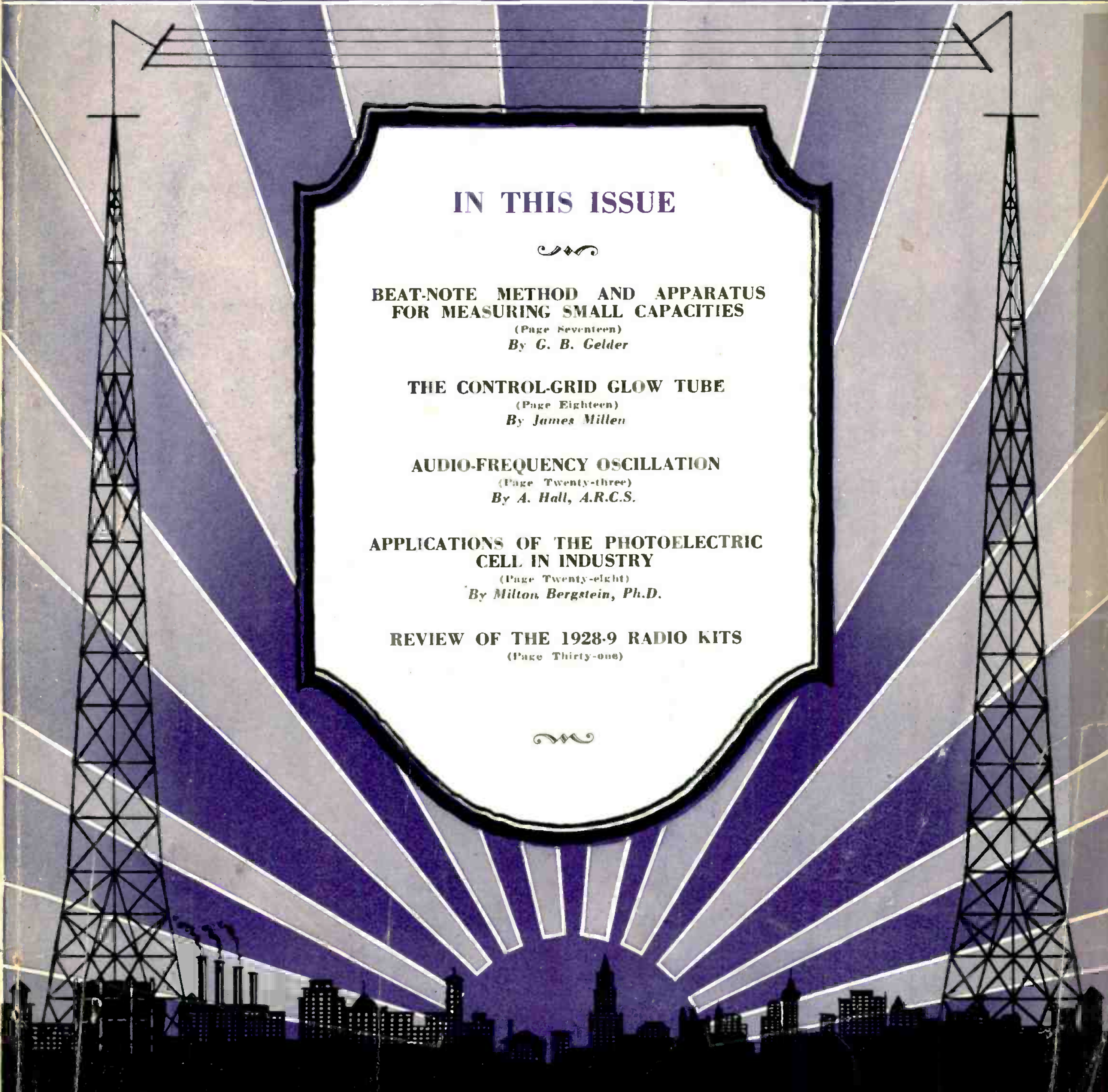
EIGHTH YEAR OF SERVICE

RADIO ENGINEERING

Vol. VIII SEPTEMBER 1928 Number 9



IN THIS ISSUE

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The TECHNICAL MAGAZINE of the RADIO INDUSTRY

FERRANTI

AUDIO FREQUENCY TRANSFORMERS

Components of Ferranti Transformer

In the Ferranti Audio Frequency Transformer the primary inductance is made large by using a great number of primary turns, a core of large cross section and a short mean core path. The mean core path is made as short as possible and is at the same time not short enough to make the D. C. saturation appreciable. The core loss has been made negligible by the use of a laminated core of ample cross-section with properly insulated laminations of high resistance alloy steel. The leakage inductance is made very small by interleaving the secondary coil between two sections of the primary coil. The mutual capacity is kept low by the use of air as the principal insulation. The dielectric constant of air is 1 as against 3 or 4 for paper and oiled cambric insulators.

The dielectric losses in the coils are reduced to a minimum by the use of skeleton coil forms and the elimination of all between layer insulation. The self capacity of the coils is reduced by winding each coil in sections and thus making the between layer voltage low. Further, the leakage inductance and the self capacity of the secondary coil have been balanced so as to prevent the amplification falling off at the higher frequencies and yet at the same time eliminate the large resonant peak that occurs in most transformers in the neighborhood of 5,000 cycles.

Ferranti Transformers Are Specified for the

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Principal parts for the SKYSCRAPER, including base, front and shields correctly drilled, 1 set of three special coils, 1 audio transformer type AF 5, 1 pushpull input transformer type AF 5 C, 1 pushpull output transformer type OP 8 C for standard speakers, or 1 OP 4 C for Dynamic Cone speakers, with drawings and complete instructions for building. LIST PRICE: $95.00. Instructions separate, $1.00.

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Hollinwood, England

FERRANTI, Inc.
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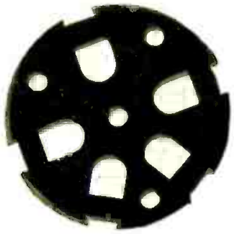

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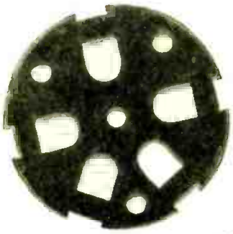
- that Punches Cold

A Phenol Fibre Sheet that punches perfectly when cold and still has insulating and moisture resisting qualities of the first rank is difficult to make—in fact, it has only recently been possible.



Formica punching stock is now available that will yield perfectly smooth edges in the punch press even when cold—in sheets up to 3/32 of an inch thick.

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RADIO ENGINEERING

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Vol. VIII SEPTEMBER 1928 Number 9

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Departments

What May We Expect of Television?

By FRED D. WILLIAMS
Vice-Pres. Raytheon Manufacturing Company

THAT television has arrived, cannot be denied. It is here, even if in the form of a crude yet mighty interesting experiment. In fact, it is going to be the broadcasting story all over again. Most of us can recall those days when a lone radio amateur, here and there, operated a radio telephone transmitter and gave phonographic concerts over the air for such radio enthusiasts as were willing to build a receiving set and tune in. And just as broadcasting was fostered, developed and popularized by the efforts of a handful of radio amateurs, so may we expect radio television to develop until it attains that ultimate perfection we have every reason to expect.

It is well, however, to issue a note of warning at this time. In the first place, let us be reasonable with television technique. Those who hope to see large screen images, with detail comparable with the excellent motion pictures of today, and with the entire world before them, are doomed to keen disappointment. We might as well disillusion them from the very start. Television technique, at this time, cannot handle more than a very small screen size, say 1½ by 1½ inches, while the detail is only of the modest variety. A face, hand, large type, a simple mechanism—these can be produced fairly well, so that the imagination is not too severely strained. In a face, for instance, it is possible to see the eyebrows and the teeth in the case of good transmission and reception. However, it is useless to expect to identify individual hairs or gold teeth.

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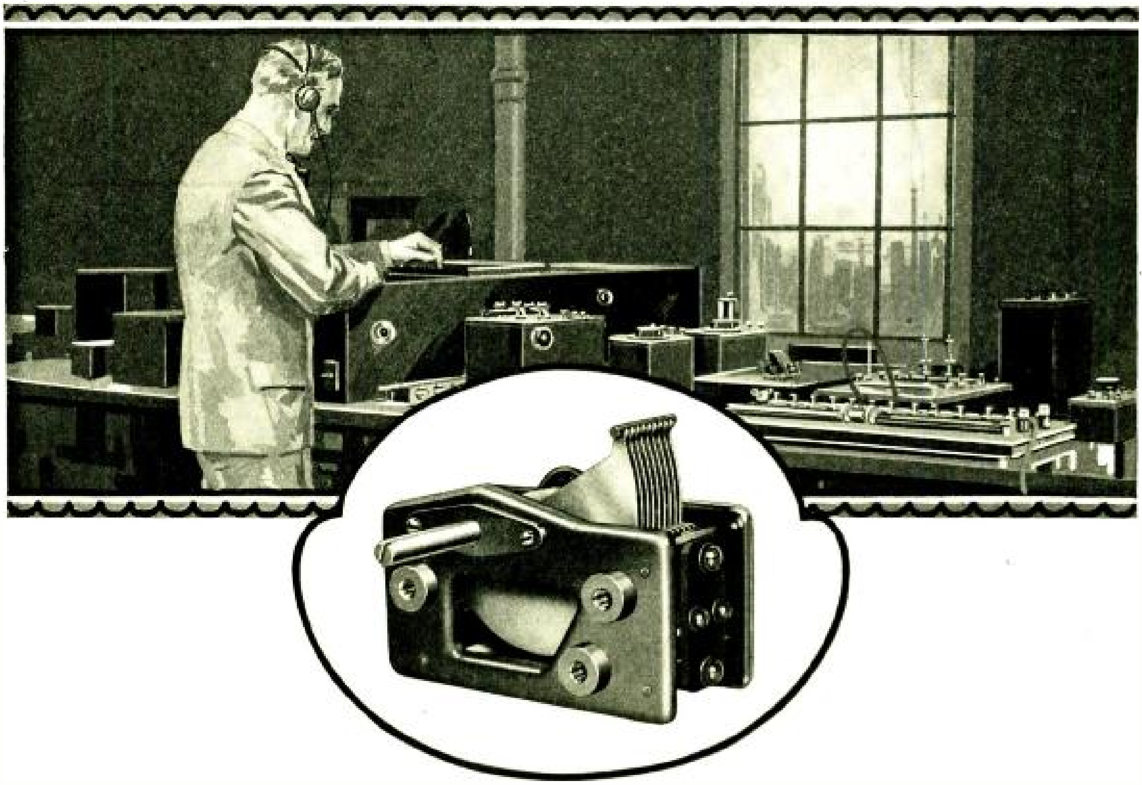
RADIO - PARTS



THOSE concerns who contract with Scovill for the manufacture of radio parts enjoy distinct advantages. Not only do they receive parts of superb quality and carefui workmanship, but they have recourse to the valuable development work constantly being undertaken by the Scovill research department.

All Scovill condensers are made under the Scovill-owned Lowenstein Patent No. 1,258,423, dated March 5, 1918. The following concerns have been licensed to manufacture under this patent:

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EDITORIAL

September 1928

ON THE VALUE OF RESEARCH

SO rapid is the progress of radio in its general aspects that each month produces at least one new commercial application. The full significance of these new developments is not always appreciated until business is involved.

The injection of money into a vague scientific proposition invariably inspires creativeness and activity to an astounding degree and results in a commercially practicable device.

Talking motion pictures have a long history. The basic system remained idle until the recent institution of a commercial venture when, nearly over night, it became an extremely valuable business enterprise. What has been a mere laboratory development is now the medium for a strong competitive force in the motion-picture industry.

Who imagined that the talking motion picture would become such a powerful element in such a short space of time?

The finances involved in talking motion pictures are almost beyond the imagination. Millions of dollars are being expended in studio equipment, let alone the amounts being invested in reproducing installations for theatres.

At this most interesting moment in the evolution of the motion picture industry a leading electrical manufacturer announces the successful development of "radio movies."

Whatever the outcome of the radio movie, the fact remains that commercial radio developments snap into line so rapidly that it leaves one dizzy. Strides in other industries of science open up new applications for radio devices. The scope of the radio field continues to grow and there is every reason to believe that eventually the fundamentals of radio will be employed in connection with every automatic contrivance in this very automatic age. If things work out in this manner the radio industry will undoubtedly become one of the five greatest industries in the world.

Much depends on whether the radio industry watches after its own business or lets others watch after it. Individual companies that are quick on the trigger will be the ones that will expand their business into the true commercial field.

The answer to the problem of expansion, if it is a problem at all, is through research. Research is one of the most important phases in business today and is highly developed. It is highly essential to the proper development of the radio industry.

Research problems differ. One company may be seeking new merchandising outlets, another is confronted with the problem of making use of waste material, another striving to strike the happy medium in advertising psychology and so on. In every case, however, the *modus operandi* is practically the same. It amounts to a study of conditions, usually foreign to the organization.

It is very good practice to develop the existing and no radio manufacturer can be criticized for employing engineers to improve on his product. But there is more to the radio business than mere improvement. It is worth the time and money of any radio manufacturer to study every phase of today's industries and all developments in other fields.

If anyone is particularly interested in what research has done to aid numerous industries we would suggest that they request a copy of the booklet covering this subject, compiled by the Policyholder's Service Bureau of the Metropolitan Life Insurance Company.

M. L. MUHLEMAN, *Editor.*

How Radio Tubes are Made

By R. W. Ackerman

Chief Engineer, Radio Tube Division, Gold Seal Electrical Co., Inc.

Radio tubes as manufactured today consist of two or more elements enclosed in an evacuated vessel or bulb generally made of glass.

In the original so-called Fleming Valve or Tube there were two elements, namely the filament or emissive element, and the plate or collective element. In this Valve there was no control of the electron flow of current from the filament to the plate by the incoming radio signal. The Tube merely acted as a rectifier or detector (a one-way street) for the small radio currents by allowing the current to flow in one direction and practically no current in the reverse or opposite direction. Today the Fleming Valve is commonly employed to rectify relatively large currents to operate in conjunction with "B" eliminators for plate supply.

The addition of a third element between the filament and plate revolutionized the two element valve making it one in which the electron stream is directly controlled by the incoming signal. This immediately made possible multistage amplifiers and oscillators, which is the fundamental basis of radio broadcasting.

The structure of Radio Tubes calls for various metals, such as nickel and its alloys, molybdenum, tungsten, magnesium, thorium, copper, iron, brass, and some of the rare earth metals, comprising barium and strontium compounds. The manufacture of the highest quality Radio Tubes involves great care in all details throughout the process. First of importance is the selection of material. Nickel is perhaps the most common metal employed in Radio Tubes. This metal is used because of easy working, welding of parts, and the ability of obtaining it in a purified state at a reasonable cost. The plates of small Radio Tubes are made of nickel. Plate supports, grid supports, and filament supports are made of nickel wire of various weights and dimensions.

Molybdenum is used to wind grids. It has the advantage of being relatively non-absorbent to gases as compared with nickel, therefore, parts subject to severe heat conditions are made of molybdenum, such as grids mentioned above, and plates of high power tubes.

Tungsten finds its application to Radio Tubes because of its relatively high melting point. Filaments are therefore made of tungsten. Magnesium has the property of uniting with various gases, therefore, a small amount is placed in the tube and is heated for the purpose of completing the job after the vacuum pumps have taken out most of the gases. This heating hastens the chemical reaction, forming magnesium compounds and vapors that collect practically all the gases left. The magnesium vapor with its residue then condenses on the glass walls of the tube coating them with a silvery deposit commonly seen on Radio Tubes. Thorium is another metal that is very essential in tube filaments. It is impregnated into the tungsten in the process of drawing the filament many times through successively smaller diamond dies until the proper size is reached. This metal renders the filament more emissive and hence more efficient at lower burning temperatures.

Copper and Iron find their way into the manufacture of tubes in the form of stem leads. A special heavy iron wire is wrapped with copper and drawn down through dies until their combined diameter is the proper size desired. Thus a small iron wire with a thin shell of copper is formed, known as "copper clad." Copper clad possesses practically the same expansion and contraction as glass and can be fused into glass without fear of cracks due to unequal expansion, hence the tube will not lose its vacuum because of cracks thus formed. Brass is not employed within the evacuated space but admirably lends itself to the manufacture of base pins and contact prongs in the base.

Barium and strontium in the form of special chemical compounds are used to coat the filaments of the popular so-called A. C. tubes of the present day. The filament is made of nickel ribbon or one of the several alloys of nickel, and is coated with the above chemical compounds to render it highly emissive at a very low burning temperature.

Lead, with a large percentage of tin, is employed in the form of solder to join the stem leads with the base prongs, to insure perfect contact, and hence to lessen tube noises due to poor contact. All of these various materials before being placed in a tube are given most rigid inspection.

The plates are stamped and formed in die presses. Two symmetrical pieces are pressed together on forms to make the finished plate. The plate with other nickel parts are cleaned and passed through a hydrogen furnace to liberate, as far as possible, inoculated gases. The grids are wound with special molybdenum wire on special grid winding machines and pressed on the proper mandrel, or form.

The first step in the manufacture of Radio Tubes is the flare. This is made by first cutting special glass tubing to a definite length and passing the pieces thus cut through a flare machine, which merely forms a flange about a quarter of an inch on one end. The flare is now ready to make the stem. It is placed in the stem machine on the stem block through which the various stem leads and element supports are placed. The straight portion of the flare now passes through successive gas flames of various temperatures until it is soft and flattens around the stem leads. A clamp flattens the stem at the proper moment, and an air blast blowing through the exhaust tubing blows a hole through the press for the exhaust. Then the stem passes through cooling flames, and comes out ready for the annealer where it is gradually cooled to avoid temperature strain. The stem is now placed in the bending machine which cuts off the nickel supports to the required length and bends them in proper shape for the mount. The mount is now ready to assemble the various elements. First the filament is cut to proper size and scraped, tabbed, and welded to the filament supports of the mount.

The next operation is the grid mounting. The grid is slipped over the filament and welded to its stem supports. The plate is now slid over the two stem supports provided and welded in place. The grid and plate is now anchored at the top with either a mica support or a glass cylindrical bead with nickel wire supports. The filament hook, made of either molybdenum or tungsten, is now placed. After the mount is completed it is turned over to the mount inspector, and after it is passed it is ready to be sealed in.

Sealing in is accomplished by a machine with successive positions and flames of various temperatures. The exhaust tubing of the mount is slipped in place to hold the mount in a vertical upright position. Then a cleaned bulb is placed over the mount. The bulb is rotated mechanically in successive positions with gas flames playing on the bulb just opposite the flare flange until the neck of the bulb softens and contracts to strike the flange for sealing. The excess glass neck below the seal drops down. Then successive positions of cooling take place until the bulb is ready to remove. After the tube is sealed in it is ready for the exhaust. This consists of manifolds that hold up to ten tubes coupled to various stages of pumps starting with high vacuum mercury pumps or aspirators, followed by a series of oil pump backers until atmospheric pressure is reached. Special precautions are taken to trap out water vapor and condensible gases by means of very low temperatures.

Several tubes up to ten in number are placed on the manifold for exhaust, and are heated in an oven that drops over them while the exhaust pumps are in operation. This clears the gas from the pores of the glass. The elements are now heated by means of an external radio frequency induction coil to drive out remaining gases. After several such cycles the magnesium is heated externally until it vaporizes on the walls of the tube. Then the tube is sealed off and passes to the baser where the leads are properly inserted, the glass bulb cemented to the base, and placed in the basing machine to harden the cement. After the basing operation the tube is passed through the testing department where it is either sent on to be cleaned, branded and labeled, or rejected for poor readings. The last step is the final inspection and packing where the tube is carefully inspected for boxing and shipping.

All the above processes require the utmost care and supervision to guard against defects and poor quality. Besides the general supervision a most important department in the manufacture of radio tubes is the engineering staff that are constantly on guard to check up on the factory to maintain the standards laid down by the engineers. It is here where all the design and development work is carried out before the tube is ready to be manufactured for the public.

The gratifying success that has been accorded Gold Seal Radio Tubes—their Golden Tone—their long life—rest squarely on the care with which the above processes are carried out.

ELKON DRY RECTIFIERS FOR YOUR PROBLEM

Elkon makes Dry Rectifiers for every conceivable use where it is necessary to change alternating current to direct.

On this page are illustrated a group of 13 low voltage rectifiers varying in size from the small 4.5 volt at 1½ amperes to 28 volts at 2½ amperes.

No matter what your problem of rectification, Elkon has or can make a dry rectifier to solve your problem.

All Elkon rectifiers have the famous self-healing feature insuring long life and freedom from trouble.

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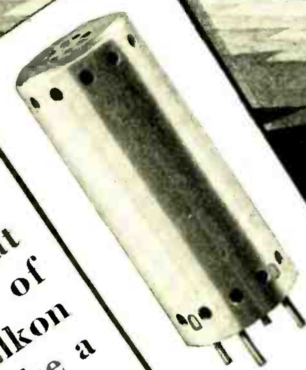
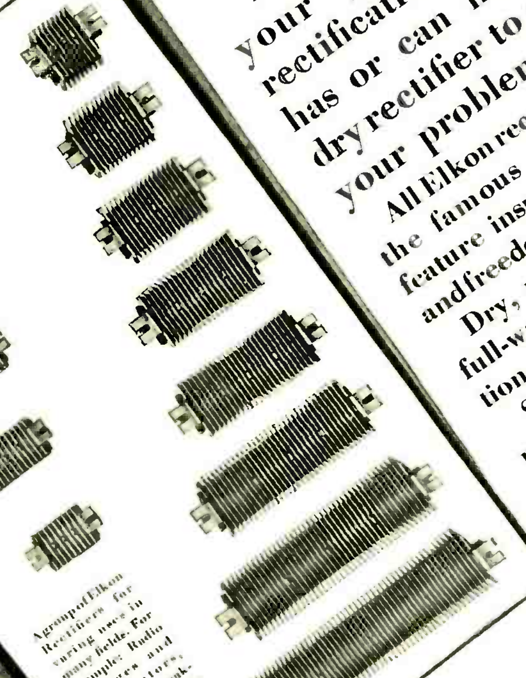
Submit your rectifier problem to the Elkon Engineers — a sample for your exact needs will be forthcoming.



The new Elkon "B" or high voltage rectifier. Now being supplied to replace BH type tubes. Has a 5000 hour guarantee.



A group of Elkon Rectifiers for curing uses in many fields. For example: Radio Chargers and Eliminators, dynamic speakers, Railway Signals, Telephone.

Of course the Wheatstone's Bridge plays its part in the Research Laboratory.

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Advertising will be carried for companies manufacturing machinery, tools, materials, engines, and any equipment essential for the construction and operation of aircraft and airports.

The Editorial Policy of Aviation Engineering will be to present non-biased technical, engineering and industrial material for the benefit of engineers, executives and technicians interested in the aviation industry.

Departments covering airports and airways, news of the industry, new developments, new aircraft, and radio communication will be included in the text.

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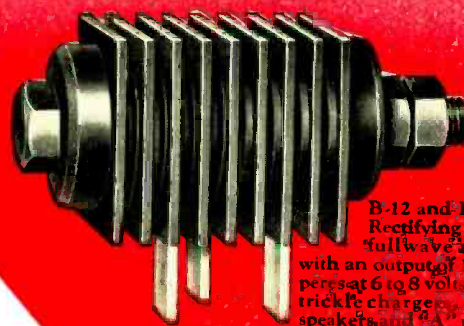
B-L RECTIFIERS



B-12 and B-16, B-L Rectifying Units are full wave rectifiers with an output of 1 to 3 amperes at 6 to 8 volts D. C. for trickle chargers, dynamic speakers and "A" power devices. List price, B-12 $4.50, B-16 . . $5.00.

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C-110, B-L Rectifying Unit is a single-wave rectifier for replacing charger bulbs. Furnished with either Edison or double-contact screw base. List price, C-110. . $4.00, C-210 . . $4.00.

Manufactured by

The BENWOOD-LINZE CO.
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D-24, B-L Rectifying Unit is a full-wave rectifier for supplying direct current to excite magnetic field coils of dynamic speakers. List price . . $6.00.

Bone Dry . . . Compact
Durable . . . . Noiseless

A PROMISE FULFILLED

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The New 1929 Aero Green Book describes 25 Receivers and Transmitters—everything from a one-tube Short Wave Adapter to the Aero Seven—for A. C., D. C., and Shield Grid Tubes. Send for your copy today.

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FOR BUILDING

SHORT WAVE AND BROADCAST RECEIVERS AND SHORT WAVE TRANSMITTERS

R. M. A. Board of Directors Plans Wider Services

Plans to Provide Facts on Television Under Way. Cooperative Advertising, Interchange of Radio Patents and Statistics Regarding the Industry Included in Service Plans

WIDER and new services for the radio public and industry by the Radio Manufacturers Association are under way. The R. M. A. Board of Directors, at their first meeting of the 1928-1929 year at Buffalo on August 10th, prepared for expansion of activities. The Buffalo meeting was the first of the new administration headed by H. H. Frost of New York, since his election as President at the Chicago Convention and Trade Show of the R. M. A. in June.

Facts on Television

A new and immediate enterprise of the R. M. A. is to give the radio industry and the public exact facts regarding the development of television. The R. M. A. Board, deploring presentation of television to the public until it is "ripe," and convinced that premature exploitation of half-baked television apparatus is and would be injurious to the interests of the radio industry as well as the public, directed that the exact truth and real facts regarding television experiments and what may be expected, by the industry and the public, be given in authoritative announcements. A special committee was directed to make a thorough survey of television and formulate a carefully digested statement for the public and the industry. President Frost appointed on this committee as chairman, Mr. H. B. Richmond of Cambridge, Mass., Director of Engineering of the R. M. A., together with Mr. B. G. Erskine of Emporium, Pa., Mr. A. J. Carter of Chicago, Ill., and Mr. M. F. Burns of New York, all of whom are identified with television development.

Cooperative Advertising

Support and development of broadcasting, cooperative radio advertising, and other inter-industry activities were planned by the R. M. A. Board, together with the extension of R. M. A. service for individual members. The plan for interchange of radio patents, recently approved by the R. M. A. membership at their annual meeting in Chicago, is to be developed, with continued up-to-the-minute information for members.

Radio World's Fair

Many proposals for increased industry and member service were made at the round-table discussion of the Directors, who received reports on the highly successful show season of last year, and of the prospects for the coming radio events, including the fall shows at New York and Chicago and the Fifth Annual Radio Industries Banquet September 18th, at the Hotel Astor in New York. With the space at the Madison Square Garden World's Fair, opening September 17th, reported over 92 per cent sold by Mr. G. Clayton Irwin of the Radio Manufacturers Show Association, the R. M. A. Board decided to open up the fall public shows in New York and Chicago to the exhibition of phonographs.

HERBERT H. FROST
President R. M. A. for 1928-29.

Planning the Third Annual Trade Show for next spring, the R. M. A. Show Committee, now headed by Mr. Morris Metcalf of Springfield, Mass., was directed to secure information regarding facilities and accommodations in a larger number of eastern and middle western cities. There was a strong demand for transfer of the 1929 Trade Show to some eastern city, the past two Trade Shows having been held in Chicago.

Industry Statistics

Steps also were taken by the R. M. A. Board to secure more reliable statistics regarding the radio industry than now are available. The fragmentary and inadequate figures which are now being circulated fall far short of meeting the needs of the radio industry, in the opinion of the R. M. A. Board of Directors, and measures to secure much wider and more complete statistical information for all branches of the industry were ordered.

In lining up the R. M. A. for the 1928-29 year, the Association's fiscal year beginning August 1st, President Frost appointed the following as chairmen of the various R. M. A. committees:

R. M. A. Committee Chairman

Broadcasting Committee, B. G. Erskine; Contact Committee, A. T. Haugh; Credit Committee, T. Sheldon; Distribution of Publications Committee, L. E. Parker; Engineering Division, H. B. Richmond; Fair Trade Practice Committee, W. L. Jacoby; Finance Committee, John C. Tully; Foreign Trades Committee, G. H. Kiley; Legislative Committee, C. C. Colby; Membership Committee, H. H. Eby; Merchandising Committee, L. E. Noble; Patent Committee, Le Roi Williams; Public Relations & Education Committee, J. B. Hawley; Resolutions Committee, T. K. Webster, Jr.; Show Committee, Morris Metcalf; Statistics Committee, L. A. Hammarlund; Traffic Committee, Wm. Sparks.

Attending the Buffalo meeting were four new R. M. A. Directors, George H. Kiley of Brooklyn, B. G. Erskine of Emporium, Pa., N. P. Bloom of Louisville, Ky., and L. A. Hammarlund of New York.

The Board also reappointed the following executive officers: Bond P. Geddes, Executive Vice President; M. F. Flanigan, Executive Secretary, John W. Van Allen of Buffalo, Legal Counsel, Frank D. Scott of Washington, Legislative Counsel, and G. Clayton Irwin, Jr., Show Manager.

CARDWELL CONDENSERS

Over the top . . .

With Commander Byrd in 1926 Into the Antarctic in 1928!

DEPENDABILITY in materials and equipment is of paramount importance in such ventures as Polar Expeditions.

VAST and silent spaces, the Polar Regions! Vast, but to the listening ear not silent when vibrant with the all pervading voice of Radio.

BYRD, DYOTT, MACMILLAN, STOLL-McCRACKEN, are some of the names identified with Expeditions placing their confidence in Cardwell Condensers for the equipment needed to keep them in touch with civilization and possible succor when in desperate need of it.

WHO will say that the equipment selected for ventures like these is not deliberately and wisely chosen?

In the air, on land and sea CARDWELL CONDENSERS retain their pre-eminence in reputation, dependability and performance, because they are fundamentally right in principle, sound in construction and time tested for dependability.

RECEIVING condensers in many capacities, notably the recently developed taper plate (best for short wave receivers) are available.

CARDWELL transmitting condensers for medium and low power are the choice of a host of engineers and amateurs who demand the best.

HIGH voltage transmitting condensers, engineered and built by CARDWELL, are being supplied in ever increasing numbers to discriminating engineers and manufacturers.

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Literature upon request

The Allen D. Cardwell Manufacturing Corp.
81 Prospect Street, Brooklyn, N. Y.

"The Standard of Comparison"

Beat-Note Method and Apparatus for Measuring Small Capacities

The Use of Coupled Oscillators for Determining Small Capacity Values at Various Radio Frequencies

By G. B. Gelder*

IT is extremely hard to measure small capacities of a few micro-microfarads accurately and consistently at radio frequencies. For this reason a beat-note method has been developed whereby measurements can be checked consistently to within ± .03 micro-microfarads with an accuracy of 0.2 to 0.4%. This applies to capacities of the order of 8 to 14 micro-microfarads such as are encountered in the inter-electrode capacities of radio receiving tubes. The range of radio frequencies at which this method may be used is limited only by the inductance and capacity used in the oscillator. The set is not interfered with by outside oscillations and is very sharp in tuning.

The principle of the beat-note method of oscillators is not new in operation or circuit but it is believed that the use of this method for the measurement of small capacities is new to a certain extent. Into an aluminum cabinet two Hartley oscillators were built: one of which was made to oscillate at a fixed frequency while the other could be varied over a small range of frequencies. However, for speed of operation and convenience both oscillators may be made variable. Between the two oscillator coils was placed another coil which is in series with a crystal detector and a head set. This coil is called a "pick-up" coil. By setting the fixed oscillator at some convenient or pre-determined frequency and varying the frequency of the other oscillator by means of the variable condenser, a beat note will be obtained between the two oscillators as their frequencies near the same value. This beat note will be picked up by the "pick-up" coil and heard in the head set. By tuning the second oscillator to the exact frequency of the first oscillator a "dead spot" will be obtained or silence will be registered in the head set.

Construction of Oscillators

The construction of the two oscillators is identical except for the capacity across the inductance coils. The condenser in oscillator No. 1 is fixed while that of No. 2 is variable in this case, however, both may be made variable for convenience. The complete wiring diagram is given in Fig. 1. All of the inductances are of the plug-in type and the number of turns per coil depends upon the desired frequency. The wavelengths covered by the coils are:

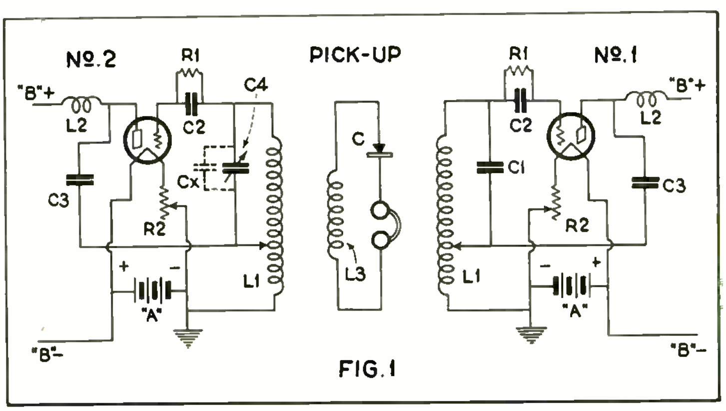
Type	M. H.	No. Turns	Wavelength
A....	.016	15	50—150 meters
B....	.050	27	100—300 meters
C....	.190	55	200—600 meters
E....	.470	84	300—900 meters

The inductances L_2 are radio frequency choke coils consisting of 300 turns of No. 36 double cotton covered copper wire wound on a ½ inch diameter form; R_1 is a 2 megohm grid leak; R_2 is a 30 ohm rheostat; C_2 is a 500 micro-microfared fixed condenser; C_3 is a 2000 micro-microfarad fixed condenser; C_1 depends upon the frequency desired and C_4 is a special vernier-type precision variable condenser having a range of 50 micro-microfarads. A fixed condenser of about 475 micro-microfarads should be placed permanently in parallel with this condenser when a large condenser is used in oscillator No. 1. L_3 is a coil of the same type as L_1, but of fewer turns; and C is a crystal (fixed). R_1, R_2, A_1, C_2, and B depend upon the type of tube used, which was a type 201-A in this case.

