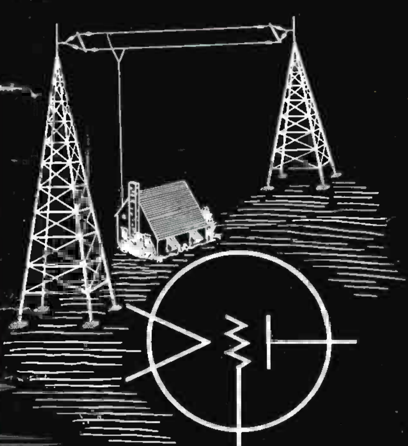
APRIL, 1933

Radio Engineering



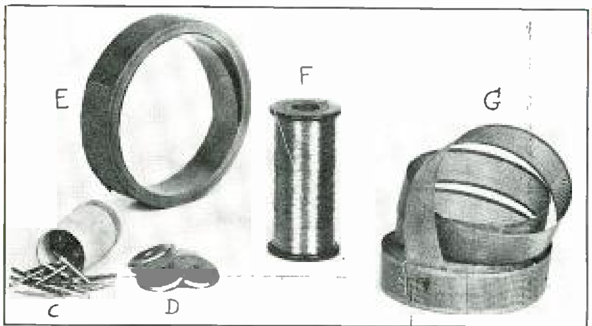
IN THIS ISSUE

THIRTEENTH YEAR OF SERVICE

The Journal of the Radio and Allied Industries

SVEA METAL

—used in more than two million of the finest tubes in service today.



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DRASTIC REDUCTION in manufacturing costs is assured by use of SVEA METAL. Leading tube manufacturers are using SVEA METAL to save approximately 50% of the cost of metal parts. SVEA METAL is available in filament ribbon, strips for plates, seamless tubing, support wire, wire for mesh, ballast wire and pertruded strip and in other desired forms.

Type 56 tube containing SVEA METAL parts.

Your request for additional information will have instant attention. Without obligation, our engineers will consult with you concerning use of SVEA METAL. C D E F G, in illustration above, show some forms in which this metal is available.

SVEA METAL

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For more than a quarter of a century suppliers of high grade metals to the foremost electrical equipment manufacturers.

Now . . . Hygrade Sylvania Announces

A Complete Electronics Department

■ full production facilities ■ leading electronics engineers

FOR more than 30 years, the Hygrade Sylvania Corporation, and its predecessors have supplied the electric light industry with standard lamps of highest quality and uniformity. And since earliest days of radio, this company has pioneered in the development of radio tubes.

Now, with the formation of its new Electronics Department, the Hygrade Sylvania Corporation expands to meet the newer demands of electronics. In addition to lamp bulbs and radio set tubes, this company now produces radio transmitters, transmitter tubes, special receivers, industrial tubes and custom-built electronic devices of every specialized nature.

A technical staff composed of William J. Barkley, General Manager; D. F. Replogle, Chief Engineer; Victor O. Allen, Assistant Chief Engineer; and 22 other electronics engineers and executives, all formerly associated with the DeForest Radio Company; a complete research laboratory fully equipped for any purpose required in the electronic art; and ample production facilities insured by a new fully equipped plant where all electronics work will be coordinated—all of these factors add to the Hygrade Sylvania resources the same skill and knowledge responsible for today's most important commercial applications of electronics.

The Hygrade Sylvania Corporation invites you to avail yourself of its technical experience, and vast production and research facilities. For consultations, write to:

THE HYGRADE SYLVANIA CORPORATION

Electronics Division

64 Lakeview Avenue **Clifton, New Jersey**

RADIO ENGINEERING

Reg. U. S. Patent Office

MEMBER AUDIT BUREAU OF CIRCULATIONS

Western Editor ULMER G. TURNER | *Editor* DONALD MCNICOL | *Managing Editor* F. WALEN

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Departments

SYLVANIA AT FORTY-SECOND STREET

THE Sylvania Foresters played a conspicuous part in making Emporium, Pennsylvania, famous. To the world at large Emporium seemed a fitting rendezvous for Foresters. But, in these stirring times events move rapidly. If one is to serve the world, whether it is with diamond rings or vacuum tubes, is not the most strategic place to have headquarters the Cross Roads of the World?

Possibly some such reasoning prompted the Hygrade Sylvania Corporation to descend upon 42nd Street, New York, where on one of the high-up floors of the highest building at 42d Street and Fifth Avenue, the company has concentrated its executive staff and executive offices.

The market developing for vacuum tubes: thermionic or electronic, for radio and various commercial and industrial uses, is likely to be of such volume in the days ahead that it behooves manufacturers who desire to participate in it to be of the up and coming school.

Congratulations to Sylvania.

BRYAN S. DAVIS
President

JAS. A. WALKER
Secretary

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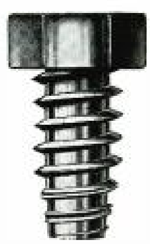
A 62% reduction

with the help of Self-tapping Screws



Hex Head

now costs no more

For certain radio assemblies, hexagon head screws permit greater assembly speed, and eliminate difficulties caused when screw-driver blades slip out of slotted head screws. This brought the development of Hex Head Hardened Self-tapping Cap Screws. These Screws were formerly made to special order, but now they are available at no higher prices than slotted head Self-tapping Screws, in a full range of diameters and lengths to meet practically any need. Free samples for trial, at your request.

In producing fine radio receivers to sell at a fraction of the 1927 price, manufacturers couldn't employ old-fashioned, slow and costly methods of making assemblies. Fastenings had to be made faster, cheaper, and stronger. So in plants, large and small, Parker-Kalon Hardened Self-tapping Screws have been tested and adopted to replace the common devices—machine screws, rivets, bolts and nuts—that require costly and unhandy operations. Inspect most any radio, today, and you'll find that the maker has used Self-tapping Screws to get costs and prices down.

Many makers save 30%

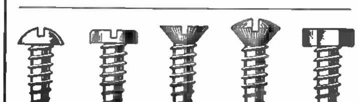
Self-tapping Screws reduced assembly costs 31% for Wurlitzer, 15% for Zenith, from 20 to 30% for Crosley, 22% on Clarion Radios. Saved thousands of dollars for Philco, Atwater-Kent, R. C. A.-Victor, Stromberg-Carlson and substantial amounts for even the smallest manufacturers. Because Self-tapping Screws make stronger fastenings, proved by unbiased tests, they also improve quality.

Try these Screws. They'll save time, labor and money for you, too. Use the coupon for free "Money-Saver Test Bag" of samples with recommendations of our Fastenings Specialists.

Where and How to use them

Type "Z" Hardened Self-tapping Sheet Metal Screws

For making fastenings to sheet metal up to 6 ga., aluminum, die castings, Bakelite, etc. Turn Screw into drilled, pierced or molded hole. It forms a thread in the material as it turns in. Can be removed and replaced. Available in a full range of diameters and lengths, and 5 styles of heads as shown below.



PARKER-KALON *Hardened* Self-tapping Screws

PAT. IN U. S. AND FOREIGN COUNTRIES

PARKER-KALON CORPORATION, DEPT. L, 190-198 VARICK STREET, NEW YORK, N. Y.

Tell me whether assemblies described on attached sheet can be made cheaper with Self-tapping Screws. I'll make a "Money-Saver Test" if you send samples and recommendations—Free.

Name and Title ....

Company ....

Address ....

Editorial

APRIL, 1933

PHOTOCELLS FOR 3.2

WE have had much discussion recently regarding the creation and development of markets for radio tubes, phototubes and associated equipment, in fields other than the radio industry. In the development of these so-called electronic fields general conditions have made for difficulty in convincing industry in general to adopt electronic devices in sufficient quantity to represent a worthwhile market for radio manufacturers. However, it appears to us that those companies which have been spending money, time, and effort in the pioneering of this industrial field, should at this time investigate thoroughly the possibilities of the use of electronic control and testing devices in the brewing industry.

For the first time in years we now have an industry which is faced with the necessity of instituting a vast program of building and rehabilitation. Large funds are available for the installation of new equipment.

Application of electronic devices for the test of color, flow, alcoholic content, etc., should find an acceptance within the brewing industry, and at a time when there is an availability of funds and an immediate necessity for expending them for new equipment.

▲

THE ELECTRON TUBE

IN view of the widespread use that is made today of instrumentalities based upon the generation of and control of streams of electrons, it is interesting to recall that it is just thirty years since Richardson's theorem for electron emission was worked out.

The philosophers of two hundred years ago were mired completely in their explorations when it was learned that an insulated sphere charged with positive electricity retained its charge as well when heated to a dull red as when the sphere was cold; while a sphere charged with negative electricity, when hot gave up its charge as quickly as applied, retaining a charge indefinitely when a cold sphere was employed.

J. J. Thomson's discovery of the electron in 1898, was followed four years later by Richardson's discovery of the "work function" of electron escape from hot metals. Shortly thereafter constants were evaluated and formulas set up which have continued to the present time as the engineering bases of thermionic emission.

A year later (1904) A. J. Fleming conceived the principle of the two-electrode valve tube, and on the heels of that came Lee de Forest's two-electrode tube, followed in a year or two by a tube containing the third electrode, the grid.

Even in the recorded history of science thirty years are the measure of but a short period of time. A century or two hence no doubt physicists will marvel at the swift advance in applied knowledge evidenced in the evolution of the tube from the two-electrode valve of 1905 to the multi-element, multi-purpose product of 1933. There are those who suspect that were it not for the economics of the situation, the laboratories would be gleefully announcing tubes containing a maze of inter-related elements as bewildering as the ways of modern finance, debts and tariffs.

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SPONSORED RADIO PROGRAMS

MAJOR W. E. G. MURRAY, public relations counsel for the B. B. C., London, is in Canada coaching the Canadian radio broadcast authorities in setting up a government sponsored system. In an interview in New York, Major Murray stated in part: "Broadcasting does not cost money in England." In the next breath he said: "In England the government takes its toll of a million pounds and then a tax of ten per cent for the post office department which collects the tax."

Much as any commercial sponsor publicity disturbs some Americans, and much as some sponsors take advantage of good nature on the part of radio listeners, in the United States we should soon hear the drums at the mention of another tax.

Donald McNicol
Editor

A chronological history of electrical communication —telegraph, telephone and radio

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This history was begun in the January, 1932, issue of RADIO ENGINEERING, and will be continued in successive monthly issues. The history is authoritative and will record all important dates, discoveries, inventions, necrology and statistics, with numerous contemporary chronological tie-in references to events in associated scientific developments. The entries will be carried along to our times.

▼

Part XVI

1882 (Continued)

(604) The Lalande and Chaperon caustic soda primary cell invented, employing as electrodes amalgamated zinc and red granulated copper oxide. (The Edison-Lalande cell of a later date was a modification of this battery.)

(605) Georges Le Clanche dies. (Born France 1839.)

(606) The Central and South America Cable Company has given contracts in England for 3,082 nautical miles of submarine cable. Lines will connect the United States with various South American countries.

(607) A central electric station is installed by the Edison Company, at Roselle Park, N. J. This installation was made several weeks prior to the opening of the Pearl Street, New York, station. The plant had a capacity of 1,000 16-c.p. lamps, operated three in series on a 330 volt circuit. Miller F. Moore, M.E., of Roselle Park, built the engine, which operated at 350 r.p.m.

(608) People's Telephone Company organized to commercialize Drawbaugh's inventions, claimed in 1869, 1871 and 1874.

(609) James Munson, of New York, applies for a patent covering a typewriter telegraph system, using selective methods.

(610) M. Menuisier, in France, proposes that a transatlantic cable be laid with taps made to the cable conductor every ninety miles, the taps being carried to the surface and there terminated at the top of buoys so that ships desiring to communicate with Europe or America may do so by attaching ships' instruments to the buoyed cable.

(611) Professor Guthrie shows that an incandescent lamp platinum filament discharges negative electricity.

(612) The Edison Company installs a central station on Pearl Street, New York, September 4. Three "Jumbo" dynamos are employed. (Later, nine dynamos were used in this station.)

(613) An Edison electric light central station is placed in service at Appleton, Wisconsin, October 15. Water power is used to drive the generator. (This generator gave seventeen years' service.)

(614) Charles E. Scribner, in the United States, procures a patent No. 266,319, October 24, providing a clearing-out signal in subscribers lines. Patent applied for November 3, 1880.)

(615) Edison's three-wire electric light patent (No. 274,290) applied for, November 27. This method of distribution was independently invented by Dr. John Hopkinson, in England, about the same time.

(616) F. B. Badt, who arrived in the United States from Germany in 1881, is appointed in the service of the United States Electric Lighting Company, and sent to Chicago as representative.

(617) Charles J. Van Depoele, a manufacturer of art furniture, in Detroit, Michigan, experiments with electric traction. A short experimental electric railroad is operated in Chicago, using an overhead trolley.

(618) The Edgar Thompson Steel Company, Bessemer, Penna., installs the first steel plant electric system.

(619) Underground cables five miles long are tried out experimentally for telephone purposes, at Attleboro, Mass.

(620) During the year Thomas A. Edison applied for 141 patents.

(621) Professor Dolbear is awarded a United States patent for a system of signaling without wires.

(622) A. G. Bell continues investigations begun in 1880 by Trowbridge in connection with conduction signaling through the earth.

(623) The Association of Railway Telegraph Superintendents, organized.

(624) Walter P. Phillips succeeds Gerrit Smith as electrician of the American Rapid Telegraph Company. On these lines an automatic system invented by Foote and Randall had been used, but is replaced by the Morse system.

(625) Theodore F. Taylor introduces the Leggo high speed automatic system on the lines of the Postal Telegraph-Cable Company, between New York and Chicago.

(626) Plans are under way for the absorption of the American Rapid Telegraph Company by the Western Union Telegraph Company.

(627) S. P. Freir, S. H. Strudwick and William Finn arrive in the United States from London to introduce the Wheatstone automatic system on the lines of the Western Union Telegraph Company.

(628) Central and South American Cable Company's lines opened to the public.

(629) At Allegheny, Penna., Dr. Joseph R. Finney, of Pittsburgh, exhibits a trolley system of electric railway.

(630) Sir William Siemens, in England, proposes the Watt as the unit of electric power—the voltampere. Also, the Joule as the unit of work—heat or energy.

(631) The National Telephone Exchange Association holds a convention in Boston.

