How to Build the "TRAUTONIUM"—Musical Instrument
See Page 522

Filamentless Tubes— Useful V. T. Voltmeters— Tube Reference Index
How to Make a New Tube Tester— Constructing a Simple Pentode Set
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The chassis of the SCOTT ALL-WAVE DELUXE is a thing of beauty. Finished in gleaming chromium plate it is dust- and weather-proofed to keep its tremendous power always ready for service. Within this chassis is the perfection resulting from tests such as the one shown at the right—which matches coils to their antennae exactly within the third of a turn of wire.

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Send me, without obligation, complete information about the new SCOTT ALL-WAVE DELUXE, including your new Brochures, "PROOF" and "The Creation of a Masterpiece."
BOOKLET SERVICE

11. SUPREME INSTRUMENTS. Contains lengthy descriptive paragraphs on certain commercial instruments, including the AAI Diaphragm, which is five instruments in one, the model 60 automatic camera, the model 45 tube tester and the models 60 and 10 oscillographs. Interesting to the Service Man because it tells how his work is facilitated by ingeniously designed equipment. It also explains why calibration is the absolute of an entire set in a few minutes. New test apparatus to take care of the job is described. Supreme Instrument Corporation.

22. HOW TO TEST PENTODES. This sixteen-page booklet contains many valuable hints on the testing of electrolytic condensers, as well as useful information to radio receivers and other radio service men. Read-It Radio Instruments. Worth having. Read-It Radio Instruments.

55. PHILCO PARTS CATALOG. This catalog will undoubtedly be of great help to every Service Men because it contains the only official, complete list of the most common replacement parts used in every Philco receiver from the very beginning. The parts included are all those which the manufacturer is anxious to continue. The list is indexed by the manufacturer and offers the service man to all who want it. Philco Radio & Television Corp.

66. WHOLESALE RADIO SERVICE CATALOG. The 1933 Radio Catalog of the Wholesale Radio Service Company is the kind of catalog the radio service man will carry around with him all the time in his back pocket. Measuring 7 by 10 inches and containing 144 pages, it is one of the most complete catalogs we have ever seen. It tells how his work is facilitated by ingeniously designed equipment. It also explains why calibration is the absolute of an entire set in a few minutes. New test apparatus to take care of the job is described. Wholesale Radio Service Company, Inc.

READERS' BUREAU

On this page are listed manufacturers' catalogs and booklets, chosen because they are of interest to all radio men. You can obtain copies FREE by using the coupon below.

76. THE COAST-TO-COAST "BROADCAST." The "Broadcast" magazine of the 1922 edition of a 100-page mail order catalog that is a veritable encyclopedia. Its listings are very varied, and run from solid-state tubes to complete 100-watt public address amplifiers. Every article is well illustrated and described for the benefit of radio dealers and Service Men, for whom the volume is specifically intended. A large amount of space is given to the placement of external resistors and for ordinary service work. This catalog is well prepared and is worth having. Coast-to-Coast Radio Corporation.

80. FLECHTHEIM ELECTRICAL EQUIPMENT. A wide variety of fixed condensers, ranging from tiny midgets, the size of ordinary whitehead pins, to transmitting units a foot high, are described and illustrated in the large and the small. This is very useful for reference in design and service work, as it gives the mechanical dimensions and electrical characteristics of all models in minute detail. A. F. Flechtheim & Co.

81. I. R. C. RESISTOR CATALOG. Sixteen-page catalog describes a very complete line of resistors, and is very useful for all service purposes. It includes full performance characteristics, so that a Service Man or an experimenter with a particular requirement in mind can select exactly the right unit for the job. The catalog contains valuable data on the conversion of milliammeters to ammeters and millivoltmeters, and on the extension of voltmeter and ammeter ranges. It also contains a list of International Resistance Company.

86. LUXEL AND EKLEN FILTERIZER AND CONDENSERS. The Eklel catalog is valuable for the Service Man because it lists numerous rheostats, potentiometers, volume controls, replacement controls and resistors for service work. Detailed dimension drawings are included: this feature will be appreciated by every Service Man who has been on to install replacement units in cranked receivers. Two pages of volume control replacement parts are included, along with fourteen diagrams showing different circuit positions for such controls. The Eklen catalog is devoted exclusively to dry electrolytic high voltage condensers for filter and bypass purposes. It also includes valuable information on commercial receivers. P. K. Mallory & Co.

91. MICROWAVES. A complete line of microphones and accessories for amateurs, public address and broadcast stations is described and illustrated in this four-page pamphlet. The "mikes" range from small hand units to large condenser microphones, with complete specifications, covering the two stages of amplification. Sound Engineering Corporation.

93. DUBLER CONDENSERS. The 1935 catalog of Dubler condensers is a large 4-page booklet describing fixed condensers for every conceivable application. It contains units for receiving circuits to man-high assemblies for transmitting work. A useful catalog to all radio men. Dubler Condenser Corporation.

94. ELECTRAF PRODUCTS. The newest and latest addition to the Electraf family contains twelve pages and lists many types of fixed and variable resistors and five different kinds of amplifiers for public address purposes. The popular Truvolt resistors have been improved with the addition of tantalum shields and heat radiating covers, and a number of new sizes have been added to the list. The new Electraf amplifiers contain some valuable data on the application of radio receivers, transformers, transformers, amplifiers and sound systems, and suggestions on how to make the most of them. A handy and useful catalog. Electraf, Inc.

95. CARDWELL CONDENSERS. This is a condensed four-page catalog of the well known Cardwell variable condensers for transmitting and receiving. These are small but not "midget" size instruments designed for purposes which are extremely limited and where a few types of bulk are desirable. Complete and detailed specifications are included for the assistance of constructors. Allan D. Cardwell Mfg. Corp.

96. TUBE FILTERIZER AND CONDENSERS. The Tube Deutschmann company is now catering to the Service Man with an extensive line of filter, by-pass and line condensers and radio noise suppressors in standard and non-standard sizes. The complete line, has just come off the press. A full page is given to the new "Filterizer" noise eliminating antenna system, an item of particular interest to Service Men because of the money-making opportunities it offers. Tube Deutschmann Corporation.

97. ARCO TUBE CATALOG. A descriptive folder giving full technical characteristics on the complete line of Arco rectifier and transmitting tubes, photosensitive cells, television tubes, hot and cold cathode tubes, cathode ray tubes, rectifiers and charger bulbs. This can be posted for easy reference. Arco Tube Company.

98. HOW TO USE NOISE REDUCING ANTENNA SYSTEM ON BROADCAST WAVES AND SHORT WAVES is the title of the latest booklet on this important subject. The A.R.P. Training Center gives the practical application of the various noise-reducing methods used for short wave, broadcast and short wave use, is also described.

A section of the bulletin is devoted to the interest of the Service Man and dealer. It tells how to set up demonstration installations which show the comparison of the new systems and the older systems by simply throwing a single pole. It details how to set up demonstration installations for increasing sales and service profits to couch the tone of these devices to new receiver buyers as well as the person who already owns a set. Lynch Mfg. Co.

RADIO-CRAFT MARCH, 1933

516
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Here's Proof

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"I can safely say that I have made $10,000 more in radio than I would have made if I had continued at an old job." Victor L. Osgood, St. Cloud Ave., West Orange, N. J.

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Victor L. Osgood, St. Cloud Ave., West Orange, N. J.

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$300 extra in 6 months

"In looking over my records I find I made $300 in my spare time in six months. My last week brought me $107. I have only one regret regarding your course—I should have taken it long ago."

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J. E. SMITH, President
National Radio Institute, Dept. 3CX
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TECHNOCRACY REVIEW

RADIO-CRAFT for MARCH, 1933
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Actual size of motor is 3" x 2" x 1 3/4". 300 rpm at 36 volts, 1 to 1 1/2 volts, to run on any ordinary dry cell. 300 rpm at 150 volts, 1 to 1 1/2 volts, to run on any ordinary dry cell. 300 rpm at 250 volts, 1 to 1 1/2 volts, to run on any ordinary dry cell. 300 rpm at 350 volts, 1 to 1 1/2 volts, to run on any ordinary dry cell.

We also supply all types of motors from 1/16hp to 1hp, up to any size the very volume or kind of current, speed and voltage desired for any application. Let us know your requirements.

Our Patented Electrical Winding Mechanism.

The striking and chime mechanisms, as well as the time movement automatic weight driven or spring driven, we cordially recommend electrically. No hand winding of any kind required.

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Send your order TODAY for what you need, or let us know what you are interested in.

Hartford Clock Co., 202 Central Ave., Jersey City, N. J.

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First shipment of parts to construct ELECTRICAL GRANDFATHER'S CLOCK. $2.00
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Radio is a highly specialized business. As it develops it is becoming more exacting in its demands. But radio is the modern field of opportunity for those who keep step with its progress and pioneer in its opportunities!

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We will be pleased to send you details of any or all of these subjects. Just mark and mail the coupon—the information will be forwarded without delay. Why not do it today—now!
ELECTRONIC MUSIC

An Editorial by HUGO GERNBACk

A NEW type of radio instrument will make its appearance within the next few years. It will doubtless be sold by the millions, and it is well to be sure that those interested in radio should be prepared for what is coming. I refer to electronic musical instruments, whereby an entirely new type of music is produced that anyone, who has knowledge of music, can play. These instruments will be quite small, and so will take up little room; in most cases they will connect with your radio set so the music will issue from the radio loudspeaker. Others will be more elaborate; probably in the form of pianos or other furniture design, with amplifiers and loudspeakers incorporated in the instrument itself. These instruments will be played by means of the usual piano keyboard, or by touching a wire-string, or even by running one finger over a resistance, similar to the instrument for the first time described in this issue of Radio-Craft.

Electronic music is not new—indeed, it was invented by Dr. Lee de Forest. The first public account of such an instrument appeared in my former publication, the ELECTRICAL EXPERIMENTER, of December, 1915, when Dr. de Forest wrote an illustrated article for me entitled, "Audion Bulbs as Producers of Pure Musical Tones." The article contains the original diagram whereby the tones were produced by depressing the key, much as we do today. Due to the imperfection of vacuum tubes, at that time, nothing much came of the idea. Years later, in PRACTICAL ELECTRICALS for March, 1924, when vacuum tubes had been greatly improved, I described an instrument of the electronic music variety which I termed the "Staccatone." This instrument I played publicly for the first time in November, 1923, over WJZ of New York. The same instrument was also used in a theater, in April, 1924, when I loaned it to Dr. Hugo Riesenfeld, who had one of his musicians play it in the Rialto Theater in New York. So much for the history of electronic music.

Last summer, in Berlin, I witnessed the performance of the first commercial instrument, the "Trautonium," invented by Prof. Trautwin of Berlin. The Germans have made great headway in electronic music, and many of their instruments have already been exported to this country. I understand on good authority that a number of American manufacturers are about to produce small and low-priced musical instruments of this kind, which may be used as an adjunct to any radio set; I am certain that we shall witness an avalanche of such instruments in the very near future.

These new electronic musical instruments are exceedingly interesting from many angles: In the first place, they may be played by anyone who can play a keyboard; second, and more important, by the mere turn of the knob (which controls resistance), it is possible to imitate anything from a piccolo down to a bass drum, all in the self-same instrument. It is possible with such instruments to obtain the pure tones resembling an oboe, saxophone, 'cello, and other tones which have not yet been heard on mechanical musical instruments.

The construction of these instruments is ridiculously simple; as a matter of fact, simpler than the usual radio set. Then, too, the price is within reason, and there are some interesting experiments that may be performed that I am convinced will soon take the country by storm, once experimenters and others have taken up this new and intensely interesting art.

Indeed, it is certain that electronic music will revolutionize the entire musical art, including the musical instrument field, during the next decade. The vistas opened to experimenters and serious constructors are tremendous. There seems to be no end to what may be accomplished by means of electronic music, inasmuch as the surface has not as yet been scratched.

Entirely new musical effects will be produced which we cannot now foresee. The production of double and triple tones, all produced in the same manner as single tones, is but one of the interesting possibilities; and, of course, by means of electronic music, all the tricks of all other musical instruments can easily be performed, namely sustained tones for any length of time, vibratos, echoes, and many other effects not as yet demonstrated, but which are sure to be perfected once a few real musicians get together with a few good technicians.

Then, too, we have the most interesting, and from a utilitarian and practical standpoint, most important point that all these electronic instruments can be played without annoying anyone. You cannot practice on a saxophone or play a piano today without disturbing other people within the house, not to say anything about your neighbors. By means of electronic music, all this is a thing of the past, because the player only has to wear a pair of headphones, and play to his heart's content from sunset until dawn without anyone, even a foot away from him, being aware that any music is going on.

But most important for the radio industry, at the present time, is the fact that these instruments can be sold for very little money. They may be attached to the owner's radio set in order to give people of small means a real musical instrument which far surpasses the piano, and has the tremendous advantage of low cost on the one hand and takes up very little space, on the other. It can, if necessary, be stored in a closet, out of sight, if not required.

And as for experimenters who are taking up this new electronic music, they will be in a paradise of their own, because there will be no limit to the number of new and novel sound effects which they will create in the very near future.
THE TRAUTONIUM: A NEW MUSICAL INSTRUMENT

A description of a simple musical instrument easily built at home by anyone. Costing but a few dollars to build, this instrument constitutes a complete unit in itself—nothing elaborate, nothing expensive. One may learn to play it in a short time, even though one is not a musician. Complete construction data is given here.

CLIFFORD E. DENTON

EVER since the vacuum tube has been used for the generation of oscillations, many experimenters have been trying to develop new musical instruments. Most readers are familiar with the developments of Theremin, who changes the pitch of his instrument by changing the capacity in an oscillatory circuit. In this instrument the pitch change is accomplished by moving the hand further from or closer to a metal rod provided for the purpose.

The accepted forms of instruments used for the production of musical tones have been with us for many years, and the major changes in them have been merely mechanical ones. Such changes have given the performer greater control of pitch, greater speed in note production, richer tone, and greater volume. New devices for the production of musical tones must offer a new conception of tone quality, scale range, and ease of tone production.

If a new instrument is to be successful and accepted as a standard, several qualities must be incorporated in its design. First, it must be easy to play; the mechanical process necessary for tone production must be as simple as possible. Secondly, the tone must be pure. Purity of tone in this case will depend upon the character of the producing device and the skill of the performer. Another angle to the requirement of tonal purity is the desire to create tones of such quality as could be easily recognized and defined by the listener. Everyone knows when a violin is being played because of its individuality. Third, the amount of volume which the instrument can produce must be ample to permit its use in an orchestra. The volume should be under continuous control of the performer so that the proper values of sound intensity may be obtained for true musical expression. Fourth, the tone color must be changeable at will (as in the organ), so that by means of color variation, the instrument will give tones with characteristics similar to the various instruments in the orchestra. By changes in the tone color, it should be possible to emulate the bass viol, trumpet, French horn, piccolo, and so on through the modern orchestra.

Fifth, it should be possible to play the standard scales of full-tones and half-tones plus the tone intervals, which, up to now, have been neglected in modern musical instrument development. Sixth, the instrument should produce all of the commonly accepted tone colors, but should be capable of new ones of pleasing sound. Seventh, the cost of the complete instrument should not exceed that of any other good musical instrument. Eighth, the instrument must not be so developed that there would be no incentive for the artist. The instrument should offer ample opportunity for the creation of pleasing tone pictures in the hands of a capable performer.

These eight requirements may seem to impose restrictions on the development of a new musical instrument, but the Trautonium seems to incorporate so many of the features desired that it may possibly be the real new musical instrument. Oscillation generation in a vacuum tube can be influenced and synthesized by the association of the proper equip-
The production of tones by vacuum tubes has been recognized as one of the outstanding methods of producing music. In presenting this description of the Trautonium, RADIO-CRAFT wishes to emphasize the tremendous possibilities for making money by building and selling such devices. They are simple, do not cost much, and represent a new idea in musical production. This is the first of a number of articles on this subject.

ment. These tones, when generated, are then capable of producing tones of varied pitch and color. These considerations have led to a new theory of "Sound Designs" which was introduced by Dr. Trautwein, of Berlin, Germany, who invented the instrument described here.

(The instrument described here is a modified form of the original Trautonium. The original has been changed so as to accommodate American tubes and American apparatus. The name "Trautonium," however, has been retained to give credit to the original designer. —Editor.)

Electrical Circuit

A study of the circuit of Fig. 1 reveals the simplicity of design. A standard feed-back circuit using an audio transformer, T1, for the coupling device as a means of oscillation production is employed. The frequency of the oscillations generated depends mainly on the time constant of the resistance used in the playing manual and the particular condenser switched into the circuit. Many experimenters have built audio oscillators following the circuit of Fig. 2. This is the same circuit as Fig. 1, only simplified, and is used for the generation of one frequency only. The frequency of this circuit is dependent on the time constant of C and R for the determination of the frequency of oscillation. In Fig. 2, with the value of capacity left constant and resistor R varied, there will be a change in the pitch or frequency of the oscillation generated. This change in generated frequency is caused by the varying time constant due to changes in the value of R.

Every one is familiar with the fact that a variable condenser connected across a coil will permit the combination to resonate at various frequencies. The same condition is found here, only the coil is replaced by a resistance.

In the case of the completed musical instrument, the condenser corresponding to C is variable over a wide range by means of the tapped switch (Sw.1 in Fig. 1), and R is varied by the changing value of resistance of the manual, R1. Thus, by the proper selection of the condenser C and the audio transformer, tones of various colors can be produced, ranging from impact tones such as from a drum beat, to the sustained tones of a bowed violin. Tone colors of the trumpet can be obtained using small values of capacity, and the simple change to a condenser of greater value produces tones similar to that of the bass viol.

Any type of tube can be used in a circuit of this kind, but the choice must be limited to any of the triode types. This selection gives the best results, and gives sufficient power output to drive a loudspeaker directly. In the model shown in Fig. A, a 30 type tube is used; and with 90 volts of "B" supply, satisfactory power output can be obtained except for the very low frequencies. If the tube is of the battery type, a rheostat should be used in series with the filament to limit the current flowing in the "A" circuit. Of course, A.C. or cathode-type tubes operating from a filament-supply transformer will not need this rheostat.

As a precaution, if the tube will not oscillate, reverse the connections to the plate feed-back coil of the audio transformer. The connections for the audio transformer are shown in Fig. 1, in which the transformer terminals are indicated in the drawing as they are marked on the transformer shell, i.e., the markings are 1, 2, 3, 4 on the diagram and the transformer.

The Playing Manual

The instrument is played by means of a manual, or key board, as shown in the photographs. This may be constructed in several ways; a simple method is shown in Fig. B in which five resistors are connected in series and held in place by means of a metal rod running through the hollow core to
hold them in place. A metal wire is held directly over the long resistance bank by means of metal brackets screwed to the base at the ends. The pressure of a finger causes the wire to make contact with the resistance strip, which, in turn, will cause a tone to be produced. The pitch of the tone depends on the resistance in the circuit and the particular choice of condenser connected into the grid circuit of the oscillating tube. Variations in the value of the resistance are caused by moving the finger along the wire will cause the pitch or frequency of the oscillation to vary. A little experimentation with the placement of the finger on the wire will show the constructor how it is possible to play a musical scale.

A playing manual of this type will not give equal spacing between tones. If a playing scale is desired that will give equal spacing between notes, then the resistance wire will have to be wound on a special form that will provide a logarithmic taper. The form of such a taper is indicated in Fig. 3.

Constructing and Wiring

Little need be said for the constructor of such an instrument as illustrated in the pictures. Everything is fastened to a baseboard by means of wood screws; Fahnstock clips are used for battery connections; and all of the parts can be assembled before the wiring is started.

It is a good idea to leave the mounting of the small panel, holding the tapped switch, until the end. This procedure will simplify the wiring, and all of the tubular condensers can then be soldered to the common connecting wire running to the terminal marked 3 on the audio-frequency transformer. After all the condensers are soldered into place, mount the panel with the switch, and solder the remaining connections.

Be sure to follow the circuit as shown in Fig. 1, as there will then be no trouble in making the instrument work. The circuit and the construction are so simple, that no one should have trouble in getting results.

The instrument as shown does not include a volume control. When the Trautonium is used with an amplifier, it will be necessary to have some means of controlling the output of the instrument or the amplifier. Most amplifiers are already equipped with a volume control of some kind, and that should suffice. If possible, the volume should be controlled by the movement of the foot, using a device as sketched in Fig. 4. Here, the volume control, suitable for the amplifier used, is mounted on a bracket. On the shaft of the volume control is fastened a wheel about three inches in diameter. This wheel is wound with cord of sufficient length, so that, as the cord is pulled down by means of the foot pedal, the volume control will rotate from the maximum to the minimum position. A spring is necessary to pull the wheel around to the minimum position again. The control should work in such a manner that with the foot removed from the control, there will be no sound.

Possibilities

Electronic devices applied to the production of musical sound should provide a new meaning to music. Sadly enough, no instrument will ever be accepted until the complete possibilities have been demonstrated in the hands of a capable performer. Time and study is necessary to develop such an individual. Study of the limitations, advantages, and the mechanical details of individualistic tone production are most important.

Though the vacuum tube has been studied for many years, little creative work has been done along the lines of musical note generation. Dr. Trautwein, in the development of the Trautonium, has taken a real step forward. His theory of sound designs or sound patterns, called Hallformant in German, opens a new field for the development of an interesting musical instrument.

There are several circuits that may be used, none of which are as simple as that shown in Fig. 1. One of the most interesting circuits uses a neon tube as the oscillation generator and incorporates an amplifier with a power output of about three watts.

A simple circuit was chosen for the first presentation of this new device in America. If there is enough interest in this new device, Radio-Craft will present the full details of one of the more elaborate designs which are capable of still more interesting tone colors and greater flexibility.

Parts List

One Silver-Marshall audio transformer, type 240, T1; One 4-prong tube socket; Twelve Fahnstock clips; One 25-ohm rheostat: type D resistors. 100,000 ohms each, R1; One Flechtheim condenser, type GB-100, 1-mf., C1; One Flechtheim condenser, type GB-50, .5-mf., C2; One Flechtheim condenser, type GB-25, .25-mf., C3; One Flechtheim condenser, type GB-10, .1-mf., C4; One Flechtheim tubular condenser, type AZ-23, .05-mf., C5; One Flechtheim tubular condenser, type AZ-50, .025-mf., C6; One Flechtheim tubular condenser, type AZ-18, .015-mf., C7; One Flechtheim tubular condenser, type AZ-17, .01-mf., C8; One Flechtheim tubular condenser, type (Continued on page 572)
THE LATEST RADIO EQUIPMENT

NEW REMLER CONDENSER MICROPHONE
A new condenser microphone of radically new design has been produced by the Remler Company, Ltd., and is illustrated in the photograph to the left. The completed unit comprises, in addition to the microphone, a complete amplifier in the same housing to facilitate its use. The parts of the unit are as follows: the connection block, known as the suspension converter, is indicated at (1); the head housing at (2); the front view of the transmitter head at (3); the complete assembly at (4); and the preamplifier between microphone and line at (5).

The completed unit has a response which is substantially flat between 40 and 10,000 cycles per second, and is equipped with a combination 50- and 200-ohm output unit.

FLECHTHEIM DRY ELECTROLYTIC CONDENSER
A new line of condensers suitable for replacement work has been announced by A. M. Flechtheim & Co., one of which is reproduced below. The unit shown is of the electrolytic type, has a screw-type base, and is either of the insulated or non-insulated type. Of course, they are made in all standard sizes. The non-insulated type is shown in the illustration.