Each oscillator should have separate battery supplies for both filaments and plates. All of the apparatus should be placed in a well grounded metal (aluminum) cabinet with the exception of C_4 the vernier condenser and C_x the capacity to be measured. For convenience a milliammeter was placed in the C_1 lead of oscillator No. 1.

The aluminum cabinet used was 24 inches long by 9 inches high by 12 inches deep with a ¼-inch micarta panel in the front for mounting rheostats, milliammeter and phone jack.

All battery leads were brought out of the back of the cabinet by means of binding posts which were well insulated from the cabinet with the exception of the —A leads which were grounded. Two well insulated binding posts were located on the left end of the cabinet for connecting C_4 and C_x to the oscillator. All apparatus



The pick-up coil with detector and head set in series is placed between the coils of the two Hartley oscillators, the whole system being installed in an aluminum cabinet

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and instruments mounted on the panel were well insulated from the cabinet.

The condenser C_1 is a special condenser with a 50 to 1 ratio motion made especially for this application. It has a total variation of about 40 micro-microfarads with a minimum of about 10 micro-microfarads. The condenser is of the parallel sliding cylinder type with the outer cylinder grounded and the inner cylinder supported inside by means of a brass rod.

Application of Device

The method used in measuring small capacities is as follows: Set oscillator No. 1 at some predetermined frequency and by means of the variable condenser in oscillator No. 2 tune it to a frequency near that of oscillator No. 1. When the frequency of oscillator No. 2 approaches that of No. 1 a note will become audible in the head set similar to that heard in a radio receiving set when tuning in a station. If the variable condenser is now moved slowly a place will soon be found where there is no sound heard in the head set. Note the variable condenser reading at this point. This is the "dead spot" and the zero reading. Since this dead spot is of some width, about one or two millimeters on the condenser scale, it is desirable for accuracy to tune to either the right or left side of this spot. By right or left side is meant the right or left turning direction of the condenser shaft. The capacity to be measured (C_x Fig. 1) is now placed in parallel with the tuning condenser C_1 and, with oscillator No. 2 untouched from the previous setting, C_1 is now tuned to the dead spot as before, being sure the same side of the dead spot is used each time. Note the condenser reading at this time. It must be remembered if leads are used to connect C_x in parallel with C_4 they should be attached to C_4 at the time of the first tuning or zero reading; since in measuring small capacities the capacity between leads may be as great as the capacity to be measured.

The difference between the two variable condenser readings when tuned to the same side of the dead spot, first without and second with the capacity C_x to be measured, is the capacity wanted. Greater accuracy may be obtained when the tuning capacity used is such that the capacity to be measured is a great part of the total tuning capacity. In this way the variation in tuning due to the insertion of the unknown capacity will be considerable.

Alternate Method

Another method of measuring the capacity is by substitution. That is, set oscillator No. 1 at some frequency when C_x only is connected across the inductance of this oscillator, then start oscillator No. 2 and tune it to the frequency or "dead spot" of the first oscillator, similar to the previous method. Then, if oscillator No. 2 is allowed to remain untouched and C_x in oscillator No. 1 is replaced by the precision condenser and tuned by this condenser to the frequency of oscillator No. 2, the capacity of the precision condenser will be equal to that of C_x.

The above methods have both proved very satisfactory as to consistency and ease of operation when measuring small capacities at various radio frequencies. The only special apparatus necessary is the precision condenser C_1 which may be replaced by any reliable precision condenser of small capacity and low loss for ordinary commercial measurements.

The Control-Grid Glow Tube

A New Non-Mechanical Relay Which Is Highly Sensitive, Rugged and Inexpensive

By James Millen*

An enterprising motor car sales company recently attracted a great deal of attention to their show windows on upper Broadway, New York City, by having a car on display which would be set in motion whenever anyone touched a certain indicated spot on the plate glass window. While somewhat similar demonstrations have been given in the past by means of costly photoelectric cells, amplifiers, and highly sensitive mechanical relays, this demonstration is of particular interest in that the entire control apparatus was contained in a cabinet, not much different in size from a cigar box and retailing for less than $100.

The whole secret is in the control-grid glow tube relay employed. This inexpensive and rugged little device serves to control directly, without resorting to the use of amplifiers or delicate instrument relays, an ordinary power relay switch, which latter device controls the power to the operating motor.

As the possibilities for the application of the glow tube relay to other fields seems so promising, it is felt that the following data should prove of considerable interest at this time.

Theory of Operation

The tube itself greatly resembles in many respects, the well-known voltage regulator or "glow" tubes used in some types of radio "B" eliminators. In fact the only fundamental difference is the inclusion of a third electrode or control grid. The commercial form of tube illustrated in Fig. 1, has a cylindrical aluminum cathode, a nickel wire anode and a nickel wire control grid, all mounted within a glass bulb of about the same size and shape as that of an UX-201A receiving tube and containing neon gas at low pressure.

With the control grid connected to the anode, the tube operates in the same general manner as the two element voltage regulator tube, having almost infinite impedance to the flow of current from the cathode to the anode and relatively low impedance to the flow of current in the reverse

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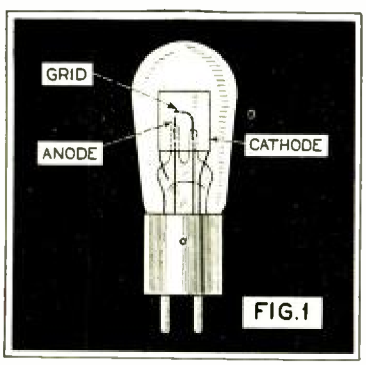
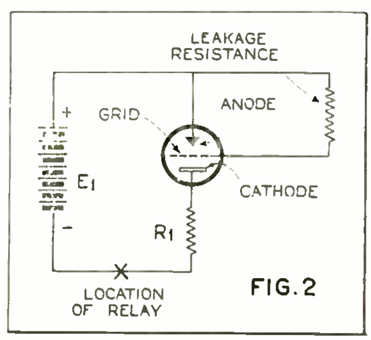


The arrangement of the elements in the control-grid glow tube. The size is approximately that of a 201-A



The connections for control method by varying the leakage resistance between the grid and anode

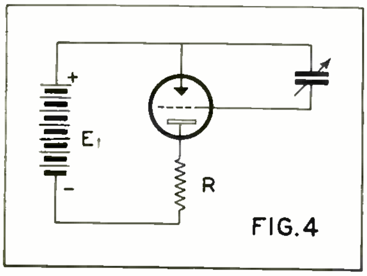


Diagram showing control method by varying capacity between the grid and the grounded anode

direction. (In other words, a rectifier.) The impedance for current flow from anode to cathode is only about 20,000 ohms at 8 milliamperes. This impedance is not constant but varies inversely with the current in such a manner as to maintain a substantially constant voltage drop of 180 volts across the tube.

The unique feature of the grid glow tube, however, is that the voltage required to start the glow, and thus reduce the internal impedance from an infinite to a relatively low finite value is subject to control within very wide limits by means of the grid or third electrode.

If the grid terminal is not connected to anything, and thoroughly protected from low-resistance leakage paths in the socket, somewhere between 600 and 900 volts, depending upon the particular tube, will be required across the anode and cathode in order to "start" the tube. This is due to the grid, when "floating," accumulating a high negative charge, which will rise sufficiently to block the tube.

If, under such conditions, only 300 or so volts are applied, through a suitable protective resistor, across the anode and cathode, the tube will not "glow" and no current will flow, as long as the grid retains its negative charge. Should, however, any conducting path be placed in the grid to anode circuit, the grid charge will leak off and permit the tube to glow and current to flow.

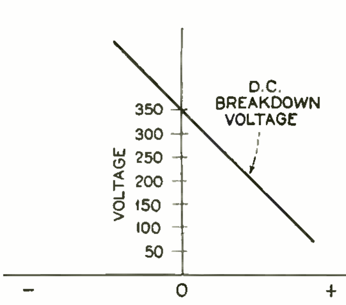


FIG.6

Curve illustrating the relation of grid bias voltage to break-down voltage

Applications

A rugged mechanical power control relay may be operated by this current, which increases from 0 to any desired maximum value that the tube has been designed to handle safely. (In the case of the particular tube herein described, this maximum current could not exceed 8 Ma.)

Fig. 2. shows the circuit arrangement for such a method of operation. The mechanical relay may be inserted in the battery line at the point indicated. The conducting path between the control grid and the anode may be in the form of a flame, a photoelectric cell, or any other variable high resistance having a magnitude of from 50 to 500 megohms. A typical curve showing relation between the breakdown voltage and the leakage resistance is given in Fig. 3.

If the electrostatic capacity between the anode and control grid is increased, as in Fig. 4, rather than the ohmic resistance decreased, as just described in conection with Fig. 2, a charging

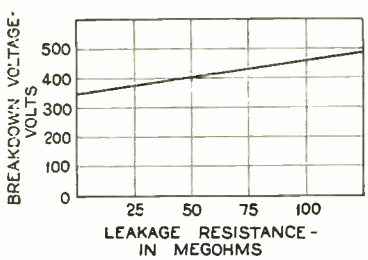


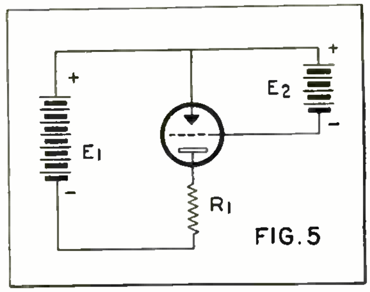
FIG.3

Curve showing relation between the leakage resistance of Fig. 2 and break-down voltage

current will flow to charge the new formed condenser. The accumulated grid charge will thus pass into the condenser, until the total grid charge is sufficiently reduced to permit the tube to glow. This method of control, which is the one employed in the automobile window display demonstration, may readily be tried out experimentally by grounding the anode, and connecting the grid to a well insulated plate. Bringing the hand near this plate will then cause the tube to glow.

In the case of the window display, the grid was connected to a piece of metal foil fastened on the inside of the plate glass window. Anyone standing on the grounded metal grating outside, and holding a hand near the metal foil would thus cause the tube to glow and operate the mechanical relay, which controlled the electric motors.

If a voltage be impressed between the grid and the anode as is shown in Fig. 5, the anode to cathode voltage

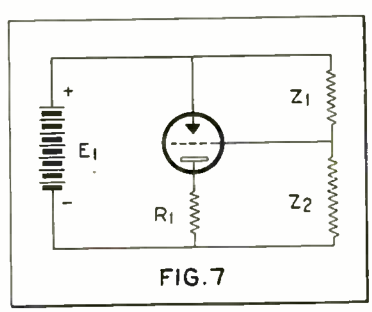


Another control method using a variable grid bias voltage, E2

required to start the glow will be as is shown by the curve in Fig. 6. This curve is a straight line, whose slope is unity and downward in the direction of positive bias.

The amount of energy which must be handled by a pair of control contacts placed in series with the leakage resistor in Fig. 2 is a very minute quantity. Accordingly it is important that dirt and dust and moisture be kept out of the tube socket. A good quality socket should be used to avoid leakage in the socket itself. If the sensitivity of such a circuit be thought too great a means of varying the sensitivity can be used as shown in Fig. 7. For a given value of voltage between anode and cathode the ratio between Z_1 and Z_2 will determine whether or not the tube is to break down. The sum of Z_1 plus Z_2 governs the sensitivity, that is—the energy which is lost in the control circuit. By reducing the sensitivity in this manner the effects of extraneous leakage paths, such as socket insulation resistance, will be lessened.

Due to the rectifying action of the grid glow tube, the voltage, E, in Figs. 2, 4, 5, and 7, may be either A. C. or D. C. as is most convenient. The curves, however, give values obtained with D. C. and which vary somewhat from the values obtained when operating on A. C. In the case of Fig. 5, the biasing voltage E_2, may also be A. C. by using the drop in a resistor.



This method of control is less sensitive than that shown in Fig. 2

The Engineering Rise in Radio

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PART IV

A new term which came into use in the early days of "wireless" engineering, is, *coupling*, of which there are several degrees. Also, the term, *damping*, which had to be reckoned with.

Briefly, *damping* refers to the rate at which an oscillation dies away. *Damped oscillations*, therefore, are those which decrease rapidly in *amplitude*. The oscillations produced by the early transmitters of the spark type were rather highly damped, each spark producing a train of oscillations which quickly died out.

A *coupler* is an apparatus used to transfer radio-frequency power from one circuit to another by associating together portions of these circuits. In the more modern radio hookups coupling may be inductive, capacitive or resistive.

In *inductive coupling* where two associated coils are employed, *very loose coupling* is that in which the secondary current exerts no appreciable reaction on the primary coil. *Loose coupling* is that in which there is an appreciable, but slight, reaction effect from secondary to primary, causing changes in the damping of the oscillations both in the primary and the secondary coils. *Close coupling* permits interactions between the two coils which changes the decrements and frequencies of the oscillations.

By *amplitude*, is meant the maximum value reached by an alternating quantity, either positive or negative. *Decrement*, or *logarithmic decrement* may be regarded as a constant of a simple radio circuit, being 3.1416 times the product of the resistance by the square root of the ratio of the capacity to the inductance of the circuit.

These various terms came into use gradually as the phenomena they represent came to be better understood. In the year 1900, the mathematics of the subject was in the lead of experimental demonstration. One reason for this being that it is not always a simple matter to design an apparatus or devise a circuit arrangement which will accomplish fully a predicted purpose.

The elements of the transmitter assembled by Marconi consisted of an induction coil capable of producing sparks from six to twelve inches in length between the terminals of the secondary winding, oscillator spheres, Leyden jar condensers, Morse sending key and antenna.

So long as the induction coil type of transmitter, with open gap discharger, was employed there was little hope of being able to send out electric waves which could be confined to close limitations of frequency (wave length).

While this situation continued there was little to be gained by making receivers selective, although it was perhaps well that while widespread efforts were being made to improve transmission, continuous attention was directed toward improving receiving circuits and devices.

CHAPTER 4

Production and Transmission of Electromagnetic Waves

The induction coil, condenser form of transmitter used by Marconi in

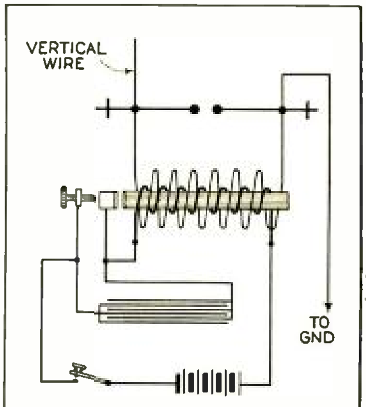


FIG. 5

The wiring of induction-coil type of wireless telegraph transmitter. On the iron core is wound the primary (in heavy line) and on top of that the secondary (in light line). The terminals of the secondary, or high tension winding, extend to the spark-gap, while the primary winding is in series with a battery, sending key and circuit-breaker. A condenser is inserted across the terminals of the circuit-breaker. In practice a condenser was connected across the spark-gap or in series with the secondary circuit

1896, continued for many years as the only practical means of sending out signals. (See Fig. 5.) It was several years before any other method was discovered of producing electric waves of the Hertz type, and although in the course of events the machine alternator method, the arc method and the tube oscillator came into use, the induction coil was in many installations still employed as late as the year 1923.

Depending upon the oscillatory discharge of a condenser the process of energy transmission is intermittent. The condenser had to be first charged and then discharged, resulting in the production of successive groups of decadent oscillations. A group might consist of from twenty to one hundred oscillations, and in general the frequency of oscillation employed was of the order of a million. Because of the intermittent nature of the process of charge and discharge, actual radiation of energy took place about one one-hundredth part of the time the transmitter was operated.

It was not long after the first attempts were made to employ wireless signaling for practical purposes that the need was sensed for a type of transmitter which would send out a continuous train of waves of sustained amplitude. It was anticipated that waves transmitted by an apparatus of this type would resemble those emitted by an organ pipe, rather than the succession of explosion-like discharges sent out by the induction coil, condenser, spark-gap arrangement.

The Arc Transmitter

A search through the records of the prior art with the thought of uncovering inventions, or proposals, which might be utilized in devising improved methods of wave transmission, disclosed that Professor Elihu Thomson, in America, in 1892, in a patent application[1] proposed a method of producing high-frequency currents from a direct-current source, by connecting a condenser and an inductance to an open, metallic spark-gap, which also was connected through two additional inductances to a source of direct current. The arc formed was constantly extinguished by means of an air-blast or a magnetic blowout. The principle of operation was that before the arc was formed, and just after it was extinguished, the condenser was given a charge from the direct current source. Re-establishment of the arc permitted an oscillatory discharge to take place. The inventor stated that oscillations up to 50,000 per second could be produced by these means. (See Fig. 6)

William Du Bois Dudell, who had carried on research work in the Central Technical College, London, 1893-1900, in the latter year read a paper on the subject "Rapid Variations of Current Through the Direct-Current Arc."

Dudell showed[2] that if a suitable arrangement of condenser and inductance were connected across the terminals of a continuous current arc, the gap between rods of carbon, a high-frequency current was set up in the condenser circuit and a musical sound produced by the arc. Dudell proposed the use of his oscillator as a transmitter for wireless telegraphy, observing that the arrangement should have particular applicability where it was desired to transmit electromagnetic waves tuned to a definite frequency.

1. *U. S. Pat.* 500,630.
2. *British Pat.* 21,629. (1900).

Three years after Duddell's device was described, Valdemar Poulsen, of Copenhagen, Denmark, contributed a very important improvement by inclosing the arc in a vessel containing hydrogen or coal gas, and forming the arc between a metal terminal, the positive; and a large carbon terminal, the negative. By subjecting the arc area to the influence of a strong magnetic field, much higher frequencies could be obtained than by means of the double carbon gap in air.

Poulsen's apparatus was a logical experimental development of the Thomson arc method, and the singing arc of Duddell. When the arc in gas is shunted by a suitable condenser in series with an inductance, oscillations are produced in the condenser circuit having a frequency of a million or more, depending, of course, upon the capacity and inductance values. By coupling the condenser circuit to an elevated and grounded antenna trains of undamped electric waves may be transmitted.

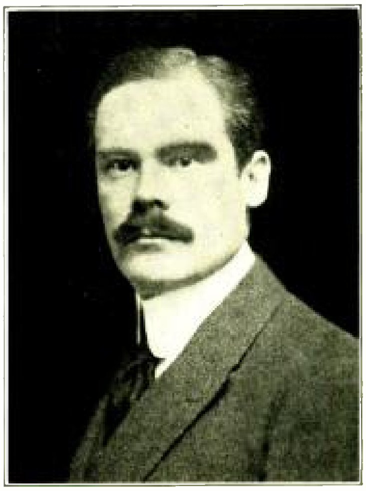
Poulsen brought the arc oscillator into the field of practicability as a transmitter. In the original Duddell arc it was not possible to obtain frequencies high enough for the purposes of practical wireless telegraphy. The highest values reached required very large units of capacity and inductance. For a wave length range of from 300 to 8,000 meters, the frequency must, of course, range from 40,000 to 1,000,000 per second, and this was accomplished with the early Poulsen apparatus.

The introduction of the arc method of producing oscillations set up the world over an entirely new crop of investigations which, in the main, resulted only in minor, detail improvements; in some instances variations in the elements employed in assembling the transmitter permitted of similar results being obtained by somewhat different means.

Arguments were advanced purporting to show that the Poulsen arc was not a true singing arc, but this was of little consequence as for the purpose of producing oscillations at high frequencies this was not essential.

Mr. S. G. Brown, in England, in 1906, described a device employing a revolving aluminum wheel against which a copper spring pressed lightly. The spring and wheel were connected through an inductance and a resistance with a source of direct current, and also by a circuit made up of a condenser in series with a coil of wire. When the wheel was rotated an arc formed at the loose contact, causing high-frequency oscillations to be set up in the condenser circuit.

About this same date, Frederick K. Vreeland, in America, proposed the use of a mercury vapor tube arc which had the merit that difficulties with the arc electrodes was considerably minimized, and the terminal voltage could be made much higher. Voltages up to 6,000 were applied per tube, and although there did not seem to be any need for such high primary potentials, the possibilities in that direction seemed preferable to the alternative of using a number of arcs in parallel, as was at the time proposed for increasing the energy available with the carbon arc method. In connection with this particular development it may here be stated that Peter Cooper Hewitt, in America had demonstrated the sensitiveness of the conductivity of mercury vapor to the varying influence of a magnetic field.



DR. E. F. W. ALEXANDERSON

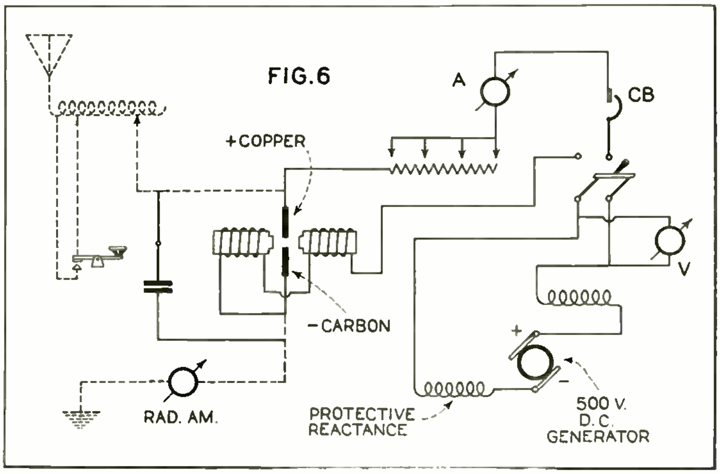
Before leaving the subject of the arc oscillator until it may again be taken up in connection with the development of radio telephony, it may be stated here, as an indication of how the method was extended to meet the growing needs of wave telegraphy in following years, that the Poulsen arc generator was developed up to units of 400 K.W., ranging down to units of 2 K.W., in thirteen sizes, the most widely used set being of 5 K.W. size. Up to the year 1920, eight hundred stations, ranging up to 25 K.W. had been equipped, and eleven units of 200 to 400 K.W. were built and installed.

Sustained Oscillation Frequencies

It was several years after the invention of the arc oscillator that the apparatus found its way into practical use on a commercial scale. Throughout the years 1900-1907, there was no end of discussion anent the new subject of continuous waves for wireless signalling, but the number of stations employing "spark" systems had greatly multiplied the world over, and there was continuous striving in efforts to eliminate deficiencies of spark systems. Immediately following the early trials in England, when the needs of distance and of tuning were uppermost in the minds of the engineers, it was evident that one serious deficiency of the spark method was the long inactive interval between the first spark of one wave train and the last oscillation (of effective amplitude) in the preceding train.

Reference has been made to a method of producing high-frequency currents, invented by Elihu Thomson, in 1892. Following this, in 1896, Tesla, in America, invented[3] a system for the production of high-frequency currents, an important element of which was a synchronous rotary discharger. The method ten years later was employed as standard in the majority of the radio telegraph stations in operation. It consisted of an iron-core step-up transformer, the primary supplied from available alternating-current mains. The secondary of the transformer had connected across its terminals a rotary discharger and the primary of an air-core transformer, with a condenser in each leg. In the patent application Mr. Tesla made no reference to the possible use of the system for wireless

3. *British Pat.* 20,981, 1896. *See, also, British Pat.* 8575, (1891).



The complete circuits of an arc transmitter telegraph purposes, and it was not until later years when the secondary terminals of the oscillation transformer were connected to antenna and earth respectively that the transformer largely replaced the original induction coil for the production of electric waves.

The Subject of "Wireless" in America

From some of the records submitted and discussed in this work so far it may be understood that in America, during the years immediately following Hertz's announcements in 1888, outstanding scientists possessing the requisite engineering knowledge to follow closely events transpiring abroad, and to carry on original research, were Elihu Thomson, Prof. Trowbridge, Prof. Dolbear, Dr. M. I. Pupin, E. J. Houston, F. B. Crocker and Nikola Tesla, all previously mentioned herein in connection with stated developments.

To the hundreds of electrical engineers, electricians and amateur experimenters in America, the discoveries of Hertz held little beyond academic interest. It was not until Mr. Marconi appeared on the scene in 1896, that the practicing engineers and experimenters directed their attention to studies of the principles of space signaling. It was not until 1897 that informative literature reached this country, appearing in the technical journals.

One of the earliest illustrated descriptions of Marconi's apparatus which appeared in America was published in the magazine *Telegraph Age*, issue of November 1, 1897. The article was reprinted from the London *Electrician* of an earlier date. The article presented an understandable story of the equipment used in the 1896 and 1897 trials in England, including the elevated antenna and the earth connection. In the *Journal of the Franklin Institute*, issue of December, 1897, appeared a review of Marconi's first demonstrations. These descriptions were followed at occasional intervals by additional references to what was being done in England and other European countries.

One of the earliest of the experimenters here was Reginald A. Fessenden, born in Canada and educated at Trinity College, Port Hope, Ontario. From 1887 until 1890 he was chemist-in-chief, in the laboratory of Thomas A. Edison, and during the following two years was an electrical expert in the service of the Westinghouse Electric and Manufacturing Company, at Newark, New Jersey. Later, he was professor of electrical engineering at Purdue University and at Western University of Pennsylvania.

In 1896, 1897, he carried on some experiments with electric wave detectors, the results of which were incorporated in a thesis.

Following a series of investigations into the variation of radiation with frequency Professor Fessenden concluded that it should be possible to construct an alternating-current generator of sufficiently high frequency and output to provide ample radiation for wireless signaling purposes. In 1900, an order was placed with an electrical manufacturing company for such an alternator, but owing to difficulties which developed in design and manufacture the machine was not delivered until 1903. The first machine was of one K.W. output at 10,000 cycles. A second machine was turned out in 1906, which, with a one-half K.W. output, was operated at 75,000 cycles. In the following year machines were constructed which had frequencies of 100,000 cycles and outputs of one to two K.W.

PROF. REGINALD A. FESSENDEN

These alternators embodied many ingenious mechanical arrangements. The armature (having a resistance of about six ohms) was driven up to a speed of 10,000 r.p.m., the frequency obtained being 60,000 cycles per second. Driven by a steam turbine a frequency of 100,000 cycles per second was obtained.

These machines were new to the electrical art and in their design and construction were employed engineers whose names in the course of time became known the world over in connection with space telegraphy. These were: Steinmetz, Alexanderson, Haskins, Dempster, Geisenhomer, Stein and Mansbendel.

The first important use made of the new alternator by Professor Fessenden, was at his Brant Rock, Massachusetts, experimental radio station, in the year 1906. Machines of this type, further improved by Alexanderson, were destined in the years following 1918 to play a large part in the establishment of permanent commercial radio telegraph service between America and England, France, Germany, Italy, Poland, Norway, Sweden, Hawaii, Japan and the Argentine Republic.

Professor Fessenden's use of the alternator at Brant Rock shall be referred to in a subsequent chapter dealing with radio telephone work.

High Frequency Electric Currents

At the outset it was clear that one very important difference between land line telegraph equipment and radio telegraph equipment was that each radio station required its own power plant. The capacity and range of the station were dependent upon the power employed and upon the amount of energy controlled for radiation purposes. In land line telegraphy and in submarine cabling the voltages required were very small compared to radio voltages and in the case of land line telegraphy from two to thirty or more individual stations could be connected in a single line conductor, power being required at the two terminal stations only.

Obviously high-frequency alternators, being of special design and special construction, were sure to be costly and their use justified only at stations where a considerable amount of traffic was to be handled or at stations intended for working very long distances.

The Thomson-Dudell-Poulsen are apparatus had certain advantages in this respect which made the system more adaptable for small and medium sized stations and for isolated stations where there was not at hand sources of commercial primary power.

The alternator idea did not find particular favor in England and it was a decade or more before machines of this type were installed there to furnish power for overseas service. Professor J. A. Fleming, who had been associated in an engineering capacity with Mr. Marconi since 1898, was in doubt as late as 1904 about the practicability and efficiency of high-frequency alternators for radio telegraph signaling. His views evidently were based on previous experience which indicated that in order that pure, free waves might be radiated in detached form from a transmitting system, it was necessary to have very high frequencies and very sudden reversals of electric force.

Nor was Fleming alone in this view. Professor C. R. Cross, in America, on one occasion, stated: "Alternating currents in the sending antenna will not produce Hertz waves in the ether. Motions of some kind would be produced, but they would be of a quite different character. Hertzian waves are produced only by the disruptive discharge." In the early legal contests between Marconi and the de Forest interests in the southern district court of New York, Marconi stated: "The difference between Hertzian oscillations and ordinary alternating current is most certainly

(*Continued on page 30*)

Audio-Frequency Oscillation[1]

A Practical Method of Eliminating A.F. Oscillation in Coupled Circuits Fed from a Common "B" Supply

By A. Hall, A.R.C.S.[2]

THE most prevalent cause of A.F. oscillation is the back-coupling that is produced by the source of "B" supply, having a resistance which is common to the plates of all the tubes; dry-cell batteries and D. C. eliminators with potential-dividers, probably show the greatest tendency in this direction. The effect of shunting the "B" source with large condensers is to ameliorate the conditions, but only such a minute amount of energy is required to be fed back to the detector tube to cause A.F. oscillation (audible or incipient) that even a comparatively low resistance, such as is produced by the length of foil in a reservoir condenser, may be sufficient. In this connection it should be mentioned that some makers of large paper-dielectric condensers tap the foil throughout its length and thus minimize this effect. It is possible, therefore, that immunity from A.F. interaction cannot necessarily be obtained by shunting condensers across the "B" supply.

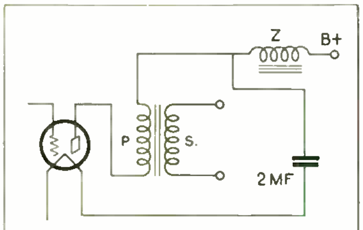


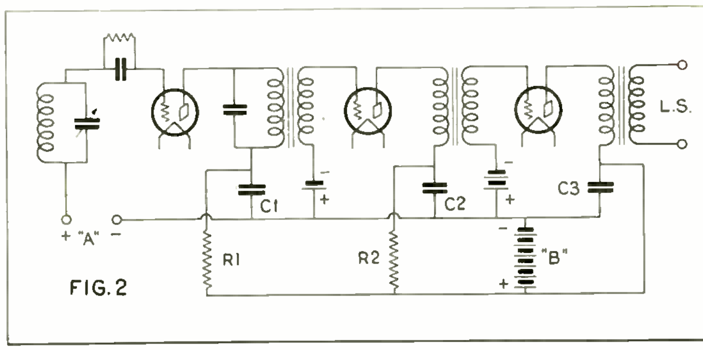
FIG. 1

The A.F. choke, Z, together with the 2 mf. condenser, that is grounded effectively block any back couplings

Reverse Reaction

The next step is to arrange that any oscillations fed back are out of phase with the normal oscillations thus producing a form of reverse reaction. This is achieved by reversing the connections to the primary or secondary of one A.F. transformer, or where, for instance, three stages of resistance coupling are employed, by substituting other forms of coupling so that no two consecutive methods are alike. This expedient at its best is only a palliative, and in the case of reversing the connections to the transformer may modify its amplification characteristics; furthermore, it may transform an audible whistle or howl into an oscillation above audibility which will cause general distortion.

By preventing the A.C. components in the plate circuit of the last tube from passing through the "B" battery or eliminator by the choke-feed method, where the loud-speaker is connected from the plate through a condenser to ground, the chances of oscillation trouble are certainly minimized, but there is still a possibility of feed-back from an earlier A.F. tube.



An amplifier connected with plate feed resistances giving an overall amplification which equals the theoretical product of the two separate A.F. stages

Circuit Isolation

It had been shown that as a result of feed-back, when using two stages of transformer coupling with a common "B" supply the overall amplification was by no means the product of the two stages as measured separately; in fact, this ideal condition could only be obtained by feeding each plate with a separate supply, or nearly be obtained with a separate "B" battery for the detector. Audio-frequency chokes of high inductance interposed in the "B" circuit of each tube were shown to prevent effectively any back-coupling, provided a shunting condenser was connected to ground as shown in Fig. 1. It was next suggested that, instead of chokes, wire-wound resistances capable of carrying the necessary current would be much cheaper and would fulfil not only the same function of preventing back-coupling and giving results equivalent to a separate battery for each tube, but would also by avoiding the necessity of tappings provide a means of evenly exhausting the whole "B" battery. It is seldom that the full voltage of "B" battery is required for any but the last tube, and by using resistances as already described any required reduction for the other tubes can be arranged.

