electronics

radio, sound, industrial applications of electron tubes ✦ ✦ ✦ design, engineering, manufacture

Can radios be sold to Europe?

✦

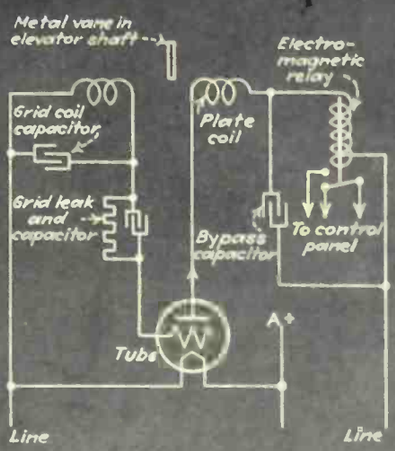
New developments in tubes

✦

15,801,620 homes with radios

✦

Electronics in train control



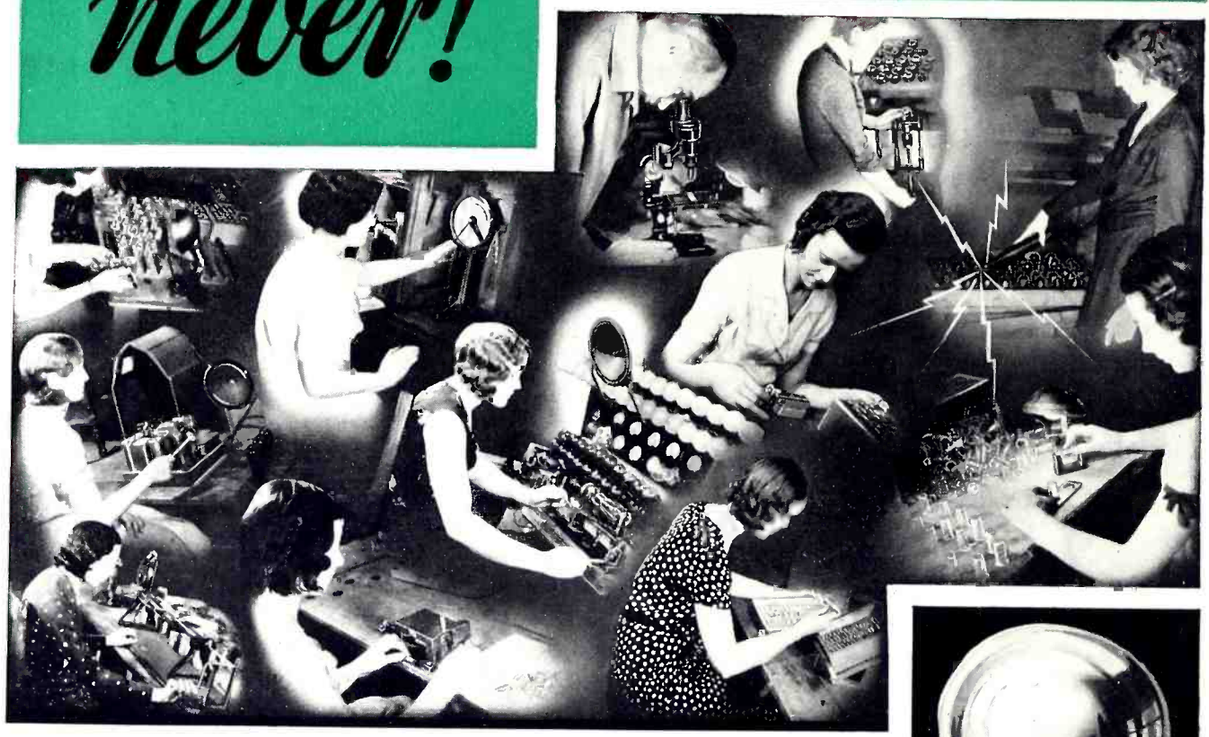
Tube control circuits for elevators in new McGraw-Hill building
(See page 231)

McGRAW-HILL PUBLISHING COMPANY, INC.

Price 35 Cents

DECEMBER 1931

ESCAPE THIS ? never!



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Reductions in prices or revisions in methods cannot . . . will not . . . interfere with Arcturus' rigid standards of giving each *blue* tube 137 tests and checks before it leaves the factory. The quality of Arcturus *Blue* tubes, recognized by critical engineers of leading set manufacturers, jobbers, dealers, consumers . . . *and even conceded by other tube manufacturers* . . . will not be sacrificed for any reason!

Not an Arcturus Tube escapes these 137 tests and checks. All raw materials, each operation, every part . . . each tube is interminably "third-degreed."

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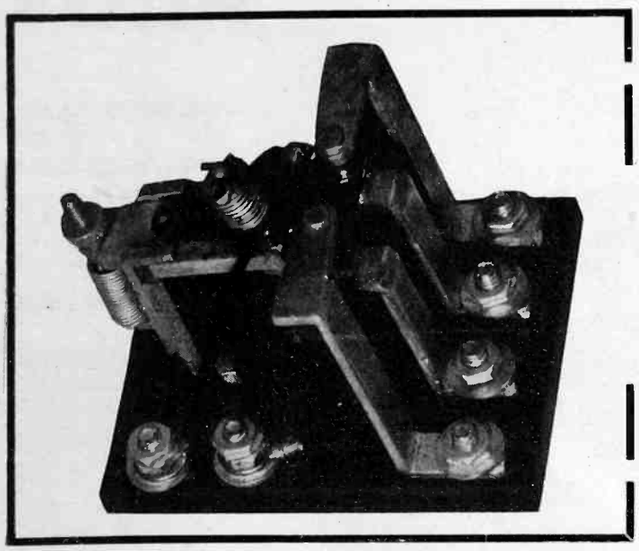
ARCTURUS RADIO TUBE COMPANY
Newark, New Jersey

ARCTURUS

The **BLUE TUBE** *with the* **LIFE-LIKE TONE**

Electronics, December, 1931. Vol. 3, No. 6. Published monthly. McGraw-Hill Publishing Company, Inc., 330 West 42d Street, New York, N. Y. $3.00 per year, 35 cents a copy. Foreign Postage, $1 extra. Canada (including Canadian duty), $3.50. Entered as second-class matter April 4, 1930, at the Post Office at New York, N. Y., under the Act of March 3, 1879.



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at midget prices

Ward Leonard engineers have developed an inexpensive Midget Magnetic Relay of exceptional merit . . . a relay particularly adapted to successful point-to-point transmitters on devices employed in broadcast station equipment, sound receiver studio apparatus, telephone and telegraph repeater systems and other electronic developments.

This small Type A relay is made with the usual fine workmanship of Ward Leonard products. It is rugged . . . built to stand severest service, even abuse. It can be equipped for either single pole or two pole operation, and can be either single or double throw. Can be used on practically any circuit, either A.C. or D.C., up to 115 volts.

Standard Features

1. A.C. or D.C. operation.
2. Coils designed for continuous duty operation.
3. Small energy consumption.
4. Can be supplied either single or double pole.
5. Silver to silver contacts . . . rated up to 6 amps. A.C. at 110-v.
6. Can be furnished in 8 different contact combinations.
7. Front or back of panel connected.
8. Relay base only 2⅜ x 1¾ inches.
9. Bakelite and fibre insulation.

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This company builds relays in many types and forms. Information gladly supplied. Let us know your requirements.

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WARD LEONARD ELECTRIC CO.

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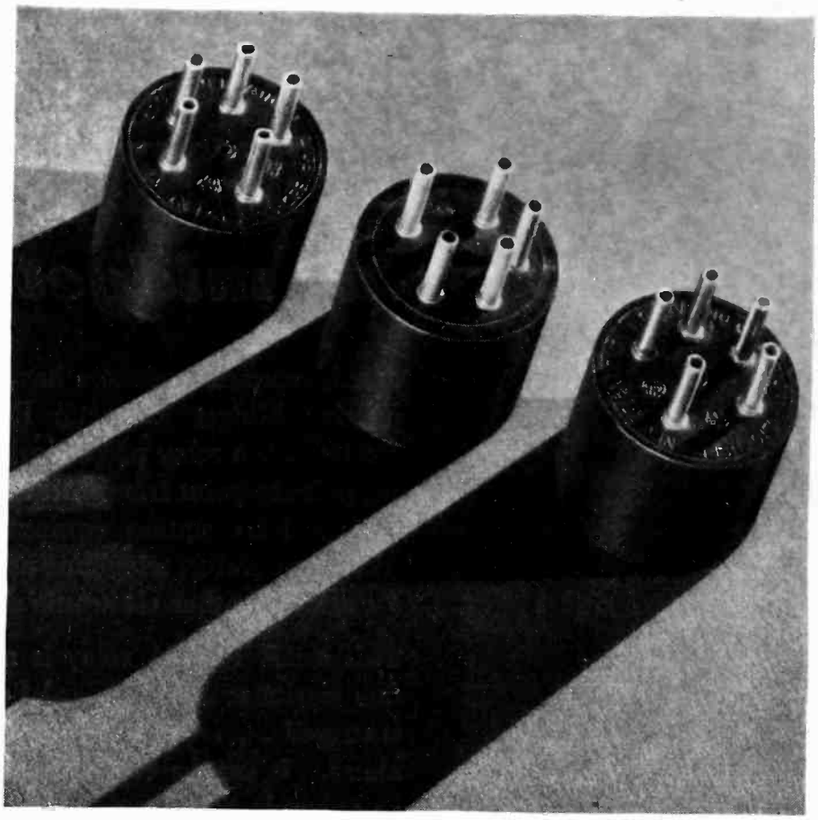

Bakelite Molded tube bases made by Associated Attleboro Manufacturers, Inc., Attleboro, Mass.

Protecting the heart of the set

with Bakelite Molded

Tubes are vital parts of radio receivers and of many other electronic devices. Subjected to high frequencies and often to high temperatures for long periods of time, they must be well constructed, and insulated with materials that retain their dielectric efficiency indefinitely under severe service. Bakelite Molded has long been and continues to be the choice for tube bases of many kinds.

Bakelite Molded possesses high dielectric and mechanical strength and its insulating efficiency is unaffected by moisture, age or temperature variations. In addition, this material lends itself to economical production through the use of multiple cavity molds and through the molding-in of metal inserts. Its fine lustrous finish adds attractiveness and enhances the salability of devices for which it is used.

We invite the manufacturers of all kinds of electronic devices to investigate the many advantages of Bakelite Molded. If you have a problem requiring a low-loss material, a heat resisting or some other special insulator, there is undoubtedly some Bakelite Material to fill your need. Write us for booklet 68M, "Bakelite Molded".

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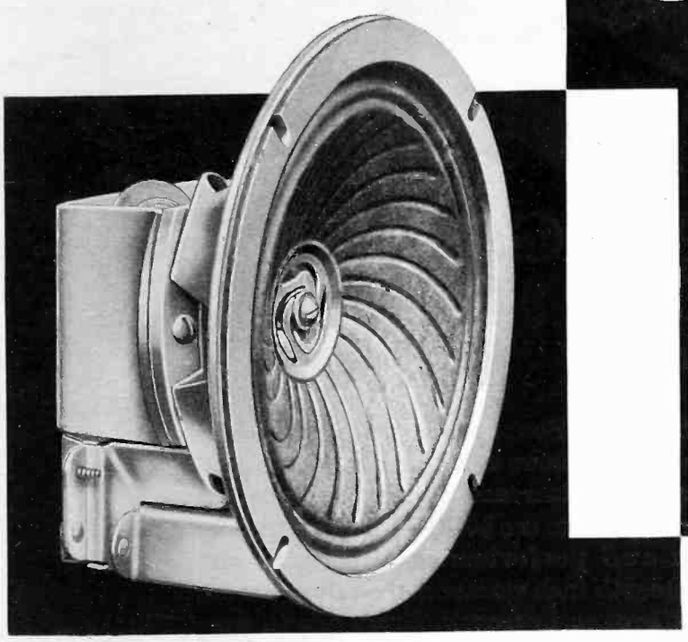
THE MATERIAL OF A THOUSAND USES

YOUR SETS NEED

The BEST SPEAKER YOU CAN BUY



New Magnavox Model 150 5½-inch cone Dynamic Speaker, for small midget sets

With better programs in the studios, with better broadcasting to put them on the air, 1932 radio buyers are going to demand BETTER RECEPTION.

The purchasers of all but the cheapest sets are going to be more critical than ever of TONE QUALITY. It's going to take *ear-appeal* to sell them. . . .

That is why *your* sets need the best speaker you can buy. You may spend a few cents more per unit—but you will get it back in appreciation of your determination to give the public a higher quality of tone rendition.

Magnavox can help you there. The new Magnavox 40 and 50 Series Symphonic Speakers are engineered to meet 1932 requirements—to reproduce the full tone-range of modern broadcasting.

Have you investigated these great speakers? Make no commitments till you have. A model, with complete engineering data, will be furnished without obligation.

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APPRECIATION

To the electrical and radio industries, Inca wishes to express its gratitude for their generous support during the year just closing . . . a support that has necces= sitated a factory production double that of 1930 in spite of general adverse conditions.

So wide an acceptance is significant . . . for it implies a type of service and a quality of product that must be of more than ordinary value.

Inca appreciates this acceptance and wishes to assure its many friends in the trade that its facilities for 1932 will be still more complete and of still greater value to the industry.

1931

1930

The spirit of the dead Inca rulers still live, they say, in the mountains of Peru. Even today their descendants, when drinking, will wet their fingers and offer them to the lips of the invisible spirits of the past.

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MANUFACTURING DIVISION

of NATIONAL ELECTRIC PRODUCTS CORPORATION

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TRIPLE-TWIN

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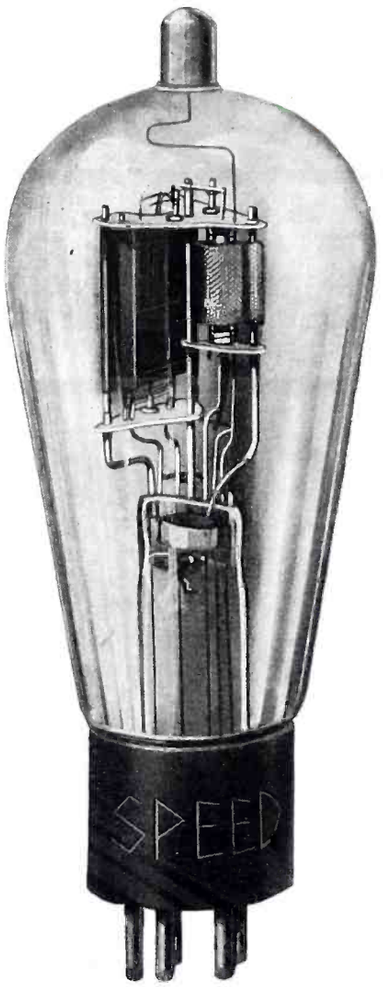
- Triple the 245's output and double the 247's without increased plate voltages.
- One "Triple-Twin" supplants complete DETECTOR and AUDIO System.
- Super sensitivity allows elimination of pre-stages in special applications.
- Flat frequency response, 30 to 50,000 cycles. A boon to television.
- Economy in chassis construction.



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BROOKLYN, N. Y.

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165 BROADWAY, NEW YORK, N. Y.

electronics

McGRAW-HILL PUBLISHING COMPANY, INC.

New York, December, 1931

O. H. CALDWELL
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Associate Editor
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Associate Editor

radio
sound pictures
telephony
broadcasting
telegraphy
counting
grading
carrier systems
beam transmission
photo cells
facsimile
electric recording
amplifiers
phonographs
measurements
receivers
therapeutics
traffic control
muscial instruments
machine control
television
metering
analysis
aviation
metallurgy
beacons
compasses
automatic processing
crime detection
geophysics

New things!

SEASONED technical observers returning from Europe report that never in their experience were there so many new ideas in course of development abroad, so many new things under way. In electricity, in electronics, in electrochemistry, in automotive applications inventors are at work in cities all over the Continent. England, France, Germany and other nations all share in this extraordinary creative activity. New inventions are "popping."

In America, too, new things are everywhere in the air. Individual inventors are striking out along radically new lines. Men out of work or men on reduced time schedules, are men with leisure to apply to pet ideas and long-cherished schemes. At the same time the manufacturing companies are crystallizing new processes and methods in their private laboratories, often behind locked doors.

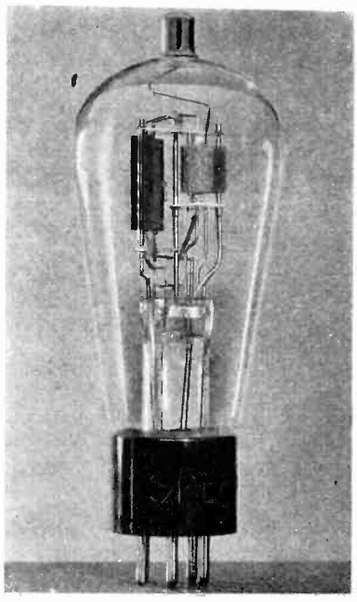
NEW tubes are being developed. New circuits are being invented and applied. New services are being put onto existing wire networks. New electrical principles are being applied to familiar uses. Ease of tuning is being improved. Sound recording has been radically altered on both discs and film. New converters and inverters give new flexibility of appliances and circuits. The exquisite mechanics of the electron itself is being harnessed for everyday service. And even the citadel of the atom and its positive nucleus are being hammered and now bid fair to crack—with what undreamt electronic results in chemistry, processing, and power supply!

THE business index may be scraping bottom. Security prices may be testing new lows. International finance may be faltering as to its next move.

But never were human ingenuity and scientific resourcefulness more active. Out of the energies and advances now incubating are being created new industries and new arts. They in turn will create the new demands and new markets of a remade world.

NEW ELECTRON TUBES

Television, radio receivers, power applications to benefit by products of tube designers



Voltage and power amplifier tubes directly connected, housed in one envelope

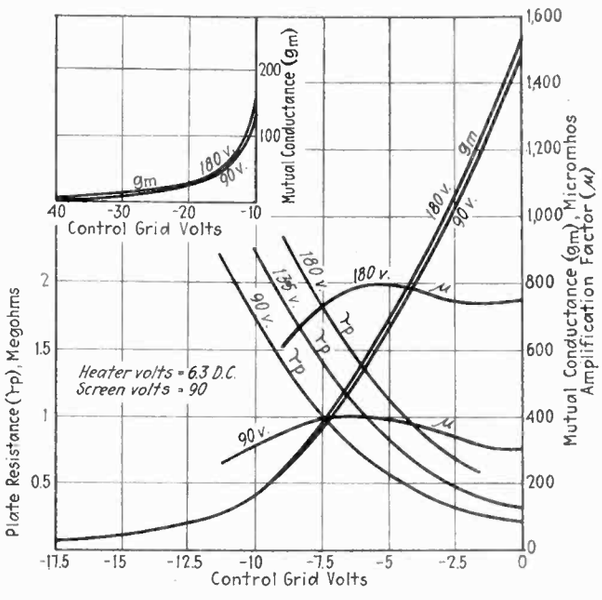
MANUFACTURERS of radio receivers, perennially looking for something new on which to hang sales campaigns have their hopes revived by rumors of new tubes; tube manufacturers, on the other hand view such rumors with mingled alarm and gratification. Perhaps there will be a new tube, not so overproduced that its sales price must go down below manufacturing cost, perhaps a profit is to be made after all. Or, perhaps a new tube is to be merely another aggravation, what with price wars and free tubes to the trade.

