell these latter electrical appliances, or any other merchandise they can obtain through regular wholesale channels. In a number of cases where radio service organizations are also electrical contractors, Service Men carry catalogues of standard electrical appliances with them in their cars and are able to quote prices and to give specifications of any particular type the set owner expresses an interest in.

(*Continued on page* 116)

AN AMATEUR'S S.-W. RECEIVER

The "A. C. Portable Pentode" described in the September, 1931 issue of this magazine has created such enthusiasm that we are pleased to present this short-wave version.

By WM. H. HENTON

THE Pentode Portable receiver described in the September, 1931 issue of RADIO-CRAFT has worked to such perfection that the writer was tempted to build a short-wave receiver using the same general idea of construction as described in the article referred to. Having built and operated the new receiver, and securing results that equal that obtained on the broadcast set, I am passing the dope along to others who may be interested.

The schematic circuit of the set is shown below. It has but two controls; the tuning condenser C2 and the oscillation control R2.

Construction

A metal case, preferably of aluminum, is cut to fit in the case to be used. The writer used an I.C.A. Insuline Midget Companion carrying case, the size of which is 6$\frac{1}{2}$x7$\frac{1}{2}$x10$\frac{3}{8}$ inches. Although any box of suitable size may be used, an old Victrola box would be suitable. The purpose of the metal box is, of course, to serve as a shield, therefore avoiding body-capacity effects which are very annoying on the higher frequencies.

All coils are of the tube-base type. Secure an old tube base and drill four holes; one directly over the plate prong, one $\frac{1}{4}$ inch higher over the F prong, one $\frac{1}{8}$ inch above the latter over the F— prong, and the last one at the end of the winding over the "grid" prong. Complete data for the coils are given in the list of parts.

In order that all those who build this short-wave portable receiver may secure the best results possible, several precautions must be taken.

First, the receiver must be capable of oscillating or no results will be secured. If all the connections have been properly made and the set still refuses to oscillate, the trouble may be due to some or all of the following:

1. Antenna condenser set wrong.
2. Low filament voltage.
3. Tickler coil connections reversed.
4. Tickler coil spaced too far from the plate coil.
5. Insufficient turns on the tickler.
6. The tube used is a poor oscillator.

This latter trouble rarely happens as long as the tube is good, but may fool you sometime.

List of Parts

Referring to the circuit diagram, the parts have the following values:

C1 Pilot type J5 5-plate midget condenser;
C2 Cardwell type B 5-plate receiving condenser;
C3 Aerovox .0001-mf. condenser;
C4 Aerovox .0002-mf. condenser;
C5A Aerovox .5-mf. bypass condenser;
C6A Aerovox .01-mf. condenser;
C5 Flechtheim 2 mf. filter condenser;
C6, C7, C8 Aerovox 4 mf. electrolytic condensers;
C9 Aerovox 1. mf. filter condenser;
R.F.C. Hammarlund 85-mhy. choke;
R1 9 megohms;
R2 Centralab 0-75,000-ohm variable resistor;
R3, R4 Electrad 12,000-ohm resistors;
R5 Electrad 5,000-ohm resistor;
R6 100,000-ohm resistor;
R7 Lynch $\frac{1}{2}$-megohm resistor;
R8 Lynch 400-ohm "C" bias resistor;
V1, V2 NaAld UY-type socket;
V3, V4 NaAld UX-type socket;
PT. Earl power transformer.

The coils necessary for the various bands are as follows:

For the 85-meter band; L1, 26 turns No. 26 D.C.C. wire; L2, 12 turns No. 26 D.C.C. wire. Both coils are wound in the same direction—clockwise, as described in the text.

For the 40-meter band; L1, 13 turns No. 26 D.C.C. wire; L2, 8 turns of No. 26 D.C.C. wire. Both coils are wound in the same direction as described in the text.

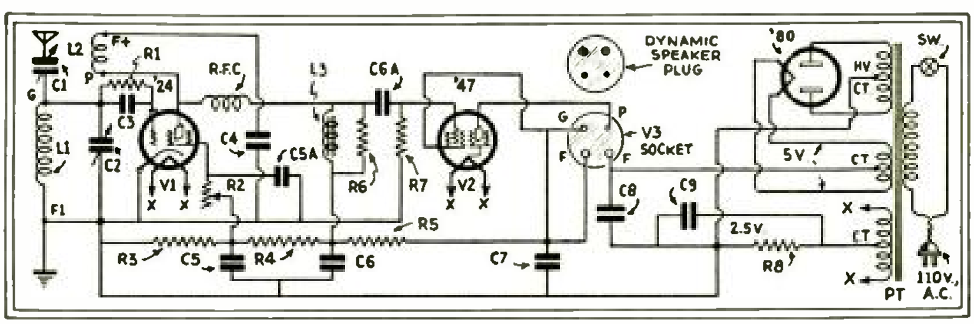
For the 160 meter and police bands; L1, 63 turns of No. 26 D.C.C. wire; L2, 30 turns of No. 26 D.C.C. wire. Both coils are wound in the same direction as described in the text.

The above brief description should be sufficient for most set builders. Because it is housed in a carrying case, it is easy to handle and therefore easy to transport from one place to another; for this reason it is called a portable receiver. The appearance of the set is exactly the same as the "A.C. Portable Pentode" described in the September 1931 issue of this magazine, and the reader is referred to it for reference as to the general procedure to follow.

It might be well to state that the tuning condenser C1, while it is shown variable, is set once for best response, oscillation control, etc., and left alone; although its adjustment may have to be changed, in some localities when changing from one band to another.

After winding the coils as per the specifications given previously, the four wires resulting therefrom are connected to the tube-base prongs in the manner shown in the diagram below. For instance, referring to the diagram, it will be seen that the two ends of the tickler coil are marked "F+" and "P," signifying that that end of the winding marked "P" connects to the "P" prong of the tube base upon which the coil is mounted; the same reasoning applies to the remainder of the coil. Care should be taken, however, that the socket into which the coil plugs is connected up in accordance with the markings shown.

To construct the choke at home, wind (jumble wound) 800 turns of No. 36 S.S.E. wire on a form (which may be a dowel stick) one-half inch in diameter and cut to a length of approximately one inch. Thus, an efficient R.F. choke may be made.



Complete schematic circuit of the short-wave portable receiver.

RADIO-CRAFT KINKS

Practical Hints From Experimenters Private Laboratories

$5 for a Practical Radio Kink

As an incentive toward obtaining radio hints and experimental short-cuts, "Radio-Craft" will pay $5.00 for the best one submitted each month. Checks will be mailed upon publication of the article.

The judges are the editors of "Radio-Craft" and their decisions are final. No unused manuscripts are returned.

Follow these simple rules: Write, or preferably type, on one side of the sheet, giving a clear description of the best radio "kink" you know of. Simple sketches in free-hand are satisfactory, as long as they explain the idea. You can send in as many kinks as you wish. Everyone is eligible for the prize except employees of "Radio-Craft" and their families.

This contest closes on the 15th of every month, by which time all the Kinks must be received for the next month.

Send all contributions to Editor, Kinks Department, c-o "Radio-Craft," 98 Park Place, New York City.

PRIZE AWARD

SIMPLIFIED SHORT-WAVE INDUCTANCE

By Russell Johnson

EXPERIMENTING around with my radio set, I made the interesting discovery that I could control a number of short-wave coils of the standard plug-in type *by means of a single 4-pole switch*, simply by connecting each of the primaries in parallel as indicated in the diagram, Fig.1.

HOW TO MAKE A CHEAP "B" UNIT

By D. E. Black

FOR an experimenter who wishes to make all of his own equipment, the author offers the following description of a simple "B" voltage supply-unit which may be built from parts borrowed from a "Lizzie."

Referring to Fig. 2, transformer T1 and filter chokes CH. may be made from the spark coils of model "T" Fords.

The first step is to take out the tar compound of a "Ford" spark coil and remove the windings. The length and diameter of the core is such that it will accommodate the new secondaries of 16,000 turns of No. 33 D.C.C. wire, center-tapped. As indicated in Fig. 2, considerable filtration is required; chokes CH. may be spark coil secondaries. This little "B" supply unit will work very nicely in conjunction with small automotive receivers.

RAISING THE A. C. LINE POTENTIAL

By R. Foltz

WISHING to make a simple "B" eliminator which, without the use of a high voltage winding, would deliver about 150 volts at about 9 to 10 ma., the writer constructed the unit illustrated in Fig. 3. The increased voltage was obtained through the use of the auto-transformer principle of connection, center-tapping the primary of a filament transformer as shown.

Constructional details for such a transformer are as follows: Primary, 600 turns of No. 30 enameled wire tapped at 400 turns; secondary, 36 turns, tapped at 18 (in lieu of this tap a center-tapped resistor may be used). The core has a cross-section of three-quarters of an inch and was obtained from a burnt-out transformer.

"CHECKING UP" OLD TUBES

By Mark Hacker

LOOK your tubes over and if you find some as described in this article, replace them and revive your old set.

In the illustration, Fig. A, are shown two type '24 screen grid tubes. In one tube, left, Fig. A, appears at the top a definite metallic deposit under and around the grid cap, the connection to the control grid—the heart of the tube. The other tube, at B, shows no such deposit. Both test "good" on a tube checker such as is found in stores, and there is trouble!

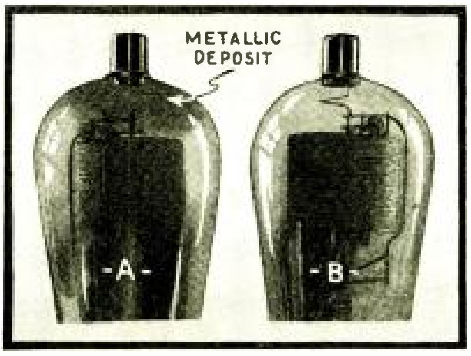


Fig. A
Here is a job for the treasure finder!

Practically all test instruments (outside of the radio laboratory) check only the static condition of a tube; which means that while on such an instrument both tubes test the same, on a dynamic test (the duplicate of conditions under which the tubes would be operated if they were placed in a radio set), they would show a great discrepancy.

The tube at A, with the metallic deposit in the top, has suffered quite a change in in-built characteristics. This deposit is the condensation of metallic vapor from the filament and other hot portions of the tube, and is usually present only when the tube has had quite some use.

This metallic layer, due to its being around the control grid wire that goes to the cap, is connected to the control grid. This extra surface of metal changes the responsiveness of the tube considerably; also, being in the grid circuit it changes the tuning of the receiver. Since any abnormal change in the tuned circuit of a receiver is deleterious to its operation, a set in which is included one or more tubes of the type exemplified by A cannot function correctly.

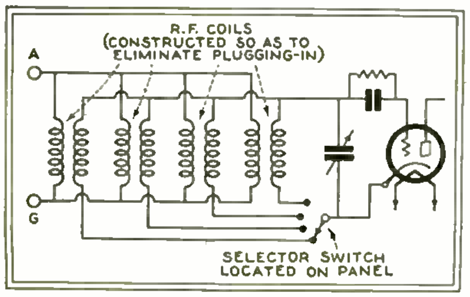


Fig. 1
This four-pole switch does the trick.

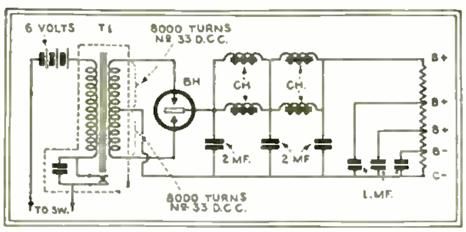


Fig. 2
The old Ford coil is here again.

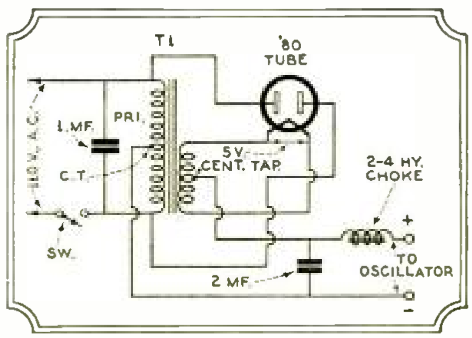


Fig. 3
Here's another way to raise that line voltage.

THE RADIO CRAFTSMAN'S PAGE

The Bulletin Board for Our Experimental Readers

THE A.C. PORTABLE PENTODE ON SHORT WAVES

Editor, RADIO-CRAFT:

In the September issue of RADIO-CRAFT you published the diagram and data for the "A.C. Pentode Portable" receiver designed for the broadcast band. Being tired of buying batteries for my short-wave receiver, I used your hookup for the 20, 40 and 80 meter bands and built the set as per your data with the following exceptions: Instead of using the speaker field for a choke, I used two 30 henry chokes; and instead of the output transformer specified, I used a type '45 push-pull transformer, all of the primary being used instead of just half. In other words, the center tap of the primary is not used at all. R.E.L. coils and bases were used and an old S.L.F. tuning condenser designed for the broadcast band was torn apart and all of the rotor plates and all but two of the stator plates were removed. One new rotor plate was cut from sheet brass and double spaced between the two stator plates that were left. This arrangement gives excellent band spreading of the "ham" frequencies. Headphones are uncomfortable because of the enormous volume. When a metal panel is used as a shield, hand capacity effects are negligible. We have tried most of the common tube combinations but have found that the '24 and '47 layout gives best results.

I have not missed a single issue of RADIO-CRAFT for the past three years; they are indexed, and the indices are kept in a loose-leaf binder so that the whole stack need not be gone over if an article two years old must be found.

Hoping that this may be of use to some other fellow, I am

J. B. SMITH, W5AXR,
216 *W. Stephenson Ave.*,
Harrison, Ark.

(We have received a number of congratulations on the use of this receiver in the broadcast band. Now, let's see how big a record we can pile up on the S.W. band.—*Editor*.)

A SINGLE CIRCUIT AUTO RECEIVER

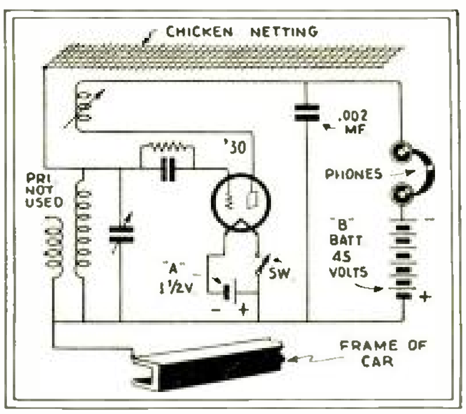
Editor, RADIO-CRAFT:

If you have never tried a single-circuit regenerative set in an automobile, you might be surprised at the results obtained under good conditions. I am not advocating it as a substitute for a standard auto radio, but in my case I often sleep in my car at night away from home, and I use a one-tube set with headphones to hear my bedtime story.

Stations up and down the Pacific coast can be heard quite plainly. With an audio tube added, it undoubtedly could be used to listen to local stations while riding, as instrumental music could be heard above the noise in my car (which is not a late model) from powerful stations 50 miles away. The accompanying sketch clearly shows the mode of connection.