WEBSTER MIXING PANEL
The Webster No. 104 mixing panel illustrated below provides facilities for mixing the output of either carbon or condenser microphones, and low-impedance pickups for program work. An integral part of the equipment is a two-stage battery-operated amplifier having an overall gain of 40 DB. Space is also provided for the necessary “A” and “B” batteries. The amplifier is normally equipped with type 30 tubes, but as optional equipment the type 864 may be had.

The unit is equipped with a master gain control; individual gain and current control for each circuit; and a master “on” and “off” switch.

YAXLEY FIVE-SECTION SWITCH
The Yaxley Manufacturing Co. now has available a new type of section switch illustrated below. Features of the unit are that as many sections as desired may be used, and a low-capacity insulated arm is employed. This latter feature, in conjunction with low-resistance contacts, makes this switch specially adaptable for S. W. work.

PHOTOMATIC EQUIPMENT
A simple and compact photoelectric unit designed to operate from standard A. C. lines, and known as the Photomatic Equipment has been produced by the Western Electric Co.

This unit, which, in reality, consists of two parts, is adaptable for the many uses to which the P. E. C. may be put. Details are shown below.

Panel view of the Webster mixing panel.
The five-section switch by Yaxley.
Right, the light source; and left, the P. E. C. unit. They may be separated 25 feet.

Radio-Craft for March, 1933
PHILCO REMOTE SPEAKER

The Philadelphia Storage Battery Co. has just made available an extension speaker which enables reception in any locality remote from the set. The speaker, shown below, is equipped with a volume control, and has an impedance of about 20,000 ohms, thus making it adaptable for most of the output circuits now being used. It is as large as the usual midget.

MECHANICAL RECTIFIER

A new mechanical vibrator-type rectifier suitable for operating standard transformers is now available from the American Radio and Television Corp. Among the features of the device are: (1) small space; (2) quiet operation; (3) rugged and long life.

LIGHT-WEIGHT PHONES

TELEPHONE receivers are used by many, outside of the transmitting amateur. The phones illustrated below, a product of the Acme Specialty Co., are light-weight, and are made in two types: 2,000 ohms, for the crystal sets; and 4,000 ohms, for tube receivers. Reports from users say that background noise is considerably reduced, declare the makers.

A NEW CONTROL PANEL

THE Oliver Hotel officials decided to incorporate a paging system along with their Centralized Radio systems. To accomplish this, a 20-watt amplifier was built and mounted on the panel board, front and back views of which are shown below.

By means of the switches, either the radio or microphone may be connected to the vital points in the hotel, at will. This panel is now available through the RCA Victor Co.

RADIO CHASSIS SET

A five-tube receiver using the latest tubes available has just been marketed by Radio Chassis Inc. The receiver is very small, but has been placed in a small console cabinet shown below. The chassis, known as the Model A.C. 25, is shown immediately below the cabinet, and the circuit diagram of the receiver is depicted below, at the bottom of this page. A 58 tube is used in the first R.F. stage, a 67 in the detector stage, a 56 as the first audio amplifier, and a 47 in the output stage. This receiver has unusual selectivity and sensitivity. The cabinet measures about 10 x 18 x 30 ins.

RADIO TIME SWITCH

THE New Haven Clock Co. has made available a new combination clock and time switch shown below. A red flag, seen to the right, indicates automatic operation. Referring to the left photograph, (1) is the A.C. line plug to an outlet; (2) is the hand set; (3) is the radio or appliance plug; (4) red flag lever; (5) red flag lever in operating position; (6) time "on" set; (7) time "off" set.

Complete schematic circuit of the A.C. 25 Radio Chassis receiver. All values are shown.

RADIO-CRAFT for MARCH, 1933
**ALDEN CODE PRACTICE SET**

The Alden Manufacturing Co. announces a new code practice set containing a key and buzzer on a single mounting, as shown to the right. The pitch of the note may be adjusted at will, and the screw adjusting the pitch used as a binding post for the connection of headphones. The code is engraved on the base for convenience when practicing. A fountain pen flashlight battery may be used, and the entire unit slipped in the pocket.

"PIX." THE NEW VARIABLE CONDENSER

Postal Radio now has available a unique type of variable condenser having a minimum capacity of .000005-mf., and a maximum capacity of .00157-mf., a ratio of about 40 to 1. As may be seen by referring to the illustration to the right, the unit consists of two sliding metallic tubes about three inches in length, each tube terminating in a binding post. The uses for this unit are as follows: (1) as a wave trap or volume control; (2) when one Pix is connected in series with each leg of a loop aerial, better results are obtained; (3) as an inside aerial when connected in series with a fixed condenser to one side of the A.C. line; (4) as a means of sharpening the tuning.

**EMERSON MIDGET SET**

A compact midget receiver, not much larger than a hand, has just been announced by the Emerson Radio and Phonograph Corp. Employing one 36, one 37, one 38, and one 39, this receiver is so designed as to operate from either A.C. or D.C. without the manipulation of any switches. The general principles of operation of receivers of this type have been described in Radio-Craft.

**NEW DUBILIER CONDENSERS**

Two new types of Dubilier condensers, shown below, are now available. The unit in the large sardine can, known as the "Pyranol," is made in 4 and 2 mf. sizes, and rated at either 1,000, 2,000 or 3,000 volts. They are especially designed for transmitting purposes. The small paper unit above the can is a dry electrolytic condenser of the two-in-one type.

**NEW VOLTAGE REGULATOR**

Having an absorbing power of twenty-five, compared to fifteen of its older brother, the new Amperite shown to the right is now available to all. One of the new features is the screw-type base, which allows the unit to be used in a standard incandescent base. When ordering, be sure to specify the model number of set.

**LYNCH ANTENNA SYSTEM**

Past issues of Radio-Craft contained articles on the relative merits of antenna systems with and without antenna matching transformers, one type of which is illustrated below. Such units, when properly installed, eliminate about 90% of man-made static. This percentage decreases slightly as the frequency increases—in the short-wave band—until at about 15 meters, only about 50% of the noise is eliminated. At such low wave lengths, however, it is recommended that the transposed lead-in be used.

**UNIVERSAL TORPEDO MICROPHONE**

Below is illustrated the new Universal Torpedo Microphone, a product of the Universal Microphone Co., Ltd. These microphones are completely protected, compact, and readily demountable. Connection is made via spring jacks into which telephone pins are inserted. The case is of heavy brass, chrome-plated for durability.

**DUMONT AERIAL ELIMINATOR**

The Dumont Electric Co. have developed a combination noise reducer and aerial eliminator for radio receivers, shown below. The A.C. line from the set is plugged into the eliminator, the plug from the eliminator into the line, one of the two "EXT.GND." wires to a radiator, and the other two to the aerial and ground of the set.
AND NOW—

THE FILAMENTLESS TUBE

Tubes of various types and classes have been described in this and other publications since the latter part of the nineteenth century; but, in nearly every case, the tubes described employed a filament as the primary source of electrons. Ionization of gas has been suggested as a means of securing electron emission, and a great deal of work has been done along this line in Germany. We herewith present the first complete description of an American filamentless tube, recently demonstrated in New York.

A FUBRE was created at the January, 1933 meeting of the Institute of Radio Engineers when Dr. August Hund, a member of the research staff of Wired Radio, Inc., discussed the development and demonstrated the operation of filamentless (“cold-cathode”), or ionized-gas, tubes. (Based on the fundamental experiments of Dr. Lee DeForest, nearly thirty years ago, as mentioned in the article, “Soon—The Cold-Cathode Vacuum Tube,” in the May, 1931, issue of RADIO-CRAFT—Technical Editor.) Over 1,000 engineers listened to every word of this well-known scientist and pioneer in the development of ionized-gas discharge devices. In a short address, just before the discussion of Dr. Hund’s paper by members of the Institute, Mr. R. D. Duncan, Jr., chief engineer of Wired Radio, Inc., stated that the primary interest of his company in new tube developments was in long life, because of the tremendous cost it would be for his company to service burned-out tubes in the rented receiver system they plan to install shortly in Cleveland, Ohio.

Uses of Filamentless Tubes

The experimental tubes demonstrated by the Doctor were put through the paces of oscillation, detection (or demodulation, as the Doctor chose to call it), voltage amplification, and power amplification. The tubes of the power class operated as class B, push-pull devices. Oscillations were produced by feedback circuits.

A four-tube set (contained in a cabinet of conventional design) demonstrated beyond a doubt, when music and speech of excellent quality filled the packed auditorium, that the filamentless tube can rival the filament tube in performance! (A beautiful lavender glow; sufficiently strong to permit the reading of newspaper print a short distance away, emanated from the ends of the tubes’ cathodes.) A one-tube set gave loudspeaker volume that would be sufficient for any hotel room.

An experimental tube design shown and described is illustrated in Fig. 1; a schematic circuit of a “filamentless loudspeaker set,” designed in accordance with the engineering data given verbally and via the blackboard by Dr. Hund, is shown in Fig. 2; a theoretical amplifier circuit is Fig. 3. It must be remembered that although experimental work is still continuing, commercial tubes are not yet available, and hard and fast figures cannot be given.

Two general types of tubes have been developed, one of which is a five-electrode tube that makes use of the conduction of negative ions, while the other is a two-electrode tube operating on the negative resistance principle involved in the operation of the Poulzen arc. Both types of tubes have been made to function as oscillators, amplifiers, modulators and demodulators, and several forms of amplifier tubes working on both the ionization and negative resistance principles were described, but the design of greatest interest to the average radio man is the former or “ionization” type.

The “Uniode” Filamentless Tube

In Fig. 4 we have the first blackboard illustration sketched by the Doctor. In this elementary form of tube, we have the basis of many already commercialized devices. A globe with about 10 or 20 mm. of some inert gas encloses two electrodes, a cathode A and an
anode B; a high-voltage battery and limiting resistor R complete the circuit. This resistor limits the current through the tube, which current otherwise would reach an excessive value due to the low resistance of the ionized gas.

With the battery current adjusted to a value that is not critical, we have a glow between the electrodes. The color is pink for neon, and lavender or purple for helium. This glow is thought to be caused by the collision of positive ions and electrons dissociated by the highly charged electrodes A and B.

This "uniode" tube can be made to detect, oscillate and amplify; also, relaxation oscillation has been produced from low audio frequencies to 30,000 kc. (10 meters), according to Dr. Hund. However, these two-element tubes have serious limitations when compared to the orderly working thermionic class used in our present receivers, and, therefore, it was found necessary to modify the design in order to more closely approximate the performance of filament-type tubes. At the same time, the feature of unlimited life was obtained. This modification, Fig. 5, is the introduction of a third element marked C.

How the Diode Cold-Cathode Tube Operates

The dissociation of electrons and positive ions from the rare-gas atom, as explained, makes it possible to pull great quantities of negatively charged ions and electrons to the third electrode, which is charged "plus plus" (the Doctor's terminology), or at a higher voltage than electrode B. We now have one stream of electrons and ions between A and B, and another to C. In a hot-cathode type diode tube the filament may be likened to the path A-B, and the internal plate circuit as the electron stream to C.

So far, the talk had only reviewed the work of previous investigators, continuing with the remark that as soon as a grid was put between the anode and the plate C, the grid became charged with positive ions and causes it to become inoperative. This was the starting point for the description of the structural changes which made the filamentless triode practical.

ADVANTAGES OF THE FILAMENTLESS TUBE

The type of tubes described in this article are not pipe dreams, but actually have been constructed and successfully demonstrated. While the total power required to work the tube is slightly greater than a corresponding filament tube, the extremely long life it enjoys more than compensates for this slight increase in power. Then again, the necessity for filament transformers is not present. Of considerable manufacturing importance is the comparative ease in gas pressure allowed, and the tube may even function with about 10 mm. of air alone! The materials used as the elements are not critical, both as to type and purity; a plate, for instance, may be of iron, and this iron may be either clean or rusty—the results are the same. It is expected that commercial tubes may be available in about one year.

RADIO-CRAFT takes pride in presenting a description of one type of American filamentless tube.

Construction of the Filamentless Triode

The next blackboard sketch, Fig. 6, showed the introduction of a perforated electrode in place of C in Fig. 5; the introduction of a grid D and plate E completed the representation of a triode which may be designed for any service.

The action was explained as follows: Electrons and positively charged ions from the arc between A and B are accelerated through the perforated cylinder; for purposes of explanation, only one of the small holes is shown. (See Fig. 1.)

The shielding effect of this positively charged cylinder slows the speed of the positively charged ions so that there is practically no trace of this trouble maker in the electron stream between the cylinder and plate. A grid in the electron stream now affords complete control of the operation of the tube, similar to any triode.

In order to obtain power from the tube, the entire surface of this cylinder, or "cathode," must be perforated, as shown in Fig. 3. (These holes measure about 40 mils in diam.) This gives us an electron stream second to none, not even the best of filament or hot-cathode emitters. Once the electrons are drawn through this cathode, the operation of the tube is exactly analogous to the operation of hot-cathode emitters, and the glass envelope, therefore, may contain all the additional electrodes necessary to produce a diode, triode, screen-grid quadrode, pentode, and, if the tube industry finds need for such, a septode or heptode.

By placing the grid and plate all the way around the cylinder it was found possible to take advantage of the electrons coming through all the holes; this is the controlling factor which enabled the Doctor to design almost any kind of a tube, be it for voltage or power amplification, or detection or oscillation. The corrugated appearance of the plate electrode (which very much resembles a biscuit-cutter) is explained when it is recalled that if it were not corrugated the electrons would tend to be drawn to that point on the surface of the plate which is nearest the cathode—because of mechanical asymmetry—and corre-

(Continued on page 570)
THE PENTODE "FOUR"

A description of a four tube receiver of novel design using the latest tubes. A 58 is used in the R.F. stage, a regenerative 57 as the detector, impedance coupled to a 56.

H. G. CISIN, M. E.

Once more ingenious engineers have added to the efficiency and performance of the marvelous "talking bottles," otherwise known as vacuum tubes. A number of these tube developments are included in the new Pentode "Four," described in this article. The circuit used is a simple one—a single tuned R.F. stage, a regenerative detector, and two audio stages. The first audio stage is coupled to the detector by resistance coupling, while the output stage is coupled to the first audio by a transformer.

One of the new 58 tubes is used in the R.F. stage. This tube is a variable mu, R.F. pentode, employing a uni-potential cathode with an A.C. heater. It is very efficient because its long "cut-off" feature effectively reduces cross-modulation. Modulation distortion is also reduced to a minimum, and the use of this tube eliminates the necessity for "local-distance" switches. Correct screen voltage is obtained by means of a series resistor in the high voltage (plate supply) circuit. The variable cathode-resistor method of volume control is used in order to obtain full advantage of the remote "cut-off" characteristic. A potentiometer (8) is employed for this purpose.

The regenerative detector stage utilizes one of the new 57, non variable-mu pentode tubes. The shield arrangement in the dome of this tube is an important development, in that it allows a decided reduction in output capacitance. Other advantages are the high transconductance, and plate resistance, and the sharp plate current, grid bias "cut-off," desirable and necessary for sensitive detection. In this circuit, grid-leak detection is employed, the 57 tube being connected to take the utmost advantage of its high sensitivity. Regeneration is controlled by means of the potentiometer (17).

A two-gang variable condenser takes care of the two tuned circuits. In the broadcast receiver, an antenna coupler is used at (3), while a standard screen-grid R.F. coil is employed at (11), with the secondary used as the tuned impedance and the primary as the tickler. The new 56 tube is ideal for use in the first audio stage. Instead of using a fixed resistor for the resistance coupling at (23), a potentiometer is substituted, thus permitting the inclusion of a means of tone control.

Transformer coupling is used between the first and second audio stages in order to eliminate any tendency towards "motorboating." The output tube is a pentode, having a power output of 2.5 watts. The advantages of using this tube, with its high mutual conductance and high power sensitivity, are universally recognized by set designers. A standard 80 rectifier is used, and the filter system incorporates dry electrolytic condensers. An automatic line-voltage control amperite is specified as an important adjunct to the attainment of excellent performance under all conditions of supply voltage.

The construction of the receiver will now be described. The holes are drilled for the sockets and power transformer, preferably before chassis material is bent. The wafer sockets and binding posts are mounted on the finished chassis. Mounting holes are drilled in the front chassis wall for the...
NEW CROSLEY RECEIVERS

A description of three different models of midget receivers featuring unusual cabinet designs.

WHEN the automobile industry had perfected the mechanical features of its cars to a high degree, it turned its attention towards beautifying and modernizing the car bodies. The radio industry has followed in the footsteps of the automobile industry. The avalanche of new tubes that has made its appearance during the past year has stimulated the engineering departments of set manufacturers to a point where they now produce very sensitive and selective receivers heretofore impossible with the same number of tubes. Now that the electrical and mechanical features have been somewhat stabilized, attention has been turned toward unique cabinet design.

Crosley has been the pioneer in this respect, as exemplified by their Book Case Model receiver illustrated in Fig. A. It takes but a glance at the upper part of this photograph to realize that even an expert can be fooled by its appearance. To all intents and purposes, it appears as a beautiful set of books; but, on closer examination, and by an inspection of the lower part of the figure, it is seen to be a little radio set, camouflaged so as to present a unique and dignified appearance.

The schematic of this receiver is illustrated in Fig. 1, and it is seen to be a five-tube superheterodyne—five tubes including the rectifier—of rather unusual design. It is operated from the conventional 110-volt, 60-cycle line, and employs the following tubes: a 24 as an oscillator—first detector, V1; a 58 as an L.F. amplifier, V2; a 57 second detector, V3; and 47 output tube. The 80 rectifier is seen at the extreme right of the diagram. Using this tube arrangement, it is possible to secure the high gain which is characteristic of superheterodynes, and, at the same time, obtain excellent selectivity by means of the efficient tuning circuits.

Coil L1 is the antenna coil, which is connected in series with another small coil acting as a cathode coupler to the oscillator portion of the tube. The set of coils L2 are the conventional oscillator inductances common to some types of dynatron oscillators. A feature of particular note is its inclusion of an R.F. choke in series with the control-grid lead of the 58 tube. This choke prevents parasitic oscillations from taking place, and also assists in blocking out high-frequency oscillations from V1. The 57 second detector is resistance-coupled into the 47 output tube, which, in turn, has its conventional output transformer connected to the speaker.

The following filament voltages exist: all tubes but the rectifier, 2.2 to 2.6 volts; rectifier, 4.3 to 5.3 volts. First detector and I.F. plate voltages, 250 to 270; second detector, 30 to 50; output tube, 230 to 260; rectifier, 245 to 280. The screen-grid voltage of the first detector and I.F. tubes are 80 to 110; of the second detector tube, 30 to 50; of the output tube, 225 to 285. The bias voltage of the first-detector tube is 8 to 10; of the I.F. tube, 3.1 to 3.9; of the second-detector tube, 8 to 12; of the output tube, 16 to 21 volts. The above voltages are valid when a Voltmeter with a sensitivity of 1,000-ohms-per-volt is connected in the circuit with the return lead of the voltmeter to the emitter contact. Bias voltages are measured from cathode to chassis.

The Model 148

Another type of Book Case Receiver, known as the Model No. 148, is a five-

(Continued on page 571)
TUBE REFERENCE INDEX

A description of a tube chart which enables one to tell at a glance the purpose for which tubes are designed. This chart covers over one hundred tubes in common use in receiving sets today, and will be expanded as new tubes arrive.

<table>
<thead>
<tr>
<th>Type Tube</th>
<th>Fil. Volts</th>
<th>Reference Letters</th>
<th>Socket Key</th>
<th>Type Tube</th>
<th>Fil. Volts</th>
<th>Reference Letters</th>
<th>Socket Key</th>
<th>Type Tube</th>
<th>Fil. Volts</th>
<th>Reference Letters</th>
<th>Socket Key</th>
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<td>4-1</td>
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<td>129</td>
<td>5.0</td>
<td>oP</td>
<td>6-1</td>
<td>*A32</td>
</tr>
</tbody>
</table>

PREFIXES

- d: special detector
- m: mercury vapor
- t: full wave
- v: variable mu
- h: half wave

CAPITALS

- T: triode, Tz: Double triode
- DG: Double grid tetrode
- P: pentode (suppressor grid)
- D: diode, Dz: double diode
- TP: triple grid pentode
- R: rectifier

NUMERALS

- 1: Two Triodes in a single envelope for complete class B operation.
- 2: Three tubes are voltage amplifiers only.
- 3: Two Tubes plus a Triode (Direct-Plate Triode).
- 4: Triode plus Output Triode (Triode Twin).
- 5: One Triode, Obsolete.
- 6: Two Triodes plus a Triode (Direct-Plate Triode).

TUBE MANUFACTURERS

These tubes are not made by all manufacturers. The particular manufacturer is given a key letter in ( ) under socket key; the manufacturers corresponding to the keys are given below:

(A) Aultcraft
(K) Kellogg (McCollough)
(B) Armstrong
(ER) Eveready Raytheon
(E) Eitel-Johnson
(S) National Union
(K) Kellogg (McCollough)
(F) Philco
(S) National Union
(ER) Eveready Raytheon
(P) Philco
(S) National Union
(ER) Eveready Raytheon
(T) Trumbull
(T) Trumbull
(ER) Eveready Raytheon
(AC) Ace

CLASSIFICATION OF TUBES

<table>
<thead>
<tr>
<th>DETECTORS AND AMPLIFIERS</th>
<th>OUTPUT TUBES</th>
<th>RECTIFIERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common Use</td>
<td>Filament/ Voltage</td>
<td>Tubes</td>
</tr>
<tr>
<td>Battery</td>
<td>1.1</td>
<td>X12, 864</td>
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<tr>
<td>1.5</td>
<td>26</td>
<td></td>
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<td>24A, 27, 29, 35, 51, 55, 56</td>
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<td>401, 485, 486</td>
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<td>4.0</td>
<td>38, 41, 42, 52, 67, 68</td>
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<td>5.0</td>
<td>79, 89, 295, K15</td>
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<td>6.3</td>
<td>36, 37, 59, 44, 64, 69, 70</td>
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<tr>
<td>8.5</td>
<td>KR22, Wunderlich</td>
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<tr>
<td>14.0</td>
<td>A22, A26, A28, A32, A48</td>
<td></td>
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</tbody>
</table>

www.americanradiohistory.com
The chart listed on the opposite page has been compiled and tabulated in order to assist those in the radio industry in determining the filament voltage, purpose, and socket connections of the numerous tubes now available for receiving sets. The chart is divided into two sections: the first, shown in the upper part of the chart, is divided into four columns: Type Tube, Fil. Volts, Reference Letters, and Socket Key. The “Type Tube” column lists, of course, all the tubes in numerical sequence that are in common use. The second column, labeled “Filament Volts” states the filament voltage of the tubes listed in the first column. The third column is labeled “Reference Letters,” and here is where the real value of the chart lies. The letters (or designations) are referred to the bottom of the chart and interpreted. The use of this column is better shown by an example:

Referring to the type 35 tube, we see by the second column that it is a 2.5-volt tube, and is designated vSG. Now, looking at the bottom of the chart, we see that the prefix v means variable mu, and that the capitals SG mean screen grid tetrode. The 35, therefore, is a variable-mu screen grid tetrode. The socket connections for this tube are given above as 5-2, as stated in the fourth column alongside the 35. In a similar manner, the 85 is seen to be a 6.3 volt, diode plus an output triode, a Duplex-diode triode; the d tells us that it is a special detector. The socket connections are given in 6-4, above.

Another example: What is the 79? By referring to the first table, the 79 is seen to be a 6.3 volt double triode (the double triode being indicated by the numeral 2 following the letter T.) The socket connections of this tube are shown at 6-5, and it is a special tube made by (S), which, it can be seen, stands for Sylvania. With a little practice, many of the symbols can be memorized.