At any rate the air is full of rumors, and some facts, about new tubes, some to be of aid to the radio-set people, some marking a step toward television success, some having applications in power and industrial uses.

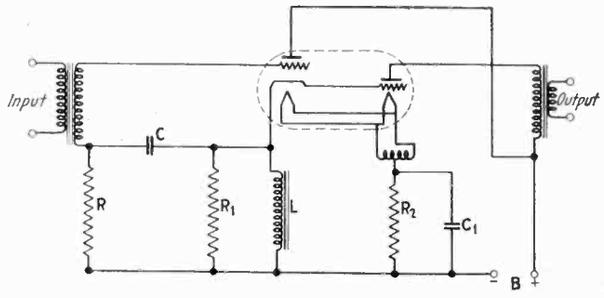
New short-wave tube—for television?

Current opinion about television—eagerly looked for by the public, whooped up by the promotors, pooh-poohed by the die-hards, shushed by those who really know if anything is going on—current opinion is that television must go on the air in the uncharted region below all present communication channels, i.e. the short-wave region below 10 meters. A fundamental obstacle to such transmissions up to the present has been the difficulty of generating such frequencies in sufficient power to get them above the buzz and rattle caused by spark plugs on countless automobiles and airplane motors.

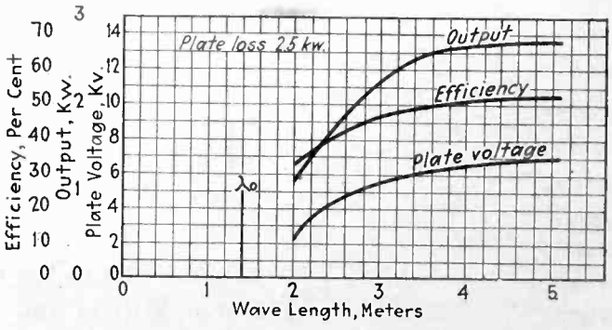
A new short-wave tube, cooled by water and generating considerable power has been developed at the General Electric Laboratories and was mentioned without fanfare in *Proceedings of the IRE* November, 1931, by E. D. McArthur and E. E. Spitzer. This tube, cut down in dimensions from the familiar 100-kw. tube will oscillate as low as 1.5 meters and delivers plenty of power at 4 meters to thrust television images as far as the eye can see the transmitting antenna. Already the National



Control characteristics of the r.f. pentode



Method of connecting the double tube into the circuit



Characteristics of the ultra-short-wave power tube

—FACTS AND RUMORS

Broadcasting company is reputed to have installed tons of apparatus built around these tubes in the top of the Empire State building in New York, some 1200 feet above the street. Television possibilities look brighter because of this tube.

The tube has a plate to grid capacity of 8 μμf., grid to filament capacity of 5 μμf., and plate to filament capacity of 1.5 μμf. The power output, and efficiency are shown in curve form.

Two tubes in one—a new power tube

A tube which has not yet reached the market but which has been talked about a great deal—and which might provide 1932 sets with that new angle manufacturers seem to need for sales—is a double tube, two tubes directly coupled in one envelope. The tube is called, alliteratively, the Triple-Twin and combines an amplifier tube of the 227 type and a power tube of the 245 or 250 type. The first tube drives the second permitting it to be worked on the positive side of its grid characteristic.

The feature of the tube is its superior sensitivity. Worked into 4000 ohms the tube, (Cable type 295), delivers 4.5 watts with an input of 4 volts, r.m.s. The 247 type, by comparison, delivers 2.5 watts into 7000 ohms with a 16 volt peak input, and the 245 into 3900 ohms requires 49 peak volts to deliver 1.7 watts, roughly. According to data from Cable Laboratories, at 4.5 watts output the combined second and third harmonic distortion amounts to slightly over 5 per cent. Into 2000 ohms and into 9500 ohms the distortion is about 8 per cent.

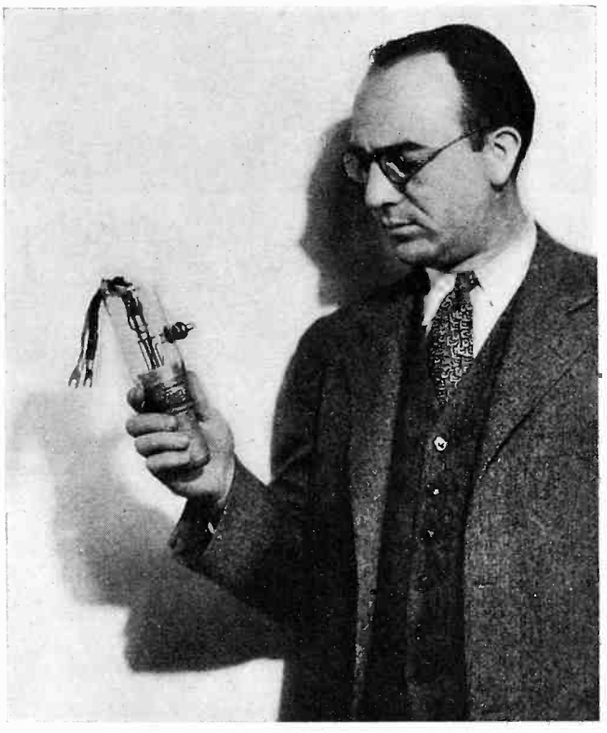
Although work in the laboratory continues on this interesting tube it appears that a detector-power amplifier tube of this nature in one envelope will deliver its 4.5 watts with a 10-volt, completely modulated input.

Old-line tube engineers look with disfavor on the trick of putting two tubes in one envelope. They say it increases cost of manufacture, doubles shrinkage, and so on. Those who have made the tube to date point out the saving in one base, one stem, envelope and so on. As usual, set manufacturers collectively decry interest in the tube, but individually instruct their engineers to learn all about it, make experimental sets around it, and by and large hope to outdistance their competitors by being the first in the field with a set embodying it.

R.f. pentodes again—and at last

Announced as *Electronics* goes to press is a tube with all the new wrinkles of the last few years rolled into one, a variable-mu radio-frequency pentode. It is designed particularly for automobile and d.c. receivers where appreciable r.f. gain per stage is desired even at the low plate voltages available. This tube, type 239, can be used as r.f or i.f. amplifier or as first detector. It is effective in reducing cross modulation—due to the variable-mu feature—and can handle appreciable grid voltage swings at low plate voltages—due to the suppressor or pentode grid. It has high mutual conductance, high plate resistance.

While this tube is aimed directly at the battery market, there is a possibility that its value may bring it into general use so that variable-mu pentodes for r.f. circuits may become the rule and not the exception.



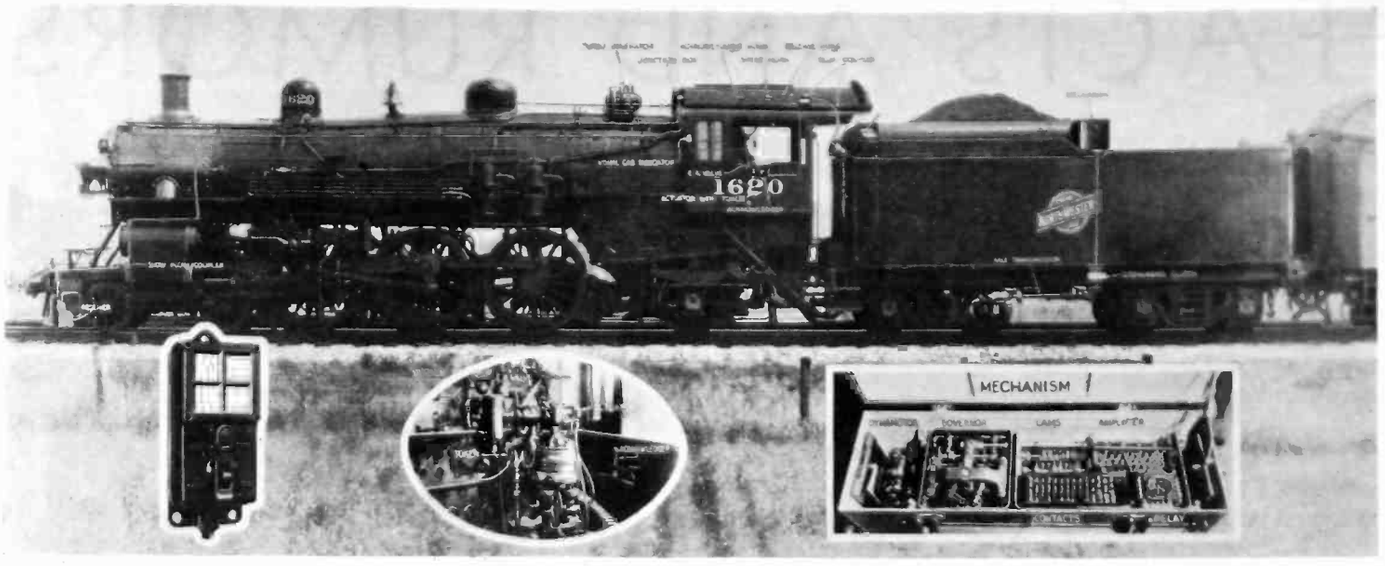
Water-cooled short-wave tube, held by E. D. McArthur

There are other new tubes for various purposes ranging from B battery eliminators for automobile radios to three-element gaseous discharge tubes in which the grid has complete control over the plate current instead of being able to start it only. This latter tube, developed by Dr. Paul G. Weiller has applications in the power field where d.c. is required from a source of a.c. and can be utilized by the automobile radio set group as well. Another tube is reputed to be of the size of the early Western Electric "N" tube, known to the radio fraternity as the peanut tube. And there are others as well.

The preliminary rating and characteristics of the new r.f. pentode are:

Heater voltage			6.3 volts d.c.
Heater current			0.3 amperes
Plate voltage	*90	135	180 volts maximum
Screen voltage, maximum	*90	90	90 volts
Grid voltage, variable	*—3	—3	—3 volts minimum
Plate current	4.4	4.4	4.5 milliamperes
Screen current	1.3	1.2	1.2 milliamperes
Plate resistance	375,000	540,000	750,000 ohms
Amplification factor	360	530	750
Mutual conductance	960	980	1,000 micromhos
Mutual conductance at			
—30 volts bias	10	10	10 micromhos
—40 volts bias	Very small, but not zero		
Interelectrode capacitances			
Effective grid-plate capacitance			0.007 μμf. maximum
Input capacitance			4 μμf.
Output capacitance			10 μμf.
Overall dimensions			
Length			$4\frac{3}{16}$–$4\frac{11}{16}$ in.
Diameter			$1\frac{5}{16}$ in.
Cap			0.346–0.369 in.
Bulb			S-12
Base			Small 5 prong

*Recommended values for use in receivers designed for 110 volt d.c. operation.



Locomotive receiving equipment designed by General Railway Signal Company showing principal component parts as installed for service use. The amplifier in this installation is mounted on the tender

Electronic equipment in train control

THE use of amplifiers and associated equipment in signal control for some of our leading railroads is not new. Intensive development of automatic train control equipment started as far back as 1922, when the first order of the Interstate Commerce Commission covering such installations, was issued. Continuous cab signal equipment is an outgrowth of the earlier automatic stop equipment, and provides a means of informing the engineer of conditions on the track ahead.

Approximately 7,000 miles of track are now operated with some form of continuous control and 4,500 engines or electric cars are equipped for operating over this mileage. The locomotive mileage protected by continuous control signals now exceeds 5,000,000 per month.

There are various modifications of the continuous control system which include: The continuous automatic stop of the non-code type; one-speed, two-speed, three-speed control for the brakes and also cab signals without automatic stop. These systems have been designed to meet the special requirements of different roads.

The continuous system of control as applied to any of the above systems provides a means of indicating to the engineer at all times when in controlled territory, any change in track conditions ahead of the train. When provision is made for automatic brake application, unless the engineer acknowledges a change in conditions as indicated by his cab signals, the train may actually be brought to a stop or its speed checked.

The Union Switch and Signal Company, and the General Railway Signal Company have been the principal companies in installing amplifiers and associated equipment for continuous control apparatus.

By mutual agreement among the different roads all installations of the continuous coder system, which has the wayside apparatus so designed that engines are interchangeable over the different lines, is in effect. This wayside equipment, as designed, provides a 100-cycle track circuit current, which is fed into the rails at the exit end of each block, and interrupted a definite number of times per minute, according to conditions in the train block ahead. The lengths of the train blocks vary, but in general are less than 4,000 feet in length. Each train block is fed by an outside power source. The current in the rails produces a sufficient voltage in the amplifier carried on the engine, to cause other apparatus to function to repeat the signal indication to the engineer.

A code transmitter which is placed at the wayside station, interrupts the 100-cycle current at predetermined rates, called the "code frequency." For example, if the necessary number of blocks ahead are "clear," the code frequency is 180 per minute; if the condition ahead is

THE reliability of vacuum tubes in industrial applications is shown by their practical use in railway signal control systems. Approximately 7,000 miles of track are protected by continuous control signal apparatus and 4,500 engines are equipped with amplifier receivers.

such as to require "approach-restricting" conditions for the train, it is 120, and if "approach" condition exists, it will be 80 per minute. If the block is occupied, the code current is shunted by the train ahead and does not reach the receiver of the following train, thus giving "caution-slow-speed," indication in the cab. This indication is given also if the 100-cycle track current is present but uncoded.

In addition to the above signals in the cab, if automatic brake equipment is also installed, the brakes will be applied, depending upon the above track conditions, except when the engineer is given discretionary power. Even in the latter case, some form of acknowledgment is required which will indicate he is alert to the signals transmitted.

Receiving and amplifying equipment

The engine equipment consists of a receiver which is mounted ahead of the forward wheels, the amplifier unit, the acknowledging and decoding relay group, and the decoder which are all contained in the equipment box; the signal lights in the cab and warning whistle; a dynamotor for supply of current to the amplifier; the acknowledging switch and main switch.

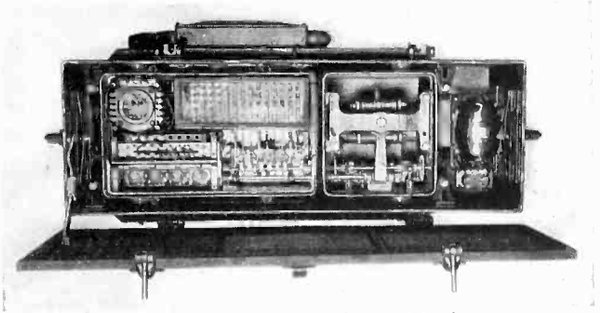
The receiver for this system consists of a laminated iron bar on which two coils are mounted, one over each rail, so that the voltages induced in them by the 100-cycle track circuit are additive. It is mounted ahead of the front truck, and in case the engine is equipped for reverse running, it is necessary to install a similar receiver on the rear of the tender.

The amplifier and associated equipment contained in the equipment box may be mounted at any convenient place on the engine. It is supported by shock absorbers to eliminate unnecessary vibration.

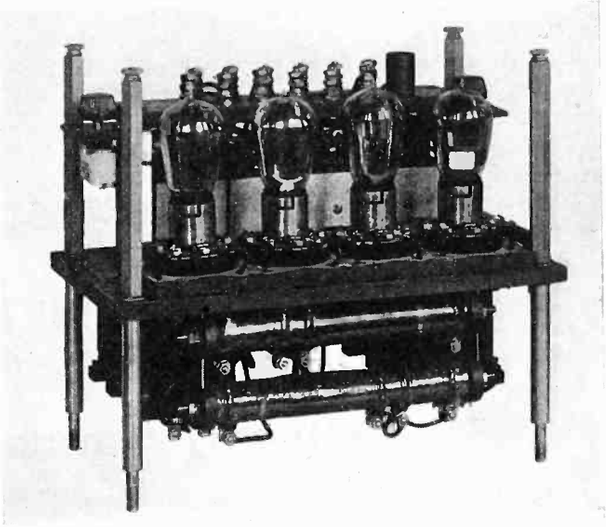
The voltage induced in the receiver is delivered to the amplifier, which is equipped with two or four tubes, depending on the type of installation. The two-element system, which uses a loop circuit, employs a four-tube amplifier to amplify through two stages, both the axle and loop currents which operate the two-element a.c. train control relay. With a single-element system, it is possible to use d.c. train control relays, requiring only a two-tube amplifier. The tubes used are Pliotrons, which are similar to those used in radio equipment but of more rugged construction. These tubes receive their operating current from a dynamotor (operating from the 32-volt headlight generator) which supplies 350 volts for the plate circuit, while the filaments are heated from the 32-volt source through suitable resistances. The amplifier is equipped with an electrical filter which suppresses all frequencies except 100 cycles.

The decoder consists of a decoding transformer with reactors and condensers necessary to tune the decoding relay circuits to their proper code frequencies. The tuning of these circuits is such that when the code frequency of 180, 120 or 80 cycles is present, the proper relays will be actuated to indicate the proper lights in the cab signals and operate the brake control apparatus. When there is no 100-cycle track circuit flowing, or when this current is not coded, none of the decoding relay circuits are energized.