The set is of the conventional type assembled in a strong oak box. A type '30 tube is used with one dry cell for filament voltage; in this manner its operation is entirely independent of the condition of the car battery. The coil is a Birnbach 3-circuit tuner with the antenna connected to the top of the secondary and the primary not being used at all. The antenna I am now using is a piece of chicken netting about 2 feet wide and 4 feet long. The set is grounded to the frame of the car.

H. A. HARRIS,
932 *Clark St.*,
Santa Rosa, Calif.



The "latest" advances in auto-radio design

IMPORTANT NOTICE

In the interest of those readers who do not like to mutilate this magazine, we have asked our advertisers not to place coupons in their advertisements.

Instead of the usual coupons, you will find a number of convenient post cards inserted between the last page and the back cover of this magazine.

This new service will save you time and work. No need to cut coupons, nor is it necessary to hunt for and address envelopes. Moreover, the space for your name on a coupon is usually so small that the advertiser is often not able to make out your writing and then you wonder why you do not get the literature sent for.

Then, last but not least—the postage for a postal card is only 1c whereas a letter costs 2c and will soon perhaps cost 3c if Congress raises the first-class postal rate.

Read the advertisements and then turn to the page containing the special postal cards. Detach, fill out and mail the card of the advertiser whose literature or offers you want to have sent to you.

Mail your card today! Show the advertisers that you appreciate their cooperation and thoughtfulness.

THESE TUBE VOLTAGES

Editor, RADIO-CRAFT:

From data sheets published by you, I note that operating voltages of the '35 tube vary greatly with different manufacturers. Some specifications call for 225 volts on the plate, others as low as 160. Also, screen-grid voltage, grid bias voltage and plate current show great variations.

I believe that a number of readers who, like myself, are not so well grounded in radio theory, would appreciate an article on this subject. Could you publish one in the near future? Have learned quite a bit about radio from RADIO-CRAFT.

WILLIAM J. RYAN,
1053 *Bryant Ave.*,
New York City.

(It is very difficult to write an article covering this subject. The same reasoning applies in the design of radio sets as would apply, for instance, in the design of automobiles. One manufacturer of a car might use one type of bearing and another manufacturer making the same class of car will use an entirely different bearing for exactly the same purpose. The reason seems to be a matter of opinion. While the rated voltages should be adhered to at all times, nevertheless, occasions arise where this condition would complicate design. For instance, the rated plate voltage of a certain tube may be 250 but when used in a resistance-coupled amplifier, an actual "B" voltage of approximately 750 may be required in order that the rated voltage of 250 be applied between plate and filament of the tube. In all probability the "B" voltage supplied in all cases cited are the same although the *actual* plate voltage on the tube itself varies with different designs.—*Editor*.)

RADIO-CRAFT'S INFORMATION BUREAU

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.

READRITE 550 OSCILLATOR

(164) Mr. Wm. B. Marshman, Washington, Pa.

(Q.) I am not a subscriber to your magazine, but I buy it every month on the newsstand.

In the May, 1932 issue you have an article on the Readrite 550 service oscillator, but values for the parts were not given. Is this information now available?

(A.) Following are data recently released by the Readrite Meter Works, in connection with this service instrument.

The capacity of the broadcast and int. tuning condenser is .0005-mf.; I.F. loading condenser, .0005-mf.; grid condenser, .001-mf.; feedback condenser, .001- or .002-mf. The value of R1 is 0.1- to 1. meg., depending upon the tone desired. The broadcast coil form is 1¼ in. in dia. and contains 100 turns of No. 24 wire, center-tapped; the I.F. tuning coil is 1¼ in. in diameter and contains 485 turns of No. 34 wire, center-tapped; the value of the R.F. choke is 85 mhy.; the pickup coil contains 15 turns of No. 34 wire wound ¼-in. from the grid end of the I.F. tuning coil.

HARRISON & GREEN'S "ANALYZER AND TOOL KIT"

(165) Mr. Walter K. Tandor, Dubuque, Ia.

(Q.) In connection with the article, "Analyzer and Tool Kit," by H. Harrison and W. Green, in the April, 1931 issue of RADIO-CRAFT, it seems impossible in some instances to obtain correct readings; in others, the meter reads backwards. What can be the trouble?

(A.) The circuit as it appeared in RADIO-CRAFT was at fault. The authors have checked the corrected one we reproduce in Fig. Q.165; at A is shown a change in the panel lettering.

MOTOR MAJESTIC RECEIVER MODEL 110 CHASSIS

(166) Mr. Karl Wegund, Tulsa, Okla.

(Q.) What service data is there available in connection with the automotive radio set of Majestic?

(A.) In Fig. Q.166 is shown the schematic circuit of the Model 110 chassis which is incorporated in the Grigsby-Grunow "Motor Majestic" car radio set.

Resistor R1, manual volume control, has a value of 0.1-meg.; R2, R3, R4, 0.2-meg.; R5, R6, 50,000 ohms; R7, 750 ohms; R8, 50 ohms; R9, R10, 0.1-meg.; R11, 800 ohms.

Condensers C1, C2, C3, tuning units, 410 mmf.; C4, C5, C6, band compensating con-

(Continued on page 114)

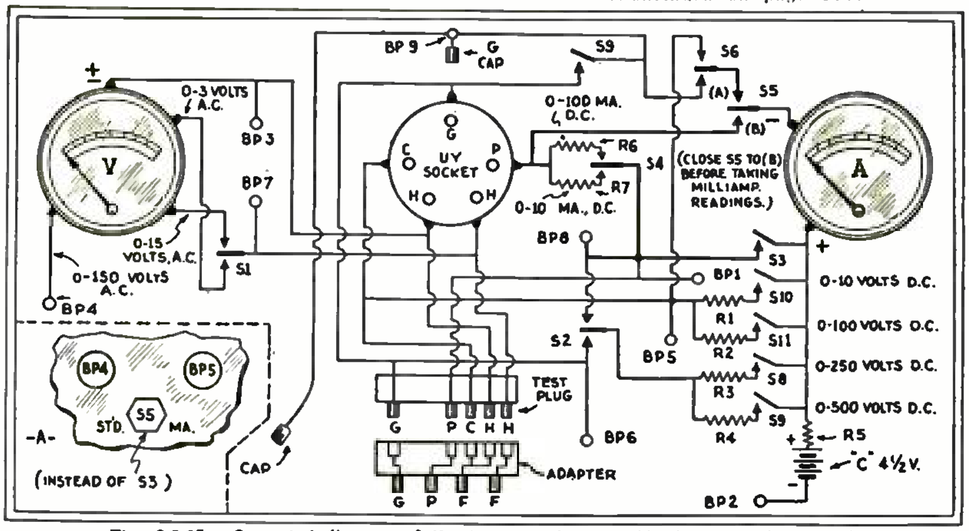


Fig. Q.165. Corrected diagram of the Harris and Green "Analyzer and Tool Kit."

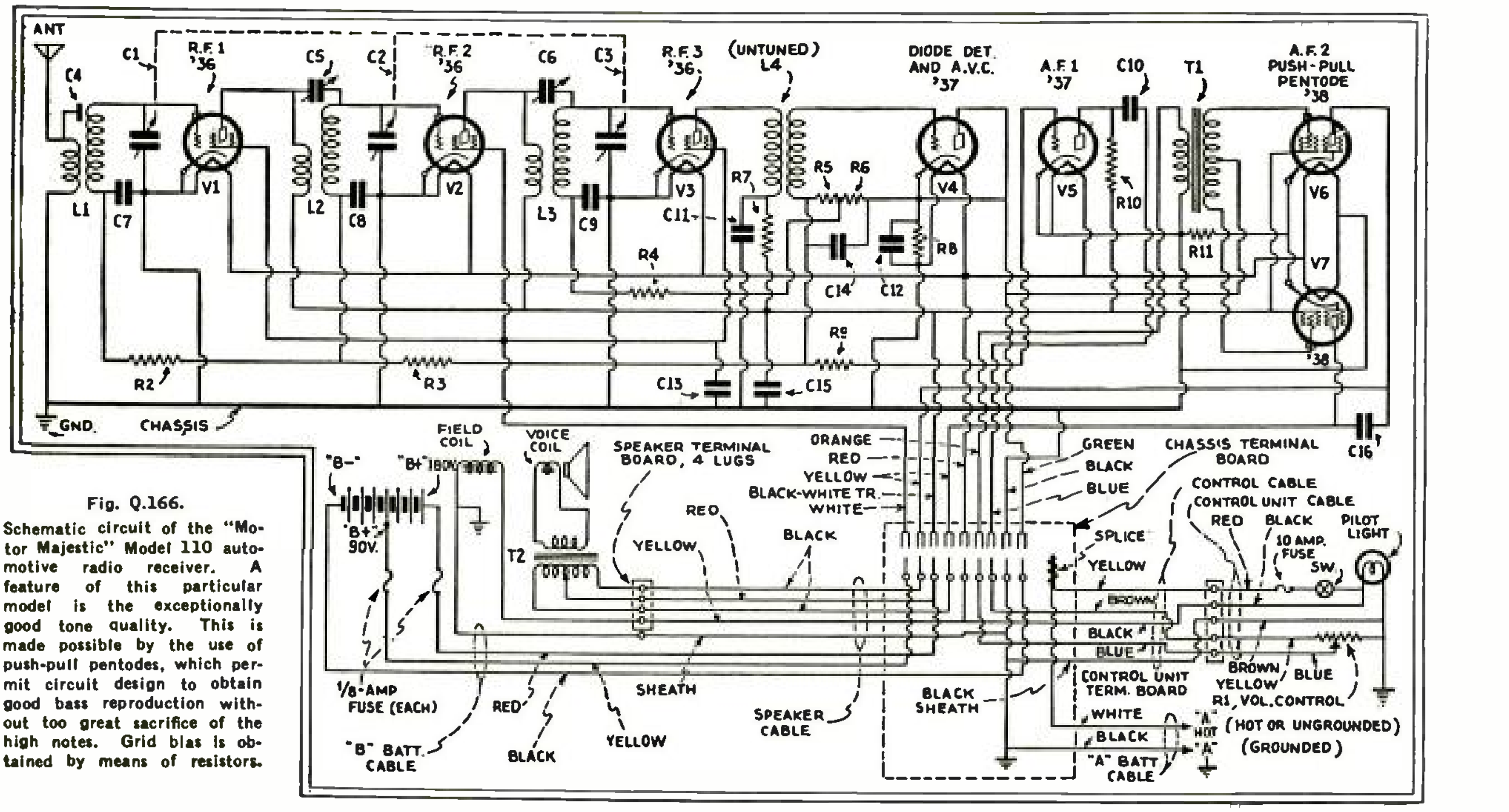


Fig. Q.166. Schematic circuit of the "Motor Majestic" Model 110 automotive radio receiver. A feature of this particular model is the exceptionally good tone quality. This is made possible by the use of push-pull pentodes, which permit circuit design to obtain good bass reproduction without too great sacrifice of the high notes. Grid bias is obtained by means of resistors.

BOOK REVIEW

"The Listeners Official Radio Log," published by All-American Service, 5707 North Clark Street, Chicago, Ill.; 36 pages, 5½ x 10 inches, price 25c.

This is a very handy reference book for both the broadcast listener and the short-wave experimenter. It lists all the broadcasting stations in the United States, Canada, Cuba and the other principal countries of the world, and also short-wave broadcasting stations and police and aircraft stations. Two very useful radio time maps of the United States and of the whole world are included. The lists of call letters are arranged in such a manner that the user of the log can record his dial settings directly on the pages.

Essentials of Television—Part I. The first book of the National Radio Institute series on television is devoted to an introduction of the subject. The fundamental terms of television are defined, and the function of scanning explained. A number of different scanning methods are illustrated and recent television inventions such as colorvision and noctovision are described generally. In common with all the other books of the N. R. I. series, the last page is devoted to a series of test questions by means of which the reader or student can determine how much he has learned.

Essentials of Television—Part II. The peculiar frequency requirements for successful television transmission are treated thoroughly and at length in this book. The problem of adapting the allowable frequencies with a maximum of effectiveness is discussed, as is the use of the photoelectric cell and the neon tube. The last few pages are devoted to a description of elementary cathode-ray tube operation.

Optics—Since the science of optics plays an extremely important part in television, this subject is treated at length, and particular emphases are given to those phenomena that have a direct relation to television problems. Among the matters discussed are the meaning of light, the properties of light waves, the reflection and refraction of light, the measurement of light intensities and the properties of various colors.

Geometric Optics—This booklet is an extension of the preceding one and is intended to complete the student's knowledge of optics as applied to television art. The subjects here considered are the action of light on plain and spherical mirrors, prisms, lenses and the important properties of polarized light. The Kerr effect, which has been made use of by Karalous and Alexanderson, is explained in very clear language.

Applied Optics—The third and last book on optics deals with the application of the previous lessons to such practical instruments as the camera, the motion-picture projector and sound film recorders and projectors. Various television systems involving the use of lenses are described.

Television Quality Requirements—This lesson goes into detail on the subject of the picture elements necessary to good television transmission. The illumination of the subject to be scanned, and the cooperation of the eye in lending persistence of vision, lead in this book to a discussion of the electrical problems of television for the faithful reproduction of the image.

Synchronization and Framing—The rigid necessities for synchronism between the scanning discs at both the transmitting and receiving ends is outlined in this book, as are the available methods for maintenance of this condition. Various types of synchronous motors are described. Special attention is given to synchronizing and framing troubles, such as the appearance of negative, ghost and inverted images.

Telephotography and Facsimile Transmission—As telephotography and facsimile transmission bear a close relationship to television, they are dealt with at length in this book to complete the education of the television student. Data are given on the coded, modulated, dot-and-dash, and photo-radio systems. The illustrations in this book are unusually complete and interesting.

(*Continued on page 114*)

AN A. C.—D. C. PORTABLE RECEIVER

(Continued from page 75)

panel laid away in a dry place for about three hours. A coat of thin shellac may then be applied and allowed to stand for about six hours. When the shellac has become thoroughly hardened the surface should be rubbed down with fine sandpaper, after which a coat of furniture wax may be applied with very attractive results, or a second coat of shellac followed by a coat of lemon oil will make a nice finish. A piece of speaker cloth should be glued to the back of the panel, over the large hole intended for the speaker opening.

The Chassis

The chassis illustrated in Fig. 3 is made from 1/16-inch sheet aluminum, with but a single bend, which is downward, and located along the front. The two lower corners of the front are cut off, to allow the chassis to slide into the cabinet without striking the corner blocks. Each end of the front is also cut back a quarter of an inch from the edge to allow the chassis to slide into the grooves that are provided in the sides of the cabinet.

For the location of components, Figs. B and C should be consulted. It would be advisable to mount the sockets first. The first R.F. socket is mounted with the heater terminals facing the front of the chassis. The heater terminals of the second R.F. socket face to the right and those of the detector socket face to the back. The heater terminals of the two A.F. and two rectifier sockets all face to the right-hand end of the chassis. The R.F. coils can then be mounted followed by the tuning condenser.

In mounting the speaker, the two bolts securing the transformer to the frame should be removed and the mounting holes in the transformer frame enlarged. Care must be taken not to break the wires connecting the transformer with the voice coil. Replace the transformer using 3/16 by 2½ in. stove bolts. Allow these bolts to pass downward through the transformer frame, the speaker frame and the chassis. By means of the same bolts, mount the filter choke, placing spacers between the chassis and the choke core; then screw on the nuts after the choke has been mounted, and tighten.