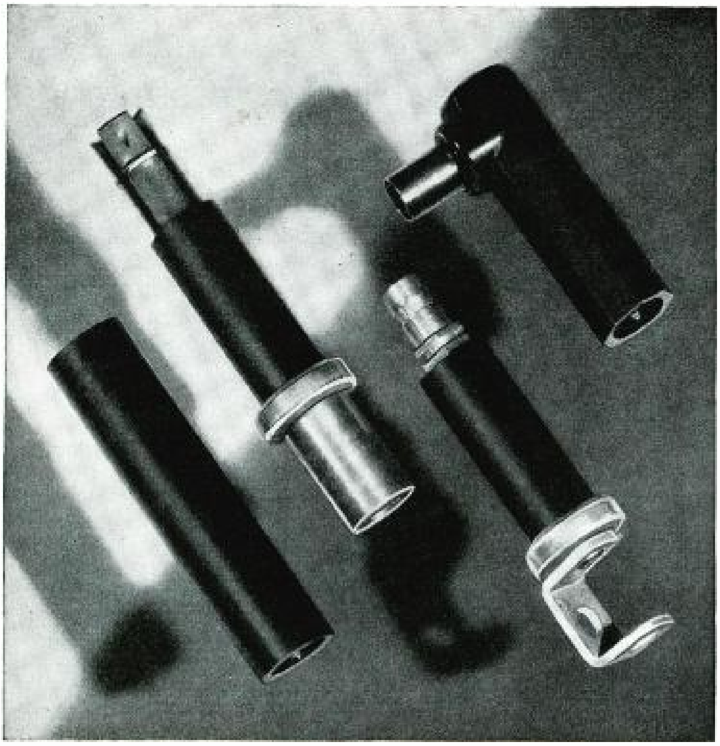
(632) A combination of electric lighting companies is made in the United States, including The Edison Company, Gramme Electrical Company, American Electric Company, Brush Electric Company, Fuller Electrical Company, United States Electric Lighting Company, Weston Electric Lighting Company and the Jablochkoff Electric Lighting Company.

1883 (633) A new insulating material is brought out in England, called "insulite," composed of wood, sawdust, cotton waste, paper pulp and other fibrous materials.

(634) John Pender, president of the Direct United States Cable Company, comes to New York, in response to reports that Mr. Garrett of the Baltimore and Ohio Telegraph Company, and Mr. Bennett of the New York Herald, were agitating opposition to continuance of Western Union control of the American end of all transatlantic cable traffic.

(635) Francois Van Rysselberghe, in Belgium, invents a method of simultaneous telegraphy and telephony over a common conducting wire. On May 17, a demonstration of the system is made between Paris, France, and Brussels, Belgium.

(To be continued)



Radio Tubes

IT is our purpose to discuss herein, with entire frankness, the present situation in the tube manufacturing field. It is our belief that a frank airing of what is being discussed throughout the industry will have a salutary effect. After all, the problems which are being faced today, while severe, are no more than a phase generated by general conditions. These problems, however, must be solved eventually and we believe that now is the time to start.

The tube manufacturer carries an enormous burden. He is expected to design new tubes promptly, efficiently and successfully—tubes which in large part furnish the "sales feature" of the receivers offered to the public. Upon his shoulders rests the responsibility of maintaining enormous laboratory and experimental facilities, a large staff of competent engineers—engineers who can and do work out many of the scores of applications of the different tube types.

The design requirements of the receiver manufacturers have led to a multiplicity of types, over-lapping and duplicating in function, with an additional burden upon the laboratories and engineering departments of the tube manufacturer. The replacement market requires tubes for receivers now in the last stages of senile decay—with the tube manufacturer expected to continually take care of this small volume, obsolete type market WITH STANDARD BRANDS.

How about discontinuing the standard brand service on these obsolete types? The tube manufacturers have spent millions of dollars in publicity to establish standard brand names. Just so long as a portion of the public can re-equip "Model T" receivers with STANDARD brand tubes, so much longer will it postpone the purchase of modern receivers. We believe that the removal of the standard brand tube backing will automatically stimulate new receiver sales.

During the boom years, with tube manufacturers springing up all over the country until their number approximated 200 at one time, a situation was created which was bound to produce its problems of over-production and competitive fallacies. In the struggle for existence during the past three years, prices have been ground down to a point where, in many cases, the manufacturer has received less for a tube than it cost him to manufacture it. In order to meet the competitive situation, questionable trade practices have developed.

The distributing trade has been given liberal discounts. In many cases this liberal discount has been used merely as a means to cut the list price. In meeting price competition, some manufacturers have resorted to the back-door sale of seconds. It is reported that some of the smaller set manufacturers, purchasing tubes in large quantities and at liberal discounts, have in turn disposed of these to dealers at prices far below that which the recognized tube distributors pay. Naturally, the field of tube manufacturing is a highly competitive one. It should not be allowed, however, to generate into a competition as to who can sustain the largest loss on the greatest volume.

Of course, the buyer of tubes is going to take advantage of this situation. Nor can one blame him—if he is allowed by the tube manufacturer to conduct a sort of private auction on the basis of the discount which he is receiving, and finally knock down the order to the last additional 5 per cent discount vender. If this is allowed to take place on standard brands, the manufacturers must assume a large part of the burden of responsibility.

None of us can afford to forget that the standard brand of tubes (and receivers as well) is one of the greatest assets of the radio industry. Whenever we "gyp" a standard brand we are handicapping the research and development facilities upon which the industry is dependent, in large part, for its future progress and livelihood.

As this issue goes to press, tube developments are following one upon the other with great frequency—developments which are of great importance to the industry. A lot of the bad spots are being cleaned up. Mergers, the addition of personnel and the expansion of manufacturing facilities are taking place. It appears that the problems confronting the tube manufacturers are being approached with a sanity of purpose which we believe is already producing favorable results.

The centering of responsibility among a comparatively few units, is bound to make for a greater degree of stability, a continuance of research and engineering advancements and a sustained progress based upon sound forward-looking policies.

RADIO TUBE MANUFACTURING EXECUTIVES ADDRESS READERS OF RADIO ENGINEERING

RAYTHEON SERVES RADIO INDUSTRY

By D. T. Schultz, Treasurer

RECENTLY the National Carbon Company arranged for the Raytheon Production Corporation to take over the sale of Raytheon four-pillar radio tubes. The Raytheon organization is a pioneer in the radio tube industry and was responsible, among other things, for the development of the famous BH tube which made possible the early all-electric radio receivers.

The Raytheon organization developed the four-pillar radio tube which is an outstanding product in the industry. The same tube manufacturing personnel responsible for these achievements will continue to produce Raytheon tubes. Also, the engineering and research activities for which Raytheon is noted will be carried on on an extended scale.

The management of Raytheon is fully aware of the difficulties of the times in all manufacturing lines, but no one doubts that among the industries radio is bound to have a consistent increase in expansion. It is the determination of Raytheon to play an important part in that expansion, and to continue to serve the radio industry.

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RADIO THE MOST DYNAMIC DEVELOPMENT OF OUR TIME

By H. R. Peters
President, National Union Radio Corporation

SEVERE suffering has been the lot of radio in company with other major industries during the period of stress we have been enduring and which, I hope, is nearing an end. While radio, like the automobile, has come to be almost a necessity in our daily lives, we can do without it. Many people under hardship simply cannot afford to maintain radio sets. While accurate statistics on inoperative sets are not available, I imagine if the truth were known the number would be surprisingly high. I hope some day not far distant these radios will again become operative. There is no entertainment more enjoyable nor more inexpensive than radio.

Within the industry, most of us have deplored price cutting which has deepened with the depression. The steady downward trend of prices has developed into an actual menace to the industry, margins of profit having disappeared months ago. We recognize the fact that high prices of 1928-29 could not last. In spite of generally poor quality tubes in those days, the newness of the industry and the tremendous demand which sprang up almost overnight enabled many manufacturers to make a profit. Since then overhead, production cost and wages have been cut. Standards of quality however have risen and for several definite reasons.

First, because of the necessity to meet standards of leading tubes or fail utterly to get business. Second, because set development of the last three years has thrown the burden more and more on to the tubes. The superheterodyne, the avc, automobile sets and recently, universal a-c.—d-c. sets require definite tube improvements. The newest tubes for the universal sets are so far advanced from the 224 that there is hardly a basis of comparison. New purposes demanded improved construction, low hum and noise level, and narrow limits, factors which were not conceivable in early tube engineering. In spite of the difficulties of tube manufacture great strides have been made; efficiency of operation has become necessary to life. Such improvements are assuring continued improvement and point to a brilliant future for radio.

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VACUUM TUBES FOR RADIO

By B. G. Erskine
President, Hygrade Sylvania Corporation

TUBES continue to occupy an increasingly important place in the radio industry. Research and development work by the tube manufacturer have made possible many of the improvements in design and performance now evident.

We are cautioning our jobbers and dealers, who handle replacement tubes, not to over-stock at this time. We are set up to give the maximum service on orders, and many of our jobbers are in the same position. In general, the future for replacements sales is bright for the manufacturer who plays fair with his outlets.

Unquestionably, the industry has arrived at the long-desired point where many homes are purchasing a second, and even a third set. The use of radio in hotels, offices and public places is greater than ever before.

Radio is playing an increasingly larger part in the life of the American home. President Roosevelt's calm and masterful explanation of the national situation by radio serves but to emphasize again the advantages which radio has over other means of disseminating information.

As evidence of our own optimism regarding the future of general business, we have made a very substantial investment in the establishing of a complete Electronics Department with a modern plant at Clifton, N. J., where we will manufacture power tubes, photocells, and a complete line of custom-built transmitters and receivers, as well as any products of the radio art which industry may require.

RADIO INDUSTRY BOUND TO ADVANCE

By G. K. Throckmorton
Vice-President, RCA Radiotron Co., Inc.

THE present great number of tube types are the result of the variety of sources of primary power available, each requiring tubes of a different voltage, and of the need of the designing engineer for specialized types about which to build today's improved receivers.

We must have clearly in mind that an engineer, in designing a radio set, is limited by the capabilities and design features of the tubes available to him. Ten years ago one type of tube was used for many different purposes. With the development of the superheterodyne circuit and the refinement in detector circuits, automatic volume control circuits, etc., the need for specialized types of tubes for each type of service in a given circuit became apparent.

This multiplication of types has resulted in many unnecessary types which are only minor variants from previous types. But this is probably a natural condition resulting from the intensive competitive struggle. Out of all this forced development will come better radio receivers and undoubtedly a better balance between receiver design and tube design.

Development and progress in this great radio industry are bound to go forward.

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COOPERATION OF ENTIRE INDUSTRY MUST BE EXERCISED

By George Lewis
Vice-President, Arcturus Radio Tube Co.

IN the constant quest of the radio engineering fraternity for refinements and developments many new tubes and also many new sets have been developed in recent months. Primarily the motive actuating these developments was to provide the jobber and dealer with "something new" which he could talk about and sell.

From the engineer's point of view this was fine. From the manufacturer's point of view this presented many problems. From the jobbers' and dealers' point of view it multiplies difficulties many times.

The question is asked today by manufacturers, jobbers, dealers and servicemen whether a practice is wise that encourages price cutting of preceding models; that complicates stocks of sets and tubes; that precludes the possibility of retailers carrying complete stocks, to say nothing of the large burdens placed on manufacturers of both tubes and sets in charging off obsolete tools and equipment.

GEORGE LEWIS,
Vice-President,
Arcturus Radio Tube Company.

B. G. ERSKINE,
President,
Hygrade-Sylvania Corporation.

H. R. PETERS,
President,
National Union Radio Corporation.

E. T. CUNNINGHAM,
President,
RCA Radiotron Company, Inc.

D. T. SCHULTZ,
Treasurer,
National Carbon Company.

G. K. THROCKMORTON,
Vice-President,
RCA Radiotron Company, Inc.

NEW MULTIPLE PURPOSE TUBES

WHILE the widespread availability of 110 volts a-c. commercial power has enabled radio manufacturers to standardize production on a considerable quantity of the radio receivers used in homes, radio penetration into all sorts of places, out of the way, remote from commercial power sources, and in mobile vehicles, has required adapting receivers to a variety of voltages.

Radio manufacturing thus is not subject to standardization in the sense that household pressing irons, refrigerators or electric fans have been standardized.

The elements of radio receivers which must vary in design in order to provide that receivers may be used in a city apartment, a remote ranch house, a camp in the bush, an automobile, a motor boat or an airplane, are the vacuum tubes.

Voltages available for general purposes used also for radio receivers are 110 a-c. and 110 d-c. Commercial storage battery units are common in 6-volt and 2-volt ratings. Dry batteries may be of 2-volts, or multiples—4, 6 and so on.

Tube functions include detection, rectification, amplification, oscillation and volume control. Originally the practice was to use a separate tube for each function. A demand developing for receivers occupying small space furthered the idea of designing tubes capable of performing two or more of the required functions in order to reduce the number of tubes necessary to produce receivers having distance range, close selectivity, fidelity of reproduction, and good volume.

The employment of multiple function tubes makes for complexity of receiver circuit design, receivers becoming rather complicated, scientific devices. This is not unsatisfactory to the radio manufacturing industry as it tends to lift the business from the amateurish plane on which it started.

In the following is reviewed what the tube manufacturers are doing to meet the market as it exists at the present time.

Tube types may be distinguished by the purpose or purposes they are to serve, by the method of heating the filament and by the number of plate and grid elements contained in the glass envelope. Variation in these particulars has given to the industry a total of more than one hundred types.

An R-F. Amplifier Pentode

Noteworthy among the tube products of the Hygrade-Sylvania Corporation is the Type 15, two-volt r-f. pentode for battery operation and especially designed for use as detector-oscillator. The heater current is .220 ampere. A unique feature is that this is a heater type tube with a low enough current consumption to permit its operation on dry cells; actually but 20 per cent of the amount taken by the 6.3 volt cathode used in tube types 36, 37 and 44. Important applications of the 15 are: combined first detector-oscillator tube in superheterodyne receivers where an oscillator coupler coil is placed between cathode and ground. As second detector where pentode characteristics and self-bias may be used to extend detector operating range, permitting increased output voltages to be obtained. Also, in any circuit where self-bias or a separate cathode connection is of importance.