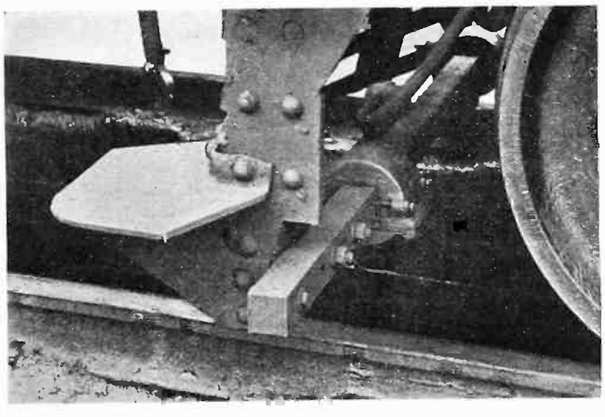
The cab signals controlled by the decoding relays will thus indicate the track conditions ahead by means of color lights or position-light aspects, depending upon the standard used for a particular road. These signal boxes are placed in such a position that both the engineer and



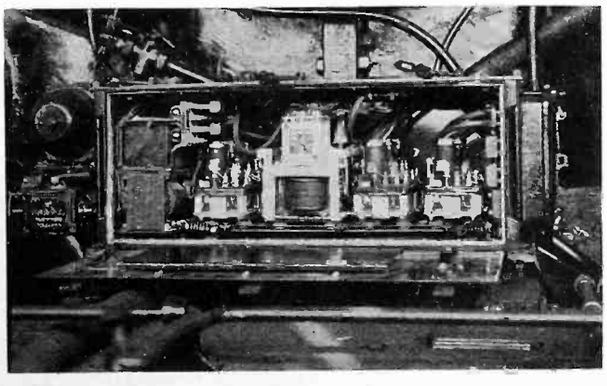
Detail view of the equipment box with dynamotor, governor, cams and four-tube amplifier



Four-tube amplifier using Pliotron tubes for cab signal equipment



Close-up view of receiving coils mounted on cross-bar in front of the engine's forward wheels



Equipment box containing amplifier unit mounted on the engine pilot, designed by Union Switch and Signal Company

fireman may observe the signals when watching the track ahead.

An acknowledging switch controlling the warning whistle is usually located in a convenient position to the engineman. Answering this signal will cause the whistle to cease sounding, but it sounds again on any change to a more restricted track condition.

How the track circuits operate

If a certain block is unoccupied, the code transmitter for that block does not operate. The track relay will be energized from the track transformer, and a circuit made through the primary of the transformer through the front contacts of a slow-acting relay, and over the back contacts of a relay called the "VR" relay. On the entrance of a train into the block, the track relay will be de-energized to close the back contact and pick up the "VR" relay. This starts the code transmitter. If the indication of the block entered is "clear," the track circuit ahead of the engine will be energized with the 100-cycle current, interrupted 180 times per minute. If the track relay of the second block next in advance of the block just entered is de-energized, the approaching train will receive a signal corresponding to the "approach-restricting" condition. This is caused by reversal of the track relay in advance of the train, assuming a three-position relay is used. This will cause the current for the primary of the track transformer to be interrupted 120 times a minute, thus sending out a code signal for this condition. Similar action takes place when the block next in advance of the train is occupied, which causes a code signal of 80 to be transmitted.

When an engine enters an occupied block, the track circuit ahead of the engine receiver is shunted by the train ahead, and therefore does not reach the receiver of the approaching train. When this happens, the "caution-slow-speed" indication is given in the cab. Any condition such as a broken rail, switch opening, obstruction across the rails that causes a short-circuit of the track circuit, will cause the most restrictive condition to be indicated in the cab.

With the above signal system installed, the engineman is relieved of much mental strain when operating his train during inclement weather conditions. Polls which have been taken of enginemen operating with locomotives equipped with automatic equipment have indicated practically 100 per cent acceptance.

▼ ▼ ▼

15,801,620 American homes with radio sets

IN APRIL, 1930, the U. S. Census Bureau took its count of the radio sets in American homes. Since that time, compilation of these figures has been going on at Washington and now after nineteen months' work, the final total has just been released.

The official census figure shows 12,078,345 homes having radio sets as of April, 1930.

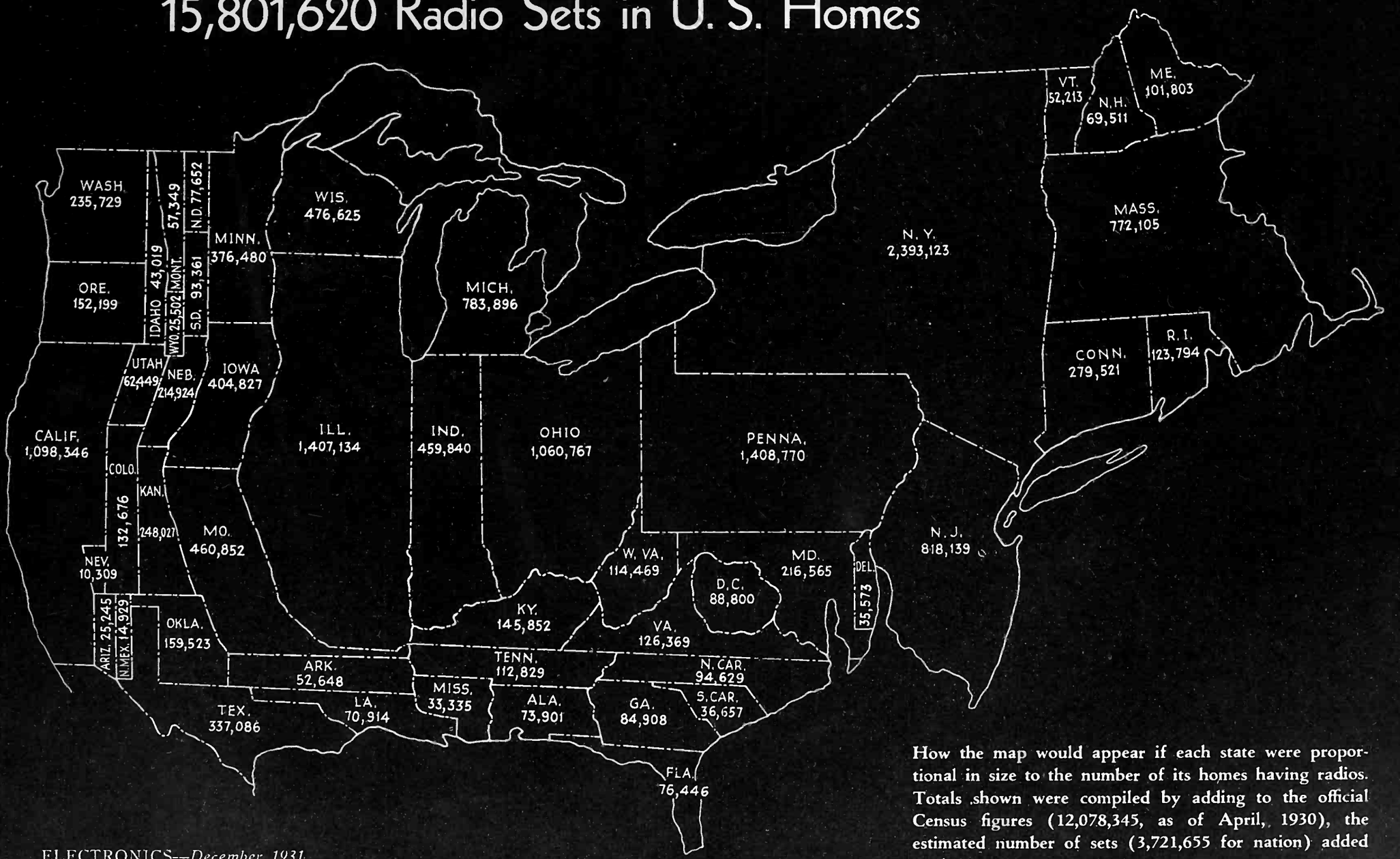
Careful estimates based on the McGraw-Hill annual production and sales statistics for 1930 and 1931, show that since the date of the census count, April, 1930, at least 3,723,275 sets have been sold to homes without radios (not including replacements and additional sets).

Combininig these, gives a grand total as of December 1, 1931, of 15,801,620 homes with radio sets.

The distribution of these sets among the states is shown in the table below, and in the chart opposite, where the map reveals the states as they would appear if proportional to the number of homes with radios.

State	U. S. census *Homes with radio as of April, 1930*	Since census *Sales to homes without radio*	Homes with radio *as of Dec. 1, 1931*
Maine	77,803	*24,000*	**101,803**
New Hampshire	53,111	*16,400*	**69,511**
Vermont	39,913	*12,300*	**52,213**
Massachusetts	590,105	*182,000*	**772,105**
Rhode Island	94,594	*29,200*	**123,794**
Connecticut	213,821	*65,700*	**279,521**
New York	1,829,123	*564,000*	**2,393,123**
New Jersey	625,639	*192,500*	**818,139**
Pennsylvania	1,076,770	*332,000*	**1,408,770**
Ohio	810,767	*250,000*	**1,060,767**
Indiana	351,540	*108,300*	**459,840**
Illinois	1,075,134	*332,000*	**1,407,134**
Michigan	599,196	*184,700*	**783,896**
Wisconsin	364,425	*112,200*	**476,625**
Minnesota	287,880	*88,600*	**376,480**
Iowa	309,327	*95,500*	**404,827**
Missouri	352,252	*108,600*	**460,852**
North Dakota	59,352	*18,300*	**77,652**
South Dakota	71,361	*22,000*	**93,361**
Nebraska	164,324	*50,600*	**214,924**
Kansas	189,527	*58,500*	**248,027**
Delaware	27,183	*8,390*	**35,573**
Maryland	165,465	*51,100*	**216,565**
District of Col.	67,880	*20,920*	**88,800**
Virginia	96,569	*29,800*	**126,369**
West Virginia	87,469	*27,000*	**114,469**
North Carolina	72,329	*22,300*	**94,629**
South Carolina	28,007	*8,650*	**36,657**
Georgia	64,908	*20,000*	**84,908**
Florida	58,446	*18,000*	**76,446**
Kentucky	111,452	*34,400*	**145,852**
Tennessee	86,229	*26,600*	**112,829**
Alabama	56,491	*17,410*	**73,901**
Mississippi	25,475	*7,860*	**33,335**
Arkansas	40,248	*12,400*	**52,648**
Louisiana	54,364	*16,550*	**70,914**
Oklahoma	121,973	*37,550*	**159,523**
Texas	257,686	*79,400*	**337,086**
Montana	43,809	*13,540*	**57,349**
Idaho	32,869	*10,150*	**43,019**
Wyoming	19,482	*6,020*	**25,502**
Colorado	101,376	*31,300*	**132,676**
New Mexico	11,404	*3,525*	**14,929**
Arizona	19,295	*5,950*	**25,245**
Utah	47,729	*14,720*	**62,449**
Nevada	7,869	*2,440*	**10,309**
Washington	180,229	*55,500*	**235,729**
Oregon	116,299	*35,900*	**152,199**
California	839,846	*258,500*	**1,098,346**
Total for United States	12,078,345	*3,723,275*	**15,801,620**

15,801,620 Radio Sets in U. S. Homes



How the map would appear if each state were proportional in size to the number of its homes having radios. Totals shown were compiled by adding to the official Census figures (12,078,345, as of April, 1930), the estimated number of sets (3,721,655 for nation) added to date.

Cathode-ray oscillograph timing axis

By F. T. BREWER, B. S.

THE cathode-ray oscillograph holds practically the same position among oscillographs as the vacuum tube voltmeter does among voltmeters. Its applications and uses are extensive, because it consumes no power from the source to which it is connected, and has a very wide frequency range. These advantages are especially valuable in radio work where the power output is very limited and the frequencies practically unlimited.

In a standard cathode ray oscillograph tube, an electronic beam passes upward from the cathode through the center of the tube and hits a fluorescent screen on the top of the tube. The bombardment of that screen causes a blue light to be given off. In passing through the tube in that manner, the beam passes between two sets of non-magnetic metal plates. The two plates of each set are parallel, and the plates of each set are at right angles to the plates of the other. If then, a potential is applied to one set of plates as shown in Fig. 1 below, the beam will be deflected a distance proportional to the potential applied.

If desirable then, points may be marked in that manner to calibrate the tube for indicating peak voltages. By the same reasoning, if an a.c. potential is applied to the plates instead of the d.c., the beam will be moved back and forth between those plates at a rate proportional to the frequency and with an amplitude proportional to the peak voltage, as shown in Fig. 2.

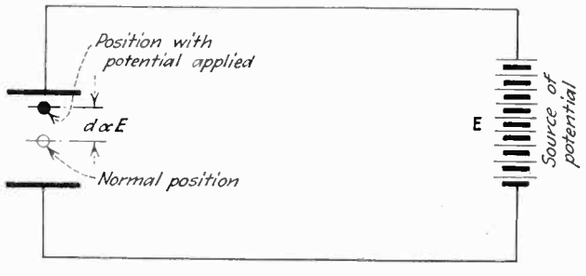


Fig. 1—Deflection is proportional to applied potential

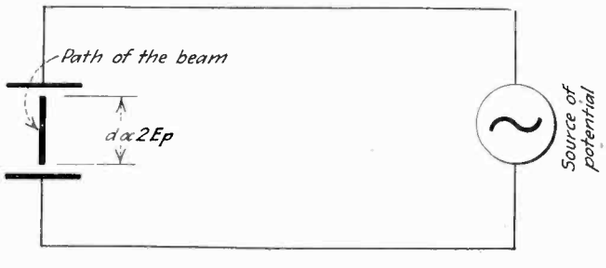


Fig. 2—Alternating e.m.f. produces straight line deflection

Measuring a.c. waves

Figures 1 and 2 above indicate a method by which the peak value of an a.c. wave may be measured. However, one of the main uses of such a tube is that of studying wave forms, and by using the other set of plates that work may be done. Two of the deflecting plates (one of each pair) are connected to the anode inside of the tube. Hence, if the other two plates are connected to sources of potential as shown in Fig. 3, the resultant position of the beam will depend upon the magnitudes of the applied voltages.

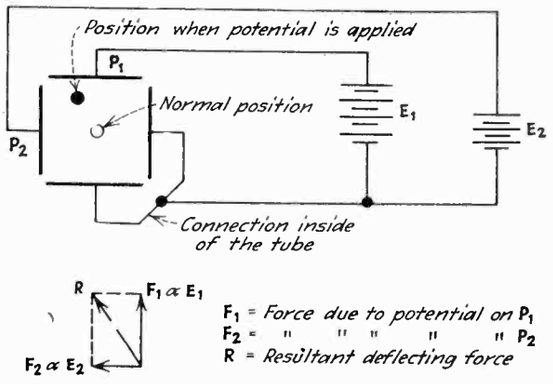


Fig. 3—Potentials applied to two sets of plates produce deflection proportioned to each

However, if the sources of constant potential are replaced by a.c. sources, the path of the beam will depend upon several variables. Namely, the frequencies of the two sources or their phase relation, the potential of the sources, and the wave form of the sources.

For the present purpose, consider two sources of perfect sine waves having the same voltage, and replace the sources of constant potential with those. Also consider them as being 90 degrees out of phase as shown in Fig. 4. Then by considering the direction and magnitude of the two voltages, and determining their resultant direction and magnitude vectorially it may be seen that such a combination will cause the beam to trace a circle. Since it is very seldom that a combination may be obtained which will give a figure, which would be as easy to analyze as the one in Fig. 4, it is very desirable to use some system by which the actual wave form may be seen. If a potential could be applied to one set of plates which would move the beam across the screen in a straight line at a uniform speed in the same time it took the potential on the other set of plates to pass through one cycle, the wave of that cycle would be traced.

The magnitude of the wave would depend upon the peak voltage of the a.c. source and the length upon the magnitude reached by the potential moving the beam across the screen. However, in order to be back for the start of the next cycle, the beam would have to move back to the starting point instantaneously. Figure 5 shows the circuit of a timing axis that will accomplish that result.

Theory of the timing circuit

The fundamental equations for a condenser suggest the theory of operation of the timing axis.

$$Q = EC = \int i\,dt$$
$$E = 1/C \times \int i\,dt$$

That is, the potential developed across a condenser is inversely proportional to the capacity and proportional to the time of charge when only a small increment of the charging time is considered.

As the potential across the condensers, C_1 and C_2 builds up, the beam is moved across the screen with a speed proportional to the plate current of the 224 tube, and inversely proportional to the capacity, because the potential across the condenser is also across one set of plates. Then when the voltage across the condenser reaches the flash point of the voltage regulator tube, the tube will flash and discharge the condenser practically instantaneously to a voltage somewhat lower which is the cut-off voltage of the tube. Thus, the beam will pass back practically instantaneously for the start of the next cycle.

Since the condensers are connected in the plate circuit of the 224 tube, their speed of charge may be controlled quite accurately by controlling the plate or charging current by adjusting the grid bias. Course adjustments are made by changing the capacity of the condensers. The curve of the potential across a condenser as it charges is not a straight line over its entire length, but is similar to that shown in Fig. 6. However, since the breakdown and cut-off voltages of the voltage regulator tube are close together, as well as fairly high, the portion of the curve used is practically straight, thus giving practically uniform motion of the beam across the screen.

A vernier adjustment is necessary on the bias of the 224 tube in order to adjust the speed or frequency accurately. Even then it is sometimes difficult to keep the timing axis exactly in step with the source of potential

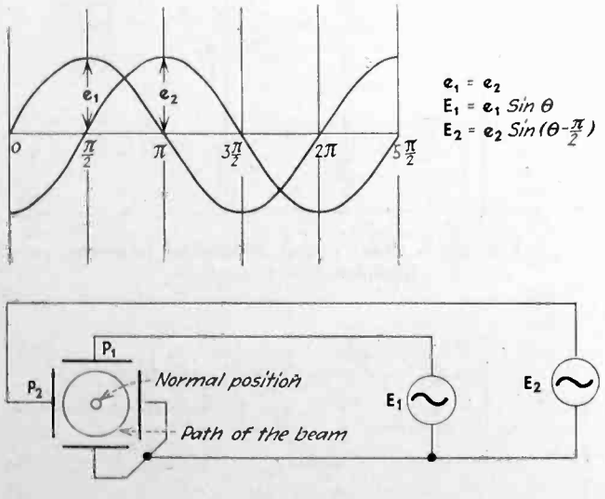


Fig. 4—Circular deflection produced by two alternating voltages of proper amplitude and phase

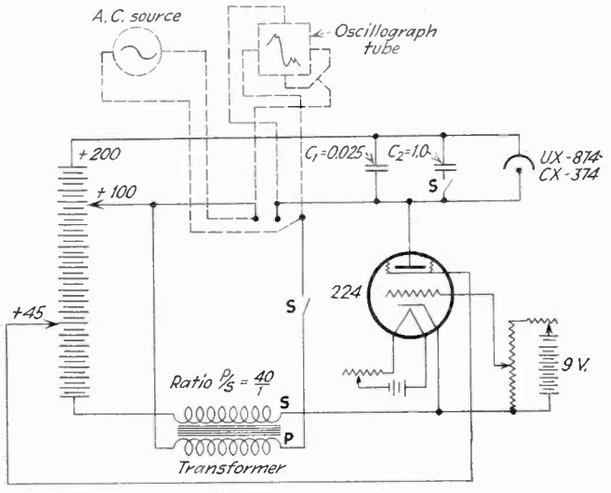


Fig. 5—Method of producing timing axis for cathode ray tube

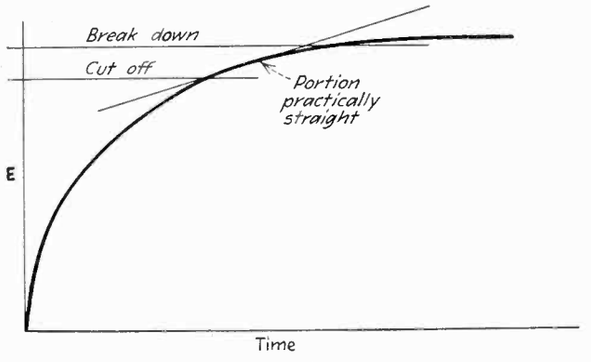


Fig. 6—Linear portion of charging rate of condenser used in timing scheme

which is connected to the other set of plates. To further facilitate keeping the two in step, the transformer has been placed in the circuit so that a small voltage from the source will tend to tip the voltage regulator tube off at the instant the source potential comes to a peak value and the condenser is charged to the proper voltage. The voltage supplied by the secondary of the transformer should not be too great, however, or it may tend to break the regulator tube down at the wrong time. In all cases, the primary impedance of the transformer should be high. Then, to work properly, the waves should be put on the screen so the peaks come at the ends.