The vitreous enamel filament resistor R9, is mounted in an upright position by means of a four-inch bolt. An insulating washer should be placed at each end of the resistor. The ⅜-in. holes located to the left and front of it, as well as the one located in front of the tuning condenser, should have rubber grommets inserted to protect the covering of the wires from being cut where they pass through the chassis. The hole to the left of the filament resistor is intended for the transformer leads, passing beneath the chassis. The one in front of the resistor is for the accommodation of the resistor leads; while the hole in front of the condenser and beneath the shaft, is intended for the leads going to the pilot lamp.

The next step in the assembly operation is to fit the tuning dial. Upon sliding the vernier dial over the condenser shaft, it will be seen that the mounting bracket extends below the top edge of the chassis, thus preventing the dial from being placed as far back on the shaft as it should go. Allowing the bracket to hang perpendicular, and pushing the dial as far back on the condenser shaft as it will go, mark the bracket flush with the top of the chassis with a pencil. Remove the dial and with a hacksaw, cut the bracket off at the place marked. Now replace the dial, pushing it back on the condenser shaft until the front edge of the bracket is flush with the front of the chassis. If the condenser shaft protrudes beyond the front edge of the dial bushing, score the shaft with a sharp instrument and saw the protruding length off with a hacksaw, afterward smoothing the edge with a file.

The panel can be bolted to the face of the speaker by means of four 8-32 screws under the heads of which finishing washers are used. The volume-control and switch, mounted beneath the speaker, also helps to secure the panel to the chassis.

In mounting the large electrolytic condensers, one lug of the mounting bracket is cut off, and the other lug straightened out parallel with the side of the condenser. This lug is then bolted to the underside of the chassis, with a spacer between the chassis and the lug thick enough to allow the necessary wires to pass between the chassis and the condensers. The small electrolytic is mounted by soldering the can lug to a solder lug bolted to the chassis. The two R.F. tubes are the only ones shielded and the rings for holding the tube shields should be mounted on top of the chassis by means of the same screws that hold the sockets.

In connecting the R.F. coils, it should be remembered, that the top of the *secondary* is the grid end and the bottom end of the *primary* is the antenna end of the first coil and the plate end of the others. In the set of coils used by the author, there was no difference between the antenna coil and the others. This is not always true, however, and each set of coils should be carefully inspected to see if the primaries of all coils have the same number of turns. If one coil is found with less turns on the primary than the others that coil should be used in the antenna circuit. Shielded grid leads should be used on the R.F. and detector tubes with the shielding grounded to the chassis.

Testing and Operating the Receiver

After connecting the antenna to the antenna binding post, attach the power-line plug to an electric light outlet of a 105- to 125-volt service. If the line switch is open, turn the knob under the speaker to the right until a snap is heard; the pilot lamp should light at once if it does not, turn off switch and check over the wiring; look for wrong connections, unsoldered or poorly soldered joints, or an open in the filament-resistor R9. Also test flashlight lamp with a battery or a continuity tester.

When the pilot lamp lights, give the tubes about a half minute to warm up, and turn the knob beneath the speaker as far to the right as it will turn, then try to tune in a station by turning the tuning dial slowly. If the service is D.C. and no sound is heard, reverse the plug in the outlet. Reversing the plug in A.C. outlets may improve reception if the grounded side of plug is not connected to the grounded side of the service. Noisy reception can sometimes be eliminated in this way. If possible, a station with a rather weak signal should be tuned in on the higher frequency or minimum-capacity side of the dial; with a small screwdriver having a wood or bakelite handle, adjust each trimmer condenser by turning the screw in and out, until the position of maximum volume is found.

One condenser will be found to be far more sensitive to adjustment than the other two. An occasional readjustment of the tuning dial may be necessary during this operation. If the volume at any time during the adjustment reaches too high a level, it should be reduced by means of the volume-control. Broad tuning and cross-talk is usually the result of using too long an antenna.

In placing the receiver in the cabinet, the two overhanging ends of the chassis should slide into their respective slots, in the sides of the cabinet. The panel should then be fastened by means of four No. 8 wood screws, with finishing washers under their heads. The screws should be inserted in the four corner holes of the panel and screwed into the ends of the corner blocks of the cabinet.

Operating from 220 Volt Service

The receiver may be operated from 220-volt service by connecting a 110-volt, 50-watt lamp in series with one side of the power cord. The lamp should be inserted in the positive lead, that is, the lead opposite the one grounded to the chassis.

(It will be recalled that the fundamental circuit used in the power supply of this receiver is identical with that used by Mr. H. G. Cisin in a receiver described in the May issue of this publication. Mr. Davis, however, was not aware of Mr. Cisin's work while designing this receiver.—*Editor.*)

List of Parts

One aluminum chassis; Blan;
One set of 3 R.F. coils and shields, Automatic

(Continued on page 112)

NON-REGENERATIVE AMPLIFICATION

(*Continued from page 81*)

ing element, the capacitative coupling is a minimum at the high-frequency end and a maximum at the low-frequency end. Thus the changes in capacitative coupling are exactly opposite to the inductive coupling and flat response over the entire band is secured.

Response curves of the receiver are indicated in Fig. 4. The upper part of the diagram illustrates the response of a 4-tube and the lower of a six-tube receiver using the Daley design. The sensitivity shown is in absolute values and must be divided by 4 to secure microvolts per meter. (The flatness of these curves are positively uncanny and really represent a desirable feature, needed for a long time.—*Editor.*)

Shielding

The second detail discussed in the first part of this paper is an important one. If the magnetic field of a coil is large, then the shield can must be abnormally large if complete shielding is to be accomplished. Since, with this system, the only field around the coil is due to the signal, the shield cans may be made very small, and in some cases actually dispensed with entirely!

This simple expedient, that of isolating the primary of the R.F. coil from the plate by a choke coil, has been used previously, but not with the idea of increasing fidelity and decreasing the necessity for shielding. If this choke is to be used, then the condenser C1 must also be added, as stated before, to isolate the grid of V2 from the plate of V1. This means that the load on V1 is no longer resistive at resonance, so to compensate for this, the leads of the primary of the R.F. transformer are reversed so that at all times the load current and the signal voltage are in phase, which, in technical language, means a resistive load.

Thus, in this system, the amount of amplification is, theoretically at least, limited only to the resistance of the coil; the lower the coil resistance the greater the load current; while in other systems, the amplification is limited not only by coil resistance, but by oscillation.

Additional Features

Another feature of this receiver is the fact that many more tuned stages may be used than were heretofore possible. In an ordinary receiver, interstage coupling limits the number of tuned stages that may be successfully employed without oscillation. With the Daley system, the R.F. currents are localized within its particular stage because of the chokes, and since the R.F. coils are shielded, interstage coupling is at a minimum. The number of tuned stages, consequently, depends upon the tolerances set in the design of the coils and the condensers. Six tuned R.F. stages were successfully employed, as indicated in the photograph of Fig. A.

Selectivity

Real 10 kc. selectivity is secured. Fig. 5 shows the selectivity curve of this receiver (six-tube type) at 600, 1,000 and 1,400 kc. Note that the curve is 10 kc. wide and only deviates from this value when the applied signal strength is 100-times normal. (These curves were made in accordance with I.R.E. standards using a standard dummy antenna and maintaining a constant output of 50 milliwatts—*Editor.*) Fig. 6 shows the selectivity curve of the four-tube receiver, the same conditions obtaining. It will be noticed, of course, that the selectivity is better with the six tuned circuits than with the four stages, which is to be expected.

By further application, this principle may be applied to audio systems as well as to R.F. systems.

Parts List

With reference to Fig. 1, the parts have the following values: C1 to C6 (inclusive), variable tuning condensers, .00035-mf.; C7 to C12 (inclusive), fixed condensers, .01-mf.; C13 to C17 (inclusive), fixed condensers, .00087-mf.; C18, C19, fixed condensers, .001-mf.; C20, C21, bypass condensers, 2 mf.; C22, bypass condenser .05-mf.; C23, fixed condenser, .005-mf.; L1 to L6 (inclusive), primary coil, 22.5 millihenries; L7 to L12 (inclusive), 275 millihenries; L13 to L18, (inclusive), R.F. chokes, 175 microhenries; R1, R.F. cathode resistor, 300 ohms, max.; R2, detector cathode resistor, 25,000 ohms; S, stage selector switch, 4 or 6 stages. Exactly the same values hold for the circuit shown in Fig. 2 as stated above.

The tubes used are of special design, having an amplification factor of 30, are similar to the high-mu '40 with the exception that they have a cathode, as indicated in the wiring diagrams. The same design, however, may be used with present-day tubes that are readily available.

Winding details of the coils used in this receiver are given in Fig. 7, which is self explanatory.

ELECTRIFYING THE MEGADYNE

(*Continued from page 85*)

ing as a voltage-limiting unit, also functions as a part of the filter system.

In the "breadboard" model, a common "can" connection for the three electrolytic condensers is obtained by mounting them on a strip of aluminum about ¾ x 5½ x 3 32-in. thick, supported, ¾-in. from the baseboard by means of two metal brackets. Resistors 8 and 9 are also mounted on brackets.

Due to the fact that the type of resistor specified for 8 and 9 has a case which constitutes one of the two connections, care must be taken to insulate these units in the event that they are mounted on either a common or a grounded strip of metal.

If a slight hum is heard, look for inductive coupling between this power pack and the receiver or its associated leads. Exceptional care has been taken in the design of this unit to reduce the hum level at the output potential terminals to the lowest possible point; however, the fields of the power transformer and the filter chokes are very strong, and if they are permitted to interact with the receiver equipment, hum from the reproducer will be heard, the strength being dependent upon whether the inductive pickup at one point adds to or subtracts from the pickup at another.

Although the power transformer has five secondaries, only three are used; consequently, only these are shown in Fig. 2. These unused (1.5 V. and 2.5 V.) secondary leads may be curled up and taped or, as in the unit illustrated in Fig. A, cut off close to the transformer. The unused leads are the following: heavy red; heavy black; thin red, black dot (the latter is a tap from the primary for matching the primary circuit to the available line voltage; whether this wire or the thin red one is to be retained is a matter of test.)

As a final word of caution, the constructor is advised to make sure that all of the parts have the values specified. In addition to the usual miscellany, screws, wire, etc., the following components will be required:

The battery type "Megadyne" described in the July issue is now connected to the Power pack. Resistors 8 and 9 are adjusted so that stations come in loudest. The adjustments are then left in position and should not be touched thereafter.

Tuning and operating the Megadyne remains as before.

List of Parts

One Polymet power transformer, type TF-917, 1;

Two Polymet filter chokes, type TC-796, 6, 7;

One Concourse electrolytic condenser, 4 mf., 400 volts, 3;

Two Concourse electrolytic condensers, 8 mf., 400 volts, 4, 5;

Two Clarostat variable resistors, standard type, 8, 9;

One Flechtheim, 1, mf., 200-volt condenser, 10;

One fixed resistor, 10,000 ohms, 1 watt, 11;

One binding post strip, 12;

One Pilot tube socket, UX-type, for V1, 2;

One G. E. power cable, with plug;

One wood baseboard, 7½ x 11½ x ⅝-in.

Be sure to turn to page 68 and read the important announcement about the extra pages which have been added to the OFFICIAL REFRIGERATION SERVICE MANUAL.

THE "B" TUBE

(*Continued from page 84*)

ment were secured. The finished "B" tube is illustrated in Fig. A; and a complete "B" unit, in Fig. B. This device measures only 8½ x 5½ x 3½ ins.; and weighs only 8 lbs.

Other improvements were brought about by this simple yet potent expedient, namely, much better waveform with an absence of troublesome harmonics—as indicated by a cathode-ray oscillograph, and freedom from mechanical noise caused by the interrupter (the parts of which are cushion mounted inside the tube).

The "B" Tube Eliminator

There are two ways in which the transformer primary may be connected with the interrupter: one, in parallel with the circuit, as shown in Fig. 1; the other, in series—indicated in Fig. 2. In the arrangement the interrupter operates directly from the storage battery, drawing some current on its own account; while the primary of the step-up transformer, being connected in shunt with the interrupter coil, is energized by the pulsating voltage across it. The eliminator illustrated in Fig. B utilizes this scheme.

Although very encouraging results were obtained by providing a separate set of contacts insulated from the primary contacts and employing them to make and break at the right intervals, thus eliminating the use of a separate rectifier tube, this scheme since it complicated the construction of the vacuum-interrupter was discarded in the course of experimentation. Although gaseous rectifier tubes have the advantage of requiring no additional current to heat a filament, this advantage is offset by low efficiency and rather fickle behavior.

A type '37 tube with plate and grid externally connected together, performed remarkably well. Its heater is rugged, and may be powered directly from the storage battery. To reduce the internal voltage drop and take some of the strain off the cathode, mercury was introduced into the bulb. Although the potential difference between cathode and heater is then in the order of 200 to 250 volts, and leakage of several microamperes takes place, the insulation between these elements does not break down. A disadvantage of this type of tube, even in quick-heater models, (partly compensated by the use of a voltage divider) is the thermal lag of the heater. A simple one-section filter with a small choke coil was quite sufficient as the waveform obtained was very good. (Full-wave rectification was tried, and discarded in favor of half-wave rectification.) Since R.F. disturbance from the vacuum-interrupter is much less than that created by a breaker in open air, it is possible to "get by" without the use of R.F. chokes, etc.

A satisfactory unit was thus evolved; and at the October meeting of the Connecticut Valley Section of the I.R.E., held at the Charles Hotel in Springfield, Mass., a completed instrument was formally demonstrated. A critical audience gave its unqualified approval to the device as power supply for a standard motor-car radio set of high sensitivity.

Comparative Efficiency

Speaking of efficiency, for the sake of comparison a standard 110 V, 60 cycle A.C. "B" eliminator of reputable make was tested; the disappointing results are revealed in Fig. 3 by the curve A. Curve B is that of a dynamotor type auto "B" eliminator which is considered of good make and representative of this class. Curve C is that of one of the vacuum-type units developed during our experiments.

A glance will suffice to show the reader that compared to the others, this latter unit has superior efficiency at about the normally required current drains—between 25 to 40 ma. At these currents the output voltages are 225 and 172 respectively and the efficiency over 50 and up to 56 percent. The input current in amperes varies from 1.2 to 2.4 and the battery voltage from 5.85 to 5.8.

Some set manufacturers deem it necessary to employ as many as eight tubes in order to secure high power output; hence, we must allow 2.4 A. for the heaters of these tubes alone; (It is presumed that 6.3 V. tubes are employed throughout.). Now, if we wish to limit the total current drain to no more than 5 amperes (and this is heavy enough) we shall have 2.6 A. at the most, available for the "B" supply. Taking 180 volts at 45 ma. as the requisite "B" voltage an overall efficiency of 52 percent *must be obtained* from the auto "B" eliminator. (A lower drain is imposed on the battery in the event the receiver has less tubes and requires lower "B" potentials; a six-tube receiver using '30-type tubes was operated very nicely with a total drain of 2.9 A., at 6 volts average.)