The second half of the chart under the heading “Classification of Tubes” is especially useful in determining the proper tube to use with regard to filament voltage. For instance, if you want to know what tubes can be used for D.C. power operated receivers, look under the column “Common Use” until the sub-head D.C. Power is reached, and, alongside, there are listed the tubes suitable for such service, tabulated according to filament voltage. The tubes are further classified according as to whether they are detectors and amplifiers, output tubes, or rectifiers. By cataloging the tubes in this manner it is possible to determine exactly what tube may be used for a specific purpose.

Another valuable feature is the listing of the standard filament voltages in terms of the type of power they may be used with. This data is listed just under the heading “Classification of Tubes.” Heater tubes are indicated by a cathode in the socket connections.

To use the chart properly, it is necessary that you carefully examine every part of the chart and make sure that you understand the details specified.

Tube reference indices have been prepared before, but the one presented here has been designed especially for men who want to find information quickly, and who are not concerned with the technicalities of tube production dates, and the like. Once again, be sure you study the chart carefully.
BUILDING THE SHALLCROSS 651 SET TESTER

A description of a simple, efficient set analyzer suitable for all of the new tubes now available. All construction data are given.

PAUL SHALLCROSS*

THE advent of 6- and 7-prong tubes has made much radio servicing equipment obsolete, and has taxed the ingenuity of the Service Man to provide himself with modern test apparatus. To assist the Service Man to meet this problem, a new radio-set tester has been designed and is now offered to the field. This instrument employs only one meter, and yet provides all the necessary D.C. voltage and current measurements for all radio tubes now in general use, including the new 59, etc.

The device is pictured in Fig. A and its schematic circuit is shown in Fig. 1. This same circuit is used in the Shallcross models 651 and 652 testers, the only difference being that in the type 651, an 0-1 ma. meter is used; while in the type 652, an 0-1.5 ma. meter is employed. The values of resistors used for either type are given in the List of Parts at the end of this article.

For the model 651 tester, four ranges of voltages are available: 0-10, 0-100, 0-200, and 0-1,000. Three ranges of current measurements are also available: 0-2.5, 0-10, and 0-100 ma. For the type 652 tester, four voltage and four current ranges are possible; voltages, 0-7.5, 0-30, 0-150, and 0-750 volts. Current ranges of 0-3, 0-15, and 0-75 ma. The instrument, as described and shown here, may easily be assembled in a short time by the average Service Man. The result will be a light-weight and compact unit. The panel dimensions may be obtained from Fig. 2.

Switching Arrangement and Operating Data

The system of switching is so arranged that damage to the instrument is impossible if the switches are set correctly. The wiring is also so arranged that short-circuits are not possible —

(Continued on page 554)

*Shallcross Mfg. Co.
**THE WHY AND WHEREFORE OF LOW AND HIGH-RESISTANCE OHMMETERS**

A comprehensive description of the fundamental principles governing the choice and calibration of ohmmeters suitable for low- or high-resistance measurements.

**ARTHUR H. LYNCH**

It is generally appreciated by the Service Man and experimenter that the various forms of direct-current meters used in radio measurements are fundamentally the same, and vary principally in the values of the resistors used with them and the manner of connection. However, considerable confusion seems to exist in reference to the application of the principle involved.

The fundamental unit is a sensitive galvanometer—the more sensitive, the greater the elasticity of ranges. Series resistors are used to increase the voltmeter range; shunt resistors to extend the ammeter range; and either the voltmeter or ammeter, in conjunction with a known voltage source, can be calibrated to read in ohms. The interrelation of voltage, current and resistance—volts, amperes and ohms—is expressed by Ohm's Law, and if the principle is understood, any meter, regardless of type or manufacturer, may be converted for current, voltage, or resistance measurements within the limits of sensitivity of the instrument.

(A complete treatise on the use of multipliers and shunts appeared in a series of articles entitled “Magic in Meters,” by Clifford E. Denton, which appeared in the November and December, 1931, and January, 1932, issues of RADIO CRAFT—Editor)

The fundamental circuit of voltmeters is essentially the same as the circuit for ohmmeters. In the voltmeter arrangement, resistors are inserted in series with the meter and the applied voltage connected between the other terminal of the meter and the remaining terminal of the series resistor, or multiplier. In the ohmmeter arrangement, the same mode of connection is used, but the applied voltage is fixed, and the series resistance varied—this resistance being the one under test. Accordingly, it is best for the reader to review, if necessary, the fundamentals of voltmeter and ammeter connections before attempting to make his own apparatus. With the above idea in mind, the question of ohmmeters will now be discussed.

**Ohmmeters**

Figure 1 shows the fundamental ohmmeter circuit. GIV-EN: E, 1.5 volts and I, .5-milliampere. REQUIRED: resistance of Rx.

**WITH A SINGLE D. C. METER**

You can measure resistors as low as a fraction of an ohm and as large as several thousand ohms. With an additional small battery you can measure resistors up to several megohms, with ease. Calibration is easy, even without standard units.

When using the circuit of Fig. 1, care must be taken that the resistor being tested is sufficiently high so that no more than the maximum current will be passed through the meter. This precaution generally resolves itself into the circuit of Fig. 2, where Rx is a variable limiting resistor. It is usual to choose Rx so that the meter will just read maximum current with the test terminals, 1 and 2, shorted. For instance, with an 0—1 milliammeter and a 1.5-volt flashlight cell:

\[
R = \frac{E}{I} = \frac{1.5}{.001} = 1,500 \text{ ohms (max.)}
\]

This circuit is easily calibrated by calculation. Suppose, for instance, that with a value of 1,500 ohms at Rx, the meter reads full scale, indicating zero external resistance at Rx. Now if Rx is made equal to 1,500 ohms, the current through the meter will be reduced to half its value (since the resistance of the circuit is doubled and the voltage, E, is constant) and the meter will read half scale. The total circuit resistance is now 3,000 ohms. If Rx now be increased to 3,000 ohms, the meter will again be reduced to half its value, or read one-quarter of full scale; the total circuit resistance is now 6,000 ohms. If the value of Rx is now increased to 6,000 ohms, the meter will read one-eighth of full scale, etc. In this manner the meter may be calibrated to read values up to about 20,000 ohms. For values of resistances below 50 ohms, this mode of connection is not recommended, as the change in reading from full scale will be too small to permit accurate estimation.

When values of resistances below 50 ohms are to be accurately measured, the circuit of Fig. 3 is recommended. Once again, the value of R is so chosen as to cause the meter to read full scale with the test leads, 1 and 2, open—equivalent to closed in the other connection. The value of R, then, is about 1,500 ohms.

An examination of this circuit will reveal an interesting fact. If the terminals 1 and 2 are short circuit, the meter reads zero, although the current throughout the circuit remains substantially constant. Now as the size of the resistor connected across the meter—that is, Rx—is increased, the meter reading increases, which is opposite to the effect produced with the standard method of connection.

(Continued on page 555)

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*President, Lynch Mfg. Co.*

RADIO-CRAFT for MARCH, 1933
CONSTRUCTING A 40 WATT CLASS AAA, P.A. AMPLIFIER

Featuring a low cost, economically-operated, high-power amplifier in a new circuit arrangement.

LEON J. LITTMANN*

The system to be described in this article is entirely successful and can be absolutely relied upon to perform just as satisfactorily as did its considerably more expensive and bulkier predecessors with a drastic saving in tube and parts cost, etc. Let us, for a moment, compare the old and new systems, side by side, not in a spirit of "knocking" the old system, but rather to show the advancing trend in amplifier design.

System A uses two 845’s, two 66’s, two 45’s, one 56, and one 80; system B, to be described in this article, uses two 50’s, two 83’s, two 59’s, and two 56’s; the list price of the tubes for system A is $84.90, while that for system B is $23.10; the approximate wholesale cost of parts for system A is $150.00, while that for system B is $45.00; the power consumption for system A is approximately 500 watts, while that for system B is 150 watts; the approximate over-all dimensions for system A is 18 x 18 x 10 ins., while that for system B is 18 x 9 x 8 3/4 ins.; the approximate weight of system A is 90 pounds, while that of system B is 42 pounds; the rectifier plate voltage for system A is approximately 1,000 volts, while that for system B is 500 volts.

From the above comparative information, it can be readily seen that the sound-truck industry will certainly welcome the advent of this new amplifier, for it solves the problem of greater sound coverage with a minimum investment of capital. By employing relatively low plate voltages, the danger of filter condenser break-down is proportionately minimized.

The attainment of 40 watts output can, of course, also be obtained by employing six type 50 tubes accompanied by four to six type 81 rectifiers. However, it can be logically observed that there is really no merit in this procedure, for the results do not justify the means. The new 40-watt amplifier to be described may be built by any Service Man, radio technician, and amateur, and, due to its absolutely fool-proof construction and perfect stability of operation, it is especially preferable for installations where the operators have no radio or technical knowledge, as in dance halls, restaurants, stadiums, skating rinks, public schools, stores, etc. It might be well to also stress the fact that because of the comparative light weight of the equipment involved, and because of the low power consumption, (Continued on page 560)

*Chief Engineer, Coast-to-Coast Radio Corp.
THE ANALYSIS OF RADIO RECEIVER SYMPTOMS

OPERATING NOTES

W. H. MYLLKANGAS

WHAT THIS DEPARTMENT IS FOR

It is conducted especially for the professional Service Man. In it will be found the most unusual troubles encountered in radio service work, written, in a practical manner, by Service Men for you.

Have you, as a professional man, encountered any unusual or interesting Service Kink that may help your fellow workers? If so, let us have them. They will be paid for, upon publication, at regular space rates.

SPECIALIZING in servicing radio-noise interference, I have listed a few radio noise cases and other radio troubles I have serviced. I read the Operating Notes section each month, and they have come in handy many times. That is why I am reporting the following radio trouble shooting cases taken from my service files.

Reception of local stations only, and plenty of static on a Victor R35, was traced to the lead-in wire being grounded to the nail on the nail knobs. A similar complaint was reported on a Crosley 124, and the customer had been advised to move! On inspection I noticed that the antenna consisted of only a lead-in wire 25 feet long along the side of the house. In both cases, after installing the antenna properly, the customer was satisfied. Many times I have traced intermittent noisy reception to a broken window lead-in strip.

In another case, every time a Zenith model 62 was turned on, there would be a loud hum, drowning out all reception for about 16 minutes. After that the set would work satisfactorily. All readings on the analyzer were correct, however, on turning over the unit containing the power transformer and 80 rectifier, I found a mouse across the A.C. power input terminals. After removing the mouse, the trouble was eliminated.

The tone of a Zenith model A was reported distorted and noisy. On inspection, I noticed a blue glow in one of the 45 power tubes, and on test the other 45 power tube proved to be shorted.

Noisy reception on a Spartan 63 (this set uses the overhead heater tubes) was found to be caused by the heater prongs at the top of the tubes being loose.

Noisy, weak, and intermittent reception on a Stewart-Warner 801 was traced to a partly broken wire in the primary of the third R.F. coil, as shown in Fig. 1.

I had a Tom Thumb P45 which had a faint spluttering sound when the aerial and ground wires were disconnected. The noise would increase with the aerial and the ground wires connected to the set, drowning out reception. The detector plate R.F. choke coil was found to be corroded. I have also found cases where leaky filter condensers have had the same symptoms.

A Rolca model F dynamic speaker had a tendency to rattle. This was diagnosed as a corroded voice coil. A loose voice-coil winding on the dynamic speaker of a Zenith model 77 was responsible for distortion and rattle.

Low volume and a blue glow in one

(Continued on page 556)
THE SERVICE MAN'S FORUM
Where His Findings May Benefit Other Radio Technicians

AN OPEN LETTER TO SERVICE MEN

Editor, RADIO-CRAFT:

I have been experimenting for several years on various systems for the elimination of man-made static, power transformer, and power line noises. I have designed an antenna system which may be built by any radio Service Man without buying expensive transformers, etc. By the use of this system, I have been able to sell radio receivers where a dozen others have not, because of the noise. I would be glad to send any radio Service Man details of design of this new system if they will send me a stamped, self-addressed envelope.

WILLIS JUDD,
Bear Lake, Mich.

(We do not promise anything fellows, but we give you Mr. Judd's (a member of the O. R. S. M. A.) story without comment, since he has not taken us into his confidence (1)—Ed.)

A CANADIAN SERVICE SHOP

Editor, RADIO-CRAFT:

A picture of my radio repair shop may be of interest to other readers, as I like to see those of others. I am a member of the Official Radio Service Men's Association and greatly appreciate RADIO-CRAFT for the practical material which I get from it. The part I like best is the "Forum."

J. A. BELLEMARE,
173, 4e Rue,
Shawinigan Falls, Que., Canada.

(Mr. Bellemare exhibits his pride in being an authorized representative of Stromberg-Carlson by indicating his authority on his letterhead (Repre-

sentant Autorite du "StrombergCarlson"). We appreciate his commendation of our magazine and we are sure service contributors to this department will be equally pleased to know of his interest in their letters.—Ed.)

ELECTROLYSIS TROUBLE

Editor, RADIO-CRAFT:

Several months ago I found it necessary to twice replace the A.F. transformers of a Motorola radio receiver which was being used on a Puget Sound fishing boat. Of course, electrolysis had caused the primary copper to deteriorate. While the windings had been impregnated with paraffin—which should have been satisfactory—this process proved inadequate. The second batch of transformers, however, I

impressed with Marine—"Spar" Varnish. (Pratt and Lambert "61" Spar Varnish.) No further trouble from electrolysis has been experienced to date.

R. L. WOOLLEY,
3008 15th Ave., S.
Seattle, Wash.

ONE ON "RESISTANCE SERVICING"

Editor, RADIO-CRAFT:

I am passing this on to other Service Men as I think it is the strangest experience I've had in servicing radio. I was called to service a home-built radio which had excessive hum. I was told that the set had been serviced by two Service Men prior to me, but after trying everything they had turned the job down as incurable. The tubes were of the 201-A type with 171's in a push-pull arrangement and used "A" and "B" eliminators. I first started with the "A" eliminator as I thought the circuit was overloaded or in need of a high-capacity condenser across the output. When this check-up was completed the set was no better. After trying everything without eliminating the hum, I was about to pass the verdict of the Service Men and say "incurable," when I noticed that the chokes were of the unshielded type, and were wrapped with friction tape—which didn't look like a factory job! The owner said he put it on to strengthen it, but on taking it off I found the real trouble; the coils had been wrapped securely with a layer of bell wire and the protruding ends twisted and soldered together! On clipping the ends, the hum disappeared entirely.

It was a perfect job mechanically but not electrically. The extra winding, shown dotted in Fig. 1, acted as a shorted winding of a transformer, thus greatly reducing the chocking effect of the chokes.

W. MARSHALL,
38-39 27 St.,
Long Island City,
N. Y.

(again the Radio Detective "clicks"; and the moral: "Don't take anything for granted." This fault, reported by Mr. Marshall, although very unusual, serves as an interesting ex-

(Continued on page 556)
IMPROVING HOME RECORDING IN RCA, G.E., AND WESTINGHOUSE SETS

Thousands of RCA, G. E. and Westinghouse receivers have been sold which have home-recording facilities as part of the receiver. Many owners of such sets are not satisfied with the results of the recordings. In this article, the author describes the changes which should be made to improve the quality of reproduction.

H. FRED PITZER

While home recording has been featured on many radio sets for the past two years, there are certain faults, the correction of which will result in a gain in sensitivity and fidelity. The original home recording instruments of two years ago were very deficient in these qualities, and the comparatively poor home-recording matrices added to their inefficiency. In those days home recording was considered as a toy; today, however, recording has passed this toy stage, as is proved by the widespread use of these instruments.

The main differences between the old instruments and the new and the best methods of adapting the newer microphones to the older radio sets are outlined below. The machines of two years ago, incorporating home-recording, were the RCA 86, the Victor 57, and the G.E. and Westinghouse sets, all of which used a single-button microphone. The first improvement which should be made upon these sets—all basically the same—is the substitution of a two-button microphone for the single button. Referring to Figs. 1A and 1B remove the old microphone transformer and replace it with one of the newer type (RCA part No. 7312). Fig. 1B should require little explanation as it is made sufficiently clear in the diagram. The two outside terminals of the primary of this new transformer are connected to the two microphone buttons; to one of these outside terminals is also connected the ungrounded lead from the pickup (the other terminal is grounded), since this transformer acts as a phonograph input transformer. Return leads for the microphone and pickup are provided by connecting the center of the primary to ground as shown in Figs. 1A and 1B. It is possible, and in some cases necessary, to ground this center terminal directly instead of by means of a jumper as shown, and to connect a one megohm resistor between the grounded shields of the secondary and ground. Means of providing connections for the new mike may be obtained by replacing one of the needle cups with a three-prong socket, which being done, it follows that some method of disconnecting the mike current must be provided when the mike is not in use. In the case of the RCA 86, 6-90, the Victor 57, and their corresponding models, this is easily accomplished by removing the wire from terminal No. 9 on the control switch. This wire, the only black-with-yellow-tracer wire connected to this switch, is the fifth one below the shaft end of the switch. Investigation shows that with this wire removed, the switch will make the same (Continued on page 537)

Fig. 1
At A, schematic and at B, pictorial view of the new microphone transformer. At C, the terminal block.

Fig. 3
Diagram showing the completed change to facilitate the use of a two-button microphone.

Fig. 4
Schematic circuit of the system without the presence of the switches. This circuit shows the connections when the switches are thrown for microphone use.

Fig. 5
Schematic circuit of the tone-control circuit used in the RCA, G.E., and Westinghouse receivers. The circuit may be opened at the point indicated and the additional control circuit, shown dotted, inserted for better quality.

Fig. 6
The resistor and condenser shown may be connected in the circuit to obtain better quality on low volume in these receivers. This change was brought about by complaints that the set distorts on low volume. Incidentally, some of the changes recommended will also improve reception when used on "radio."

RADIO CRAFT for MARCH, 1933
**SHORT CUTS IN RADIO SERVICE**

**Prize Award**

**D. C. SETS ON A. C.**

J. H. Blanche, Jr.

In the past few months I have had a number of D. C. sets to service, and not having D. C. at my disposal, I decided to make my own outfit. The schematic circuit is Fig. 1. Although this outfit does not furnish enough current to test the D. C. sets that have a heavy current drain, it has, however, served my purpose for the majority of the D. C. sets I have serviced lately. Another use for this outfit, which has been of even greater advantage to me, is the testing of noisy transformers, R. F. coils, choke and field coils, resistors, and condensers. Often, sets have parts which are breaking down and cause static-like noises when the set is in operation, although when these parts are tested with a continuity test meter the defect is not located.

The following test has never failed me, using this outfit, which I use as a continuity tester by simply placing a good grade phone and a pair of test leads in series with the 110 volts D. C. The slightest breaking down of a transformer, for instance, will not show up with a battery and meter test, but will show up in the earphones in my D. C. test as a crackling, static-like noise.

I constructed this outfit at absolutely no cost to me, as I used only spare parts that I had in the shop. The average repair shop will, likewise, in many instances, have enough spare parts to make this outfit.

The parts used in making this D. C. outfit are as follows: Two rectifier units from RCA model 105 speaker; one (choke coil) filter reactor from RCA model 18 power pack; one 20 mf. condenser from RCA UP972 "A. C. Package" condenser bank; three 2 mf. condensers in parallel (RCA 20, 25 or 28 bypass condenser); one A. C. receptacle (to plug in D. C. sets); four binding posts for test leads and phones; one A. C. input cord and plug; one mounting panel, a few feet of wire, a few screws and the like.

Note that the RCA 18 power pack filter reactor is composed of two choke coils. I found that the hum is practically eliminated and the purpose best served by using only one with the highest resistance. However, any good audio choke coil should serve the same purpose as well as other parts such as those mentioned above. All the parts can be mounted on a board. An A. C. switch can also be placed in the A. C. line if necessary. A D. C. 150-volt range meter can be used instead of the earphones for average continuity and low-resistance tests.

**HOME MADE ANALYZER CABLE**

Mike Fedorchak

Not having on hand a six wire cable, and not being able to buy one in town, I improvised one for my analyzer by using a pair of high top shoe laces in the manner illustrated in Fig. 2.

By cutting off the tips, it is possible to work the laces over six lengths of No. 18 stranded insulated wire, each lead being about 30 inches long.

**DYNAMIC SPEAKER CONE REPAIR**

S. E. Atcheson

Cones of dynamic speakers of the type using a solid piece of fabric for the center support often become flimsy at this "spider" that not only is the tone quality impaired but the centering screw will no longer hold the cone in a central position. This may be remedied by removing the cone and voice coil from the speaker and applying a small quantity of any celluloid-base household cement, as shown in Fig. 3, being careful to get the cement in the seam between the voice-coil form and the fabric of the cone. A small quantity of the cement may also be smeared over the whole center supporting section. This cement dries quickly and leaves the center of the cone strong and flexible. It is also a good idea to use a felt washer under the supporting screw and washer, and between the cone center and the cone pole-piece. (Some manufacturers supply these to their dealers without cost.)

**IMPROVING THE FAULT-FINDING ADAPTER**

Louis B. Sklar

Most Service Men are familiar with the fault-finding adapter which opens the plate circuit of a tube and connects a pair of headphones in series; to obtain detection, most of these adapters use a switch for connecting a grid-leak and condenser in the grid circuit of the tube. As this introduces a considerable change in the operation of the tube, particularly as regards the tuning of the circuit, the writer submits the stunt illustrated in Fig. 4. Thus, the plate circuit of the tube, whether it is an R. F. detector, or A. F. unit, is controlled, as regards the plate voltage for detection, by the adjustment of resistor R.

**IMPROVING THE ANALYZER PLUG-ADAPTER**

Walter H. Rice

Here are two ideas which may be applied to increase the usefulness of the Na-Ald analyzer plug and adapter used on the Weston 666-3 and other set analyzers. Every Service Man having trouble with this type of analyzer plug separating from the adapter when being removed from a UX socket will welcome the first idea as it makes the lock positive in action, saving much time and inconvenience.

A small fiber bushing is made to fit snugly into the hole molded in the base of the plug to receive the prong on the adapter, as shown in Fig. 5. (A small amount of "radio" cement may be used in addition to the snug fit to hold the bushing permanently in place in the analyzer plug base.) The bushing is drilled for a loose fit on the adapter prong and should be as long as the base is thick at the hole. The bushing should not be pushed in so

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$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 Wrinkles 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, at 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.

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W. B. RYAN
far that it will bind the lock. A three-cornered file is used to make the groove on the adapter prong slightly deeper on the side the plug lock engages.

In many sets this control-grid lead is not long enough to reach either cap on the analyzer plug, especially when analyzing UV tube circuits. To replace this “missing link” I have made a simple extension from a length of threaded brass rod, a length of fiber tubing, a brass binding-post base and a National Grid-Grip. As an alternative, a similar extension may be made from a screen-grid tube cap, a short length of wire or rod, and a Universal clip.

THE PERFECT ALIGNING TOOL

M. J. Rebennack

BALANCING wrenches and fiber screwdrivers to fit the various makes of radio sets are rather expensive and hard to secure. However, you can, with a little careful work, make four tools which will take care of almost any set now in use.

Secure four large Sparton fiber wrenches, cut as illustrated in Fig. 6. Fiber screwdriver A contains no metal and is used in aligning the oscillator section of Silver-Marshall and other superheterodynes (It is also used to adjust the antenna trimmer on all Spartons), while B is a handy size for aligning gang condenser trimmers and, on RCA 60 series, the antenna compensating and oscillator trimmers.