(*Continued on page 30*)

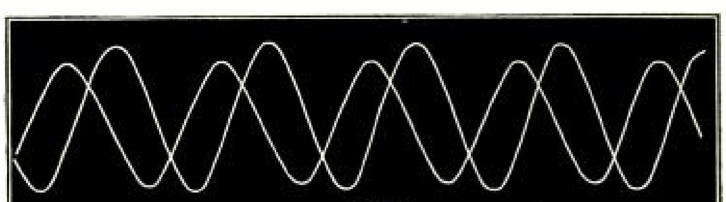


FIG. 3

Fig. 3. The input and output waves of the amplifier shown in Fig. 2, showing no distortion. Fig. 4, below, shows the same waves, but a common battery of 200 ohms is used without the plate feed resistors. The output has a high-frequency ripple superimposed

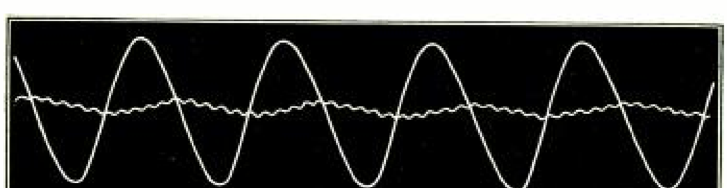


FIG. 4

[1] *Courtesy of Wireless World (England).*
[2] *Chief Engineer, Ferranti, Ltd.*

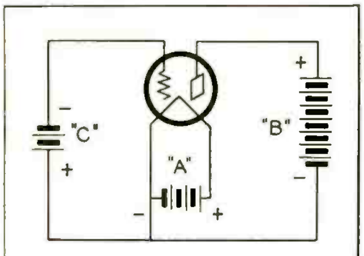
The Mathematics of Radio

Regarding Vacuum Tube Characteristics and Their Relation to the Voltage Amplification of Audio Frequencies

By John F. Rider, Associate Editor

PART X

THE association between the vacuum tube and the coupling unit located in the plate circuit is very close. In the radio-frequency amplifier it governs total amplification and in the audio frequency amplifier it governs tone quality by virtue of its effect upon the transfer of energy between the output circuit of the vacuum tube and the coupling unit. If all the audio frequencies present in the vacuum tube are transferred to the coupling unit, in the amplitude relations present in the vacuum tube, they will be present in, and made audible by the loud speaker. That the present loud speaker cannot faithfully reproduce the complete audio-frequency spectrum is beyond the discussion at this time. We are interested in energy transfer from the tube to the coupling unit. Let us first consider the audio system. It is true that this is contrary to the arrangement employed in the regular receiver, the audio system following the radio, but we will assume that license.



A conventional vacuum tube circuit with the three batteries, "A, B and C", supplying the correct voltages for filament, plate and grid

Before we can discuss energy transfer between the tube and the audio coupling unit, and the importance of certain impedance relations between the two, we must consider the source of the energy, the vacuum tube. Fig. 52 shows a conventional tube circuit, utilizing a three-element vacuum tube, filament, plate and grid bias batteries. According to the illustration, a battery source of filament potential is employed. The tube discussion which will ensue, is however not limited to the D.C. filament type of tube, but is applicable in every way, to the A.C. tube and the screen-grid tube. The fact that the filament potential is "raw" A.C. does not influence the electrical constants of interest to us. The factors governing "amplification constant" or "mu," "mutual conductance" and "plate resistance" are likewise applicable to D.C. and A.C. filament type tubes.

We find a definite relation between the amplification constant or mu of a tube, its mutual conductance value and the plate resistance. This is true of all types of tubes. To summarize we find that the amplification constant cannot be appreciably increased without increasing the plate resistance. The mutual conductance expressed as Gm is equal to the amplification constant divided by the plate resistance. Expressed in a formula it is

$$Gm = \frac{K \text{ (amplification constant or mu)}}{R \text{ (plate resistance)}}$$

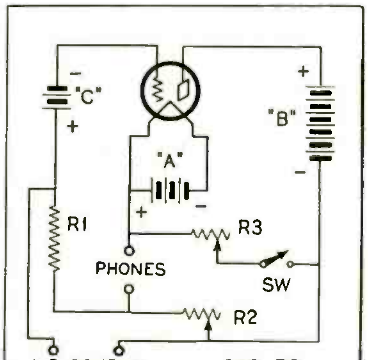
We further find that the plate resistance can be decreased by decreasing the distance between the filament and plate, but under these conditions, the distance between the grid and plate would be likewise decreased, with a consequent decrease in amplification constant. It is true however that the amplification constant of the tube is also governed by the mesh of the grid and the diameter of the grid wire. But the distance between the filament and grid does not influence the amplification constant, hence a small filament, close to the grid may provide a large value of mu with a fairly low value of amplification constant. Such conditions are somewhat realized in the present crop of A.C. tubes.

Progressing further we are advised (*Thermionic Vacuum Tubes, Van der Bijl*, page 256) that the larger the value of mu or amplification constant, the smaller is the permissible input voltage for a constant value of plate potential. In other words, an increase in amplification constant value of tube, reduces the permissible A.C. input grid voltage. Herein lies the reason for not using high mu tubes as output tubes in an amplifier, and on the other hand, for the comparatively low value of amplification constant for all of the power tubes in use today. By reducing the amplification constant, the permissible input grid voltage is increased in value.

Measuring Tube Characteristics

At this juncture, one wonders why this cursory discussion of vacuum tubes. The answer is simple. The above considerations find definite application during the subsequent discussion. A more detailed discussion of vacuum tubes will be made later, but the above facts are essential at this time. In fact a simple method of determining mu, plate resistance and then calculating mutual conductance, is shown in Fig. 53. This arrangement permits the determination of the dynamic plate impedance, rather than the D.C. resistance, which is equal to the plate voltage divided by the plate current. The plate resistance values mentioned in tube tables are usually the dynamic values and the word resistance is used in place of impedance, since impedance too, is expressed in ohms.

With respect to Fig. 53, R1 is a 10 ohm resistance. R2 is a calibrated 4000 ohm resistance, variable in nature. R3 is a 30,000 ohm variable calibrated resistance and SW is a single pole, single throw switch. A source of A.C. voltage, such as a 1000 cycle oscillator, is connected across the extremities of R1 and R2, one lead connecting to the end of R1 connected to the plus side of the "C" battery and the other lead connects to the end of R2 connected to the "B" minus. A pair of phones are connected to the terminals designated as Phones. The value of "B" potential and "C" bias



By means of this circuit the amplification constant and plate resistance can be determined, the mutual conductance then being calculated

potential applied to the tube is governed by the desired testing voltage. The method of testing is as follows: First the amplification constant is determined by applying the A.C. voltage as mentioned, opening SW, varying R2 until the signal in the phones is balanced out. The value of mu is then equal to

$$Mu = \frac{R2}{R1}$$

The plate impedance is determined by closing SW. varying R2 and R3 until the phones are silent, when the plate impedance is equal to the setting of R3. The mutual conductance value is then equal to mu/Rp (plate impedance; previously designated as R)

Energy Transfer

When considering energy transfer between a vacuum tube and a coupling unit, it is customary to designate the tube circuit as shown in Fig. 54. E is the voltage available from the tube and the plate resistance is shown as Rp. The coupling unit usually spoken of as the "load" upon the tube is connected as shown. to the points designated as X. This coupling unit load may be the primary of the audio frequency transformer, the plate coupling resistance of a resistance coupling unit, or the plate coil of the tuned double impedance unit, illustrations of which will be shown as we progress.

One of the properties of the vacuum tube is that the full amplifying power, as expressed by the amplification constant, is obtained only when the load upon the tube is infinite. Not that the amplification constant of the tube varies with the impedance value of the load, but that the amount of signal voltage present in the tube, the result of the input grid voltage multiplied by the amplification constant of the tube is not available across the load unless the impedance of the load is infinite with respect to the plate resistance of the tube. Infinite impedance is of course an impossible value.

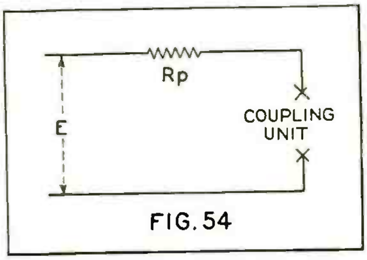


FIG. 54

E is the voltage available from the tube and Rp the plate resistance. This is the customary manner of designating these quantities in a tube circuit

since it is not of a definite figure. But the impedance ratio between the load and the tube must be of a definite value in order that the major portion of the available tube voltage be transferred to the load. Fortunately the difference between infinite load impedance and a certain value of impedance with respect to the tube plate resistance does not make an appreciable difference in energy transfer. That is, if the load impedance is of a certain definite value, the amount of A.C. signal voltage transferred to the load is a major portion of that available from the tube, and if the load impedance is increased to what we call infinite value, the additional voltage obtained from the tube is very small in magnitude. Hence we see that the ratio between the tube output resistance, expressed as the plate resistance, and the load impedance has a definite bearing upon the results obtained with a certain tube-load combination.

During the progress of audio amplification we are interested in the transfer of all signals in the tube to the load. In other words all of the signal frequencies present in the tube should be transferred to the load. Unfortunately however, the impedance value of the average load comprised of a winding on a core of iron, silicon steel or some alloy, is not constant with frequency, whereas the tube output resistance is constant. Therefore we are confronted with the problem of a constant impedance feeding a varying impedance, since the audio frequencies present in an audio amplifying tube during the progress of musical or speech reception may extend from 30 to 8000 cycles, or at least to 5000 cycles as the maximum. It is therefore evident that the magnitude of the energy transfer between the tube and the load will vary according to the frequency of the voltage within the tube.

Take for example the audio frequency transformer arrangement shown in Fig. 55-A. Here the primary P, is the load upon the tube VT whose plate resistance is represented as Rp in Fig. 55-B and the primary of the transformer is represented as a resistance since its equivalent impedance is expressed in ohms. The voltage transfer between the vacuum tube and the load is governed by the A.C. voltage across the resistance, which represents the primary winding. The designation E represents the voltage available in the tube and the value E1 is the A.C. voltage transferred to the transformer primary. If we call the impedance of this primary R when expressed in ohms, instead of applying the usual impedance designation Z. the voltage transferred to the primary or developed across the load, is equal to

$$E1 = E \times \frac{R}{R \text{ plus } Rp}$$

In other words if the voltage available in the tube is 10 volts. the value of tube plate resistance (Rp) is 15,000 ohms and the impedance of the transformer primary at a certain frequency is 150,000 ohms. the voltage across the transformer primary as shown in Fig. 55-A and 55-B is

$$E1 = 10 \times \frac{150{,}000}{150{,}000 \text{ plus } 15{,}000}$$

$$= 10 \times .93$$

$$= 9.3 \text{ volts}$$

We made mention in the previous chapter, that the reactance of a winding decreases with a decrease in frequency and increases with an increase in frequency. With the resistance at a constant value, it is self evident that the impedance varies in proportion. In the discussion of the reactance and the impedance of transformer primaries it is safe to consider the reactance as being equal to the impedance, since the ratio between the reactance and the resistance of the primary winding is sufficiently high to make the resistance value neglible in the impedance calculation. Hence future reference to the impedance of audio frequency coupling unit windings will be the reactance value.

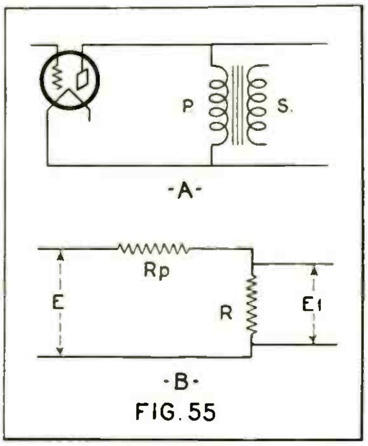


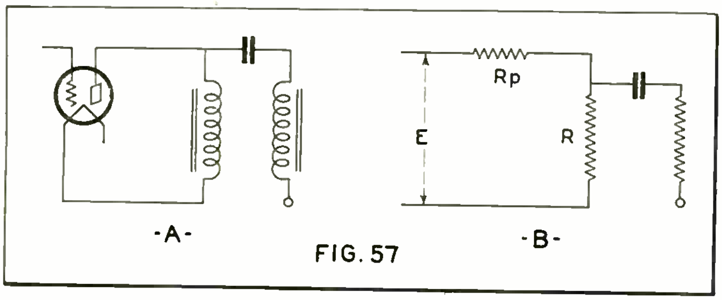
FIG. 55

B of the above figure is a generalized diagram of A and represents the true electrical characteristics of the vacuum tube circuits.

Comprehension is facilitated by using but one term.

Variation of Impedance With Change of Frequency

We observed in the above illustration of voltage transfer that 93% of the maximum voltage was delivered to the transformer primary when the impedance of the load was equal to approximately 10 times the tube plate resistance. But this load impedance is not constant. it varies with frequency. If the value quoted is that of the transformer primary at 1000 cycles, what about the voltage transfer at frequencies between 30 and 1000 cycles? If we obtain 93% voltage transfer at 1000 cycles, satisfactory energy transfer will be obtained at all frequencies above this value, since the voltage transfer increases as the load impedance is increased and the impedance of the load mentioned increases with frequency. Hence we must determinate the voltage transfer at the lowest frequency to be encountered. Since the plate resistance of the tube is constant at all frequencies in the audio band, the same amount of voltage is available at 30 or 5000 cycles. The first step is the determination of the impedance of the load at the lowest frequency. say 30 cycles. This value is governed by the inductance of the primary winding. It is logical



A. Vacuum tube working into a double impedance load. B is the generalized circuit.

that if we obtain satisfactory voltage transfer at 30 cycles, we will obtain satisfactory voltage transfer at all higher frequencies. If the above mentioned load impedance of 150,000 ohms were that of the primary winding at 30 cycles, further calculation would be unnecessary, since only 7% additional voltage transfer would be possible between load impedance values from 150,000 ohms and infinite impedance.

At this time we cannot help but observe the advantages accruing when the tube has a low plate resistance. The lower the plate resistance, the better the voltage transfer between the tube and the load of a certain impedance value. Furthermore, it is easy to observe the need for high load impedances when the tube has a high plate resistance. To obtain faithful reproduction in the audio system we must of necessity amplify with fidelity all the audio frequencies passed into the audio amplifier from the detector. As such we must obtain the maximum voltage transfer between the audio tube and the load on all frequencies. To determine the extent of voltage transfer over the audio band in question we consider the lowest audio frequency. The inductance value of the transformer primary is usually mentioned in the manufacturers' specifications. Suppose that the inductance value is quoted as being 100 henrys. According to the reactance formula (we ignore the impedance formula since the ratio between reactance and resistance is oftimes 4000 to 1) mentioned in the previous chapter

$$XL = 6.28 \times 30 \times 100$$

$$= 18{,}840 \text{ ohms at 30 cycles}$$

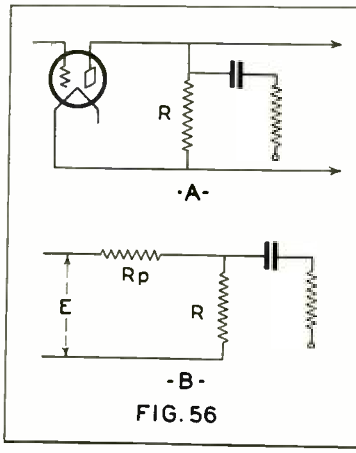
This transformer primary has a reactance value of 18,840 ohms at 30 cycles and if we consider this value as the impedance, and if used with the tube mentioned, the voltage transfer at 30 cycles is equal to

$$E1 = 10 \times \frac{18{,}840}{18{,}840 \text{ plus } 15{,}000}$$

$$= 10 \times .556 \text{ (approx. slide rule calculation)}$$

$$= 5.56 \text{ volts}$$

At 1000 cycles the reactance of this transformer is 628,000 ohms and the voltage transfer is



A. Vacuum tube working into a resistance load. The electrical characteristics are indicated in diagram B

$$E1 = 10 \times \frac{628{,}000}{628{,}000 \text{ plus } 15{,}000}$$

$$= 10 \times .976$$

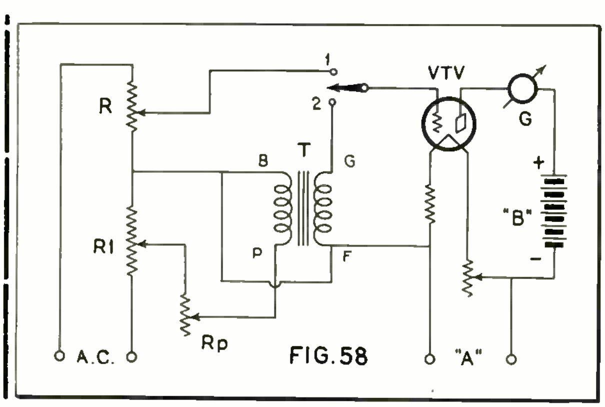
$$= 9.76 \text{ volts}$$

It is very evident that the voltage transfer between the tube and the load as shown varies to an appreciable degree. Hence we see the need for a low tube plate resistance and a high load impedance. The above data is sufficient to show the method used to determine the voltage transfer between an audio amplifying tube, and the primary winding of an audio frequency transformer utilized to couple this tube to a subsequent amplifier tube. The low notes, that is the presence of low notes in the audio system is an oft discussed problem. The above data shows the method of calculating the possible voltage transfer at low audio frequencies, between the tube and the load. Mind you that at this time we are not considering power amplification or power transfer between the tube and the load. That will come later. Neither are we considering transformers wherein the primary circuit is tuned. We are considering the average type of audio-frequency transformer and have observed the importance of the impedance relation between the tube and the load for voltage transfer.

Pure Resistance Load

The same method of calculation is applicable when the load is a pure resistance, as in the case of resistance coupled audio-frequency amplification, as shown in Figs. 56-A and 56-B. Here we find a constant resistance which does not vary with frequency, hence the voltage transfer between the tube and its load is constant or uniform over the entire audio band, that is when the resistance alone is used without any additional units. This, however, is not the case in actual practice, since we must consider the coupling capacity and the grid leak resistance. As the applied frequency is increased, the reactance of the condenser decreases, with the result that the effect of the grid leak is that of a shunt resistance across the plate coupling resistance. While this phase of the problem is not involved in our present discussion it is mentioned in order to remove the idea that the action of the tube and the plate resistance results in a combination with uniform voltage transfer characteristics over the entire audio spectrum. It is true that the use of a resistance

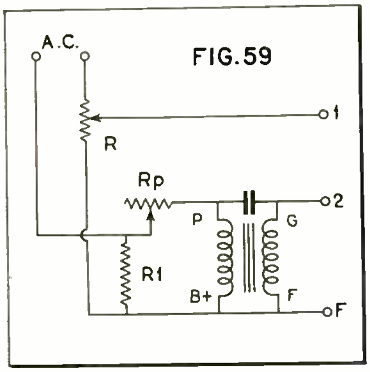
Circuit arrangement for making A. C. voltage measurements in a transformer coupled A. F. circuit. The tube VTV functions as a vacuum tube voltmeter.



as the plate load does produce uniform voltage transfer between the tube and the load, but only when the load resistance is alone and not associated with other structures.

This data is not intended as disparaging information, but purely as an explanation of the phenomenon involved. Mention must be made at this time, that while the resistance coupled audio amplifier does possess a fairly flat characteristic, the complete unit does not possess an absolutely flat characteristic but falls off at the low and at the high ends of the audio scale. This is due to the presence of the equipment utilized in conjunction with the plate coupling resistance.

With respect to the voltage transfer between the tube and the load when the load is a resistance of say 100,000 ohms, the value of voltage across the load resistance is the same at all the audio frequencies involved, since the value of the plate load resistance does not change with frequency. With a definite value of resistance, such as the figure quoted, the voltage transfer between the tube and the load is the



Circuit for making A.C. voltage measurements on a tuned double impedance coupling unit

same as that obtained when the impedance of an inductance constituting the load is equal to 100,000 ohms. In other words, if the impedance of a transformer primary at 150 cycles is 100,000 ohms, the voltage transfer will be the same as that if the transformer primary were replaced with a plate coupling resistor of 100,000 ohms. In order to obtain the 97.6% voltage transfer available with the transformer primary at 1000 cycles, it would be necessary to employ a plate resistance of 628,000 ohms.

Double Impedance Amplifier

The calculation of voltage transfer when the plate load is the plate coil of a tuned double impedance unit, is the same as that employed for the transformer primary and the resistance. Again we desire to mention that the voltage transfer values obtained in these calculations are not the operating characteristics of the complete audio frequency coupling unit. It is, however, an indication of the fact that the audio frequencies present in the tube are being transferred to the coupling unit, which in itself is an important item. The coupling unit may be resonant at some high frequency or at some low frequency, but the presence of these frequencies in the output circuit of the audio coupling unit is dependent solely upon transfer of these signal voltages from the tube to the load.

One of the characteristics of the tuned double impedance system of audio-frequency amplification; as a matter of fact of all impedance coupled systems, is that large values of inductance are usually used, and the impedance of the plate load is quite high at even the lowest frequency, with the result that very satisfactory low frequency voltage transfer is obtained. It is not uncommon to employ 225 henrys of inductance for the plate coil of a tuned double impedance unit, and the impedance of such a winding at 30 cycles is approximately 42,250 ohms. With the tube mentioned, the voltage transfer at 30 cycles,

$$E1 = 10 \times \frac{42{,}250}{42{,}250 \text{ plus } 15{,}000}$$

$$= 10 \times .739$$

$$= 7.39 \text{ volts}$$

It is understood of course that the voltage transfer increases as the applied frequency is increased. The tuned double impedance arrangement is shown in Figs. 57-A and 57-B.

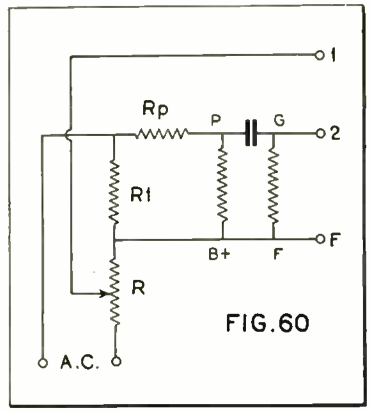
A.C. Voltage Measurements

The method of making A.C. voltage measurements upon audio-frequency coupling units to determine the operating characteristics, are shown in Figs. 58, 59 and 60. Fig. 58 illustrates the transformer measurement, Fig. 59 that of the tuned double impedance unit and Fig. 60 that of the resistance coupler.

The operation of these units has been described in RADIO ENGINEERING by several able writers, and concrete operating instructions have been described by Mr. D'Arcy in several previous issues. Since the determination of operating characteristics is beyond the scope of the "Mathematics of Radio," we will not dwell in detail upon these measuring systems. The coupling unit is located across one arm of a bridge system, fed with a signal voltage from a variable frequency audio oscillator. The output of the coupling unit is then measured with a vacuum tube voltmeter, voltmeter readings being taken at the various test frequencies. The vacuum tube voltmeter is alternately switched to the output of the oscillator and by adjustment of the voltage divider resistance R to produce a certain reading on the vacuum tube voltmeter, a certain voltage input ratio is obtained. The value necessary to produce identical readings on the tube voltmeter is the voltage amplification ratio of the coupling unit under test. These measurements are made at various audio frequencies and the response characteristics of the unit under test is determined. Rp in the illustration is a variable resistance set to simulate the plate resistance of a tube. This is necessary in order to test the coupling under conditions similar to that entailed if the voltage scource were a vacuum tube instead of the oscillator.

The formula for impedance on page 36 of the August issue was misstated. It should read $Z=\sqrt{R^2+(XL)^2}$. The calculations, however, were not in error.

(To be continued)



Circuit for making A.C. voltage measurements on a resistance coupled audio frequency stage.

DR. ALEXANDERSON TO DEMONSTRATE NEW TELEVISION EQUIPMENT

A TELEVISION projector large enough to show a life-size image of a person's head or two entire moving figures in reduced form has been developed by Dr. E. F. W. Alexanderson, consulting engineer of the General Electric Company.

The new projector will be demonstrated at the Radio World's Fair at Madison Square Garden, September 17-28.

Production of an image twelve inches square, as compared to the three-inch image obtained by earlier television receiving systems and the projection of the image, whether moving or motionless, upon a screen formed by ground glass plate are the two notable developments incorporated in Dr. Alexanderson's new projector.

The problem of projecting the image was solved principally through the use at the receiving station of a special neon tube, known as the Moore crater lamp, which gives a highly concentrated light. The tube, responding to electrical impulses from the photo-electric cells operating at the transmitter, casts its light through a forty-eight-hole disc, each hole containing a lens. The image is projected from the disc to the ground glass plate.

Applications of the Photoelectric Cell in Industry

Covering the Various Uses of the Alkali Metal Photoelectric Cell and the Most Desirable Circuits

By Milton Bergstein, Ph.D.*

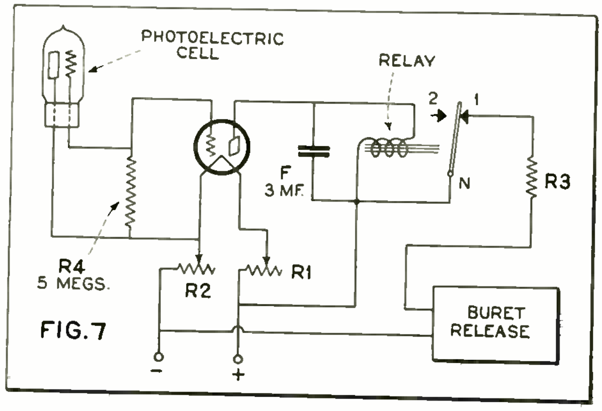
PART II

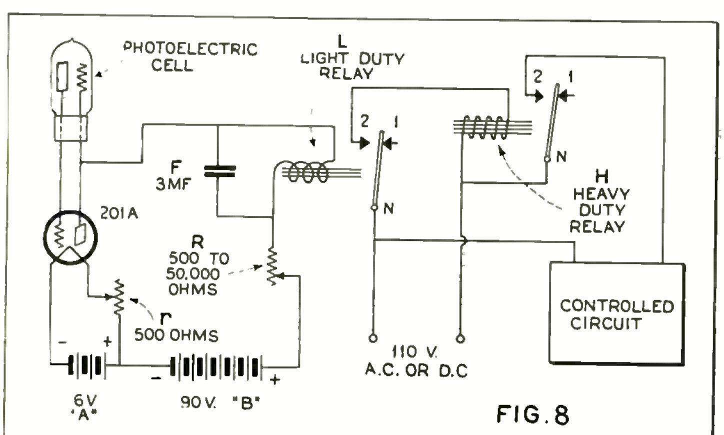
THE circuit of Fig. 7 was designed primarily for automatic titration (i. e. in quantitative chemical analysis) but the applications may be extended to include automatic control of many chemical processes. This particular method of application of the photoelectric cell was devised by Müller & Partridge.[1]

The device works directly from a 110 volt line. Either A.C. or D.C. can be used, but if A.C. is used the condenser F should be inserted where indicated. R_1 and R_2 are resistances adjusted to give the proper drop across the filament and 90 volts on the plate. 199 and 120-type tubes were, according to the inventors, found most satisfactory and they recommend the use of tubes having an output of at least four milliamperes with 90 volts on the plate. The relay they used was a Bunnell standard telegraphy relay rewired to a resistance of about 3,000 ohms capable of operating on a few milliamperes. Various A. T. & T. standard relays may likewise be used. The author has found them rather satisfactory. The grid leak R_4 of approximately five megohms is connected as shown.

The action of the circuit is as follows: With the cell unilluminated the normal output of the amplifying tubes is sufficient to hold down the armature of the relay. The resistance R_4 is adjusted to such a magnitude that, when the photoelectric cell is illuminated, the photoelectric current is sufficient to make the grid negative by several volts with respect to the filament, thereby decreasing the output. The relay now opens and throws a line voltage on the buret relay through the protective resistance R_3. Instead of the buret relay various power control heavy-duty relays may be inserted at R_3 for the control of mechanical processes. It is possible to insert a cascade of relays as described above instead of the telegraphy relay, so that a range of power control operations may be conducted absolutely mechanically.

Circuit designed primarily for automatic titration but adaptable to the automatic control of other chemical processes. The arrangement works directly from a 110 volt line, A.C. or D.C.





A circuit similar to that of Fig. 7 but battery operated. With this arrangement the accuracy of control of the relays is enhanced

Automatic Titration

When the device is used for making a titration, light from a lamp passes horizontally through the beaker of the

* *Photion Instrument Corp.*

[1] *Müller & Partridge Ind. & Eng. Chem., Vol. 20, page* 423 (1928).

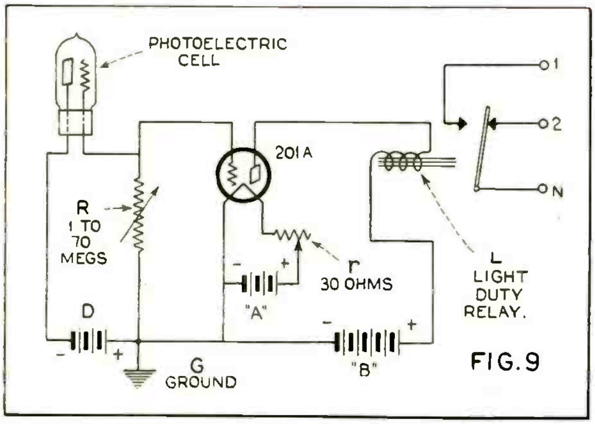


FIG. 9

Another photoelectric circuit with numerous applications. If the relay is replaced by a milliammeter the circuit may be used for color matching

solution being titrated (to avoid the variation in intensity of light due to change in the length of the optical path through the solution) and impinges on the photoelectric cell, which is located in a light-tight box except for the opening in contact with the beaker. The change in color during the titration varies the intensity of the light sufficiently to actuate the photoelectric cell and through the amplifying tube to operate the relay and buret relay.

In carrying out a titration a beaker of water of the color of the final solution is placed in contact with the opening on the light-tight box and the intensity of the light is adjusted by a resistance in series with the lamp until the relay just opens. The beaker can now be removed and filled with the solution to be titrated. Assuming that this original solution is darker than the final solution the relay will be closed, because sufficient light does not reach the photoelectric cell. The solution is stirred automatically and the buret stop-cock is connected to the buret relay, which stops the flow of titrating solution immediately when the solution arrives at the final color desired. The mechanical details of this device are described completely in the original article (see footnote) and should be referred to to gain an idea of how these automatic devices operate.

Other Applications

It may be seen that if a cascade of relays is used instead of the individual relay a variety of control operations may be obtained depending upon the color of the solution at the time. The principle, of course, may be extended to solutions in motion through pipe lines. Oils flowing through a pipe may be separated according to color with this device. The range of applicability of such a device in mechanical processes is quite evident and the application of this simple and inexpensive arrangement of the photoelectric cell in mechanical operations should prove economically valuable in chemical plants.

The application is not limited to liquids. Instead of having a light pass through the cell it may be reflected from an opaque body such as cloth or paper through the hole in the light-tight box to the cell.

By a cascade of relays materials may be graded automatically according to color or materials may be compared as to color, if a meter is inserted instead of the relay.

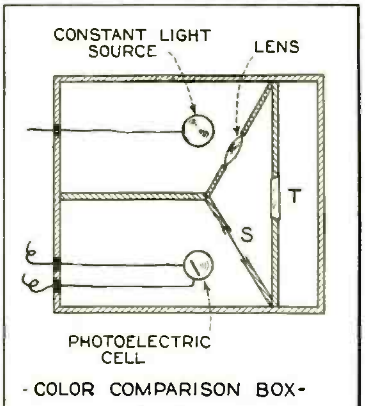


FIG. 10

Constructional details of a color comparison box

Fig. 8 is partially battery operated and because of the possibility of exact adjustments with the batteries the degree of accuracy of control of the relays is considerably enhanced. This circuit may be used to give a nicer degree of distinction than Fig. 5.

Color Matching

In the circuit of Fig. 9 increase of light gives a decrease of current flowing through the amplifier tube. This circuit is preferable to Fig. 2 in some respects because the necessity for adjustment of a "C" battery is eliminated. In all other respects the suggestions given for operation of this circuit correspond with those given for Fig. 2. This circuit may be used for any application for which any of the preceding circuits are suggested. Outside of the fact that it is battery operated there are practically no faults to find with it. If the relay is replaced by a milliammeter this circuit may be used for color matching work. A suggested arrangement for color matching is indicated in Fig. 10. The photoelectric cell is in one compartment of a light-tight metal box and the constant light source is in another compartment. The box should be grounded. The light may be focused on a piece of material by a lens as indicated and the reflected light shines on the cell. Several pieces of material are inserted alternatively for comparison at the point T. In order to enhance the degree of accuracy of comparison, color screens (a book of about 50 Wrattan filters is obtainable from Eastman Kodak Co.) may be inserted at S. The accuracy of comparison may be further enhanced by making comparisons, with several different color screens, of the electrical outputs caused by the two materials. If the meter readings correspond for each different color screen then the two colors being compared are identical.