Duplex Diode Triode

Sylvania has a duplex diode triode, type 85, which is suitable for use as a diode detector and a triode audio amplifier. In addition automatic volume control can be obtained from the diode. It has a 6.3 volt, .3 ampere heater. Sylvania has been successful in making this a tube having fast heating time.

The Hygrade-Sylvania Corporation has a complete line of vacuum tubes for all radio purposes. The company is rapidly expanding its manufacturing facilities to include transmitting tubes, photocells, and tubes for industrial purposes.

New Raytheon 2A6, 2B7 and 6B7

It will be recalled that the 75 type tube is a high-mu variety of the 85 type. The 75 is a duplex diode triode of the 6.3 volt family, for a-c. or d-c. heater supply. The new 2A6 is a twin diode-high-mu triode, the same as the 75 except that the heater is designed for 0.8 ampere at 2.5 volts. It is intended for manufacturers who are building series of 2.5 volt sets.

The Raytheon 2B7 and 6B7 are duplex diode pentodes for high frequency amplification with the diodes used for rectification, avc, etc., also employing the diodes as rectifiers and the pentode section as an audio amplifier.

National Union 6F7

The National Union Radio Corporation has just announced the 6F7, consisting of a small triode and a remote cut-off pentode, both in one envelope. The primary purpose of the 6F7 is to serve both as the oscillator and the first detector in a superheterodyne receiver. The triode elements and the pentode elements are separate except for a common cathode sleeve. The active emitting cathode area for the triode is not the same as the emitting area of the pentode. A 6.3 volt, .3 ampere filament is employed to heat the cathode.

The pentode portion of the 6F7 contains a remote cut-off control grid, permitting the output of the first detector unit to be volume controlled. The triode portion, while small, is a satisfactory oscillator tube. Applications may be of the same type as employed with separate oscillator and first detector tubes. As the triode has its cathode connected to the cathode of the pentode, it will prove convenient to return the cathode circuit through a portion of the oscillator to ground, introducing into the pentode some of the oscillator voltage and thereby effecting the desired mixing.

FOR 1933 RADIO RECEIVERS

Duplex Diode Pentode

As announced by RCA Radiotron, Inc., and E. T. Cunningham, Inc., the 2B7 is a uni-potential tube with a-c. heater, a-c., or d-c., 2.5 volts (Type 6B7 for 6.3 volts.)

The 2B7 performs simultaneously the functions of automatic volume control, detection and amplification. For detection the diodes may be utilized in a full-wave circuit or in a half-wave circuit. In the latter case one plate only or the two plates in parallel may be used. The use of the half-wave arrangement will provide approximately twice the rectified voltage as compared with the full-wave arrangement. For automatic volume control a rectified voltage which is dependent on the r-f. or i-f. carrier is usually employed. This voltage is used to regulate the gain of the r-f. and/or i-f. amplifier stages so as to maintain essentially constant carrier input to the audio detector. The regulation of amplifier gain by means of the rectified voltage may be accomplished by a number of methods, differing chiefly in the method of applying the voltage to the various electrodes of the amplifier tubes. The regulating voltage may be applied to the control grids of the amplifier tubes; or, the voltage may, depending upon the requirements of the set designer, be applied to other electrodes—suppressor, plate and/or screen of an r-f. pentode.

The complex structure of the 2B7 permits of obtaining avc voltage in a number of ways. In one case the required voltage is obtained from the detector circuit by utilizing the voltage drop caused by the rectified current flowing through a resistor in the detector circuit. In another case the required voltage is obtained by utilizing one diode for the single purpose of avc. This method is of particular interest since it confines the sensitivity and time delay function to the avc circuit. Time delay is, of course, determined by the use of a resistance and capacity combination having the desired time constant. Sensitivity control action is determined by applying a negative voltage to the avc diode plate of such value as to accomplish the desired reduction; or, the pentode may be used as a d-c. amplifier to furnish the regulating voltage.

The Pentagrid Converter

Another new RCA Radiotron-Cunningham product is the type 2A7 for 2.5 volts (6A7 for 6.3 volts). This is a multi-electrode tube designed to perform simultaneously the function of a mixer tube and of an oscillator in superheterodyne circuits. The tube 6A7 is especially fitted for receivers of the automobile type and in receivers in which the heaters are operated in series from the power line.

The action of this tube in converting a r-f. to an i-f. depends on independent control of the electron stream (1) by three electrodes (including the cathode) connected in an oscillator circuit and (2) by a fourth electrode (a grid) to which the radio input is applied. As a result of this arrangement it is apparent that the simultaneous control by these two groups of electrodes will produce variations in the electron stream between cathode and plate. Since the electron stream is the only connecting link between these two control factors this converter system may be said to be electron coupled.

A Push-Pull Output Unit

In the type 79 tube we have the heretofore two tubes of the push-pull arrangement in one envelope. The tube is made by RCA Radiotron-Cunningham, Sylvania and Arcturus. This is a class B tube with two sets of triode elements designed for output service. It delivers a power output far in excess of any previously available tube comparable with it in size (ST bulb with top-cap and 6-prong socket). Heater rating is 6.3 volts, .6 ampere, power output up to 5.5 watts, with 180 volts on plate. Moderate increases in plate volts yield rapid increase in power output. Each triode element is of double grid construction, and two grids connected together. No grid bias is required and distortion is quite low due to careful design.

The Hexode Tube

In this issue of Radio Engineering will be found an important paper by H. A. Wheeler, dealing with the design and utility of the new Hexode tube.

Hum in Radio Tubes

Since the introduction of the 36, 37 and 38 tubes in the summer of 1931, there has prevailed the idea that these tubes are suitable for operation only with d-c. applied to the heater—a single coiled filament concentrically located in the cathode sleeve, without provision for hum cancellation.

The Arcturus Radio Tube Co. successfully met this situation by employing a return helix type of heater in which provision is made for hum reduction by causing the current to enter and leave in opposite directions, through two helically wound wires having a common axis. These helices have the same diameter and pitch and the turns are interlaced. The heater is applicable to 2.5 and 6.3 volt tubes.

Materials for Tube Elements

It is interesting to learn that there have been produced about one million and a half vacuum tubes in which the metal elements are made of Svea metal. The Swedish Iron and Steel Co., (Radio Engineering, September, 1932, page 18) has been successful in developing a metal used for tube elements.

To the materials lava and Crolite there has been added a new insulating product known as Calit for use as a separator in tubes requiring insulation elements.

The HEXODE vacuum tube†

Emission valve mechanism makes practicable oscillation, modulation, high amplification and grid-bias control of amplification.

By Harold A. Wheeler*

WITHIN the past three years a great deal of attention has been paid to the special problems of the superheterodyne receiver, partly with a view to improving the performance and partly with a view to decreasing the number of tubes required. Many attempts were made to combine the oscillator and the modulator (or first detector) in one tube. There was no fundamental reason why this could not be done, but it was found to be difficult. Even when two separate tubes were used, the modulator conversion gain was much lower than the gain of an amplifier stage using the same type of tube. By conversion gain is meant the gain from the signal-frequency input to the intermediate-frequency output of the modulator stage, measured from grid to grid. The conversion gain was especially low when gradual-cutoff tubes came to be used as modulators to permit the use of a grid bias for controlling the conversion gain. These tubes were given a gradual cutoff of plate current with increasing grid bias, whereas a sharp cutoff is beneficial when high gain is desired in a modulator.

As a result of a large number of experiments, a number of circuits have been developed, which use only one tube to perform both functions of oscillator and modulator. Some of these circuits have been extensively used in commercial broadcast receivers. The problem was attacked from two points of view. First, circuits were devised which made the best use of tubes then commercially available, such as the type 24 tetrode, and the types 57 and 58 pentodes. Secondly, a special hexode tube has been developed which is giving even better performance as oscillator-modulator than the two tubes previously employed for the purpose. The new hexode is called an emission valve modulator, by way of describing the mechanism of modulation in this tube.

All of the circuits to be described are, in some respects, similar to the separate oscillator and modulator circuits shown in Fig. 1. At the time this work was started, a type 24 tetrode was commonly used as modulator and a type 27 triode as oscillator. The former is well adapted for the function of modulator, because it has a fairly sharp cutoff. The presence of the screen makes the tube capable of giving fairly high conversion gain. The triode is a satisfactory oscillator.

In the circuit of Fig. 1 the oscillator voltage is applied to the cathode of the modulator tube by a cathode coil coupled to the oscillator. This coil and the signal circuit are effectively in series between grid and cathode. It is generally desired to couple to the cathode coil as great an oscillator voltage as the grid-cathode bias of the modulator will permit without causing grid current. The optimum value of oscillator voltage is maintained uniformly over the range of signal frequencies by combined condenser and inductive feedback in the oscillator. A series condenser is used in the oscillator tuned circuit to assist in maintaining a constant frequency difference between signal and oscillator circuits, the latter having the higher frequency. This same condenser is used as the main feedback coupling when the oscillator is tuned to lower frequencies, while the inductive feedback is mainly used at higher frequencies. These two are proportioned to apply a uniform oscillator voltage between the grid and cathode of the modulator.

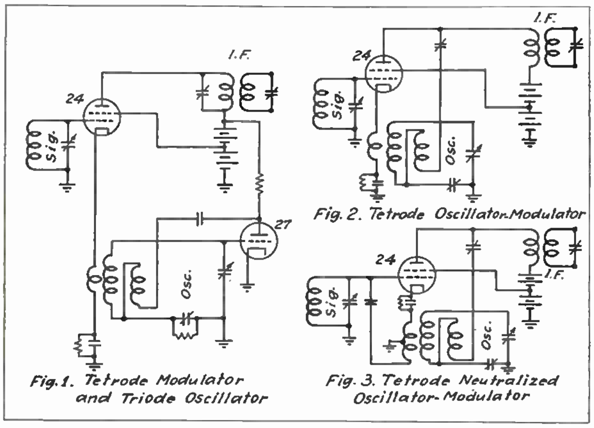
Fig. 2 shows an oscillator-modulator circuit which has the same circuit elements as Fig. 1 except omitting the triode tube, two resistors and a condenser. In Fig. 2, the tetrode is used also as an oscillator, retaining the combined condenser and inductive feedback in the tetrode plate circuit, and using the cathode coil as a link in the feedback arrangement.

The circuit of Fig. 2 requires careful but not critical proportioning of the circuit constants to maintain the oscillations at a level just below that which would cause grid current. Having adjusted the inductive feedback in the plate circuit so that the grid-cathode oscillator voltage is uniform over the tuning range, a value of the cathode resistor is chosen which is sufficiently great to prevent grid current, but is much less than the value required to stop the oscillation. The oscillator circuit is then self-regulating without relying on grid current. When the oscillations start, the cathode current increases by rectification of the oscillation, which in turn increases the grid-cathode bias and regulates the amplitude of oscillation without grid current.

There are several difficulties which are sometimes encountered in the circuit of Fig. 2, for which appropriate corrective measures have been found.

The intermediate-frequency primary coil may cause some trouble because it is effectively across the oscillator feed-

†*Paper presented before the Radio Club of America, March 8, 1933.*
**Bayside Laboratory, Hazeltine Corporation.*



Figs. 1, 2 and 3.

back circuit. In general, a coil has one fundamental natural frequency, and also a number of overtone frequencies. The latter are each slightly higher than an even multiple of the fundamental. At these overtone frequencies of the primary coil, it is likely to reflect considerable resistance into the oscillator circuit. This is corrected by choosing this coil to have a fundamental frequency at least half the highest frequency in the oscillator tuning range.

There is a tendency for the circuit to oscillate at the natural frequency of the oscillator plate coil, instead of at the oscillator frequency. Where this occurs, a nominal resistance in the plate lead is a satisfactory corrective.

The by-pass condenser across the cathode resistor must be made smaller than usual to avoid periodic blocking of the oscillator at an audio frequency. The maximum safe value is easily determined by trial.

The grid-cathode capacitive coupling of two or three micromicrofarads causes appreciable interaction between signal and oscillator circuits at the higher frequencies. The effects are (1) degeneration in the oscillator circuit, (2) regeneration in the signal circuit, and (3) radiation of oscillator currents from the signal circuit. The best cure for all of these effects is neutralization of the grid-cathode capacitive coupling. Fig. 3 shows a circuit having such neutralization added to the oscillator-modulator circuit of Fig. 2.

When the types 57 and 58 pentodes became available, the connection of all three grids to separate terminals opened up new possibilities in the oscillator-modulator field. In the first place, the type 57 pentode gave improved results in the circuits designed for the type 24 tetrode, the added suppressor grid being connected to ground. Then a number of new circuits were developed, two of which are shown in Figs. 4 and 5. These two circuits differ mainly in that the oscillator circuit of Fig. 4 is connected to the outer electrodes of the pentode while that of Fig. 5 is connected to the inner electrodes. In both cases the plate is connected to the intermediate-frequency transformer, as in the foregoing circuits.

In the oscillator-modulator circuit of Fig. 4, the oscillator includes the suppressor grid and the plate of the type 57 pentode, the feedback arrangement being somewhat similar to that of Fig. 1. The suppressor has such a wide mesh that it must be given a considerable negative bias before it exercises sufficient control over the plate current, which is necessary for the production of oscillations. This bias is provided by the second cathode resistor in Fig. 4. For the same reason, the plate voltage is reduced by another resistor. The modulation is effected by the large oscillator voltage on the suppressor grid. The tube operates under unusual conditions, the screen voltage and current considerably exceeding the plate voltage and current.

Figs. 4 and 5.

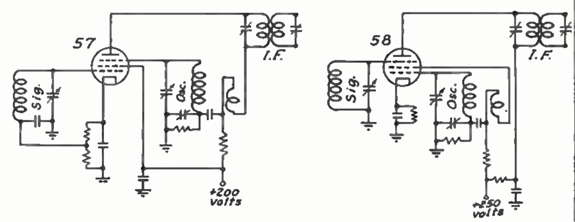


Fig. 4. Pentode Oscillator-Modulator with Outer Oscillator

Fig. 5. Pentode Oscillator-Modulator with Inner Oscillator

The circuit of Fig. 4 has several distinct advantages over those of Figs. 2 and 3. One is the complete shielding of the signal circuit from the oscillator and intermediate-frequency circuits, preventing feedback of any kind and also preventing radiation of oscillator currents. Another is the complete avoidance of control-grid current, regardless of the oscillator voltage, requiring less care in oscillator design. The circuits of Figs. 2 and 3 still have some advantages, especially if the type 57 pentode is substituted for the type 24 tetrode. They are capable of higher conversion gain and usually require fewer circuit elements.