Wrench C is for Majestics and Spartons. The reason for filing down C and D is that the Majestic has a rather small hole in the condenser shield and the chassis.

Tool D, with its long shaft, can be used on almost any other sets.

ANOTHER METERLESS TUBE TESTER

P. J. Frechette

For the beginner or Service Man who wishes to make all of his equipment, here is a suggestion whereby he can test power tubes and rectifiers. By referring to Fig. 7, the simplicity becomes apparent.

Tubes plugged into the socket will give the following indications if they are good:

- Tube
- Lamp
- Lamp
- Type
- No. 1
- No. 2
- 10
- Dull Red
- Dull Orange
- 80
- Dull Orange
- Dull Orange
- 81
- None
- Dull Orange
- 45
- Dull Red
- Dull Orange

The lamp filament in tube should glow cherry-red; if the tube is shorted, lamp No. 1 will be bright. Other tubes may be tested in this manner after a few experiments and tests.

The following parts are necessary:
- One 6-volt battery or suitable D. C. source; one 2.5 amp. power rheostat.
- One UX socket; two 110 V., 10 W. lamps; two lamp sockets; two 45 V. "B" batteries or an eliminator.

CONTINUITY TESTING BY SOUND

John Malicharek

Much time can be saved when testing for continuity and shorts, by having a foolproof "sound" indicating device, as illustrated in Fig. 8, making it unnecessary to look at the meter each time a test is made.

A relay unit taken from a discarded Philco "A-B" unit, or other old eliminators, is rewound to about 2,000 ohms, and is wired in series with the test prods, "B" supply source, and milliammeter. The other circuit is made by using only one set of contact points.

(Continued on page 588)
Radio Service Data Sheet

CAPEHART MODELS 200 AND 300 DE LUXE 11-TUBE AUTOMATIC PHONO-RADIO

[Visual tuning meter; phono. pickup pre-amplifier; tone control; silent-tuning control; automatic record-changer; delayed A.V.C.; superheterodyne circuit.]

The Model CK chassis incorporated in this automatic record-changer has phono pickup and superheterodyne radio receiver combination, manufactured by The Capehart Corporation, is produced by Howard Radio Corp. as their Model K chassis, the "C" designation indicating that the circuit has been modified by the Capehart concern to include a separate tube, V10 in the diagram, as a phono pickup pre-amplifier. The "200" uses a Jensen 12 in. 0.6 ohms; speaker and the "300" a 14 in. "Maxitone," and the cabinets and record changers are different. The sensitivity is 6 microvolts-per-meter; undistorted power output, 8 W., and power consumption, 142 W. (set, 115 W.; motor, 17 W.; cabinet light, 10 W.).

Tube Fill Cath. S.G. Sup. G. Plate

<table>
<thead>
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<th>No.</th>
<th>Volts</th>
<th>Volts</th>
<th>Volts</th>
</tr>
</thead>
<tbody>
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<td>99</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>2.5</td>
<td>7</td>
<td>90</td>
</tr>
<tr>
<td>3</td>
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</tr>
<tr>
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<td>7</td>
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</tr>
<tr>
<td>12</td>
<td>7</td>
<td>7</td>
<td>160</td>
</tr>
</tbody>
</table>

Voltage indicated at a line potential of 110 V. All readings taken between tube element and chassis with R3 in the least effective position.

The receiver chassis incorporates a special A.V.C. circuit so that at low signal levels the A.V.C. is inoperative, due to the high bias on the grid of V10, and only when the received signal exceeds 50 microvolts input does the A.V.C. circuit operate, after which point it holds the output of the receiver substantially constant up to an input as high as 4 volts. During the condition of "no signal," there is no current flow through R11, R12, and therefore the control-grid of V9 has zero potential, causing a large current to flow through R16, producing a blocking potential on the control-grid of V5. During the condition of "signal," V8 operates and develops a voltage across R11, R12, and applying a negative potential on the control-grid of V9, reducing its plate current to zero, thus reducing the control-grid potential of V9 to normal. (For more positive noise suppressor action the control-grid and suppressor-grid of V8 are tied together.)

Use a low value of service oscillator output in realigning the circuits to counteract the apparent detuning effect due to the action of the A.V.C. circuit. Padding condenser C4 is accessible through a hole in the upper part of the variable condenser shield can. Transformer color code: winding X, X, (3.5 A) blk. & maroon: Y, Y, (1 A) and Z, Z, (5 A) yel.
HOWARD MODEL M "TRIPLEX CONTROL" 4-TUBE SUPERHETERODYNE

In the Howard Model M 14-tube superheterodyne, manufactured by Howard Radio Co., are incorporated several new circuit details with which the author, Service Master, has become acquainted. Use of a "triplex control" circuit in this set results in improved performance, in the reduction of station background noise, and sensitivity and inter-station noise suppression, over the "duplex control" Model K chassis.

The following tube voltages are used in this set:

<table>
<thead>
<tr>
<th>Tube</th>
<th>FIL.</th>
<th>Cath.</th>
<th>S.G.</th>
<th>Sup. G.</th>
<th>Plate</th>
</tr>
</thead>
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<tr>
<td>V1</td>
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<td>80</td>
<td>2.7</td>
<td>190</td>
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<tr>
<td>V2</td>
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<td>4.5</td>
<td>80</td>
<td>100</td>
<td>160</td>
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<td>V3</td>
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<td>80</td>
<td>100</td>
<td>145</td>
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<td>V4</td>
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<td>80</td>
<td>60</td>
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<td>120</td>
<td>158</td>
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<td>160</td>
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<td>16.5</td>
<td>50</td>
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<tr>
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<td>16.5</td>
<td>50</td>
<td>160</td>
<td>207</td>
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<tr>
<td>V10</td>
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<td>160</td>
<td>207</td>
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<td>V11</td>
<td>2.5</td>
<td>10.0</td>
<td>50</td>
<td>180</td>
<td>185</td>
</tr>
<tr>
<td>V12</td>
<td>2.5</td>
<td>7.0</td>
<td>50</td>
<td>120</td>
<td>180</td>
</tr>
<tr>
<td>V33</td>
<td>6.3</td>
<td>8.0</td>
<td>3.0</td>
<td>180</td>
<td>374**</td>
</tr>
<tr>
<td>V44</td>
<td>5.0</td>
<td>15.5</td>
<td>3.0</td>
<td>180</td>
<td>374**</td>
</tr>
</tbody>
</table>

(Voltages indicated at a line potential of 115 V. *Switch Sw. 2 closed. **Read between V13, V14 chassis.)

The values of the components used in the Howard model M receiver chassis are given below:

Resistor R1, tone control, 1½ meg.: R2, R6, R8, R10, R11, R12, 2.0-meg.; R5, 2,000 ohms; R7, 1,000 ohms; R9, R12, 600 ohms; R14, R17, R28, 30,000 ohms; R15, 155 ohms; R16, 2 meg.; R18, R19, R27, 0.1-meg.; R28, 50,000 ohms; R21, R23, 10 ohms, center-tapped; R22, 15-meg.; R23, 5,000 ohms; R24, 5,000 ohms; R26, 30 ohms, center-tapped; R29, R30, R31, 2,000, 3,700 and 3,900 ohms, respectively, and on one resistor unit. The field coil has a resistance of 300 ohms.

Condensers C1 to C3, tuning units: C1A to C3A, trimpots; G4 to C7, C18, C1F. Trimmers: C8, C11, 001-mf.; C9, 1 mf.; C16, 0.002-mf.; C12, C13, C17, C24, C25, C27, C28, C29, C31, C32, C38, C39, 0.1-mf.; C14, C16, C19, C20, 8-mf.; C21, C28, 65 mf.; C26, 0.000153-mf., padding condenser: C30, 0.5-mf.

Pilot lights V15, V16 connect to winding X, X on the power transformer, PT.

A red-lead 0.5-mf. condenser, in the same can as with the blue-lead unit, C9, but not shown in the schematic circuit, bypasses the plate current supply to V5. An 11-section condenser block includes the following condensers: C12, C13, C14, C15, C17, C19, C24, C28, C30, C31, C32. The color code is as follows: brown, 0.1-mf.; green, .05-mf.; red, 0.6-mf.; all are rated at 200 V, as are condensers C25, C27, C29, C33.

To gain the I.F. circuits, disconnect the control-grid cap on V2 and connect the 175 kc. oscillator between the control-grid and ground (chassis); then, by means of either the ear or a meter connected across the voice coil or plate circuit output stage, adjust trimmer condensers C4 to C7 for greatest output. Make the input signal as small as possible in order to eliminate the apparent detuning condition met with due to the operation of the A.V.C. system.

Due to the fact that the silent-tuning circuit (S.T.C.) and automatic volume control (A.V.C.) system constitute a tuned unit, it will be necessary to tune the plate circuit of the type 55 "triplex control amplifier," V10, and also the tuned circuit which is associated with the type 55 tube, V12. This circuit can be readily tuned to correct resonance by use of the 175 kc. oscillator operated at the low input to the first-detector grid, V2. All that is necessary is to first tune the plate circuit of the "triplex control amplifier," V10, until the tuning meter needle swings the greatest distance to the right. Next, tune the suppressor or type 55 tube, V12, circuit until the meter swings to the greatest distance toward the right. It may be possible that both circuits are exactly in tune so that any additional adjustment of these two tuned circuits will not effect the meter swing.

Be sure, when making this adjustment, that you nump on switch Sw. 2 associated with resistor R2. If this switch is not thrown to the "on" position, the meter will not operate because switch Sw. 2 opens the cathode circuit of V15 and the plate current will flow (unless V12 is gassey).

If it is not possible to obtain a sufficiently flat-topped voltage in the oscillator to "gain" this "triplex control" system, you can rotate the knob of R2 further to the right, when you will note that the meter needle swings away from the zero or maximum right position, and when this condition is obtained, you can again check the tuning of the two tuning circuits until the maximum right swing of the needle on this meter. If your input signal from the oscillator is excessive, as previously stated, with the minimum right rotation of R2, you will note that when tuned to a station or to your service oscillator, the tuning meter swings to the full right position, and in such a position you cannot tune the noise-control circuits. Be sure, when tuning these circuits, that either your input signal from the oscillator is as small as possible, or if this is not obtainable, rotate R2 to the right until the meter swings away from the zero or maximum right position. The tuning of these two circuits is simple if you take precautions referred to above, and if these two circuits are properly tuned, you will note that by snapping Sw. 2 the inter-station noise will disappear and you will have quiet operation between stations. This tuning operation, when correctly done, increases the apparent selectivity of the receiver and provides a beautiful operating receiver which embodies the latest development of the "duplex control" feature of previous Howard set models.

The output of V5 is fed to the parallel push-pull circuit through a step-up transformer T1 with a ratio of 2:1.

Associated with the plate circuit of the "triplex control," or S.T.C. and A.V.C. pre-amplifier tube V10, are three coils, L4, induc- tively coupled to each other. The first coil, A, is merely a coupling primary in the plate circuit of the pre-amplifier, V10; the second, B, provides voltage for the rectifier system of V11 in the A.V.C. circuit; the third coil, C, provides the noise-suppression voltage on the control-grid of the second-detector, V6, through the medium of the voltage drop across resistor R23 in the plate circuit of the S.T.C. tube V12.

In the event that is necessary to realign the R.F. circuits, connect the service oscillator to the antenna and ground post of the set and tune the oscillator to 1,600 kc. Adjust the set dial to this setting and align the trimmers, starting with C24, then C14, and then C1A. It is necessary to align the padding condenser C26 at 600 kc. It will be necessary to go through the adjustment process in order to get alignment of the high-frequency trimmers again. Condenser C26 is accessible through a hole in the upper part of the container which shields the variable condensers.
A SURVEY OF THE VACUUM-

A detailed article dealing with the construction of various types of vacuum-tube voltmeters suitable for various classes of service. An important article for the up-to-date Service Man. V. T. Voltmeters may be used as output meters in lieu of the more general types of rectified meters. A comprehensive review of the applications of vacuum-tube voltmeters was contained in a series of articles which appeared in the May, June, August, 1932, and the January, 1933, issues of RADIO-CRAFT, by Beryl B. Bryant.

C. H. W. NASON

THERE is probably no instrument better adapted to the uses of the radio technician than the vacuum-tube voltmeter. It is a device which can—when understood thoroughly—be flung together hurriedly for some shop measurement when a special instrument is required; when made up in portable form, it can be used as an output meter by measuring the voltage developed across a known resistance, or to accurately measure the source of overloading in a radio receiver.

The simplest form of tube voltmeter is that shown in Fig. 1, where a simple diode, made by connecting together the grid and plate of a three-element tube, may be employed to measure the voltage input to the tube in terms of the plate current passed. Such an instrument is of value only in cases where the loading effect of the tube input circuit does not affect the circuit under measurement; that is, to say, the device shown could well be used as an output meter, but could not be employed across the input of a vacuum tube because of the loading effect which would destroy the accuracy of readings.

A Simple Tube Voltmeter

As an example of the simplicity with which a device of this character can be made and calibrated, refer to Fig. 2. Here a 20 tube—the old output tube which was companion to the 99—is used in conjunction with two inexpensive meters to form a simple, accurate, and effective measuring device having negligible loading effect in all audio-frequency circuits. For R.F. measurements, a more complex device is required. The meter shown has been used by the writer without variation for the past few years in some hundred or more measuring arrangements. It has done duty in conjunction with a standard signal generator in the laboratory, and as an output meter or resonance indicator on the test benches in a number of manufacturing plants where a compact instrument with a fair degree of accuracy was required.

The calibration chart in Fig. 3 comes from the writer's notebook and is characteristic of the device. Without doubt, it will serve quite accurately for a similar instrument should the reader not be in a position to obtain an accurate calibration. This is the simplest form of V.T. voltmeter for use in all-around measurements in service, repair, and test of radio receivers. A pair of 4.5-volt "C" type batteries in parallel will serve for filament supply over a long period, while the "B" and "C" batteries will last indefinitely. A periodic check of the calibration is, of course, necessary when it is desirable to have accurate readings. Where the device is required only as a resonance indicator in the alignment of receivers, no such periodic check is required.

R.M.S. and Peak Voltmeters

The average A.C. instrument gives R.M.S. readings; that is, the values read are the root mean square values of the sine wave. Calibration of such meters is carried out with a potentiometer and a transformer in conjunction with an A.C. voltmeter of known ex-

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Fig. 1
A simple V.T. voltmeter circuit suitable only for low-impedance circuits. It is illustrative, however, of the fundamental principles.

Fig. 2
A simple, practical V.T. voltmeter. A tube, a few batteries, a meter are all the apparatus required to complete this versatile unit.

Fig. 3
A calibration curve of the V.T. voltmeter illustrated in Fig. 2. This meter will read voltages up to about 15, very easily. A 20 is used.

Fig. 4
A simple circuit for calibrating the V.T. voltmeter. For every reading of the A.C. meter, a corresponding reading of the V.T. voltmeter is taken.

Fig. 5
Schematic circuit of the "peak" or "side-back" V.T. voltmeter. Peak voltage is determined by the change in bias required to maintain a steady deflection of the milliammeter.

Fig. 6
A V.T. voltmeter suitable for the measurement of high voltages. This meter is known as a "Reflex" voltmeter, and is good to about 25 volts.

Fig. 7
Calibration curve of the Reflex voltmeter illustrated in Fig. 6, to the left.
The Vacuum-Tube Voltmeter In Service Work

Many Service Men use the V.T. voltmeter in lieu of output meters. Thus, it becomes one of the most useful test instruments available. It has the added advantage of being able to measure voltage across high-impedance circuits—something the output meter cannot do. It is economical and reliable.
**Prize Award**

**A HOME-MADE PANEL CUTTER**

*E. F. Houser*

**EXPERIMENTERS** often have use for a circle cutter. As it is rather difficult to make an adjustable circle cutter, the simplest solution is to make up "fixed" cutters of various sizes, as they are required, until a complete kit of assorted sizes is available. A very satisfactory design for a home-made tool is illustrated in Fig. 1.

Cut a piece of heavy gauge iron, \(\frac{3}{4}\)-in. larger in dia. than the size of the desired hole. Now, determine the exact center of this sheet and scribe a circle exactly the size of the hole to be cut, and then drill a \(\frac{3}{4}\)- or \(\frac{1}{2}\)-in. hole in the center for the cutter-guide. Finally, solder a strip of light-gauge iron \(\frac{1}{4}\)-in. wide to form a complete circle on the line scribed as the desired hole size, flowing the solder from the outside surface of this strip to the periphery of the heavy plate. The result will be as shown at "A" in Fig. 1.

Next, cut a hack saw blade the exact length necessary to fit tightly inside the "cup" made by the \(\frac{3}{4}\)-in. strip; the edges of the blade must butt tightly. The teeth of the blade must point in the direction of rotation.

Now fit the cutter-guide (a small drill) snugly into the center hole, permitting it to extend \(\frac{3}{4}\)-in. below the level of the hack saw blade; leave sufficient length in the other direction for the drill chuck to grasp firmly. Accurately align this cutter guide so that it is at right angles to the heavy plate and flow solder into the cup so blade and guide are held firmly in position. Now drill two or three holes in the heavy plate for removing the discs due to cutting circles, and the tool is complete. However, some constructors may wish to cut a circle from a thin piece of fibre, permitting this disc to remain inside the blade where it may be held in position with flat head bolts to act as a re-enforcement and anchor of the blade.

**"DRESSING UP" THE COUPLING CHOKE**

*J. K. Hallaway*

**LAST year an article was published in** Radio-Craft entitled, "Pentodes and Their Use." Since then I have had occasion to couple magnetic speakers to pentodes. Although in all cases a 30 hy. choke has furnished the proper reactance, the greatest difficulty encountered was to find some way to attach the choke. The chokes were generally from old eliminators and looked pretty bad when stuck up on a neatly arranged sub-panel.

I solved the problem by placing the choke and uncased condenser in a cocoa can, and filling the remainder of the can with "compound" as shown in Fig. 2. (The can had been drilled to allow an opening for the four leads.) This makes an output unit that may be painted to match the chassis, with choke and condenser enclosed in one container. Attachment lugs may be soldered to the can in any position.

**AN IMPROVED REGENERATIVE CIRCUIT**

*Irving Gottlieb*

In constructing a short-wave set, I found it difficult to make it oscillate smoothly over the entire band when using the conventional tickler coil for regeneration. As a remedy to other fans who are troubled in this respect, I suggest the circuit in Fig. 3, which will oscillate smoothly over the entire band providing the phones or primary of the audio transformer are not by-passed.

This circuit is a good basis for an all-wave set because there is no critical tickler inductance to be tapped. (Here you are, fellows. A simple regenerative circuit which at first glance presents no new feature: however, here is where Mr. Gottlieb, who is only 12 years of age, puts one over on the fellow who jumps to conclusions. Since the headphones [or the primary of a transformer] form the necessary common coupling between the grid and plate circuits, thus producing regeneration, the author does not need a tickler coil or variable condenser method of control, instead, he uses a resistor. Then, by coupling the antenna through a condenser C2 in the usual manner, he is able to accomplish two results. First, even regeneration over a very wide tuning range; and second, a tuning circuit which requires only one inductance. We are sure that many experimenters will want to apply this idea in the construction of all-wave receivers, A. F. modulated R. F. oscillators, and other devices where it is desired to operate with a minimum number of coils.—Technical Editor.)
$5 for a Practical Radio Kink

As an incentive toward obtaining radio kinks 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.

GANGING PILOT MIDGET CONDENSDERS

W. C. Stevens

While using two Pilot midget condensers in parallel, it was decided to gang them in order to eliminate one control. It was found that the rotor plates could be removed from their shaft in a single unit by simply holding them and turning the shaft counterclockwise. It will be seen from Fig. 4 that the rotor unit is threaded at just one end.

Now in order to gang the condensers, the end nut of condenser No. 1 is removed, and the rotor unit of condenser No. 2 is screwed on in its place, and a drop of solder used to hold them tight. (It may be necessary to file the ends slightly in order to make the plates line up.) Next the stator plate screws of condenser No. 1 are replaced by screws long enough to hold the added plates of No. 2. In this way it is possible to make a very neat condenser of almost any capacity.

It would also be possible to tune two separate stages by using a suitable tapped and threaded insulating shaft between the two rotor units and using insulating washers between the stator sections.

"A NUTTY" TOOL

D. Barry

The writer is so well pleased with the little tool illustrated in Fig. 5, that he is passing on a description of its construction.

Just solder little fins of spring brass to a piece of hexagonal brass rod (countersunk to accommodate the screw ends). It will be necessary to file down two of the surfaces at one end to hold the smaller size nuts. This is certainly a great little jigger for holding nuts until they engage a screw thread.

A LEAD PENCIL TEST PROD

A. R. Eggensperger

Here, fellows, is a chance to use that old lead pencil that has been parking in the way; just solder a wire to one end of it as shown in Fig. 6 and you have a very nice test prod.

Some experimenters may prefer to solder a phone tip to the end in place of the needle, thus making it convenient for connection into tip jacks.

AN S-W. COIL MOUNTING

Doyle Witgen

Perhaps some "wind your own" fans have had difficulty with the problem of mounting short-wave coils on tube bases in such manner that they may easily be changed without disturbing the windings. A good form of construction used by the writer is illustrated in Fig. 7.

SPEAKER KINK

B. L. Woolley

I recently found it necessary to widen the armature gap of a Philco balanced-unit speaker. The unit was being used as an extra extension on a very powerful set, and, for this reason, the armature chattered. Fig. 8 illustrates this speaker kink. This is all you need to do: place a piece of cellophane between each pole-piece spacer, as shown; this permits a greater armature swing.

AN EMERGENCY TAP SWITCH

M. C. Clapp

Some time when you feel a creative urge and lack a tap switch, dig into your scrap box and resurrect a rheostat, remove the resistance wire, notch the fibre strip, and re-wind with copper wire, in the manner illustrated in Fig. 10. (Continued on page 559)

RADIO-CRAFT for MARCH, 1933

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A SEQUEL TO "MORE NEW TUBES"

Editor, RADIO-CRAFT:

Since the publication of my letter, suggesting the need for a line of heater-type tubes, designed for use on 1 ½-volt circuits, (See page 238 of the October, 1932 issue of RADIO-CRAFT.) I have received considerable correspondence pertaining to this subject. Inasmuch as it is impossible to answer all who have expressed interest in the subject, I will do the next best thing, and respectfully submit the following, trusting that this statement will clarify the situation in the minds of many who are interested but who do not quite grasp the situation.

There are three groups of people who have expressed themselves with regard to my suggestion; one group, and it leads in numbers, includes those who are experimentally inclined, and also numerous amateurs who operate short-wave stations, who are forever investigating and learning something new from time to time. This group has expressed itself as being decidedly for the proposal.

A second group includes a number of men engaged in service work who wonder why any more tubes should be thrust upon the market. Their viewpoint seems to quite overlook the fact that there are thousands of persons engaged in experimentation, research, and investigation (the very people, in fact, who have made radio what it is today) who have, undoubtedly, a very definite use for such a line of tubes. These Service Men recognize the fact that there are altogether too many voltages for which receiving tubes are designed, and I thoroughly agree with them; but, even so, many "servicers" could use some 1 ½-volt tubes.