The circuit of Fig. 11 may be used for extremely accurate comparison of

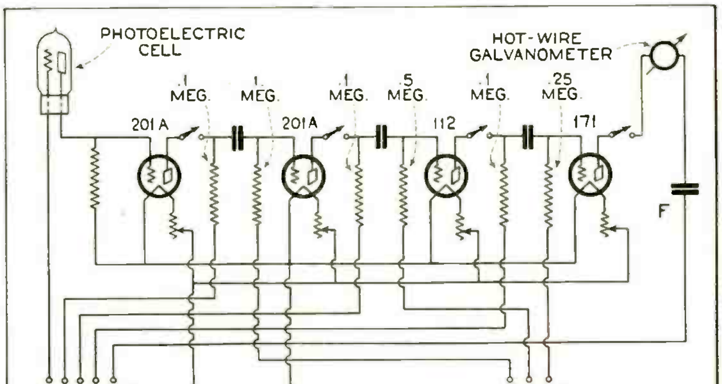


FIG. 11

A circuit designed for extremely accurate comparison of colors or for measurement of intensity of a very weak light source. A revolving shutter is inserted between the light source and the photoelectric cell colors or for measurement of intensity of a very weak light source. A revolving shutter is inserted between the light source and the photoelectric cell. The adjustments required for this circuit are best determined by experiment.

It must be remembered that if accurate comparisons are at all times to be made, meters should be inserted in the circuits so that the voltages of the batteries and the voltage across the filament may at all times be kept constant.

Conclusion

The information given in this article is necessarily of the briefest nature. However, it is obvious how tremendous the applications of the photoelectric cell in industry really are. The engineer working with a cell for the first time will doubtlessly be confronted with considerable difficulty but the effort he devotes to experimental work will not be in vain, for every eye added to the blind machine is another man saved.

In the entire article we have alluded only to process control. The cell, of course, may also be used as a safety device to stop operation when the danger point, because of interruption of certain movements, of breakage of certain parts, or of overheating of certain points is reached. The possibility of application of the cell in long distance high-temperature pyrometry should also not be neglected.

It is impossible to suggest all the applications of the photoelectric cell. No doubt countless ones of great value remain to be discovered.

(The End)

(In Part I of the article by Dr. Bergstein, which appeared in the August issue, errors were made in the diagrams of Fig. 5 and Fig. 6. In each instance the grid and plate elements of the photoelectric cell were shown reversed.)

THE ENGINEERING RISE IN RADIO

(Continued from page 22)

not one of degree. It is clear to me that there is no Hertzian wave telegraphy without the essential feature for producing Hertzian waves, which is the Hertzian spark." This was the "whip crack" doctrine, which in time was shown to be in error.

Even with the Poulsen arc oscillator, a system in existence in 1903, four or five years elapsed before this apparatus was placed in service on a scale which might demonstrate its usefulness. The delay was in large part due to a misunderstanding of the possibilities of the method. Dudell, himself,[4] three years after his work on the Thomson arc idea held the opinion that frequencies much above 10,000 could not be obtained by these means. This, with Professor Fleming's statement[5] to the effect that an abrupt impulse was essential, and that high-frequency currents could not, without a requisite suddenness of reversal, produce radiation.

Proposals for Improvement of Spark Transmitters

While the alternator of Fessenden and Alexanderson, and the arc oscillator as improved by Poulsen were bidding for consideration as producers of sustained oscillations, innumerable attempts were made to improve transmitters of the spark type so that these might be expected to keep up with the rapidly expanding needs of wireless signaling.

As a record of the trend of thought on this subject reference may be made to the work of S. M. Eisenstein and J. Sahulka. Eisenstein, employing three-phase current supply for energizing the primaries of three transformers or induction coils, in which the current from each phase passed through the primaries in turn, caused the production of oscillations at three spark-gaps, one after the other.

By this means the transmitter could be kept excited even when using a current of comparatively low frequency. The purpose was to avoid the inactive intervals between the sparks of a train, previously referred to as objectionable, and thus make the energy supplied to the antenna approach in uniformity that of a sustained frequency.

This scheme was a step in the right direction as, clearly, the inactive intervals were in large measure bridged over, but there remained a lack of constancy between successive discharges, and although it was not recognized fully at the time the element that was wanting was an improved form of spark-gap, which subject will be dealt with in Chapter 6 of this treatise.

The solution proposed by Professor J. Sahulka,[6] in Austria, sought to accomplish the same purpose by mechanical instead of electrical means. He pointed out that the main cause of the inactive intervals between wave trains in spark transmitters was that during the whole time the spark continued the current source was practically short-circuited, its terminal potential-difference being reduced to zero. The voltage could increase only gradually upon the cessation of a spark, due to the inductance of the circuit and the necessity for again charging the condenser.

To remedy this condition Sahulka employed a rotating commutator of special design. The device differed from the rotary discharger of Tesla in that two condensers were employed, alternately switched from a charging circuit to the oscillatory circuit. Automatically one bank of condensers was being given a charge while a companion bank discharged into the oscillatory circuit. The surface areas of the commutator segments were such that the contacts for charging were of shorter duration than those for discharging. This provided that the discharge connection was maintained long enough to reduce to a minimum the breaks between successive wave trains.

(To be continued)

[4] *The Electrician*, 1903, *Vol. LI, page* 902.
[5] *Proceedings, International Electrical Congress, St. Louis, Mo., Vol. 3, page* 603.
[6] *German patent*, 176,011, 1906.

DETECTION WITH THE SCREEN-GRID TUBE

Radio Engineering has published quite an amount of data on the screen-grid tube relative to its use as a radio-frequency amplifier, an audio-frequency amplifier and as a space-charge-grid tube.

It has been recognized by engineers that the screen-grid tube also offers advantages when employed as a detector, if the tube is properly applied. Data on this particular application of the screen-grid tube has been conspicuous by its absence mainly because progress has been slow.

Radio Engineering is pleased to inform its readers that first hand data on this application will appear in the October issue. The article will cover the results of the research conducted by Mr. J. R. Nelson of the Engineering Department of E. T. Cunningham, Inc.

You will find this material decidedly valuable. Do not miss it.—_Editor._

AUDIO-FREQUENCY OSCILLATION

(Continued from page 23)

Plate Feed Resistances

Fig. 2 shows an amplifier connected up with plate-feed resistances giving, in fact, an overall amplification which equals the theoretical product of the two separate A.F. stages.

Fig. 3 gives the reproduction of an oscillograph photograph of the input and output waves of this amplifier showing that there is no wave-form distortion. Fig. 4 shows an oscillogram of the input and output waves of the same amplifier, using a common battery of 200 ohms D.C. resistance, but without the plate-feed resistances. The output is a wave of the same frequency as the input, but of much reduced amplitude, having a high-frequency ripple superimposed, causing a shrill whistle in the loud-speaker.

Every receiver with A.F. stages employing a common "B" source is prone to produce a change in wave-form and amplification characteristic due to interaction of which Fig. 4 is an exaggerated case.

Hammarlund-Roberts "Hi-Q 29"

By H. M. Kelley

THE Master D.C. Model "Hi-Q 29" employs screen-grid tubes in a circuit especially developed for these tubes by the Hammarlund-Roberts Board of Engineers, consisting of the engineering departments of ten parts manufacturers.

The circuit employed uses two screen-grid tubes working at maximum efficiency, followed by a standard detector and two stage transformer-coupled audio amplifier. The special "tuned-grid, tuned-plate" circuits employed in the radio-frequency stages are primarily responsible for the receivers excellent "pick up" and selectivity. These stages are really band-pass filters, both plate and grid coils of each stage being tuned to exact resonance by separate variable condensers. This efficient circuit makes it possible to utilize a much higher proportion of the theoretical amplifying properties of the screen-grid tubes than would be possible if some other and less efficient circuit were used. This filter type of circuit has the added advantage of providing a degree of selectivity hitherto unobtainable without excessive "side band cutting" with its accompanying loss of quality. The shape of the tuning curve closely approaches the flat-top, sharp cut-off curve long considered ideal by radio engineers.

Operating Principles

The remarkable performance of this receiver can best be understood by consideration of the principles involved in its design. The interstage R. F. transformers are quite unique, in that they consist of two exactly similar coils. One constitutes the primary of the transformer and is connected in the plate circuit of the preceding tube, the other coil acts as the secondary and is connected to the grid of the following tube. Each coil is tuned to resonance with the desired signal by means of a .00035 mfd. variable condenser. Due to the rather unusual mounting arrangement the mutual inductance of coupling between primary and secondary is very small. However, this does not mean that the energy transfer from primary to secondary is inefficient. On the contrary, when two tuned circuits are coupled to each other, the maximum secondary voltage is obtained when the relation $(2\pi f)^2M^2=R_1R_2$ is satisfied, where f=frequency to which both circuits are tuned, M=mutual inductance in henries, and R_1 and R_2 are the effective radio-frequency resistance of the primary and secondary respectively. In the case of the coils used in the receiver under discussion the maximum secondary voltage is obtained with a coupling coefficient of the order of one per cent. The physical arrangement of the coils, as shown in the photograph of the completed receiver, was chosen because it seemed the simplest way to secure such loose coupling while still keeping the coils close to each other, thus conserving space.

Due to the inherent characteristics of loosely coupled tuned circuits each of these doubly tuned R. F. transformers really constitutes a band-pass filter.

While one of these double-tuned R. F. transformers provides an unusual degree of selectivity, the use of two such stages in cascade results in a vast improvement.

Rectangular Resonance Curve

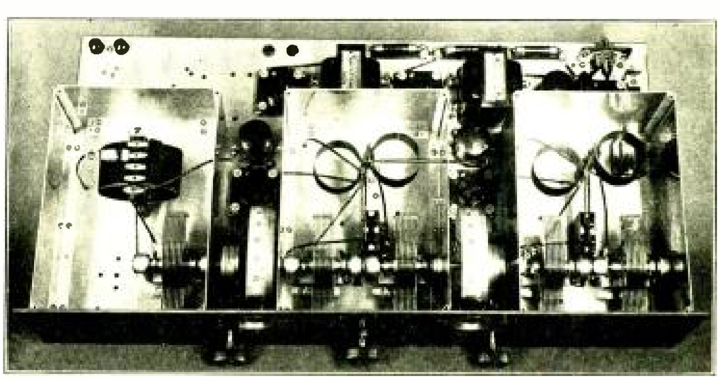
The width and flatness of a resonance curve has an important bearing on the quality of the received speech and music. This is due to the fact that a broadcast station does not transmit on a single frequency, but rather on a band of frequencies. The width of the side bands varies somewhat depending on the transmitter adjustments and also on the type of program being broadcast. They are, however, generally conceded to be about five kilocycles wide for high-quality transmission. It is therefore apparent that the receiver should be capable of amplifying a band of frequencies substantially uniformly if the program is to be received faithfully. Hence the desirability of the wide flat top on the overall response curve of a high-grade receiver. When the top of the response curve is sharp instead of flat all the frequencies in the band are not amplified equally. Consequently certain of these frequencies reach the detector much stronger than others with the result that even the most perfect A. F. amplifier and loud speaker will be unable to reproduce the program with its original quality. This is the type of distortion referred to previously as "side band cutting," and usually results in the loss or weakening of the high audio frequencies making the output from the loud speaker dull and muffled.

The two double tuned R. F. transformers used in the Hammarlund Roberts "Hi-Q 29" necessitates the use of four variable condensers—one to tune each of the four coils. Since all four of the tuned circuits are identical these four variable condensers are rotated by a common shaft actuated by a new model drum dial having a smooth positive drive without backlash. The tuned input circuit to the grid of the first screen grid tube, often referred to as the antenna coupler, is of the conventional type having a tapped primary making it adaptable to different length antennas. The variable condenser tuning this antenna coupler is on a separate shaft and has a separate drum dial, thus enabling this circuit to be tuned to exact resonance with the received signal, regardless of the type of antenna used.

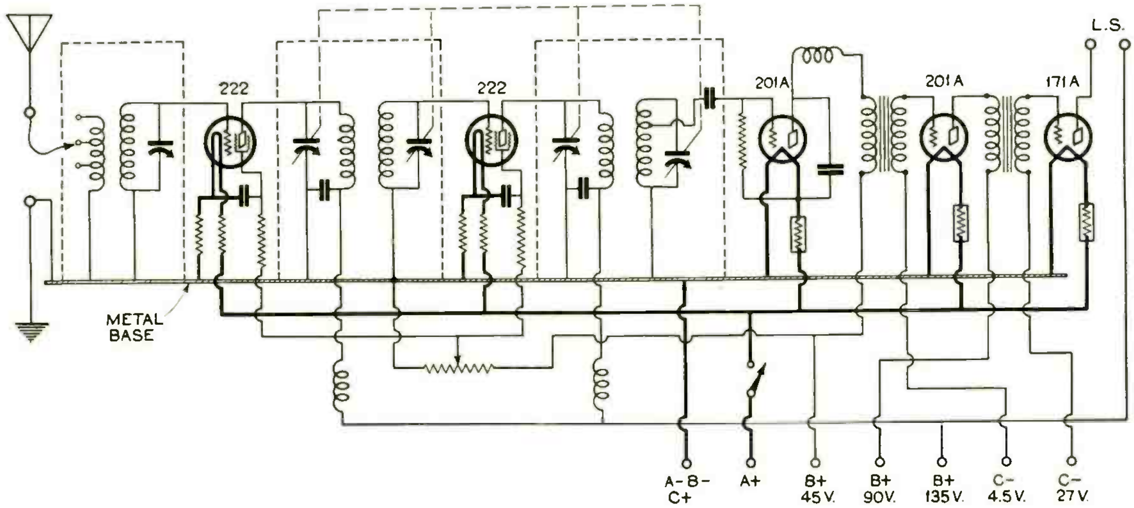
The Volume Control

The volume control is quite out of the ordinary and is made possible only by the characteristics of the screen grid tubes. It consists of a 100,000 ohm potentiometer connected across the 45 volt "B" supply. The center tap of this potentiometer provides a variable voltage which is impressed on the screen grids of the two R. F. amplifier tubes. The amplification obtainable from these tubes varied within wide limits as the voltage on the screen grids is changed, being at maximum around 45 volts and dropping rapidly as the screen-grid potential is reduced. This provided a very smooth control of volume within wide limits without affecting quality or tuning in the slightest degree.

While the screen grid tubes have a very low value of capacity between plate and grid, thus almost entirely obviating the tendency of feedback through the tubes themselves, causing self-oscillation, this advantage is nullified if feedback occurs in other parts of the receiver. Taking this into consideration every effort has been made to isolate all circuits in which coupling might result in instability. The negative bias for the grids of the R. F. tubes is secured by the drop across individual 10 ohm resisters in series with the negative leg or each 222 tube filament. Since the screen grids of both these tubes are biased by the 100,000 ohm potentiometer, a 5000 ohm isolating resistor is inserted in the lead to each of the screen grids, which are in turn by-passed by means of separate one-half mfd. by-pass condensers. The plate circuits of these tubes are likewise isolated by individual filters consisting of separate radio-frequency choke coils and by-pass condensers. In addition to the above mentioned precautions the entire R.F. end of the receiver is thoroughly shielded. Each stage is entirely enclosed in a snug fitting aluminum box which is securely fastened to the metal chassis. The screen grid tubes are so located that the leads to the control grids are as short as possible and farthest away from the plate leads which are also very short. By placing these tubes between the cans, as shown in the photograph, the can sides are used also as tube shields effectively preventing coupling between the tube elements and other parts of the circuit. This arrangement provides the minimum coupling between output and input circuits, which is extremely important.



The two screen-grid, band selector R.F. stages are completely shielded from the other apparatus in the Master "Hi-Q 29" receiver and are gang tuned. The antenna circuit is tuned separately.



The schematic diagram of the Master "Hi-Q 29" battery operated set. Note that both the plate and grid circuits of the screen-grid R.F. tubes are tuned, thus forming practical band selector circuits.

The Audio Amplifier

The audio-frequency amplifier is of the conventional type consisting of two stages of transformer coupling. The A.F. transformers used have a very flat frequency characteristic over the usual A.F. range. A radio-frequency choke coil is placed between the plate of the detector tube and the first A.F. transformer to prevent any stray R.F. voltages from getting into the A.F. amplifier. A 171-type tube is recommended for use in the last stage, although other types may be used if suitable "A," "B" and "C" voltages are available.

Although the above description is based on the battery operated model, a complete all electric variation has been developed. Arcturus A.C. tubes are used and some slight changes in wiring are required. Otherwise the operating characteristics and set performance are identical.

LIST OF PARTS REQUIRED

5–Hammarlund No. ML-17 .00035 mfd. Midline Condensers ....

1–Hammarlund No. HQ-29 Coil Set......

2–Hammarlund No. SDW Knob-Control Drum Dials (Walnut) ....

3–Hammarlund No. RFC-85 Radio Frequency Chokes ....

Hammarlund Mfg. Co., Inc.

5–Benjamin Cle-Ra-Tone Sockets, No. 9040

Benjamin Electric Mfg. Co.

1–Sangamo .00025 mfd. Fixed Mica Condenser ....

1–Sangamo .001 mfd. Fixed Mica Condenser ....

Sangamo Electric Co.

1–Carter No. 11-S "Hi-Pot" Potentiometer with switch, 100,000 ohms.

Carter Radio Co.

2–Thordarson No. R-300 Audio Transformers ....

Thordarson Electric Mfg. Co.

4–Parvolt .5 mfd. Series 200 By-Pass Condensers ....

1–Durham Metalized Resistor, 1½ megohms ....

International Resistance Co.

1–Yaxley No. 660 Cable Connector and Cable ....

1–pr. Yaxley No. 422 Insulated Phone Tip Jacks ....

Yaxley Mfg. Co.

2–Amperites No. 1-A ....

1–Amperite No. 112 ....

Radiall Co.

2–Eby Engraved Binding Posts........

H. H. Eby Mfg. Co.

1–"Hi-Q 29" Master Foundation Unit (containing drilled and engraved Westinghouse Micarta panels, three complete aluminum shields, drilled steel chassis, shafts, binding post strips, Fahnstock clips, fixed resistance units, resistor mounts, brackets, clips, wire, screws, nuts, washers, and all special hardware required to complete receiver) ....

Hammarlund Mfg. Co., Inc.

The S-M 720 "Screen Grid Six"

By McMurdo Silver

THE radio receiver desiribed in the following paragraphs has been developed in an attempt to provide effective ten to fifteen kilocycle selectivity, a quite regular reception range of two thousand miles, a closer approach to realism of reproduction than has been had with preceding receivers, yet all at a cost so low as to place the set within reach of the great majority of fans.

The new "Screen Grid Six" employs three stages of high gain R.F. amplification (using screen-grid tubes) with four tuned circuits, a detector, and two stages of audio amplification utilizing the new Clough audio transformer system.

Since the "Screen Grid Six" design would seem to represent not only a new high level of radio receiver performance, but a new low level in cost almost regardless of performance it is felt that a description of the engineering features of the design, together with other points of interest, will not be unwelcome to RADIO ENGINEERING readers.

Antenna Input Circuit

For the "Screen Grid Six" a tuned antenna input circuit was designed having the very best possible characteristics which could be attained in practice. This circuit consisted in final form of a very low resistance coil consisting of 39 turns of No. 20 enameled wire upon a threaded bakelite form 4 inches long and 2¾ inches in diameter. Any student familiar with average coil resistances will realize that the values of 3.3 ohms at 550 meters and 11.5 ohms at 200 meters obtained upon the coil, tuned by a .00035 mfd. condenser, represent an unusually good circuit, (the coil itself has a "figure of merit" practically double that of the many commercial coils found on the open market). This input coil, L1, is tuned by a single condenser, C1, actuated by the left-hand drum, D1. A representative antenna of 400 mmf. capacity, 25 ohms resistance and 28 microhenries inductance was coupled to the input coil through, optionally, a small primary coil of 20 turns, or a large primary of 69 turns in series with a 75 mmf. midget condenser, C5, which was used to regulate selectivity. The voltage step-up provided by this tuned antenna input circuit varies from 64 at 200 meters (1500 K.C.) to 28 at the middle of the broadcast band and rises to 100 times at 550 meters. At 550 meters is where the greatest step-up is always needed, for the amplification of any practical R.F. amplifier always falls off at high waves.

The "Screen-Grid Six" has two tuning controls, a volume control (3000-ohm potentiometer) and a selectivity control (75 mmf. variable condenser).

Tuned R.F. Circuits

The antenna input circuit is followed by three identical tuned circuits, each housed in individual copper shielding cans SH1, SH2, SH3. These circuits employ small plug-in inductances L2, L3, L4, the secondaries of which consist of 98½ turns of No. 29 enameled wire wound upon a threaded moulded bakelite form 1½ inches in diameter and 1½ inches long. Two of these tuned circuits feed the two remaining screen-grid amplifier tubes, S5, and S6, while the third circuit feeds the detector tube S9. The actual measured voltage amplification of one individual stage varies from 14 per stage at 550 meters to 30 at 200 meters. While this amplification may seem very low for a screen-grid R.F. amplifier stage, it must be borne in mind that the high amplification that may be obtained from them in practice; that the maximum voltage gain which can be had from these tubes in the broadcast band with practical circuits will vary between 30 and 65 per stage, and that in order to obtain such amplification selectivity must be thrown utterly to the winds. In the "Screen Grid Six," this has purposely not been done and the effective amplification of the three shielded R.F. amplifier stages has been purposely held at a low value in order that maximum possible selectivity could be obtained in these circuits. The overall voltage amplification of the three screen-grid stages, neglecting the antenna coupler, varies from 2,500 times at 550 meters to 15,500 times at 200 meters.

It would, of course, be ideal if the curve could be made flat, but, unfortunately, in a practically stable R.F. amplifier this cannot be accomplished sufficiently effectively to justify the complications the effort would introduce. (The few means which have been devised for flattening out the curve have not been wholly successful to judge from the popular desuetude into which they have fallen.)

Shielding and Circuit Isolation

Before passing on from the R.F. amplifier, it is well to mention that every precaution has been taken to render the performance of this portion of the receiver as stable and dependable as possible. This can easily be realized from an examination of the design which reveals individual copper stage shielding for the tuned R.F. amplifier circuits, individual by-passing of all "B" supply leads by condensers directly in the stage shields, and the isolation of all R.F. currents from any common paths which might cause coupling and instability. The antenna input circuit is thoroughly shielded from the three remaining R.F. circuits, and when the receiver cabinet is in place, it is thoroughly shielded from extraneous interference; it is then practically impossible to receive even the strongest local signal if the antenna lead-in wire be removed from the set. Yet with a 1 foot wire for an antenna added, many stations come in with ample loud speaker volume, so great is the pick-up of the set.

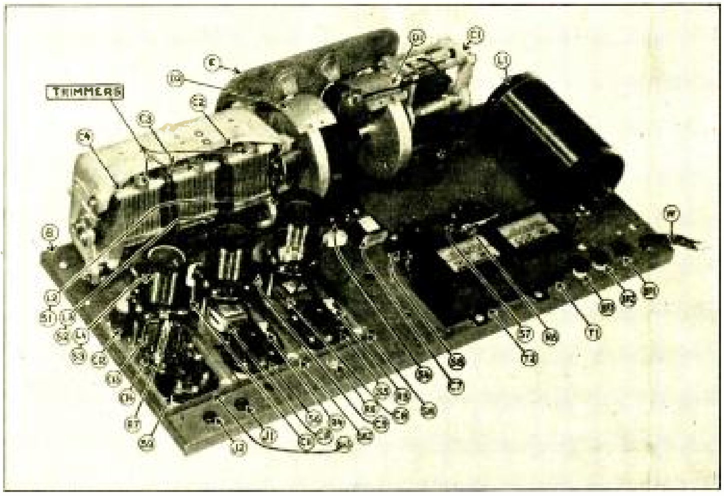
In order to compensate for varying antenna characteristics, the option of two methods of antenna coupling is provided and one is equipped with a variable selectivity control in the form of a 75 mmf. antenna series condenser, CS. The single tuning condenser, C1, tunes the antenna circuit, and the triple gang condenser, C2, C3, and C4, tunes the three remaining R.F. circuits housed in shields SH1, SH2, SH3. The construction of this condenser is such that its accuracy is permanently assured through the use of a heavy die-case frame which adequately protects and permanently aligns all plate assemblies which are double spaced. The condenser accuracy is guaranteed by the manufacturers to within 1% over the upper half of the dial and to within 1 micromicrofarad over the lower half of the dial, which accuracy is more than ample to provide 10 K.C. selectivity (1% plus and minus is usual tolerance for the finer ready-made sets). Three compensators are provided upon sections C2, C3, and C4, which allow compensation, once the set is assembled, for variations in tube and circuit capacities.

Oscillation over the lower portion of the broadcast band, and volume over the entire band, is controlled by the potentiometer, R1, which varies the potential on the screen-grids of the R.F. amplifier tubes, S4, S5, S6. The detector, S9, presents no unusual features, being the conventional grid-condenser, C13, and leak, R7, type with negative filament return, since this was found to give best results in the "Screen Grid Six."

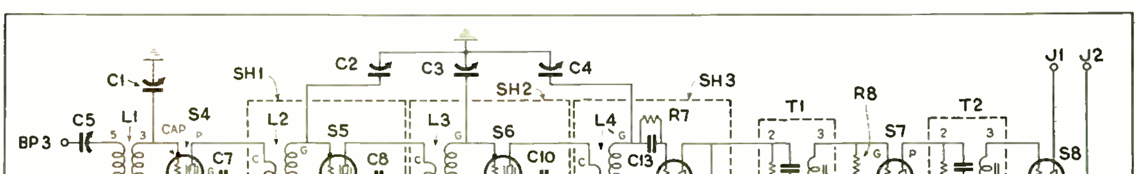
The Clough transformers employed, T1, T2, will be seen to consist of auto-transformers, resonating condensers and plate resistors, all sealed in individual pots. These transformers have an effective transformation ratio of about 4.3 for T1, and 3.5 for T2, and through a unique phenomena of resonance obtained from proper proportioning of the auto-transformer windings, the condenser, and the resistance, together with the plate resistance of the tubes used, a rising low-frequency characteristic is obtained which provides a hump in the amplification curve just below 100 cycles.

The desirability of this curve cannot be over-emphasized for it is in this range that broadcast transmission begins to fall off seriously and where average loud speakers are most deficient in response. In addition to this rising low note characteristic, hysteretic distortion, due to the direct plate current of tubes flowing through transformer primaries, has been practically completely eliminated by isolating the direct current from the transformer windings and causing it to flow through the plate resistances, 1–2 The effective voltage amplification of transformers T1 and T2 with a UX 112–A first stage tube and UX 112–A or UX 210 output tube would be approximately 1100 or about twice that obtained from an ordinary transformer amplifier employing 3:1 transformers which would give a voltage gain of only 575 times as well as a bad drop in low-frequency amplificatian and hysteretic distortion, even for the best transformers now available.

The photographs, drawings, and parts list presented herewith are believed to be so clearly marked and keyed as to require practically no explanation.



The layout of the "Screen-Grid Six" receiver. The various parts may be identified by consulting the list of parts on page 34.



The complete circuit diagram of the "Screen-Grid Six." It will be noticed that the wiring has been reduced to a minimum as the negative "A" and "B" circuits have been grounded. The new Clough audio amplifier is employed.

LIST OF PARTS REQUIRED

1 B—S-M 701 Universal pierced chassis
1 E—S-M 809 dual control escutcheon
1 D1—S-M 806L (left) vernier drum dial
1 D2—S-M 806R (right) vernier drum dial
1 C1—S-M 320R .00035 mfd. Universal condenser
1 C2-C3-C4—S-M 323 .00035 mfd. 3-gang condenser
1 C5—S-M 342B .000075 mfd. midget condenser
3 SH1-SH2-SH3—S-M 638 copper stage shields
1 L1—S-M 140 antenna coil
3 L2-L3-L4—S-M 132A plug-in RF transformers
3 S1-S2-S3—S-M 512 5-prong tube sockets
5 S4-S5-S6-S7-S8—S-M 511 tube sockets
1 T1—S-M 255 first stage A.F. transformer
1 T2—S-M 256 second stage A.F. transformer
1 W—S-M 708 10-lead, 5-foot connection cable
1—S-M 818 hook-up wire (25 ft. to carton)
1 R1—Yaxley 53000-P, 3,000 ohm junior potentiometer
1 SW—Yaxley 500 switch attachment
2 J1-J2—Yaxley 420 insulated tipjacks
3 R2-R3-R4—Carter RU10, 10 ohm resistors
1 R6—Carter AP-6, 6 ohm sub-base rheostat
1 R5—Carter H1½, 1½ ohm resistor
1 C6—Potter No. 4, 1 mfd. bypass condenser
6 C7-C8-C9-C10-C11-C12—Sprague or Polymet ¼ mfd. midget condensers
1 C13—Polymet .00015 mfd. grid condenser with clips
1 C14—Polymet .002 mfd. bypass condenser
1 R7—Polymet 2 megohm grid leak
1 R8—Durham .15 megohm resistor with leads
1 S9—Naald 481XS cushioned tube socket
3 BP1-BP2-BP3—Moulded binding posts consisting of 8/32 screw, nut, and moulded top
1—Set hardware as listed below:
6 ¾" x ¼" hollow condenser studs
8 1⅜" x ¼" hollow coil studs
8 1⅞" x 6/32 R.H. machine screws
6 1" x 6/32 R.H. machine screws
29 ⅜" x 6/32 R.H. machine screws
37 6/32 nuts
46 Shakeproof lock washers
4 1½" x No. 10 R.H. wood screws
3 lengths of spaghetti
4 lengths bus-bar
2 sets binding post insulating washers
3 sets instrument insulating washers
2 tipjack insulating washers
1 metal washer
18 long soldering lugs
3 grid clips

Accessories for UX250 Power Tube

If UX250 (CX350) power output tube is to be used in place of UX171A (CX371A) for finest possible tone quality, the list of accessories for light socket operation should be changed. An S-M 675 ABC Reservoir power unit should be procured instead of type 670B, a 4½ volt C battery instead of a 40.5 volt type and a UX250 (CX350) tube instead of a UX171A (CX371A).

Output Transformers

Some form of output coupler, tone filter or transformer (between power tube and loud-speaker) is desirable with a UX171A power tube, and vitaly essential with a UX250 or UX210 power tube. S-M type 251 output tone filter is desirable with UX171A output tube, and may be incorporated in the set as shown.

The 5-Tube Skyscraper

By Clifford Denton

WITH the advent of the screen-grid tube, numerous designers have used it in radio-frequency amplifiers. In the majority of designs, volume has been sacrificed to obtain selectivity and stability.

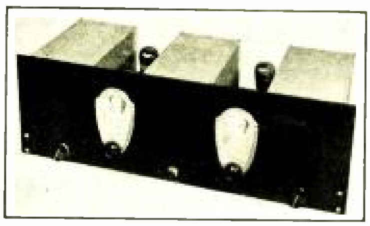
Mr. Robert Arnold has succeeded in designing a 5-tube set using two screen-grid tubes in the radio stages which develop unusually high gain while retaining selectivity and stability when operating on antenna or loop. On account of this unusually high gain and the ability of the set to bring in distant stations, it has been given the name of "Skyscraper."

Since the radio-frequency voltage amplification depends only upon the load impedance of the coupling circuits and the mutual conductance of the tube and since the mutual conductance of the tube is approximately constant over broadcast frequencies, attention should be directed to the coupling circuits, as this is the limiting factor in securing the maximum amplification. The equation expressing this is:

Voltage amplification=load impedence x mutual conductance expressed in ohms.

The mutal conductance of a 222 tube is considered to be approximately 300 microhms when operating with the correct potentials for Gm, the maximum mutual conductance.

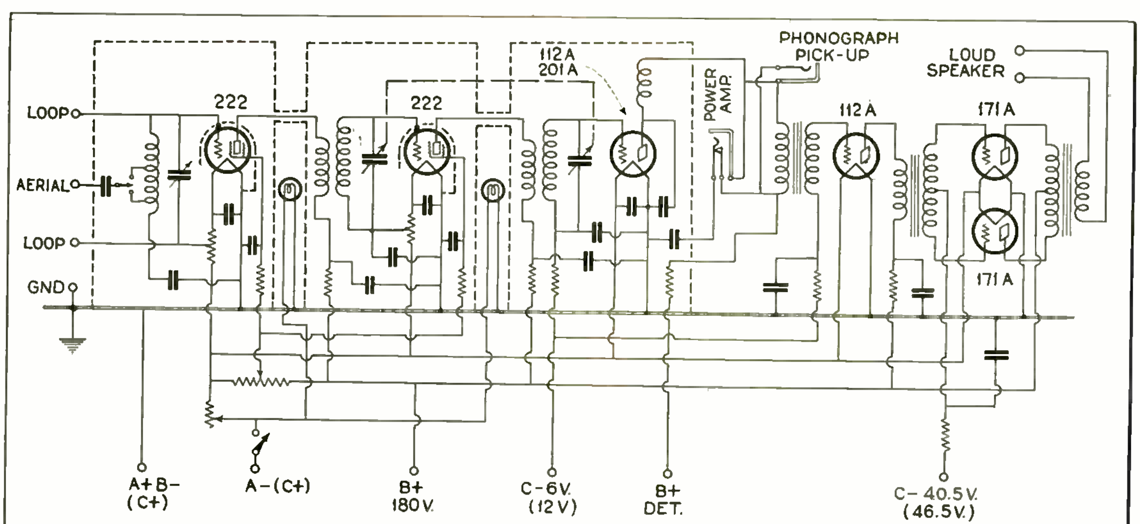
In using the above equation it can be seen that if a load impedance of 100,000



Panel view of the "Skyscraper" receiver, which has two tuning controls, volume and selectivity controls, and a filament switch.

ohms is obtained the voltage amplification per stage will be 30, and also if a correspondingly higher load impedance be obtained the voltage amplification will increase. The value of load impedance of a tuned circuit is governed by two factors; the capacity-inductance ratio and the equivalent radio-frequency resistance of the circuit. The higher the ratio of inductance to capacity, the greater will be the impedance; the lower the effective radio-frequency resistance the higher will be the impedance of the circuit. Unfortunately we are not able to use very high inductance-capacity ratios because of the fact that the radio-frequency increases greatly with the increase in inductance, but from the standpoint of selectivity a higher value of capacity to inductance is desired as the selectivity of a tuned circuit is proportional to the square of the capacity.