Construction Details

The primary of the step-up transformer was wound *over* the secondary.

The dry electrolytic filter condensers have a working potential of 450 V.; the voltage divider resistors measure 50,000 ohms and are rated at 2 watts. Two condensers, one of .05-mf. and one of .01-mf., are sufficient for completely preventing the R.F. currents from entering the receiver circuit.

Of interest, also, is a unit which enables the operation of 110 V. A.C. receivers from 110 V., D.C. lines. Such a unit using the "B" tube is now under development since considerable demand exists for just this thing. Briefly, in order to obtain a sinusoidal waveform similar to that of the standard A.C. lines, the 110-volt D.C. must be broken up and fed into a transformer having a special primary, and a secondary capable of delivering 110 volts. Fortunately, miserly economy of current is not essential in this case.

Two units of this type have been designed, one for light midget receivers and another for standard radio sets of seven or more tubes. In the former instance, one "B" tube is used; and in the latter, two of them are so connected, that they operate 180° out of phase with each other. In both cases the primary of the special transformer is "tuned" to approximately 60 cycles. This new unit design may be readily adapted for 32-volt as well as 110-volt D.C. use.

For those people who do not care to have a radio in their car as a permanent installation but would like to be able to take their midget receivers along with them to picnics, seashores, camps or other outdoor places, a "B" tube vacuum-interrupter pack of 6 (or 12)

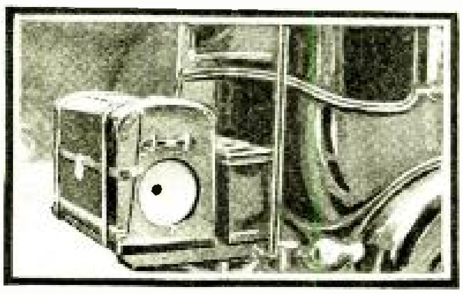
(*Continued on page 111*)

A MOBILE P. A. SYSTEM

(Continued from page 87)

tracks underneath the dashboard, at the right. The metal plate that the turntable slides on, is notched, so that it can be set and locked in any position. In the illustration, the turntable is shown in the "playing" position. When the phonograph is not in use, the unit slides under the instrument board. The electromagnetic pickup is also arranged on a sliding arm, so when the turntable is pulled out to the playing position, the pickup can be centered and locked.

A small A.C. switch on the metal plate serves to start and stop the phonograph motor. Flexible leads run to an extension outlet on the floor board, so the entire job may be removed for trouble shooting, without unsoldering or resoldering the connecting wires. The design is very compact; and the ingenious method of sliding it out of the way, does not interfere with operating efficiency.



The photograph above illustrates how the power unit and speakers appear when in a normal operating condition. Note that the speaker cone is exposed. In bad weather a cover is placed over it which prevents the cone being damaged due to splashing, rain, etc.

The microphone is suspended vertically within a microphone ring, as illustrated. A high-quality two-button microphone is used. The method of suspension uses four points and eight springs, thus protecting the instrument from jars and mechanical vibration. The microphone ring is fastened on the end of a ¾-inch diameter hollow brass arm in such a way that it can be pivoted in any direction. Connecting wires run through the arm. The other end of the arm is connected to a swivel mounted beside the rear vision mirror. When the microphone is not in use, the arm is pushed back until it is parallel with the windshield and close to the top of the car, causing it to snap into a spring which holds it in place. An automatic switch at the arm serves to open the microphone circuit when the arm is pushed back. The arm may be locked in any position when opened, by means of a set screw located at the swivel end. When the arm is swung forward, it moves down at an angle, facing the person at the steering wheel.

The Power Supply

The 110-volt A.C. for operating the system is obtained from a motor-generator outfit. This consists of a 32-volt D.C. motor, operated by means of six storage "A" batteries. This motor drives a 110-volt A.C. generator capable of delivering 300 watts. Under load, the motor draws 15.5 amperes. In addition to supplying current to the amplifier, the generator also supplies field current to the two dynamic speakers. The method of mounting motor generator, speakers and storage batteries is unique and worthy of special attention.

Metal strips are welded on the trunk rack extending it about a foot. The trunk, which is standard equipment on the car, is bolted on the extension rack. The motor generator is mounted on the bottom of the trunk at the center. Holes are drilled at each end of the trunk for the two loudspeakers and these are fastened in place against ½-inch celotex baffle boards, as shown in Fig. B. Six one-inch diameter holes are drilled in the top of the trunk and four in the bottom, thus creating a continuous draft in order to provide adequate ventilation and prevent overheating. The ventilating holes, and speaker apertures are covered with copper-screening, light enough to be stretched taut, but heavy enough to protect the speakers. Wooden disks are provided for each speaker. The disks fit into metal clamps and keep dust and dirt from the speaker cones. Large size 110-volt A.C. Wright-DeCoster dynamic reproducers are used. These are able to handle the output of the amplifier without distortion.

Three A.C. wall socket outlets are fitted to the back of the trunk, for completing connections without unlocking the trunk. Outlets of three different colors are used, so that their functions are made apparent; these may be obtained from any 5- and 10-cent store.

The storage batteries are mounted in a sheet iron case, which is mounted on the original trunk rack, in back of the trunk. Six Exide 100-ampere storage "A" batteries are employed. Extra heavy double rubber covered wiring connects the batteries to the apparatus at the front of the car. The wiring is run beneath the right rear fender and then under the running board.

A sign on top of the car supported at each end by a heavy iron pipe completes the installation. This is run obliquely, so that it may be seen from any direction. One pipe is mounted on the right side of the trunk rack, while the other pipe is mounted on the left side of the front bumper. The pipes are threaded, so that they can be unscrewed, permitting the sign to be taken down when desired.

This installation is arranged for "one man" operation; the driver of the car can operate the sound system without additional assistance and the arrangement of the sound equipment is such that the car's use as a passenger vehicle is not affected, nor is space for riding convenience eliminated.

Efficiency

This sound amplification instrument has ample range above the street noise level to be heard for a city block. When tested under an elevated structure, both voice and music could be heard distinctly above the noise of passing trains. The amplifier is pitched high enough, so that when used with the microphone, it is unusually distinct and the "boom" common to most installations is entirely eliminated. The higher pitch also permits the sound to carry without sacrifice of bass response. Due to the excellent design, careful matching of parts and proper selection of speakers, the tone quality is excellent, even at maximum volume.

The schematic wiring diagram in Fig. 1 shows the method of hooking up the various components on this group address system. The pictorial diagram, Fig. 2, gives an idea of the relative locations of the different units.

The author and his associates will be glad to render any assistance desired to those technicians who may undertake the construction of this public address system.

The values of the parts given in the circuit diagram of Fig. 1 are as follows: R1, 50,000 ohms; R2, 1,350 ohms; R3, 400 ohms; R4, 800 ohms; R5, 5,000 ohms; R6, 5,000 ohms; C1, 2 mf.; C2, 2 mf.; C3, 4 mf. (1,500 volt); C4, 2 mf. (1,500 volt); L1, 30 hy.

THE "B" TUBE

(Continued from page 110)

volts input and 110 V., A.C. output was designed. However, due to the usual midget receiver drawing at least 40 watts and in most instances much more the current drawn from the storage battery is rather heavy.

The writer believes that this field may prove lucrative if a radio receiver is manufactured particularly for the purpose.

In this "universal current" radio receiver, automotive-type tubes could, perhaps, be used and the power pack so designed that with a simple switch to cut a resistor out of circuit the 110-volt A.C. input connections may be changed for 6 or 12 volts D.C. supply. In any event, a suitable interrupter design, in the "B" tube, is now available to manufacturers.

RECORDING AT 33-1/3 R. P. M.

(*Continued from page 88*)

armature is not perpendicular to the plane of the record, and as a result, fidelity of reproduction is not obtained. The pickup should be placed as shown in Fig. 1.

Surface Noise

In 33-1/3 recording, surface noise is more pronounced than at the higher speed. The frequency of this scratch is in the neighborhood of 3,600 cycles and for this reason is more objectionable. In commercial recording, this surface noise has been diminished considerably by improving the record material, but in instantaneous recording, no determined effort has been made to overcome it. The use of a scratch filter is not recommended; if one were used, every frequency above 4,000 cycles would be eliminated, and the record would lose its brilliancy. In the use of aluminum, this noise becomes especially objectionable near the periphery of the record.

Scratch in recording is due to two things. First, the hardness of material used, and second, the angle the diamond needle makes with the record. Aluminum should be of medium hardness and should be well lubricated or waxed. If the material is too hard, the needle will rip and tear the record and terrific surface noise will result; if it is too soft, the danger of destroying the record will be increased. It is a good policy, after purchasing a ready-made 16 inch recording disc to go over it with a piece of waste that has been soaked in wax. The disc must be spotlessly clean, and when cleaning, soft cheesecloth should be used.

In Fig. 2A is shown how a steel recording needle normally sets in the cuttinghead; note the steep angle that it makes with the record. If a diamond needle is used, the shank should be bent to the position shown in Fig. 2B, so that the sides barely clear the record. Steel needles are made of hardened metal which cannot be bent, but the shanks of diamond needles are made of soft metal, and bending is a simple matter. See that the point of the needle is not too sharp; otherwise, it will tend to cut the record instead of *compressing* it.

Good 33-1/3 R.P.M. records can be made if care and patience are exercised, and the recordist should not be too easily discouraged if his first trials are unsatisfactory.

Home Talkies

As stated before, the fields for slow-speed instantaneous records are developing rapidly, and the most interesting one is home talkies. Considerable work has been done on the sound-on-disc method, and in the near future such a machine will be marketed for use by the amateur. While no material is available for publication on this apparatus, the mechanism is quite simple.

From the turntable motor a flexible coupling is brought out which connects to the camera. In making the sound picture, the film is marked with a punch, and a corresponding mark is made on the record. The recording head is then placed on this mark and the section of film with the hole is placed in the aperture. The switch is then thrown and the action started after a few seconds have elapsed to allow the motor to reach operating speed. In showing the picture, the film is placed in the projector with the punched hole in the aperture, the pickup is placed on the "start" mark, and then the motor is started.

When the film breaks, each frame, preparatory to the patching, should be replaced with a blank frame. This protects against the loss of synchronism.

The question of playback needles is another serious problem in reproducing from 33-1/3 R.P.M. aluminum records. The fibre or thorn needle, unless treated, wears out before the end of the record is reached. To prolong the life of these needles, some manufacturers have impregnated the needle with bakelite or shellac, and it is surprising how much longer these needles last. Where a fibre needle barely finished one 12-inch 78 R.P.M. record in good condition, it is now possible to play four of them without resharpening the needle. This means that the needle will now easily last through a fifteen minute, 33-1/3 R.P.M. record.

AN A. C.—D. C. PORTABLE RECEIVER

(*Continued from page 108*)

Winding Co., L1 to L6 inclusive;
One 50-mf., 100-volt dry electrolytic condenser, Aerovox, C16;
One 8-mf., 500-volt, dry electrolytic condenser, Aerovox, C15;
One 10-mf., 20-volt, dry electrolytic condenser, Aerovox, C14;
Five .1-mf., 200-volt, tubular condensers, Aerovox, C10, C12, C8, C4, C5.
One .0035-mf., mica molded condenser, C7;
One .00025-mf., mica molded condenser C6;
One 250-ohm, 50-watt, vitreous enamel resistor R9;
One 500,000-ohm, 1-watt, carbon resistor, Trutest, R6;
Two 250,000-ohm, 1-watt carbon resistor Trutest, R4, R5;
One 50,000-ohm, 1-watt carbon resistor Trutest R3;
One 100-ohm, 1-watt, carbon resistor, Trutest, R7;
One 100-ohm, flexible resistor, Truvolt, R8;
One 300-ohm, flexible resistor, Truvolt, R2;
One line switch and 10,000-ohm volume-control Carter, R1;
One antenna binding post, Eby;
Seven U. Y. wafer sockets, Eby;
One wood panel;
One Jensen-type P.M.1 dynamic speaker, with output-transformer for operation with pentode tubes;
One A.F. transformer with 1,200-ohm secondary, Kenyon, (choke);
Two-tube shields with bases, Hammarlund;
One .000375-mf, three-gang condenser, De Jur, No. 3503, clockwise, min. to max., C1, C9, C2, C11, C3, C13;
One vernier dial—De Jur type R, sector vision, flat, clockwise 0-100;
Two large size brown bakelite knobs;
One dial light, De Jur type U;
One escutcheon, De Jur type D, sector vision;
One appliance attachment split plug;
One and one-half feet shielded copper wire for grid leads;
Ten feet of lamp cord;
Ten feet of solid push-back hookup wire;
Ten solder lugs;
Eight No. 8—32 hex nuts;
Four No. 8—32 x ¾-in. nickle oval-head screws;
Four No. 8 x ¾-in. nickle, oval-head screws;
Four No. 8, nickle finish washers;
Thirty-five No. 8—32 x ⅝ in. screws;
Thirty-five No. 8—32 hex. nuts;
Four No. 8 lock washers;
Thirty-five No. 6 lock washers;
One stove-bolt 3/16 x 4½ in. with nut;
Two stove-bolts 3/16 x 2½ in. with nuts;
Three ⅜-in. rubber grommets;
Five tube grid clips;
Two brass spacers ½-in. long with 3/16-in. hole;
Two fiber washers, ¾-in. diameter with 3/16-in. hole;
Two brass spacers ⅛-in. long with ⅛-in. hole;
One square foot of speaker cloth;
One wood panel, Blan;
One cabinet and cover;
One pair separable hinges;
One spring lock;
Four rubber cabinet feet;
One leather carrying handle;

OUTPUT METERS

(*Continued from page 92*)

One Lynch 100,000-ohm resistor, 1 watt, R7;
One Lynch 100,000-ohm resistor, 1 watt, R8;
Four International Air tip-jacks;
One bakelite panel 4½x6¼x⅛ ins.;
One Best switch, Type 3NS6K;
One 4½-volt battery;
One pair International Air test leads, No. 128.

WATCH YOUR WATCH

Those in vocations requiring contact with magnetic fields usually know from annoying experience that they cannot expect consistent service from their watches while working around electrical apparatus. Steel, of course, is readily magnetized, and the hairspring and most other parts of a watch movement necessarily have heretofore been made of steel.

But a means of avoiding the annoyance of permanently magnetized watches has been evolved by an eminent *Swiss* physicist of international fame, Dr. Charles Edouard Guillaume, well known as the recipient of the 1920 Nobel Award in Physics for the development of certain rust-resisting nickel steel alloys, particularly Invar and Elinvar.

Laboratory experiments show that the conventional watch with regulation steel hairspring and usual type of balance wheel will become so erratic after exposure to magnetic fields up to 360 lines per square inch as to be useless as a timekeeper; whereas, with an Elinvar hairspring and a non-magnetic balance wheel it is but slightly affected in fields of that strength.