In the circuit of Fig. 5, the oscillator includes the control grid and the screen, while the signal is applied to the suppressor grid. This is an elementary form of the emission valve modulator which will be described in more detail with reference to Figs. 6, 7 and 8. The inner electrodes behave as in a triode oscillator, while the other electrode behaves as in a triode modulator. The latter has a very low amplification factor, because of the wide mesh of the suppressor, and therefore the conversion gain is very low. This circuit is very stable in operation, and is interesting as the forerunner of the new hexode circuit.

All of the circuits using the available tubes were found lacking in one way or another. A circuit was desired which would perform with one tube the following functions:

1. Oscillation;
2. Modulation;
3. High amplification;
4. Grid-bias control of amplification.

Even the separate oscillator and modulator of Fig. 1 failed to meet all these requirements. When a sharp-cutoff modulator such as type 24 or 57 was used, grid-bias control was not satisfactory. When a variable-mu modulator such as type 35 or 58 was used, high conversion gain could not be secured. The arrangements of Figs. 2, 3 and 4 could not be subjected to grid-bias control without stopping the oscillator. That of Fig. 5 gave very low gain, but had the advantage that grid-bias control would not stop the oscillator.

Work was then carried forward on the development of a new tube to perform all four of the desired functions. The third and fourth requirements seemed at first to be incompatible, because high conversion gain requires a sharp-cutoff grid, while grid-bias control requires a gradual-cutoff grid. This problem was solved by locating two separate grids in the same electron stream, each having the structure best adapted to perform its function. The sharp-cutoff grid was used for the oscillator, giving a maximum modulating effect. The gradual-cutoff grid was used for the signal and the grid-bias control.

New Hexode Tube

Fig. 6 is a schematic diagram of the special tube which was selected as the best compromise between simplicity, low cost and low cathode current on the one hand, and a high degree of refinement on the other hand. It is a hexode having a structure generally similar to the 58 tube, but having a fourth grid and a redesign of all the grids. This was found to be the smallest number of grids which could be used and still meet the requirements. The cathode and the inner two grids are used as a triode oscillator. The outer two grids and the plate are used as the grid and plate electrodes of a tetrode modulator. The relative polarities of the electrodes are indicated on the diagram.

In operation, electrons emitted from the cathode 1 are attracted to the positive screen 3 through the meshes of the negative grid 2. As the electrons ap-

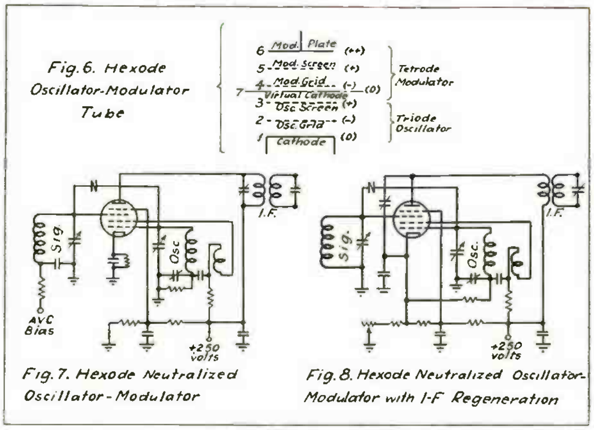


Fig. 6. Hexode Oscillator-Modulator Tube

Fig. 7. Hexode Neutralized Oscillator-Modulator

Fig. 8. Hexode Neutralized Oscillator-Modulator with I-F Regeneration

Figs. 6, 7, and 8.

proach the screen 3, they are travelling at a high speed, so that most of them shoot through the screen 3 and approach the negative grid 4, where they are retarded and then attracted back to the screen 3. The cloud of retarded electrons between the screen 3 and the grid 4 is called a "virtual cathode," because electrons can readily be drawn away from this cloud in the same manner they were originally drawn away from the actual cathode. The relative position of the virtual cathode is indicated by the line 7 (which is not a part of the tube structure).

The modulator section of the tube includes the modulator control-grid 4, the modulator screen 5, and the plate 6, in addition to the virtual cathode 7 (formed by the oscillator section of the tube).

Part of the electrons arriving at the virtual cathode 7 are attracted toward the positive screen 5 and the more positive plate 6 through the meshes of the negative-grid 4. When the oscillator grid 2 is only slightly negative, or even somewhat positive, the virtual cathode 7 has a plentiful supply of electrons available for the modulator section of the tube. When the oscillator grid 2 swings considerably negative, the virtual cathode 7, and hence the modulator plate, are momentarily deprived of their electron supply. This is the "emission valve" mechanism by which modulation is effected in the new tube.

The modulator grid 4 (not the inside grid) is connected to the cap terminal of the tube, and is constructed to have a gradual-cutoff action so that a variable negative bias can be used to control the conversion gain over a wide range without distorting strong signals applied to this grid. It is important that this negative bias has practically no effect on the oscillator behavior, because the modulator grid is incapable of cutting off the major part of the oscillator screen current.

Hexode Circuits

Fig. 7 shows a representative circuit using the new tube. It is now unnecessary to provide any parts for coupling the oscillator to the modulator, since this is accomplished by the emission valve action. The capacitive coupling of two or three micro-microfarads between oscillator screen and modulator grid causes appreciable reaction between signal and oscillator tuned circuits at the higher frequencies. This coupling is readily neutralized by a small neutralizing condenser of about one micro-microfarad, denoted by the symbol "N," which also prevents radiation from the oscillator. In order to prevent feedback from the oscillator screen circuit to the signal circuit through the same capacitive coupling, it is desirable to make the self-reactance of the oscillator screen circuit very small at the higher frequencies. This is done by sufficiently reducing the insulating condenser in this circuit. It is interesting to note that the transconductance from modulator grid to oscillator screen is negative, and therefore a capacitive load in the oscillator screen circuit is regenerative in the signal circuit.

Fig. 8 shows the circuit of Fig. 7 with two modifications, either of which may be used individually. A cathode rheostat is shown for manual gain control, arranged for minimum disturbance of the relative voltages on cathode, screens and plate in the tube. Regeneration in the intermediate-frequency primary circuit is provided by connecting the primary condenser between plate and cathode. The cathode condenser is reduced to increase the amount of regeneration. This expedient is not critical and is under control of the grid-cathode bias.

High Gain

Using a good intermediate-frequency transformer tuned to 175 kilocycles, the conversion gain of Fig. 7 is 120 times. Using a good transformer tuned to 450 kilocycles, the conversion gain of Fig. 8 is 120 times with only 40 per cent regeneration.

One of the interesting possibilities opened up by the new hexode is the five-tube receiver with automatic volume control, having the following order of tubes:

1. Hexode oscillator-modulator;
2. Pentode intermediate amplifier;
3. Diode detector and triode audio amplifier;
4. Pentode audio amplifier;
5. Power rectifier.

In conclusion, it is desired to acknowledge the valuable assistance of other engineers of the Hazeltine Corporation, particularly D. E. Harnett, J. K. Johnson, V. E. Whitman and N. P. Case. It is also desired to express the gratitude owing to the executives and engineers of Hygrade Sylvania Corporation for their cooperation in constructing the many experimental tubes which were needed in the development of the new hexode.

▲ ▲ ▲

Experiments were started April 4 with KDKA's new blimp antenna, located at Saxonburg, Pa., which may have considerable effect upon the future efficiency of broadcasting stations. Held aloft by a baby blimp, an experimental half-wave antenna, about 500 feet long, now trails 1,500 feet in the air. A light aluminum wire, serving as a combination guy and feed wire, serves the dual purpose of restraining the "captive aerial" from free flight and "feeds" it radio programs.

DETECTOR TUBE PERFORMANCE CURVES

By J. R. NELSON*

THE introduction of separate diodes which may be used for diode rectification and avc has resulted in several new types of detector tubes within the last year. Not much information as to the relative performance of the various types of tubes has been available so that the circuit designer has not had the information to enable him to choose the best type of detector tube for his particular purpose. This article summarizes the results of an experimental study of the performance of the various types of detector tubes now available.

The performances of the various types of tubes are shown on the accompanying chart. It would have been impossible of course to have plotted curves for all the conditions under which the various types of tubes might be used. Resistance coupling was used in all cases, and it is believed that the values of resistances chosen represent close to the optimum values considering both sensitivity and distortion. The results given for the lower impedance tubes such as the 227, 55 and 85 types may of course be easily changed to transformer coupling by well known methods of circuit analysis. The values of resistors, voltages, etc., are indicated in the tabulation, Fig. 2.

Four types of circuits were used in this study. Circuit A, Fig. 1, shows the circuit used in the case of the diode. The output using a diode as shown plotted in the figure is linear because the input given is 5 volts or more. With smaller input voltages there would have been more curvature. Circuit B was used for the conventional tubes such as the 224, 227 and 57 types. The operation of these types is obvious and of course requires no further comments except that G refers to grid circuit detection and P to plate circuit detection.

*Raytheon Production Corporation.

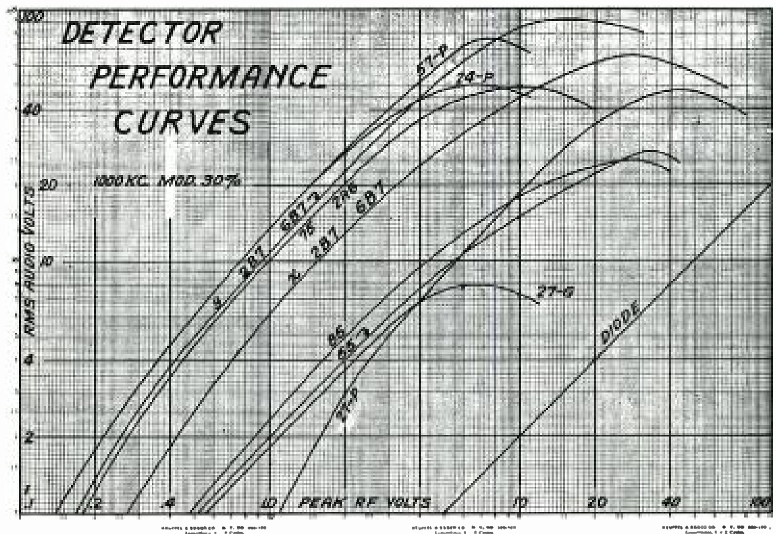


Fig. 3.

Circuit C shows the connections for the 55 and 85 duplex diode-triode tubes. This connection is not the most favorable one as regards overload conditions because the bias is proportional to the carrier and consequently the tube is overbiased as the modulation voltage must be equal to or less than the carrier voltage. Enough output may be obtained generally with this connection but in avc systems it is possible to obtain enough r.f. voltage to overbias the triode section thus cutting off the plate current. A connection using a fixed bias such as shown in D may be used in which case the output voltage will be raised considerably before overloading occurs since the triode bias is then independent of the carrier amplitude.

Circuit D was used for the 75 tube and the new 2A6 type which is the same as the 75 except that it has a 2.5 volt heater. The 75 and 2A6 tubes have a high mu triode section in which the operating bias on the control grid must be close to the point where grid current starts so that the grid may draw current over part of the cycle at least. The resistance of one megohm in the grid circuit keeps the grid-cathode resistance high, thus preventing shorting the diode leak resistor. This circuit has been investigated quite thoroughly experimentally and has been found to be satisfactory.

The 2B7 and 6B7 tubes are duplex triode pentode tubes which have been recently introduced for two services. One is to use the pentode as a high frequency amplifier with the diodes used for rectification, avc, etc. The other application is to use the diodes as rectifiers and the pentode section as an audio amplifier. It is the latter service which is of interest in this study. Two conditions for the 2B7 and 6B7 are given. The curve labeled X, Fig. 3, is for 100 volts on the screen grid and represents conditions under which it is not desirable to reduce the screen voltage to values lower than used for the other tubes. Condition Y it is believed represents the optimum condition but requires a screen voltage of 45 volts and hence an extra voltage divider in the usual small receiver.

The experimental curves show one

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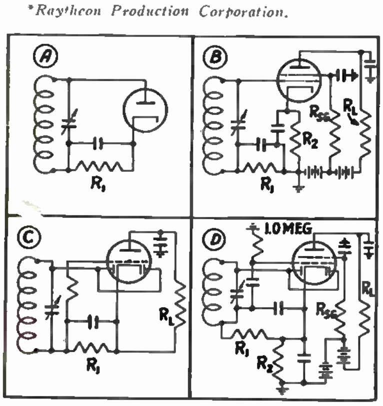


Fig. 1.

TUBE	CIRCUIT	MEGOHMS				VOLTS	
		R_1	R_2	R_{SG}	R_L	E_{SG}	E_P
DIODE	A	.5	-	-	-	-	-
G-27	B	.5	-	-	.02	-	250
P-27	B	-	.035	-	.25	-	250
P-24	B	-	.025	.5	.5	100	250
P-57	B	-	.025	0	.5	90	250
85	C	.5	-	-	.03	-	250
55	C	.5	-	-	.02	-	250
2A6 75	D	.5	-	-	.25	-	250
2B7 6B7 X	D	.5	-	-	.027	100	250
2B7 6B7 Y	D	.5	-	-	.5	45	250

Fig. 2.

Gas and vapor tube multipliers for indicator use

By DR. PAUL G. WEILLER

IN various vacuum tube applications it is frequently necessary to obtain either several watts for relay operation or at least sufficient voltage to operate a moderately priced indicating instrument from original voltage changes of small fractions of one volt. Where the changes occur rapidly during a definite period, well known a-c. or impulse circuits may be used. The control problems met most commonly seldom belong to this class. A thermocouple pyrometer is typical of a great number of cases.

The maximum voltage change is only a few millivolts. The instrument or control device must be sensitive to a fraction of a millivolt. Changes take place over periods of random length, but are so slow that the impedance of a condenser is practically infinite. In all such cases a so-called d-c. amplifier must be used.