The effective radio-frequency resistance of a tuned circuit is mainly localized in the inductance of the circuit and this can be decreased by the use of space wound coils of as large a wire size as practicable, say approximately 22 or 24 guage. The use of a tuned plate impedance with a grid blocking condenser and grid leak for supplying "C" bias potential to the succeeding tube is not advisable due to two detrimental factors. Such a system will amplify low-frequency disturbances, and partial rectification will take place in each



Two separate "C" batteries are employed, one for biasing the 171-A tubes and the other for the detector and first A.F. stage, thus carrying out the complete isolation scheme. The function of the numerous resistors is explained in the text.

stage, and for these reasons, the use of transformer coupling is desirable.

Radio-Frequency Transformers

Having decided the characteristics of a good coil it is now necessary to devise means for utilizing this coil as a radio-frequency transformer. The coil in its final form is wound on a threaded hard rubber tube; the plate coil is first wound with a small guage wire in the bottom of the groove; on top of this primary winding the secondary is laid. The secondary wire size is such that the wire lays on top of the groove, the coupling ratio is 1 to 1 and the mutual inductance between the primary and the secondary is as high as can be obtained. The load impedance of the tuned secondary winding is directly transferred to the primary winding where it is effective as a plate circuit load of maximum impedance. The total load impedance of the coupling circuit is

$$Z_{Total} = \frac{1}{Z_{lc}} + \frac{1}{Z_{pf}} + \frac{1}{Z_{gf}}$$

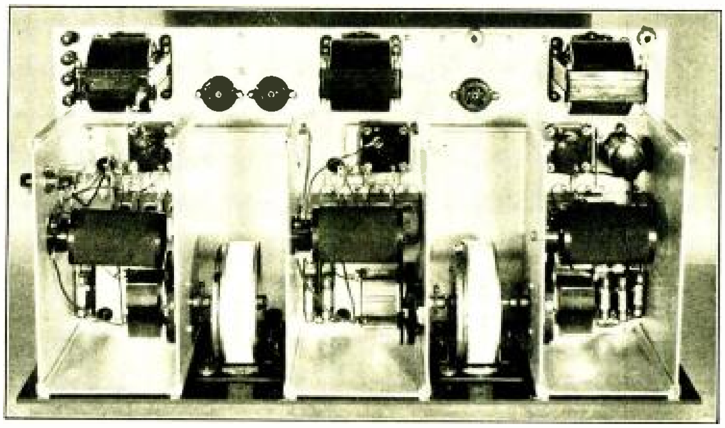
$$Z_{lc} = \sqrt{R^2 + \left(2\pi fl\right)^2 - \left(\frac{1}{2\pi fc}\right)^2}$$

Inasmuch as Z(pf) and Z(gf) are very high, the resultant load impedance will be very close to Z(lc). On account of the very high load impedance obtained with the use of such a transformer, it is absolutely essential to shield thoroughly the radio-frequency stages, both electro-magnetically and electrostatically. It is also necessary that the radio-frequency amplifying tubes be shielded as well, particularly with loop operation. The radio-frequency energy should be prevented from passing into the current feed lines and from them re-entering another stage. This has been accomplished in this receiver by the use of aluminum box shields with double walls between stages and resistance-capacity filters in all "B," and in most of the "C" circuits, and by the use of by-pass condensers across all filaments in the radio-frequency stages and detector.

These by-passing condensers in the radio-frequency end of the set are non-inductive and hence have a much lower reactance to the radio-frequency component than the ordinary inductive type. Audio-frequency regeneration is also prevented in the detector and audio-frequency channel by the use of resistance-capacity filters.

Detection is accomplished by the use of anode bend rectification, which, as is well known, is much superior to the grid leak method of detection where quality, selectivity and volume are required. Due to the tremendous amount of radio-frequency amplification obtained, the sensitivity which could be obtained by the grid leak condenser rectifier is not necessary, so that nothing is sacrificed by the use of anode bend rectification. To prevent further feedback as a result of several currents flowing over a common circuit, all parts of the receiver, except the detector are fed straight from the 180 volt supply. To accomplish this, non-inductive resistors of the correct value have been calculated for each circuit so that the correct current will flow.

As a result of the use of all of these resistance capacity filters, feedback and motorboating are eliminated and both the radio and audio channels deliver far greater output without distortion than the usual radio receiver. A further result of the filtering and shielding lies in the fact that even on loop operation with full volume the receiver remains absolutely stable. Loop effects within the receiver, resulting in extraneous coupling, are eliminated by the use of one-half mfd. blocking condensers between the "A" negative filament connection at the socket and the common battery connection. Tuning condenser circuits are fully insulated from other components and shields.



The components of the "Skyscraper" receiver are so placed that there is no crowding and yet the set is not unweildy. Double shielding is employed.

A.F. Amplification

Push-pull amplification has been chosen for two reasons; first on account of the volume obtainable tending to overload a single output tube, and secondly, to eliminate grid distortion. With the push-pull system, the grid voltage swing resulting from a given signal input is divided between the two tubes by means of a center tap on the secondary of the second audio transformer. The center tap is connected to a common grid bias. Each tube can, therefore, be worked at its maximum permissible grid swing and because of this, the signal input can be doubled without causing distortion resulting from overloaded grids.

Further with this system the even harmonics due to the tube distortion are neutralized in the primary of the output transformer and do not appear in the speaker circuit. The average vacuum tube has to be heavily overloaded before the odd harmonics appear. Because of this the two power tubes in push-pull can be overloaded to the point just below that at which distortion would be caused by the appearance of the odd harmonics. This permits of volume without distortion several times that of a single tube.

Provision is made by means of jacks whereby a phonograph pick-up or a power amplifier may be connected in the circuit. The output transformer specified is for the standard magnetic speaker, but a 25 to 1 ratio transformer may be used for the usual type of dynamic cone speaker.

In tests conducted with this receiver, Chicago has been received in New York with ample loud speaker volume on an antenna consisting of an 18-inch length of bus bar. The average indoor or outdoor antenna is more than sufficient for local and distant reception.

LIST OF PARTS REQUIRED

1—Ferranti transformer, type AF 5.
1—Ferranti transformer, type AF 5C.
1—Ferranti transformer, type OP 8 C, for magnetic speakers, OP 4 C for dynamic cone speakers.
3—Remler Universal variable condensers SLW capacity .0005 mfd.
2—Remler tube shields, type 56.
3—Hammarlund radio-frequency choke coils, RFC 85.
3—Hammarlund shaft couplers, type FC.
3—Na-Ald sockets 424.
3—Na-Ald sockets 428.
3—Benjamin sockets 9040.
1—Pair Benjamin brackets 8629.
2—National drum dials, type VF with type 28 illuminators.
2—Carter connectors for screen-grid tubes 332.
1—Yaxley open circuit jack, insulated.
1—Yaxley jack 702-A, insulated.
1—Yaxley junior rheostat, 6 ohm, No. 506.
1—Yaxley midget battery switch, No. 10.
1—Yaxley aerial switch, No. 11.
1—Yaxley 7-wire mounting plate and cable.
2—Carter resistors, types J-5-15.
1—Carter midget potentiometer MW-6M.
2—Tiny Tobe condensers.
14—Toby by-pass condensers.
10—Toby resistors, 2-watt.
4—Eby binding posts, insulated.
10—Lynch resistor mountings.
1—Set of 3 special RF coils.
1—No. 10 guage aluminum base, drilled.
1—Bakelite panel 8" x 24" x 3/16" walnut finish, drilled.
3—Aluminum Co. of America standard shields, drilled.
13—Rubber insert rings for feed lines and through base. Acme flexible wire in colors to match Yaxley cable, for wiring.

The Metropolitan Screen-Grid 5

By M. Seidman

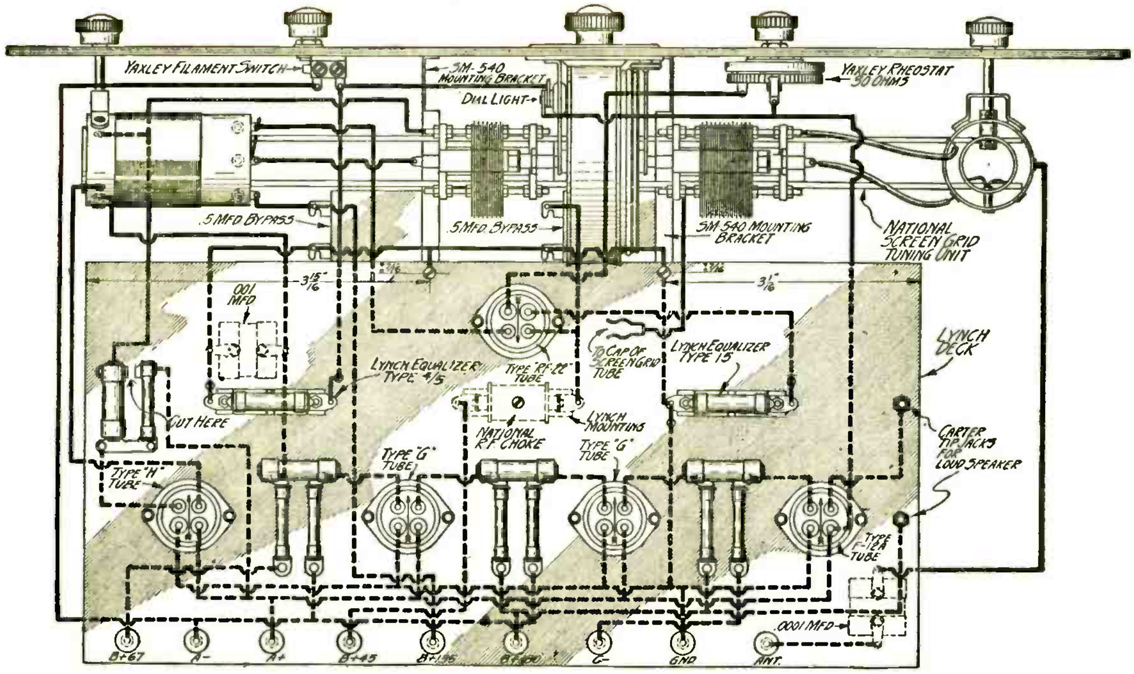
FOR a receiver to function satisfactorily in New York, and I assume the same is true of nearly all other large centers, consideration must be given to the fact that most of the homes are within easy range of from fifty to sixty broadcasting stations. The receiver must, therefore, be selective. The majority of residents in large cities live in apartment houses, and the difficulty of erecting an antenna on the roof of the average apartment house is one which most folks find it hard to overcome. The best solution of this problem is the use of a receiver requiring for its satisfactory operation an antenna which does not have to go to the roof and which may be laid around the picture molding of the living room or in some other way be completely hidden from view. The receiver we consider here will perform with an antenna having a total length of between thirty and fifty feet.

Another rather important consideration in connection with the building of a receiver for use in urban territories is the matter of having the receiver small enough to be conveniently placed in the living room without making it necessary to crowd the room by the addition of an extra piece of furniture. The receiver we are considering is not very deep and the front panel measures only 7 x 18 inches.

This receiver has a single stage of screen-grid radio-frequency amplification, feeding a regenerative detector. The audio amplifier has three stages and is resistance coupled.

Because of the fact that the total filament current required by this receiver is slightly less than 1¼ amperes it may be used with a very small storage battery and a trickle charger, such as a battery having a 40 ampere hour capacity. Where the receiver is operated on dry B batteries the author recommends the use of 135 volts in conjunction with a type 112-A power tube. With this combination the total plate current drain of the receiver is approximately 15 milliamperes. This means that the average life of a set of three heavy duty B batteries would be between nine months and about a year and a half, depending upon how much the receiver was used.

Where the receiver is to be used with an alternating current supply and a high voltage eliminator employed we recommend the use of a tone filter in the out-



The wiring diagram of the "Metropolitan Screen-Grid 5," in which is shown not only the type circuit but also the location of the apparatus.

put circuit of the last tube, and recommend also the substitution of a type 171-A tube for the type 112-A tube recommended for use in connection with batteries.

Since the antenna circuit of the National screen-grid tuning unit is provided with an inductive trimmer any variation between the tuning in the antenna circuit and the detector circuit which would ordinarily take place is counteracted by a simple movement of this trimmer.

This unit is also provided with a special high impedance transformer designed particularly for use with a screen-grid tube, and the radio frequency gain of this receiver is therefore very high.

LIST OF PARTS REQUIRED

1—National type 222 tuning unit.
1—National type 90 radio-frequency choke coil.
1—Lynch R. F. choke mount.
1—Lynch five tube deck.
1—Lynch type 15 equalizer with mount.
1—Lynch type 4/5 equalizer with mount.
1—Filament switch.
1—30 ohm rheostat.
2—Carter tip jacks.
9—Binding posts.
1—Sangamo .001 mfd. mica condenser.
1—Sangamo .0001 mfd. mica condenser.
2—Tobe .5 mfd. bypass condensers.
1—Acme eight-wire cable.
1—Pair Silver-Marshall type 540 mounting brackets.
1—Front panel.
1—CeCo type R. F. 22 screen-grid tube.
1—CeCo type F-12A.
2—CeCo type G hi mu. tubes.
1—CeCo type F-12A or J-71A power tube.
3—Heavy duty B batteries or one National type 7080 B eliminator.

Transmitter Construction Hints for 1929

*By Frank A. Gunther**

THE new law as passed at the International Radio Conference held in 1927 will necessitate the use of an entirely new language when referring to the wavelength of a transmitter beginning January 1, 1929. By this the writer means that no longer will wavelength specified in meters suffice. This is especially so in the spectrum below the broadcast band. Any point in the wavelength scale will be specified, as so many kilocycles in frequency, the latter method being a thousand fold more accurate. The new bands allotted for amateur transmission and the numerous number of commercial stations that operate will necessitate this use of frequency precision.

The above method of talking frequency instead of wavelength is not harder to use. Perhaps it seems so because of its novelty. It is all for the best however as will be seen after the new regulations are in effect.

Transmitting equipment will also have to be designed along the lines of more precision than they have in the past. However, before this can be accomplished an instrument must be had that will allow adjustments in frequency to be made, which cannot be done with the old type wavemeter. The difference is comparable to a rule and a micrometer. From this point on calibrations of the emitted frequency of transmitters will be very much more accurate than they have been in the past.

* Radio Engineering Laboratories, 100 Wilbur Avenue, Long Island City.

New Frequency Meters

In Fig. 1 are shown several types of frequency meters to be used in 1929. Each frequency unit contains a coil and condenser, which are so arranged as to cover sufficient frequency to include one particular amateur band; for instance the unit at the right covers 3,500 to 4,000 kilocycles (new 80 meter band), this being a range of 500 kilocycles on practically 100 degrees of the condenser dial. A curve drawn to cover 500 kilocycles on 100 degrees of the dial will show more precision than most any instrument previously designed for frequency calibration. At double 3,500 kilocycles there is another amateur band to be covered, namely where the old 40 meter band once was. This band is only 300 kilocycles wide (7,000-7,300 kilocycles).

It is impossible to use the 3,500 kilocycle

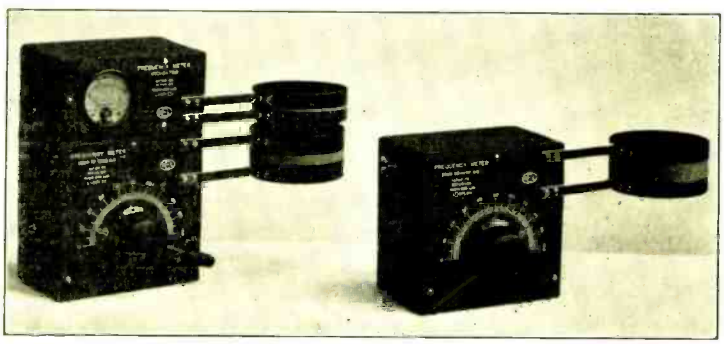


Fig. 1. New types of frequency meters which are so designed that they will cover a particular small frequency band, thus getting greater accuracy.

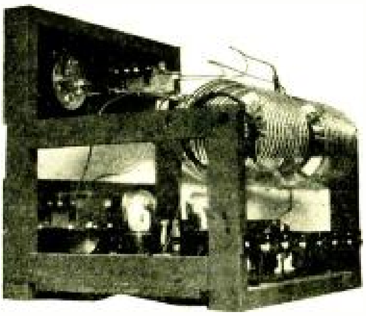


Fig. 2. A low power short-wave transmitter.

frequency unit at 7,000 kilocycles and attain any precision readings. First of all the 7,000 kilocycles band is only 300 kilocycles wide and because it is of a higher frequency, the use of a smaller inductor in the frequency unit is required. This automatically increases the capacity over inductance ratio and the condenser scale from 0 to 100 degrees will cover a tremendous amount of frequency. In the laboratory this was tried and it actually covered 5,290 kilocycles. Therefore the narrow 300 kilocycle band would be crowded into a very small portion of the 100 degree scale.

In order that the frequency meters would not become too complicated, they were designed to have one single indicating device, which could be attached to any particular one that was needed. This indicating unit is shown in the upper left hand portion of the picture. It contains a pick-up coil, a D.C. milliammeter and a crystal detector. The rectified component of the crystal detector operates this milliammeter and thus furnishes one of the sharpest indicating devices known. An instrument of this type is of primary importance in the construction and adjustment of a 1929 transmitter.

Operating Frequency Bands

Amateur transmission is divided in various branches, namely: DX Hunting, Traffic, Telephone, rag-chewing and experimenting. Sometimes an amateur may enter into more than one of these fields. In order to decide which of the new amateur bands is to be used, it is first necessary to come to a conclusion upon the problem of what most of the transmission is to be like. By the decision of what type of transmission is to be accomplished will the selection of the operating band depend. However, there is one more thing that has a bearing on the decision to be reached: will most of the transmission be attempted in daylight or darkness?

The following table of the various new amateur bands will show for what and when each particular band is best suited:

Kilocycles	Meters	Width in. K.C.	Best use
56,000 to 60,000.	5.00 to 5.36	4000	Experimental
28,000 to 30,000.	10.00 to 10.71	2000	Exp. Daylight DX
14,000 to 14,400.	20.83 to 21.43	400	International DX daylight & early evening
7,000 to 7,300.	41.1 to 42.9	300	International DX night
3,500 to 4,000.	75.0 to 85.7	500	Domestic, night
1,715 to 2,000.	150 to 175	285	Domestic

Traffic transmission can best be accomplished in the 7,000 and 3,500 kilocycle bands, especially so in the latter. DX is best found in the 7,000 and 14,000-kilocycle bands. If most of the transmission is to be done in the daylight hours the 14,000-kilocycle band will allow the best operation.

Low Power Transmitters

As the UX-210 tube is the most widely used of all tubes for amateur transmitting purposes the photographs and data shown will, therefore, pertain to low power transmitters. The construction cost of such a transmitter is not prohibitive as it may be in a higher powered set.

Several types of low powered built up transmitting kits are shown. Fig. 2 shows a transmitter built in a wide open type wooden frame. This set will transmit either telegraph or telephone in any amateur band. All that is necessary to

Fig. 4. Interior view of the transmitter shown in Fig. 3.

operate this transmitter is a power source of 400 volts direct current plus the standard filament supply. Fig. 3 and Fig. 4 describes a more modern type of all metal transmitter which includes its own power supply. This set is adapted by means of plug-in coils to any amateur band and may be used either as a telegraph or telephone transmitter. In the lower half of this unit is a half way rectifier, employing a UX-281 which delivers approximately 450 volts. The schematic wiring diagram is shown in Fig. 5. The constructor, of course, cannot build a set exactly similar to the one shown, but he can employ many of the features shown in the construction of his own set. In order to assist him the writer is showing several views of new apparatus that can be employed in transmitters of the UX-210 type.

New Apparatus

Fig. 6 shows a new type of variable condenser which has a tank condenser

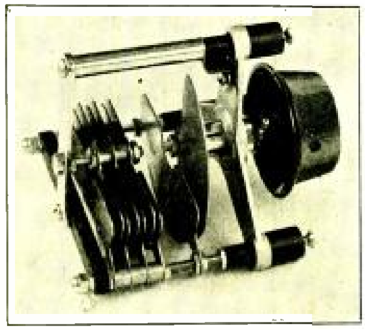
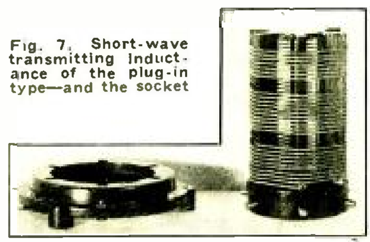


Fig. 6. Low capacity variable condenser for short-wave work.

mounted directly on it. This tank condenser with the inductance of the circuit can be tuned to the lower end of the band in which operation is desired, then by means of the one plate variable condenser the transmitter's range can be run through an entire band, using practically the whole condenser scale similar to the one explained previously in the new frequency meter. A condenser of this type is very valuable in that the lump capacity of the tank condenser allows a good proportion of inductance and capacity to be used. This naturally stabilizes the complete circuit and the emitted frequency as well.

Fig. 7 shows one of the plug-in transmitting inductors that will be used. These coils are designed so that each coil will cover a different amateur band. The plug-in arrangement will allow instant change from any one band to another. These inductors may be used in any type circuit, of which there are many. In other words no matter where an inductance

Fig. 7. Short-wave transmitting inductance of the plug-in type—and the socket



is needed a unit of the type shown may be employed. The inductors are designed to be built on a practically all-air dielectric form making an efficient coil in every respect. It is necessary that the coil plugs make absolute contact in the base.

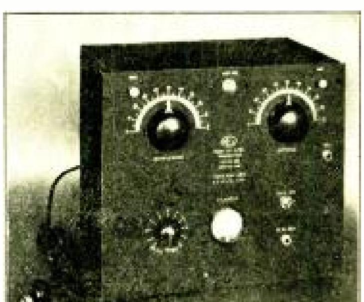
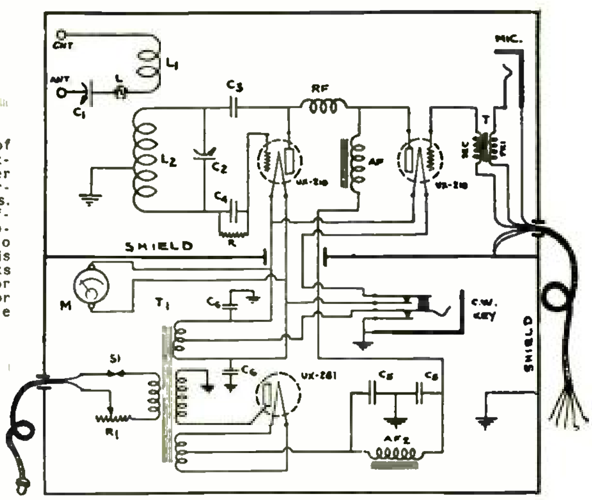


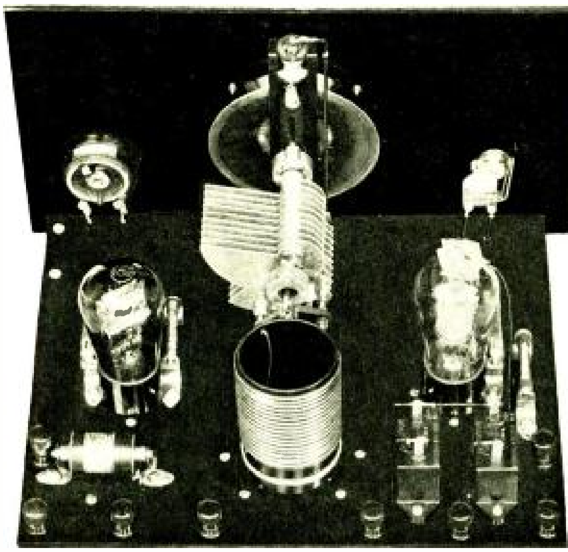
Fig. 3. All-metal short-wave transmitter which includes its own power supply.

Circuit diagram of a low power, short-wave transmitter embodying numerous improvements. A single 281 half-wave rectifier supplies the power. No external power is required. Jacks are provided for inserting a mike or a key into the circuit.



The Elements of Television Reception

By D. E. Replogle



Rear view of the National Screen-Grid Short-Wave Receiver. Note that it is virtually a single control set. Regeneration is controlled by the variable resistor mounted on the panel. The R. F. choke is mounted on the sub-base, directly in front of the 112-A tube. The inductance is of the plug-in type.

TELEVISION is far from perfect. Nevertheless, it is sufficiently advanced today to provide an interesting and fruitful field for the radio amateur and experimenter. In several localities, there are television signals "on the air," ready to be received with relatively simple and inexpensive equipment, while in others television service is promised in the not distant future. Therefore, this is an opportune time for a study of the elements of television reception and experimentation, to which end the writer desires to present the following data.

To begin with, it is well to build no false hopes regarding the results from present-day television transmission and reception. The pictures are small, generally 1½ inches square, and the detail is but fair. It is possible to recognize the person televised, see him turn his head, open his mouth, and roll his eyes. Even the smoke may be seen to rise from his cigarette.

While there are several television systems being employed at present, they have many points in common, and an outfit designed to receive images from one source may readily be altered to work from other transmitting stations. The system employed at WLEX, Lexington, Mass., is typical of that most generally followed, and therefore serves as our basis.

Because of the relatively wide channel required for television signals, such transmission must take place on the higher frequencies, or short waves. Accordingly, the following components are required for television reception: (1) The short-wave receiver; (2) the audio-frequency amplifier; (3) the neon tube; (4) the scanning device.

The Short-Wave Receiver

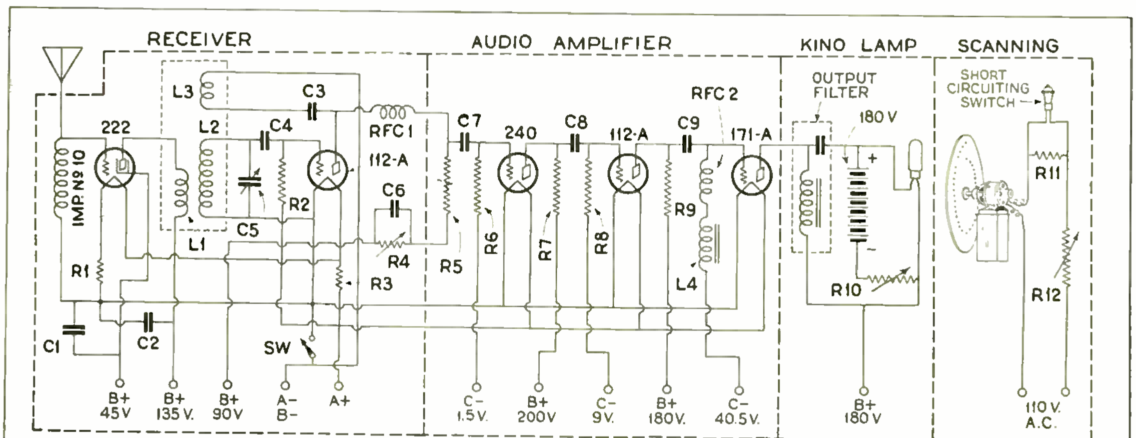
While any good receiver, capable of being tuned to the wavelength of the transmitting station, may be employed, it has been found that a receiver employing a stage of untuned R. F., using the screen-grid tube, is generally preferable. In the accompanying illustration is presented an ideal receiver for this purpose. (Described in June issue of RADIO ENGINEERING.) It is built around a single tuning control and a foundation unit design which permits an efficient layout of parts with a minimum of connections to be made by the assembler. As a result of the screen-grid tube, the sensitivity of the receiver is better than that of the plain regenerative detector. Furthermore, the use of this R. F. stage ahead of the regenerative detector precludes radiation, which must become an important consideration with the increasing use of short-wage receivers. Still another important advantage is the elimination of tuning "holes" or "dead spots" commonly encountered with plain regenerative receivers. Shielding is unnecessary, because of the use of the untuned antenna system. The only precaution in assembling the receiver for television reception is to obtain the utmost rigidity for the coils and mountings, as well as other parts and the wiring.

The Audio Amplifier

The perfection of the picture received depends upon how good a signal is transmitted in the first place, and how well it is reproduced at the receiving end. The audio amplifier, therefore, plays a vital part. If the signal to be received contains frequencies of from 18 to 20,000 cycles, it is obvious that the audio amplifier must be capable of amplifying all frequencies within these limits.

The ordinary audio amplifier may be employed for fair results, although as the experiments progress it will be necessary to build a better amplifier than is ordinarily employed in broadcast reception.

The amplifier shown in the accompanying diagram is one of considerably higher frequency range than the usual broadcast amplifier, and when employed for television provides ample detail. It is essentially a resistance-coupled layout, with a 240 or 340 high Mu tube for the first stage, a 112 for the second, and a 171 for the third. The values of the coupling resistors, grid leaks and coupling condensers are given in the diagram legend.



IMP. Nº 10 - SHORT-WAVE ANTENNA IMPEDANCE.
RFC 1 - 90 M.H. R.F. CHOKE
RFC 2 - 500 M.H. R.F CHOKE
L1.L2.L3 - SHORT-WAVE PLUG-IN COILS

L4 - A.F GRID IMPEDANCE
C1,C2 - .5 MF COND
C3 - .001 MF COND
C4 - .00025 MF CONO
C5 - .000125 " "
C6 - 1.0 MF. COND
C7.C8.C9 - .5 MF. COND.

R1 - 15 OHMS.
R2 - 6 MEGOHMS
R3 - 2 OHMS.
R4 - 0 TO 500.000 OHMS.
R5 - 50.000 OHMS
R6 - 500.000 OHMS
R7 - 300,000 "

R8 - 500.000 OHMS.
R9 - 25.000 "
R10 - 0 TO 10.000 OHMS
R11 - 5 TO 10 OHMS. 40 WATTS
R12 - 0 TO 100 " 75 "

A complete circuit diagram for the reception of television signals. The list of parts shown below are for a receiver operating on short wavelengths.

The grid leak is replaced in the case of the 171 power tube by an audio-frequency choke in series with a radio-frequency choke. In the output circuit two 30-henry chokes are connected in series. Spring-suspended sockets should preferably be employed in constructing the amplifier in order to avoid microphonic tube disturbances when motor and scanning disk are placed close by. Another important point is to employ high-grade resistors, free from noises. In television, a "noise" or current variation is represented by black spots and streaks that appear in a continually shifting position, unless it is periodic "noise."

The Neon Tube

The output circuit is so arranged that the neon tube is always illuminated, and when a signal is received, the brilliancy of illumination merely varies in accordance with the signal. A resistance must be connected in series with the tube because, as with all gas conductors, it has a negative resistance coefficient.

A good background will be obtained if the current is limited to 10 or 20 milliamperes. More current will cause the tube to glow brighter and brighter, but there is no advantage in this so far as the picture is concerned, and it only serves to shorten the life of the tube. In fact, quite satisfactory results can be obtained by adjusting the D. C. voltage just below the starting voltage for the lamp. In this case a black background is obtained and the image stands out in sharp contrast.

The scanning disc and driving motor used in the television receiver shown diagramatically on the opposite page.

There are two ways of adjusting the current through the Neon tube once it has started; namely, by varying either the D. C. voltage or the series resistance. The latter method is more practical. A fixed resistance of 10,000 ohms in series with the lamp can be used, however, with satisfactory results. If this is done, the D. C. voltage on the lamp should vary until it will light with a soft, medium glow. If a variable resistance is used, it should be of 10,000 ohm maximum resistance, in series with a one-thousand ohm fixed resistance. The resistance should be decreased until the Neon tube plate is covered with a soft glow.

The Scanning Disk

Several different concerns are manufacturing scanning disks suitable for use with signals now on the air. A suitable motor, such as universal type 1/10 horsepower, should be employed to rotate the scanning disk. The diagram shows the method of speed control for synchronizing purposes. R 12 is a power rheostat of 75-watt, 4 to 100 ohm rating, while R-11 is a 7-ohm, 10 watt fixed resistance, shunted by a push button. The variable resistance is so adjusted that with the push-button released, the motor runs at slightly below the proper synchronous speed. Then, when the push-button is depressed, the disk tends to speed up.