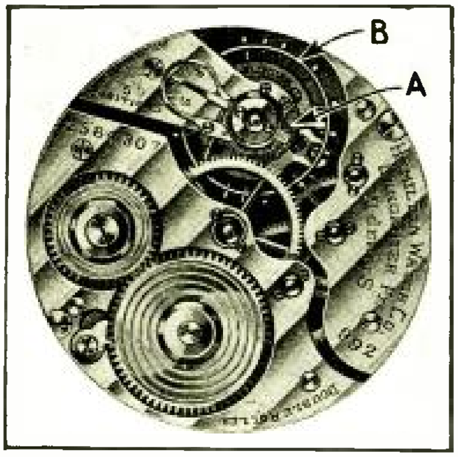


Fig. A
Photograph of the newly developed watch which may be used in a magnetic field.

An increase in temperature—whether due to weather conditions or to proximity of the watch to heat—causes the hairspring to lose some of its elasticity. Decrease in temperature, conversely, increases the elasticity of the hairspring. To offset the errors in timing which these changes would cause, the "compensating" type of balance wheel is so constructed that it contracts and therefore oscillates more quickly when a rise in temperature caused the hairspring to weaken—and vice versa.

This form of construction consists of making the rim of the balance wheel A, in Fig. A

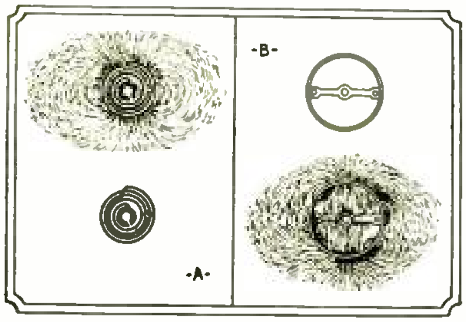


Fig. 1

and Fig. 1, of two different metals—brass and steel—and of cutting the rim at two opposite points in its periphery.

The Elinvar hairspring makes it possible to use a monometallic, uncut, non-magnetic balance wheel B, in Fig. A and Fig. 1.

The lack of magnetic susceptibility of these Elinvar components is shown in the lower and upper halves of A and B, respectively, of Fig. 1.

Without some means of counteracting a magnetic influence, the hairspring may be so strongly attracted to the balance wheel as to actually touch it, as shown in Fig. 2, when the watch will no longer keep time.

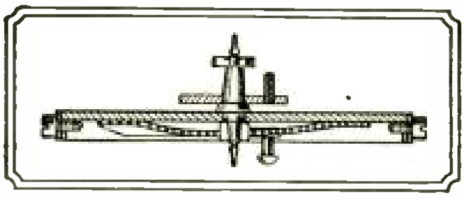


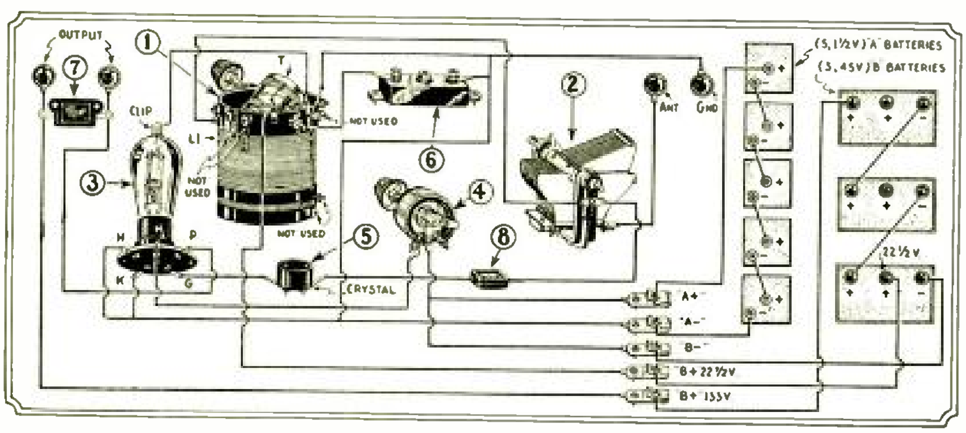
Fig. 2

The whole assembly, therefore, renders a watch practically immune to permanent magnetism and unaffected by temperature changes. Furthermore, an Elinvar equipped watch when adjusted in two extremes of temperature operates at the same rate in intervening temperatures. Heretofore, a watch correct at say 40° F and 90° F would not be exactly correct between or beyond those temperatures.

MEGADYNE CORRECTIONS

In the July issue of this magazine there was published an article dealing with the construction of the "Megadyne" receiver. In the pictorial representation of the receiver an error was unavoidably made. With the connection as shown in the July issue, the "A" battery will short circuit—*use the corrected diagram shown below*. The schematic circuit shown in the same issue is, however, correct and may be relied upon when building the set.

In this issue of Radio-Craft, there is described the power unit that goes with the receiver if the constructor desires to electrify it. See page 85.



BOOK REVIEW

(*Continued from page* 107)

Mechanical Television Systems — This book offers a fairly detailed analysis and description of the prominent mechanically operated television systems. They include the Telehor, the Baird, the Telefunken, the Jenkins, the Sanabria, the Alexanderson, the Bell Telephone and the Gramophone systems. An attempt is made to estimate the peculiarities and value of each.

Electronic Television Systems—The attempts to overcome some of the inherent difficulties in mechanical systems by the use of varying electron streams are described here in the form of the Zworykin, Farnsworth and Von Ardenne electronic systems. The construction, qualities and use of each are outlined.

Television Studios and Transmitters — Although television is generally considered to be in an experimental state, nevertheless it has developed a studio technique and related problems peculiar to it alone. The layout of a television studio, the photo-cell arrangement, the studio equipment and wiring and outside pick-ups, as they are used in present practice, are fully described. The design, location and operation of the television transmitter itself is also taken up.

How to Build Radiovisors—A practical and detailed method for constructing a machine to receive television images is described here. The building of the scanning disc, the means of driving and synchronizing it, the building of lens discs and methods of connecting them, are all discussed.

How to Build Radiovision Receivers—Part I. This book discusses chiefly the radio problems in the building of a receiver. Adapting the receiver to the frequencies on which it must be used is covered fully, with special emphasis on detectors and picture frequency amplifiers.

How to Build a Radiovision Receiver—Part II. This book completes the work of 13 TA by discussing the complete television circuit, based both upon the mechanical type of scanning and the electronic systems. Commercial radiovision receivers are described.

INFORMATION BUREAU

(*Continued from page* 106)

densers; C7, C8, C9, C10, .05-mf.; C11, 0.2-mf.; C12, C13, 0.4-mf.; C14, 100 mmf.; C15, 0.6-mf.; C16, .0015-mf.

The circuit has three stages of T.R.F., diode detector, magneto-dynamic reproducer, automatic volume control and, in the output circuit, push-pull pentodes. The R.F. transformer which is used to couple the R.F. amplifier to the diode detector is of aperiodic or untuned type. Grid circuit bias potentials are obtained by means of resistors in the return circuit of the "B" supply; thus, there is no need to supply a separate "C" battery.

If the R.F. tubes are slightly below normal in mutual conductance value, the receiver will not have its normally high gain. Realign the circuits (when necessary) at 1300 kc. All of the tubes are of "automotive" or 6.3 volt filament type.

In installing the reproducer, the best tone quality will result when the instrument is mounted on the dashboard facing the rear. It should not be mounted so that the reproducer is facing downwards toward the floorboards.

A-A-A-A-A-H!

Los Angeles. — Radio service companies, wrestling for first listing in the classified phone lists, are seeing which can prefix the most 'A's' to its name.

Four radio shops on Western avenue now start their names with five 'A's' to squeeze ahead of the AAAA Radio Service, which has 16 branches.

List is currently headed by the AAAAA Aanderson Radio Shoppe.

THE THEORY AND CONSTRUCTION OF ATTENUATORS AND LINE FILTERS

(Continued from page 95)

$$Z_0 = 2\sqrt{Z_1 (Z_2 + Z_1)}$$
$$Z_0 \times 2\sqrt{82 (40.4 + 82)}$$
$$Z_0 = 2\sqrt{82 \times 122.4}$$
$$Z_0 = 2 \times 100$$
$$Z_0 = 200 \text{ ohms}$$

Therefore "Z_0" the image impedance of 200 ohms equals "Z_0" the characteristic impedance, which also equals 200 ohms.

Design of "T" Pads

Having designed an H-type pad to give us the desired loss, let us proceed to do the same with a "T"-type pad.

This attenuator is so called, because it is composed of three resistors taking the form of the letter "T." This pad is known as an unbalanced network in that series resistors are used in only the high side of the line. The other side of the network may or may not be grounded depending on the type of circuit in which it is to be placed. This network is shown in Fig. 12.

The equivalent circuit of Fig. 12, is given in Fig. 13, and everything that has been said about H-type pads, holds true for the T-type pad, *except* that "Z_1" the series arm for a T-type pad is exactly twice the value of "Z_1" for an H-type pad giving the same loss. This is easily seen, for if we take the series arms out of the low side of the line, and still wish to maintain the same characteristic impedance in the circuit, the series arms in the high side of the line, must be exactly twice their original values. Therefore, knowing the constants for an H-type pad, and wishing to design a T-type pad to give the same loss, all that would have to be done, is to leave the two series arms out of the low side of the line entirely, and make the two series arms in the high side of the line just twice their original values. The shunt arm "Z_2" remains the same in both cases.

The working formulas for T-type networks are as follows:

"Z_1" the series element $= Z_0 \left(\dfrac{A - 1}{A + 1}\right)$ ....(4)

"Z_2" the shunt element $= \dfrac{2\, Z_0\, A}{A^2 - 1}$ ....(5)

"Z_0" the characteristic impedance $= \sqrt{Z_1 (Z_1 + 2Z_2)}$ (6)

Example of Design

As an example of design to illustrate the use of this type of network, we may proceed to apply the above formulas to the design of a T-type pad to also give a 20 decibel loss.

Given—To design a 20 decibel pad to work between two 200-ohm impedances, (see Fig. 14).

Then "Z_0" is equal to 200 ohms (given).

From Table 4, the value of "A," the amplification constant for 20 decibels, is given as 10.

Then "A" is equal to 10.

Solving for "Z_1" the series element from equation (4).

$$Z_1 = Z_0 \left(\frac{A - 1}{A + 1}\right)$$
$$Z_1 = 200 \left(\frac{10 - 1}{10 + 1}\right)$$
$$Z_1 = \left(200 \frac{9}{11}\right)$$
$$Z_1 = 200 \times .82$$
$$Z_1 = 164 \text{ ohms.}$$

"Z_2" the shunt element is the same as for the H-type pad, as the formulas from which "Z_2" the shunt arm is determined, is the same for both H and T-type pads. This is seen from inspection of the formulas for the two types of networks.

The completed network shown in Fig. 15, having the constants as determined above, of "Z_1" the series element equal to 164 ohms, and "Z_2" the shunt element equal to 40.4 ohms, when interposed between the two 200-ohm impedances, will give the desired 20 decibel loss.

It will be noticed (see Fig. 15) that the series arm "Z_1" as determined for the T-type pad, is exactly twice the value found for "Z_1" in the H-type pad, and checks with the values given in Table 4, from which the constants "Z_1" and "Z_2" for T-type pads may be found, when working between 200- 500- and 600-ohm impedances.

Design Information for Resistors Used in Attenuators

The resistors used in attenuators must be non-reactive (have negligible inductance and capacitance) so that the attenuator will maintain a constant impedance throughout the audio band to the impedances between which it is working. By designing the attenuator to have a constant impedance, it will offer the same degree of attenuation to all audio frequencies, with the result that the frequency response characteristics of the circuit will be practically flat, which is the ideal strived for in all voice transmission circuits.

The following constructional data on the resistors used in attenuators is given, so that the above mentioned characteristics may be obtained.

All resistors lower than 300 ohms are wound in bifilar fashion. The bifilar method consists of paralleling the wire throughout the winding as shown in Fig. 16.

For all resistors below 300 ohms, the following accuracy limits for resistance should be adhered to:

Resistor values in ohms	Accuracy limits
1......50	± .1%
50......100	± .25%
100......150	± .5%
150......200	± 1.0%
200......250	± 2.0%
250......300	± 5.0%

Resistors whose values are greater than 300 ohms, are wound in the well-known reversed layer method, in which the layers are wound upon each other in reversed directions.

For all resistors above 300 ohms, the following accuracy limits for resistance should be adhered to:

Resistor values in ohms	Accuracy limits
300......450	± .1%
450......600	± .25%
600......750	± .5%
750......900	± 1.0%
900......1000	± 2.0%
1000 ohms and above	± 5.0%

The inductance of a resistor is expressed in micro-henries, and the capacitance of a resistor is expressed in micro-micro-farads.

The maximum allowable inductance in micro-henries for resistors below 1,000 ohms is given in the following table.

Resistor values in ohms	Inductance should not exceed
1...... 25	3 micro-henries
25...... 50	6 " "
50......100	8 " "
100......200	13 " "
200......300	23 " "
300......400	33 " "
400......500	43 " "
500......600	53 " "
600......700	63 " "
700...... 800	73 " "
800......900	83 " "
900.....1,000	93 " "

The maximum allowable capacitance in micro-micro-farads for resistors above 1,000 is given below:

Resistor values in ohms	Capacitance should not exceed
1,000......2,000	63 micro-micro-farads
2,000......3,000	50 " " "
3,000......4,000	44 " " "
4,000......5,000	40 " " "
5,000......6,000	37.5 " " "
6,000......7,000	35.7 " " "
7,000......8,000	34.3 " " "
8,000......9,000	33.3 " " "
9,000......10,000	32.5 " " "

If the resistors are wound as specified, and the accuracy limits for resistance, inductance, and capacity, as given above are maintained, a practically constant impedance attenuator will be the result.

ELECTRIC CODE

(*Continued from page* 102)

The points in favor of replacing unapproved extensions with standard wiring, may be marshalled as follows:—

(1.) SAFETY. Where a householder knowingly permits an electrical menace to exist after his attention had been called to its dangers, responsibility for consequences must be his own. Loss of life or injury in fires, burns from short-circuit flashes, shock and possible heart failure from contact with live conductors, electrocution if such contact is made while the body is moist and is also making contact with a grounded object, are the possibilities arising from such systems. There is often found an attitude among householders who seem to feel that, while such results occur in other houses, they cannot occur to them. This resembles the state of mind of a man who has been used to dodging across streets laden with heavy traffic, secure in the feeling that a special providence is looking after him. After being bumped by a taxi or learning to drive himself, he finds that he had merely been lucky and had been depending upon the mechanical excellence of the automobile and the skill and attention of the driver for his safety.

(2.) LITTLE ACTUAL DIFFERENCE IN COST. Convenience outlets may be installed for slightly higher cost than the exposed lampcord, that is generally supplied. In new buildings, outlets are installed at an average cost of $1.50 each, while the walls and floors of a building have not yet been finished. The actual wholesale value of the material used to install an attachment receptacle is about $1.00, the items required being:

15 ft. 14/2 BX cable, @ .04 per ft.	$.60
1 Gem Box, @ .12 ea.	.12
1 Duplex Receptacle, @ .21 ea.	.21
1 Brass Plate, @ .07 ea.	.07
Total	$1.00

Contractors buying material in large quantities, can obtain prices as much as 25 per cent lower. If so, there remains $.75 for the labor. While this seems low enough, a journeyman electrician and helper, using labor saving devices and materials, can install as high as 35 to 40 outlets per day, which explains how an electrical contractor can still make a profit after paying $13.20 and $8.00 per day respectively to the electrician and helper. The prices to be quoted by Service Men must depend upon the type of household and the construction of the building. This will be taken up in a later section.