The third group of people represent the minority in number, however, their inquiries indicate a considerable amount of interest in the subject and many asked for further information as to just why a 1 ½-volt line of tubes, instead of some other voltage, was outlined. By way of directly answering them, and also to make my own point clearer, I desire to say that the most common, and easiest to obtain, source of power for filament heating is the good old 1 ½-volt dry cell. It can be obtained anywhere that any kind of filament supply can be obtained, as a rule; and one such cell would supply the heater of a low-drain, 1 ½-volt tube for many hours. Such tubes could also be used on 1 ½-volt A. C. filament supply when such a source of power might be at hand. The experimenter, then, would have a tube which would immediately adapt itself to two different, yet very common, sources of power; moreover, four such tubes could be operated with their heaters in series on the standard 6-volt storage battery, thus making a third common form of filament supply usable in those cases where series operation of the heaters might be permissible! Of what other tube, placed at the disposal of the American public, can as much be said as to flexibility of heater supply?

Personally, the writer has for some time been using type 32 tubes in circuits designed to supply type 26 tubes; in fact, he is operating type 32 tubes in parallel with type 26 tubes. (However, it goes without saying that such a procedure cannot obtain under all conditions of operation to which it may be desired to subject these particular tubes.

By way of conclusion, the writer desires to direct the attention of all who may be interested, to the Sylvania type 15 tube, a 2-volt tube of the heater type, described in the January, 1933, issue of RADIO-CRAFT. This tube is quite along the line of the tubes suggested in my previous letter, and it occurs to the writer that perhaps the tube manufacturers may already be in a position to put before the public a 2-volt, heater-type tube with characteristics, as to heater flexibility, which will permit the operation of either 1 ½ or 2 volt circuits, or circuits whose rated supply voltage are multiples of 1 ½ volts, as is the case of a circuit powered by a 6-volt storage battery.

May we not hear from the tube manufacturers in connection with the subject under consideration? Also, let us hear more from those who may be interested, both pro and con.

C. M. DELANO,
Lincoln, Nebr.

WORLD WIDE RADIO RECEPTION

Editor, RADIO-CRAFT:

You ask for DX results, here are some. I might remark that location is not so "hot" as too many code stations are located within a few miles. And don't they break through, even unto the 125th harmonic! On the broadcast band, we receive rather regularly a station in San Juan, Porto Rico on about 1250 kc. Also all Cuban, and most of the Mexican stations. KFI, KSI, and KOM in like locals as soon as the other stations on the same channels say good-night. But the prize catch is LR3, Buenos Aires, on about 970 kc., which

(Continued on page 560)

The Bulletin Board for
Our Experimental Readers

RADIO-CRAFT for MARCH, 1933
Furnish sufficient information, and draw a careful diagram when needed, to explain your meaning; use only one side of the paper.

Those questions which are found to represent the 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.

PARALLEL RESISTORS—RESISTOR POWER RATING

(A.1) Mr. Stanley Mozorwit, Boise, Ia. (V. 1.) Is there available any "abcd" or chart which would make it possible to determine the effective parallel resistance, without using the usual formula?

(A.2) The graph illustrated in Fig. Q.16A (reprinted by courtesy of Ohmite Mfg. Co.) will meet this demand. (It is possible to obtain 1,096 combinations of resistance values from 123 different stock resistors listed in Ohmite Stock List No. 5, the manufacturers are particularly pleased.)

(Q.2) What would be the power rating of a 1,000-ohm resistor in the plate circuit of a type 24 tube with 250 volts plate potential?

(A.2) The correct rating for any value of resistor operating with any current load may be determined by reference to the chart of Fig. Q.16B. (Reprinted by permission of Modern Radio Publishing Co.)

Using the example furnished by our correspondent, we find that a 1,000-ohm resistor is quite adequate to the demand. Taking as an example a 1,000-ohm resistor to carry 60 ma., trace along the R line until a value slightly higher than 60 is reached, in the 1" column. This is 100. The graph indicates that a 1,000-ohm resistor will do, but the unit will be operating at full rating, or "hot." To run "cool," continue to the right until a figure about 1½ times the load current is reached; in this case, 115, in the "20W" column. In general, for a particular resistance value, doubling the current will require four times the power rating in watts, and tripling will require nine times the rating. One-half the current calls for one-half the power rating, and cutting the current to one-third will reduce the power rating to one-ninth its value.

FIG. Q.16A, TOP. SCHEMATIC CIRCUIT OF A LABORATORY MODEL Sound METER. SOUNO DIFFERENCES ARE READ DIRECTLY ON THE DECIBAL OUTPUT METER CONNECTED TO THE DRY-DISC RECTIFIER.

FIG. Q.16B, ABOVE. BLOCK ILLUSTRATION OF A SOUND METER SETUP. THE WAVEFORM CIRCUIT IS AN ELECTRICAL NETWORK FOR WEIGHTING ENERGIES AT DIFFERENT FREQUENCIES IN A MANNER SIMILAR TO THAT IN WHICH THEY ARE WEIGHTED FOR LOUDNESS BY THE EAR.

FIG. Q.16C, RIGHT. AN ILLUSTRATION OF THE LEVELS OF SOME COMMONLY ENCOUNTERED NOISES.

ACOUSTIC NOISE METERS—ELECTRIC TRIC NOISE METERS

(A.1) Mr. Carlton Parkske, Burlington, Vt. (V. 3.) Some time ago, there was demonstrated at a meeting of the N. Y. Electrical Society a "noisel meter" which demonstrated the relative noise levels of Times Square, N.Y.C., and the loop district of Chicago. What is the circuit employed in such devices?

(A.2) The demonstration in question was typical of the "noisel meter" long line setup between the two cities, terminating in a sound meter or "audimeter." A general circuit of one type of noise meter is illustrated in Fig. Q. 16A (Electrical values are governed by individual design): a block view of a noise meter set-up is shown in Fig. B. The tabulation at C indicates the relative sound intensities of a few of the sounds and noises. (Figures and C are reproduced from "Indicating Meter for Measurement and Analysis of Noise Levels," by H. F. Tice, Reitmann, and Tucker.) The "zero noise level" of C was determined by an "equal loudness" curve and further by a test of certain common types of noise.

Some makers of noise meters comprise only a calibrated microphone, A.F. amplifier and indicator system while others include a local oscillator (see Fig. Q.16A) for setting up a reference sound level. The level of a sound is taken as the level of this oscillator tone which gives a meter reading equal to that given by the sound under consideration expressed in decibels above this reference point. The advantage of this reference point is that it is definite and re-producible, and does not depend upon the personal equation. It can be related to the threshold of audibility, as accurately as the latter is known. Noise meters of this type are described as "acoustic noise meters;" electric noise meters are described in the article, "Sleuthing for Static," in the February, 1933 issue of Radio-Craft.

Noise meters have proved useful for city noise surveys, for the use of health departments or other legal officials in inspecting alleged noise nuisances, for measuring noise in offices or other rooms before and after noise-reducing treatment, for the use of salesmen selling noise-reducing materials, for factory or field inspection of fan, motor, machinery, and electrical equipment, and for the majority of other problems of practical noise engineering. A recommendation that builders' or buyers' specifications for fans, refrigerators and similar equipment no longer should guarantee "noiseless" or "quiet" opera- tion, but should specify noise production less than so many decibels, as measured on a reliable noise meter, opens a new field for the progressive Service Engineer to sell, install and service these devices.

The range of the meter illustrated in Fig. Q.16A is determined by the setting of the 85db. potentiometer: more accurate adjustment is then obtained by operation of the calibrating potentiometer. The output of the pick-up microphone is fed into the amplifier by means of the jack connector.

In connection with the tabulation of C it may be mentioned that interesting observations in Reader's Mail by illustrators show that the peaks of many noises, above the general noise level, have the following values: dishes on tray, 6 db.; chairs, 6 db.; dishes on table, 7 db. Those peaks recur at the following rates, respectively: 0.2 per minute. 0.5; 1.5; 5.0; 10.0; 25.0; 50.0; 100.0; 250.0; 500.0; 1,000.0; 2,500.0; 5,000.0.0; 10,000.0. (Q.2) Please show the connections of an interference locator.

The data requested appears in the schematic circuit published in connection with the article, "Sleuthing for Static," in the February, 1933, issue of Radio-Craft. The components have the following values: Resistor R1, 50,000 ohms; R2, 10 ohms; R3, 3 meg.; R4, 0.8-meg.; R5, R6, R7, 0.1-meg. Condensers C5, C6, 0.6-mf.; C7, C12, 250 mmf.; C8 to C12, 0.1mf. Condensers C1 to C4 are ganged.

(Continued on page 555)
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Here are two of the most surprising announcements that we have ever made to the radio trade and we know that it is such good news that every radio man will be greatly enthused.

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It is needless to say how valuable the OFFICIAL RADIO SERVICE MANUALS have been to members in every branch of the Radio Industry, and how many thousands of each edition have been sold to manufacturers, jobbers, dealers, Service Men and experimenters. But we must emphasize this one fact: Service Men now realize that they are tremendously handicapped without the full set of Gernsback Manuals. So much so, that those who have purchased only one or two volumes, are now ordering the MISSING BOOKS. They want their files to be complete.

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(A.1.) The schematic circuit of this device is shown in Fig. 187A; at B is shown the man-
er in which this instrument connects to the
associated radio receiver, etc.; various models are available, depending upon the required drain,
as shown at C which also indicates the regulation of the re Battery
The current consumption from the storage battery is 1.5 A, for an output of 25 ma. at 135 V. The interrupter is of full-wave type; it feeds a special Utah type P-561 mercury-vapor, catherode-type rectifier made by Ken-Rad. The "A" relay is an externally-connected shunt-type unit which may be added to automatically control the "A" position of the instrument by the opera-
tion of an existing off-on switch at the set. When installing the eliminator in place of the "B"-type of battery, do not change the connections from the car battery to the set. However, when replac-
ing an eliminator using a series type relay, remove the relay and connect the "hot" lead from the set to the "hot" terminal of the battery; if replacing an eliminator not using a relay, (as in the case of "B" batteries), it is not necessary to change the connections from the set to the battery. The figures of graph C were taken at 6.2 V, input.

(Q.2.) Is it possible to use a number of "set" couplers in conjunction with a single antenna and "antenna" coupler together with the usual shielded R.F. transmission lines, for operating a number of remote radio sets?

Copyright, 1927, by Q.1. How can I make a transformer for electric "lead burning," which will enable me to

(Continued on page 579)

Fig. Q. 187A, right. Schematic circuit of the Utah full-wave car-radio "B" unit.

Fig. Q. 187B, left. Block illustration of the "A" connections to the car-radio units.

Fig. Q. 187C, above. Graph of the regulation of various car-radio "B" unit models.

Fig. Q. 187D, upper right. Methods of connecting several radio receivers to one antenna while still retaining the advantages of the shielded R.F. transmission line. A - A connections where the location permits the use of A; two or more leads; at B, the next best arrangement.

WELDING TRANSFORMER

(188) Mr. Robert Crowley, Mobile, Ala.

A1. Are there any connections, etc., of the Utah "B" eliminator described on page 397 of the January, 1933, issue of Radio-Craft?

(A.1.) The schematic circuit of this device is shown in Fig. 187A; at B is shown the manner in which this instrument connects to the associated radio receiver, etc.; various models are available, depending upon the required drain, as shown at C which also indicates the regulation of the re Battery
The current consumption from the storage battery is 1.5 A, for an output of 25 ma. at 135 V. The interrupter is of full-wave type; it feeds a special Utah type P-561 mercury-vapor, catherode-type rectifier made by Ken-Rad. The "A" relay is an externally-connected shunt-type unit which may be added to automatically control the "A" position of the instrument by the opera-
tion of an existing off-on switch at the set. When installing the eliminator in place of the "B"-type of battery, do not change the connections from the car battery to the set. However, when replac-
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(Continued on page 579)

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Fig. Q. 187C, above. Graph of the regulation of various car-radio "B" unit models.

Fig. Q. 187D, upper right. Methods of connecting several radio receivers to one antenna while still retaining the advantages of the shielded R.F. transmission line. A - A connections where the location permits the use of A; two or more leads; at B, the next best arrangement.
OVER-THE-COUNTER SUGGESTIONS

Jack Grand

We get calls here, and we get calls there. In fact, we get service calls everywhere. But, the thing that worries us most and always will, is how to make the results show in the fill.

Meeting countless radio men in the course of a year, it finally dawned upon you that it is a big evil in radio is the slip-shod antenna installation that the average customer gets through one reason or another. It's a pain for the poor unsaucing customer. Maybe somebody somewhere might get in a number of lines to get rid of such fears. People can't see any further than their nose, and doesn't know what it is all about: or maybe the installer couldn't "see" it, and couldn't "feel" it. Why not put in a good R.F. transmission line, such as Kolster is now advertising, under the name of "Bedast that?"

There is a good scheme one automotive radio service shop employs, for testing this type of set—take it for the "automotive" antenna type. It consists of a screen with an area of 9 sq. ft., permanently strung in the shop. It's a bit easier to sell your automotive sets when you point out to Mr. Prospect that by arranging the reproducer to plug into a "home" car, it is convenient to range a similar socket in the house; thus, the car speaker may be used for dual operation. It's a remote unit or a supplementary single-room set-up inside the rooms (for dancing, improved tone quality, etc.). The usual "outlet tube plate-to-1 m. condenser-to speaker-to ground" is usually satisfactory. If not, it must be energized in a manner determined by the design.

An extension-cord sale will be made if you point out that where the bungalow lacks a radio set, the car radio may be put into service by extending the speaker connections to the reproducer brought into the house.

This idea will be appreciated on rainy days, when everyone is a "stay-at-home." (Continued on page 555)
three potentiometers; in the side wall for the condenser (6, 10), and the three condensers (34, 35); in the rear wall for condenser (41) and audio transformer (28). These parts are then fastened in place. The dual variable condenser is mounted on top of the chassis as shown. The chassis is then turned right side up and condenser (15, 16) is mounted. Then the coils (3, 11) and the R.F. choke (28) are fastened in place. The chassis then turns right side up and the power transformer and audio choke are mounted.

Wiring the Set

Starting the wiring, the filament circuits are wired in first, a separate 2½-volt winding being provided for the output tube. Grid circuits are wired next, with control-grid connections to the caps of tubes (5) and (14) made as indicated on the schematic diagram. The various socket terminal connections are plainly indicated on the top view layout. In the case of both (5) and (14), the suppressor grid is the one which is grounded to the cathode.

Plate circuits are wired next; if the primary of coil (11) (here used as a tickler coil) is reversed, there will be no regenerative whistle. In most cases, it is simplest to reverse the connections at the primary (P) terminals. Cathodes are then wired, and next, by-pass condensers and negatives returns to the chassis. Antenna and ground connections are completed. The primary circuit of the power transformer is wired through the rear socket to the left terminal being in series in this circuit. The rectifier and filter circuits are then put in, completing the wiring to the four-prong speaker socket (31, 32, 37, 39). This socket is mounted at the rear chassis wall.

List of Parts

Two Trutest binding posts, 1.2.
One Premier "Conoid" shielded antenna coupler, 3.
One Cardwell .0055 mf. (each section) two-gang (Dual) variable condenser, type 217-C, 6.6.

One Trutest equalizer. capacity 2 to 5 mmf., 4A.
One Trutest No. 4R four-prong plug for speaker connection, 3IA, 32A, 37A, 38A.
One type 55 tube, 5.
Two Trutest six-prong wafer-sockets, type 2M3001, 5, 14.
Two Aerovox .005 mf., each section, double-section metal case condensers, type 260-21, 6, 10, and 16.

THE PENTODE "FOUR"

(Continued from page 530)

One Electro-Truvox 200-ohm flexible resistor, type 20250, 5.
One Electro potentiometer, 10,000 ohms, type RI-240P, & with switch 44.
One Premier "Conoid" shielded screen grid R.F. collector, 11.
One I.R.C. 2 meg., 1 watt, metallized resistor, type MP4, 18.
One Aerovox .001-mf. mica condenser, type 1456, 12.
One I.R.C. 2,000,000 ohm, 1 watt, metallized resistor, type MP4, 18.
One Electro-Truvox 50,000 ohms, type RT-205, 17.
One Electro-Truvo, 20,000 ohm, 1 watt, metallized resistor, type MP4, 18.
Two Trutest five-prong wafer sockets, type 2M3006, 26, 39.
One Trutest audio transformer, 3 to 1 ratio, type 2C1550, 28.
One Trutest, power output tube, 30.
Three Trutest four-prong wafer sockets, type 2A176, 51, 32, 37, 60, 46.
Three Aerovox 4-mf. 25-volt dry electrolytic condenser, type EH-4, Ti can, 38, 34, 35.
One Trutest 30-henry choke, 75 ma., type 2C1571, 38.
One '47 output transformer, 38.
One 180-type full-wave rectifier tube, 49.
One Aerovox 25 mf., 25-volt dry electrolytic condenser, type EZ-20, 41.
One Electro-Truvox 400-ohm flexible resistor, type 2G604, 42.
One Trutest power transformer, flush mounting, type 2C1402, 43.
One Trutest full-vision, high ratio dial, complete with encased plate and pilot light socket, type 2148615, 45.
One Amerite self-adjusting line-voltage control, type 5A9, 46.
One aluminum chassis, 12 to 14 gauge, 10½x½ ins.
One Wright-DeCoursey dynamic speaker, Infant Model with 2500-ohm field; one 0.006-mf. mica condenser, 47.

THE SHALCROSS 651 SET TESTER

(Continued from page 534)

provided that the elements in the tube under analysis are clear.

An operating chart is included to facilitate operation. This chart contains a list of the switches that must be set for any particular tube under test. In using this chart, the particular tube under test is associated with a letter which classifies the tube into a group. For instance, a type 34 tube is under test. At the bottom of the chart, a list of tubes is given from which the letter associated with this tube is found to be A. Then, referring to the data above the tube listing, it is seen that a type A push button adapter must be used on the cable plug, and that the following voltages and currents may be measured: plate voltage, by turning switch MA-V to the V position and turning the P switch to the left, or P position; plate current, by turning switch MA-V to the MA position, and the P switch to the left, or P position; D.C. heater voltage, by turning the MA-V switch to the V position, and the H switch to the H position; control-grid voltage, by turning the MA-V switch to the V position, and by turning the G switch to the G position.

The switches are thrown in any of the above-mentioned positions for a particular reading, any of the voltage or current buttons may be depressed in order to secure a convenient deflection on the meter. For reversed readings, reversing switch is included on the panel. An examination of the chart shows that approximately 70 different types of tubes may easily and conveniently be tested with this device. The view showing the location of all holes on the panel is given in Fig. 2. No adapters are required for this tester, except those required to be used with 4-, 5- or 7-prong sockets. The diagram of Fig. 1 is self-explanatory, and no further comment concerning it is necessary. The cable uses a 6-prong plug with a control-grid clip on the side; thus, adapters for the plug are only required when testing 4-, 5- or 7-prong tubes.

List of Parts

The following list of parts is required for either the model 651 or 652 testers.

Five Wade type 5091 push buttons, Sw.1 to Sw.5.
Sw.8 inclusive.
Three Yaxley type 720 switch, Sw.6.
Three Yaxley type 780 switches, Sw.7, Sw.8, Sw.12.
Three Yaxley type 760 switches, Sw.9, Sw.10, Sw.11.
Two Na-Ald type 425, four-prong sockets, V1, V3.
One Na-Ald type 424, four-prong socket, V2.
One Na-Ald type 426, six-prong socket, V4.
One Na-Ald type 427, seven-prong socket, V5.
One Na-Ald type 906WL plug with cable; type 9481S adapter.
One Na-Ald type 948SDS adapter.
One Na-Ald type 948GDBS adapter.
One Na-Ald type 948SSS adapter.
Two Eby binding posts.

The following parts, in addition to the above, are required for the type 651 tester:

One drilled and engraved control panel.

(Continued on page 559)
OHMMETERS
(Continued from page 535)
in which the meter reading decreases—pointer moves to the left—with increasing values of Rx.
The reason why this mode of connection is capable of reading low values of resistance is best illustrated by an example. The resistance of a standard 6-1 ma. meter of the D. C. type is about 30 ohms. Thus, if the value of Rx (Fig. 2) is made equal to 30 ohms, the meter reads half scale, because only half the current flows through the meter; the other half flows through the resistor Rx which now acts as a shunt. Now, the point to keep in mind is that half the meter scale is used for only 20 ohms, while in the circuit of Fig. 3, half the scale is used with an external resistance of 1,500 ohms! That’s why the shunt method is good for small resistors.

Calibration Data
Both types of ohmmeters may be calibrated by calculation, using the following formulas:
For the series type ohmmeter (suitable for high resistances, Fig. 1)

\[ E = \frac{R_x}{R} \]

where E is the voltage of the battery—usually 1.5 and/or 3 volts; I is the reading of the meter in amperes; and R is the value of limiting resistor.

For the low-resistance ohmmeter illustrated in Fig. 3

\[ R_x = \frac{R_m}{n-1} \]

where Rm is the resistance of the meter (about 30 ohms) and n is the ratio of the full-scale current reading to the actual current reading. For instance, with the meter under discussion, what resistance is being measured when the reading of the meter is .75-ua? Substituting in our formula, we obtain:

\[ R_x = \frac{30}{0.75} = 40 \text{ ohms.} \]

\[ (1.25-1) = 25 \]

The above is valid so long as the resistance of R is large compared to the meter resistance, almost always the case.

Circuit 3 may also be calibrated against low-value standard resistors. As a matter of fact, all mathematical calculations should be checked this way at three or four points. A few “spit” points on the proper cross-section paper will greatly facilitate calibration. Using D.C. meters, circuits 2 and 3 will plot a straight line only on logarithmic paper.

Special scales can be prepared and placed over the milliammeter scale for direct reading.

In Conclusion
All equations given in this paper are based on volts, amperes and ohms. Considerations involving megohms, millivolts, milliamperes, or any other subdivision or multiplication of the fundamental units should be converted accordingly before computations are undertaken.

The power requirements of the resistors used in these circuits are usually well under two watts—with the exception of high-range voltage multipliers. The dissipation can be easily calculated by multiplying the current in amperes squared, by the resistance in ohms—i.e., \( W = IR^2 \).

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on market using a 3 Gang Condenser
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Will operate in country as well as city
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Price
Complete with
5 Cunning-
ham
Tubes
1-C43 & 1-C25Z5
2-C39 1-C36
LIST
PRICE
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COMPLETE

This receiver, designed by Mr. Squire employs all the latest engineering developments. We have purposely refrained from trying to put a model of this type on the market until seasoned experience had been given all of our suppliers based on the mistakes made by most of the portable models on the market at the present time. Now, in cooperation with engineers of the Cunningham-Radiotron Co.—Dubuiler—Rola—Aerovox—General Instrument—Centralab Companies and several laboratories such as Hazeltine Radio Corporation—American Telephone & Telegraph Companies, we feel that our receiver is the last word in engineering and are sure that the results received by those purchasing them will justify these claims and make us many new friends and boosters.

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OVER THE COUNTER SUGGESTIONS
(Continued from page 559)
The old stunt of shorting the posts provided for a reductor field coil, to check operation against the voice of the speaker, doesn’t always work—the voltages throughout the set go “off the handle,” due to the lowered resistance in the filter circuit. Instead, use a heavy-duty Bradleyohn or Clarostat variable resistor, adjusted by means of your ohmmeter to the value of the field coil, connected to the field coil terminals; if the value for the setting is not known, it may be necessary to pick out a portion of the circuit the voltage of which is known, and then vary the resistor until this voltage is obtained.
**OPERATING NOTES**

(Continued from page 537)

...of the 45 power tubes was reported on a Philp '77. This trouble was caused by one side of the input push-pull transformer secondary being open. (See Fig. 2.)

A Little Giant five-tube set was brought in with the remark that the power transformer was smoking and the unit was becoming heat radiated. This was ten minutes after I had replaced the 8-ft. 4-mf. dry electrolytic filter condensers which were charged.