Do not mount the television receiver in the same cabinet with the motor and scanning disk. Vibration of the motor will introduce horizontal lines drawn across the picture.

So much for the essentials of television reception. It is left for the experimenter to develop his own particular version of the art—and that is precisely where the fun comes in.

The R-P-L A.C. Receiver

By F. A. Jewell

THE seven-tube A.C. or battery-operated receiver, which is shown in the accompanying illustrations, makes use of the patents of Loftin-White, Jewell and Meissner. Under the first is designed the tuner and the radio-frequency amplifiers; under the Jewell patents the audio-frequency amplifier is designed and the power supply unit is made under the Meissner patents.

The outstanding advantages of the radio-frequency amplifier are constant energy transfer on all wavelengths and automatic stabilization against oscillations.

The designing of the Loftin-White tuner is four full tuned stages, three stages of radio-frequency ahead of the detector controlled by a single dial. It is single dial controlled due to its mechanical design, each stage being absolutely balanced. Once the knob on the panel adjusts the antenna secondary circuit to the particular antenna with which the receiver is to be used, except possibly for a now and then refinement adjustment of this knob in extremely long distance reception, no further adjustment is required.

Complete double shielding is employed, each of the three radio-frequency stages and the detector being incased in its own fully shielded compartment, but each compartment is no larger than physically needed to house the necessary parts for a stage. As a result the four compartments form the interior of a metal box condensed to the dimensions of 12 long by 6 wide by 6½ inches high, yet by reason of the Loftin-White Circuit this close shielding is accomplished without loss of efficiency from absorption. This double shielding is most helpful when used with A.C. tubes and is one of the reasons why the A.C. "R-P-L" receiver is one of the quietest operated sets on the market. Also due to the individual shielding of each stage, interstage coupling is eliminated, preventing undesirable feed-back which naturally stabilizes the circuit.

Selectivity

This design is extremely selective, and is ideally adapted for present broadcast conditions. The Loftin-White principle of control of plate reaction introduces a selective characteristic heretofore impossible, which is a most valuable virtue in a closely shielded receiver, in which absorption losses would otherwise tend to broaden the set. This circuit has a slight reverse feed-back through the internal capacity of the tube, which feed-back is controlled by a patented device, eliminating all oscillation difficulties and enables the use of extreme high amplification ratios and compact spacing per stage. In the Loftin-White design the non-reactive circuit allows balancing of the circuits without regard to the grid to plate capacity of the vacuum tube, which allows the use of any tube in this circuit.

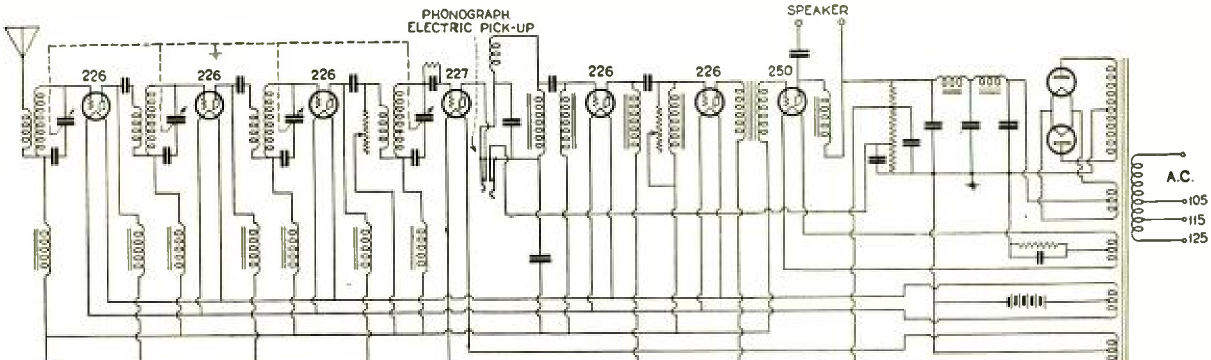
The Audio Amplifier

The object of an amplifier is to deliver undistorted electric energy to a loud speaker to be converted into mechanical energy, which in turn is converted into sound waves.

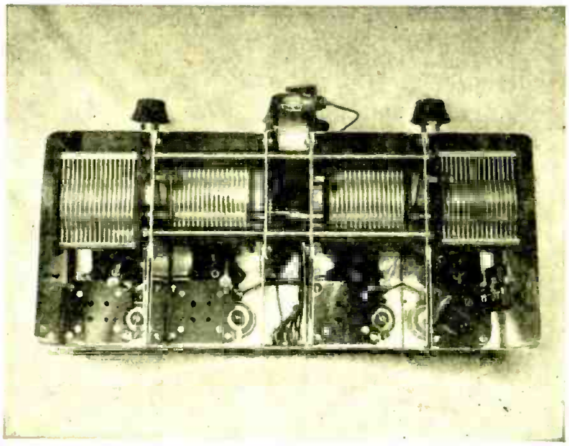
Inasmuch as it is agreed by radio engineers and experts that the 250 type of tube is capable of delivering to the loud speaker the greatest amount of undistorted energy, this tube is used. With this tube, which has an undistorted output of approximately 500 milliwatts, one can obtain any volume desired with minimum distortion.

However, to be able to obtain the maximum results from this type of tube, a potential amplifier will have to be placed between the output of the detector and the input of the power stage that is capable of amplifying this weak potential to a point of maximum grid variation.

With this type of tube, the grid swing



The complete schematic diagram for the A.C. operated R-P-L receiver. Notice the use of a "C" battery, connected through ground, instead of the conventional biasing resistor.



The interior of the radio-frequency and detector portions of the A.C. operated R-P-L receiver. The four condensers are operated by the single drum dial. The dimensions of the entire shielded portion of the set is 12 x 6 x 6½ inches.

(voltage variation on the grid) should be at least 80 volts, to be able to utilize the maximum amperage output of this tube. Obviously a single stage of transformer coupling, which only has an amplification factor of approximately 20 would not be sufficient to actuate the grids of the power tube so that this tube would be operating at maximum efficiency without overloading the detector. It has been found that where only one stage of transformer coupling is used ahead of the power tube requiring an 80-volt grid swing, distortion takes place in the detector long before the power tube begins to overload.

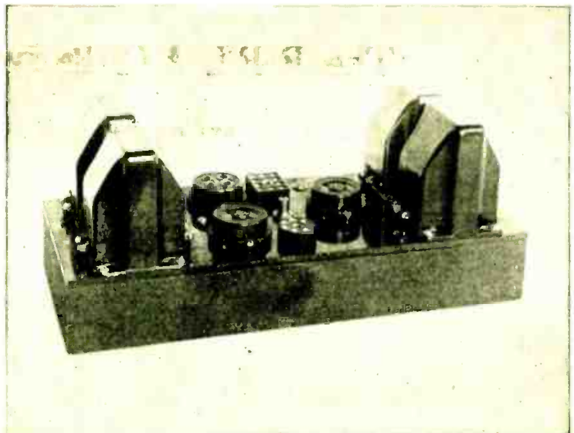
If two stages of transformer coupling were used the amplification factor would be approximately 400. This would be entirely too much and the distortion resulting from overloading would make it absolutely worthless as a quality amplifier, but with two stages of dual impedance feeding into the transformer of the power stage an amplification factor of approximately 200 is obtained, which means that only four-tenths of a volt is required to flow in the output of the detector to obtain an 80-volt grid variation on the power stage and as the undistorted output of the detector is well above the four-tenths volts required this amplifier is capable of delivering the maximum amount of power with a minimum of distortion to the speaker without overloading the detector or any of the audio stages.

By placing the transformer between the input of the power tube and the output of the 226 the necessary 80 volts grid variation on the 250 tube is obtained without working past the characteristics of the 226, as this transformer has a 3 to 1 ratio, which means that only one-third of the necessary grid voltage (or 27 volts) will have to flow in the plate circuit of the 226, which is well within its characteristic curve.

Use of "C" Battery

By referring to the schematic diagram it will be apparent that a "C" battery is used on all the 226 tubes instead of a resistance drop in the power pack, to obtain the necessary grid bias. By using a small "C" battery to obtain approximately 9 volts negative "C" bias on the grid of this tube, it does not present any objection, as this battery has no current drain and its life is about one year. However, the advantages gained by its use are many, for these reasons: when a resistance drop is used so many complications set up that it makes its use imperative if a high amplification factor is desired and still retain the quality of reproduction.

When a grid resistance is used to obtain the grid bias, it is a fundamental fault of the circuit that when there is a rise in plate current there is a proportionate rise in grid current which gives an automatic form of regeneration. This is not such a serious problem when only one stage of amplification is used, preceding the power stage, as the amplification factor is very low (about 20) and there is not much chance of interstage coupling, but when two stages are used, giving an amplification factor of approximately 200 and by the second tube feeding back to the first tube it makes it necessary to use a "C" battery to prevent the loss of volume and the destroying of the quality of reproduction.



The A.F. amplifier which has two stages of dual - impedance coupling and a stage of transformer coupling. Two 226-type tubes are used and a 250 power amplifier tube is employed in the last stage.

A 250 Power Amplifier Combination

By William H. Fortington

WITH the advent of the alternating-current tube and tubes having a low output impedance, together with the ability to handle an exceptionally high amount of power at both input and output circuits, the acoustics of radio are shaping themselves into new standards. The introduction of the UX-250 and CX-350 tube brings us to the threshold of a new era so far as broadcast reception is concerned.

Not so very long ago the experimenter was led to believe that the crux of the tonal quality situation lay in the coupling device itself. While this consideration holds good for amplifiers handling a small amount of power, the coupling device does not by any means determine the ultimate tonal quality where power of the order of a few watts is concerned. It might be safely said that 80% of the distortion in average receivers today is due to overloading of one or more tubes, but with the combination of a good power tube in the output circuit and good coupling device preceding it, there is no reason why the reproduction of an amplifying system in a radio receiver should not be as good as the amplifying system employed in the transmitter itself.

Since the maximum permissible A.C. input voltage at the grid of a 250 tube is of the order of 55 to 60 volts, it is necessary to raise the voltage produced at the plate of the detector tube to this amount, in order to warrant the use of a tube of the 250 type.

Voltage Amplification Requirements

Should impedance coupling be utilized as a means of stepping up the voltage produced at the plate of the detector tube to the permissible voltage at the grid of the 250 tube, more than one stage of amplification between the detector tube and the output tube would be necessary, but with two intermediate coupling devices and one tube the necessary results can be attained when the proper A. F. transformers are used.

The operation of the UX-250 or CX-350 tube necessitates the use of a special power pack, since a transformer and rectifying system designed to operate a 310 tube will not usually handle a 350 at all satisfactorily. The 350 tube alone will draw approximately 55 milliamperes at the plate and this load alone is usually the maximum limit of the complete 310 power pack. Any atempt to operate a set as well as a 350 tube from such a rectifier is apt to prove disastrous both to the transformer and the rectifier tubes themselves.

Referring to the schematic diagram it will be seen that two CX-381 tubes are used in a full-wave rectifying circuit to supply the plate potential for all the amplifier tubes. The power pack and the choke unit are specially designed to fulfill the outlined conditions. The use of a voltage regulator tube is optional.

A transformer for use on a circuit as that shown will deliver considerably more voltage on open circuit than it will under normal load conditions. A good transformer has a small percentage of voltage drop with current load.

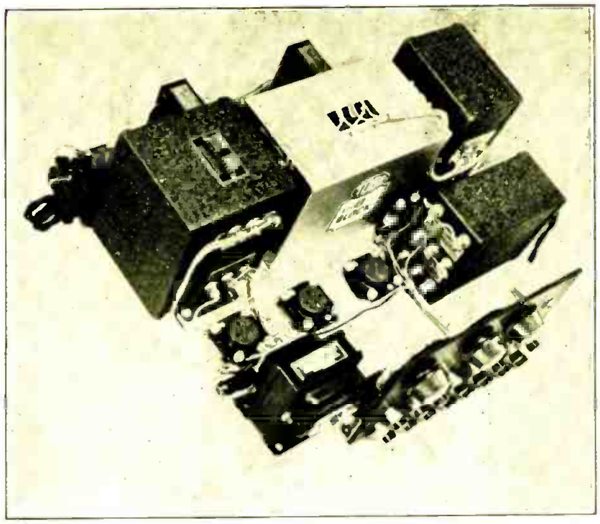
By incorporating a loud speaker of the electro-dynamic variety an excellent amplifying system for use in dance halls and such places may be obtained at a very reasonable cost. Such an amplifying system will usually handle several loud speakers with their moving coil windings connected in parallel across the secondary of the output transformer.

Filter Condensers and Resistors

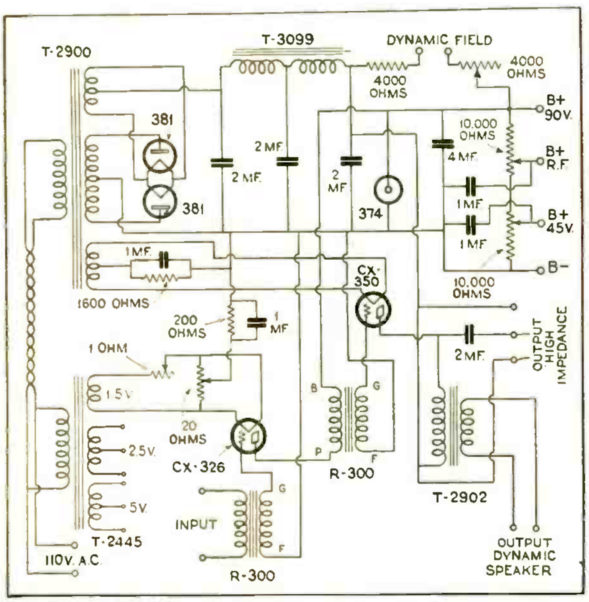
The matter of filter condensers for use in the rectifier and filter systems is one which must not be regarded in a trivial manner. In view of the fact that the voltage produced across the rectifier tube under very small load conditions is of the order of 700 volts, it will be immediately realized that the filter condensers must be capable of withstanding these high voltages, although under actual operation the filter condensers are not subject to such an enormous strain. However, in view of the fact that the filter condensers themselves draw some little part of the A.C. component of the rectified current, only condensers of the highest order should be used in this circuit. Here again condensers designed for use with 210 power packs are not suited for use with 250 power amplifier combinations.

Another important point to be watched when amplifiers of such power are to be considered, is the type of resistance to be used in the plate and voltage divider circuits. The vitreous enameled type of resistance has gained considerable popularity during the last few years and is to be well recommended as worthy of the place which it now holds in its fields.

The 84 volts of "C" bias necessary at the grid of the 350 tube is obtained by inserting a resistance of 1600 ohms between the grid return of the second audio transformer and the center tap of the filament winding of the 350 tube on the power transformers. In a similar manner the grid bias for the other tubes may be secured. This provides regulation of grid bias which is automatic and concomitant with the existing plate voltage at any given moment.



Two 381 rectifier tubes supply operating current for an A.C. operated receiver's plate current and for that of the power amplifier. The "A" current for A.C. tubes is supplied by the transformer having a 1.5, 2.5 and 5-volt output



The schematic diagram of the power amplifier and power unit. Provision is made for the operation of a dynamic speaker with a high voltage field, or a magnetic speaker. A 374 tube is employed to keep the "B" voltage constant

A volume control is desirable in a circuit of this description, the proper location of it being across the secondary of the first audio transformer. The total resistance of this volume control should be between 350,000 and 500,000 ohms.

The primary of the first audio transformer can be used to couple directly in the plate circuit of the detector tube or across an electro-magnetic pick-up. When used under the former conditions the plate circuit of the detector tube should be by-passed by a condenser of approximately .002 mfd. This condenser should be connected in the receiver itself rather than in the amplifier circuit.

LIST OF PARTS REQUIRED

1—Thordarson T2900 Power Transformer.
1—Thordarson T3099 Choke Unit
2—Thordarson R300 Transformers.
1—Thordarson T2445 Power Transformer.
1—Thordarson T2902 Output Transformer.
5—Benjamin 9040 Sockets.
1—Carter M.W.1 Rheostat.
1—Carter A.P.20 Potentiometer.
1—Carter 4000 Ohm Vitreous Enameled Resistance.
1—Carter 10,000 Ohm Vitreous Enameled Resistance.
1—Carter P.W. 10-M Variable Resistance.
1—Carter P.W. 4-M Variable Resistance.
1—Carter H-1600 Resistance.
1—Carter 200-H Resistance.
1—Tobe 250 "B" Block.
1—Tobe 2. mfd. Filter Condenser.
16—X-L Binding Posts.
2—CX-381 Tubes.
1—CX-326 Tube.
1—CX-350 Tube.
1—CX-374 Tube.

The Aero "Metropolitan" Four

By Bert E. Smith

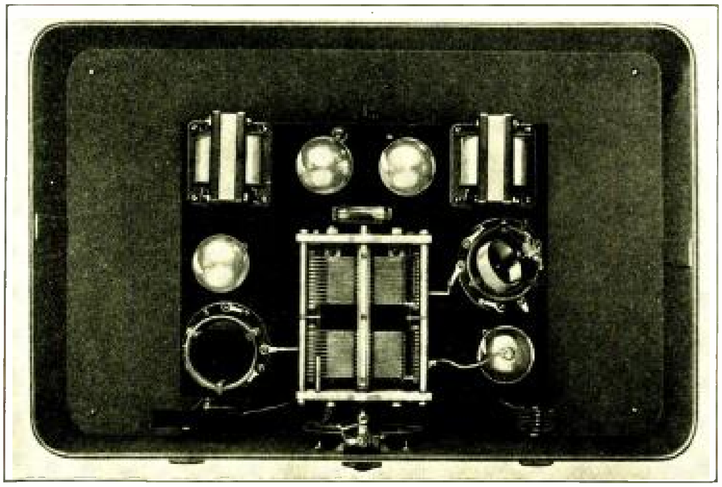
EVER since tuned radio-frequency amplification has been practical the most popular receiver and certainly the one which holds all the distance records, has been four tube sets incorporating a stage of tuned radio frequency, usually neutralized, a regenerative detector, and a good two-stage audio-frequency amplifier. This combination made its initial debut as the "Roberts Reflex," was closely succeeded by the "Browning-Drake" and has hung on until the most popular sets in the whole country last winter were the "Chicago Daily News Four" and the "Everyman Four," both of this type. Probably the major reason for the success of this particular type of receiver has been its simplicity and comparative inexpensiveness to build, of course combined with its remarkable sensitivity.

Neutralization and the 222

The greatest drawback to such receivers in the past has been the difficulty in properly neutralizing the radio-frequency amplifier tubes, but the development of the shield-grid tube has opened up a wonderful new field for this receiver. This tube, which has been especially designed for use as a radio-frequency amplifier, eliminates all of the inter-electrode feed-back through coupling between the grid and plate due to the capacity of these two elements. This makes it possible to obtain considerably higher voltage amplification per stage than is possible with an unneutralized tube of the ordinary three element variety.

Due to the structure of the tube the plate current does not change to any great extent with variations in the voltage applied to the plate. As a result the amplitude of the plate current change, caused by variations of the grid voltage, is to all intents and purposes absolutely unaffected by any changes in the load resistance. Therefore it is possible to use a tremendously high impedance in the plate circuit with the resulting high voltage amplification obtainable by the use of this very large load. In this tube the voltage amplification in the final analysis is only dependent upon the mutual conductance of the tube itself and the load. The voltage across the output load is directly proportional to the load, and therefore when a circuit can be employed, which will have a large reactance, an unusual degree of amplification can be obtained.

At the lower radio frequencies, such as are ordinarily used for superheterodyne



The majority of the wiring in the "Metropolitan 4" receiver is run beneath the sub-panel. There is sufficient room in the metal cabinet for batteries or a power device.

intermediate amplification, this high load can be easily built up; at broadcast frequencies it is rather difficult to obtain a very high load impedance and still retain selectivity. For example, it is possible to obtain the desired high load by the use of a tuned-plate circuit, such as would cause an ordinary tube to become an oscillator of the first magnitude, without causing such disturbances, but there are drawbacks to this system, which has been very extensively employed with the tube up to the present. In the first place the selectivity of this combination is extremely poor since the large losses incurred in both the plate circuit of the shield-grid tube and the grid circuit of the following tube are placed directly across the tuned circuit and broaden it tremendously. In addition this direct coupling allows low-frequency disturbances to pass through the tubes without a great deal of difficulty and such a connection very frequently causes motor-boating and other similar audio-frequency oscillations, due to resistance acting as coupling resistors, and making the radio-frequency amplifier effectively an audio-frequency oscillator.

Use of Autoformer

The use of a radio-frequency transformer or autoformer of the proper type will block out the transmission of these low-frequency disturbances. This transformer must be designed with unusual care, in order that the optimum load impedance may be obtained without too great a loss of selectivity and at the same time result in an almost even transmission of energy between primary and secondary over the entire broadcast spectrum.

Another complication enters here. This is the matter of coupling the plate of the regenerative detector to the grid coil as well as coupling from the plate of the preceding tube. In the case of an ordinary tube, the self inductance of the primary coil used is comparatively small and the mutual inductance of the primary and tickler is utilized and an entirely different phenomena occurs. The inductance coupling between both the primary and tickler coils and the secondary must be in phase. In this case, of course, coupling between the tickler and primary would cause voltages in each other in quadrature, varying the load impedance of the detector tube considerably.

In actual practice very mystifying actions take place until the reason is discovered. For example, it will frequently occur in an improperly designed coil that when the coupling between the tickler and the secondary is increased the regeneration is actually reduced and vice versa.

A protracted course in experimentation finally resulted in the design of a coil which not only places the requisite load in the plate circuit of the screen-grid tube, but at the same time had an excellent figure of merit in selectivity and operates to great advantage as a feedback coil. The use of this coil has made possible the excellent results obtained from the Aero "Metropolitan Four."

With this coil as a base, the circuit shown was developed. The antenna coupler is of a type which allows an adjustment of the primary inductance to match antenna characteristics. In order to keep the radio-frequency resistance at the lowest possible figure, instead of introducing a separate primary, which, as it is not entirely connected at all times in the circuit, would have a shorted turn effect, a portion of the secondary is used in an audio transformer arrangement. For great selectivity with any type of antenna, the antenna is connected to tap No. 1 while for great sensitivity or short antennas, tap No. 4 is used.

Regeneration and Volume Control

Regeneration is accomplished by a constant feedback through a fixed tickler coil, and a resistance across the tuning condenser of this serves to subtract sufficient energy from the circuit to stop oscillation and then become a volume control, permitting the voltage on the grid of the detector tube to be reduced to zero if desired. This shunt resistance across the condenser has the same action as a series resistance in the oscillating circuit. The relation is obtained from the relation

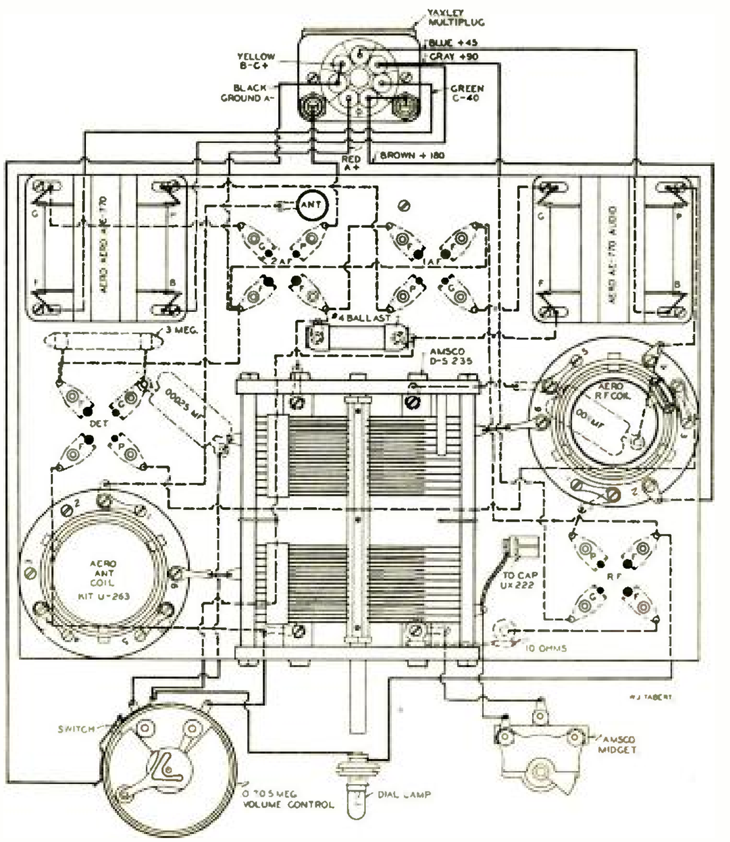
$$r = \frac{1}{w^2 C^2 R}$$

where R is the series resistance and r the shunt resistance.

The adoption of this method of regeneration rather than a variable feedback was caused by the tendency of any variation in coupling between the plate and grid circuits to detune the circuit slightly and when a ganged condenser is utilized, this cannot be tolerated. Furthermore the absorption method used provides an extremely smooth method of control and at the same time makes possible the reduction of the volume to zero by the same instrument which controls regeneration, thus simplifying operation considerably.

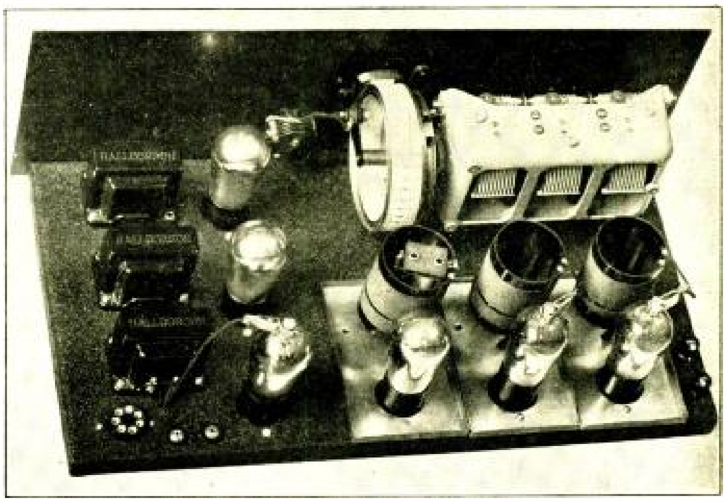
A new type of audio-frequency amplifying transformer was built into this receiver. These transformers have practically a flat amplication curve from 30 to 7000 cycles and then have a sharp cut-off, amplifying frequencies above 7500 cycles not at all and as a consequence their use in this receiver has resulted in extremely quiet operation with almost complete silence when no music is being broadcast.

This kit is supplied in complete form. The metal cabinet is also supplied and the kit itself contains every part down to the soldering lugs and pieces of hook-up wire and machine screws necessary for its assembly. Sufficient room is provided in the cabinet to use an "A" eliminator and "B" eliminator without having leads running outside.



In this wiring-layout diagram the dotted connections are beneath the sub-panel. All necessary details are given. It is suggested that this layout be followed closely.

"Halldorson Shield Grid 56 Receiver"



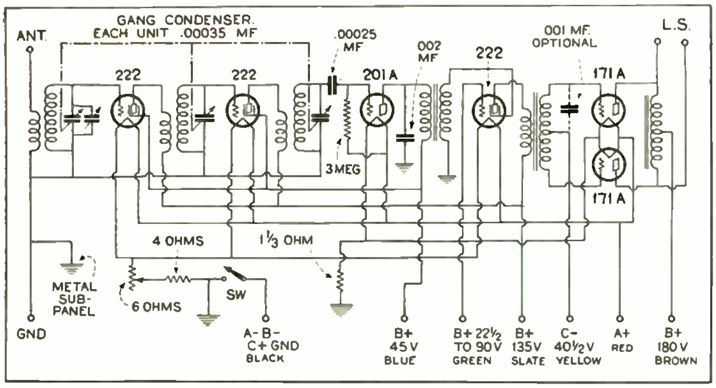
THE Halldorson Shield Grid 56 Receiver uses screen-grid tubes in both the radio frequency and first audio stages. The first two R. F. tubes are screen grid tubes operating in conjunction with speeial R. F. transformers, both R. F. and detector stages beng totally shielded with polished copper shields.

The screen-grid audio stage has a very interesting effect in bringing out weak distant signals that are ordinarily of not sufficient strength to actuate the amplifiers. The second audio stage consists of two 171 tubes in a push-pull circuit, the output of which is sufficient for any of the present speakers to be operated with excellent tonal quality.

By an ingenious jack arrangement the set may be disconnected and the amplifiers used for phonograph purposes with volume and quality equal to the finest electrical phonographs. While the first model is announced for battery operation, the manufacturers state the kit will also be available for alternating current operation using standard A. C. tubes.

LIST OF PARTS REQUIRED

1—Halldorson escutcheon plate, single window.
1—Front panel mahogany finish, 7x21 inches.
3—Halldorson copper stage shields.
1—Halldorson three-gang condenser.



Above: Rear view of the completed receiver with shield cases removed from the tuned circuits. Left: Schematic diagram of the "Shield Grid 56". The first A.F. stage uses a 222 as a space-charge-grid tube.

2—Halldorson Overtone audio transformers, push-pull input and output.
1—Halldorson Overtone screen-grid audio coupler.
3—Halldorson screen-grid R. F. coils.
1—Halldorson steel crystalyne sub-base with sockets attached.
1—7-wire multiplug and cable.
2—Halldorson drum dials.
1—Halldorson trimmer condenser.
1—Halldorson volume control and switch.
1—Potter .002 mfd. fixed condenser.
1—Potter .5 mfd. by-pass condenser.
1—Double circuit phonograph jack.
1—6 ohm rheostate with switch.
1—7 ohm resistance strip, tapped at 4 ohms.
1—Assortment hardware, wire, screws, nuts, etc.

The Screen-Grid Four

By Robert Frank Goodwin

OF late there has been a considerable number of receiver designs incorporating the new screen-grid tube, submitted for the constructors' approval. Most of these designs have been extremely elaborate affairs, which were not only difficult to construct, but also rather expensive.

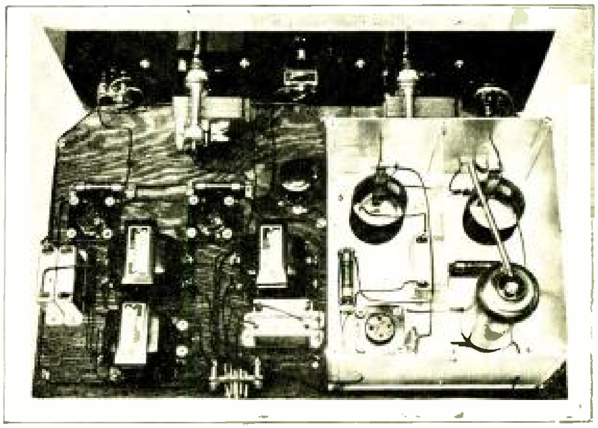
The possibilities of this tube were realized and also that there were numerous people who would like to construct receivers incorporating them, providing the design was not too difficult and the outlay not to expensive. Therefore, advantage was taken of the situation, realizing that it was possible to design a receiver to meet these requirements.

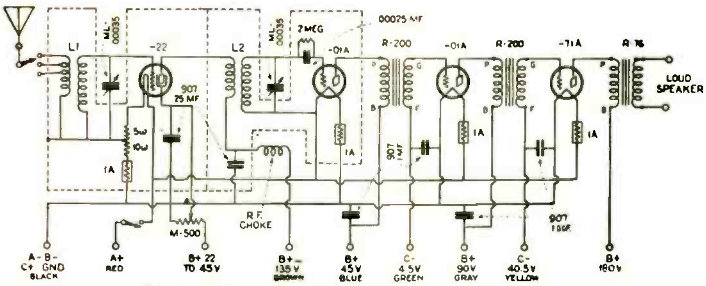
The receiver was to be a four tube affair, using one stage of screen-grid amplification, a tuned detector and a two stage transformer-coupled audio amplifier. The reason for the limitation of one stage of screen-grid amplification was not only for economy, but because after actual test, it was found that a single stage screen-grid R. F. amplifier properly designed, feeding into a non-regenerative detector with a good two-stage audio amplifier, compared well with a laboratory three stage R. F. amplifier using 201-A tubes. In fact the completed design functioned far more efficiently than the laboratory three stage affair. The overall amplification was far greater and the quality and selectivity slightly favored the screen grid amplifier.

The "Screen-Grid Four," is the result of much experimenting. The radio-frequency portion of this receiver is completely shielded to prevent coupling between stages and prevent outside pickup, low-loss radio frequency transformers being used for the coupling devices. These were chosen in preference to tuned plate inductances, because with them greater selectivity is obtainable, and also low-frequency disturbances do not reach the grid of the succeeding tube.

Two single variable condensers are used for tuning. This adds to the efficiency and simplicity, for the unbalanced conditions experienced with tandem condensers is eliminated. The antenna coil is tapped at three places and with the aid of a three-point inductance switch, mounted to the front panel, the value of the antenna coil can be corrected for the various stations, thereby increasing the selectivity of the receiver. With a broad signal the value of the antenna coil can be decreased to sharpen the tuning, and with a weak signal the antenna inductance can be increased, thereby increasing the

One stage of R.F. amplification using a screen-grid tube, a detector and two stages of transformer-coupled A. F. amplification is the make-up of the "Screen-Grid Four." The layout of the apparatus is quite simple due to the relatively few parts used.