A number of such amplifiers made up of several receiving tubes have been proposed and have found industrial applications. All are subject to "drifting;" that is, the relation between output and input varies continuously during operation. Adjustments must be made from time to time to reestablish proper operating conditions. Drifting is due partly to minute changes in grid bias, and partly to changes in tube characteristics due to gradual heating of the tubes in operation. If the changes in grid bias become of the order of magnitude of the control voltage changes, the amplifier becomes useless as the changes to be indicated will become blanketed by the changes in grid bias.

Difficulties arising from variations of bias voltages are increased by the fact that it is difficult to operate high vacuum tubes at less than 1½ volts bias as they then become very erratic due to the effect of stray potentials within the tube itself. These and other difficulties increase with the number of stages employed. One-stage amplifiers are not sufficiently sensitive for many purposes.

It is the object of this paper to discuss the availability of grid controlled rectifiers for the design of multipliers for small d-c. voltages.

The term multiplier is used here in preference to amplifier to indicate that, while a larger indication in the output is related to a larger input voltage, there is no simple proportionality as in amplifiers.

In fact, the input is d-c. The output is pulsating d-c. and the waveform is non-sinusoidal. A steady reading is obtained due only to the integrating properties (damping) of the indicating instrument.

The relation between input and output of high vacuum tubes is generally expressed by the two principal characteristics:

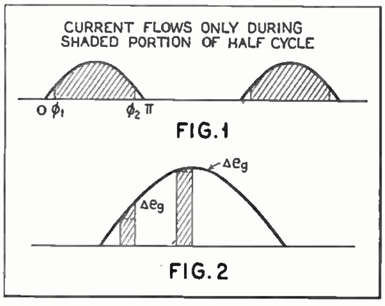
the amplification factor μ
the mutual conductance G_m.

Most indicating and control devices, unless they are delicate and expensive, require substantial currents for reliable operation. A rugged relay requires several watts. An inexpensive and rugged indicating instrument also is difficult to design for readings less than one milliampere.

For this reason a tube chosen for the operation of indicating or control devices must yield a large change in plate current for small changes in grid voltage, or, expressed mathematically, it must have a large G_m.

G_m can be expressed in milliampere plate change per volt grid change when the impedance of the load is negligible. Receiving tubes have mutual conductances of from less than one to about 2.5 milliamperes per volt. That is very little for the purpose. Some tubes designed specially for control work have a G_m of 5 milliamperes. This value of G_m is, however, accompanied by a normal plate current of 250 ma. at a plate voltage of 250 volts.

The plate of such a tube must be capable of dissipating 50 watts or more. It must therefore be rather large and unwieldy. Grid controlled vapor or gassy rectifiers are free from these fundamental objections.



Figs. 1 and 2.

Fig. 1 gives the output of a rectifier without a grid. Instantaneous values of current or voltage are represented by the well known relation:

$$I = I_0 \sin \phi \qquad E = E_0 \sin \phi \qquad (1)$$

where I = instantaneous current
E = Instantaneous voltage
I_0 = peak current
E_0 = peak voltage

The vertical lines at ϕ_1 and ϕ_2 indicate that current flows only after a definite ignition voltage is exceeded and stops when the plate voltage falls below the extinction voltage.

Ignition and extinction voltage are as a rule between 5 and 15 volts. The exact values are dependent on the kind of gas or vapor pressure and electrode configuration. The drop in the tube is also of substantially the same value and varies very little with changing loads.

The current through a rectifier is therefore determined only by the voltage available and by the design of associated circuits and met by the tube. Due to the small drop in the tube the energy loss in it is much smaller than that in a high vacuum tube with equal plate current.

Combined with the fact that current and voltage can be chosen freely to suit circuits and instruments operated with the tube this small energy loss is of considerable advantage because relatively large powers can be handled without inconvenience.

If ignition and extinction voltages are taken into consideration the total mean d-c. output is represented by:

$$i = \int_{\phi}^{\phi_2} I_0 \sin \phi \, d\phi = \frac{1}{2\pi}\left(\operatorname{Cos} \phi_2 - \operatorname{Cos} \phi_1\right) \qquad (2)$$

This formula covers all cases dealing with definite ignition and extinction voltages. It is the arithmetic mean of all instantaneous current values averaged over the entire cycle.

If a grid is interposed between anode and cathode it becomes possible to vary ϕ_1 at will by placing suitable charges on the grid.

For our purposes the relation between the ignition voltage E_1 and e_g represented with sufficient accuracy by $\mu e_g = E_1$ (3) where e_g is the grid voltage, we have further by substitution in (1) .

$$\mu e_g = E_o \sin \phi_1 \qquad \sin \phi_1 = \frac{\mu e_g}{E_o} \quad (3)$$

The physical meaning is that ignition can be retarded so as to take place at any time between ϕ_1 and π where ϕ_1 is the angle corresponding to the ignition voltage. If the charge on the grid is such that $\mu e_g = E_o$, ignition is prevented entirely and no current will flow.

In effect we can vary the mean current from maximum to roughly 50 per cent of the maximum by varying the grid voltage.

Some types of grid controlled rectifiers operate with a grid bias of one volt and a μ of 100.

The grid current before ignition is of the same order as that of high vacuum tubes. After the discharge strikes, the grid current is substantial unless protective resistances are provided. As the grid has no controlling action on the glow discharge this grid current is not detrimental.

To determine the mean d-c. current for different values of e_g we have only to substitute in formula (2). We have then:

$$i = \frac{I_o}{2\pi}\left(-\sqrt{1-\left(\frac{\mu e_g}{E_o}\right)^2} + \cos \phi_2\right) \quad (4)$$

To emphasize the fact that the relation between grid voltage change and plate current change is of an entirely different nature from that in high vacuum tubes we will call the characteristic designating this relation for vapor tubes the "virtual" conductance and express it in milliamperes plate current per grid volt.

It may be well to note here that while in high vacuum tubes the d-c. resistance of the tube is changed by varying the grid voltage, in grid controlled rectifiers only the time interval during which current can flow within each cycle is varied.

By referring to Fig. 2 it is obvious that for the same grid change a greater plate current change will occur if ϕ_1 is near 90 than if nearer to zero.

The bias voltage provided should therefore be so chosen that ϕ_1 is near 90.

It appears furthermore that the virtual conductance must be proportional to the peak current. Because of the small energy loss in grid controlled rectifiers of this type the current may be chosen quite large.

In the following we will attempt to evaluate the possibilities of such tubes by calculating actual values.

$\mu = 100$
$I_o = 650$ ma.
$E_o = 150$ volts
$e_g = 1.3$
$e_g^1 = 1.4$

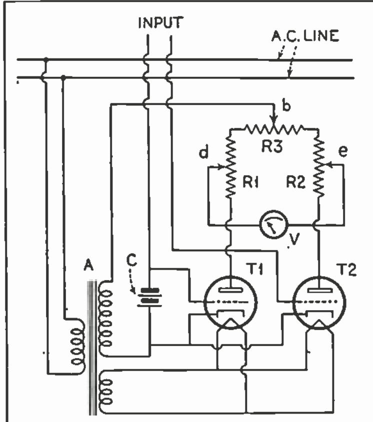


FIG.3

Fig. 3.

Substituting $\sin \phi_2 = \frac{\mu e_g}{E_o}$, in formula (2) we have:

$$i = \frac{I_o}{2\pi}\left(-\sqrt{1-\left(\frac{\mu e_g}{E_o}\right)^2} + \sqrt{1-\left(\frac{\mu e_g^1}{E_o}\right)^2}\right) \quad (5)$$

for $\Delta\, e_g = .1$ volt, $i = 15.60$ m.a.

This corresponds to a virtual conductance of 150.

The virtual conductance obtainable is of a very substantial value and far exceeds anything possible with high vacuum tubes. In addition we obtain a-c. output for d-c. input. If the output is still too small to operate the desired indicator or relay it can easily be amplified.

While we have now a very large virtual conductance, there is still an uncomfortably large plate current present which would require instruments of a range much greater than the maximum changes to be indicated. Our purpose to obtain the maximum possible deflection from small initial changes would be partly defeated. The bridge circuit of Fig. 3 is free from this objection. The transformer A provides the desired voltages for filament and plate.

C is a source of bias voltage which may well be a small rectifier and filter operated from windings on the same transformer.

T_1 and T_2 are two grid controlled rectifiers, each one in series with the resistances R_1 and R_2 respectively.

The two cathodes are connected to one terminal of the high voltage winding, the other is connected to the variable resistor R_3. By moving its slider slight differences in the drop in the tubes may be compensated for.

If the input terminals are shorted both tubes will be equally biased. Equal currents must flow in all bridge arms at all times. No potential difference will appear at d e.

If a small voltage is connected to the input, T_1 will remain biased as before; T_2 will receive the input voltage in addition to the bias.

Consequently, current will flow in the branch T_2 R_2 during a longer or shorter time interval of each cycle than in $T_1 R_1$. During that part of each cycle when current flows in one of the branches and not in the other the full difference of potential between, b and d or e will appear at d and e.

Indication on meter V will therefore be an indication of this time interval and with it, of the input voltage.

We have assumed a G_m of one hundred for example. Tubes with a G_m of 1000 have been made and can no doubt be adapted to measuring purposes.

The tubes available at present are not designed with the service here suggested in view. Greater uniformity than now prevailing is essential to any general application for metering and control purposes. While grid controlled rectifiers with their relatively large spacings are much less subject to the effect of small variations in parameters, it is still difficult to attain a sufficient degree of uniformity where electrodes are made of thin sheet metal and supported by wires. When the plate support is carried through the top of the bulb it is particularly difficult to keep close tolerances of plate grid spacing.

Heavy metal parts appear to be excluded because of the difficulty of degassifying them. Thorough exhaust before filling with gas or vapor is, however, essential to uniformity.

It is, therefore, suggested to machine the structural parts of the tube from the insulator known as "lava." This material can easily be held to very close tolerances.

Appropriate surfaces should be coated preferably with a platinum metal to form grid and plate.

The wires connecting the electrodes to the lead-ins cannot affect the spacing of the former.

For proper operation the tubes must be well shielded from electrostatic and electromagnetic fields. If they are mercury vapor tubes they should be in a simple thermostatic chamber as their characteristics are affected by temperature changes.

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DO NOT MISS IT

The May number of RADIO ENGINEERING will be devoted to problems of radio receiver design and manufacture. There will be articles on the subject of vacuum tubes of interest to engineers in all branches of the radio business.

The 77 as a Biased Detector with 100 Volts Plate Supply

TO the set engineer faced with the problem of most efficiently resistance coupling the detector to the output tube in small universal sets, the following circuit with its table of constants is of interest.

Inasmuch as 100 volts is about the maximum plate supply voltage available in universal a-c.—d-c. receivers, tests for optimum operating conditions for a *77* as a self-biased detector were conducted at this voltage. Even when receiving signals of low percentage modulation, it has been found possible to secure an output voltage from the *77* when operated at this low plate voltage comfortably sufficient to insure full audio output from a type 43 resistance coupled to the *77*.

In the tabulation of conditions obtaining for optimum operation, the column headings have the following meanings:

R_p is the plate load resistance of the *77*.

R_g is the grid resistor for the 43.

R is the self-biasing resistor for the *77*.

Mod. per cent refers to the per cent modulation of the r-f. signal supplied to the *77*.

E_{c2} is the screen grid supply voltage for the *77*.

R.M.S. r-f. mod. volts is the root-mean-square, radio-frequency modulated voltage which must be supplied to the *77* in order to obtain full audio output from the 43.

Cathode I is the cathode current of the *77*. The first column shows the current with no signal, and the second with a signal.

Bias voltage is the bias on the grid of the *77*. The first column shows the bias voltage with no signal, and the second with the specified signal voltage.

If a higher bias resistance, or a higher screen supply voltage is used instead of the values shown in the table, the sensitivity of the detector will be reduced.

The tabulated conditions for optimum operation were determined by varying first one and then another of all possible variables and noting the results. Oscillograms of the resulting waveforms were also taken to guide the selection of optimum conditions. In this way, conditions for maximum power output with minimum distortion for a required r-f. signal input and various combinations of plate and grid resistors were determined, with the output voltage of the *77* held constant at 14 peak volts input to the 43.

CONDITIONS FOR OPTIMUM OPERATION AS A SELF-BIASED DETECTOR; RCA-77, C-77

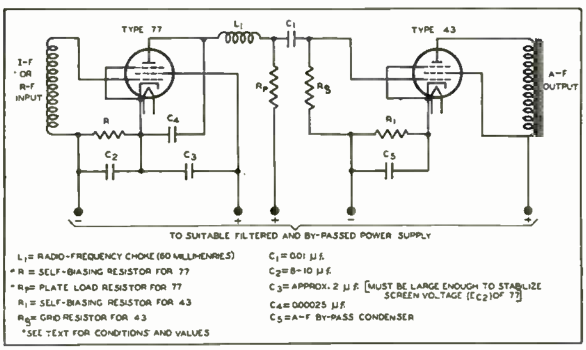
(Plate supply of 100 volts)

R_p	R_g	R	E_{c2}	R.M.S. r-f.	Cathode I		Bias Voltage	
Megohms		Ohms	Volts	Mod. Volts	No. Sig. (Microamps.)	Sig. (Microamps.)	No. Sig. (Volts)	Sig. (Volts)
0.25	0.25	12,500	36	1.88	155	255	1.94	3.18
0.50	0.25	17,500	30	1.86	100	178	1.75	3.15
0.50	0.50*	15,000	20	1.10	90	135	1.35	2.02

Notes:

*A resistance of 0.5 megohm in the grid circuit is allowable only when the receiver is so designed that the heater voltage for the 43 does not exceed 25 volts under the maximum line-voltage conditions encountered in service.

All of the above readings were taken at 1,000 kc.



This circuit may involve patents. A word of caution is given to set manufacturers to investigate this phase of the subject.

Detector circuit for universal receiver.

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Book Review

THE RADIO AMATEUR'S HANDBOOK, by A. F. Collins and G. C. B. Rowe; historical introduction by Donald McNicol, 417 *pages, illus., cloth, New York,* 1933, *published by Thomas Y. Crowell Co.,* 393 *4th Avenue. Price,* $2.00.

This is the seventh edition of a radio handbook which has had wide circulation among students of radio, both amateur and professional. The chapters covering the fundamentals of radio are extensive and thorough. The radio transmitting and receiving circuits presented and described cover both telephony and telegraphy. The book contains Government rules and regulations dealing with radio operation.