If the wave finger moves on the screen, the timing axis is not set at an integral multiple of the frequency of the source. If stationary, but more than one cycle of the wave is shown, the speed of the timing axis is too fast.

The position on the screen and magnitude of the wave may be regulated by regulating the source and battery voltages. Batteries are recommended to supply the voltages, because steady sources of d.c. are necessary. The frequency range of such a timing axis should be from about 25 to 5,000 cycles per second. The principal limiting factor seems to be the voltage regulator tube. If the frequency is very high, the time of discharge becomes appreciable. Hence, for such work, a tube should be selected which has the flash and cut-off voltages as close together as possible.

Audio-frequency compensation methods

By JULIUS G. ACEVES
Amy, Aceves & King, Inc.

PRESENT tendency to increase the selectivity of radio receivers to the point where severe sideband discrimination results is forcing amplifier engineers to consider methods of compensating for these deficiencies in high-frequency response. Lack of baffle area to properly reproduce fundamental low notes makes another demand upon the ingenuity of the amplifier designer. In addition to making up for losses in some part of the spectrum there may be—and often is—an over-amplification at some frequencies, or because of an electrical or mechanical peculiarity of some other part of the system, an actual loss in amplification at some frequency may be needed. Thus it becomes important not only to know how to make up for losses, but to decrease the gain or otherwise to distort a straight characteristic.

Reinforcement of high audio-frequencies

For example, there are a few cases where it is desirable to increase the gain toward the upper end of the audio-frequency band, as in ultra-selective superheterodynes, in phonograph reproduction, or in sound moving pictures with film recording where the audio amplifier is far away from the light cell.

One method consists of utilizing the capacity coupling between windings of the audio-frequency transformers which, combined with the leakage reactance and the capacity of the tube input circuit, form a network similar to the schematic diagram of Fig. 1. It is rather difficult to calculate the gain at various frequencies even if the values of C_0, C_2, L_2 and L_0 were known. It is better to connect the audio-frequency transformer windings with such "polarity" that the capacity coupling C_0 will have an additive effect with the mutual induction between windings, and to choose a suitable type of audio-transformer with the required leakage reactance. There are many such transformers on the market, particularly of old design.

A second method lends itself to predetermination of the gain and consists of a combination of choke-and-resistance in the feed circuit of the anode as shown in Fig. 2. The resistance R_2 may be replaced by a choke or by the primary of an audio-frequency transformer. If, for simplicity, we assume that this resistance or impedance is large in comparison with the impedance $Z_1 = R_1 + j\omega L_1$, it will be noted that the gain per stage will be given by substituting the value of Z_1 in the fundamental equation $G = \mu \frac{Z}{Z + r_p}$ where Z is the load impedance and r_p is the tube plate resistance.

$$G = \mu \frac{R_1 + j\omega L_1}{R_1 + r_p + j\omega L_1} \quad \text{or rationalizing:}$$

$$G = \mu \sqrt{\frac{R_1^2 + \omega^2 L_1^2}{(R_1 + r_p)^2 + \omega^2 L_1^2}}$$

It will be noted that as ω increases, $(\omega L_1)^2$ will be large in comparison with R_1^2 and $(R_1 + r_p)^2$ and the fraction inside the radical will approach unity. For low frequencies, however, $(\omega L_1)^2$ will be small compared to R_1^2 and to $(R + r_p)^2$, and the gain will tend to the value of:

$$G = \mu \frac{R_1}{R_1 + r_p}$$

which would be the gain had there been no choke in the circuit. If we make $R_1 = r_p$, the gain at low frequencies will be nearly one-half the corresponding value at high frequencies, and the effect of duplicating this circuit in two of the stages will make the net ratio between low and high frequency gain nearly four, or 12db. The value of the inductance L_1 should be such that ωL_1 will be sensibly equal to $R_1 + r_p$ at the frequency at which it is desired to begin the boosting, for example, 700 cycles.

There is nothing to prevent the combination of both low and high frequency boosting in each stage; all that

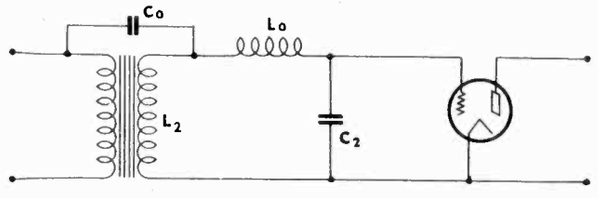


Fig. 1—Method of utilizing capacity between transformer windings

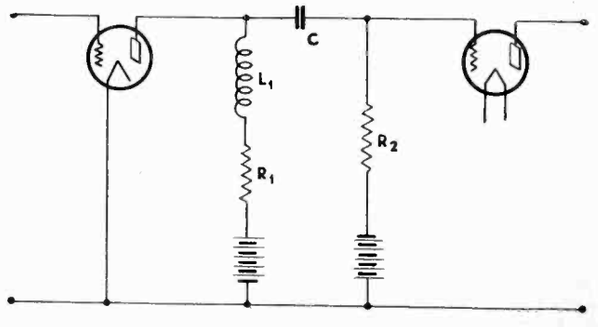


Fig. 2—A shunt circuit method of boosting high-frequency response

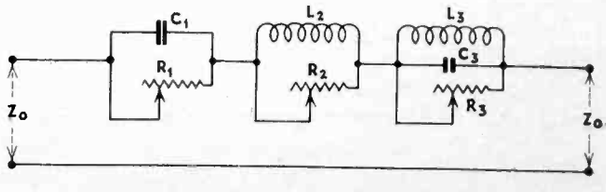


Fig. 3—Band suppression circuit consisting of a series of elements

is necessary is to substitute the resistance R_2 of Fig. 2 for an inductance of the proper value according to previous discussion. Thus an amplifier, by judicious design, can be made to have a humpbacked characteristic, or can have higher amplification at the extreme ends of its transmission range than it has at the middle.

At the present time the upper end of the musical scale is quite a bit mutilated even by moderately priced commercial radio sets. Superheterodynes are rarely built with band-pass filters, and tuned r.f. sets with Vreeland tuners or equivalent band-pass effects are conspicuous for their scarcity. Hence, compensation in the audio-amplification is needed for good fidelity and speech articulation.

The pernicious practice of bridging condensers across some parts of the audio-frequency system cannot be too strongly condemned as it makes speech almost unintelligible and music dull and colorless. It is true that it helps to reduce "static" and other high-frequency noises but these, like needle scratch in gramophone reproduction, should be reduced by circuits much sharper in cut-off than mere condensers so as to interfere as little as possible with the amplification of the high frequencies. Carefully designed tone compensation networks are very useful in correcting for losses in frequencies occurring in some part of an audio circuit.

Frequency band suppression

There are cases where it is desirable to amplify the low frequencies, the high frequencies, or some intermediate frequency band to a smaller extent than the rest, or even to eliminate them altogether. Low, high and band-elimination filters can be employed, but in the majority of cases a simple device is quite suitable, and it may be secured at hand from standard parts. A combination of a variable resistance of about 100 to 100,000 ohms, a fixed condenser and a multi-tap inductance, such as commercial variable-ratio transformers, will be quite effective in reducing a frequency band. The resistance with the condenser only will reduce high frequencies, and the resistance with the inductance alone, the low. The place to connect these elements may be either the grid or the anode circuit of any of the stages, according to the values of the resistance, inductance and capacity of these parts and the impedance of the circuit to which they are to be attached. They may be connected in shunt or in series as per Figs. 3 and 4. If the output impedance Z_2 is infinite, as when connecting the circuit to the grid of a tube, the calculation for the voltage reduction at various frequencies is very simple. Representing by Q, the ratio of the reactance to the resistance of the source (vacuum tube or phonograph pick-up, etc.) and q the ratio of the reactance of the coil, to the total resistance of the shunt circuit r, l, c, Fig. 4, we shall have:

$$Q = \frac{\omega_0 L}{R} \text{ and } = \frac{\omega_0 L}{r}$$

Where $$\omega_0 = \frac{1}{\sqrt{Lc}} \text{ and } = \frac{\omega}{\omega_0} = N$$

the gain will be

$$G = \mu \sqrt{\frac{Q^{-2} + (N - N^{-1})^2}{(Q^{-1} + q^{-1})^2 + (N - N^{-1})^2}}$$

Figure 5 gives some graphs calculated for various values of Q and q, for $\mu = 1$. It will be noted that the sharpness of the peak is mostly controlled by the selection of Q while the reduction is governed by the choice of q. Thus it is possible to control both the amount of "cut-out" and the band of frequencies affected.

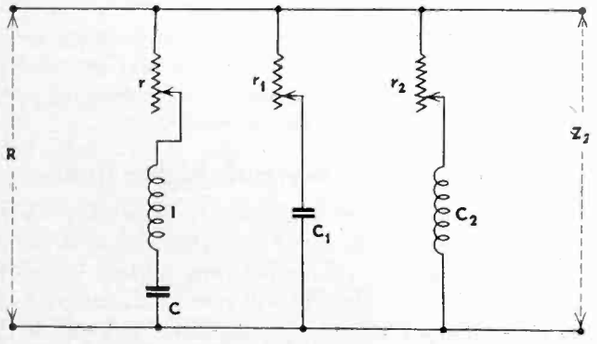


Fig. 4—Parallel elements for suppressing certain frequencies

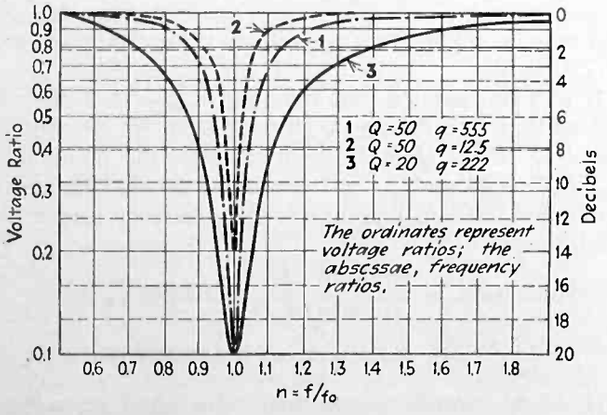


Fig. 5—Effect of varying circuits constants on sharpness and depth of suppression

Use as "scratch filter"

If the impedance Z_2 is not large in comparison with the impedance of the shunt, the results will be only approximate but sufficiently accurate to enable the designer to make a good choice of parts for an experimental trial from which the final circuit constants can easily be selected. The similarity of the circuits containing inductance or capacity only with resistance, Fig. 4, to the circuit of Fig. 2, will be apparent, and the calculations will be almost identical. In Fig. 3, the circuits in series with the line are quite well known and we need only to point out the fact that they are not suitable for operation in connection with a high impedance load such as the grid circuit of a tube except perhaps in one instance; when the capacity reactance of the grid to filament is low. An inductance with a resistance in shunt with it, such as L_2 R_2, Fig. 3, may work very well in surface noise elimination in phonograph record reproduction. The inductance together with the electrode capacity of the tube will act as a single stage of a low-pass filter that should be designed to cut off just below 3,500 cycles, as the "scratch" predominant frequency seems to be around 3,700 cycles. The shunt resistance will permit the control of the sharpness and the extent of the cutting off of the upper frequency band so as not to interfere unnecessarily with the reproduction of the overtones and at the same time to sufficiently reduce the obnoxious needle scratch.

NOTE: This material is taken from the section on Audio Amplification in a Handbook for Radio Engineers to be published by the McGraw-Hill Publishing Company during the winter.

Pentode tubes used as triodes

By J. R. NELSON
Raytheon Production Corporation

THE power output type of pentode tube represents tube designers' efforts to realize the theoretical efficiency of 50 per cent obtainable with class "A" amplifiers using peak input voltages no greater than the negative bias on the control grid of the tube.

In the case of the triode output tube only about 20 per cent of the maximum possible efficiency of 50 per cent is realized unless plate voltages higher than the safe limit of the tube, or higher than other limitations permit, are used.

Consider in Fig. 1 the load line AB which is drawn through I_o, the rated operating point, $2I_o$ and the curve for —50 volts bias. This load line is purposely drawn without regard to distortion to get the maximum possible power with an input voltage of 50.0 volts peak with the tube bias voltage—50.0 volts. The a.c. power output is one-eighth the block of power represented by the rectangle of which the line AB is the diagonal. The maximum possible a.c. power is, however, one eighth the power represented by the rectangle of which CD is the diagonal. The maximum possible efficiency of the 245 tube under the above conditions then is

(1) Efficiency $= \frac{\text{triangle } JAB}{\text{triangle } OCD} \times 50$ per cent, or as above

$\frac{.059 \times 242}{.066 \times 500} \times 50$ per cent or 21.6 per cent

Actually, however, the efficiency is cut down somewhat because of distortion considerations. The power output of the 245 under the above conditions is $.216 \times 250 \times .033$ or 1.77 watts while the rated value is 1.6 watts.

A study of Fig. 1 reveals the characteristics of an ideal triode. For example, if the current for zero bias fell along the line OC and for some negative bias voltage E_c fell along GH and for $2E_c$ fell along DK and if the tube were operated so that the initial current were I_o a signal voltage of peak value E_o would give an output of $\frac{2E_o \times 2I_o}{8}$ or $E_oI_o/2$, which is one-half the d.c. power supplied or I_oE_o.

Such characteristics as outlined above are impossible of attainment as such a device would have zero resistance and would be unstable. The 245 characteristics are about as good as may be realized practically using a thermionic tube. It is impracticable to reduce the mu further as the grid turn spacing is about as wide as practical now. Even with the spacing of the 245 the grid loses some control as may be seen by the dragging off of the I_p-E_p curves for high biases in Fig. 1.

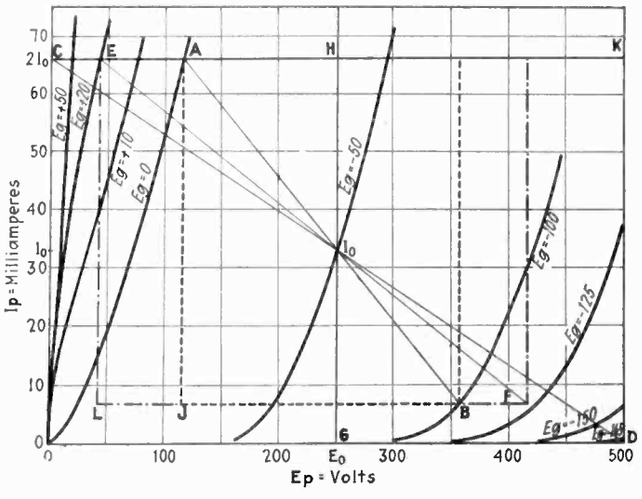


Fig. 1—Pentode characteristics; 247-type

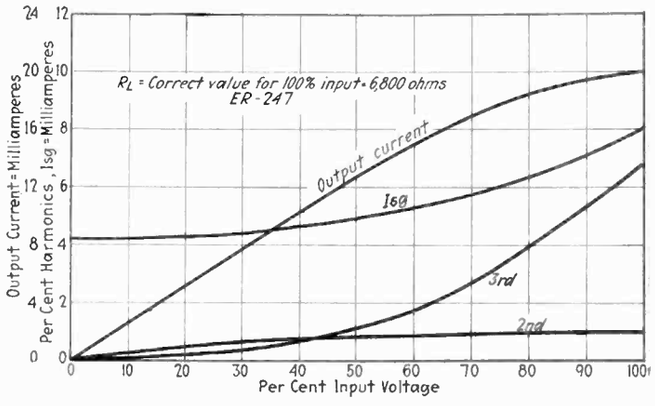


Fig. 2—Output current and harmonic content of power pentode

Increased efficiency with higher input

The efficiency may be increased considerably by running up the input voltage and disregarding grid current. The practical difficulty of maintaining a good wave form when grid current is drawn will not be considered here. The I_p-E_p characteristics for positive values of grid biases will next be considered. An infinite number of operating points would be possible but only one will be considered, namely minus 50.0 volts C bias and 250 volts plate, as a study of the operation of the tube under these conditions will show about the maximum efficiency that may be obtained using no higher than the rated value of 250 volts.

It will be assumed that the grid swings 20 volts positive so that the total peak voltage swing is 70 volts. A load line EF is shown drawn through the points $I_p = 2I_o$, $E_g = 20$ and I_o and continued to the intersection with the—120 volt bias line. The efficiency under these conditions is

$$\text{Efficiency} = \frac{\text{triangle } LEF}{\text{triangle } OCD} \times 50 \text{ per cent, or}$$

$$\frac{59 \times 378}{66 \times 500} \times 50 \text{ per cent, or } 33.9 \text{ per cent}$$

It would require a low turn ratio input transformer with a fairly low d.c. secondary resistance to obtain even the above efficiency with good wave form so a

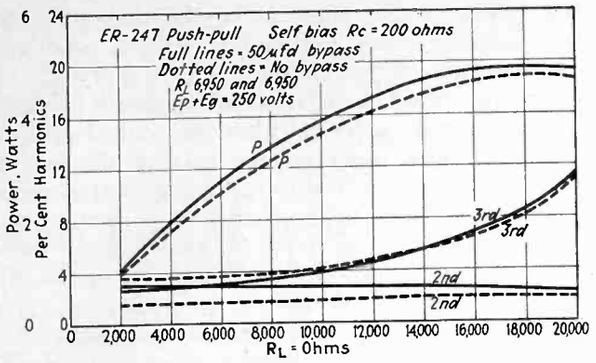


Fig. 4—Effect of by-passing self-bias resistance—push-pull pentodes

higher grid swing would be impractical. A peak swing of 165 volts would be required to realize the theoretical efficiency of 50 per cent. The actual efficiency, however, with a 165-volt grid swing would be greater than 50 per cent due to the harmonics which would be introduced in the process.