Schematic diagram of the "Screen-Grid Four".

amplitude of the incoming signal voltage.

For a volume control a variable resistance is connected in series with the screen-grid and the "B" positive 45 volts. By varying this resistance the voltage applied to the screen-grid can be increased or decreased. Therefore, the volume is controlled by altering the amplification of the screen-grid tube.

Since the amplification of the screen-grid tube is extremely high, it was necessary to shield it from its respective coil, besides the complete shielding of each stage. Also, by-pass condensers are used to prevent feedback through battery coupling. In the audio-frequency circuit it will be noticed that there are four 1-mfd. by-pass condensers connected to the filaments and "B" positive returns of each transformer. These are used to prevent radio-frequency currents from entering the audio circuit, which would effect the quality of reproduction.

These audio transformers were carefully selected for their flat characteristic curve, which is vitally important when quality of reproduction is desired.

For the detector and first audio stage, CX-301-A tubes are used with 45 volts on the plate of the detector and 90 volts for the first A. F. stage and a 4½ volt grid bias, whereas in the last stage a 371-A power tube is used with 180 volts on the plate and a negative grid bias of 40½ volts. At this voltage the tube has an amplification factor of 2.9 and an undistorted output of 0.710 watts. Although it is suggested that this power tube be operated at the above specified voltages, it can be operated with 135 volts on the plate and a negative grid bias of 27, without a noticeable decrease in amplification, but with a great decrease in undistorted power output, which would be 0.320 watts as compared with 0.710 watts.

LIST OF PARTS REQUIRED

1—Thordarson R-300 or R-200 Audio Transformer for first stage
1—Thordarson R-200 for second stage
1—Thordarson Speaker Coupling Transformer, type R-76
2—Hammarlund Variable Condensers, type ML-17
1—Hammarlund R. F. Choke, type RFC-250
1—Hammarlund Screen-Grid R. F. Coil, FGP-17
1—Hammarlund Screen-Grid Antenna Coil, type AC-17
1—Hammarlund Hi-Q Box Shield
1—Carter Tube Shield with armour lead, type No. 322
1—Carter Adapter Ring, type No. 332
1—Carter 500,000 Ohm Volume Control Potentiometer, type No. 55
1—Carter 15 Ohm Tapped Resistance, type U5-15
1—Carter Three Point Inductance Switch, type No. 110
1—Carter Power Switch
4—Radiall Amperites, type 1-A
1—Eby Socket
1—Eby Binding Post (Ant.)
1—Dubilier .00025 Micadon with Grid Leak Mount, type 640-G
2—Dubilier .25-mfd. Condensers, type 907
4—Dubilier 1-mfd. Condensers, type 907
1—Yaxley Seven Wire Cable Connector, type 670
2—Yaxley Pup Jacks, type 416
2—Kurz-Kasch Dials
1—Roll Solid "Braidite" Wire
1—Westinghouse Micarta Fabricators Panel, 7" x 18"
1—Daven 5-meg. Glastor Resistor
2—Cunningham CX-301-A Tubes
1—Cunningham CX-371-A Tube
1—Cunningham CX-322 Tube
1—Corbett Cabinet (7" x 18" x 12" deep)
Screws, washers, solder, etc.

A New High Quality Resistance-Push-Pull Audio Amplifier

By Joseph Morgan

FOR many purposes the 210-tube is almost ideal for the last stage of a resistance-coupled amplifier. However, if it is desired to obtain good volume in even a medium sized room, a 210 tube will overload quite perceptibly if it is used in the last stage of an amplifier which is capable of amplifying frequencies as low as 30 cycles. Especially now that phonograph pick-up devices are coming into common use it is necessary to handle large power since many of the new process phonograph records include frequencies as low as 30 cycles.

As shown in the diagram, the input may come from any suitable detector, which, of course, may be preceded by a radio-frequency amplifier. The primary of the transformer T is connected to the plate of the detector tube and the proper positive "B" voltage for that tube, in the usual manner. The primary of the transformer is shunted by a mica condenser which should have a value not exceeding 0.0001 mfd., and a radio-frequency choke should be placed in series with the detector plate. The secondary should be shunted by a resistance of not less than 50,000 ohms nor more than 500,000 ohms. The best value may be determined by trial.

The transformer *must* be of the finest quality and capable of passing all frequencies from approximately 30 cycles to 6000 cycles equally.

It will be noticed that the amplifier is a *double* push-pull type; that is, both the first and second stages are push-pull stages. This is necessary to secure perfect balance and symmetry between stages and further to insure the elimination of second harmonic distortion in both stages.

The two tubes of the first stage are the 240 type having an amplification factor of 30. The grid bias of 1.5 volts for these tubes is fed through two 2 megohm metallized grid leaks as shown. The plate voltage of 180 volts is fed through two metallized plate resistors of ¼ megohm each. It is exceedingly important that these resistors be noiseless and constant in value.

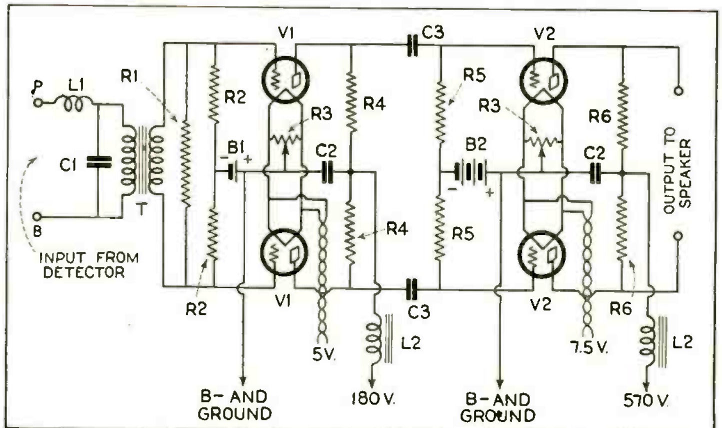
Two type 210-s are used in the second or output stage. The grid bias of approximately 35 volts, used in this stage, is fed through two resistors, each having a value of 0.5 megohm. The plate current is fed through two resistors, each 8,000 ohms. These metallized resistors must be capable of dissipating 2.5 watts continuously. The most advantageous plate voltage for this stage is between 500 and 700 volts although voltage as low as 400 may be employed. However, if less than 500 volts is used, it is best to use plate resistors of 6,000 ohm rather than 8,000 ohm units as specified.

The entire amplifier may be operated from a *good* "B" eliminator. The filaments can be operated from raw A. C. from the "B"-eliminator transformer, but D. C. is recommended for the filaments of the first stage. A rheostat should be inserted in one of the filament leads of the first stage to reduce the voltage across the filaments to 5 volts and the voltage across the filaments of the second stage should be 7.5 volts. The variable center-tapped resistors across the filament of the first and second stage should be at least 30 ohms. If a storage battery is used to light the filament of the detector tube it should also be used to light the filaments of the first push-pull stage.

It is not advisable in this amplifier to obtain the C biases from the "B" eliminator since it complicates matters and reduces stability.

LIST OF PARTS REQUIRED

R1—1 Durham 100,000 ohm resistor.
R2—2 Durham standard 1 meg. resistors.
R3—2 General radio 30 ohm center-tapped var. resistors.
R4—2 Durham standard ¼ meg. resistors.
R5—2 Durham standard ½ meg. resistors.
R6—2 Durham 8,000 ohm, 2½ watt power-ohms.
C1—1 Dubilier .0001 mfd. fixed condenser.
C2—2 Dubilier 1. mfd. fixed condensers.
C3—2 Dubilier 0.1 mfd. fixed condensers.
L1—1 Samson No. 85 R. F. choke.
L2—2 Samson No. 3 A. F. chokes.
T—1 Samson symphonic A. F. transformer.
B1—1 C battery, 1.5 volts.
B2—1 C battery, 35 volts.
V1—2 UX-240 or CX-340 tubes.
V2—2 UX-210 or CX-310 tubes.
4 Benjamin UX sockets.
9 Durham resistor mountings.
(Note: A. F. chokes are unnecessary with a good "B" supply unit.)



The schematic diagram of the resistance-coupled push-pull A.F. amplifier. V1 are 240-type tubes and V2 are 210s. T is a low-ratio transformer.

POLYMET PRODUCES NEW COLORED RESISTANCES

The Polymet Manufacturing Corporation has just placed on the market strip resistances made in various bright colors. A request for this new feature came from the Assembly Departments of several of the largest radio manufacturers who are now using the new Polymet colored resistances and report complete satisfaction with the increased speed in assembly made possible through this color method of distinguishing the different resistances that go into a particular set.

NOVEL RECORD TO DEMONSTRATE NEW SPEAKERS

Putting a miniature broadcasting program on a Victrola record is the unique idea used by United Radio Corporation of Rochester, N. Y., to free dealers from the limitations of broadcasting hours in demonstrating Peerless Speakers. The record gives a program that is a sample of the Sunday Peerless Half Hour.

NEMA FALL MEETING

The National Electrical Manufacturers Association will hold its Fall meeting during the week of October 29, 1928, at Briarcliff Lodge, Briarcliff, N. Y.

LEKTOPHONE LICENSES JENSEN CO.

Lektophone Corporation, who own and control basic patents on controlled edge radio cone speakers, have issued a license to the Jensen Radio Manufacturing Company, Oakland, California, for the manufacture and distribution of their new dynamic and other speakers.

EBY LICENSED BY R.C.A.

License to manufacture under patents held by the Radio Corporation of America and its associated companies, was granted to the H. H. Eby Mfg. Co., of Philadelphia.

This license according to Mr. F. C. Trimble, sales manager of the Eby organization, covers the manufacture and sale of power audio amplifiers and power units. This arrangement heralds the entry of the manufacturer of the smallest radio accessory, the binding post, into the power audio amplifier field.

Development of a combination power audio amplifier and power pack by the Eby engineering staff has been in progress for the past year. The perfection of the unit was climaxed by the patent negotiations and granting of the license.

SOVIET COMBINE AND R.C.A. FORM COOPERATIVE AGREEMENT

Mr. M. G. Gurevitch, acting chairman of the board of directors of the Amtorg Trading Corporation, 165 Broadway, made recently the following announcement:

An agreement calling for technical cooperation has been concluded between the Soviet State Electrotechnical Trust of Weak Current Factories and the Radio Corporation of America. The agreement provides for exchange of patent and engineering information in regard to various radio equipment. Technical assistance with reference to the manufacture of certain radio apparatus is also provided in the agreement.

DEJUR ABSORBS AMSCO

The DeJur-Amsco Corporation is the new name of an organization resulting from the absorption of the facilities of the Amsco Products Corp., by the DeJur Products Co., Inc.

According to Mr. Ralph A. DeJur, President of the new firm, the organization will maintain quarters in two buildings, occupying a total floor space in excess of 40,000 square feet. An entire floor with an operating area of approximately 20,000 square feet will be devoted to the manufacture of variable condensers of single, double, triple and quadruple section type. The remaining space in the other building will be devoted to the manufacture of power resistances, rheostats, potentiometers, variable resistances of all types, radio frequency chokes, tip jacks and sockets.

A new development laboratory, equipped with the latest condenser and resistance measuring devices will be installed to augment the equipment now at hand.

SCOTT TRANSFORMER CO. MOVE TO LARGER QUARTERS

The Scott Transformer Company recently moved to new and larger quarters at 4450 Ravenswood Ave., Chicago, Ill. This company manufactures the well-known Scott Transformers for the Scott World's Record Superhetrodyne Receivers including the power amplifier packs.

MASTER ENGINEERING CO. ORGANIZED

The Master Engineering Company, 122 South Michigan Ave., Chicago, Ill., was recently organized by Leroy Eschner, well known in radio, to manufacture and merchandise the Master Voltage Control.

ADDITION TO FORMICA PLANT

An addition to the plant of The Formica Insulation Company, Cincinnati, is now well under way and will be completed and ready for occupancy by October first. The new building will add 18,000 feet of floor space to the facilities of the Company.

The Formica Company was one of the first producers of phenol fibre insulation and has concentrated on this one product for the past 15 years. The product is well known to all makers of electrical and radio apparatus. Shipments during the past year have been reported as running about 40 percent ahead of 1927—making the new space necessary.

DETROIT ELECTRIC CO. OPENS KALAMAZOO BRANCH

The Detroit Electric Company, Detroit, Michigan, distributors of products of A. H. Grebe & Co., Inc., in the Detroit area and surrounding territories, announced late in August the reopening of its Kalamazoo Branch at No. 132 North Rose Street, Kalamazoo, Michigan. The new branch is under the managership of S. Kenneth Shull. Mr. Shull has associated with him H. P. Lockwood assisting in the territory.

H. B. HOLMES WITH DE FOREST RADIO COMPANY

H. B. Holmes, recently vice-president of Henry L. Crowley & Company, Inc., East Orange, N. J., has been made general sales manager of the DeForest Radio Company, Jersey City. He was formerly secretary and general manager of the Isolantite Company of America, Belleville, N. J.

ROLLER-SMITH APPOINTS E. E. VAN CLEEF AS CHICAGO DISTRICT SALES AGENT

The Roller-Smith Company, 233 Broadway, New York, N. Y., announces the appointment of Mr. Elliott E. Van Cleef, 53 W. Jackson Boulevard, Chicago, Ill., as its District Sales Agent in the Chicago territory.

Mr. Michael B. Mathley, who has been connected with the Chicago office for many years will be associated with Mr. Van Cleef.

E. H. McCARTHY APPOINTED TO MAJESTIC SALES

The Grigsby Grunow Co., announces the appointment of E. H. McCarthy as distributor contact man in Metropolitan, New York, formerly with Symphonic Sales Co., who will work out of the New York office of Herbert E. Young, 33 West 42nd Street. Mr. McCarthy was for five and a half years in charge of Columbia Graphaphone Company's advertising and Dealer Service Dept. at Boston during which time he supervised Retail Sales Campaigns for Columbia Dealers employing thirty three salesmen in this division.

RADIOVISION CORP. APPOINT NEW REPRESENTATIVES

The Cooley Rayfoto, which is being merchandised by the Radiovision Corporation of 62 West 39th Street, New York, will be represented on the Pacific Coast by Lombard J. Smith, who is to take over the Southern Californian territory running north to Bakersfield and including Los Angeles. A. J. Anderson, who has just associated himself with Alex Kelly, will sponsor the Rayfoto kit in San Francisco and south to Bakersfield.

Isadore A. Margolies, well-known to the Philadelphia trade as the Tobe-Deutschmann man, has taken on the agency for the Cooley Rayfoto in Philadelphia and Camden.

BENJAMIN ELECTRIC APPOINTS RADIO SALES REPRESENTATIVES

The Benjamin Electric Mfg. Co., 120 So. Sagamon St., Chicago, has appointed radio sales representatives, to contact radio distributors and manufacturers in their respective territories, as follows: A. Irving Witz, 611 Widener Bldg., Philadelphia, Pa., as far West as the North and South line through and including Harrisburg; the State of Delaware and the cities of Baltimore and Washington. Brower Murphy, 214 Red Rock Building, Atlanta, Ga., the States of Georgia, Alabama, Florida, Tennessee, North Carolina, South Carolina, and Virginia. B. J. Fitzner Company, 159 E. Elizabeth St., Detroit, Michigan, the State of Michigan excepting the northern peninsular, and the city of Toledo. Otto E. Heilmann Co., 620 Chemical Building, St. Louis Mo., the State of Missouri.

E. C. CARLSON APPOINTED R.C.A. ASSISTANT ADVERTISING MANAGER

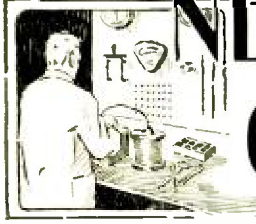
The Radio Corporation of America announces the appointment of Mr. E. C. Carlson, who until August 1st, was District Advertising Manager of their Chicago District, as Assistant Advertising Manager in charge of sales promotion with headquarters in New York.

He has charge of all Sales Promotion activities and will coordinate the functions of the District Advertising Divisions with those of the General Advertising Department.

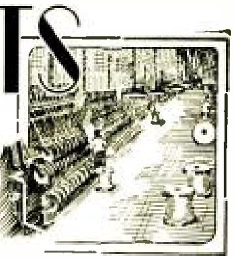
Mr. Carlson was formerly connected with Pillsbury Flour Mills, Cheney Talking Machine Company, Rue Motor Company and the Chicago and Northwestern Railway.

ARMSTRONG ELEC. CO. MOVE TO NEW QUARTERS

The Armstrong Electric & Mfg. Co., Inc., manufacturers of vacuum tubes, have moved into larger quarters at 187-193 Sylvan Ave., Newark, N. J. The new plant provides three times the former floor space and increased facilities. The Armstrong Co. is going into production on all types of vacuum tubes.



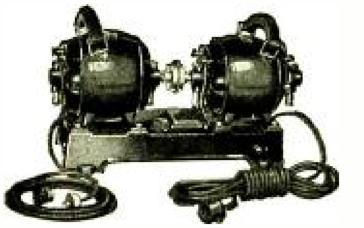
NEW DEVELOPMENTS OF THE MONTH



NEW BODINE RADIO MOTOR-GENERATOR SET

The Bodine Electric Company, 2254 W. Ohio street, Chicago, Ill., announce an improved model of their standard motor-generator set. The principal improvements are the incorporation of an improved filter system, and a change in general design permitting the filter and regulating rheostat to be enclosed in the base of the set, thereby protecting them from damage.

The Bodine Radio Motor-Generator Set converts direct current to single-phase, 60 cycle alternating current. This enables



New Bodine Radio Motor-Generator

dealers in direct current districts to successfully demonstrate and test A. C. radio receivers and accessories. The filter system prevents any electrical disturbances from being carried to the set and producing noises in the loudspeaker. The rheostat is provided to correct variations in the D. C. supply. The set delivers 250 watts, sufficient to operate any radio or radio-phonograph combination. It is small, compact and easily handled. Suitable extension cords are furnished, ready to plug in. No wiring is necessary.

LINCOLN 105 AND 106 "REVOLUTIONARY" AUDIO TRANSFORMERS

The new Lincoln 105 (first stage) and 106 (second stage) audio-frequency transformers use the system designed by Kendall Clough.

The new 105 first stage transformer is designed for use between any standard detector and first stage audio tubes, and provides an effective transformation ratio of 4.4 to 1.

A new high impedance audio frequency transformer employing the Clough System of amplification.

The 106 second stage transformer is used between the first and second stage audio tubes, and provides an effective transformation ratio of 3.7 to 1.

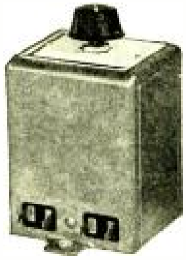
The Lincoln Transformers are encased in a satin-copper finished case 3½ in. high, 2¾ in. wide, and 3 3/16 in. over mounting feet. Provided with solder lug terminals for convenience in wiring.

Lincoln 105 First Stage A.F. Transformer List Price, $7.00

Lincoln 106 Second Stage A. F. Transformer. List Price, $7.00

LINCOLN 101 MANUALLY TUNED INTERMEDIATE-FREQUENCY TRANSFORMERS

The Lincoln 101 I. F. Transformer, manufactured by the Lincoln Radio Corp., 329 So. Wood St., Chicago, contains in



A new intermediate frequency transformer for superheterodynes which is manually tuned by a variable condenser.

addition to the primary and secondary, a small tuning condenser, which tunes the primary to exactly the desired frequency. The knob of this tuning condenser projects through the case of the transformer and is always available for retuning. After a set is built incorporating two, three or more of these transformers, it is placed in operation and then the transformers are tuned individually by the builder to exactly the same frequency, thereby compensating for all differences in wiring, tube characteristics, etc.

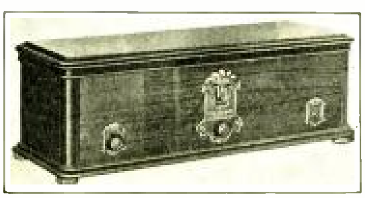
The Lincoln 101 transformer is housed in a copper shield can, 100% shielded, the Bakelite tuning knob with pointer projecting through the top. Size is 2⅝ in. wide, 3½ in. long and 3½ in. high. Convenient mounting lugs are provided on each side, equipped with solder lugs for convenience in wiring. List price, $7 each.

R.C.A. ANNOUNCES NEW RECEIVERS AND LOUDSPEAKERS

A new line of Radiolas including superheterodyne receivers utilizing A. C. radiotrons throughout, for simplified electric operation with self-enclosed loudspeakers of the improved dynamic type, and a new loudspeaker of artistic design, is announced by the Radio Corporation of America.

The new A. C. superheterodyne receivers are introduced in three models to be known as Radiola 60, a popular priced table model, Radiola 62, a console cabinet with enclosed dynamic speaker, and Radiola 64, a larger console cabinet with a dynamic speaker of greater power.

The table type A. C. superheterodyne, model 60, includes seven UY-227 radiotrons and one UX-171-A power radiotron. The circuit comprises two stages of tuned radio frequency amplification, first detector, oscillator, two stages of tuned intermediate-frequency amplification, a second



New R. C. A. Radiola 60

(power) detector, and one stage of power audio-frequency amplification. Rectification of the current for the "B" and "C" requirements is accomplished by a UX-280 radiotron. A voltage switch is provided to take care of variations in line potentials of 105 to 125 volts. Both receiver and power supply unit are housed in a two-toned walnut cabinet. In the center of the panel is a bronze escutcheon plate framing the selector dial and concealing the bulb which illuminates the dial and tuning control. Operation of this new superheterodyne has been reduced to its simplest form by means of a single tuning control. In addition there is a power switch and volume control.

NEW ARCTURUS A-C AMPLIFYING TUBE

A new amplifying tube for use in radio and audio-frequency amplifiers has been placed on the market by the Arcturus Radio Company, of Newark, N. J. This new tube, type 48, is of the 15-volt heater design and is similar in many respects to the No. 28 amplifier. However, the new tube is designed to operate with a 4.5-volt bias, at a plate potential of 135 volts, instead of the 1.5-volt bias required by the earlier tube.

Redesign of the tube makes it possible to accommodate a much larger grid swing, raising the voltage input the tube can handle without distorting and increasing its value as a general amplifying tube.

BALDOR TELEVISION MOTORS

The Interstate Electric Co., 4339 Duncan Ave., St. Louis, Mo., announce a series of single phase induction motors especially adapted for television transmitting and receiving. Induction motors are best for this type of work as there is no commutator and therefore no sparking to set up any interference. A speed control mechanism in the form of a switch, variable resistance, reactance or a combination of

Standard type Baldor Television Motor.

the foregoing can be easily incorporated in motors of this type. Needless to say this is an important factor in television reception.

This type of motor was designed to meet the requirements when constant speed which may be varied at will, is needed. Due to features of design and the absence of switching mechanism in connection with the rotor, the motor can be controlled so that any speed from 50 to 100 R.P.M. up to synchronous speed can be obtained when connected to a suitable load. The magnetic action is similar to a polyphase motor, the usual hum being absent.

Type Y1V, 1/8 H.P., 110 volts, 60 cycles, single phase, 1,800 R.P.M. Recommended for television receivers employing a 24 inch scanning disc. Speeds between 750 and 1700 R.P.M. easily maintained with a 5 to 45 ohm variable resistance. Price, bare motor, $30.00.

Type Y2V, ¼-H.P., 110 volts, 60 cycles, single phase, 1200 R.P.M. Variable speed and range with 30-ohm rheostat, 500 to 1100 R.P.M. Price, bare motor, $33.00.

Type M2V, 1/15 H.P., 110 volts, 60-cycles, single phase, 1800 R.P.M. for receiving sets using 9 to 18-inch scanning disc., also resistance controlled; 1700 R.P.M. full load. Variable speed range with 60-ohm rheostat, 750 to 1750 R.P.M. Price $23.00.

KNAPP "A" POWER

The Knapp Electric, Inc., of Port Chester, N. Y., announce a new "A" power unit, which is now being sold through the established trade channels and has several very interesting features:

Four or 6 volts from same unit. Thus it is possible for dealers and jobbers to stock but one item. On the panel are located three taps: A+; A—4V; A—6V. Absolutely dry. Oversize filter system

Knapp "A" Power Unit.

consisting of three *dry* Elkon Condensers and two large choke coils. Total capacity 4,500 mf., insuring freedom from hum. Elkon rectifier delivers 2½ amperes at 6 volts, and proportionate current at 4 volts. Operates on 105-120 volts A.C. 50 to 60 cycles. List Price, $37.50.

NEW ELKON METALLIC RECTIFIER

Elkon, Inc., of Port Chester, N. Y., announce a new type of rectifier, which is made of the same elements as the more familiar Elkon rectifiers is shaped like a tube and has a standard tube base.

The new Elkon Metallic Rectifier which will replace the usual form of full-wave rectifier in a "B" supply unit.

Electrically it has the same characteristics as the standard BH type tubes, but with a guaranteed life of 5,000 hours. It is designed solely as a replacement unit and fits all types of tube sockets. List Price, $6.00.

PIERCE-AIRO CHASSIS NOW AVAILABLE IN CABINETS

Pierce-Airo, Inc., manufacturers of the 7 tube Pierce-Airo chassis which has become so popular with the trade and public are now offering the same chassis housed in a handsome two tone russet bronze metal cabinet as illustrated. With these two jobs Pierce-Airo dealers will be able to meet the demands of their customers for either a high class chassis or a fine receiver at a moderate price. Pierce-Airo chassis are manufactured by Pierce-Airo, Inc., 117 4th Avenue, New York City.

New Pierce-Airo 7-Tube Receiver

NEW EBY 171 POWER AUDIO AMPLIFIER

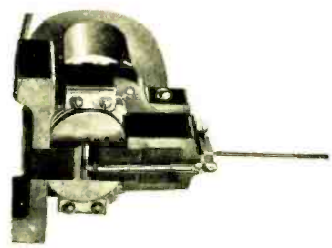
A new combination power audio amplifier and power pack, operating directly from the A. C. house supply circuit, with an output of approximately 1.5 watts, and known as the 220 Power Audio Amplifier, has been announced by the H. H. Eby Mfg. Co., of Philadelphia, Pa.

According to Mr. F. C. Trimble, sales manager of the organization, this, the first of a series of combination power packs and audio amplifiers, is a two-stage transformer-coupled unit, employing a 226 type A. C. tube in the first stage and two 171 tubes connected in push-pull fashion as the output stage. A three stage amplifier utilizing a 227, a 226 and a pair of 250s will be ready shortly.

The units are designed for complete A. C. operation, A, B and C voltages being obtained from the power unit which utilizes a 280 full wave rectifier tube in the power amplifier equipped with 171 tubes, and two 281 half wave rectifiers in the power amplifier equipped with the 250 type tubes.

BRIELLE LOUD SPEAKER MOTOR

The G. R. Penn Manufacturing Co., 34 W. 3rd Street, New York City, announce their B. A. Motor, which can be installed



Brielle Loud Speaker Motor.

in any type of cone speaker. The unit is large and powerful and has laminated pole pieces that provide maximum efficiency to the A. F. energy generated by the coils. This feature also eliminates eddy currents. Price of motor alone, $10.00; with complete kit of 24, 30 or 36-inch cone, $15.25.

NEW ANSONIA REPRODUCER

The Radio Foundation, Inc., 1 Park Place, New York City, announce their new cone square-type reproducer which is encased in a beautiful walnut cabinet with rounded corners and gold inlay, the finish and design harmonizing with many of the new 1928-29 receiving sets.

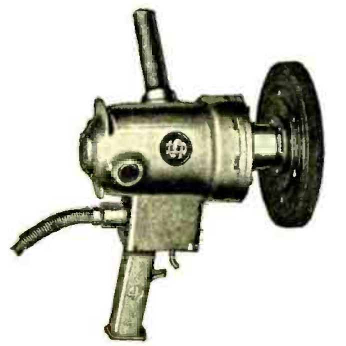
Using the new Ansonia chassis, the Ansonia square type reproducer possesses the same pleasing tone quality and rugged construction as found in other Ansonia models. Height 12", width 12", depth 6". List Price, $29.50.

NEW TRANSFORMER COIL WINDING MACHINE

The Chicago Transformer Co. announced recently that its Chief Engineer, Wilmer J. Leidy, has invented a winding machine which accomplishes interspaced winding in approximately the same time required for winding ordinary transformer coils. By the use of this machine it is said that the company will be able to produce a "straight line" A.F. transformer at a reasonable price. No licenses to other manufacturers have yet been granted.

NEW U. S. DISC SANDER

The United States Electrical Tool Company, Cincinnati, pioneers in portable electric tool making, announce a new and improved disc sanding tool.



New U.S. Disc Sander

Care has been given to make the new disc sander fully as sturdy and powerful as the other tools in this broad line. A fan-cooled Universal motor of well known make operates the 9-inch disc at 3600 r. p. m. under load, the most widely accepted speed for this work. Ball bearings also of a favored make are used throughout. The familiar two-pole trigger switch in the handle, one of today's many electrical tool features introduced by U. S., is included.

Thought has also been given to the "heft" or balance of the U. S. Disc Sander. It handles easily, making for maximum ease and speed in operating.

Fine, medium and coarse sanding discs are furnished. Also twelve feet of flexible rubber covered cable, two-piece attachment plug and armored cable guard are regular equipment. Weight is only twelve pounds. The price complete is $85.

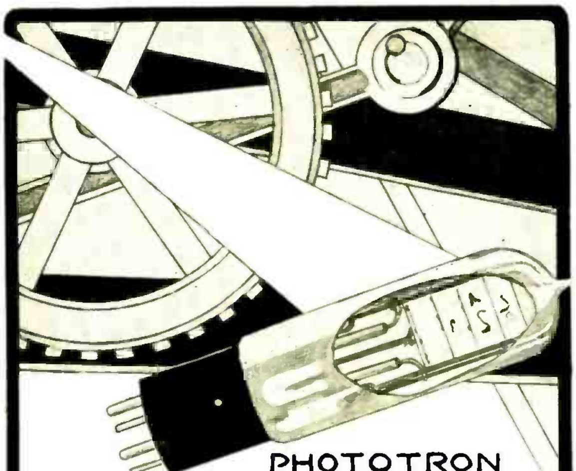
DRESNER SHORT-WAVE CONVERTER

The Dresner Radio Manufacturing Co., of 642 Southern Boulevard, New York City, announce a Short-Wave Converter, which can be plugged into any type of broadcast receiver, and pick up stations on the lower bands of wave lengths.

The entire apparatus of the Converter is housed in a cabinet 8¼ x 5¼ x 5¼ inches, the weight being 3 pounds. Tuning is accomplished by the two dials on the Converter's front panel, the dials of the receiver itself not being used for short-wave tuning. Five plug-in type coils make it possible to cover a wave-band of 15 to 550 meters with this Converter Unit. The coils are fitted with prongs such as are used on vacuum tubes, and are readily distinguished by the different colors of the forms on which they are wound.

The lead from the Converter is plugged into the socket of the detector tube, which is plugged in the socket on the top of the Converter. The only other changes necessary are the transferring of the antenna and ground leads from the receiver to the binding posts of the Converter. The circuit of the Converter is regenerative. Two knobs on the top of the cabinet control the sensitivity and signal strength. Price, $22.50.

Dresner Short-Wave Converter



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Photoelectric cells and cell units for industrial purposes

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Neon Television lamps, low starting voltage, high milliampere capacity and long life.

Special gas filled tubes made to order.

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High voltage electro-static voltmeters from 200-100.000 volts.

Caesium and rubidium metal and salts, barium, strontium, and calcium azides produced in our own chemical laboratory.

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TELEVISION KITS AND PARTS
Complete Kits ready to assemble; Neon Tubes, Discs, Photo Electric Cells, Motors, etc. Write for new catalog.

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Drilling, Engraving and Machining to Specifications. All Popular Panels in Stock. Complete line of Insulating Materials.

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TELEVISION is now an accomplished fact.

Experimenters will welcome the Raytheon Kino-Lamp, the first television tube developed commercially to work with any system.

Uniform glow over the entire plate, without the use of mirrors or ground glass, gives it perfect reproduction qualities.

Kino-Lamp is the latest achievement of the Raytheon Laboratories which have made so many original contributions to radio science.

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Raytheon Foto-Cell

Available in both *hard vacuum* and *gas-filled* extra sensitive types—each in two sizes. Write us for special specifications.

RAYTHEON MFG. COMPANY
Cambridge, Mass.

Raytheon KINO-LAMP

DEPENDABILITY

QUALITY

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BROWN & CAINE INC.

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FIXED CONDENSERS

«PRECISION»

NATIONAL
Velvet Vernier Dial Type N, Solid German Silver Dial, 4" diam.

Bakelite Knob, three ranges of Divisions with Vernier for fractional readings. Attaches to face of panel at three points.
Price $6.50

Note: *For high frequency work a Bakelite Apron to protect the fingers from burning can be provided at a slight additional cost.*

Precision measuring instruments require precision parts. It is for these and for more precise logging of short-wave receiving and transmitting apparatus that NATIONAL CO. INC. has produced its new Velvet Vernier Dial Type N. This solid German Silver dial has a REAL VERNIER permitting accurate reading to 1/10 division. The movement is the original and the unexcelled Velvet Vernier mechanism.