New chapters included among others: the Hammarlund "Hi-Q 30" broadcast receiver; a 245-pushpull radio and phonograph amplifier; new developments in vacuum tubes; a low-power telegraph transmitter; a combination 10-watt telegraph and telephone transmitter; the construction and use of wavemeters; radiovision—the amateur's next job; and radio in other fields. The seventh edition contains the following new material: Chapter XIX-A, "Further Developments in Vacuum Tubes;" Chapters XXVIII, XXIX, and XXX, "Radio and Talking Motion Pictures," "The Photoelectric Cell and Its Uses," "Ultra Short Waves." Additions have been made to Chapter XXVI: sic "Cathode Ray Television," and "The Peck Television System."

Recent developments in cathode ray tubes and associated apparatus

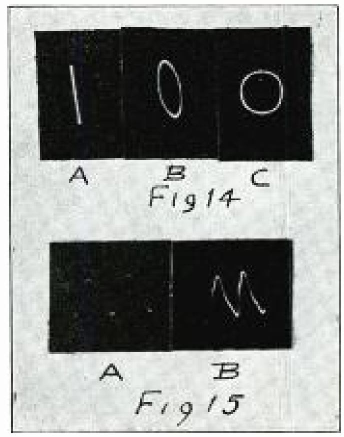

Fig. 14.
A. A-C. wave across one set of deflecting plates.
B. Trace of a-c. voltage on each set of plates.
C. Same as 14B, but with greater phase difference between the two voltages.

Fig. 15.
A. A-C. wave using linear sweep circuit and synchronization adjustment.
B. Same as 15A, but through a cheap transformer.

By Allen B. DuMont

(Concluded from March issue)

Applications Requiring Some Independent Time Base

CERTAIN applications arise in which a base deflection is required which is not provided by the circuit under investigation and is not a simple time base. Such cases arise whenever it is necessary to graph an electrical quantity against a variable, other than time, and which is not directly obtainable from the circuit itself. The most important variable is frequency. For example, it might be required to make the oscillograph show the frequency response curve of, say, a band-pass filter. We would need first an oscillator of variable frequency and constant output, or at any rate we would need to know the output as a function of the frequency. The output from the filter would be applied to one pair of plates. To the other pair we would have to apply a voltage representing frequency to some known scale; a matter which could be arranged either mechanically or electrically.

Photographic Recording

The methods commonly used to record waves or figures drawn by the cathode ray tube may be classified into two general classes. The first method is to use an ordinary camera, focus it on the screen of the tube and expose the film. The time of exposure depends upon the brilliance of the trace, the size of the figure and the rate of movement of the spot. This method is satisfactory for stationary figures or for recurring phenomena. Fig. 14-A is a photograph taken showing an a-c. wave across one set of deflection plates. Fig. 14-B shows the trace caused by an a-c. voltage on each set of plates, the voltages being out of phase. Fig. 14-C is the same but with a greater phase difference between the two voltages. These were taken with a standard Graflex camera using Verichrome film. An exposure of one half second was used with the accelerating electrode voltage only 500 volts. Fig. 15-A shows an a-c. wave as traced using the linear sweep circuit and the synchronization adjustment. Fig. 15-B shows the same wave through a cheap transformer. These were also time exposures of the same length of time. By increasing the voltage to the accelerating electrode it is possible to photograph in considerably less time. For instance, with 2,000 volts on this electrode successful photographs were taken in one thirtieth of a second with an F11 opening of 16 cycles of a 1,000 wave covering an area on the screen approximately 2½ square inches.

The second method for photographic recording is mainly used for non-recurring phenomena. The wave is applied across one set of deflection plates and the spot is focused onto a moving film which supplies the time axis.

Some Present and Future Applications Checking Percentage Modulation

The cathode ray tube lends itself very nicely to modulation studies and the determination of the percentage modulation of a transmitter. This determination may either be made with or without a sweep circuit. In the first case a constant amplitude and frequency signal is used to modulate the transmitter. The sweep circuit is then adjusted so that the modulated r-f. wave applied across one set of plates is stationary. and synchronized on the screen of the tube. Percentage modulation is the ratio, expressed in per cent, of the amplitude of a sinusoidal modulating signal wave to the amplitude of the carrier wave. This is illustrated in the following figures. Fig. 16 shows the unmodulated radio-frequency carrier wave, having an amplitude of A. Fig. 17 shows the same carrier wave, modulated at audio-frequency which results in a maximum amplitude of a_1 and a minimum amplitude of a_2. The percentage modulation is then

$$\frac{a_1 - a_2}{2A} \times 100.$$

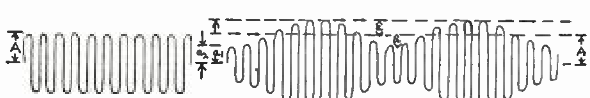

Fig 16 Fig 17

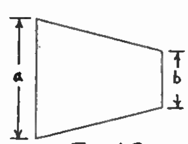

Fig 18

Figs. 16, 17 and 18.

This is equivalent to considering the envelope as an alternating current having an amplitude of (a) superposed on the carrier of amplitude A, as shown in Fig. 17. The per cent modulation is then

$$\frac{a}{A} \times 100.$$

The modulation becomes 100 per cent when the amplitude a_2 becomes zero, that is when the amplitude of the audio-frequency wave (a) becomes equal to that of the carrier A.

The second method which does not use a sweep circuit has one disadvantage in that any phase shifting makes determinations rather difficult. In this method the modulating voltage (a-f.) is put on one pair of plates, and the modulated r-f. across the other pair; then, provided no phase shift occurs, the resulting figure should be a solid trapezium; at least the sloping sides of this figure should be linear so long as the modulation is linear. Fig. 18 shows the shape of the figure. Where

$$\text{Percentage modulation} = \frac{a - b}{a + b} \times 100.$$

With undistorted, complete modulation, the resulting figure is an isosceles triangle. Any distortion of the modulating wave which occurs between the grid of the modulator tube and the antenna output will be indicated by the converging boundary lines of the pattern.

With the standard cathode ray tube it is somewhat difficult to check accurately the percentage modulation during regular programs unless photographs are taken. However, with the time delay screen patterns may be studied by using a quick acting switch to sample the trace.

Cathautograph

The cathautograph is an interesting and useful application of the cathode ray tube for the transmission of intelligence either in printed or written form. The electron beam is controlled by a suitable transmitting apparatus which causes the spot to move in any desired direction for any desired distance on the screen. If a standard cathode ray screen were used the operation of the transmitting apparatus would cause the spot to move around but it would be impossible to tell what was being written. However, with the special screen previously mentioned which, instead of having a decay period of a fractional part of a second, has a decay period of around a minute, a line can be drawn the same as with a pencil.

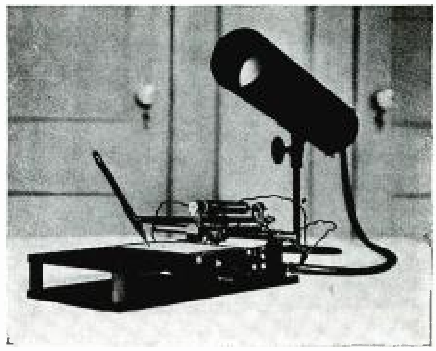

Fig. 21. Cathautograph. Complete apparatus.

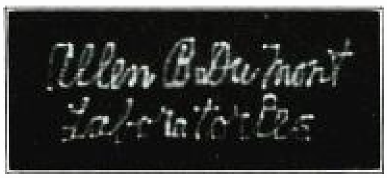

Fig. 20. Specimen of cathautograph writing.

At present some ten words can be seen on the fluorescent screen of the cathode ray tube at one time. As the eleventh word is being written the first word has faded out.

The transmitting system consists of a pencil or stylus which is connected with two resistances so that as the pencil is moved a voltage is picked off the resistances which is proportional to the movement of the pencil. The receiver consists of a standard cathode ray tube with two pairs of deflection plates having the time delay screen. Fig. 19 shows the connections used and Fig. 20 is a sample of the writing as it appeared on the screen of a 3-inch tube. A suitable shielded stand or holder supports the tube. The voltage picked off one resistance is applied across one pair of plates and the voltage picked off the other resistance is applied across the second pair of deflection plates.

Provision has been made so that when the pencil of the transmitter is brought into writing position the receiver at the distant station is set into operation, which requires less than two seconds. A buzzer signal is also operated at the distant station. Provision has been made so that when the pencil is lifted from the paper the spot is turned off eliminating traces between the words. The complete apparatus is shown in Fig. 21.

The cathautograph may be operated over radio circuits by modulating two separate tones on a single carrier. At the receiver each tone is rectified and used to operate a set of deflection plates.

Some of the applications which suggest themselves are communications between airplanes and ground stations, communication between small vessels at sea (not carrying a licensed operator) and land stations, office intercommunication, and communication between distant offices, communication between police department and radio equipped cars, noiseless instructions to broadcast artists, Chinese or Japanese communication circuits and also for advertising displays.

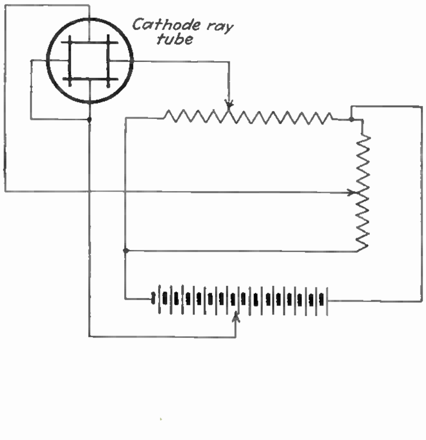

Fig. 19. Connections of the cathautograph.

Depth Measurements

By rotating the beam in a circle at a known rate and sending out an impulse at a predetermined time the echo can be made to appear as either a spot or a radial line along the circumference of the circle. A suitable scale will indicate the depth. Using cathode ray tubes for this purpose it is economical to place repeaters at any desired point in the ship. Due to the fact that there is no

(*Concluded on page 23*)

Antenna transmission line systems for radio reception

By C. E. Brigham*

(Concluded from March issue)

IN an attempt to employ a low impedance transmission line for the antenna lead-in between the antenna proper and the receiver chassis an arrangement has been used as shown in Fig. 4. With this arrangement an auto-transformer is used at the antenna end in conjunction with an ordinary shielded lead-in. When such a system is used on a low impedance input receiver its effect on sensitivity is shown in Fig. 5. It is immediately noticed the improvement this system has over the ordinary shielded lead-in system. Even with 100 feet of ordinary shielded lead-in wire between the auto-transformer antenna unit and the receiver chassis the maximum attenuation is only six decibels. However, when such a system is employed on a high impedance input receiver the attenuation for various lengths of shielded lead-in is shown in Fig. 6. These curves show maximum attenuation of over twelve decibels over a considerable portion of the broadcast frequency range. The improvement of the auto-transformer arrangement with the shielded lead-in wire over the ordinary shielded lead-in system is shown for the low impedance input receiver in Fig. 7. The attenuation above 900 kc. on the low impedance input receiver with the antenna auto-transformer is caused by detracking of the first r-f. tuned circuit by reaction of the transmission line. Retrimming of the first tuned circuit at 1400 kc. results in less attenuation.

*Chief Engineer, Kolster Radio, Inc.

TRANSMISSION LINE WITH ANTENNA AND RECEIVER AUTO-TRANSFORMERS AND SHIELDED LEAD-IN.

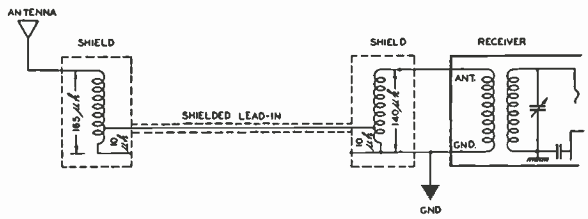

Fig. 8.

From the foregoing curves shown in the figures any transmission line system on a high impedance input receiver has disclosed bad attenuation over a considerable portion of the broadcast spectrum. This high loss of signal over such transmission line systems has been due to by-passing of the signal energy from the capacity of the conductor to ground shield and the mis-matching of impedances between the low impedance of the auto-transformer and the high impedance input.

Antenna—Input Balance

One arrangement in properly matching or balancing impedances between the antenna and input of the receiver is by employing auto-transformers at both the antenna and receiver as shown in Fig. 8. With this arrangement its effect on sensitivity of a high impedance input receiver is shown in Fig. 9. Compared with the attenuation curves in Fig. 6, which show the condition for the auto-transformer at the antenna end only, the improvement in the proper impedance matching is clearly demonstrated. It is noticed in Fig. 9 that even with 400 feet of shielded lead-in wire between the antenna and receiver auto-transformers no attenuation is noticed up to 1200 kc., and only a maximum of six decibels loss between 1200-1500 kc. The effect on sensitivity of the antenna and receiver auto-transformer transmission line system on a low impedance input receiver is similar to that obtained with the antenna auto-transformer alone with the shielded lead-in wire.

Another effective method in obtaining the proper impedance matching between the antenna and receiver input over a low impedance transmission line system is by the use of simple antenna and receiver r-f. transformers as shown in Fig. 10. In this arrangement the two transformers are connected by means of a twin conductor shielded cable. Such a system gives attenuation curves on a high impedance input receiver similar to the curves shown in Fig. 9.

Link Circuit Balanced to Ground

In locations where the electrical disturbance is particularly violent, such as with violet ray machines, it is possible for the inductive interference to get in upon the transmission line. To take care of such a possibility the transmission line, particularly the link circuit, should be carefully balanced to ground. Such an ideal system is shown

EFFECT ON SENSITIVITY OF ANTENNA TRANSFORMER ONLY WITH SHIELDED LEAD-IN ON HIGH IMPEDANCE INPUT RECEIVER

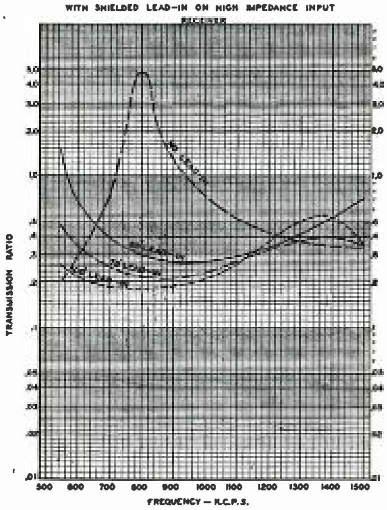

Fig. 6.