(3.) UNSIGHTLINESS. No matter how carefully lampcord is tacked across a ceiling, and down a wall, it will always show and be a collector of dust. Kalsomined ceilings cannot be washed without rekalsomining and, while wires along walls may be cleaned, it is not a safe procedure to wash them with wet cloths. Since there is no substitute for soap and water to clean grime, the careful housewife leaves the wires decidedly alone. Approved installations are nearly always concealed in the plaster. Even when exposed, the conductors are enclosed in a fireproof or metal sheath and there is little danger of penetration to them without tools being used. Rats and mice do not seem to have developed a taste for cold rolled iron or zinc treated steel.

(4.) OVERLOADING FIXTURE CONDUCTORS. Most fixtures are wired with No. 18 Rubber Covered wire, known as fixture wire. This size wire has an allowable current-carrying capacity of 3 amperes. Most radios are placed in dining or living rooms and the fixtures in such rooms usually have 3 to 5 sockets. Fixtures so wired with No. 18 wire, while having current carrying capacity enough for lamps, are not designed to further supply the 125 to 175 watts required for an electric radio. The danger in overloading conductors is not immediately apparent. The rubber covering of the wire gradually loses its elasticity due to the heat from larger currents than it was designed to pass and it becomes brittle and drops off from the wire, then the bare conductors ground against the fixture and the householder assures the trouble shooter that, for no reason at all, the fixtures suddenly spat flame and the lights went out. Inspectors testing wiring materials

(*Continued on page* 123)

ON Page 69 of this issue will be found full details of the

OFFICIAL RADIO SERVICE MEN'S ASSOCIATION

Be sure to turn to this announcement and read it carefully.

OPERATING NOTES

(Continued from page 96)

bayonet contact pin of the band-selector. To make the task more simple, it is best that the cable be disconnected from the terminal strip, so that the entire unit may be placed in a position where it may be easily handled.

The next step will be to remove the six machine screws holding the subpanel assembly to the can, one in each corner of the sub-panel and one on either side of the can. After the pilot-light bracket has been loosened and pushed back and out of the way, the sub-panel may be lifted out, the side opposite the cable being pulled out first. While this is done, the cable must be fed through the shield can as the panel is lifted. The entire procedure should take no more than ten minutes.

A screw and nut hold the bakelite socket in position over the contacts. When these are loosened, the socket is removed and the contact prongs bent into proper shape. They may be cleaned at the same time by the judicious use of steel wool.

The second common complaint on the same model is a strong hum *only on resonance*. Sparton employs a .006-mf. condenser connected from one side of the A.C. line to chassis ground (the black wire emerging from the pack and connected to the ground binding post is the lead which connects this unit to ground). On many occasions, it is possible to reduce this resonance hum by substituting a .25-mf. or .5-mf. condenser in place of the .006-mf. condenser.

In all cases, however, a good ground connection is important and essential. A cold-water pipe does not always prove to be the best ground and it may be necessary and expedient to experiment with several before the proper results are obtained.

Stromberg Carlson 25, 26

Lack of volume control on the Stromberg Carlson models 25 and 26 is caused by a number of defects; in the main, however, the .04-mf. bi-resonator condensers have been largely responsible for this complaint. When one of these models with this complaint is serviced, the tubes should be tested and any below par, replaced. The chassis must be removed from the cabinet to ascertain the source of the trouble, which is usually caused by leaky bi-resonators; a test procedure to determine this fact will be here outlined.

Switch the receiver "on" and tune for a fairly good broadcaster. Referring to the chassis arrangement A, in Fig. 2, unsolder the two slate-colored leads (from the bi-resonator) at points (1) and (2). (The complete circuit of this chassis appears on page 427 of the OFFICIAL RADIO SERVICE MANUAL, Vol. II.) Shunt a wire across these two points and if the volume control is effective then the bi-resonator in this circuit is bad and should be replaced. However, if the first bi-resonator proves perfect, the same operation should be performed at points (3) and (4), after the leads have been soldered back to the correct lugs at (1) and (2).

It may, sometime, save time and trouble to determine which bi-resonator has failed by following a somewhat different method. With a good ohmmeter, measure the total resistance between the control-grid cap of the R.F. stage (nearest the rear of the chassis) and chassis. A reading of approximately 0.1-megohms should be obtained. A resistance measurement from the control-grid cap connection of the I.F. stage to chassis and from the control-grid cap of the first-detector to chassis should indicate approximately 0.2-meg. These values are correct for the 60-cycle models. In the 25-cycle receiver, the readings are about 60,000 ohms less, in both cases.

The bi-resonator condensers in this receiver are located within the close quarters of the condenser gang shield housing and therefore are very difficult to replace. If it is necessary to make a change, the leads to the condensers may be removed and the new units installed beneath the chassis in close proximity to the coils. A glance at Fig. 2B will disclose the internal connections of the bi-resonators (the additional lead was brought out to save an operation in manufacture).

Distorted reproduction on the same model has been traced to leaky detector-cathode bypass condensers, when the station selector is correctly tuned to resonance. This bypass unit is composed of two .3-mf. sections, connected externally, to make .6-mf. Distortion at low volume, has almost invariably been found to be caused by a poor type '24A tube in the second-detector stage. This quick heater or A-type tube in many instances has proven to be a poor detector in T.R.F. sets; or second-detector in superheterodynes.

A not infrequent cause for an inoperative receiver of this model—total lack of reception—is an open grid section of the oscillator coil.

At other times, a shorted trimmer condenser across one of the I.F. coils has produced the same condition. Ordinary tests with an analyzer will not reveal this failure—*again the writer voices the Service Man's need for an ohmmeter capable of accurately measuring the lower resistance values.* (See the article, "A Universal-Range Ohmmeter," in the July, 1932 issue of RADIO-CRAFT; the range available in this compact instrument is from 0.5-ohm to 15 megohms.—*Technical Editor.*)

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....

I EQUALS E OVER R

(*Continued from page 94*)

around one proton as shown in Fig. 2. Carbon contains 12 protons grouped together with 6 electrons as a nucleus around which 6 electrons revolve as shown in Fig. 3.

The central portion of the atom is known as the *nucleus* and it may consist of a single proton or a group of protons and electrons. The electrons *revolving around* the nucleus are known as the *planetary* or *free* electrons, *because they can be removed from the atom without changing its general character.* These planetary electrons revolving around the nucleus may form a single ring or a number of rings around the nucleus, depending on the complexity of the atomic structure of the substance. The atomic structure is shown graphically in the form illustrated in Fig. 4—first, there is the molecule of an element which is composed of atoms and these in turn are made up of electrons and protons.

Single elements, as described, are familiar to all, but many substances we encounter consist of chemical combinations of the atoms of two or more different elements forming another substance—a compound—whose appearance and physical properties are different from any of the elements, such as salt, water, etc.

For the sake of simplicity, we will limit our explanation to the elements and atoms.

The Charge

We have shown that atoms are composed of minute charges of electricity which, normally, are in such a form that the sum of the charges of all the electrons or negative charges equal the sum of the charges of all of the protons or positive charges. We have also explained that some of the electrons are revolving around the nucleus in orbits in a manner similar to the stars around the sun. It is to be noted that although the substance contains electricity, (electrons and protons) it is uncharged simply because the charges are equal and balanced.

If we remove one or more of the planetary electrons from an atom, the atom becomes unbalanced and lacks negative electricity (electrons). In this case, the atom is said to be *positively* charged. On the other hand, if we place an *additional* electron or electrons in one of the planetary orbits of an atom, it also becomes unbalanced—in the opposite direction—and has too much negative electricity (too many electrons). In the latter case, the atom is charged *negatively*.

From this it can be concluded that a substance is *electrified* when it has *more* or *less* than its *normal* number of electrons and the *amount of charge* is determined *only* by the quantity of electrons displaced. Also, it can be deducted that all electrons are the same regardless of the element or compound from which they come.

The Electric Current

Every substance has a tendency when displaced from equilibrium, to return to a state of balance as quickly as possible. Just as water will find its own level, so atoms which have lost electrons (positively charged) will attempt to attach electrons to themselves, and atoms which have excess electrons will attempt to loose them and thus become neutral.

Therefore, if we have two substances, one charged positively and the other charged negatively, and we touch them together, the excess electrons from the negative will *enter* the other substance in order to reach a neutral state. If the two bodies are charged equally (and oppositely) the electrons will continue to transfer until both substances are neutral.

Figure 5 shows this effect. In the upper part of the illustration the two substances are charged; and in the lower part, the excess electrons from the negative body have entered the positively charged body and neutralized the atoms lacking electrons.

If we have some means of maintaining the charges on the two balls (shown in Fig. 5.) continuously, there would be a constant passage of electrons from the negative to the positive ball. *This continual passage of electrons is what is known as an electrical current or simply a current.* This follows logically from the statement we made before; that electrons *are* electricity.

It is not possible to add or remove electrons from a substance without the aid of some external force. This force is known as an electromotive force (E.M.F.). We will not go into the various means of maintaining an E.M.F., here. Several common sources of electromotive forces are dry batteries, storage batteries and generators.

The *amount* of current flowing in a circuit (for example the two balls in Fig. 6) depends on the number of electrons passing through the circuit. The number of electrons, in turn, depends (among other things) on the amount of the charge *which is dependent on the E.M.F. applied to the circuit*. We may safely conclude, therefore, that the amount of current flowing in a circuit depends on the value of the E.M.F. applied to the circuit.

When visualizing the motion of electrons through a solid body, such as copper, we must remember that the electrons are very small and that there are comparatively large spaces between the atoms. As an example, if a copper cent were enlarged to be the size of the earth's diameter, the distance between atoms would be about three miles and the electrons would be only a few inches in diameter!

Resistance

It is well known that certain materials such as copper, brass, silver, etc. will readily permit the passage of an electric current, while other materials such as rubber, mica, porcelain, cotton, silk etc., do not. The former materials are called *conductors* and the latter, *insulators*. The reason why metals are such good conductors of electricity is that their atoms apparently have a weak attraction for electrons and large numbers of them are either practically in a free state throughout the body of the metal or they are easily shifted by any outside electric forces. The more easily the electrons can be shifted in a metal, the lower its resistance to a flow of current, merely because a greater current flows for the same value of applied E.M.F.

This action of resistance in conductors introduces another factor in the consideration of the strength of current flow. Up to this point we have seen that the amount of current increases as the E.M.F. increases and since the *opposition* offered by the conductor of the current *decreases* the current, it may be said that the magnitude of the current flowing in any circuit depends upon the E.M.F. applied and the opposition offered by the circuit itself.

In order to facilitate the measurement and computation of electric currents, several units have been set as standards. The E.M.F. is measured in a unit called a *volt;* the current is measured in *amperes* and the opposition or resistance is measured in *ohms*. The first of these units is usually represented by the letter E, the second by the letter I and the resistance by the letter R.

To sum up: the current (number of amperes) flowing in a circuit depends upon the voltage applied and the resistance of the circuit. To state this in another way,

$$I\ (\text{amperes}) = \frac{E\ (\text{voltage})}{R\ (\text{resistance})}$$

A problem involving this condition is shown in Fig. 7. This involves a resistance of 5 ohms in a 10-volt circuit. Then $I = \frac{10}{5}$ or 2 amperes.

Another type of problem might arise in which it is desired to know the value of the resistance in a circuit when the voltage and the current are known. Here again, Fig. 8 illustrates the conditions. This may be determined from the ratio $R = \frac{E}{I}$; or, if the *potential* (volts) is 50 and the current is 2 amperes, the resistance will be $\frac{50}{2}$ or 25 ohms.

The third condition of the relation considered above is one in which the resistance and the current are known and it is desired to know the applied potential. In this case, the voltage E is equal to the product of the current and the resistance ($E = I \times R$).

If a current of 10 amperes is flowing through a resistance of 20 ohms, then the potential applied is 10 x 20 or 200 volts.

From these three examples, it is established that there are three individual conditions involving the relation of E.M.F., current and resistance. These three classifications are as follows:

When E and R are known and the current is desired:

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

When E and I are known and the resistance is desired:

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

When R and I are known and the voltage is desired:

$$E = R \times I$$

The above three formulas are known as Ohm's Law in honor of the noted physicist George Simon Ohm.

Resistances in Series

We have already learned that resistance is the opposition of a substance to the flow of current. It is natural then, that the longer the substance composing the resistance, the greater will be the value of the resistance. Also, if two conductors are connected so that the current passes through each of them in succession, then the resistance of the circuit will be the *sum* of the individual resistances of the two conductors. This effect is illustrated at Fig. 8. The resistance of the conductor at 8A is R. Then the total resistance of the two resistors at 8B is the sum of the individual resistances.

When the *area* of a conductor is increased, the opposition to the flow of current will be *decreased*, as there are more atoms to lose and gain electrons. It also follows logically that if two conductors are connected as shown in Fig. 9, the resistance of the circuit will be *less* than that of either of the individual resistors R. This is known as a *parallel* method of connection.

The method of figuring the total resistance of the circuit for parallel resistances is different from that for series resistances. If we refer again to Fig. 9, it will be noted that the current flowing from point A to point B will be divided and part of it will pass through each resistance. If these resistances are equal, half the current will go through each. Then, if the applied E.M.F. is 10 volts and the current in each resistor is 1 ampere, the resistance of *each* of the resistors will be $\frac{10}{1}$ or 10 ohms. However, the total current flowing is 2 amperes, so the resistance of the *parallel circuit* is $\frac{10}{2}$ or 5 ohms.

For those readers who are familiar with the elements of algebra, the above reasoning may be expressed in the following formula:

$$\frac{1}{R} = \frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3} \text{ etc.,}$$

in which R is the total resistance and resistors R1, R2, etc., are the individual resistances of the parallel circuit.

The discussion of electricity and resistance given should be of assistance to many radio enthusiasts who are confused by the explanations of Ohm's Law usually given. It is suggested that the article be read over several times so that the details discussed will all be understood.

(It might be well to add that the current through a given part of a circuit will vary directly as the applied E.M.F. and inversely as the resistance, as stated by Mr. Palmer. It should be emphasized, however, that when *part* of a circuit is under consideration, the current, voltage and resistance of that *particular part* should only be considered, regardless of whatever else occurs in another part of the circuit.—*Editor*.)

THOSE D. C. SETS

Did you ever service a D.C. power-operated set and flounder around for several hours before discovering that the D.C. line plug was reversed? Remember that it will only work with the plug in only one direction. And another thing, be sure that the set uses an antenna series condenser.