When a Tom Thumb P 45 was turned on, smoke would come from somewhere in the chassis. On inspection I noticed that one of the 8 mf. dry electrolytic condensers had leaked. Some of this paste had made its way to the 8-ft. coils read a short across the two plate prongs. The socket was replaced by new ones made by Replacing some with a defective paper condenser onto the leak. Both 8 mf. condensers were replaced with new dry electrolytic condensers. Figure 3 shows the location of dry electrolytic condensers and 80 rectifier socket at the bottom. A Graybar 600 kept blowing out the rectifier tube each time it was replaced, and smoke would come from the receiver chassis. I went about locating this trouble by replacing the plate of the SERVICE condenser until the trouble was cured. I have determined that there is a permanent way out of depression and job-ear.

**THE SERVICE MAN'S FORUM**

(Continued from page 538)

A rectifier tube that was replaced with a new 600-ohm type would light. The trouble was traced to the rectifier filament winding in the power transformer.

A customer complained that the Greybar Soldering set 706 was a direct short and the rectifier plates were red. This trouble was caused by the cover of the Marshon condenser.

---

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HOME RECORDING
(Continued from page 59)

connections as before, but in a slightly different manner. This contact is indicated in Fig. 10.

Since it requires power—taken from the audio end—to run the monitor speaker, and since a monitor is not actually necessary after a little experience in recording, it seemed good policy to disconnect the monitor entirely. When this is done as indicated in Fig. 9, a material increase in fidelity will be noted. The lack of a monitor was not found to be a drawback, inasmuch as the cutting head and record acted as a soundboard, reproducing the program sufficiently loud to be used as a monitor.

In order to eliminate the monitor from the above models, proceed as follows: on the control switch, removal of terminal No. 9 disconnects the choke across the speaker cone coil to ground. To disconnect the series resistance in the cone coil, locate the resistor and reactor assembly, fastened to the left end of the chassis, and remove both black- and red tracer wires from terminal No. 7, but leave the two wires connected to each other. See Fig. 2. This resistor and reactor unit contains the disconnected choke, the 150-ohm series monitor resistor, the 1,000-ohm paralleling resistor around the old mike, and the 5,000-ohm resistor used to parallel the 16,000-ohm resistor in the cathode circuit of the second detector when it becomes an audio amplifier. Now it will be necessary to obtain microphone current.

Figure 2 shows the completed change to non-button type wire use. First, put the red and yellow wire connected to terminal No. 4 on the phonograph strip. This red and yellow wire is one of five coming out of a cable running to the control switch. Remove this wire from the screw contact and solder on the other wire sufficiently low to reach down to the power tap, tapping the newly made connection. In series with this wire put a resistance of sufficient size to allow 10 ma. through each button of the mike. This value will be in the neighborhood of from 5,000 to 15,000 ohms. Connect the other end of this resistor to power pack terminal No. 6 which already has a red wire connected to it. You are then ready to record. Note, on Fig. 3, that the cathode connection of the mike runs to contact No. 5 on the control or change-over switch. This contact closes the current supply to the mike.

1932 Models

On the 1932 models of the RCA Victor, G. E., and Westinghouse sets, there are several slight changes in the design to improve the quality and increased volume, both on audio and radio operation. First, we will take up the home recording unit. Cleared of the accumulation of switches, etc., the microphone connections are approximately as shown in Fig. 4. Incidentally, this diagram shows the use of the one-megohm resistor referred to previously. It will be noted that this circuit retains all the fundamentals of the circuit outlined above, but has certain modifications which particularly apply to the De Luxe machines.

Figure 5 is a rough diagram of the tone control system employed on these receivers. If the trap circuit containing C39 and R24 is opened at the point indicated, there will be a noticeable increase in volume. It is recommended, however, that this connection be made only when playing records or making home recordings, since there will be a noticeable peak at high frequencies. This peak can be flattened out by the addition of the items shown dotted, without loss of tone and volume. These items comprise an audio choke in series with a condenser of such size as to smooth out the "hiss," the audio choke indicated was an old audio transformer. Be sure the choke end is connected to terminal No. 1. Also insert the 1-mf. condenser across terminals 1 and 5 as shown.

As an additional kink, the tone may be still further varied by experimenting with the values of condenser C39 and resistor R24, some individuals preferring a combination such as 20,000 or 50,000 ohms for R24 and .025 mf. for C39.

In many of the series 50 and 55 chassis, as well as their corresponding models in G. E. and Westinghouse, there has been an objection raised regarding the tone quality at low volume. It seems that when low volume is used, there is an apparent fuzziness and roughness to the reproduction. This may easily be cured by removing the chassis, locating the yellow lead which leaves the end contact of the resistor and condenser terminal board and goes to the first R. F. tube in the chassis. In series with this yellow lead, insert a .5-megohm resistor. Now, from the tube end of this resistor, connect a .5-mf. condenser to ground. This will effectively cure distortion on low volume. See Fig. 6.

Long-Playing-Record Attachment

The long-playing record has been developed to a stage of perfection that is amazing to the writer. But what is more amazing to him is the apparent sparsity with which the radio Service Man regards this record. Here is a field absolutely new—a method whereby most of the objections to a record are overcome, and yet the Service Man cannot, or will not, sell his customer a simple device which instantly converts his old phonograph to a "long-playing" phonograph. This device, called the Sr. 1, 2, or 3 is a turntable for replacement of the old turntable, and by means of a ball-bearing arrangement, successfully reduces the turntable speed from 78 to 33 1/3 R. P. M.

ADDRESS CHANGE

We have just been advised by the Sun Radio Co. that, because of the erection of a new Post Office building on their location, they have moved to new quarters at 227 Fulton St., New York City. They were formerly at 84 Vesy St.

www.americanradiohistory.com
on the relay in series with a 30-watt light, a 2,000-ohm speaker unit (Utah or other make), and a 110-volt A.C. line.

AN A.C.-D.C. CHANGE-OVER DEMONSTRATOR

Fred Westerfield

HERE is a wrinkle that will be used over, and over to save lots of work (and argument) when you get an A.C. radio set to change over to operation on D.C. You can let the customer hear exactly how the job will sound after the change, and he will then know what to expect.

Simply break the "B-I-I" lead at X as shown in Fig. 9, insert a Bradley-ohm resistor, vary the voltage by means of the variable D.C. (which may be taken as the D.C. line potential) and you have a good idea "what is what" after the change. Don't touch any other wiring.

A SIMPLIFIED TUBE-TESTER DESIGN

Robert C. Reinhardt

A TUBE-TESTER that I happened to discover in Radio Life's experience column is portrayed by diagram in Fig. 10. It is made of "junk-box" parts, and costs almost nothing. I write Service Man and ask that he will have in his shop. The meter is a 15 ma. Readout which is obtainable for less than a dollar and is calibrated by inserting tubes of known quality and value. If desired, a new paper scale may be inserted and the various measurements recorded directly. The tester tests all present-day tubes, including both types of pentodes and triodes. The new type 12AT7 and 356 tubes that are so different can be balanced by inserting tubes of known quality and value. It is a very simple matter to take any tube set in hand, and show the serviceman that they will handle the 35 in place of the 10A, or in some cases I have left the primary winding and inserted a 4500 or 5000 ohm resistance within the coil form, and in series with the R.-F. plate lead. 

VOLUME CONTROL FOR 2-VOLT RECEIVERS

O. D. Elder

THERE is considerable profit to be made by the Service Man in rewiring battery sets and installing new low-drain tubes. The saving in battery current, alone, is usually enough to entitle the repair of the set to the customer. I have written over several of these older sets in the past few months with very limited success, except where the mechanical arrangements made it feasible to use the 22 screen-grid in the R.F. stages (replacing the 22A or 6A7-type originally used). It is a very simple matter to use the 22A and have the customer return to the station and pay the man an extra price. The new type 6G6-A tubes are obtainable for about $8.75. They have worked over 10,000 miles, and have given perfect satisfaction in all cases. The units are testable by using a 4500 or 5000 ohm resistance within the coil form, and in series with the R.-F. plate lead. It is not always possible to use the 6G6-A type, but the advent of the 6G6-A type is more clearly seen.

The device is very useful because of its freedom from inaccuracy due to variations in the voltage applied. With a 200 microampere meter, a change of forty volts causes a change of one point ten in the range which can be increased by increasing the plate and grid voltages and by shunting the meter as to have read approximately half the actual current values passing. Where it is desired to make readings of voltages in excess of the meter range, it is always possible to construct a potentiometer of high resistance such as grid leaks, and to measure the voltage drop across any portion of the divider thus formed.

CLASS A', CLASS B

So many receivers are now using class A' amplification, and so many men and confusing the properties of the class of amplification with that of ordinary class B operation, that perhaps a little explanation would be in order. In A' operation, the tube is biased so that no plate current flows when no signal is applied, but the current rises very rapidly as soon as a signal is applied. It is not possible to apply for large output.
RADIO KINKS
(Continued from page 547)
9. Tin these "contact turns" and take a lead wire from each section. Some of these old style rheostats may be conveniently ganged.

MODERNIZING OLD SWITCHES
F. J. Wylie
A SIMPLE way of improving the appearance of an off and on switch is by the simple process of filing off or turning down, on an emery wheel, the little bump on the end of the switch until a standard wooden knob, to match the panel, can be slipped onto the shaft. This idea, illustrated in Fig. 10, may be applied to both the push-pull and "side-swiper" switch types.

A MOTORWHEEL "B" UNIT
L. B. Robbins
BY following the design illustrated in Fig. 11, the writer succeeded in developing a very successful "B" unit for the operation of a high-power P. A. system. For use in the "sticks," where it is not always convenient to charge batteries. Although this wheel could also have been used to drive a low-voltage generator to furnish "A" potential, we found it more convenient to use "automotive" tubes and a six-volt diamagnet battery.

A HOME-MADE KNOB
H. Newkirk
EXPERIMENTERS may be interested in the following description of a home-made knob.
The center bushing of the knob was obtained from a discarded radio dial, the cap was obtained from a bottle which had contained Peppermint mouth wash. After drilling a hole in this cap in line with the set screw, in the coupling, a screw of sufficient length to extend from the coupling to the outside of the cap is then threaded into place, after which the coupling is fixed in the position illustrated in Fig. 12 by means of sealing wax. Then the long screw was removed and the regular set screw placed in position.

THE SHALLCROSS 651 SET TESTER
(Continued from page 551)
One Weston model 501 D. C. 0 to 1 ms. meter.
One Shallcross resistor type 170, 125 ohms, R1.
One Shallcross resistor type 6T, 8,850 ohms, R2.
One Shallcross resistor type 6T, 90,000 ohms, R3.
One Shallcross resistor type 6T, 100,000 ohms, R4.
One Shallcross resistor type 6T, 150,000 ohms, R5.
Two Shallcross resistors type 6T, 100,000 ohms, R6 and R7.
One Shallcross resistor type 6T, 90,000 ohms, R8.
One Shallcross resistor type 6T, 150,000 ohms, R9.
The following apparatus, in addition to that listed at the beginning of this section, is required for the model 651 tester:
One drilled and engraved panel.
One Weston model 501 D. C. 0 to 1 ms. meter.
One Shallcross resistor type 170, 83 ohms, R1.
One Shallcross resistor type 6T, 4,900 ohms, R2.
One Shallcross resistor type 6T, 15,000 ohms, R3.
One Shallcross resistor type 6T, 80,000 ohms, R4.
One Shallcross resistor type 6T, 400,000 ohms, R5.
Two Shallcross resistors type 6T, 100,000 ohms, R6 and R7.
One Shallcross resistor type 6T, 4,000 ohms, R8.
One Shallcross resistor type 6T, 800 ohms, R9.
Watch forthcoming issues of RADIO-CRAFT for a description of a real tube tester. It tests all tubes without the use of any adapters.

INTEGRA RESEARCH
RADIO CRAFT for MARCH, 1933

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has been many a night with sufficient field strength to cut through the other stations on the same channel.

On S. W. we have had stations from all over the world. Saigon, Sidney, etc. have been received pretty well, also most of the European stations. But the best S. W. station is DJB on 1973 meters, which is received all year round with the quality and volume of a local. This station is on the west side of the city and to 10 and 11 A. M., E. S. T. daily. There is interference, sometimes, from stations in Japan. On 1870 m. is FTA, which is also on the air every morning from 8 to 10, but the programmes are punk. Just talky-talky propaganda, Francomité.

Equipment used: An 11 tube Oscha and an S-M converter.

(If you are interested in checking up on DJB, call Bayport 1854 any Sunday morning around 10:30 A. M.)

FREDERIC G. HEIN
P. O. Box 875
Saville, L. I.

A NEAT RADIO WORK BENCH

Editor, Radio-Craft:

I have just built the A.C. reinventor published in your October issue of Radio-Craft. Thanks to Mr. Shaw, it is working fine. I owe your book many compliments for the very valuable information published in it. I am sending you a snap-shot of a switchboard and outside service box I built from many of your ideas. Here's hoping you keep the good work up in your valuable book.

THOMAS BOYD
11 Cherry Grove
Ecorse, Mich.

(A is evident by reference to the photograph illustration, Mr. Shaw has built a very neat appearing test bench. Note the close reference to this bench and the one described in the March, 1930 issue of Radio-Craft, in which appeared an article entitled, "The Complete Description of a Radio Work-Bench."—Technical Editor.)

"THE DECLINE OF RADIO SETS"

Editor, Radio-Craft:

It is with genuine desire for an expression of intense satisfaction, that I decided upon writing you this letter, and wish to convey to you my sincere wishes for success in your enterprise.


Every word and argument expressed in your article is hitting the historical nail right on its head and brings out those facts which for a long time have been felt by radio customers and Service Men alike who are stoically supporting our radio stations.

The general appeal should convince you of the appreciation given your enterprise in bringing about a just change in the practices of set manufacturers, and I wish you the greatest success ever. Service Men and public, I am sure will stand behind you and insist that manufacturers take into account the ultimate customer, whose satisfaction must be obtained, and the industry is to benefit by this buying force.

Here is "Good Luck" and "Best Wishes" for your efforts.

G. MORGAN
C. Alvero Oropas,
Tamora, Missouri.

(Your comments are appreciated, and we are sure that you express the interest of a good many readers of Radio-Craft, judging by our correspondence.—Editor.)

40-WATT, CLASS AAA AMPLIFIER

(Continued from page 536)

Determining Amplifier Output

It might be well to compare for a moment, and outline briefly, how the undistorted power output ratings of any amplifier system are determined. The undistorted power output of a type of electronic device, such as one particular type of power tube is dependent solely upon the power circuit and circuit usage, and upon the accompanying voltages and currents employed. (The latter causes the tube to dissipate actual heat in watts and not exceed a certain maximum safe value.) For instance, the 504 type of tubes can be used in the four following amplifier circuits: class A; class A prime (also known as class A double prime, class A triple prime, and increased class A); class B; and class C.

Refer to Fig. 1 which shows the plate-current grid-voltage curve of a single type 50 tube with a filament voltage of 7.5 and plate voltage of 500. Inspection of this curve shows the conventional straight-line portion labeled class A. Under this condition, the average D.C. plate current remains at a constant value when a sine-wave voltage is impressed upon the grids of the tube, and the maximum undistorted power output of 13 watts may be obtained when using two such tubes in a conventional push-pull class A circuit. In the class C circuit, the tubes are placed under such operating voltages—cathode, grid and plate—so that the current draws plate current during a very small lapse of time; for this reason the tube heat is dissipated in an amount of current which may be much larger than an in a standard class A circuit; the total heat dissipation now being concentrated into the corresponding small lapse of time.

This type of circuit has been found only satisfactory when applied to radio-frequency and to audio amplifiers for code transmitters, as its application in audio-frequency amplifiers for receiving sets would produce an output with far too great a distortion factor.

In class B circuits, the tubes draw plate current only during one-half of the cycle and can, accordingly, dissipate at least twice the amount of heat that it would if it were forced to dissipate this heat continuously. In other words, the type 50 tubes in class B circuits can be used to advantage in transmitters to reduce the plate current to practically zero with no grid excitation; no plate current flows over the rest of the cycle.

The 40-watt class C amplifier, herein described, employs a circuit that has all the advantages of standard class C circuits, as well as the feature of enormous power output due to the incorporated class B circuits of operation. The 40-watt power is only really called a hundred constant wattage class B circuit. This circuit is variously called class A prime, class A double prime, class A triple prime, or class C. They are all high frequency class B circuits with the output of the circuit in which the heat dissipation of the output tubes is considerably below normal with no signals impressed upon their grids. It can also be considered as a combination push-pull and push-pull circuit. However, the following recommendations are closely followed:

(1) The driver tubes should be capable of producing at least 400 watts of audio-frequency power output of at least 5% of the total output desired —in the herein described amplifier, this amount to more than 150 watts.

This text combines a purely mathematical treatment of the subject with a practical consideration of the subject. Thus, it not only provides a solid foundation for those who intend to specialize, but also furnishes an adequate knowledge of the subject, in comprehensive form, for those who intend to specialize in other branches of engineering. Although designed chiefly as a college textbook for students of physics and optometry, it may also be used as a reference work for specialists in the fields of illumination, motion pictures, television, instruments manufacture, etc. R. H.


In these days of pentodes, band-pass tuners, automatic volume control, diode detectors, etc., etc., it is a relief to have a thorough treatment which sidesteps the fundamentals Just a little and devotes itself to the problems of modern radio design. Radio Engineering performs this function admirably.

The fundamentals of radio have been treated in a manner apparently new, that it was with a somewhat prejudiced attitude of boredom that this book was opened. After the first page or two, however, the ground covered by the book became apparent: it brings before the reader a comprehensive treatment of the factors governing the design of modern vacuum tubes, amplifiers, speakers, oscillators, etc., in a manner that makes it difficult to lay the book down. For instance, all derivations of formulae are given in footnotes rather than in the body of the book itself. In this manner the reader is saved the trouble of wading through a lot of mathematics that may not be desired; or, if the reader is mathematically inclined, reference may be made to the footnotes for a more detailed analysis. Algebra is sufficient for most of the derivations, but the calculus is helpful for those requiring the expansion of a power series. Of particular note is the use of several convenient chart and work sheets, which are of invaluable assistance to the practical design engineer.

The method of treatment is simple: The fundamentals of the subject are given briefly, stressing the high-light: the reader is then launched into a description of the application of the fundamentals, with the problems of modern radio receiver design in mind.

It is recommended, therefore, that the reader acquaint himself with a complete knowledge of radio before reading this book, as it is not intended as a textbook on radio or electronics.

A partial list of the contents follows: circuit constants, properties of resonant circuits, functional properties of radio circuits, triode amplifiers, oscillators, detectors, special vacuum tubes, modulation, sources of power, electrical properties of vacuum tubes, transmitters, receivers, antennas, propagation of radio waves, aids to navigation, radio measurements, sound and sound equipment, etc. L. M.


This is an authoritative and exhaustive work on the photocell, written by two well-known research workers who have specialized in this field. Zworykin is especially noted for his development of the cathode-ray tube for television purposes, and for other notable achievements in the science of photoelectricity.

The book is intended as a general introduction to the "electric eye," and strikes the happy medium of being simple enough for the untrained man and yet not too shallow for the specialist. It makes interesting and instructive reading for the radio man.

Starting with the history of photoelectric effects, the book covers radiant energy, photo-emissive effects, photo-sensitive films, material and apparatus for making photocells, and cells of the vacuum, gas-filled, photo-conductive and photo-voltaic types. Subsequent chapters deal with the problems of amplification, special high-frequency, and the use of the photocell in photometry and colorimetry, the photocell in sound movies, television and facsimile transmission, miscellaneous applications, and photocells in the future. We can recommend this book very highly to all radio men.


This book is a most comprehensive survey of the field of photoelectricity. It is mathematical, concise, and accurate. For the engineer interested in establishing a complete analysis of photoelectricity this book is recommended without any hesitation.

The field of photoelectricity changes so rapidly, that it is almost impossible to attempt to look up all the back references on the subject in order to actually know its present status. This book has been prepared in order to supply a treatment that may be looked upon as authentic. Its completeness is apparent at the outset. Starting with the fundamental laws of photoelectricity, the reader is taken carefully and smoothly into the photoelectric threshold, energy and spectral distribution of photoelectrons, the selective photoelectric effect, theories of photoelectric emission, ionisation of gases and vapors by ultra-violet light, photo-conductivity, photo-voltaic effects, etc. Truly an important and much needed contribution to the field of photoelectricity. L. M.

AUTO INTERFERENCE

A very interesting experience with automobile radio receivers has been reported by a number of different persons. It seems that in certain cars the sets give forth a great deal of noise of the kind usually due to static. This interference is not caused by the ignition systems, as it persists even with the engine completely shut off and with the car merely coasting under its own momentum.

One man reports that the trouble is most noticeable when the car is driven over dry cement pavements and that it disappears when two of the wheels are allowed to roll on the pavement on to the dirt shoulders of the road.

This interference is undoubtedly caused by frictional electricity generated by the rubber tires in contact with the cement pavement, which is a rather good insulator when dry. Since the entire metal body of the car is quite effectively insulated from the ground by the rubber tires, the discharges are quite likely to make themselves felt in a sensitive radio receiver. You undoubtedly have noticed that gasoline tank trucks invariably have a length of iron chain hung from the rear axle, merely dangles along the ground. Its purpose is to prevent an accumulation of static charges, which naturally are very dangerous in a vehicle of this type. That such static discharges can build up to an appreciable extent is well known to owners of automobiles.

RADIO-CRAFT for MARCH, 1933

"Look to your Resistors!" has made set owner and service-man alike OHIOHM CONSCIOUS

1932 marked the first year that resistors were popularized, 1933 points for strides in this direction. The makers of OHIOHMS lead the country in aggressive- ness and greater profits for its trademark. Keep in pace with this progress by tying up with OHIOHM.

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40-WATT AMPLIFIER:
(Continued from page 560)
(2) Improved voltage regulation is probably the most important factor, and is only obtainable with perfectly designed power transformers. Input filter choke, and mercury vapor rectifiers tubes. (The 81 rectifier tubes are poorly fitted for this purpose, as their large internal voltage drop usually amounts to about 65 volts and varies with the current passing through them, while the 85 mercury vapor full-wave rectifier tubes have a corresponding voltage drop of only 40 volts, and are independent of current variations. Besides remaining much cooler in operation, each 85 tube can supply 250 ma. as against 65 ma. for the 81 tubes.
(3) The total power consumption should be kept at a minimum to avoid excessive and expensive damaging heat accumulation, and to avoid the need of larger power supply equipment.
(4) The bias voltage required for the output tubes must be obtained from a power source that is not affected by the large current variations of the output tubes.
(5) All parts should be especially designed for this circuit, and no attempt should be made to employ standard type A, 12 volt output parts. Thus, full constructional details are given for the push-pull input transformer, in Fig. 2A, and all circuit constants are shown in the schematic diagram, Fig. 2B.

FUNDAMENTAL PRINCIPLES OF RADIO
Radio Simply Explained, in Plain Language and Functions
By Louis Martin
Prepared with special consideration to young members in the radio profession, and those who have gained their experience in a hand-worked cubical. This book is designed for the working man and for the radio amateur. The full text is based on the book "Electrical Engineering," by Louis Martin. It explains the principles of radio in an easy and understandable way. It is a step-by-step guide to understanding radio.

FORMULAS and RECIPES
For the Practical Man
By W. G. Bergman
An extremely helpful book showing you how to save money by making your own home, at a fraction of the expense cost, the hundreds of home improvements which you now buy for at home and hardware.