We know of no finer dial for use on oscillators, wave meters, tube testers and other accurate radio apparatus.

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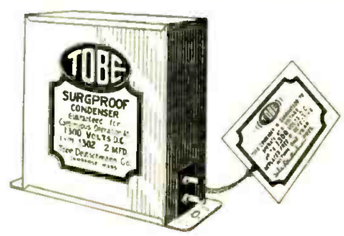
RADIO PRODUCTS

NATIONAL CO. Inc. W. A. Ready, *President* MALDEN, MASS.

TOBE

SURGPROOF CONDENSER



A new type condenser with a full year guarantee.

The test of a manufacturer's faith in his products is how long will he guarantee them?

SURGPROOF CONDENSER carries an immediate replacement guarantee if defective within one year.

SURGPROOF CONDENSER has a safe working voltage of 1300 volts D. C. and is recommended for any high-voltage amplifier using two 210 Power Tubes in Push Pull or the new 250 or 280 Tubes. Encased in a familiar TOBE SILVERED CASE 4½" x 5" x 1½".

Type 1302—2 Mfd..$5.00
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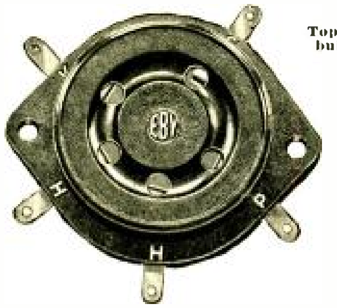

Top view showing built-in-guide for tube prongs

Bottom view without base showing contacts

SOCKETS

Eby Sockets have —

1—Good looks that will improve the appearance of any set.

2—Grooved tops to guide tube prongs.

3—New and improved prongs providing long tight spring contact. High current-carrying capacity and low interelectrode capacity. Ideal for use with A.C. tubes.

List price: UX type..............40c
UY type..............50c

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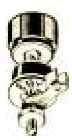

Eby Binding Posts are all that binding posts could be.

Completely insulated with non-removable tops engraved in popular markings.

TIP JACKS

Eby Tip Jacks have countersunk tops so that the pin can't wobble. Equipped with red and black Bakelite washers for insulating from metal panels.

List price...........25c per pair

The H. H. EBY MFG. CO., Inc.
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TRUE A. C. CONSTANTS

of Radio Tubes can now be obtained

By Means of a

DIRECT READING INSTRUMENT

Known as The Weston Model 526

RADIO TUBE TESTER

ITS principle of operation is based upon the fundamental definition of the tube constants and thus it becomes an absolute tester, affording quick and accurate measurements without the use of telephone or other complicated auxiliary devices. These values could be obtained formerly only by means of complicated bridge methods.

The Weston Model 526 will measure:

Voltage amplification factor; plate impedance in ohms; mutual conductance in micromhos; plate current—as well as plate, grid and filament voltage.

The values indicated are the true A. C. values of the tube constants which are obtained by applying to the plate and grid circuits an alternating current. This current may be from an ordinary lighting circuit, and the values obtained are independent of variations in voltage of the A. C. circuit used.

For complete information write direct to

WESTON ELECTRICAL INSTRUMENT CORPORATION
612 Frelinghuysen Ave. Newark, N. J.

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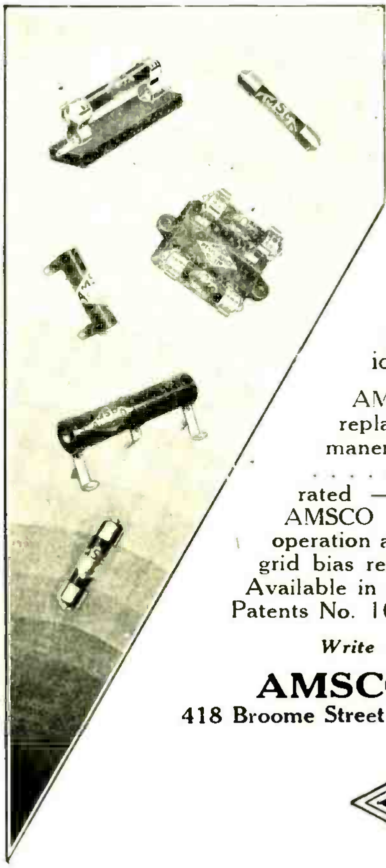
RADIO
INSTRUMENTS



ENGINEERING ABILITY

.5 of 1
micromicrofarad at minimum

capacity and 1% at maximum capacity are the tolerance values of the AMSCO "Bathtub" gang variable tuning condensers. . . . Such perfect "matching" at the low end of the scale makes the AMSCO "Bathtub" the ideal tuning condenser for good receivers.

AMSCO "Metaloid" resistances need never be replaced . . . . . Their scientific design assures permanency of resistance and physical characteristics . . . . . Accurately calibrated — conservatively rated — moisture proof and acid proof — AMSCO "Metaloids" are available for perfect operation as grid leaks — coupling resistances — grid bias resistances and power resistances . . . Available in all sizes . . . . . Made under U. S. Patents No. 1034103, 1034104, 1635184.

Write for descriptive literature.

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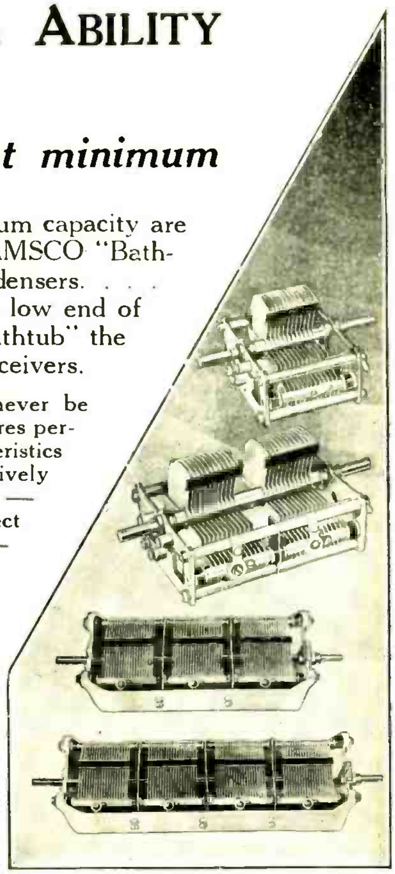
AMSCO



THE PYROHM IS BUILT *TO CARRY THE LOAD!*

Aerovox Fixed and Tapped Vitreous Enamelled Pyrohm Resistors are made in a wide range of resistance values and wattage ratings to suit every power supply requirement. They are built to the same high standards as Aerovox Mica Condensers, Socket Power Condensers and Filter Condenser Blocks.

The August issue of the Aerovox Research Worker contains an interesting and instructive article on How to Calculate Voltage Dividers for Power Supply Devices. A copy will be sent free on request.

AEROVOX
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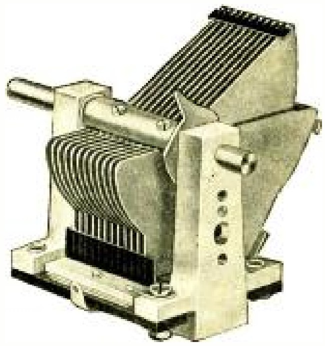
May we see you at the show?

Booth 2
Section Z, Mez.

For best results in all power work use ELMENCO Resistors.

NOTE TO MANUFACTURERS—Special tapped resistors can be supplied on order to manufacturers only. In ordering please specify number of taps resistance per section and current drain. *Write us today.*

Electro-Motive Engineering Corp.
127 W. 17th St. New York



Includes every essential feature of the famous standard Midline model —only simplified to better meet the set manufacturers' requirements.

The New
HAMMARLUND
Manufacturers' Model
MIDLINE CONDENSER

SO MANY manufacturers have asked us why we didn't make a simplified Midline Condenser, designed for receiver production in large volume.

The answer now is:—"We DO!"

And the new manufacturers' model illustrated here is a real achievement. For not only does it embody every essential technical characteristic of the standard Midline model, it will give the same high degree of precision accuracy and faithful service.

Die-cast frame of new design—built for hard usage. Soldered brass plates with tie-bars. Smoothly operating bearings. Positive spring-friction contact. Convenient terminal lugs.

Your receiver should have the extra prestige of using Hammarlund Condensers—*famous for quality the world over.*

The price is unusually attractive.

May we quote on your needs for the current season?

Write for Hammarlund literature and ask for quotations on your requirements

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424-438 W. 33rd St., New York, N. Y.

For Better Radio
Hammarlund
PRECISION
PRODUCTS

PUSH-PULL 250!

The features (reduction of hum on AC operation and large overload capacity) of the push-pull amplifier circuit render its use with the new type UX 250 (CX 350) power tubes the natural solution for installations demanding the delivery of unusual power to the speaker.

Sufficient power is obtained to operate several reproducers, and to fill a small hall or out-door space.

Output transformers are furnished either for high impedance or low impedance (dynamic) speakers. The 541 transformers are supplied in two combinations each containing an input and an output transformer.

Type 541-A and Type 541-B (for 2000–5000 ohm speakers)
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Price (either combination of two transformers) $25.00.

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L. M. C. RESISTORS

Vitreous Enameled ***Wire Wound***

The wide acceptance and increasing use of "L.M.C." RESISTORS by the electrical and radio industry is attributable directly to the following facts--

We are not merely assemblers.
We are Metallurgists, making our own Alloys.
We are Ceramists, making our own Enamels.
We are Electrical Engineers, prepared to work out any problems pertaining to controlling devices.
We know there are other good resistors on the market, but invite manufacturers to judge the "L.M.C."
Our engineering department is at your service.
Send in your problems.
In fairness to yourself, let us quote on your requirements and send you samples.

LAUTZ MANUFACTURING COMPANY, Inc.
Electrical Alloy Products—Controlling Devices
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CENTRALAB
GIANT POWER RHEOSTAT

SMALL in diameter but large in capacity, this rheostat will safely carry any power load of 70 watts. Constructed of heat-proof materials throughout. No fibre to warp or burn out. Wire is wound on a steel core insulated with asbestos. Extra wide core assures large area for quick heat dissipation.

This unit is ideal for primary control of "AC" receivers or "A" Power Units. It will keep the line at a constant workable average, keeping the secondary output well within rated limits. These units connected in series across the output of a Rectifier and Filter system for "B" Power will provide all necessary voltage taps.

These units can be used in any power circuit position without any danger of burning out—the capacity is only limited by the capacity of the wire.

Manufactured with either two or three terminals. Diameter 2"; Depth 1¼". Write for new Booklet on "Volume Controls and Voltage Controls—their use."

CENTRAL RADIO LABORATORIES
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ZINC-FOIL
(MIKROFOIL)

FOR CONDENSERS

A STRONGER, BETTER FOIL AT A LOWER PRICE

Zincfoil is not only much stronger and tougher than 83-15-2 composition foil but its cost is substantially less.

It solders readily, has high conductivity, and from every angle is an ideal foil for condensers.

In coils of all thicknesses up to .0004 inch.

Samples gladly submitted for test. Write for them and for prices.

Reynolds Metals Company, Incorporated
Division of United States Foil Company
BROOKLYN LOUISVILLE SAN FRANCISCO

ALL GRADES OF FOIL

Aquadag

A concentrated colloidal solution of Acheson Electric Furnace Graphite in distilled water.

Manufacturers of grid leaks, other resistances, "getters," and those interested in the establishment of positive contacts are consistent users of Aquadag.

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Newark, N. J.

Oxide Coated Filament
for
All Tubes

Special Getter
for
Detectors — A.C. Tubes — Amplifiers
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A large variety of standard shapes carried in stock. Special designs stamped to your order.

Our BOOKLET on LAMINATIONS (sent on request) gives specifications of Stock Standard Shapes, and contains much data of value to the designer—and buyer.

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We Unconditionally guarantee

The LOFTIN-WHITE JEWELL *and* MIESSNER A-C "R-P-L" Receiver

to be the

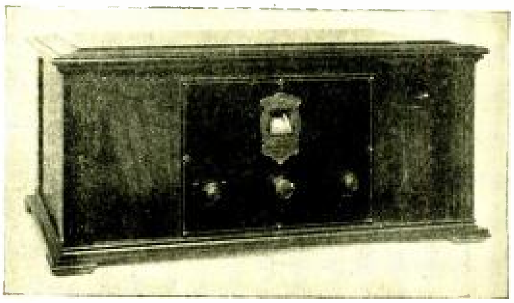
World's Greatest

RADIO BROADCAST RECEIVER

REGARDLESS OF PRICE

Sold Only Through Authorized Representatives Complete or in Unit Form

PROVISION IS MADE FOR ELECTRIC PHONOGRAPH PICKUP



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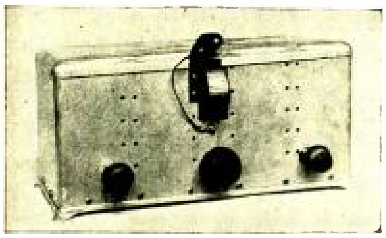
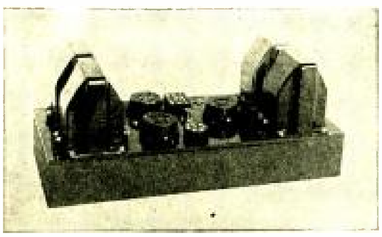


LOFTIN-WHITE TUNER



JEWELL DUAL IMPEDANCE POWER AMPLIFIER

Distributors for Loftin-White Tuner R. F. Amplifier, Jewell Audio Amplifier, CeCo Tubes, Airchrome, and Jensen Loud Speakers

SPECIFICATIONS

THESE SPECIFICATIONS MEAN SOMETHING TO ANYONE WHO KNOWS ANYTHING ABOUT RADIO

Three stages of Loftin-White constant coupled tuned radio frequency amplification, giving practically a straight-line amplification factor over the entire broadcast wave band. Giving 10,000 cycle separation, and due to new design of coupling in each stage it has an unusual sensitivity factor. True single dial operation with tuned antenna input and full volume control. Automatically adjusted below the point of oscillation. Non-regenerative detector feeding the audio amplifier that has an amplification factor of over 750, which is from three to five times greater than any commercial types that are now on the market. Two stages of Jewell Dual Impedance audio amplification, assuring straight-line amplification over the entire band of audible frequencies, feeding into a 250-power tube that has an undistorted output of over 4500 milli watts. This amount of power is capable of overloading any of the commercial loud speakers now on the market. In other words, nothing has been left out in the engineering of the receiver that could be desired by the most discriminating radio critic, and also due to the fact that the Miessner system of A.C. operation is employed the A.C. hum is reduced to an absolute minimum.

Mr. Radio Fan and Professional Set Builder!

Why not capitalize the prestige and distinction that goes with being our local representative in your territory by selling the most remarkable radio receiver that has ever been offered to the American public? This receiver was designed and engineered by the most prominent radio engineers in the world today. Write us NOW for our EXCLUSIVE REPRESENTATIVE PLAN.

Unconditional Guarantee---You Being the Judge

We unconditionally guarantee this receiver to be the best radio broadcast receiver that can be built under the present known theories of the science and if, for any reason, it does not come up to your every expectation, it may be returned to us, in good condition, any time within thirty days and your money will be refunded in full.

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1931 Broadway, New York, N. Y.

Gentlemen: Kindly send me, without obligation, your Field Representative Plan.

Name....................................

Address..................................

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RADIO PRODUCTS LABORATORY
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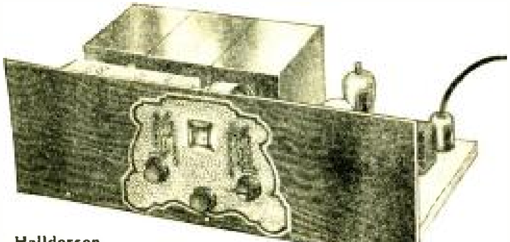
1931 BROADWAY - - NEW YORK, N. Y.

Advanced Construction Ideas Feature New Halldorson Kits



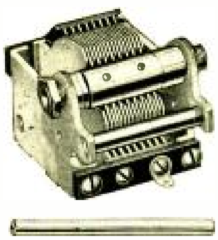
Halldorson
Shield-Grid 56

THE Halldorson Shield-Grid 56 is a marvelous six tube kit, unusual in selectivity, sensitivity, and volume, and an unheard-of value at the price for which it is offered. **Specifications:** Handsome bronze escutcheon plate on mahogany finished steel panel; all parts mounted directly upon steel sub-base; two stages shield-grid r.f. amplification with shield-grid first audio; copper shields; push-pull audio system; and phonograph switch. Price, $59.85 ***A.C. job in same style, using 226 and 227 tubes, a knockout at $63.85. A.C. Power Supply, $37.50.***

Ask your jobber—Catalog of Halldorson Radio Products sent upon request—write today.

THE HALLDORSON COMPANY
Dept. E, 4745 N. Western Ave., Chicago, Ill.

UNITED SCIENTIFIC — **TYPE UXB**



JOBBERS and DEALERS

Can make money stocking this universal precision instrument, which is adaptable to any circuit. It can be mounted for all sorts of drives and ganged in any number.

Characteristics:

1. Patent leveled brass rotor and stator.
2. Precision spacing that assures accurate calibration.
3. Removable shaft can be adjusted to any desired length. Adaptable to ganging in any number.
4. Universal mounting permits clockwise or counter clockwise rotation. Provided with integral frame lugs for sub-panel mounting.
5. Modified straight-line frequency curve to take care of all present day broadcasting wavebands.

This new condenser is made in .00035 and .0005 sizes.

See Our Display at New York Radio Show, Booth 1, Sec. Z

United Scientific Laboratories, Inc.
117 Fourth Avenue — New York City

BRANCH OFFICES: St. Louis, Chicago, Boston, Minneapolis

UNITED SCIEN. LAB. INC.

BRANCH OFFICES: Cincinnati, Los Angeles, Philadelphia, San Francisco

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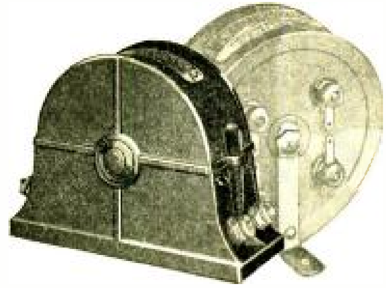

Eclipsed

A Great Radio Transformer Now Gives Way To A Still Greater Achievement

After long, and particularly exacting tests, a new Victoreen Super Transformer is announced which, we believe is literally years ahead of its time in its many vital improvements.

The new 1929 Victoreen circuit and transformers are an outstanding achievement in Radio Engineering. Using them, you can assemble a receiver uniquely alone in quality performance. Better can neither be built or bought.

Build the Perfect Receiver for 1929 with the Following Remarkable Features

1ST. AN IMPROVED METHOD OF DETECTION
2ND. AN UNUSUAL AND SMOOTH VOLUME CONTROL
3RD. A SPECIAL OSCILLATOR, ELIMINATING OBJECTIONABLE "REPEAT" POINTS
4TH. A SIMPLIFIED CIRCUIT, MAKING ASSEMBLY EVEN MORE EASY.
5TH. A SPECIAL FIXED ADJUSTMENT IN OSCILLATOR TO SIMPLIFY TUNING.
6TH. A REDESIGNED AND NEW TYPE R. F. TRANSFORMER, PROVIDING GREATER SELECTIVITY AND SENSITIVITY.
7TH. A SHARPENED LOOP CIRCUIT, WITHOUT USING REGENERATION.
8TH. NO HUM, THEREFORE NO HUM ADJUSTMENT NECESSARY.
9TH. VARIABLE ADJUSTMENTS REDUCED IN NUMBER.

Unmatched Ease of Assembly

Every feature of the 1929 Victoreen A.C. Circuit has been planned for the set builder's convenience. The placing of parts and binding posts—the careful testing of each instrument—the sound engineering policies back of Victoreen design—are as near 100% perfect as modern science has been able to obtain.

Blue Print FREE—together with complete assembly instructions. Write for it today.

Another New Development Victoreen "B" Power Supply

Supplies 45-90-180 and 450 volts, using a UX 210 or 250 in the last stage. Contains two voltage regulator tubes so that the 90 and 180 volt taps are supplied with a constant volt potential. It is the last word in "B" supply. For the most satisfactory results you *must* have it.

Free Blue Print, with list of parts and complete assembly instructions will be sent upon request.

The Geo. W. Walker Company
Merchandisers of Victoreen Radio Parts
2825 Chester Ave. — Cleveland, Ohio

Victoreen

Buyers Directory of Equipment and Apparatus

Readers interested in products not listed in these columns are invited to tell us of their wants, and we will inform the proper manufacturers. Address Readers' Information Bureau.

Addresses of companies listed below, can be found in their advertisements—see index on page 70.

ADAPTERS:
Carter Radio Co.

ALUMINUM:
Aluminum Co. of America

ALUMINUM FOIL:
Lehmaier and Schwartz Co.
U. S. Foil Co.

AMMETERS:
General Radio Co.
Jewell Elec. Inst. Co.
Westinghouse Elec. & Mfg. Co.
Weston Elec. Instrument Corp.

ANTENNAE, LAMP SOCKET:
Dubilier Condenser Mfg. Co.
Electrad, Inc.

ARRESTERS, LIGHTNING:
Electrad, Inc.,
Jewell Elec. Inst. Co.
Westinghouse Elec. & Mfg. Co.

BASES, VACUUM TUBE:
Formica Insulation Co.

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Eby, H. H., Co.
General Radio Co.
X-L Radio Labs.

BOXES, PACKING:
Tifft Bros.

BRACKETS, ANGLE:
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Electrad Inc.
Scovill Mfg. Co.

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Scovill Mfg. Co.

BROADCAST STATION EQUIP'T:
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General Radio Co.

BUTTS:
Scovill Mfg. Co.

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Copper and Brass Research Assn.
Crowe Nameplate Mfg. Co.

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Photion Instrument Corp.
Photo-Electric Devices Co.
Radio Electrical Works.
Raytheon Mfg. Co.

CERIUM:
Independent Labs.

CHARGERS:
Acme Elec. & Mfg. Co.
Elkon Co.

CHASES:
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General Radio Co.
General Transformer Co.
Samson Electric Co.
Silver-Marshall, Inc.
Thordarson Elec. Mfg. Co.

CHOKES, RADIO FREQUENCY:
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Fahnstock Elec. Co.
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Westinghouse Elec. & Mfg. Co.

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Dudlo Mfg. Co.

COILS, INDUCTANCE:
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Cardwell, Allen, D., Mfg. Co.
Dresner Radio Mfg. Co.
General Radio Co.
Hammarlund Mfg. Co.

COILS, MAGNET:
Dudlo Mfg. Co.

COILS, RETARD:
Hammarlund Mfg. Co.

COILS, SHORT WAVE:
Aero Products Corp.
Dresner Radio Mfg. Co.
General Radio Co.
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COILS, TRANSFORMER:
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Allen-Bradley Co.
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Burt, A. G., Jr.
Carter Radio Co.
Condenser Corp. of America.
Deutschmann, Tobe Co.
Dongan Electric Mfg. Co.
Dubilier Condenser Mfg. Co.
Electrad, Inc.,
Fast, John E. & Co.
Flechtheim Co.
Muter, Leslie Co., Inc.
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Fast, John E. & Co.
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Dongan Electric Mfg. Co.
Dubilier condenser Mfg. Co.
Electrad, Inc.
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Fast, John E., & Co.
Flechtheim Co.
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Silver-Marshall, Inc.
United Scientific Laboratories

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ELIMINATORS, B BATTERY:
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National Co.
Radio Receptor Co.
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Radio Receptor Co.
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Deutschmann, Tobe Co.
Electrad, Inc.
Electro Motive Eng. Co.
Hardwick, Field, Inc.
International Resistance Co.
Lautz Mfg. Co.
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Eby, H. H., Co.

HINGES:
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JEWELL

When It Comes To Service

Pattern No. 199 A.C.-D.C. Set Analyzer

When it comes to service it is quite likely that you will have to look a long time before finding a service instrument that so thoroughly fills the requirements for radio service equipment as does the Jewell Pattern No. 199 A.C-D.C. Radio Set Analyzer.

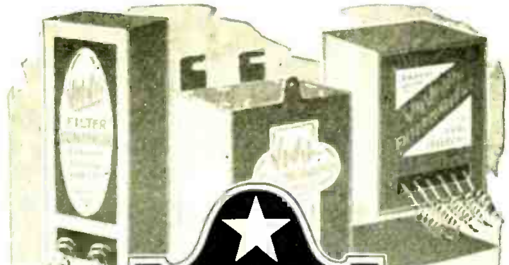
This set was designed to take care of the service needs of the many new A.C. operated radio sets as well as those of the battery operated type. Features that have made it a favorite with experienced radio service men are given below.

- Easily portable leather covered case with removable cover.
- Five prong plug with four prong adapter.
- Four reading A.C. Voltmeter 0-4-8-16 and 160 volts.
- Six reading D.C. Volt-milliammeter 0-7.5-75-300-600 volts and 0-15-150 milliamperes.
- Accurate tube test.
- Positive, silver contact push button switches for taking readings.
- New cathode voltage test.
- All ranges brought to binding posts for continuity tests.

These features are all described in descriptive circular No. 2002 which tells in detail all about this set analyzer. Write for a copy.

"28 Years Making Good Instruments"

Jewell Electrical Instrument Co.
1650 Walnut St., Chicago



DEXSTAR

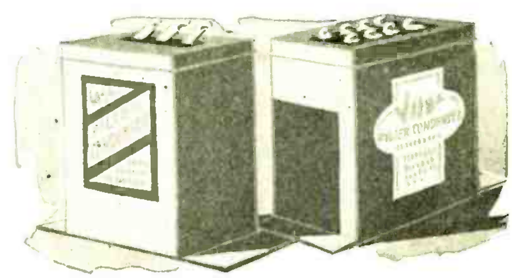
CONDENSER TISSUES

NO Radio set is any better than its weakest link, and the weakest link is very often a filter Condenser. No Condenser is any better than the thin strips of Insulating Tissue which separate the layers of metal foil. A pinhole or a speck of metal in the Condenser Tissue means a break down of the Condenser, with the entire set put out of commission.

DEXSTAR Condenser Paper is regarded by Radio experts as being the highest grade Insulating Tissue ever made—the freest from defects, the most uniform in quality, the most lasting under exacting and unusual requirements. DEXSTAR Condenser Tissue is the specialized product of a paper mill which has excelled in Tissue Paper production for three generations.

RADIO designers and builders should have the assurance that Condensers which they use are made with DEXSTAR Condenser Tissues. It is insurance against many radio troubles. The leading Condenser manufacturers are now using DEXSTAR Condenser Tissues exclusively.

C. H. DEXTER & SONS, INC.
Makers of Highest Grade Thin Papers
WINDSOR LOCKS, CONN.



INDUCTANCES, TRANSMITTING:
Aero Products, Inc.
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INSTRUMENTS, ELECTRICAL:
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General Radio Co.

OSCILLOSCOPE:
Burt, Dr. Rob't C.

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Electrad, Inc.
General Radio Co.
United Scientific Laboratories

RECEIVERS, ELECTRIC:
United Scientific Laboratories.

RECTIFIERS, DRY:
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Elkon, Inc.

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Lautz Mfg. Co.
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Radio Institute of America

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X-L Radio Laboratories.

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General Transformer Co.
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Ferranti, Ltd.
General Radio Co.
General Transformer Co.
Muter, Leslie, Co., Inc.
Samson Electric Co.
Silver-Marshall, Inc.
Thordarson Electric Mfg. Co.
Transformer Co. of America.
Victoreen Corp.
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General Transformer Co.
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Transformer Corp. of America.
Victoreen Corp.
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Silver-Marshall, Inc.
Thordarson Electric Mfg. Co.
Transformer Co. of America.
Victoreen Corp.
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Cunningham, E. T., Co.

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Jewell Elec. Inst. Co.
Westinghouse Elec. & Mfg. Co.
Weston Elec. Instrument Corp.

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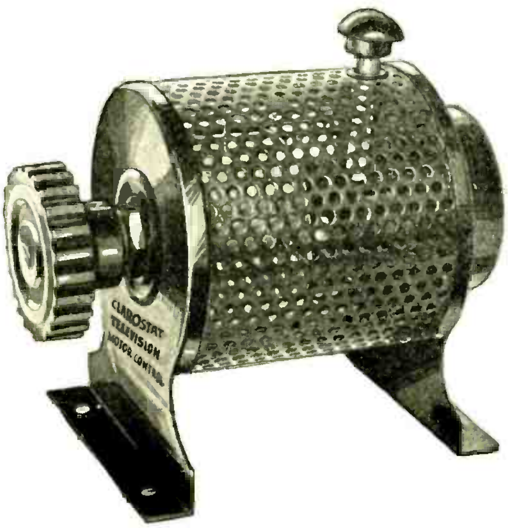
Announcing the

TELEVISION CLAROSTAT

GRANTED a good signal and a satisfactory kino-lamp or neon glow tube, the heart of successful television reception is the scanning disk. This member should have the proper arrangement of holes for the necessary "lines" of the television image being received, and it should be revolved at the ***proper speed*** and also in ***perfect step*** with the transmitter scanning disk.

The TELEVISION CLAROSTAT has been developed to serve both ***proper speed*** and ***perfect step*** functions. It provides a perfect speed control for the universal or the condenser motor, operating on A.C. or D.C., up to 1/8th horsepower, together with a phase-shifting push-button to bring the disk into step.

Note the neat, compact, practical appearance of this device. A special power type Clarostat of 80-watt rating is contained in the sturdy, ventilated iron casing with mounting feet. Connections are made to screw terminals, protected by removable end plate. Motor speed is controlled from dead stop to practically full speed, so that any small motor may be used if its rated speed is above that required for television purposes.



Practical television is only possible with stepless, adjustable resistance for scanning disk motor control. In combination with the STANDARD CLAROSTAT for controlling the voltage applied to the kinolamp for necessary contrast between lights and shadows, the TELEVISION CLAROSTAT spells television success.

There's a CLAROSTAT for Every Purpose

From the delicate grid leak function served by the GRID LEAK CLAROSTAT, to the grid bias and plate control functions of the —50 type power tube, served by the POWER CLAROSTAT, you will find a Clarostat available for every radio purpose. From the requirements of remote volume control, served by the TABLE TYPE CLAROSTAT, to the precise fixed resistance arrived at by actual trial as provided by the DUPLEX CLAROSTAT, you will find a Clarostat available for every radio purpose. From a resistance range of a few ohms to a resistance range of many megohms, you will find a Clarostat available for every radio purpose. Think of ***CLAROSTAT***, and you have the entire resistance field in mind.

Write for data regarding the Television Clarostat as well as other Clarostat products. Also, if you are the radio engineer or production manager of a radio company, ask to be placed on our mailing list to receive our technical data bulletin, issued every so often to help you solve your resistance problems.

RADIO MANUFACTURERS ASSOCIATION RMA MEMBER

CLAROSTAT MANUFACTURING COMPANY, INC.

Specialists in Variable Resistors

285-7 North Sixth Street : : Brooklyn, N. Y.

CLAROSTAT

Williams Press, Inc., New York — Albany

QUALITY DONGAN PRODUCTS

New and Improved Power Amplifier

TRANSFORMER

for use with

UX 250 Tubes

This newest Dongan Transformer is designed for full wave rectification using two UX 281 tubes to supply B and C power to receiver and power for two UX 250 tubes.

There are two low voltage windings, one for 226 tubes and the other for 227 tubes so that you can build a power amplifier for either the radio receiver or for phonograph pick-up.

With No. 8529 Transformer use one No. 6551 double choke in filter circuit. Approximate D.C. output from filter, 525 V 130 mils. Secondary voltages 650-650V, 170 mils. 7½V 2½ amp. C.T. 7½V 2½ amp. C.T. 2½V 1¾ A C.T. 1½V 4.2 A.

No. 8529—$16.50

Approved Parts for UX 250 Tubes

No. 6551 Double Choke. May be used where current does not exceed 250 mils. . $15.00

No. D-600 Power Amplifier Condenser Unit has been designed for use with the CX 281 rectifier tubes, and CX 210 or 250 power tubes. Having a working voltage of 1000 volts, and mounted in crystal lacquered steel cases, they will be found unsurpassed for reliability and stability. Unit contains sections of 2-2-4 Mfd. $16.50

No. D-307 contains condensers of 4-2-1-1 Mfd. sections with a working voltage of 400 volts for use in connection with D-600. . . . . $10.00

No. 1177 A splendid straight power amplifier output transformer designed for use with UX 250 P. A. Tube. $12.00

No. 1176 Similar to No. 1177 but of the Push Pull Type. $12.00

Set Manufacturers and Custom Set Builders

You are cordially requested to take advantage of Dongan's very complete engineering facilities. All approved parts are in production now. Prompt attention will be given to any special design in which you are interested.

DONGAN ELECTRIC MANUFACTURING COMPANY
2995-3001 Franklin St.,
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TRANSFORMERS of MERIT for FIFTEEN YEARS

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