Virtues of the pentode

In the previous case we found that one ideal tube should have zero resistance and we found the maximum possible efficiency under various conditions of a commercial tube having characteristics approaching as closely as possible to the ideal characteristics. The other extreme case would be a device having infinite impedance. The commercial pentode is reasonably close to this ideal characteristic.

Inspection of plate current curves of a typical pentode, ER 247 for example, shows that a practical efficiency of 32.7 per cent can be realized with a power output of 2.62 watts.

The second harmonic minimum is rather sharp with respect to load resistance and the third increases quite rapidly with load resistance after the point of minimum second harmonic is reached. These characteristics call for a load impedance having a fairly constant value with respect to frequency. If the load impedance varies considerably the harmonic content will become rather high.

Figure 2 shows various characteristics as a function of per cent input voltage using the ER-247 tube with a constant load resistance of 6800 ohms which value gave minimum 2nd harmonic with 100 per cent input voltage. The value of peak input voltage equal to the grid bias in all cases is called 100 per cent. It is to be noted that the maximum value of distortion occurs with 100 per cent input voltage although some other value of load resistance R_L would give less second harmonic distortion for any value of input voltage less than 100 per cent. It is also to be noted that the current is not proportional to the input voltage over the entire range of input voltages from zero to 100 per cent. The screen-grid current varies considerably also with input voltage.

The power output of a single pentode is not in all cases considered to be sufficient. The quality of the output from a single pentode even under the best of conditions will not be quite as good as that obtainable from a triode. The percentage of harmonics decreases in a triode as the load impedance increases while the percentages of harmonics increase quite rapidly with an increase of resistance after the optimum value in the case of a pentode. The per cent second harmonic increases also with a decrease of resistance below the optimum value. The pentode then under the usual conditions of a varying load impedance with respect to frequency introduces a considerably larger percentage of harmonics than does the triode.

It will be desirable to study power output and distortion curves before considering methods of operating the pentode so as to reduce distortion or arbitrarily matching it according to the usual power output practice, that is using twice the single tube load impedance for push-pull operation or one-half the impedance for parallel operation.

Curves showing parallel and push-pull operation of pentodes are shown. From a quality standpoint push-pull tubes should be worked into a lower value of output resistance than the theoretical value in view of the variations of speaker impedance with frequency.

Figure 4 was taken with a 200-ohm fixed resistor in series with the cathode, from which the C-bias was obtained. The total applied voltage was 250 volts so that the output is reduced somewhat from that given by the C-battery connection with 250 volts on the plate and screen grid. The harmonic distortion is less with this resistor by-passed but no serious harm was done with this resistor not by-passed. The increase of the second harmonic is caused by the screen-grid currents not being exactly the same so that the effective bias was higher on one tube than on the other. The operation is about the same for the case of the self-bias as with the C-bias, when the tubes are connected in parallel. This resistor in the case of the parallel connection should be either by-passed or decoupled.

Pentode used as a triode

As a matter of interest the characteristics of a typical 247 type of tube connected as a triode are shown. The screen-grid in this case is connected directly to the plate. The power output and percentages of 2nd and 3rd harmonic distortion are shown plotted in Fig. 5 for a plate voltage of 250 volts.

The 247 as a triode has to have a total applied volt-

[*Please turn to page 254*]

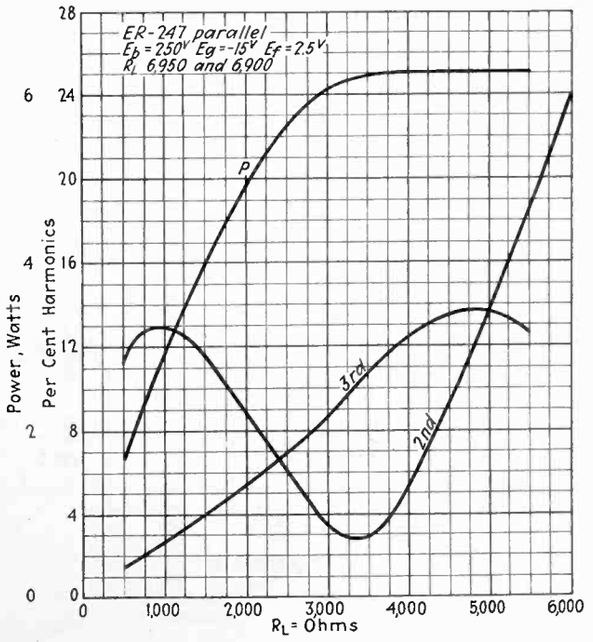


Fig. 3—Power output and distortion of pentodes in parallel

Overload limit extension of the tetrode detector

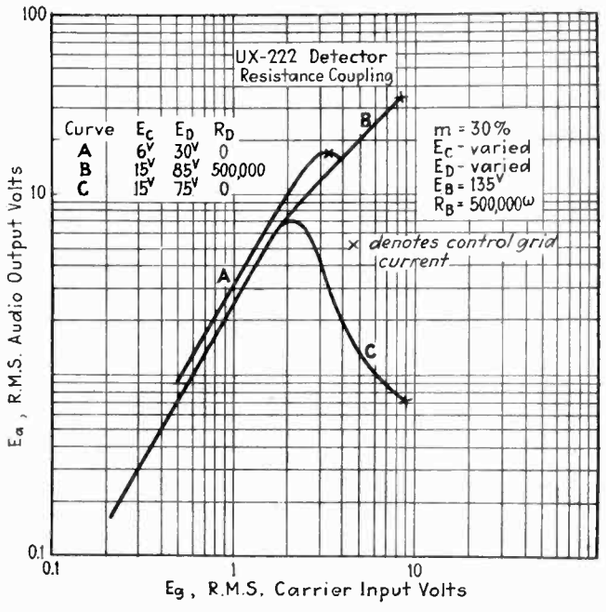
By PAUL O. FARNHAM
Radio Frequency Laboratories

THE problem of designing a vacuum-tube detector circuit which possesses high sensitivity for weak carrier inputs and at the same time which will handle high levels of input and output voltages without distortion has been met, in the case of separate heater tubes, by the use of a control grid bias that increases with increasing carrier inputs. The cathode current of the tube is made to flow through a resistor and the resulting d.c. bias is applied to the input circuit control grid. This bias voltage is made correct for sensitive plate-circuit rectification by the proper choice of biasing resistor and will increase automatically with the increase in cathode current caused by higher levels of carrier input. Such a circuit has been found to work well with both triode and tetrode detectors using resistance or impedance coupling in their output circuits.

Unless one uses a separate filament battery or a separate plate battery, some other method must be employed in the case of a filament-type detector when used with apparatus involving other filament-type tubes, if similar overload characteristics are to be obtained.

The following description shows one method useful with the filament-type tetrode detector in obtaining better overload characteristics than are to be had with conventional arrangements, particularly in the case of a resistance-coupled output circuit.

Overloading in such a detection arrangement as shown in the diagram may occur in either the control-grid circuit, when the peak input voltage exceeds the bias E_c and causes grid current to flow, or in the output circuit when the voltage swing in the plate load is great enough to cause the instantaneous value of plate voltage to become less than the steady screen voltage. For the conventional arrangement in which $R_D = O$ optimum values of E_D and E_c may be determined from the standpoint of sensitivity and output at overload of either sort. Such a condition is illustrated by Curve A where grid and plate circuit overload occurs at about the same level of carrier wave input and a maximum audio output of 17 volts.

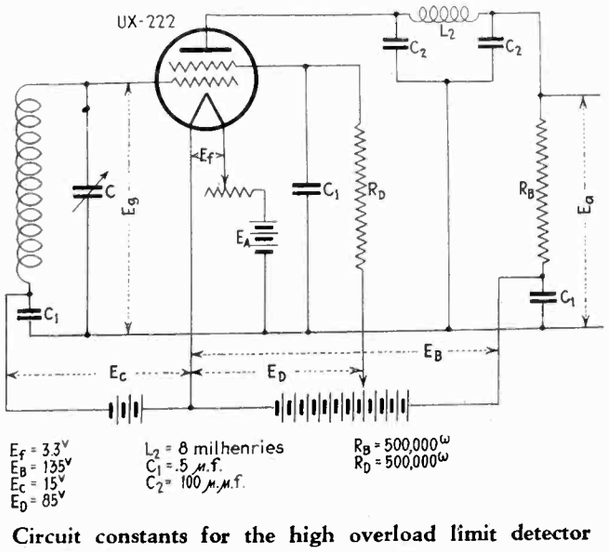


Improvement in overload characteristic demonstrated

To postpone grid-circuit overloading to higher levels of input, the bias E_c must be increased as well as the screen voltage E_D to keep the sensitivity at its highest possible value. Curve C illustrates what ocurs when such steps are taken. Plate-circuit overload occurs at a much lower level of audio output, 7 volts with control grid overload postponed until a carrier input level of 9 volts is reached.

If now a resistance R_D is used in series with the screen battery voltage an increasing carrier input will serve to increase the d.c. screen current thereby reducing the steady screen voltage below that of the battery in such a way as to allow for a greater audio voltage swing in the plate load before plate overloading is reached. Curve B illustrates this condition in which overload is not reached until an audio output of 34 volts is obtained.

Curve B shows a substantially linear relationship between audio and output and carrier input for the useful range of input levels below that required for overload down to about 2 volts. This method of controlling the detector characteristic is thus similar to the usual arrangement of an automatic bias resistor in series with the detector cathode for increasing the overload limits of the system and for obtaining so-called "linear detection," allowing one to realize these desirable features with filament type tetrode detectors.



Circuit constants for the high overload limit detector

Can radio sets be sold to Europe?

By S. E. LASZLO
Export Engineer

THE number of radio receivers in Europe seems to keep pace with the number in the United States. In 1929, the number in use in Europe was roughly 11,000,000, in the United States and Canada slightly less, in 1930 the numbers were about the same, and in 1931 the number of receivers in use in Europe was 13,000,000 roughly, according to figures of the U. S. Department of Commerce, Bureau of Foreign and Domestic Commerce.

The situation, then, in Europe is that the total number of sets has been increasing rapidly; many of these receivers must be replaced because they are simple crystal or cheap home-made one to four tube affairs utterly unable to cope with the increasing number of high-power stations in Europe on adjacent channels. Owing to high price of European merchanise compared to what an American gets for his money, it seems that American manufacturers should look at the European market.

With the increase in high-power stations there is a greatly increased demand among radio listeners for a superior type of apparatus, capable of receiving all distant stations. The life of the European radio listener is strongly influenced by prevailing unfavorable economic conditions. Generally speaking, the income of Europeans has shrunk considerably since the war, but the desire for the enjoyment of life has increased. Because of contracted income, Europeans are compelled to give up part of their theater, movie and musical entertainment. Radio has filled a gap in these circumstances and has become intensively popular. The popularity of radio in turn aided the radio industry, which at present is the only one among the electrical industries that, despite prevailing gloomy business conditions, is still expanding.

From the beginning of the radio industry, American manufacturers failed to explore the possibilities of export into Europe. There were, and still are, many obstacles in the way. Possibly the most important of them is the patent situation and the formation of a world patent pool between Continental, British and American basic patent holders. The erection of tariff walls and special regulation of radio apparatus for the protection of local manufacturers, together with the rigid enforcement of patent rights against those who were not included in the aforementioned patent agreement, made export into certain countries extremely difficult, in many cases impossible. Thus the radio industry in the various countries developed independently and adopted different standards for tube sockets, etc. Apparatus in Europe for instance, must be capable of receiving from 200-545 and 1340-1875 meter waves. Stations of the higher band are almost without exception selected stations of high power, broadcasting the highest type of programs. As a result, if American radio manufacturers want to find a market for their receiving sets in European countries, they will have to ship apparatus suitable for receiving within aforementioned frequency bands and furthermore to introduce American tubes and accessories simultaneously for replacements.

Despite all difficulties there are sales possibilities for American made sets in some countries of Europe where

Statistics of American radio sets and accessories exported into Europe

No.	Name of country	Tubes	Transmitting sets and parts	Receiving sets	Receiving set components	Receiving set accessories	Loud speakers	Grand total	No. of receivers in use	Population per set	License fee	Broadcasting stations	Shortwave stations
1	Italy	$117,624	$154,481	$574,069	$117,132	$40,980	$141,090	$1,145,376	126,000	163	$3.95	4	2
2	United Kingdom	69,536	8,097	20,801	205,362	118,946	208,444	631,186	3,411,910	14	2.43	10	1
3	Russia	1,087	355,751	5,001	2,653	49,514	36	414,762	1,000,000	294	*	45	..
4	Spain	50,609	41,010	169,680	63,418	11,273	30,773	366,763	550,000	43	.97	10	1
5	Holland	2,133	6,447	3,096	216,459	38,485	40,832	307,452	253,527	55	Free	4	1
6	France	26,562	2,451	23,250	54,776	41,769	54,708	203,516	2,000,000	27	.40	30	7
7	Germany	6,510	12,553	8,330	15,494	73,850	74,353	191,090	3,241,725	20	5.71	28	4
8	Switzerland	15,760	.....	45,529	52,885	12,277	17,155	143,516	100,000	51	3.00	5	2
9	Denmark	33,348	7,806	1,475	27,368	11,885	5,213	87,094	437,244	10	2.68	3	1
10	Belgium	5,100	399	5,079	41,982	3,733	20,381	76,663	69,437	125	None	11	..
11	Roumania	6,397	34	19,056	11,126	2,442	5,599	44,654	40,000	695	3.60	1	..
12	Czechoslovakia	4,589	5,198	10,671	8,019	1,665	3,278	33,420	325,000	48	3.60	4	1
13	Portugal	4,527	539	14,831	8,037	1,101	2,091	31,126	2,500	2,250	None	1	..
14	Sweden	1,060	.....	4,049	3,484	7,649	2,887	19,129	460,750	13	2.60	31	1
15	Austria	8,017	2,412	2,128	1,559	1,678	1,279	17,073	439,322	18	10.08	5	1
16	Poland	.....	.....	.....	.....	.....	.....	8,154	230,000	.....	3.36	5	..
17	Norway	.....	.....	.....	.....	.....	.....	5,044	60,000	.....	5.36	10	1
18	Hungary	.....	.....	.....	.....	.....	.....	4,222	273,000	.....	.45	1	..
19	Finland	.....	.....	.....	.....	.....	.....	3,928	106,559	.....	2.00	7	..
20	Greece	.....	.....	.....	.....	.....	.....	1,787	1,500	.....	6.50	..	..
21	Bulgaria	.....	.....	.....	.....	.....	.....	1,440	1,612	.....	1.44	..	..
22	Latvia	.....	.....	.....	.....	.....	.....	1,137	36,300	.....	4.56	1	..
23	Azores & Madeira Island	.....	.....	.....	.....	.....	.....	1,005	430	.....	None	..	..
24	8 countries**	.....	.....	.....	.....	.....	.....	1,974	101,769	.....	.....	..	..
	Aggregate value							$3,739,511	13,269,585				

Trade information and figures from U. S. Dept. of Commerce, Bureau of Foreign & Domestic Commerce.
*No figures available.
**Estonia, Gibraltar, Iceland, Ireland, Yugoslavia, Malta, Lithuania, Luxemburg.
Export figures that of 1929.
Receivers in use as of July, 1931.

the tariff and patent restrictions are not prohibitive. Extensive, individual study of each market is necessary. German manufacturers of radio sets have found the way to supply these markets because they have adapted themselves to local requirements. In some cases local competition and tariffs have compelled them to ship component parts into the respective country and assemble apparatus there. This procedure lowered tariff expenses and permitted them to compete successfully with the local industry with the result that they exported last year, into all European countries an aggregate value of $16,600,000 worth of merchandise against American exports of only $3,700,000, during the same period. Let us see conditions in the various countries in order of their importance from an American point of view.

Italy

Italy has shown an increased rate of broadcast development during the past years. With recent easing of governmental restrictions, Italy is becoming one of the leading countries in Europe in broadcast development. It has six broadcast stations, including two short-wave transmitters. No sets may be installed unless approved by the Minister of Commerce, but samples of sets can be deposited by manufacturers or importers in lieu of individual inspection of sets which is otherwise required. A sales tax is assessed, for tubes $0.32; crystal sets, $0.65; loudspeakers, $1.25; tube sets, $2.80. Socket power sets are generally used but voltage and frequency of central stations vary considerably. Short-wave sets are popular. Out of the quarter million sets in use, American, French, German and English sets are used besides the local made apparatus. Recent change in tariff however makes importation of foreign sets very difficult.

United Kingdom

Twenty broadcasting stations, including one short-wave station, indicate that Great Britain is a country with the highest degree of radio development. The needs of the British market are supplied by some two thousand domestic manufacturers, but German and American sets are also used in large numbers, with some of French, Italian, German and Swedish manufacture. Alteranting current receivers, known as mains sets, are attaining popularity. Short-wave receiving and broadcasting is very popular. Prices on domestic sets are controlled by leading manufacturers, who are selling their products on the installment payment plan, requesting about 10 per cent down and the rest in twelve equal payments. Some guiding prices are:

Leading manufacturer—	
All-electric 3-tube sets, console	$ 71.80
" " 4-tube sets, console	115.70
" " 4-tube sets, midget	40.85
Competitive manufacturers—	
All-electric 3-tube sets, midget	36.40
" " 2-tube " "	33.70
" " 3-tube " "	55.80
" " 4-tube " "	57.70

Spain

Spanish development has been moderately fast, with a great interest on the part of the people. Unfortunately purchasing power is low and mostly concentrated in larger cities. About four-fifths of the registered radio receiving sets are cheap tube sets or crystal receivers but half of the high-grade apparatus is American made with an equal number of German made sets. There is no restriction on the import of foreign-made sets. Spain has ten stations, several short-wave transmitters, and short-wave receiving is very popular. A.c. sets are in demand and lighting current systems are at considerable variation, but mainly 110-200 volt, 50-60 cycles, a.c.

Holland

The development of radio broadcasting and reception has been very rapid since it was introduced into Holland as there is a great interest in radio and the general distribution of wealth has enabled almost every one to purchase a receiver. There are four broadcasting stations in Holland—one on short waves. As everywhere in Europe, all-electric sets are rapidly supplanting battery sets. A large Dutch firm, controlling the principal radio patents, has recently become very active in protecting its rights. British, Dutch, French, German sets are used in about equal numbers. Short-wave reception is unusually popular.