ELEMENTARY MATHEMATICS
for the Technicians and Craftsmen
By C. M. Shafran
This manual has been especially prepared for the men who are called upon to acquire a working knowledge of the elementary mathematics of their work. It is designed to meet the needs of a technical and practical nature, with special attention to the use of mathematics in radio and other technical work for those who employ it for formulas daily.

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Radio Craft for March, 1933
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HOME EXPERIMENTS

DURING the several months in which this article has been in preparation, a number of articles on quasi-optical home experiments have been appearing in RADIO-CRAFT magazine, a number of simply built pieces of light-sensitive apparatus have been described and their uses explained. In this month's department we digressed a time to take a look at what is going on in the commercial world in the progress and development of light-sensitive equipment.

In the laboratories of the country's leading electrical houses, experimenta have been and are being conducted to determine the further commercial uses of this modern Aladdin's lamp; the photocell and its associated apparatus. In the usual technical bulletins issued by these firms, the editors felt that much of the technical material received was of particular moment and that it should be kept in a permanent and easily accessible file. For that reason much of it is presented here, in a boyled-down fashion, to be sure, but none the less instructive.

Thief Catchers

From the Intellect-A-Ray Corporation comes the technical information concerning three of their devices: the relay or burglar alarm, the sound cell, and the NO Op cell. The first is named in a most complete burglar alarm system, the second in sound heads of talking-picture projectors, and the third is especially designed for use with the 16-mm. home-movie outfit, to provide home talkies. A most unusual and practical thief catcher is illustrated in the photograph. The pieces of apparatus shown, when connected together in the relay of a simple set of directions which accompany each outfit, provides a most efficient burglar alarm system. An invisible ray generator and projected point, the special "siren" No. 2 which is appropriately designated for wall mounting on a swivel joint. This ray detector is composed of a special system of high transmission quality lenses and filters using an invisible ray which penetrates ordinary glass in fifty watts at 110 volts. The ray is projected so as to impinge on the active surface of the relay which is housed. When aimed in operation, the cell mounting, No. 4. If it be required to reflect the invisible ray on the relay double layer, the "mirror" is flat and the special ray mirror, No. 5, is used for the purpose. The lock-box, No. 1, the brains of the installation, is the terminus of the various connecting cables and also contains the control mechanism.

Light-Beam Narrowcasting

From the News Bureau of the General Electric Company at Schenectady, New York, comes the following release concerning the successful lighting of a mine shaft by a human voice on a beam of light over a distance of twenty-two miles.

"It was a twelve-hour trip to walk the distance from Schenectady to the Adirondacks. The voice was carried 22 miles on a beam of light; the previous record was about six miles. The successful spanning of the much greater distance was accomplished on the evening of November 22, 1932, when Heywood Broun, newspaper columnist and radio speaker, stood before a microphone in one of the buildings of the General Electric Company at Schenectady. Beside him was a 24-inch reflector, concentrating into a narrow beam the light from an electric arc. The light appeared constant but surprisingly was very rapidly varying in intensity, being modulated by the voice of Mr. Broun. Through a closed window the light beam was pointed northward to the foothills of the Adirondacks."

"High up on a hillside near Lake Denoliation, at a cow-flight distance of more than 22 miles was placed a steamer and other scientific instruments of the G.E. They had a 90-inch reflector, at the focus of which was mounted a light-sensitive phototube equipment. The technicians had established the contact. The phototube equipment, responding to the light variations, translated the lot into electrical waves and then into sound."

"The principle used in this broadcasting was that worked into our 'flying' telephone in the last month on the occasion of the visit of the U.S. Navy dirigible Los Angeles to Schenectady. At that time under the direction of Mr. Taylor aboard, the dirigible circled the roof of one of the laboratory buildings and kept up constant communication by means of a similar but less powerful beam of light."

Check and Double Check

One of the simplest uses of the photocell in commercial work is in the prospecting and counting of manufactured objects in the production department of a manufacturing concern. Interruption of a light beam focused on a photocell by the progress of the manufactured object along a conveyor enables one to keep track on the products as they are turned out.

Seeing Through Fog

Within recent months at least two new inventions in which the principles of use of light-sensitive apparatus have been applied have been announced to the public. Both were somewhat alike although used in different ways for different purposes.

It is a well known fact that mariners on the ocean obtain their bearings by "shooting the sun" with a sextant and then mathematically computing their exact position in terms of latitude and longitude. On overcast or foggy days or during storms, when the face of the sun is obscured, they are out of luck, so to speak, since they are unable to "shoot the sun." Or so it would seem until science stepped in and surmounted this very serious difficulty.

Although at times invisible to the human eye, the sun's rays, to a certain extent, do penetrate the intervening layers of clouds and atmosphere. So much so, in fact, that on the first day of an electrical sextant, utilizing the properties of the photocell, when aimed in the general line of the sun will respond immediately; and, by means of appropriate meters it is possible to ascertain exactly when the electrical sextant is accurately aimed at the sun by the maximum deflection of the meter indicator.

The second practical use to which the phototube has been put is in the detection and location of airports. Shown in a plane in flight by an instrument of foot. When the plane, on which is mounted a light sensitive apparatus enters the influence of a beam of light projected upward from a neon beacon, the pilot is made aware of his proximity to the landing field and can come in for a landing.

If you have any particularly good photographs of the light sensitive apparatus you have constructed and wish to let others know about it, send them to this department, with a short description of the same. If you desire to have such photos returned to you be sure to include the necessary stamped addressed envelope.

Photograph of the Intellect-A-Ray apparatus described by the author. The unit is shown divided into five different parts, as follows: (1) the lock box, brains of the equipment, is the terminus of the various connecting equipment and also contains the control apparatus; (2) the light-sensitive ray; (3) the phototube; (4) the electric-cell proper, upon which the invisible ray is impinging; (5) housing of the Intellect-A-Ray, shown in (5). [A 4-inch beam cannot be focused well.]

Make More Money

Now you can test automatic volume control, diode, resistance coupling, phase shifting, automatic noise suppression, automatic tone control and the many variations of these circuits. Until this new, exclusively Readrite meter appeared, it was necessary to pick your way through the circuits by a laborious and confusing proud contact method. The fact that voltage tests are inadequate and that they lead to gross errors compels testing of modern sets by the resistance method.

Quoted At a Popular Price

All parts are carefully assembled in a strong, fine leatherette case with a removable cover. Handy instructions on the panel, show in detail the circuit and tube socket connections for each position of the various switch positions.

This precision tester is quoted at $3.99 net to dealers—a price so low that you can afford to own it immediately. Besides, it will do work that you would not expect from more expensive units.

If your jobber cannot supply you, we will ship the No. 1000 Tester directly to you—when remittance accompanies your order at dealer's net price of $3.99.

READRITE METER WORKS
44 College Ave., Bluffton, Ohio

MAIL COUPON NOW
Readrite Meter Works, 44 College Ave., Bluffton, Ohio

Gentlemen: Please send me information about Readrite No. 1000 Resistance, Continuity and Capacity Tester. Also catalog of other servicing instruments.

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SOUND TECHNICIANS' COURSE embracing Television Fundamentals, Public Address Systems, Recording, Sound Motion Pictures, Electronic Tube Applications.
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POSTAL RADIO
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How to build an up-to-the-minute Tube Tester

How to build an up-to-the-minute Tube Tester

Converting RCA and Air-Water Kenmore Receivers

Point-to-Point capacity testing

Coming in future issues of Radio-Craft

CLASSIFIED ADVERTISEMENTS
Advertisements in this section are inserted at the cost of ten cents per word for each insertion—minimum, initials and address as one word. Cash should accompany all classified advertisements placed by a remittance drawn on a bank in New York. No less than ten words are accepted. Advertising for the April, 1933, issue should be received not later than February 5th.

CHEMISTRY

DOGS
BEAUTIFUL, Registered bull pups, $15. Bulldogs, $65-RG. Rockwood, Dallas, Texas.

INVENTORS
PATENTS—SMALL IDEAS may have large commercial possibilities. Write immediately for free book, "How to Obtain a Patent" and "Record of Invention" forms. Delays are dangerous in patent matters. Free information on how to proceed. Clarence A. O'Brien, 331-3 Adams Building, Washington, D. C.

MISCELLANEOUS
CABINETS, GRANDFATHER CLOCK style, 5 ft. high, walnut veneer, $5.00. Midcentury table, 1154 lbs. $18. All brands of mechanical and electronic organs. Send money, or dollar deposit for C. O. D.'s. E. R. Stevenson Co., 161 Champlin St., Rochester, N. Y.

RADIO


MAGNETIC Speakers added—cables re-wound, $1.50. Radio Service, Flora, Indiana.


MAGNETIC Speakers added—cables re-wound, $1.50. Radio Service, Flora, Indiana.


Cobalt Alloy Filaments

A new type filament for practical two-volt battery tubes, and for future application to other types of tubes, is announced by the Engineering Department of the DeForest Radio Company. This cobalt alloy filament is said to overcome the usual deficiencies. It is experienced with the 30, 31, and 32 types of tubes in which a finely drawn nickel filament is employed. With a diameter of .001-inch, the usual nickel filament provides uncontrolled emission and is subject to premature burn-out, and makes for a short-lived tube.

The cobalt alloy filament developed by De- Forest engineers has a much greater hot tension strength. Furthermore, the increased diameter for a given resistance makes for maximum efficiency of emission. A relative comparison between the nickel filament and the cobalt alloy filament is as follows:

<table>
<thead>
<tr>
<th>Material</th>
<th>Ni Co</th>
<th>Fil.</th>
<th>Fil. cone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight in milligrams</td>
<td>9</td>
<td>15</td>
<td>75%</td>
</tr>
<tr>
<td>Diameter</td>
<td>10</td>
<td>15</td>
<td>33%</td>
</tr>
<tr>
<td>Area</td>
<td>43</td>
<td>43</td>
<td>100%</td>
</tr>
<tr>
<td>Tensile Cold Strength</td>
<td>4</td>
<td>300</td>
<td>100%</td>
</tr>
</tbody>
</table>

The 30, 31, and 32 tubes produced with the new filament have a service life consistently over 1,000 hours. The new filament makes for a tube one-third as microphonic as when the usual nickel wire is employed. The cobalt alloy filament is stronger, easier to handle, and the tension is more accurately secured, making for greater precision in stem mounting. The operating temperature is the same as for nickel.

The cobalt alloy filament offers a promising field for development because of its low thermal emission. It is entirely probable that the development work on this filament will be extended to other types of tubes by DeForest engineers.

A.C. AND D.C. RESISTANCE COMPARISONS

In certain applications in a radio set it is highly important that the resistance should be independent of frequency. For example, a 1 megohm unit which may be employed as a grid leak between the last B.F. stage and the detector tube should retain its resistance value at radio frequencies, for otherwise the amplification may be materially altered. In most resistors, par
ticularly those employing a large mass of resistive material, the resistance value varies inversely to the square root of the A.C. at different frequencies due to the skin effect of surface conduction of A.C. of different frequencies. A resistor employing a thin resistive coating on an insulator base, such as the metallized resistor, is free from any materially variation between D.C. and A.C., since the conducting medium is practically the same under any condition.

On actual test, the usual solid conductor type of resistor shows a wide difference in resistance between D.C. and A.C. of varying frequencies. For example, a 1 megohm unit when measured at 750 K.C. shows a resistance of anywhere from ½ megohm to 300,000 ohms.

In the latest type of metallized resistor employed the newly developed "K" filament, the resistance variation is extremely small for D.C. and radio-frequency applications. If there is any difference at all, the radio frequency resistance is but slightly higher than the D.C. resistance, and therefore the amplification might rise rather than fall, although by a negligible amount.

It is therefore possible for definite resistance values to be obtained in a radio circuit irrespective of whether D.C. or A.C. of different frequencies is employed.

Ready March 1st—New Hand Book

Although the 1932 ELECTRAD Hand Book was considered the last of its kind for more than 10,000 users—the new 1933 edition is BIGGER, BETTER, MORE COMPREHENSIVE. It lists in easy readable form, full data on all resistors (including carbon) and volume controls—indispensable information for the busy service man. The $1 subscription includes three supplements, as issued during the year. Send your dollar NOW!
How to Become An Amateur Radio Operator

W. T. Draper has written this book because he has been years of experience in the amateur field, and has made him a proficient in the line. This book gives a very concise instruction of radio equipment to the reader, and in this book he has described all the essential parts of the radio equipment. The book is divided into two parts: one for the beginner and one for the advanced student. The first part gives the working terminology of the radio operator. The second part gives a complete description of the various parts of the radio circuit. General radio theory is explained in detail, and the beginner will learn the fundamentals of radio operation. The book is well illustrated with diagrams and charts, and is a valuable reference book for amateurs and students of radio. The author, Draper, is a member of W.T.C. (American Institute of Radio Engineers), also member of the Radio Association of America. This is an invaluable book for all beginners in the art of radio operation.

How to Build and Operate Short Wave Receivers

The third part of the book is devoted to the building and operation of short wave receivers. The book gives step-by-step instructions for building a receiver, and includes a detailed description of the parts and circuitry required. The author, Draper, has also explained the theory of operation of short wave receivers, and the beginner will learn the fundamental principles of the art.

Mail Coupon at Left for Books!

Here's a book every Radio Man will refer to dozens of times every day.

OFFICIAL REFRIGERATION SERVICE MANUAL

This book is designed to be a complete guide for the service technician. It contains over 1000 diagrams, more than 300 complete service data, and over 300 pages of material at no extra cost.

A Valuable RADIO BOOK!

Here is a radio book that answers every conceivable question on interference. It contains 15 pages, 8 x 11 inches, chuck full with wiring diagrams, drawings and photographs, showing where the interference is, how it is distributed, and how to eliminate it. This is a wealth of information needed by every radio listener, and it is a valuable reference book for service men.

Send fifty cents in stamps or check for this book.

RADIO-CRAFT MAGAZINE

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BULLETIN

THE BIGGEST NEWS-MAGAZINE IN

THE RADIO INDUSTRY

Issued Monthly for Radio Service Men

This new magazine is filled with interesting service information; plans of the Association; Service Men's experiences; answers to inquiries about servicing; hints on making extra money in the servicing field, in short, it is a magazine written for and by members of the O. R. S. M. A. It is the voice of the Association in which the problems and suggestions of the individual members are presented for review and discussion among the fraternity. It is a magazine for, of and by the Service Men. Published by the Service Men's Association, sponsors of the OFFICIAL RADIO SERVICE MEN'S ASSOCIATION.

In appearance this BULLETIN is made in the fashion and size of a tabloid newspaper. It contains up-to-the-minute service information. A partial contents of the first issue is found below:

Editorial:—The purpose of the O. R. S. M. A. BULLETIN.

Managing Editor:—Service Managers of large Radio Service Men's Associations and Service Men's Associations, experienced in the methods of handling. The Service Men's Association—by members. What the Service Men should charge—various angles of this vital question. A sermon to set owners—Beginning the War on Free Spares.

The Service Men's Own Forum—Letters on all aspects of the service business.

Electrolyzing and Modernizing old receivers as a source of income to the Service Men. Making Money at Servicing—the ways in which these organizations are using new methods to extend and otherwise extend their sources of income.

The Question Box—questions and answers of servicing, questions of general interest.

Subscription Rates for the O. R. S. M. A. BULLETIN.

O. R. S. M. A. Members:
Non-Members:

$1.00
$1.50
$2.00
$2.50

Price of Single Copy 10c

Subscription Blank

Executive Secretary O. R. S. M. A., 50 Park Place, New York, N. Y. Enclosed find my remittance of $ for subscription for years.

I am a member of The Association and my membership certificate number is .

I am not a member, but would like to receive your application blank to join the O. R. S. M. A. (no dues to be paid by me).

Name

Address

City

State

"A".

AUTO-MOTIVE RADIO DATA

The following interesting information has been compiled by Magnavox Company Ltd., makers of automotive radio reproducers: The considerableness of this information should thoroughly squelch the envy of those who insist that there is no business to be had in the radio field and that it is all over the "satisfaction point" as a couple of handy words with which to end their arguments.

Dealing in round figures, states the report, there are 25 million passenger cars in this country. It is generally assumed that there are about a half million auto radio sets in use. On that basis this market is 2% saturated. For every two cars with radio there are ninety-eight without.

The sale of household radio receivers is based upon 57 million families, which indicates the importance of the automobile market. Perhaps some of us haven't given as much thought to the potentialities in this field as it deserves. Each successive year shows an increase in auto radio sales over the preceding, and 1933 will not be an exception. Think it over.

Operating conditions of auto radio make rugged construction one of the most vital factors in design. Auto radio sets made today are more rugged in every way far advanced over the first ones. (Magnavox has helped in pioneering this field with a dynamic speaker that "stays put" and which must have good tone, then rugged, dustproof, and quickly installed.)

TELEMETRY RADIO SETS

Editor, Radio-Craft

Dear Sir:

I am writing you relative to the service manual on the Temple Radio.

Temple Radio, prior to the time they were forced into bankruptcy, made only two models of electric sets using one 2-224's, 2-227's, 2-245's and 1-280; the other uses 4-224's, 2-245's and 1-280. These sets were both tuned radio-frequency circuits.

When Temple was sold to the new company composed of Len Welling of New York, Wexler of New York and Izenstark of Chicago together with others, the Temple set became an auto trade name only, and during the time they sold the Temple they were made with Columbia chassis or any chassis that was handy to put into a cabinet and sold under the name of Temple.

At the present time Transformer Corporation of America, 4072 West 59th Street, Chicago, Illinois, are making a Temple set for a holding company in New York, so the set you have in question is either a Columbia, or a what have you, or possibly a Clarion.

We are very happy for the opportunity of giving you any information that we may be able to offer and will be happy to help you at any time on problems of your Temple.

Yours truly,

L. BOLLEN & J. STAEFFENBERG

Temple Radio Service Station, 2515 West 59th Street, Chicago, Illinois.

BRUNSWICK AND BREMER-TULLEY

Of special interest to all radio Service Men and also to many dealers and distributors, is the announcement regarding the establishment of a national headquarters in New York City for Bremer-Tully radio parts and Brunswick radio and phonograph replacement parts and service.

Hereafter, these parts can be obtained from the Bredero Radio Corporation, 424 Liberty Street, New York, N. Y. This concern has been organized to act as the authorized central source of genuine replacement parts for these two makes of receivers, and, also, to perform actual servicing in instances where highly specialized aid is imperative.

Servicing and replacing activities, formerly handled by the Brunswick service department at Muskegon, Mich., will benefit from the establishment of the New York offices of the Bredero Radio Corporation.

Brunswick has turned over the entire factory replacement parts inventory to the new organisation, including parts for all phonograph models, for Brunswick Radiola and Panastronic Radiola models, for all Bremer-Tully models, for all instruments incorporating RCA units and for all Brunswick radio receivers, with the exception of the "D" and "E" models.

VOLTAGE AND RESISTANCE MEASUREMENTS

95% of radio-set troubles can be located quickly and accurately with the CENTRALAB Quality cost so little.

Use Centralab resistors in your replacement jobs...they cost so little more that you put them to shame the usual "bargain type" products. Centralab products are baptized in fire at 3000 degrees to insure permanent, perfect performance. Play safe...use only CENTRALAB Resistors.

10 fixed resistors—in carton—(choice of values) list at 2.25, your price, special.

Voltage and Resistance Measurements

95% of radio-set troubles can be located quickly and accurately with the CENTRALAB Quality cost so little.

Use Centralab resistors in your replacement jobs...they cost so little more that you put them to shame the usual "bargain type" products. Centralab products are baptized in fire at 3000 degrees to insure permanent, perfect performance. Play safe...use only CENTRALAB Resistors.

10 fixed resistors—in carton—(choice of values) list at 2.25, your price, special.

CENTRALAB RESISTORS

CENTRAL LABORATORIES

393 E. Kenne Ave., Milwaukee, Wis.

BACK ISSUES OF RADIO-CRAFT can be had at the price of 25c each. Address RADIO-CRAFT, 98 Park Place, New York City.

SHALLCROSS No. 681

Quick-Change Volt-Ommeter

10 - 100 - 300 - 1000 volts 0 ohm to 3 megohm

This instrument is very easy to build. The important parts required are a 1-milliamphere D.C. meter and the SHALLCROSS Resistor Kit No. 681.

Send 6c in stamps for Bulletin 681-P, describing the service man's most useful test instrument.

ELECTRICAL SPECIALTIES

Collingsdale, Pa.
WIREDB RADIO

The largest number of subscribers to "wire radio" is in Holland, with a list containing 170,000 names, states a short item in "Radio-Television Retailer and Jobber." In Europe the public telephone lines are usually employed as the carriers, and the systems are frequently tied in with the space broadcasting programs. That is, the "wire radio" stations pick up the broadcast programs and relay them over the wires to the subscribers.

In the United States it is proposed to use the power lines as carriers, and the system will be worked in competition with space broadcasters. In order to provide adequate service, it is necessary for the sponsoring company first to acquire patent rights for devices used and then to obtain dependable sources of broadcast material.

RADIO AS A SOCIAL FORCE

The influence of radio, as a social force, has become most pronounced in the linking up of all human activities instantaneously. Except for the barrier of language it is now possible for human beings in all parts of the earth to learn of great events almost as soon as they occur and to respond to them instantaneously.

This was marked very well in the nomination of Franklin Roosevelt as president on the Democratic ticket last summer. The whole country, at least, was able to follow the balloting from the moment it started; it knew, as soon as the delegates in the hall did, that Roosevelt had been nominated; it was as well posted as the delegates on the dramatic trip by Roosevelt to the convention hall by plane; it was able to follow closely the reactions of the delegates as Roosevelt addressed them. The country became a living breathing organism responding at once to world events.

How different this is from events in colonial days when days were necessary before a candidate knew of his nomination or election. The time lag then must have been terrific. Even the telegraph did not remedy this entirely, because people in rural sections still had to wait until news was telegraphed to newspapers, the papers were printed and sent to subscribers.

The radio speeds up the life processes and enables us to live more quickly; to crowd more events into a lifetime.

Should another war come, it is quite possible that radio audiences will be able to keep in instantaneous touch with campaigns, events and personalities on the field of battle. Unless censoring becomes too heavy, the victors in the war will feel more elation as event progems, and the defeated less despair. Psychologically, therefore, wars should end quicker than they did in pre-radio days.

Since the whole world will be tuned-in in the future, and possibly translators will be on hand to translate international hookups on events as they occur, people will become more interested in international events. Great international crises that provoke war will now get an immediate public reaction. Leaders who respond to the public will, be able to get an immediate judgment on a course of action to pursue.

Rural prejudices may be expected to fade out as the suburbanite sets the urban point of view through the radio, and vice versa. The farmer can tell us of his troubles and get a personal sympathetic bearing through the air; while the city worker will have an audience of farmers, on whom he can speak.

Great disasters will provoke immediate response from sympathetic people the world over, and help for the stricken will be sent quicker. This too will help to promote international goodwill. It might be a good question to ask, what the events of 1914 would have been had present day radio service been in existence at that time.

The effect of radio is only beginning; it is sure to change many of our habits and thoughts and to create far-reaching social changes. It has already gone far to create new educational and artistic outlets. If properly handled it should be a means for constructive propaganda never before possible.

Of course improperly or unwisely used it can become as great a menace as it might be a boon. It is vital therefore that it be kept from becoming a weapon in the hands of those in power to maintain themselves. The radio, above all, should be open to all parties and all social and political opinion. An enlightened policy on the part of broadcasting companies will do much toward this.