A "3-TUBE" SUPER

(Continued from page 86)

One Meissner, 262½ kc. composite oscillator coil and input I.F. transformer, I.F.T. 1, L2, L3;
One R.F. choke, 8 millihenries;
One Meissner antenna coil, type X, L1;
One chassis;
Four knobs;
One A.C. cord and plug;
One 10,000-ohm vol. control with "on-off" switch R10 pot, type, cathode ant., ¼-inch shaft, 1 inch long;
Two .00007-mf. padding condensers, C15, C17;
One DeJur .001-mf. padding condenser, C2A;
One DeJur dual trimmer, .00014, C3, C4;
One 6 mf. 450-volt electrolytic condenser with leads, C9;
One 8 mf. 450-volt electrolytic condenser with leads, C10;
Two .001-mf. molded condenser, C7, C11;
One .005-mf. molded condenser, C12;
One .25-mf. cub type 200-volt condenser, C13;
Two .1-mf. 200-volt cub condenser, C5, C6;
One 20 mf. electrolytic condenser, 50 volt, C8;
One shield can 2¼ inches long, 2⅛ inches diameter, drilled for dual trimmer;
One base for same;
One short-wave coil and bracket, L4;
One rotary switch (S.P.S.T.), SW1;
One 50,000-ohm variable rheostat (tone control), R11;
One .05-mf. cub condenser, C16;
One .01-mf., 400-volt cub condenser, C14;
One 7,500-ohm, ⅓ watt resistor, R1;
One 200-volt, ⅓ watt resistor, R2;
One 25,000-ohm, 1 watt resistor, R3;
One 25,000-ohm ⅓ watt resistor, R4;
One 1-megohm, ⅓ watt resistor, R5;
One 100,000-ohm, ⅓ watt resistor, R6;
One 400-ohm, ⅓ watt resistor, R7;
One 1,000-volt, ⅓ watt resistor, R8;
One 20-ohm center tap resistor, R9.

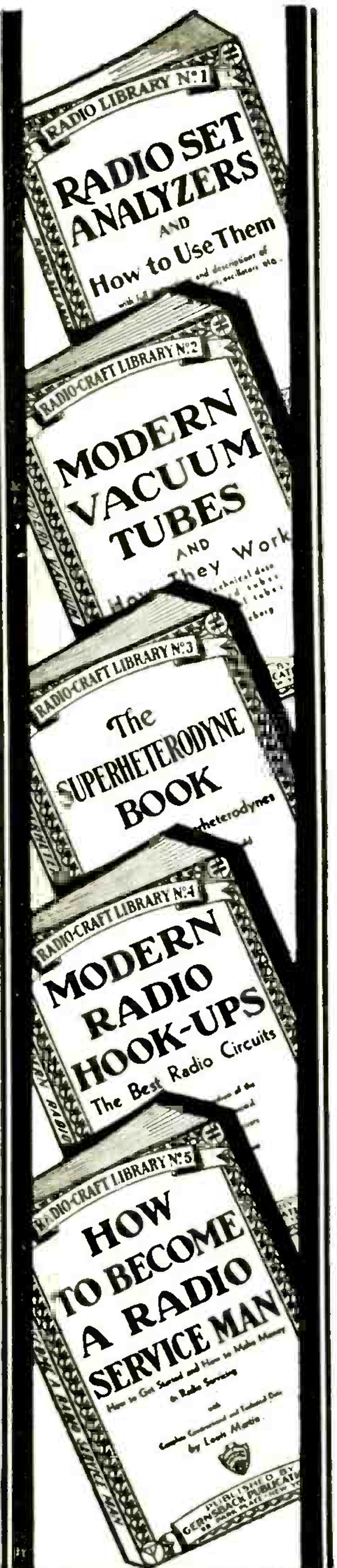
I. F.-R. F. OSCILLATOR

(Continued from page 91)

The same procedure can be carried out at the zero setting of the oscillator dial. In this case the frequencies worked out accurately at the first trial. A harmonic was tuned in at 72 on the tuner dial, indicating a frequency of 700 kc., and at 43, indicating a frequency of 1050. The difference, 350 kc., is the fundamental frequency of the oscillator at this setting. The second, third and fourth harmonics are marked on the graph of Fig. 5. This procedure was carried out at every 10 degree setting of the oscillator dial. A series of curves, as shown on the chart of Fig. 5 were plotted. It was found that the curves were actually straight lines, due to the straight-line-frequency characteristic of the oscillator condenser.

If one desires very accurate readings, an output meter may be connected to the radio receiver so that a visual indication, rather than an audible one, may be had. A suitable output meter is described on page 92 of this issue.

To make an accurate check of the calibration curves of the oscillator, one of the side plates should be removed and a piece of wire connected across the grid condenser so as to short-circuit it. Then the side plate should be replaced. In this condition the oscillator will generate a non-modulated wave which can be used to heterodyne the wave of a crystal-controlled broadcast station tuned in on the receiver. When making this test a short indoor aerial, just sufficient to pick up the broadcast station, should be connected to the aerial post of the receiver. The oscillator is left connected to the receiver. By tuning-in a station, such as WOR at 710 kc., the oscillator should cause a heterodyne squeal at 73, 112½, and 135½ (dial settings of the oscillator) working on the third, fourth and fifth harmonics respectively. Tune the oscillator dial for zero-beat adjustment and the calibration will be exact. Several stations may be tuned-in in this manner and slight corrections can then be made to the previous plotted curves if necessary, after which the short-circuiting wire in the grid condenser may be removed.



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Presented on these two pages are the new books of the RADIO-CRAFT LIBRARY—the most complete and authentic set of volumes treating individually, important divisions of radio. Each book has been designed to give radio men the opportunity to specialize in one or more of the popular branches of the industry. The material contained in these books will increase your knowledge; you will find them a real help in your work and they will contribute to your money earning capacity. Read these books during your spare time at home.

The authors of these books are well-known to everybody. Each one is an expert radio man; an authority on the subject—each is thoroughly familiar with the field which he represents.

Book No. 1

RADIO SET ANALYZERS

And How To Use Them

With Full Instructions and Descriptions of Set Analyzers, Tube Checkers, Oscillators, Etc.

By L. VAN DER MEL

This book explains thoroughly the operation of set analyzers, tube checkers, oscillators and other testing equipment. For every radio man this book is extremely helpful. It covers every phase of testing and gives you valuable short cuts: completely illustrated with photographs and diagrams to facilitate the use of modern testers.

The following chapters briefly outline the contents. INTRODUCTION; THE ANALYZER: Fundamentals, Switches, A.C. and D.C. Voltmeters, Calibration and Design; TROUBLE SHOOTING WITH THE ANALYZER: Classification of Trouble, Analysis of Troubles, Uses of Various Analyzers, Care and Maintenance; CONCLUSION.

Book No. 2

MODERN VACUUM TUBES

And How They Work

With Complete Technical Data on All Standard and Many Special Tubes

By ROBERT HERTZBERG

MODERN VACUUM TUBES describes the fundamental electron theory which is the basis of all vacuum tube operation, and goes progressively from the simplest two-element tubes right up to the latest pentodes and thyratrons. It is written in clear, simple language and is devoid of the mathematics which is usually so confusing. Valuable reference charts and characteristic curves of standard and special tubes are to be found, also diagrams of sockets and pin connections.

Here are some of the chapters: The Edison Effect and The Electron Theory; Electron Emitters and the Ionization Effect; The Three-Electrode Tube; Vacuum Tube Characteristics; Four- and Five-Element Tubes; Light Sensitive Cells and Other Special Tubes.

Book No. 3

THE SUPERHETERODYNE BOOK

All About Superheterodynes

How They Work, How to Build and How to Service Them

By CLYDE FITCH

There is no more fascinating a subject in the large array of radio circuits than the famous superheterodyne circuit. Whether you are a Service Man or experimenter, first-hand knowledge about the construction of superheterodyne receivers is very important. The book on Superheterodynes gives underlying principles of their construction, right from the very first set made.

The following is a short list of contents: Basic Principles of the Superheterodyne; The Oscillator; First Detector; Single Dial Tuning Systems; Intermediate Amplifier; Second Detector, Audio Amplifier and Power Supply; Commercial Superheterodyne Receivers; Servicing Superheterodynes.

Book No. 4

MODERN RADIO HOOK-UPS

The Best Radio Circuits

A Complete Compendium of the Most Important Experimental and Custom-built Receivers

By R. D. WASHBURNE

It is fascinating to the experimenter, or even to the up-to-date Service Man, to take a commercial set and to change it into one using a famous hookup that is not found in any manufactured set. Many excellent circuits have never been commercialized, but limited only to home-set builders. Thousands of these popular circuits have been requested from time to time, and in this book we have included over 150 circuits, which include the famous Peridyne, Cash-Box A.C.-D.C. Set and others.

The circuits cover the following: Broadcast Receivers, All-Wave Receivers, Short-Wave Receivers, Converters and Adapters, Television Receivers, Home Recording Apparatus, Automobile Receivers, Audio and Power Amplifiers, Power Units and Miscellaneous Equipment.

Book No. 5

HOW TO BECOME A RADIO SERVICE MAN

How To Get Started and How To Make Money in Radio Servicing

By LOUIS MARTIN

The ambition of many men in radio today is to become a first-grade Service Man. It is not as difficult as one might believe, but it cannot be done in a few short months. Following very carefully the advice of Mr. Martin, who has dealt with the problems of thousands of Service Men, this book deals very carefully with the essential stages in the preparation for qualifying as a Service Man.

Here are the chapters: The Small Independent Service Man; Advanced Commercial Aspects; The Radio Set; Semi-Technical Considerations; Advanced Service Data. Each chapter is again subdivided to bring out in minute detail every point of importance.

Book No. 6

BRINGING ELECTRIC SETS UP TO DATE

With Pentodes, Multi-Mus, Dynamic Speakers—Complete Information How to Modernize A.C., D.C. and Battery Operated Receivers

By CLIFFORD E. DENTON

In this country there are over ten million electrically operated receivers that could be modernized—by placing in them new type tubes, new speaker equipment and other modern improvements. This business of improving old sets can go to the experimenters and Service Men if they will quickly jump into action.

Read in this book by Mr. Denton, how easily you can modernize any obsolete set, and with little additional costs.

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Book No. 7

RADIO KINKS AND WRINKLES

For Service Men and Experimenters

A Complete Compendium on the Latest Radio Short-Cuts and Money-Savers

By C. W. PALMER

It often becomes necessary for experimenters and Service Men to call upon their memory for some short cut or radio wrinkle that will solve a problem quickly. In business, "short cuts" mean time and money saved, and to the Service Man "time saved" means money earned.

This book is a compilation of important radio kinks and wrinkles and discusses only such items as are constantly used today.

Here are some of the more important chapters: Introduction; Servicing Short-Cuts; Testing Equipment and Meters; Vacuum Tubes and Circuits; Volume-control Methods; Amplifiers and Phonograph Reproducers; Power Supply Equipment; Coils and Tuning Circuits; Short Waves; Loud Speakers; Tools and Accessories.

Book No. 8

RADIO QUESTIONS AND ANSWERS

A Selection of the Most Important of 5,000 Questions Submitted by Radio Men During the Course of One Year

By R. D. WASHBURNE

There has been collected a wide variety of questions which have come into our editorial offices during the past two years, and only those whose answers would benefit the majority of men engaged in radio have been incorporated in this amazing question and answer book.

The tremendously long list of topics better explains the subjects which are treated. Here are the titles:

Radio Servicing; Receiver Design; Home Recording; Television; Sound Equipment; Short Waves; Antennas; Operating Notes; Test Equipment; Tubes; Ultra-Short-Waves; Police Radio; Reproducers; Superheterodynes; Automotive Sets; Power Packs; Automatic and Remote Control Devices; Aligning Procedure; Photo-electricity; Adapters; Measuring Apparatus; Band-Selectors; Converters; Public Address Equipment; Midget Sets; Oscillators; Phonograph Pickups.

Book No. 9

AUTOMOBILE RADIO AND SERVICING

A Complete Treatise on the Subject Covering All Phases from Installing to Servicing and Maintenance

BY LOUIS MARTIN

Automobile radios are up and coming, and someone has to service them properly. It therefore behooves you to read this immensely important new book on the art of Automobile Radio. The book is concise, and full of illustrations, photographs, diagrams and hookups.

Here are only a few of some of the really interesting chapters: Introduction; Automotive Radio Installations; Complete Descriptions of Commercial Automotive Receivers; Servicing Automotive Receivers; The Ignition System; General Service Considerations; Effects of Temperature on Power Supply; Conclusion.

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ELECTRIC CODE

(Continued from page 116)

always dig into the insulation with a finger nail to determine the life in rubber covered wire.

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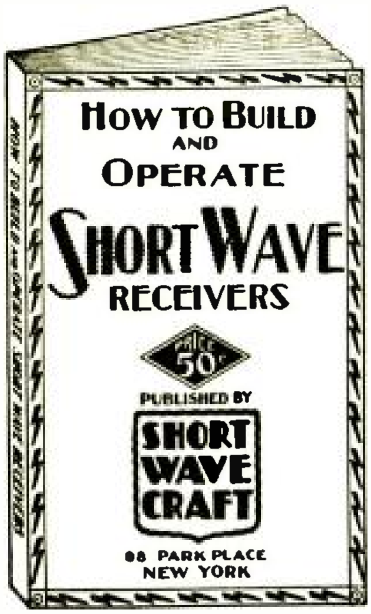

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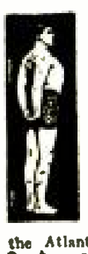

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• Index to Advertisers •

(While every precaution is taken to insure accuracy, we cannot guarantee against the possibility of an occasional change or omission in the preparation of this index.)

A SET ANALYZER

(*Continued from page 93*)

tween control grid and cathode of screen-grid tubes; No. 13 is "CG-K60V." and is the same as No. 12 but using the 60-volt scale; No. 14 is "P-K-300V." meaning the 300-volt scale is connected between plate and cathode; No. 15 is "P-K600V." and is the same as No. 14 using the 600-volt scale; No. 16 is "P-12MA." meaning the 12-ma. range is in series with the plate circuit. No. 17 is "P-60-MA." and is the same as No. 16 using the 60-ma. scale; No. 18 is "P-120-MA." and is the same as No. 16 and 17 using the 120-ma scale; No. 19 is "G-120-MA." meaning the 120-ma. scale is in series with the grid circuit; No. 20 is "PG-K30V." meaning the voltmeter is between the "pentode grid" and cathode of an R.F. "pentode tube." This "pentode grid" is the one on the side of the base of an R.F. pentode tube. The 30-volt scale is used. The "P" in this case should not be confused with the "P" position on other positions of the switch which refer to plate connections. No. 21 is "Output" and the range covered is determined by the external connection to the output jacks. These are marked—Low—Med. and High. This scale is used as a visual indicator of resonance in connection with an oscillator. Directions for the use of this scale will be given later. No. 22 is not marked and represents the "off" position of the D.C. meter.

A.C. Selector Switch

The A.C. meter is controlled by the smaller selector switch to the left. It has seven positions. Two of these are marked "off." Counting from the top, No. 1 is the "off" position, No. 2 is marked H-H1-4V meaning the A.C. voltmeter is connected across the filament circuit using the 4-volt scale. No. 3 is H-H1-8V meaning the 8-volt scale is connected across the filament circuit. No. 4 is the other "off" position and this "off" position separates the low-voltage scales from the high. No. 5 is "P-H800V." and means the 800-volt scale is connected from plate to filament. This refers to rectifier tubes and measures directly the A.C. voltage applied to one plate of an '80 rectifier or to the plate of an '81 rectifier. No. 6 is "G-H-800V." and measures the A.C. voltage applied to the second plate of the '80 rectifier. No. 7 is marked and connects the current range of the A.C. meter to the proper small jacks at the rear of the panel.