France

Domestic manufacturers supply nearly all of the demand but British, German, Swiss and American apparatus is also used in small numbers. A patent pool was formed late in 1929, controlling the principal radio patents and enforcing rigidly their rights. A.c. sets are becoming increasingly popular but curiously enough short-wave reception enjoys little popularity. Current characteristics of central power stations show little uniformity.

Germany

Germany is well advanced in radio. The broad-casting system sponsored by the government, includes stations in all parts of the Republic. The purchasing power of people is generally fair and almost every family is able to afford a set capable of receiving some one or more of the national stations. Radio stations are controlled by the government which owns the equipment of all stations, but the broadcasting itself is done by corporations which have monopolies in each section of the country and are supported from the proceeds of license fees. Cheap labor plus efficient manufacturing methods permits German manufacturers to supply the domestic market with sets at very low price which reacts unfavorably upon the demand for imported apparatus. In Germany, a very rigid control of dominating domestic manufacturers is exercised, with the result that nearly all of the sets in use are of German origin. American and British receivers are also in use in small numbers. All electric sets and short-wave receiving sets are very popular. Lighting current is mostly 110-220 volts, 60-cycles, a.c.

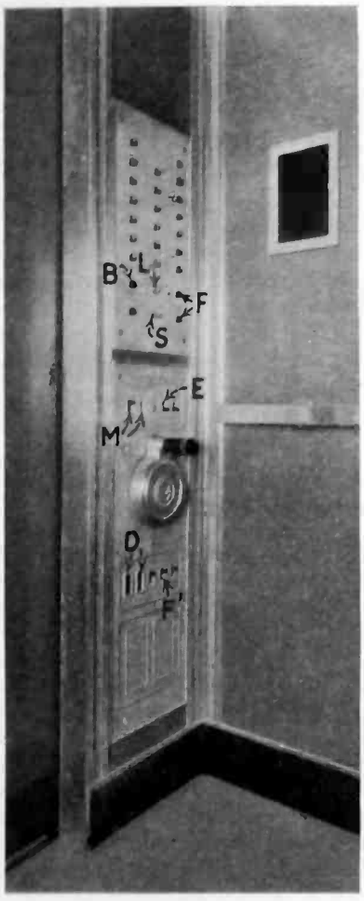
Switzerland

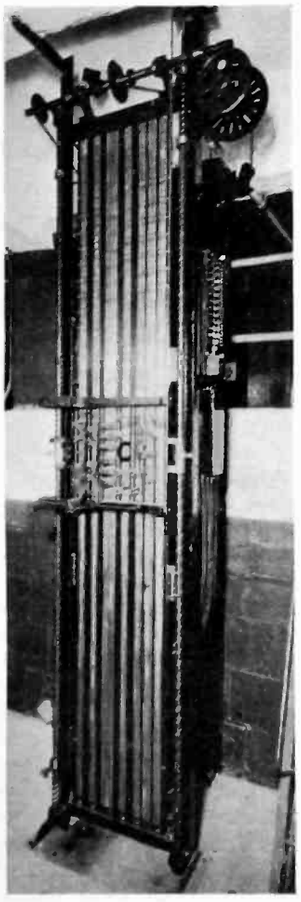
The topography of Switzerland is such as to render radio broadcasting and reception difficult on the ordinary type of inexpensive apparatus, consequently high-grade apparatus is in demand. No specific restrictions are imposed on manufacturers, importers or merchants. Apparatus in use is mostly of Swiss and German origin. Trading is highly competitive. All electric sets are being used in great numbers and 110-220 volt, a.c., is used most everywhere. At the present time, products of six or seven American manufacturers are being sold in Switzerland. Prices of American-made sets, varying from $100 to $200, are nearly twice as high as they are in this country.

Tube control of high-speed elevators

New McGraw-Hill Building
330 W. 42d Street, N. Y. City

Control-tube unit

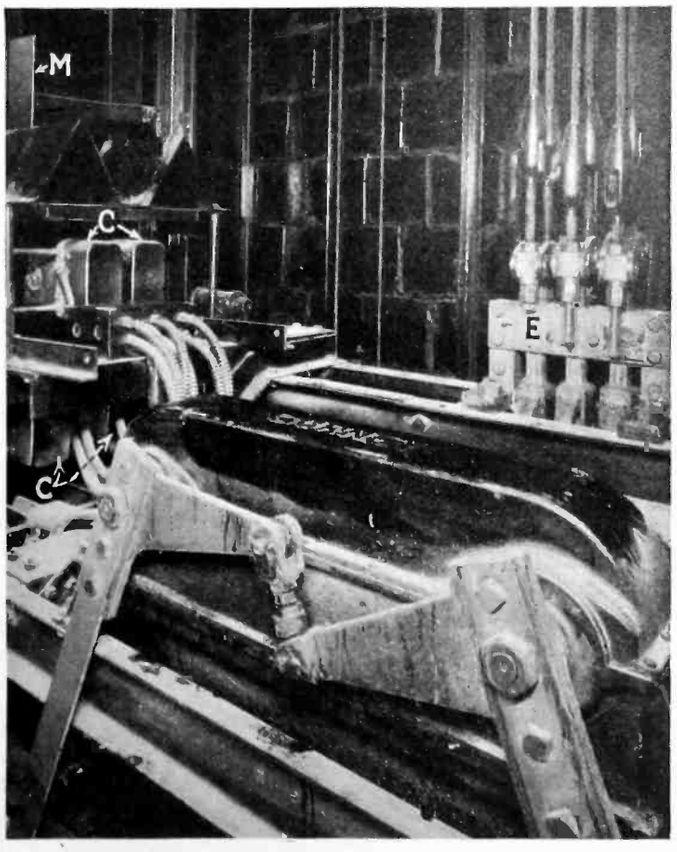




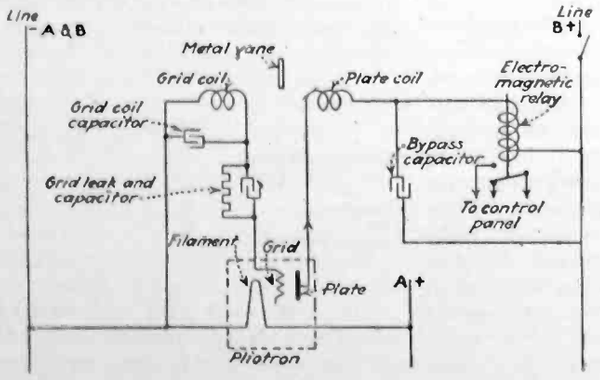
(Left)—Car-operator's lever and push-button panel

(Right)—Floor selector that slows down the car before the tube leveling equipment makes the final stop

IN the new 33-story home of *Electronics* (see front cover of this issue) oscillating Pliotron tubes and relays level the five high-speed express elevators, and the four express passenger elevators. To cause the relay to close its contact, the car's travel brings a metal plate between grid and plate coils spaced one inch apart. When the plate has entered $\frac{1}{16}$ of an inch into this space, the oscillations (200 kc.) of the tubes have ceased, the plate current has increased and the relay started to work. Five triodes are used on the high-speed elevators, four on top of the car.



Top of one of the express cars, showing four leveling tubes at C, and one of the leveling vanes at M



Simplified connection diagram of elevator-control system

+ + + ELECTRONIC NOTES

Charts for solving wire problems

By W. Waterman

A large portion of work done by radio engineers is devoted to the design of parts requiring the use of wire. Customarily wire tables are used, but unfortunately tables never give as clear a picture of conditions involved as a simple curve. It is the purpose of these notes to acquaint the readers of *Electronics* how simple curves, to take place of wire tables, may be constructed and used to advantage.

The wire gage in universal use in the United States, namely the American Wire Gage of Brown and Sharpe, is based upon the definition that diameters of two successive gage numbers are in the ratio of $\sqrt[39]{92}$ to 1. From this fundamental definition we get that the ratio of diameters of any two gage numbers is $\sqrt[39]{92^N}$ to 1, where N is numerical difference between gage numbers. Rewriting the expression in symbols.

$$\frac{D_a}{D_b} \sqrt[39]{92^N} \qquad (1)$$

Taking logarithm of both sides to base 10

$$\log D_a - \log D_b = \frac{N}{39} \log 92$$

Solving for N

$$N = \frac{39}{\log 92} \log D_a - \frac{39}{\log 92} D_b \qquad (2)$$

Let D_a be the diameter at 0 gage (324.9 mils) and D_b the diameter at any other gage, then N will be expressed directly in gage numbers. Thus

$$N = 49.89 - 19.86 \log D_b. \qquad (3)$$

This is the equation of a straight line of the form $y = mx + b$. The slope is therefore negative and equal to 19.86 and the intercept on Y axis is 49.89. In the wire chart presented it was found more convenient to interchange X and Y axis.

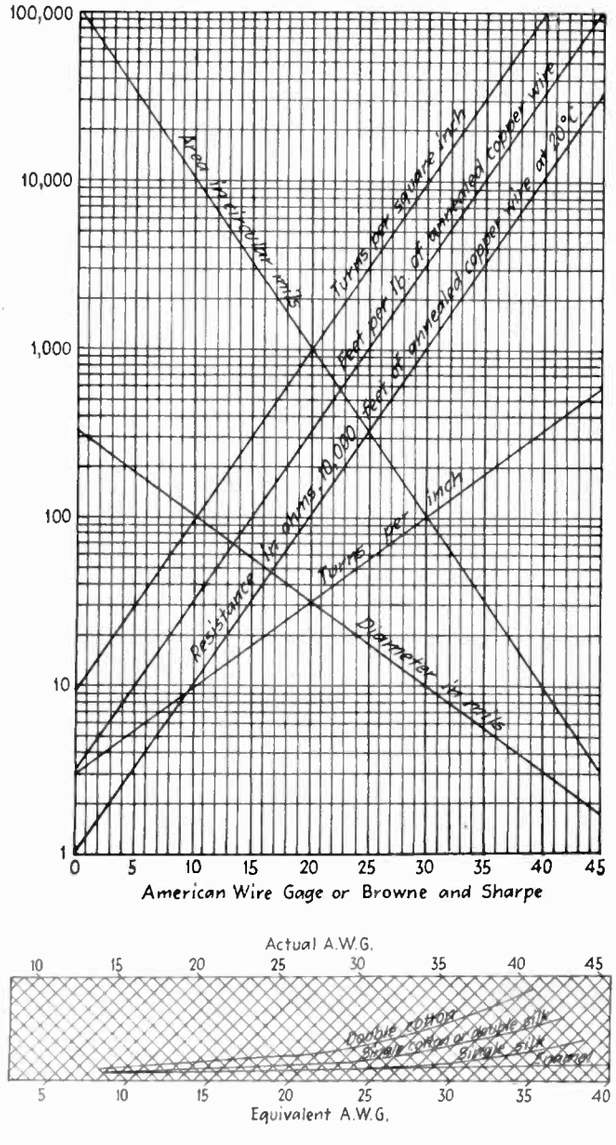
Likewise, it is easy to show that all other factors relating to bare wire when plotted on semi-logarithmic paper against gage numbers will form straight line curves.

With reference to the wire chart itself, the abscissa is in American Wire Gage or Brown and Sharpe Gage numbers from 0 to 45. The ordinate is divided into five cycles from 1 to 100,000. It represents turns per inch, turns per square inch, diameter in mils, area in circular mils, feet per pound of annealed copper wire, and ohms per 10,000 ft. of annealed copper wire at 20 degrees C. On the chart there are six curves, each one appropriately marked.

To illustrate how the chart may be used, one example will suffice. Let us find all data pertaining to 25 gage bare copper wire at 20 degrees C. Upon intersection of ordinate marked 25 with the curves, we read in proper succession: diameter 17.9 mils; 55.8 turns per inch, area 320.4 circular mils; resistance 323.7 ohms per 10,000 ft.; length 1,031 ft. per pound; and 3,120 turns per sq.in. It must be realized that values obtained are only nominal as the actual wire will differ somewhat due to manufacturing tolerances. Also, in case of turns per inch or square inch, allowance must be made for the small space between wires inherent in the winding process.

To enable one to use the wire chart not only for bare wire but for insulated as well, an auxiliary chart is presented. The top side is calibrated in actual A.W.G. of insulated wire and the lower side in the equivalent gage to be used with the chart for finding all data pertaining to outside dimensions of insulated wire. Four curves are plotted; one for double cotton, another for single cotton or double silk, still another for single silk, and the last for enamel.

On the wire chart it is possible to plot other curves, such as resistance of nichrome wire, etc. All that is necessary is the value at two different gage numbers. A line joining these points is the desired curve.



✦

Cobalt alloy filament

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

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

	Nickel filament	Cobalt filament	Percentage of increase
Weight—milligrams per 100 millimeters	9	15	75
Diameter	10	13	33
Area	25	43	70
Tensile strength, cold	1	4	300

The —30, —31 and —32 tubes produced with the new filament have a servive life consistently over 1,000 hours. The new filament makes for a tube one-third as microphonic as when the usual nickel wire is employed.

FROM THE LABORATORY + + +

Interspaced transformer windings

By W. J. Leidy*

The design of a transformer, like that of any piece of electrical apparatus, is a compromise of various elements which are combined to produce a given result. In any commercial design, the cost factor is always extremely important, but other demands may necessitate a design of higher cost.

In the design of transformers for audio-frequency amplification in radio receivers, public address systems, or telephone circuits, the uniformity of amplification over a wide frequency range is a dominating factor. However, it is not always possible to produce a transformer of low cost because to achieve a flat response curve usually calls for core material of high permeability, a larger amount of copper in the windings, a heavier core, or perhaps a combination of all of these elements. Such a combination often leads to a transformer of considerable bulk which, in itself, is a disadvantage in audio-frequency amplification units. Furthermore, since these units are often used in large numbers, tremendous pressure is always put upon the transformer manufacturer to produce a design of lower cost.

It is interesting to note, therefore, what can be achieved in the direction of designing a transformer with a flat response curve by resorting to a rearrangement of the windings on the core, allowing other elements to remain constant. This rearrangement of transformer coil windings is known as "interspaced winding" and a simple type of interspaced winding is shown in the illustrations. Fig. 1 (a) is a typical standard transformer layer winding with a single primary and a single secondary winding. Fig. 1 (b) is the same transformer with an interspaced winding involving the use of two primary windings and one secondary winding. Such interspaced windings are produced in many forms and combinations of coils. The precise arrangement of interspacing involves mathematical computations of an intricate nature. Interspacing is not always the solution for an improved transformer design and can be used only when other factors are such that interspacing produces the desired result.

The response curve shown in Fig. 2 illustrates what was accomplished by merely changing the type of winding from the standard layer winding to the interspaced type of winding. Curve *A* is the response curve of an audio-frequency transformer using the standard winding. Recalculating this winding and converting it to an interspaced winding of the proper constants brought about the sharp change in the shape of the curve *A* to the nearly flat response curve *B*. It must be borne in mind that this approach to a nearly flat response curve was achieved without the use of special core material of high permeability or without changing the mass of core or copper. In fact, the transformer with the interspaced winding was exactly the same shape, size, and weight as the transformer with the layer winding.

A word of caution should be given concerning the general use of interspaced windings. Interspacing is not a cure-all for poor response curves, and only when other conditions are satisfactory can interspacing achieve a marked improvement in the shape of the response curve. It must also be remembered that the design of interspaced windings involves extended mathematical computations based on a full knowledge of all the factors attending the application of the transformer. When conditions permit a change to interspaced windings, as for instance when the transformer is used to couple a 30-type triode amplifier tube to a 500-ohm line for such units as a microphone or photoelectric cell, or for coupling other circuits with low plate impedance, interspaced windings should be considered. The resultant saving in size and weight coupled with the superior response curve obtained justifies the added research necessary to produce the correct interspaced winding for these applications. However, if interspacing is attempted by other than intelligent mathematical analysis, the results will be unsatisfactory.

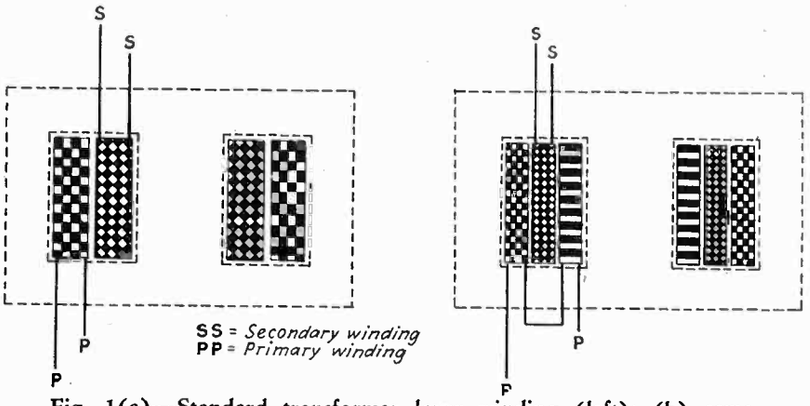


Fig. 1(a)—Standard transformer layer winding (left); (b) same transformer with interspaced winding (right)

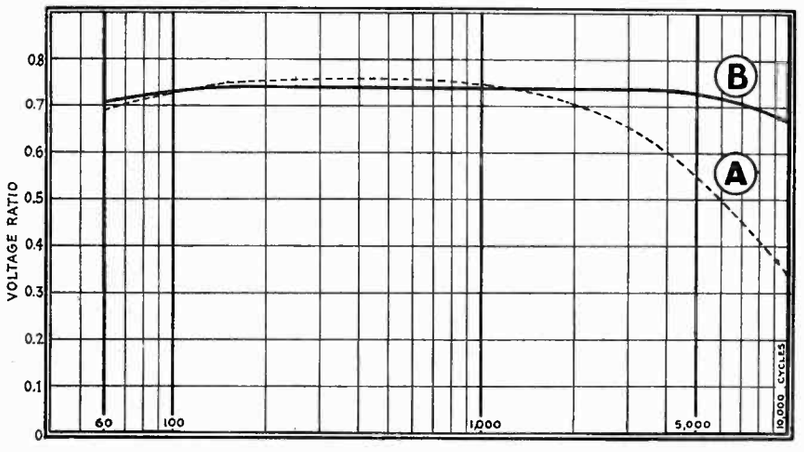


Fig. 2—Response curve (A) obtained with standard winding, (B) with interspaced winding

✦

Testing for short-circuited windings

[Haak] Description of a simple apparatus, consisting essentially of a bridge excited by a buzzer or other source of a.c. wherein two choke coils are balanced for silence in a head-telephone. These coils are wound on open iron cores, the coil to be tested being slipped over one of these. If no short-circuited windings exist, no change is caused in the balance thereby.—*Funk, Berlin, October 23, 1931.*

*Chicago Transformer Corporation, Chicago, Ill.