EFFECT ON SENSITIVITY OF ORDINARY SHIELDED LEAD-IN VERSUS ANTENNA TRANSFORMER ONLY—LOW IMPEDANCE RECEIVER

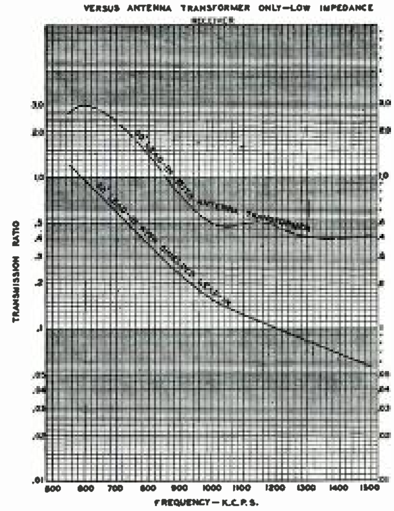

Fig. 7.

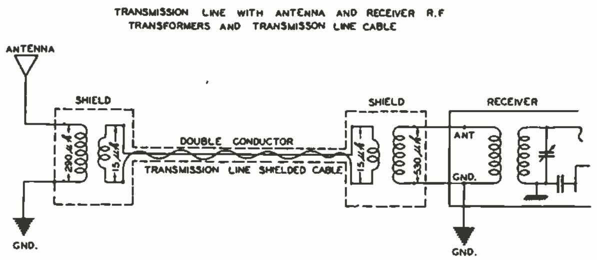

Fig. 10.

in Fig. 11. Due to the capacity effect of the windings a copper shield is used between the primary and secondary windings to prevent any noise transfer which is not balanced to ground. Although the copper shields do not affect the inductance value of the windings, the mutual inductance is decreased on account of the physical space required for the shields. A tuned antenna system as shown in Fig. 11 allows a uniform attenuation over the broadcast frequency band. With a 500 foot transmission line an average of only six decibels of attenuation is obtained over the broadcast spectrum.

Shielded transmission line systems with proper impedance matching and carefully designed to give little or no attenuation over the complete broadcast frequency range, serve as ideal systems for the elimination of man-made static. The type of transmission line system used, whether of the antenna and receiver auto-transformer type; the simple antenna and receiver r-f. transformers; or the more complicated and elaborate tuned antenna and receiver balanced system, is at present one of preference. It may suffice to say that such systems give remarkable results in the elimination of man-made static where heretofore noise interference was so great as to drown out the radio reception. Successful installations in congested theatre districts, newspaper rooms, office buildings, etc., have proven the value of such transmission line systems for radio reception.

These transmission line systems, properly balanced and employing correct impedance matching, do not require an excessive aerial length. A flat top at least 75 to 100 feet long and at least 30 feet above the roof of any building or obstacles, is more than sufficient. It is vital and important that the antenna be erected outside the field of the electrical interference. If the lead-in to the antenna unit is long, it should never be shielded as loss in signal will result. If it is found that the noise interference is getting on this lead-in some means must then be provided for locating the antenna unit nearer the antenna proper.

A perfect installation may be ruined by the reradiation of noise from other antenna structures, power and telephone lines in close proximity to the antenna proper of the transmission line system. It has been found that violent noise interference such as from violet ray and X-ray machines, is picked up by neighboring antenna wires, telephone and power lines, which in turn radiate in-

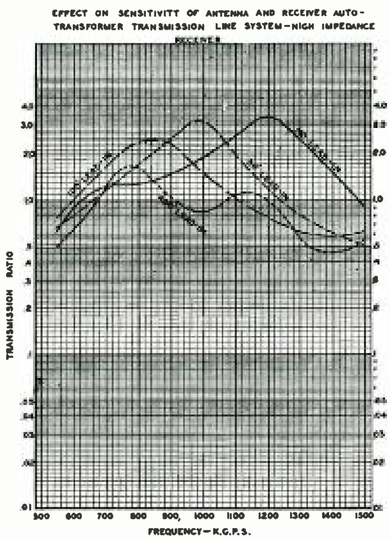

Fig. 9.

terference to the antenna of the transmission line system.

Grounding of the transmission line system is of next importance. Improper or insufficient grounding may mean failure in the performance of the transmission line system in eliminating noise. This ground wire should be as short as possible. Any piece of pipe is not necessarily a good ground, neither are soil pipes found on the tops of large buildings and apartment houses. Metallic water drains (many times dry) and steel structures are also not good grounds. A water pipe is the best type of ground which can be obtained. Grounding at both the receiver and antenna ends has often been found to be extremely important in eliminating noise interference, especially in metropolitan areas. In very extreme cases where the noise interference is particularly violent, and where the shielded transmission lead-in cable is several hundred feet long, it may be found necessary to ground the sheath of the transmission line cable at several points. When more than 100 feet of transmission cable are used, it is good practice to ground the cable every 100 feet. Although the grounding is very important, no definite procedure and recommendation in grounding can be given on account of inconsistent results obtained due to length of ground leads, resistance of grounds and types of grounds. The type of grounding employed on one installation may or may not be correct for another installation in a different location. When having difficulty with noise interference it is highly recommended that experimentation be made with different grounding systems until the source of noise interference is eliminated.

In conclusion, the importance in reducing man-made static is shown by the great number of transmission line kits which have recently been brought on the radio market.

The logical place to eliminate man-made static is at the source of interference, but this is such a costly and difficult procedure, especially in these times, that radio manufacturers have been forced to solve this problem independently.

However, manufacturers of electrical appliances and power companies have coordinated with the radio manufacturers for the past few years in combatting noise interference in radio reception. The Joint Coordination Committee on Radio Reception of the National Electric Light Association, the National Electric Manufacturers' Association, and the Radio Manufacturers' Association are meeting four times a year on this one subject of noise elimination.

Until such time as these noises are reduced at the source the antenna transmission line system is one answer to the reduction of man-made static, and more enjoyable radio entertainment with freedom of interference.

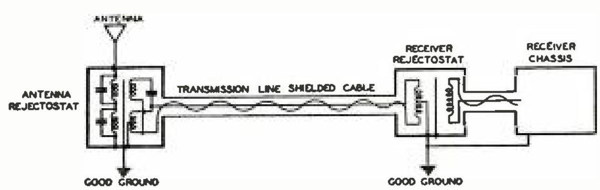

Fig. 11.

NEWS OF THE INDUSTRY

G. W. PRENTISS & CO. SERVE RADIO MANUFACTURERS

Following seventy-five years in the manufacture of high grade iron and steel wire, George W. Prentiss & Company, of Holyoke, Mass., have added to their lines a department for the production of alloy wires in wide variety.

This places Prentiss products definitely in the electrical field through nickel-chromium resistance wire; wire from pure nickel; monel, nickel silver, etc., as well as copper base alloys.

They are prominently featuring radio tube materials such as filament, ribbon, strip, round wire and other forms from pure nickel and also from "SVEA Metal" that has been recently introduced in the trade and is creating widespread interest.

As part of the development George W. Prentiss & Company recently took over the producing plant including machinery, equipment, trade names, etc. of the National-Harris Wire Company, of Newark, N. J., and consolidated the same with their main works in Holyoke.

The experience and facilities of Prentiss wire mills assure high quality product and service in these lines.

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RCA CONSOLIDATION

At a meeting of the board of directors of the Radio Corporation of America, held March 17, J. R. McDonough, assistant to the president of the company, was elected executive vice-president of the Radio Corporation of America.

As a step toward the consolidation of two of the corporation's wholly-owned subsidiary companies, the RCA Victor Company, Inc., and the RCA Radiotron Company, Inc., Elmer T. Cunningham, now president of the RCA Radiotron Company, Inc., was elected president of the RCA Victor Company, Inc., succeeding Mr. McDonough in that position.

The RCA Victor and RCA Radiotron companies are engaged in radio research, engineering, manufacturing and sales activities, the former in the field of radio broadcast receiving instruments, phonographs and other radio equipment, and the latter in the radio tube field.

The election of Mr. McDonough as executive vice-president of the Radio Corporation of America and of Mr. Cunningham as president of the RCA Victor Company, became effective April 1, 1933.

It is announced that the tube manufacturing activities of the RCA Radiotron Company are to be consolidated at Harrison, N. J., the staff from the Cleveland, Ohio, plant to be transferred to Harrison.

▲

CHANGES AT AMERTRAN

At the annual meeting of stockholders of the American Transformer Company, Newark, N. J., held February 28, 1933, Cyrus H. Loutrel, prominent Newark business man, was elected president. On the same date a reorganization was authorized which merged the radio and industrial divisions of the company.

Under the new plan Thomas M. Hunter is made vice-president in charge of sales and John L. Schermerhorn is vice-president in charge of engineering. Before the reorganization Mr. Hunter was head of the industrial division and Mr. Schermerhorn was in charge of the radio division.

The company's engineering department will be divided into three parts, each section concentrating on sales, design, and development of a particular type of product. The personnel and division of products in this department is as follows: A. A. Emlen—dry-type transformers, except audio-frequency transformers, and special apparatus; Walter Garlick—audio-frequency transformers and amplifiers; special radio apparatus; John R. Gaston—oil-immersed distribution, power and testing transformers.

BOOKLET ON CONTROLS AND RESISTORS

A new and interesting 12-page booklet has just been published which contains complete descriptions and technical data on the Stackpole variable resistors, fixed resistors and spark suppressors. There is included in this booklet two pages of circuits showing the proper application of the volume control and tone control to most every tube and circuit arrangement. It is a handy and valuable aid to engineers and servicemen. A copy of this Stackpole radio booklet will be sent without charge, upon request to the Stackpole Carbon Company, St. Marys, Pa., or to the Chicago office at 3341 Belmont Avenue, Chicago, Illinois.

▲

RECORD CHANGERS

The 1933 model of the Electromatic record changer is an unfailing, fully automatic 2-speed device. With the Electromatic, radio manufacturers and dealers can successfully meet price and quality competition. Electromatic answers the demand for a dependable high quality automatic record changer. The manufacturer reports that the unit occupies less space, therefore makes it possible to use combination cabinets of ordinary size.

Automatically starts, stops, plays and changes all makes of 10-inch records—ten of them.

Any 10 or 12-inch record can be automatically repeated as many times as desired. Plays 12-inch records manually, and repeats.

Any record can be instantly rejected by pressing a lever.

Automatically rejects imperfect record.

Record is safely supported in magazine. Record does not wipe across any part of the mechanism.

Simple to load records into magazine.

Plays both standard records, 78 r. p. m. and the new "long playing" 33 1-3 r. p. m.

Counter-Balanced inertia pickup and arm.

Manufactured by the Electromatic Record Changer Corpn., 303 N. Wabash Ave., Chicago, Ill.

DETECTOR TUBE PERFORMANCE CURVES

(*Concluded from page* 15)

result that is rather startling on first thought. This is that it is possible to obtain with a high mu triode with auxiliary diodes about as good sensitivity as with pentode tubes. Thus in a small receiver the 75 or 2A6 tube will give practically as good sensitivity as the 224 or 57 type detector tubes and in addition allows avc to be used. A duplex diode-pentode may be used also in this combination but will cost more for equal or even less sensitivity as the X curve for the 2B7 and the curve for the 2A6 show more sensitivity for the 2A6 as the 2B7 is necessarily a more expensive tube than 2A6.

In general a study of the diagram shows that new tubes have been worth while from improved circuit performance and flexibility. Thus the 2A6 and the 2B7 tubes give about the same sensitivity as the 57 or 24 types and in addition the diodes may be used for avc, etc. The duplex diode triode types such as the 55 and 85 give considerably better results than 227 type of tube as regards sensitivity and overload and in addition they may be used for other circuit functions also such as avc, etc.

▲

RECENT DEVELOPMENTS IN CATHODE RAY TUBES AND ASSOCIATED APPARATUS

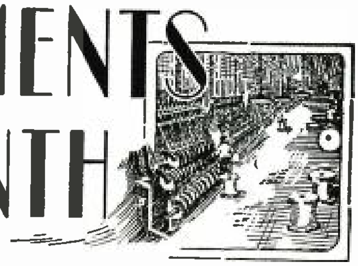
(*Concluded from page* 20)

inertia to the system it is also possible to use these tubes to detect extremely small differences in time such as might be useful in a radio altimeter, etc.

Radio Compass

For a long time the use of the cathode ray tube for this purpose has been experimented with. One suggested method was to use two large fixed loops at right angles to each other and feed the voltage from each loop to a set of deflection plates. Hence, if the common deflection plate lead was periodically interrupted a line would be drawn on the screen of the tube pointing directly toward the sending station. So far, because of the extreme sensitivity of the cathode ray tube which is required, no great success has been obtained. However, if the signal from the loops is amplified and then fed into the tube, the problem is simplified, providing the apparatus is so designed that each amplifier gives exactly the same overall gain. Recent developments along this line appear to be practical and there is a good possibility that the tube may become a valuable aid in this field. The advantage over the present radio compass would be that it could be left on continuously and would constantly indicate the location of the sending station. Furthermore the device would indicate a group of stations when they were within range, each being distinguished by its respective time interval.

NEW DEVELOPMENTS OF THE MONTH



NEW DEVELOPMENT IN RADIO SOCKET

The Cinch Manufacturing Corporation of Chicago, has developed a revolutionary idea in the making of radio sockets. It is complete in one part and eliminates rivets and riveting. It is necessary only to punch a hole in the chassis leaving three

small projections for gripping. The socket is then inserted into this hole and a short turn locks it securely and rigidly in place. Not only does it save materials and labor, thus cutting manufacturing costs, but it requires less space. Available for four, five, six and seven prong tubes, this improvement should interest everyone in the radio manufacturing industry.

▲

SCREENS FOR CATHODE RAY TUBES

A new screen material developed by the Allen B. DuMont Laboratories for use on cathode ray tubes enables a spot intensity five times as brilliant as any screen previously used. This is particularly valuable for photographic recording. A unique feature of this screen is the ability to retain for well over a minute any wave or figure applied to it when used in a darkened room or hood. This feature, however, in no way affects the use of the tube for ordinary oscillograph use or for photographic recording, because of the large difference between the spot intensity and the afterglow. Any of the various styles of cathode ray tubes made by this laboratory can be supplied with this new screen at slight additional cost.