For example, when Technocracy became a household word, Howard Scott appeared quickly on a national hookup. This gave the people of the country a chance to get into immediate and personal contact with the Great Technocrat; and it is possible that the radio talk might have been responsible for the break in the group that later occurred. Events must move quickly in this radio world.

"Cliff" Denton has written

Point-to-Point Resistance Measurements

The Modern Method of Servicing Radio Receivers

ANOTHER VALUABLE BOOK FOR SERVICE MEN

Of the difficult problems which Service Men face today when repairing receivers, the greatest is that of replacing proper resistors in sets. This task becomes even more difficult when the values of resistors are unknown; and manufacturers of many standard sets do not pass this information on to Service Men.

In this new book, "RESISTANCE MEASUREMENTS," radio men will find the information needed to quickly place a receiver in proper condition. This book cuts in half, the time usually required to adjust the average set.

Sufficient space has been devoted to the elementary problems and the theory of electricity as it is applied to resistance measurements so that the Service Man will have a comprehensive idea as to how to overcome this problem.

Below you will find a partial list of the contents which will appear in this new book . . . . prepared by one of radio's foremost service writers, Clifford E. Denton.

Partial Contents of POINT-TO-POINT RESISTANCE MEASUREMENTS


CHAPTER 2—Basic Principles.

CHAPTER 3—Methods of Resistance Measurement.

CHAPTER 4—Resistors in Radio Receivers and Amplifiers.

CHAPTER 5—Point to Point Resistance Measurements in Typical Radio Set using Ohmmeter.

CHAPTER 6—Resistance Measurements using Modern Testers.

CHAPTER 7—Routine Testing where Circuit Diagram is Available and where Resistances are Known.

CHAPTER 8—Routine Testing where Circuit Diagram is Not Available and where Resistances Are Unknown.


CHAPTER 10—APPENDIX. Resistance Charts, etc.

64 PAGES OVER 100 ILLUSTRATIONS 6x9 INCHES

THIS BOOK IS A NEW ADDITION TO THE RADIO-CRAFT LIBRARY SERIES
"TRY THIS ON YOUR—"

Scanning, a common term in television, believed by many people to be something new, is really as old as man. Make up Holli Baird, chief engineer of Shortwave and Television Corp.; for the human eye has always scanned the world all the time. And always will. As few people realize how simple it is to prove this (one of the fundamentals of television) the continuation of Mr. Baird’s remarks will be of general interest.

Without thinking definitely or analytically about it, we would not know what to look at a picture or a scene we see it all at once, but the fact is that we see only a tiny spot. What happens is that our flexible, efficient eyes rapidly travel across and up and down a given scene, registering the various parts so rapidly that a complete picture seems to be seen.

It is easy enough to test this. Hold your hand out straight in front of you and then look at the thumb nail. Now without shifting your eye in the slightest try and see how much else you can see clearly, not just surmised, but vividly. And find that the area comprising the end of your thumb is about all that is sharp.

Now open your eyes and decide you want to see all of it. As you do, notice carefully what your eyes are doing and you will see that they are sweeping back and forth in various cross directions until they have covered every bit of your hand. Then you have a very definite picture of what your hand looks like—yet it was obtained piecemeal.

Taking something more concrete, more nearly like what a television camera must pick up, let us look at a motion picture. As the action goes on, you see nothing (or almost nothing) happening on the whole screen but if you will pick out a single spot on the screen and look at it, without moving your eye, you will find that the eye is actually seeing but a small part of the picture clearly, the rest being in sort of out-of-focus relation to the main spot of vision. The human eye, however, moves so quickly that it takes in the whole picture in a series of rapid glances and the memory retains these pictures, each piece in its proper place, and the effect seems to be a whole, complete picture. In television the same thing takes place: the television camera rapidly scanning a scene which, in turn, is reproduced in the same order by the television receivers. Of course, this scanning is much more rapid than the human eye, as the scanning spot cannot pick up as much detail as the human eye will register correctly at one instant, and so must travel faster to get in all the points.

Another point of difference is that the human eye needs no definite routine to follow in scanning a scene, for it may move across the top, down to the bottom and across there, back to the top again, up at all angles from the lower left to the upper right corner, etc. In television, as in anything mechanical or electrical, an accurate pattern must be followed to be repeated in rapid succession, in order that at the receiver the same pattern may be followed and a picture reproduced which will be the same as the picture picked up at the transmitter.

Thus, while television may seem to be a far cry from any human parallel it actually follows the human eye more accurately in its procedure than does a camera which takes in all at once a complete picture. Eye scanning is a fascinating thing to experiment with and should offer a lot of fun for the person who likes to contemplate television problems. Since the apparatus is already a part of one's body there is no cost involved. A study of the human methods of taking in a scene is indeed interesting.

"SPLIT" PROGRAMS

The "split" program, possible only where long- and short-wave stations are available. The musical part of the program is simultaneously transmitted from both the long broadcast-wave of KDKA and the short wave of WXKK, as usual done with ordinary station programs. However, when reaching the spoken part of the program, which is to be "split," one part of the program (for instance, a conversation in English) going over KDKA and other part (for example, a talk in Spanish) going over short-wave station WXKK, it requires a switch in lines.

P. A. OPERATORS!
On the output end of your amplifiers—

FOX electro-
dynamic UNITS
and Aluminum HORNS—

—more mean and more dependable performance. All precautions have been taken to assure that FOX is the most dependable. Even the diaphragm is guaranteed for one year and as a P. A. Operator or user of heavy duty units, you cannot afford to overlook a product with such a positive guarantee on it.

FOX American trumpet horns too. They are constructed in four and six foot sizes, sturdy, beautiful in tonal quality and will withstand any weather conditions.

Service also—we repair any make or type of sound microphone. Work guaranteed, prices reasonable and return shipment prompt.

ATTENTION TO ALL!
Write for complete descriptive information also the new FOX portable P. A. system. It is the smallest, most power you ever saw, only 7x5x10 inch, entirely self con-
trolled and gives more than enough volume to distri-
bute speech throughout most small and small-sized or able to hear a whisper.

Price list $49.00, including a free class double button hard rubber microphone. Send in your order now.

Write for descriptive bulletins and permit us to quote trade discounts.

THE FOX ELECTRIC & MFG. CO. 3100 Monroe Street, Toledo, Ohio

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With Short-Wave Heat Effects Cure Human Ills?, by Dr. John T. Whipple, Vice-President and Di-
rector, General Electric Company; Short-Wave Control Model Ship, by A. S.瑞
Portable All-Wave Receiver, by J. S. K. "Zappper," Low-Power Transmitters, by W. W. S. Williard; Super-Wasp, by A. C. Lewis; Brought Up To-Date, by A. D. Davis; Short-Wave Receiver Built in a Glass Box, by W. E. S. Dillard; Two Tube A. C. "Band-Preaster," by W. P. Lassiter, Loud Breaker, by George W. Smube, W2ANW—W2OCU, Winner of $50.00 Contest Prize; A-Nut S. W. Super-condenser, by A. C. Mat-
alo; Radio Consultant; Feb. Two Tube Portable Receiver—the Ultimate in Sig-
Ness, by W. E. S. Dillard; Receiver The Longest From Four Tubes, by H. G. Bills, W. E.

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RADIO-CRAFT for MARCH, 1933

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www.americanradiohistory.com
AND NOW—THE FILAMENTLESS TUBE
(Continued from page 529)

gating the plate tends to result in the electrons being drawn through all the holes in the cathode and distributed over the entire area of the plate (provided the elements are symmetrically positioned with the usual commercial tolerances).

Characteristic Data

Although it is regretted that curves of the static and dynamic characteristics of the experimental tubes described by Dr. Hund are not available at the present time, considerable information may be obtained from the figures given and from known data regarding the operation of gas discharge devices.

A potential of 100 volts is shown in Figs. 2 and 3 as the value required to produce ionization between the two over-lapping electrodes; this figure, however, will depend entirely upon individual tube design. The current required to produce sufficient ionization for operation in the desired service is another variable factor; in one tube model this figure was 60 ma. The "power" consumption of this ionized path (equivalent to the more usual "filament") is therefore, 6 watts. In both Figs. 2 and 3 the cathode is shown placed at a potential 50 volts above that required for normal ionization, or 150 volts; the cathode current consumption will vary with tube design.

The grid and plate voltages, shown in Fig. 2, are those usually employed for grid-leak detection and types of hot-cathode triodes (zero grid bias, and 50 volts on the plate with equivalent plate current drain). The grid and plate voltages, and plate current of Fig. 3 parallel the figures for operation of a type 71A tube used as an amplifier. As Fig. 2 indicates, it makes no difference whether the operating potentials for a filamentless tube are obtained from batteries or a "B" eliminator, provided correct bypassing is secured in the latter instance.

Grid input impedances may run as low as 30,000 ohms and as high as present tubes. Output impedances can be made to match present tubes so that present transformers can be used. The power transformer must be designed to accommodate the additional 150 volts required by the ionizing and cathode circuits at the current drain of the particular tube types.

At the conclusion of the reading of Dr. Hund's paper, it was not necessary for the President of the Institute to ask for a rising vote of thanks as the audience showed their appreciation of this amazing development by loud and long applause. The discussion which followed brought to light several interesting points.

The Discussion

For instance, was brought to light that some heat is developed by electron bombardment of the electrodes; however, this heat is carried off through the stem of the tube by conduction, and does not reach a temperature high enough, for instance, to burn the hand.

In answer to another question, it was explained that the material used for the electrodes did not make much difference. In some tubes the electrodes were made of iron, while others used aluminum and nickel. The iron could be rusty, oily, and dirty, clean electrodes were no better than dirty ones.

The kind of gas used did not seem to make any difference. Combinations also did not exhibit any differences in operation. Chemically pure gas reduced the ionizing potential from about 100 volts, which was not considered too high down to as low as 30 volts. The amount of gas was usually between 10 and 20 millimeters, but Dr. Hund said it should be obtained quite satisfactory operation by using only air exhausted to 10 mm., and without the addition of any other gases. (Apparently enclosed gases cause little trouble in a tube of this type, and since high evacuation on expensive pumps is one of the most costly procedures in the manufacture of present-day hot-cathode tubes, it follows that a marked saving should be effected in the procedure of manufacturing cold-cathode tubes.)

The doctor explained to another engineer that the insulation within the tube was carried right up to the electrodes by extending the glass to the point of contact with the electrodes. This is done in order to prevent "sputtering" or uncontrollable sparking from point to point which otherwise occurs in gas-filled tubes.

Although the inquiries of four engineers and the impromptu calculations of another tended to indicate that the over-all power consumption of a tube of the filamentless type exceeded that of the filament type, it was pointed out that the practically "lifetime" longevity of the tube, its low cost of production, its freedom from variations in characteristics with relatively large changes in gas pressure, the absence of a filament winding on the power transformer, the ease of reproducing tubes having a given characteristic, and the simplification of receiver wiring, far more than offset the added cost of the increase in high-voltage output necessary to supply the ionization and cathode potentials and currents. Undoubtedly, this talk by Dr. Hund has done more to stimulate nation-wide interest in the cold-cathode or filamentless type of tube than any other publicity so far.

COMING IN FUTURE ISSUES

How to build an up-to-the-minute tube tester

Converting RCA and Atwater Kent Receivers

Point-to-Point Capacity Testing

The RADIO-CRAFT INDEX

It contains a thorough, alphabetical and topical arrangement of EVERY article and subject which has been published in all the issues of RADIO-CRAFT from July, 1929 to June, 1932.

Briefly outlined below appears only a partial contents of the book

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3. Intermediate Frequency
4. Low Frequency

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2. Indoor Antennas
3. Antennas for Short-Wave
4. Special Applications

CIRCUITS—
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RADIO-CRAFT INDEX
ABSOLUTELY NOTHING WHICH HAS APPEARED IN RADIO-CRAFT HAS BEEN OMITTED FROM THIS VALUABLE COMPILETATION
CAR AERIAL COSTS
Now that people are taking a greater interest in car-radio listening, Service Men will be interested in the following information furnished to Transistor Distributors.

Frequently people ask, "so and so" is charging ten dollars or more for an antenna. And they feel justified in charging this because they have to give top of the line from five to ten dollars for the work.

There is still a lot of hokum connected with installing an antenna, but you could do it. I could do it, practically anybody except the extremely careless person could do it—and do a good job of it. And it wouldn't take more than two or three hours to do it, either. That top man or upholsterer is only getting the cream.

Here are some actual figures. There is a service station not far from here where they do their own antenna work from the Ford to a Lincoln limousine. They have a young chap who knows enough to keep his hands clean when working with the heading for which they pay him twenty-two dollars a week. In addition to installing the antenna, he also helps with the rest of the installation and motor interference suppression. They average about eleven cars a week and in case installations are not so frequent, he is used for other work.

Not considering the other work, he installs eleven antennas a week at an average cost of $2.00 each for labor. The actual cost of this labor figured out over a period of several months however, is well under $1.50.

The cost of copper screen is approximately $1.00 per car where used. Even such as copper screen is not required in 50% of all installations, the average cost of the screen is only $0.80. The total cost of installing an antenna at this service station is $2.90, including labor and material. This certainly is a lot better than paying an outside shop anything five to ten dollars for each job and never knowing in advance just when you can get him to work.

CROSLEY RECEIVERS
(Continued from page 521)
tube superhetodryodn for operation from standard A.C. circuits, and having an intermediate frequency of 456 kc. This receiver uses a 68 oscillator-detector; a 56 i.F. amplifier; a second detector; a 42 output tube; and an 80 rectifier.

A photograph of the chassis of the Model 148 is indicated in Fig. B. The compact arrangement of the parts of the completed assembly, and their complete accessibility, is readily apparent from the inspection of the photograph. Of particular note is the fact that while the Model 141, described here, has an intermediate frequency of 181.5 kc, the model 148 has an i.f. of 456. In view of this fact, care should be taken in the attempt to line up the Crosley Book Case Receivers. Be sure you know the number model you are working with.

The Totem, Model 147
Public fancy has turned towards the ultra compact receiver, and to satisfy this craving, Crosley has announced their Model 147, better known as The Totem. It is a four-tube tuned R.F. receiver designed for operation from 110 volts, either 25 or 60 cycles, or from 110 volt D.C. An inspection of the photograph (Fig C) shows that the off-on switch and volume control are combined at the lower left-hand side of the panel, while the station selector, or tuning dial, is located on the top right-hand side. The loudspeaker grille is placed directly above the control knobs, as is evident. The two openings on the top of the cabinet provide space for ventilation, and also, in a measure, as additional outlets for loudspeaker output.

The complete circuit and additional views of this receiver will appear in a forthcoming issue of RADIO-CRAFT.

How to build an up-to-the-minute Tube Tester
Converting RCA and Atwater Kent Receivers
Point-to-Point capacity testing
Coming in future issues of Radio-Craft
CAR "B" BATTERIES
We print below some interesting information which, although furnished to a Trans- 
 publicly Service Station, is sufficiently receiv- 
 the attention of every radio

A Transistor owner recently drove into one of our service stations, and stated the 
lease, "with a request for service. A new model 7 had been installed in his car a few 
weeks before, in a distant city. After a few days the receiver stopped playing.

"An examination revealed that the "B" 
the batteries were dead. The batteries 
 and the "B" drain checked. Everything 
peared normal, and the owner now 
the customer was back for new batteries.
This time the trouble was found. When 
receiver was installed, the inner battery 
early looped over the exhaust pipe.

"It wasn't long before the insulator 
was burned through and the batteries charged.

Six "B" batteries and a battery cable, to say nothing of inconvenience and dissatisfac-
tion to the customer, and service expense to 
other service station are the price of this 
bit of carelessness.

"It shouldn't be necessary to warn service 
stations to keep clear from exhaust manifolds 
and pipes—the results of such neglect are 
no apparent. Every day, however, we see 
cases that are as bad, if not worse than 
this, so you had better instruct all your 
service stations.

1. Don't locate the battery box 
inside the mower where the batteries will become 
hot and dry out, causing short life.

2. Don't use wires that loop over 
exhaust pipes.

3. Every cable or wire should be fast-
secured to prevent it from interfering 
with any mechanism of the car.

THE TRAUTONIUM

(Acontinued from page 552)

AZ-14, .006 mf, C9:
One Flechtuber tubular condenser, type AZ-8, 
.001 mf, C10:
One Flechtuber tubular condenser, type AZ-6, 
.0005 mf, C11:
One Flechtuber tubular condenser, type AZ-4, 
.0005 mf, C12:
One Flechtuber tubular condenser, type AZ-1, 
.0002 mf, C12:
One Flechtuber tubular condenser, type AZ-6, 
.0001 mf, C13:
One Blum 16-contact induction switch, Swl: 
Two small baseboards, wire, wood screws, etc.; 
One type 30 tube.

replace broken terminals on storage batteries?

5. Electro "lead burning" is nearly 
ubrupt, practically all work in battery houses 
being done by the use of the oxy-acetylene torch.

Where electrical welding is occasionally 
ployed, the operator in nearly every 
stance will use a storage battery as a source of 
current supply, two or four cells outputting the 
four to eight volts required. Instead of using an 
ultraviolet battery to supply this voltage, it 
possible to use the storage battery upon which 
ork is being done (where the work involves 
the welding of storage battery terminals).

If it is desired to employ AC. for the 
aplication, it is possible to use a standard 
sed-welding transformer. This device may be built by 
inducing 10% Ibs. or 644 feet of No. 10, B. & 
auge D.C.C. wire for the 110 V. A.C. primary. 
wind this coil over an iron core 5 ins. long, 
5% in. wide. This core will be pointed to this 
ond by the low-voltage secondary is made by winding 31 turns of No. 6, 
B. & 5% gauge wire and (or, two No. 6, 
. wires in the same coil.

It will be necessary to use a husky carbon rod 
as one contact; this rod may have a diameter 
of about one inch and its connection being 
ated to the battery poles by means of a heavy 
clamp. This clamp must be shaped in such 
that any part of the work may be reached. 
The circuit is completed by connecting the 
other secondary lead from the long tube which 
is to be clamped onto the work.

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40-WATT AMPLIFIER
(Continued from page 568)

The applied R.M.S. plate voltage never exceeds 500 volts. This permits the use of low cost electrolytic condensers almost throughout.

One of the two received tubes is used in conjunction with its corresponding power transformer, PT1, and associated filtering equipment to supply the three-stage voltage amplifier, (type 6A6, and 259's) with the required voltage, as well as the bias voltage for the type 50 output tube. The other type 83 rectifier and its associated power transformer, PT2, are used solely to provide the filament and "B" voltages for the two type 50 tubes.

The primary of the output transformer T3 has a plate-to-plate impedance of 8,000 ohms. The secondary windings are suitable for 500 and 15 ohm outputs, tapped at 7.5 and 3% ohms.

List of Parts
One Coast-to-Coast chassis and four removable cans, type 5667C:
One Lynch Metalized resistor, 10,000 ohms, 1 watt, R1;
One Lynch Metalized resistor, 200,000 ohms, 1 watt, R8;
One Lynch Metalized resistor, 250,000 ohms, 1 watt, R8;
One Lynch Metalized resistor, 2,700 ohms, 1 watt, R4;
One Lynch Metalized resistor, 25,000 ohms, 1 watt, R6;
One Lynch Metalized resistor, 525 ohms, 2 watts, R5;
One Coast-to-Coast wire-wound resistor assembly, 6,000 ohms, 11 watts, type 5767, R7;
One Coast-to-Coast wire-wound resistor assembly, 1,500 ohms, 15 watts, type 5767, R8;
One Coast-To-Coast modified l.pad. 600,000 pot., type 6516-B, V1;
Two Coast-To-Coast electrolytic condensers, 10 mfd., 50 volts, type 5225, C1, C4;
One Coast-To-Coast electrolytic condenser, 2 mfd., 500 volts, type 5225, C2;
One Coast-To-Coast paper condenser, .02 mf., 400 volts, type E615B;
One Coast-To-Coast paper condenser, 1 mfd., 1000 volts, type 2890D, C5;
One Coast-To-Coast electrolytic condenser, 3 x 8 mfd., 500 volts, type 6896, CA-C6, CT, C8;
One Coast-To-Coast electrolytic condenser, 2 x 16 mfd., 500 volts, type 6896, CT, C8;
One Coast-To-Coast variable condenser tone control, type 6518, V2;
Two Coast-To-Coast resistor choke, 15 Hz, 300 volts, type E526CH, CH2, C8;
One Coast-To-Coast resistor choke, 15 Hz, 60 volts, type E526CH, CH2, C8;
One Coast-To-Coast push-pull push-pull transformer, type 6517, V3;
One Coast-To-Coast interstage push-pull transformer, type 6524, T2;
One Coast-To-Coast push-pull push-pull transformer, type 6517, V3;
One Coast-To-Coast push-pull transformer, type E625PT, PT3;
One Coast-To-Coast push-pull transformer, type E625PT, PT3.

FEDERAL SETS

Judging from our correspondence with Service Men all over the country, considerable confusion exists in regard to the Federal, Brandes and Kohler receivers. The following letter from J. H. Schmidt, factory service manager of Kohler Radio, Inc. of Newark, N. J., should help to clear up some of this misunderstanding:

"The Federal line of radio sets was manufactured by the Federal Telephone and Telegraph Company of Buffalo, N. Y., who we believe are no longer in existence. At the time C. Brandes, Inc., and the Federal Telephone Company of Palo Alto, Calif., merged and were manufacturing Kohler sets, the organisation became known as Federal-Brandes, Inc. However, there is no connection between the Federal Telephone and Telegraph Company of Buffalo and the Federal Telegraph Company of Palo Alto, nor has the Federal Telephone and Telegraph Company of Palo Alto any time been affiliated with this organization."

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Malletic P.F. Choke—50 Hz. 50 mwa. 100 ohms .. 59
Victor Int. Audio for Model R-32. RE-46, etc. ... 39
Victor Int. Juns and output trans. for above models.. 59
Victor Power Amplifiers—1-30. 2-65 x. P. 7.50
Victor Power Amplifiers—1-30. 1-60 x. 6-65 x. P. 7.50
Supersonic Diatron Type Model A 1A1.... 144.55
Strandol Airfoil Type Model A 1M. 160.00
De Forest types 410. 500 and 481—new and used.... 39
Minellk Electrolytic Cond. (wet), single 18 mfd. 39
Minellk Electrolytic Cond. (wet), single 36 mfd. 39
Minellk Electrolytic Cond. (wet), 3-6-18 mfd. (Zenith type). 187.50
Minellk Electrolytic Cond. (wet), single 18 mfd. 39
Minellk Electrolytic Cond. (wet), single 36 mfd. 39
Sprague Electrolytic Cond. (wet), single 9 mfd. 39
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By R. D. Washburne

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By C. W. Palmer

If often becomes necessary for the experimenter and Service Men to know what circuits are in use, what are the short cut or radio wrinkles that will save them time and labor. This book on the business, "short cut" means time and money saved, and in this book it is "saved" money saved.

This book is a compilation of important radio kinks, such as kinks and differs such as are constantly used today.

By C. W. Palmer

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 a Year

By R. D. Washburne

There have been collected a wide variety of questions which have come into our editorial offices during the last two years, and only those whose answers would benefit the majority of men engaged in radio have been incorporated in this amazing question, and answers book. Without the help of topics is treated.

By R. D. Washburne

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A Complete Treatise on the Subjects Covering Radio Servicing and Maintenance

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On page 548 of this issue will be found an important announcement about new books which will be added to the RADIO-CRAFT LIBRARY SERIES.

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RADIO-CRAFT For MARCH, 1933
RADIO-CRAFT
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Model
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RADIO-CRAFT for MARCH, 1933

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