A new selenium tube

An application of modern vacuum technic

By G. F. METCALF and A. J. KING
Vacuum Tube Engineering Department
General Electric Company

THE effect of light on the conductivity of metallic selenium was observed as early as 1851 and has been used in the production of light sensitive elements since 1873. From that time the construction and utilization of the so-called "selenium cell" has received much attention from both scientist and layman. The characteristics were slowly improved, but those familiar with the literature of these workers and their critics will understand the meaning of such terms as "time lag," "temperature effect," "instability," and others used to describe the deficiencies which have so hindered the practical application of these earlier devices.

Now, the engineer has turned to selenium as a likely answer to the need for a rugged, stable, highly sensitive, and relatively low impedance photoelectric device for use in the many fields which industry is now opening for such a product.

Selenium tube made according to modern vacuum technique

Evacuated selenium tubes

Since the growth of the vacuum tube industry, it has become customary to enclose selenium elements in glass bulbs and sometimes the bulbs are evacuated. This, together with improved technic and greater care in the preparation of the selenium elements, has done much to improve the quality of the contemporary product. However, it has been found that the instability is largely due to effects of the moisture and oxygen in the atmosphere, during the formation and annealing of the selenium layer as well as during operation. Enclosing a selenium element in an air and moisture proof container is not sufficient, the major part of the variation being caused by impurities introduced in the formation of the sensitive surface.

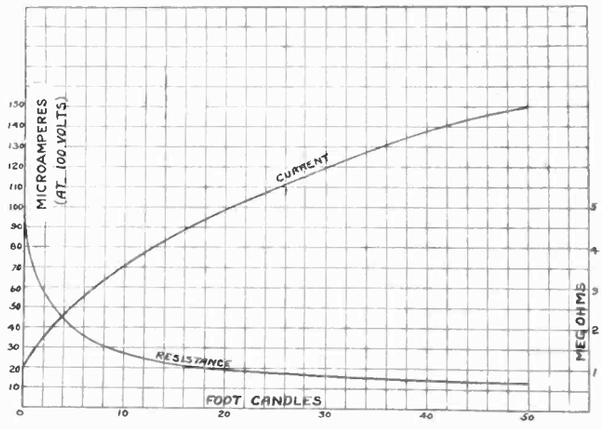
A method has been developed for forming the selenium surface entirely in vacuum. This method is similar to that used in vaporizing metals in thin films on the bulbs of radio receiving tubes during the manufacturing process. A pure, dry, inert, gas is admitted during the annealing process and is allowed to remain in the tube.

Tubes made in this manner show relatively small temperature changes and remain substantially constant over long periods of time. Due to the extremely thin layer of selenium and the conditions of crystallization, the time lag is negligible for most purposes and the dark resistance is unusually high.

As typical of a modern selenium tube utilizing vacuum tube technic in its design and manufacture, there follows descriptive data on the General Electric tube type FJ-31:

Average resistance at 100 foot-candles	=	.75 megohms
Average resistance in dark	=	6.0 megohms
Maximum voltage a-c. or d-c.	=	125 volts
Maximum current	=	0.5 m.a.

The light-current and light-resistance characteristic of an average tube are shown. Data for these curves were taken in a standard photometer box, the different values of light being obtained by varying the distance of the lamp



Light-current light-resistance characteristic of selenium tube

from the tube. A projector lamp calibrated 35 candle power at 2870°K. was used. Almost every experimenter with selenium has attempted to find a universal law connecting change in resistance with incident light. Many empirical formulas have been proposed, each one especially applicable to a particular design of selenium tube. Most of these have been of the form

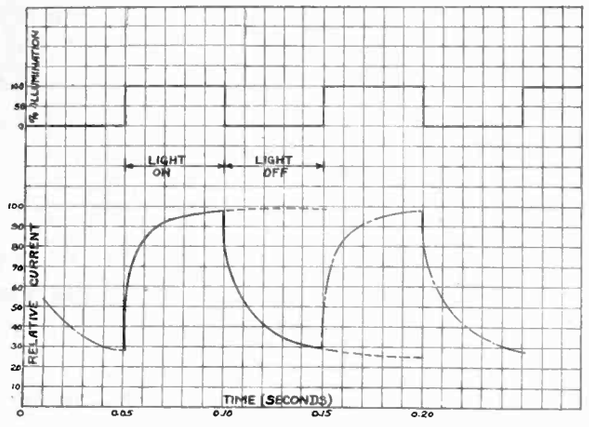
$$R_E = \frac{1}{\frac{E^{\frac{1}{x}}}{A} + \frac{1}{R_o}}$$

where

E = illumination
R_E = resistance at illumination E
R_o = resistance in dark
A = a constant

Values for x have ranged from 0.25 to 1.0, with the average at 0.5. The light sensitivity of selenium is quite commonly mentioned as a function of the square root of light intensity. The type FJ-31 selenium tube follows the above relation quite closely using 0.6 to 0.8 as the value of x.

The data for the time-current characteristic of the type FJ-31 selenium tube were taken by subjecting the tube to an indefinitely repeated cycle of alternate light and dark periods, each of 0.05 seconds duration. The illumination was about 15 foot-candles and the light was substantially either all on or all off. The data were taken with a cathode ray oscillograph. On the vertical ordinate, 100 represents the current reached after 30 seconds steady illumination. This may be considered the static value of "light current." The dotted extension of the decay cycle may be seen approaching 20 which is the value of current reached after keeping the tube dark for



Time-current characteristics of typical selenium

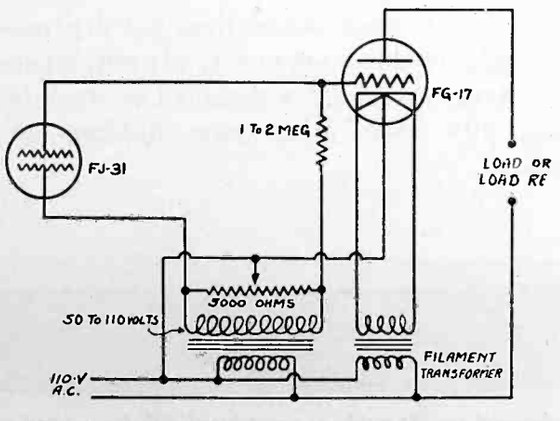
30 seconds. This may be regarded as the static "dark current." It is noteworthy that about 90 per cent of the total change in resistance under illumination takes place in one hundredth of a second.

The data for the frequency characteristic were taken with a toothed wheel light interceptor giving approximately a sine wave fluctuation in light intensity. A voltage proportionate to the selenium tube current was amplified and read on a tube voltmeter.

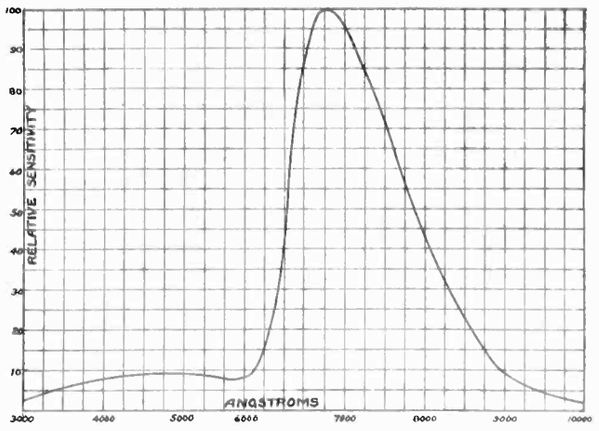
The spectro-sensitivity characteristic of the type FJ-31 selenium tube was measured as follows:

The tube was exposed to monochromatic light of equal energy and various wavelengths. The tubes are very uniform in their color sensitivity and the peak in the red and infra-red explains the high sensitivity of this tube when used with an incandescent lamp.

A simple selenium tube bridge for controlling a Thyratron such as the FG-17 is shown. Such an arrangement can be made very sensitive to small changes

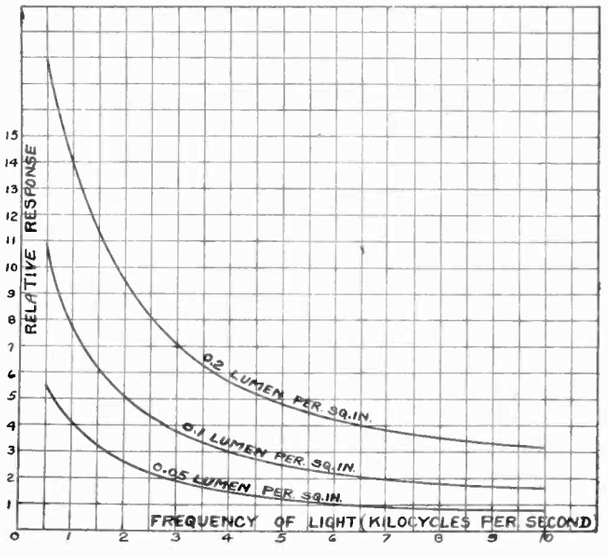


Use of selenium tube to control a Thyratron circuit



Spectral sensitivity of selenium showing high response in red

in light. Many operations which depend upon the presence, absence or degree of daylight as well as many which depend upon the interruption of a beam of artificial light—for example, counting, alarm signalling, and interlocking—can be performed. Referring to the Thyratron circuit the grid transformer voltage may be anything from about 50 volts upward, but not exceeding the rating of the selenium tube. Higher voltage allows greater sensitivity. The polarity of this transformer determines



Selenium tube frequency characteristic

whether the Thyratron is controlled by increase or decrease of light.

In the arrangement described above, the Thyratron is controlled by critical adjustment of its grid voltage. The selenium tube may also be used in circuits which control the Thyratron by adjustment of the phase of its grid voltage. With these, it is possible to obtain a wide variety of operation ranging from critical control to continuous control in which the Thyratron current is increased in proportion to illumination.

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electronics

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O. H. CALDWELL, *Editor*

Volume III — DECEMBER, 1931 — Number 6

Space radio—wired radio—long-playing records

RADIO has never taken seriously the threat that music might, someday, come into the home by means other than through "the air." Telephone wires are in telephone service only 18 minutes of the day; systems are ready by which programs of high grade music could go over the same conductors. A system is ready for installation for transmitting several music channels over power wires.

Radio, complacent, may be wrong in believing that the public would not buy such services. Excessive talk has so calloused the ear drum of the public that it no longer hears the talk, nor the music either. Instead of a carrier of music, a radio is too often used merely to overcome an annoying stillness in the home. It is used as background noise for conversation, reading, or card playing.

Realizing the extent of this callousness, the individual radio manufacturer, desirous of putting his competition out of business, decreased fidelity, cut his prices, flooded the country with poor sounding instruments used as silence preventers.

In New York City a company sends music to a chain of hotels, dance halls, or other public places via wires. The quality and volume range can be as great as the listener requires. There is no talk on those programs.

Wired radio will soon be ready to make the initial plunge for public favor in a very large middle-western city.

Also already announced is a phonograph record that will play for 15 minutes, or 30 minutes if turned over once. There need be no talk on these records. The fidelity and volume range can be vastly better than the average radio set can interpret.

Radio may be shaken from its complacency.

Links in the chain of quality sound reproduction

SOUND-equipment, whether it applies to a home radio receiver, public-address system or film reproduction apparatus, will perform no better than the weakest link in the system will allow, unless the weakness of that link be balanced by exaggerated strength in some other part. High frequencies, for example, eliminated by inferior components, are lost until they are replaced by that magic called "equalizing," often an expensive process. Every link in the sound-system must be as perfect as possible, or its deficiencies made up elsewhere, if the resultant output is to sound natural.

An example of high quality versus poor reproduction is clearly shown by the accompanying oscillograph photograph (made through the courtesy of the Bell Laboratories), of the word "radio" as it would appear transmitted through two different receivers. Note the high frequencies present in Curve 2 but not in Curve 1. The upper curve represents reception with frequencies below 250 cycles and above 3,000 cycles all cut off. Crispness and clarity of speech are lacking, and in music reproduction timbre and quality would be missing.

Fidelity of reproduction does not depend upon any single unit or component. It obtains only if the system as a whole is designed to work in harmony with each other part holding up the standard.

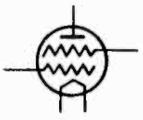
Here is the word "Radio" recorded on a high-speed oscillograph as reproduced (1) by a poor radio set cutting

Transatlantic phone cable to tap airplane floats

CONFIDENTIAL reports indicate that the transatlantic telephone cable is being temporarily held up, pending changes in design which will be possible if the mid-ocean airplane landing stages are completed. As now proposed, these landing stages would consist of vast floating steel-rafts, with open aerdromes, and hotels, restaurants, etc., the structures being supported on mushroom floats so that waves and ground swells would sweep through them, without injury.

The first of these stages is already declared to be under construction.

If the cable can be laid to the site of such a landing stage, and looped up through it, repeater stations could be inserted in the cable at this point, thus simplifying the cable loading. At the same time, the cable would give desirable connection with the continents of Europe and America for handling plane traffic, sending messages from passengers, etc.

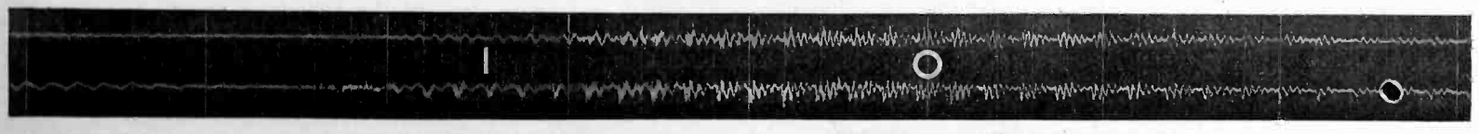


U. S. still behind other nations in broadcasting powers

AFTER long political delays, broadcasting powers of 50 kilowatts have just been granted to a number of important American stations by the Federal Radio Commission, but this still leaves the United States far behind other nations in point of the powers of its broadcasting stations and therefore the effectiveness with which they can be heard by millions who make up our outlying and farm populations. Even backward Mexico now has completed its 75-kilowatt station, the highest power unit on the North American continent. Germany, Norway and the other countries of Europe have 75-kilowatt transmitters. Poland has a 150-kw. station at Warsaw. Russia has a complete program for erecting 150-kilowatt broadcast units, in addition to its present 200-kw. station at Noginsk; and in England there has just been exhibited the largest radio tube ever built, the great 500-kilowatt continuously-evacuated tube for the Daventry station. Yet America, with the most enterprising and daring radio engineers in the world, must still trail far behind other nations.

Can people be made immune to noise?

DR. Donald A. Laird of Colgate University, already well known for studies of the psychological effects of noise, is experimenting to determine whether city people may not be able to build up in themselves a resistance or immunity to noise so that they can live happily and efficiently even in the city's din. Effects of noise on working efficiency are to be tested, for example, by a machine called the "miniature factory," in which a long strip of paper like the perforated roll of a player piano passes in front of the person to be tested. Here and there on the paper roll are irregularly spaced holes. The person being tested must touch each of these holes as it appears, accurately and quickly, with a small metal pencil. Errors and omissions are recorded. This and similar tests will be applied to a number of subjects, first under quiet conditions, then under noisy ones. The noisy conditions are expected to show somewhat lower efficiencies and somewhat greater fatigue. Then comes the most important part of the experiment. By feeding the subjects extra amounts of sugar or other concentrated foods or by giving them other stimulating or strengthening materials, Dr. Laird proposes to see whether he thus can counteract the damaging effects of noise so that the scores made by these individuals in the tests become as good in noisy surroundings as in quiet ones.



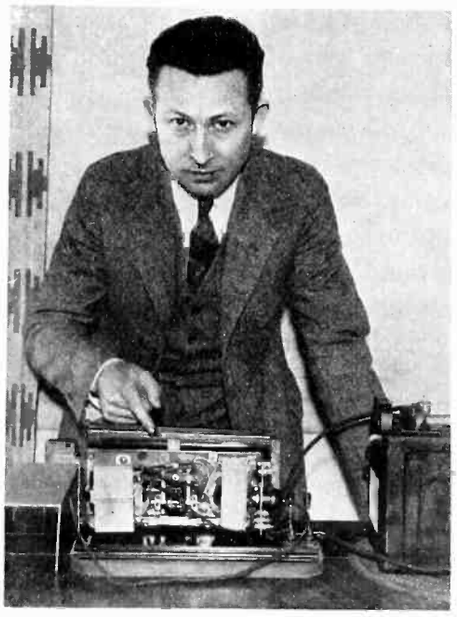
off above 3,000 cycles and below 250 cycles, and (2) as reproduced by a modern set passing all frequencies

The march of the electronic arts

Radio truce, but no peace

When the Washington Post, commonly regarded as very close to the White House, characterizes the Department of Justice dealings with the Radio Corporation as "most lenient" and "patient" some Washington observers wonder if the patience is not about exhausted. If RCA and its owner affiliates, General Electric, Westinghouse, and A. T. & T. do not agree with the U. S. Department of Justice on a new patent pool arrangement, those who take this point of view believe that these corporations stand a chance to lose not only the department suit, but also every type of operating license for any class of radio station. They think the independent tube and set manufacturers stand a fair chance of securing some sort of new opportunity to use "the Radio Trust's" patents without excessive license fees. Incidentally, the RCA subsidiary, National Broadcasting Company, finds itself under attack in a new quarter, before the Interstate Commerce Commission for "excessive rates" charged for broadcasting services. It remains to be seen whether a broadcasting station does come under full jurisdiction of the I.C.C. as to rates and facilities. Close observers feel that the I.C.C. is likely to decline the honor of being a co-boss with the Federal Radio Commission over radio's troubled affairs.

BATTERY CONVERTER



F. F. Hutchinson of San Francisco, with his power converter which steps up 6 volts d.c. to 110 volts a.c. for operation of radio sets

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French radio development

If France's new government retains office, something like $2,500,000 will be expended from the 1931-32 budget for the development of broadcasting. One proposal that has been advanced calls for the erection of a series of 60,000-watt stations so located as to cover the entire country. French radio development, however, is still divided between two schools of thought—one wanting a state monopoly and the other wanting private enterprise with government regulation.