Automatic Switch for Tube Tests

The small selector switch to the right is for testing tubes. It is automatic and springs back into the "off" position when released. All but rectifier tubes are tested with this switch. As the rectifier does not have a grid, such a test is not needed for it.

To test all other tubes, first record the normal plate current, if the tube is one of the screen-grid types such as the '22, '24, '35, '51, '37, or '38, push down on the selector switch and a second plate current reading should be obtained. If the tube under test is an ordinary three-element type, or '47 type, turn the switch in the "up" position to get the second plate-current reading. This change in plate current determines the condition of the tube. In most cases the greater the difference in the two plate current readings, the better the tube.

It is not possible to give any definite values to determine the condition of tubes. Receivers apply different voltages to tubes and therefore different current values will be recorded. However, after a little practice in testing good and bad tubes by this method, one can soon learn to tell when a tube is defective. When testing a detector, it is best to move the tube to another socket as in the detector stage a high bias is present which limits the plate current to a small value.

LEAD-IN STRIPS

When servicing a receiver which is noisy, has intermittent reception or no reception at all, test the lead-in strip to be certain that the window, especially in the summer, has not broken through the insulation and ruined the strip.

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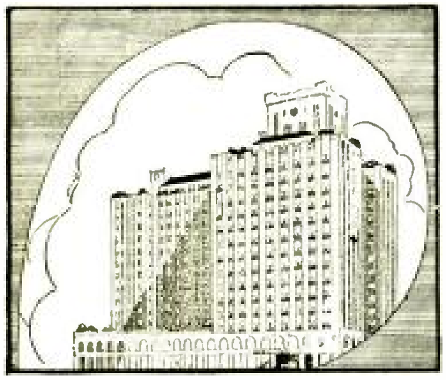
The Hotels on this page are Patronized by the Radio Trade. Make them your Headquarters.



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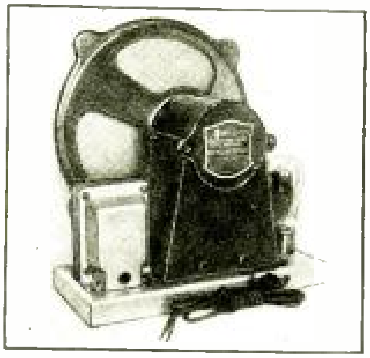

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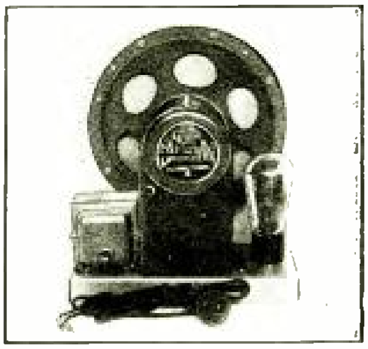

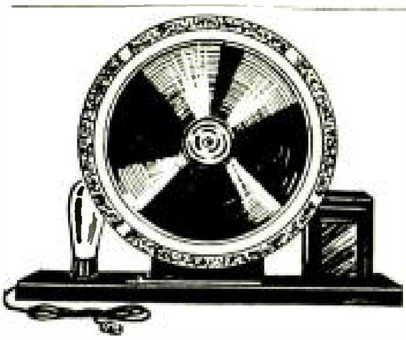

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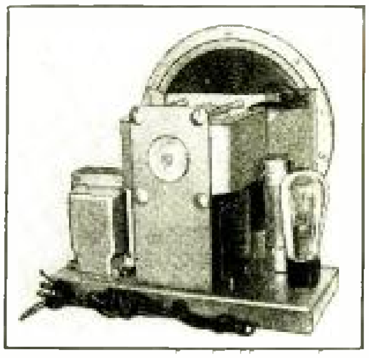

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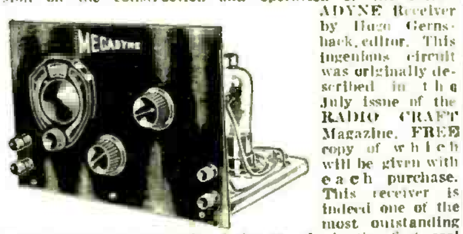

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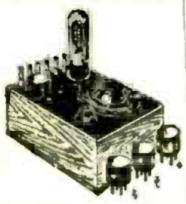

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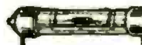

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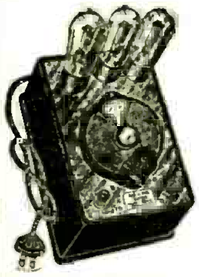

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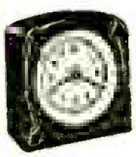

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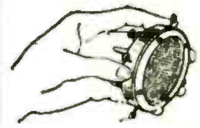

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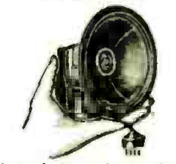

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TUBE CHARACTERISTICS AT A GLANCE

By C. H. W. NASON

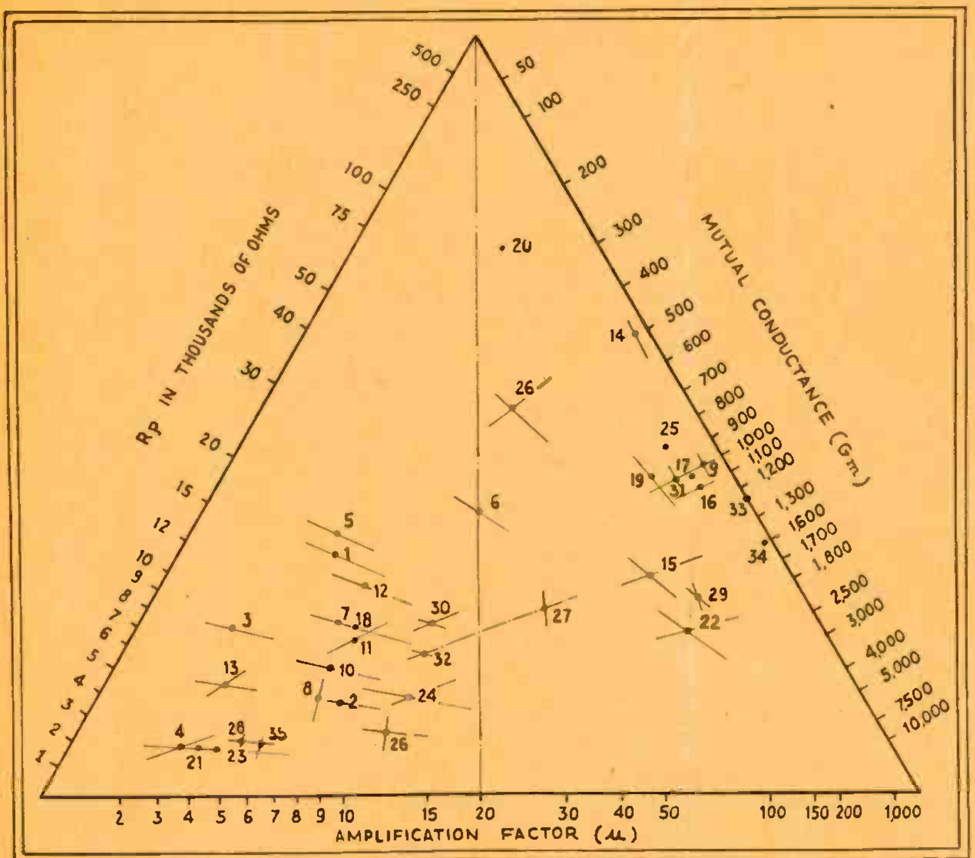

Fig. 1. A self-perpetuating nomograph for determining tube characteristics.

RECENTLY, in Europe, a graphic chart has been developed which represents directly the characteristics of the vaccuum tube. It is based on the theorem of Ceva which states, briefly, that if lines be drawn through the apices of a triangle so as to pass through a point within the triangle, the sides will be divided by the lines into segments having a definite relation between one and the other. Conversely, if the location of a given point within the triangle is known, the relative length of the lines into which the sides of the triangle will be divided may be predetermined.

As shown in Fig. 1, a line drawn from an apex through an index number to a side of the graduated triangle will indicate amplification factor, u; plate resistance, R_p; and mutual conductance, G_m.

The tube reference numbers used in Fig. 1 are as follows: 1, WD-11, 12; 2, '12A; 3, '20; 4, '71A; 5, '99; 6, '00A; 7, '01A; 8, '10; 9, '24; 10, '26; 11, '27; 12, '30; 13, '31; 14, '32; 15, '33; 16, '35; 17, '36; 18, '37; 19, '38; 20, '40; 21, '45; 22, '47; 23, '50; 24, 852; 25, 865; 26, 211; 27, 841; 28, 845; 29, LA; 30, Wunderlich; 31, 44; 32, 56; 33, 57; 34, 58; 35, 46 (Class A).

The chart is self-perpetuating, since when a new tube is released it is only necessary to draw lines through the apices or corners of the triangle, cutting the points on the sides at the designated characteristics. These lines will meet at a point which may be marked for future reference as the locus of intersection for that particular tube.

Other data on tubes and other equipment may be plotted in this manner; and technicians may be interested to make a number of such nomographs for handy reference.

If these are accurately prepared, and uniformly arranged, they may be submitted to RADIO CRAFT for publication at space rates.

A CONTINUITY- AND OHMMETER

By JOHN C. BANK

ONE of the most useful devices in making tests is a continuity meter; in other words, a voltmeter with a battery in series. However, in addition to straight continuity tests, it is often desirable to know the *resistance* of certain portions of the *circuit*.

Volt-ohmmeters, on the market, depend for their accuracy on the voltage of the battery being exactly the value to which the meter is calibrated. In the factory-made types they are equipped with a "regulator," consisting of a magnetic shunt (a piece of iron), which is moved in front of the poles of the instrument magnet by a screw, to compensate for changes in the reading as the battery voltage changes.

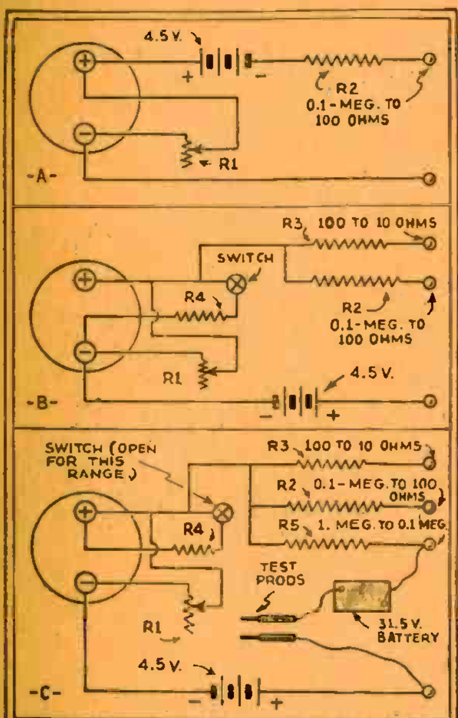

Fig. 1. Continuity-Ohmmeter Connections.

This method is not practical for one who wishes to construct his own ohmmeter, so we will show how one can be made with a regulator for voltage variations.

The best and least expensive meter to select is a 1. ma. milliammeter such as a Jewell Pattern 88, or a Weston Model 301. Connect in accordance with Fig. 1A. Resistor R1 is a 200-ohm rheostat; R2, an Electrad Truvolt type B-35 unit, 3,500 ohms. All of this equipment will mount nicely in a box measuring 8x4x2½ inches deep.

To find the value of an unknown resistance from the reading of the meter, consult column Dma., Table I, below:

TABLE I

Rx.	Dma.	Rx.	Dma.	Rx.	Dma.
0	1.000	1,600	.687	10,000	.260
100	.972	1,800	.660	12,000	.226
200	.946	2,000	.637	14,000	.200
300	.921	2,500	.583	16,000	.180
400	.898	3,000	.538	18,000	.163
500	.875	3,500	.500	20,000	.143
600	.852	4,000	.467	25,000	.123
700	.832	4,500	.438	30,000	.104
800	.814	5,000	.412	40,000	.080
900	.796	6,000	.368	50,000	.065
1,000	.778	7,000	.333	75,000	.045
1,200	.743	8,000	.305	100,000	.034
1,400	.713	9,000	.281		

A better way, however, is to mark the points on the scale. To do this, remove the cover from the meter and mark the values along the top arc of the scale with a very fine pen and india ink. Put figures, over the cardinal points, starting with zero, 1,000 2,000, 5,000, 10,000, 20,000, 30,000, 50,000 and 100,000. Since these run into a large number of figures it is necessary to use 1, 2, 5, 10, etc., and to multiply the reading by 1,000. Note that the cardinal points are positions on the ohm scale where the value of the divisions change. For example, from 0 to 1,000 we have ten divisions. This means that each mark is 100 ohms. From 1,000 to 2,000 we have five divisions, or 200 ohms per division. Thus, by consulting the numbered points we know where to look for a change in value.

Although the range of this instrument is from about 100 to 100,000 ohms, it may be necessary to increase the scope to include values above and below.

To extend the lower end of the range, *below* 100 ohms, add an "off-on" switch to the circuit so that shunting resistor R4 may be cut in and out, around the meter itself, as shown in Fig. 1B; use an Electrad type B-.05 resistor, 5 ohms, which has a sliding contact that can be adjusted and then clamped in position. Also, add resistor R3, of 350 ohms; its value is conveniently reached by connecting in series an Electrad type B-3 resistor of 300 ohms and a type B-.5 unit of 50 ohms.

To calibrate, short the two posts for the 100,000 ohm range and set the pointer on the top mark by means of the regulator. The shunt must be disconnected. When this setting is made, cut in the shunt and vary it until the pointer is at 0.1, which is one-tenth of the full-scale deflection. Check back by opening the shunt and note whether the pointer is at full scale. When this calibration is complete and the test leads are connected to the common post and the one through resistor R3, the meter will read one-tenth the values on the scale. This will enable us to read down to at least 10 ohms.

To increase the range *above* 100,000 ohms we must add another resistor, R5, of 35,000 ohms; its value is conveniently checked by connecting in series an Electrad type B-300 resistor of 30,000 ohms and a type B-50 unit of 5,000 ohms.

To make the circuit complete, an additional battery of 31.5 volts must be placed in series externally, as shown in Fig. 1C. To use this combination, short the test leads and set to full scale by means of the regulator. Open the test points, connect in the unknown resistance, read the deflection and multiply by 10. This gives a scale up to 1,000,000 ohms.

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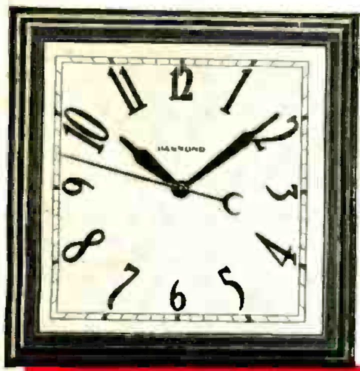

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