▲

AUTO RADIO SUPPRESSORS

The Erie Resistor Company, Erie, Penn., announces a new line of auto radio suppressor resistors.

The new resistors were developed in response to a demand for a more compact type of unit and one permitting universal use on all types of cars. They are available in two sizes.

The high tension cable is attached directly to the suppressor by means of a screw recessed in a socket in the composition case. This eliminates the possibility of grounding of the cable or suppressor, because there are no exposed metal parts.

The distributed capacity effect of the Snap Type suppressor is very low, due to the small metal parts used in its construction.

These units will change less than 10 per cent in resistance value in 50,000 miles use, provided one suppressor is used in each high tension lead. The suppressors are effectively protected from moisture, oil and all conditions caused by motor heating.

▲

TIME DELAY UNIT

This bow type hot wire time delay is designed for applications where a short time delay interval with rapid, but not immediate recycling is required. In conjunction with relays it can be used to secure either delayed opening or delayed closing.

This unit is designed for delays from 1 to 5 seconds; the time of cooling is proportional to the time of heating up. It is compensated for changes in temperature and has an accuracy of approximately plus

or minus ten per cent dependent on constant current supply. Changes in timing can be accomplished by altering the position of the adjustable fixed constant members.

Manufactured by Struthers Dunn, Inc., 139 N. Juniper St., Philadelphia, Penn.

▲

MAN MADE INTERFERENCE

The Consolidated Wire and Associated Corporations, 512 So. Peoria St., Chicago, Ill., are marketing an interference control device called the Filtron. A unit is attached to the aerial. This unit filters out any static picked up on the aerial, and the shielded lead-in wire keeps it filtered until the broadcast waves reach the set. The Filtron B unit is connected in series with the power line and the attachment plug of the receiver, thus filtering the power input.

NEW BROADCAST EQUIPMENT

With the announcement six months ago of an improved two stage condenser microphone, Remler Company, Ltd., established and continuously in business since 1918, returned to the field of national distribution.

The latest addition to the Remler line is an all a-c. operated remote control amplifier and microphone power supply which is portable and permits of highest studio fidelity. It is said to be extremely efficient

and simple to install. Battery requirements are completely eliminated.

The three stage amplifier brings the microphone output to a maximum of plus 10 decibels input into the telephone line, to operate normally at a plus 2 db. level. Output is flat within plus and minus 1 decibel, over the audio range of 40 to 10,000 cycles.

Equipped with level indicator and attenuator calibrated in decibels, both units are housed in a single attractive duco finished metal cabinet 21" x 9" x 10". The weight is forty pounds.

The a-c. power supply for condenser microphones is available as a separate unit. It eliminates the inconvenience and cost of batteries and is suitable for studio and remote installations. Size: 12" x 8" x 9". Weight: 26 pounds. Remler Company, Ltd., 2101 Bryant St., San Francisco, Cal.

▲

NEW TECHNICAL BOOKLET ON WUNDERLICH TUBE

A 22-page technical booklet has just been released on the Wunderlich tube which contains complete data on the practical application of the Wunderlich tube to almost every type of receiver or circuit. Full information is given on the correct values and constants to employ in each circuit, illustrations and diagrams of receivers ranging from 5-tube superhets to 14-tube de luxe receivers, all employing the Wunderlich tube as an improved non-overloading detector, audio-amplifier, and avc, all from the one tube.

A copy of the Wunderlich technical booklet will be sent to anyone for fifty cents, upon request to The Wunderlich Corp., 1337 Fargo Avenue, Chicago, Ill.

▲

COLOR CODE CHART

International Resistance Corpn., Philadelphia, Pa., is mailing upon request a chart showing the RMA color code for resistors.

A-C. UTILITY METER

The Shallcross Mfg. Company, Collingdale, Penna., announces the No. 681 quick change d-c. volt-ohmmeter and the No. 685 a-c. utility meter.

The Shallcross a-c. utility meter No. 685 will provide essential a-c. voltage measurements and a wide range of impedance meas-

urements using the universally available 110 volt 60 cycle commercial power.

In order that this instrument will be of maximum value to radio servicemen and others requiring such test apparatus, the impedance ranges are calibrated in inductance, capacity and resistance.

▲

A NEW CERAMIC INSULATOR

Lee Skipwith and Co., Inc., 369 Lexington Ave., New York, are marketing a new ceramic insulator in units for various radio purposes. The material is known as Calit. The volume resistivity is one thousand times that of porcelain. It is used in making separators for certain types of vacuum tubes and for stand-off insulators.

▲

NEW SPARK PLUG RESISTOR

To meet the demand for spark plug resistors to be used for L or right angle connections, the Allen-Bradley Company, 1311 South First St., Milwaukee, Wisconsin, has developed their new Type W suppressor, mounted in a bakelite case with a right angle spark plug terminal at one end. This suppressor has been developed primarily for application on Buick cars, but

it also is applicable to many other motor cars.

The Type W suppressor is the latest addition to the standard line of Allen-Bradley suppressors, which consists also of the Type X suppressor for spark plugs, Type Y for distributors, and Type Z for cables.

▲

FUSES

According to the Littlefuse Laboratories, 1772 Wilson Ave., Chicago, Ill., the wire used in the company's instrument fuses is a platinum wire—invisible to the naked eye—and so fine that 13,300 can be laid side by side on a 1-inch space.

Instrument Littelfuses are made in 1/100, 1/32, 1/16, 1/8, 1/4, 3/8, 1/2, 3/4, 1, 1 1/2, and 2 amperes capacity to protect any delicate instrument. They are backed by a $100 Protection Guaranty when used according to directions.

NEW TYPE AMPERITE

A new series of Amperite automatic regulators with standard flat prong connections is announced. Fitting the standard electrical outlet, it can be used in all commercial and public address installations. Radio sets equipped with flat prong ballast sockets can use the improved regulators directly, without extra adapters. For example, the Amperite 70 will plug directly into the regulator sockets of the Majestic Models 70, 71, or 72; Amperite 90 can be used in the Majestic 90, 91, or 92.

The new and recently improved regulating characteristics are obtained with this ballast. Improving the regulating characteristics means more and better regulation with less wattage. In fact, the wattage consumption of the new Amperite is 40 per

cent less than that used by any former types of regulators.

The transformer primary current of radio sets (without '50 tubes) averages 0.1 ampere per tube. The current of a 7-tube set is therefore 0.7 ampere—Amperite 7-A-5 is used. An 11-tube set—1.1 amperes— an Amperite 11-A-5 is used, etc. —Amperite Corporation, 561 Broadway, New York.

▲

A NEW MICROVOLTER

The model 10B microvolter manufactured by the Ferris Instrument Corpn., Boonton, N. J., has been designed to supply a convenient, portable unit for sensitivity measurements on radio receivers. It is intended for factory and field testing, and for much of the use in laboratory and development work where the features of a more expensive signal generator are not needed.

It covers a frequency range of 150 to 20,000 kc. by means of six coils included in the instrument. This permits measurement not only at broadcast and intermediate frequencies, but at practically all frequencies covered by the vast majority of aircraft, police and other high frequency receivers.

The change from one coil to another is made by means of a knob on the front panel. This is very handy when broadcast and intermediate frequencies are to be checked alternately, in factory testing, or where multi-range receivers are to be tested.

A self-contained 400-cycle oscillator provides 30 per cent modulation at 400 cycles. A switch is provided so that the modulation can be used or turned off, as desired.

Power supply is obtained from the 115 volt, 60 cycle a-c. line. Filters are included inside the case, to prevent "leakage" along the power line.

Factory Testing: Final sensitivity testing of completed receivers, also alignment and adjustment of both r-f. and i-f. units. Its portability and small cost make it more economical than a testing system involving r-f. distribution lines, as well as much more flexible.

▲

REMOTE CONTROL PANEL

Universal Microphone Co., Inglewood, Cal., has produced an addition to its 1933 line in the form of a new remote control panel.

This is a one-stage microphone amplifier and tone control which may be used for low or high impedance pickup for broadcast purposes.

It may also be used as a telephone amplifier; a pre-amplifier for home recording purposes; a phono-mike mixing panel for public-address systems; a remote control microphone amplifier and monitor panel with phonograph pickup; and from telephone or control-line with monitor head phones.

The panel consists of a single stage amplifier to bring the output level of the microphone up to approximately that of the phonograph pickup.

Equipment is portable, housed in black enamel castings, and includes A and B batteries with total weight of 20 pounds.

There are two output combinations . . . a low and high impedance . . . one designed to feed into an amplifier, and the other to feed into a line of the order of 400 to 600 ohms.

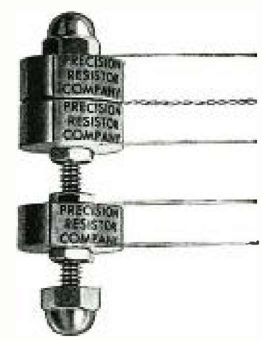
Volume controls on the phonograph and the microphone allow a low musical background when needed, and a fading in and out of phonograph and voice while program is going on.

Tube used is a 230, drawing 50 mils on the filament, and two mils on the plate, thus making a self-contained battery amplifier of extremely low current consumption. Tone control allows all possible adjustment to eliminate difficulties often experienced.

▲

PRECISION TYPE "L" RESISTOR

The Precision Resistor Co., Newark, N. J., have now available their New Type "L" resistor. This unit was designed to meet the demand for a low price, compact, wire-wound, high resistance unit, that could be used as a tapped resistor in the



construction of decade, bridge, set analyzer and other electronic circuits. By assembling two or more of these units on a stud, as shown, a very compact and efficient tapped unit can be constructed.

▲

HALOWAX

The Halowax Corporation, 247 Park Avenue, New York, announces a line of waxes possessing high insulating qualities, non-corrosive to metals and which have excellent flame extinguishing qualities.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912, OF RADIO ENGINEERING

Published monthly at New York, N. Y., for April 1, 1933.

State of New York }
County of New York } ss.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared B. S. Davis, who, having been duly sworn according to law, deposes and says that he is the Business Manager of RADIO ENGINEERING, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24th, 1912, embodied in section 411, Postal Laws and Regulations, to wit: 1. That the names and addresses of the publisher, editor, managing editor, and business manager are: Publisher, Bryan Davis Publishing Co., Inc., 19 East 47th Street, New York. Editor, Donald McNicol, Roselle Park, N. J.; managing editor, F. Walen, Union City, N. J.; Business Manager, B. S. Davis, Scarsdale, N. Y. 2. That the owners are: Bryan Davis Pub. Co., Inc.; B. S. Davis, Scarsdale, N. Y.; Roy T. Atwood, Albany, N. Y.; G. R. Bacon, Douglaston, N. Y.; M. V. Breitenwischer, Cleveland, O.; J. A. Walker, Richmond Hill, N. Y.; A. B. Goodenough, New Rochelle, N. Y. 3. That the known bondholders, mortgagees, and other security holders owning or holding 1% or more of the total amount of bonds, mortgages, or other securities are: None. 4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where a stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustees is acting, is given; also, that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

(Signed) B. S. DAVIS, Business Manager.

Sworn to and subscriber before me this 5th day of April, 1933.

(Seal) A. GRAHAM APPLETON, Notary Public.

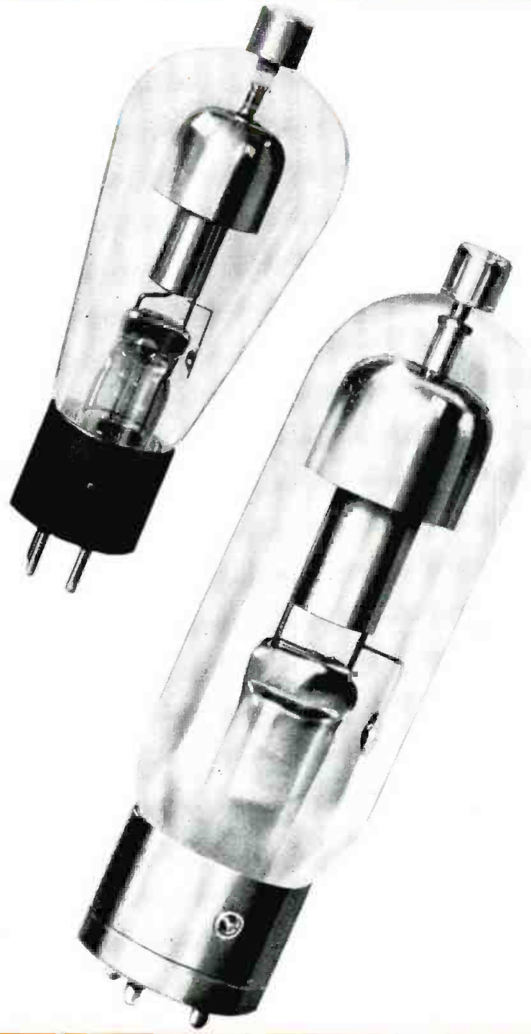
Westchester County,
New York Co., Clerk's No. 106
New York Co., Register's No. 4-A-56
Commission expires March 30, 1934

INDEX OF ADVERTISERS

RCA Victor Radiotrons

for

TRANSMITTING SERVICE



In response to a demand for mercury vapor rectifier tubes of intermediate rating, the RCA Victor Company, Inc., is pleased to announce two new types—RCA 866-A and RCA 872-A, which have a maximum inverse peak rating of 10,000 volts.

Many Broadcast Engineers who in the past have been using inefficient rotating machinery and high vacuum tubes will wish to modernize their equipment with these more economical types.

Uniformly high quality and long life of Transmitting Radiotrons are guaranteed by the vast engineering and laboratory facilities of the RCA Victor Company.

If you are interested in reducing the operation and maintenance expense at your station, send for technical information sheets covering these and other modern Transmitting Radiotrons.

RCA Victor BROADCAST EQUIPMENT

TRANSMITTING RADIOTRON SECTION

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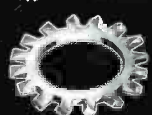

Type 11. External

Type 15. Countersunk

Type 20. Locking Terminals

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Other Patents Pending
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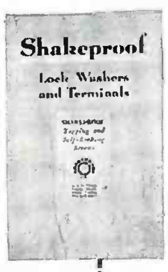

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