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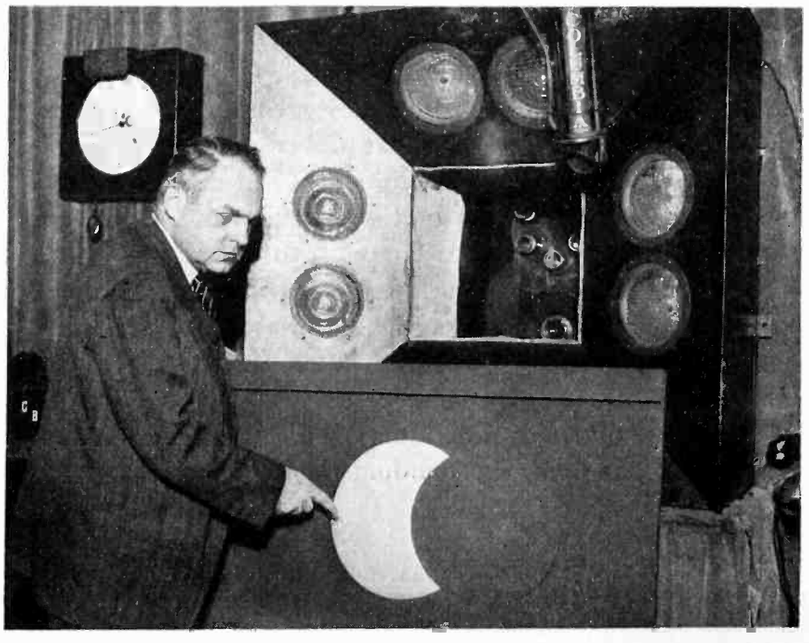
ECLIPSE BROADCAST BY TELEVISION



O. H. Caldwell with his model eclipse which was broadcast over the television channel of the Columbia System and which will be repeated in the coming eclipse of August 31, 1932

✦

Radio legislation in Congress

As this issue of *Electronics* comes off the press, Congress will already be in the midst of its legislative program. Important changes are expected in the membership of the Marine and Fisheries Committee, which has charge of radio legislation. Ranking Democrat of the committee and its probable next chairman is Representative Ewin L. Davis of Tennessee. He will succeed to the mantle of Wallace White, Jr., Republican of Maine, co-author of the Radio Act of 1917, who goes to the Senate.

Congressman Davis is well known in radio circles for his opposition to what he believes to be a radio trust, for his convictions that the spread of high-power broadcasting is a menace and for his amendment of two years ago requiring a zone and state equalization of broadcasting facilities.

Senator White may or may not win a place on the important Committee on Interstate Commerce, which has charge of radio there and of which Senator Dill, Democrat, of Washington, also co-author of the radio law, is a member. At any rate, the Senate will have two of the best informed men on radio subjects while the House Committee is led by one of the most harshly outspoken critics of the present radio set up.

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IRE make nominations for 1932

Professor W. G. Cady, of Wesleyan University, Middletown, Conn., and L. E. Whittemore, of the American Telephone & Telegraph Company, New York City, have been nominated for the 1932 presidency of the Institute of Radio Engineers. Elections take place at the January annual meeting.

The IRE has also nominated Professor E. V. Appleton, of Kings College, London, and Balth van der Pol, Jr., of the Philips Works, Holland, for the honorary vice-presidency which annually goes to a foreigner. For managers, two of the following are to be elected: W. R. G. Baker, RCA Victor Co.; O. H. Caldwell, former radio commissioner; E. L. Nelson, Bell Laboratories, and Capt. R. H. Ranger, Newark consulting engineer.

U. S. Census Bureau to collect sales statistics

EARLY IN 1932 the U. S. Census Bureau will send questionnaires to all radio manufacturers for the annual federal statistics. The Census Bureau assented to a request by the RMA to provide for a separate radio manufactures census because of the industry's growth, distinct from its usual electrical manufacturing census. Forms for the 1932 census were submitted to the RMA and are being perfected by the association's Statistics Committee of which George C. Furness of New York is chairman.

✦

Federal Telegraph Company to expand activities

FUTURE PLANS FOR THE contemplated activities of the Federal Telegraph Company in the manufacture of radio transmitting and receiving equipment as well as special apparatus for associated fields are being rapidly completed. The manufacturing plant for this company, located at 200 Mt. Pleasant Ave., Newark, N. J., is now being completely re-equipped with modern apparatus. The Federal Company is the manufacturing organization for International Telephone and Telegraph Company in so far as the domestic market is concerned.

The present plant will house the service organization of the Postal Telegraph Company, the Mackay System and All American Cables. The International Communications Laboratories will also be located in this plant.

The Federal Company is now building ship transmitters, radio compass equipment, and transmitting tubes. This company expects shortly to manufacture all forms of resistors and paper condensers. It also will undertake the manufacture of special testing apparatus, amplifiers for special purposes, photo-electric relay work and special equipment requiring research or design.

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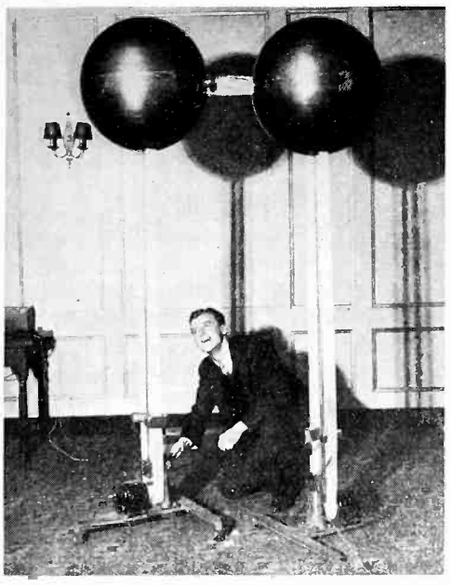
Dr. H. C. Parmelee Vice-president McGraw-Hill

THE MCGRAW-HILL PUBLISHING COMPANY has announced the election of Dr. H. C. Parmelee a vice-president of the company. Dr. Parmelee will continue his present activities as editorial director of the company's various publications, to which executive position he was appointed in 1928. He was formerly editor of *Chemical and Metallurgical Engineering* and in 1916-17 was president of the Colorado School of Mines. He holds memberships in many of the leading technical societies here and abroad.

TO SMASH ATOMS



Dr. Robert J. Van Greef demonstrates his generator capable of producing 1,500,000 volts and a model of which will be used with higher voltages to disrupt atoms

✦

October sound-equipment exports $301,178

EXPORTS OF motion picture sound equipment during October were valued at $301,178. This shows a slight increase over September, 1931, when the value of exports amounted to $295,100, but is a decrease from October, 1930. The value of exports during that month was $544,729.

Radio Commission squelches synchronization plan

BY A CLOSE DECISION of three to two, the Radio Commission has denied the application of the Columbia Broadcasting System to install a 250-watt booster station in Washington, D. C., to be synchronized to the clear channel of WABC, its New York key. The station was sought as an experiment to determine the feasibility of such common frequency operation. Columbia also wants the station because it cannot get all the hours it seeks for network programs from WMAL, its present Washington outlet.

Reasons for the majority's decision have not been announced to date, but Chairman Saltzman and Commissioners Starbuck and Lafount voted in its favor, the latter issuing a statement declaring his opinion that "the Commission should acquaint itself with all scientific developments of the art and should permit such experiments as may demonstrate the practicability of such developments."

It is anticipated that the Commission's grounds for decision, now being prepared by its legal division and from which Columbia can appeal if it chooses, but probably will not, will be based partly on quota regulations and opposition to new construction, and partly on a determination not to break down any more clear channels in the fear of establishing a precedent that other clear channel operators might seek to follow. The Commission also denied an application from WLBW, Oil City, Pa., to place a booster to operate on its wave-length in Erie, Pa.

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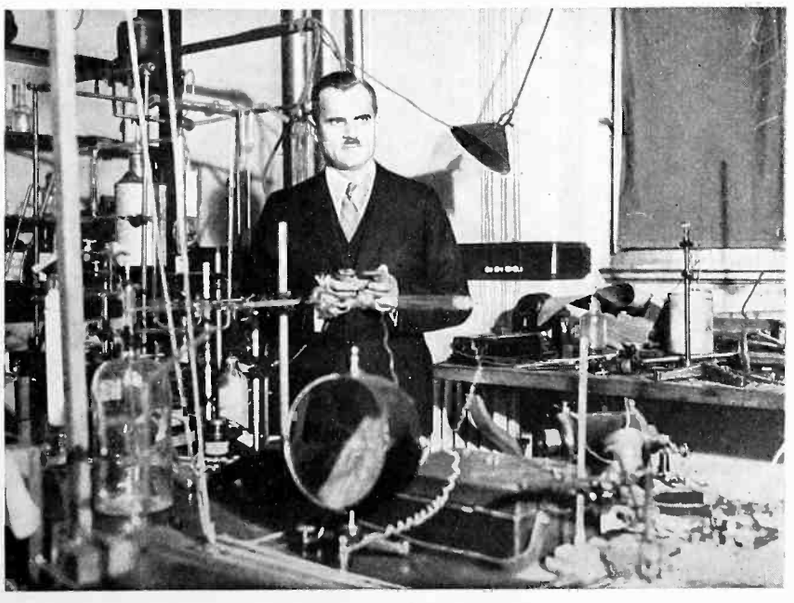
COMPTON DISCUSSES THE "HEREAFTER"



Science does not supply a definite answer to the question: "Does death end all?" according to Dr. Arthur H. Compton, speaking at Yale University on "Science and Immortality"

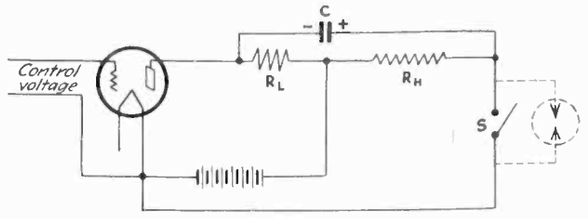
A self-stopping d.c. thyratron circuit

By HERBERT J. REICH
Dept. of Electrical Engineering
University of Illinois

THE use of hot-cathode thyratrons is limited in some types of circuits by the fact that once discharge has started the grid no longer has control of the anode current. In order to stop the discharge it is necessary to open the anode circuit or to reduce the anode voltage below the normal tube drop for a sufficient length of time for deionization to take place. When alternating voltage is used in the anode circuit no difficulty is experienced since the voltage falls to zero periodically.

When direct current is used the anode current may be stopped by employing the circuit below.* The action of this circuit is as follows. The normal voltage drop through the tube is about 15 volts, and the rest of the applied voltage appears across the load, R_L. For an applied voltage of 220 volts, for instance, the load voltage is 205 volts, and a condenser, C, connected across the load through a high resistance, R_H, charges up to this potential in the direction shown. When the switch S is closed, the positive side of the condenser is connected to the filament, and the potential of the anode is reduced to —205 volts. The condenser immediately begins to discharge through the load resistance. With sufficient capacity, however, the time taken for it to discharge to a point at which the anode again becomes 15 volts positive is greater than the time of deionization. If, therefore, the grid has previously been made sufficiently negative, the anode current will be permanently cut off.

ONE of the characteristics of the Thyratron tube is that once the discharge starts, it cannot be stopped by variations in control electrode voltage; the grid has started something it cannot stop. A glow-tube connected as described by Professor Reich will perform the function of automatically stopping the anode current.



Circuit of the automatically stopping Thyratron

Automatic stopping circuit

For certain applications this circuit is entirely satisfactory, but sometimes it is desirable to make the action automatic, as, for instance, in circuits operated by photocells. The writer has found that this can be accomplished very readily, if the load current is not too large, by substituting a glow-discharge tube for the switch. Then as soon as the condenser potential equals the breakdown potential of the glow-tube, the latter becomes conducting and the potential across its terminals drops to very nearly the extinction value. The potential of the anode with respect to the filament is therefore suddenly lowered by an amount approximately equal to the difference between the breakdown and extinction potentials of the blow-tube. The condenser discharges until the potential across its terminals equals the extinction voltage of the glow-tube and then again starts charging. If the discharge is slow enough to give the thyratron time to deionize before the anode again becomes 15 volts positive, then the anode current can be cut off by making the grid sufficiently negative. Just as long as the thyratron grid is more positive than the critical control value the only effect of the blow-discharge is to cause a periodic instantaneous interruption of load current.

Since the condenser does not discharge completely it is necessary to use higher capacity than when a switch is used. The glow-tube should have a break-down voltage which is slightly lower than the load voltage and the extinction potential should be as low as possible. No ballast resistance should be used in series with it. A ten-microfarad condenser in conjunction with a UX-874 voltage-regulator tube will cut off a one-ampere current through an FG-67 thyratron. Greater care in the choice of the glow-tube would without doubt make possible the reduction of condenser size.

The average time interval between the setting of the grid voltage and the extinction of the thyratron is controlled by changing the value of the resistance R_H, which may well be the plate resistance of a vacuum-tube. If the thyratron grid is made positive for only an instant, the thyratron will pass current for a short interval of time whose average length may be adjusted by changing the value of R_H.

*A. W. Hull: "Hot-cathode Thyratrons"; G. E. Rev., Vol. 32, No. 7; July, 1929; 390-399.

REVIEW OF ELECTRONICS LITERATURE

HERE AND ABROAD

Receiver for a.c. and d.c.

[SCHW] Description of experimental receiver usable without switching on both supplies, using a four-element selenium rectifier in bridge connection followed by the usual filters, and without mains transformer.—*Funk Berlin, September 25, 1931*

✦

Recognizing faults in television reception

[D. R. CAMPBELL] The television images broadcast by the British Baird Company have to fit themselves into the same group of frequencies that the British Broadcasting Company uses for sound. Faulty spacing of the apertures in the scanning disk may be recognized when any article which has a straight edge is being transmitted, say, the top of a table, it will appear either jagged or lopsided. Bad spacing along the radius is noted by the presence of continuous vertical black or white lines. Suppression of low frequencies may result in a white surface thrown up behind a person's head, while the remainder of the original white background on either side is almost black on the top of the picture. Sometimes a dark flare is seen on the forehead, or two shadows on the lower jaw. In extreme cases white flares will appear streaming upwards over the eyes and mouth. Lack of high frequencies gives blurred pictures, an excess of high frequencies haloes above horizontal lines (negative image due to oscillations in the receiver) and a second image above. Heterodyning makes a fine mesh appear all over the picture. Interference produces moving shadows. — *Television (London), November, 1931.*

✦

Recording photocell distribution photometer

[W. F. LITTLE and H. J. ECKWEILER, Electrical Testing Laboratories] The photocell used is a thickly coated cesium vacuum cell. A greenish filter is used to correct the response curve. The photoelectric current is amplified and by careful choice of the circuit constants it is possible to secure a linear correspondence over a limited range between plate current and cell current or illumination.—*Trans. Illum. Engin. Society, October, 1931.*

Anti-fading device

[SCHR] German patent 525207 in which the fall of voltage across a resistance in the plate circuit of the detector controls an auxiliary tube, the plate current of this heating the filament of the first r.f. amplifier tube.—*Funk, Berlin, November 6, 1931.*

✦

Automatic tube testing, sorting

[W. TRAUB and F. MENZLER] Before a tube is packed the Osram factory measures its mutual conductance, plate current at certain grid voltages, filament current and ionization factor *(Electronics, April, 1931)*. All these tests reduce in each case to reading a current strength. Operators are bound to make mistakes when working at high speed *(see Electronics, May, 1931)*, and an automatic testing table has been devised and used for over one year. The defective tubes are thrown out by relays, the task of the operator being merely to place the lamps on a wheel carrying 36 five-prong sockets. Potentials are applied by means of sliding contacts which give the lamp ten different tests as the wheel moves. If a lamp falls below a relay causes a rod to push the lamp out of the socket. The machine tests 1,800 tubes in one hour. — *Electrotechnische Zeitschrift, October, 1931.*

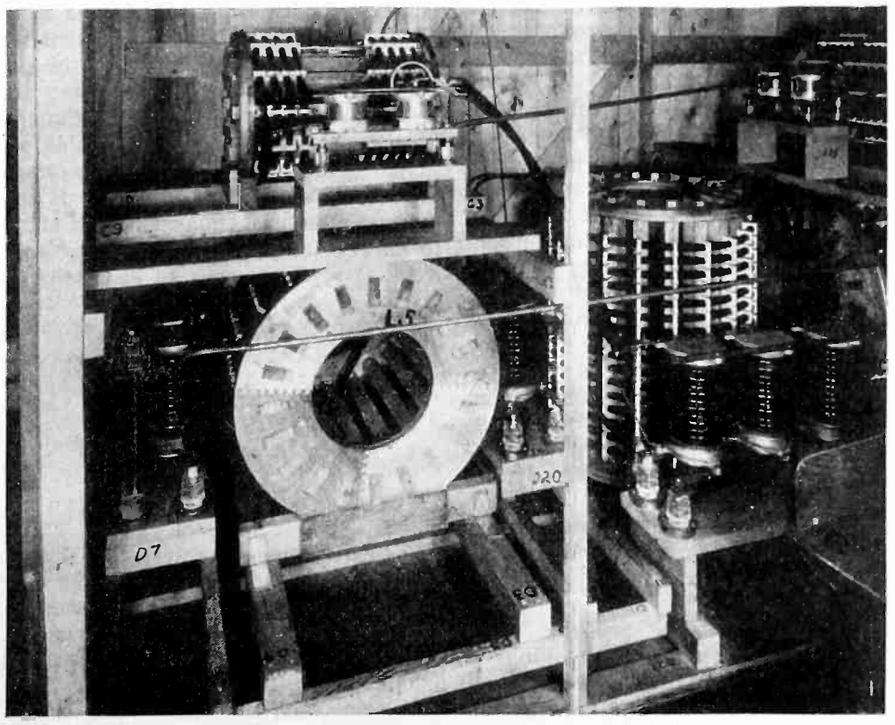
✦

A 24,000 watt filter

[MANFRED BROTHERTON] Description of a filter weighing over a ton and occupying space as great as an automobile developed to determine if two voice channels at different carrier frequencies could be transmitted from a single antenna without objectionable cross-talk due to modulation. The work was carried out as part of the transoceanic long-wave telephone circuit research in which 12 kw. at 67 kc. and 12 kw. at 69 kc. were impressed on an antenna. Modulation currents appearing from any cause were to be one-millionth of the desired current.

The inductances were made of wire specially made having 7,000 strands of enameled No. 36 wound on a $\frac{3}{4}$ inch rope core. Condensers adjusted to within $\frac{1}{4}$ per cent of their theoretical values were used. The "Q" of the coil was 1,500; the total heat loss produced by five coils and ten condensers was less than 3 kw. per test channel.—*Bell Laboratories Record, December, 1931.*

✦ ✦ ✦



A huge completely shielded filter built at the Bell Laboratories for long-wave radio telephone research

Ultra-short-wave broadcasting

[SCHRÖTER] (Communication from the Telefunken Laboratories.) Résumé of the history of this development, from the Telefunken point of view. Some points which have not hitherto been dealt with are: Advantages of waves around 7 meters over those around 3 meters as regards the greatly decreased absorption by buildings and the lessening of shadow and interference effects in the neighborhood of metallic structures. From 8 meters upwards the space wave is of importance. On 9 meters fading was noted, though not on 11 meters. The Nauen tests on 6 meters in 1930 gave good reception up to 5 kilometers with 250 watts, the optical horizon being 19.6 km.; freak reception at 35 km. also took place. The same transmitter now relays the Berlin programs from a point in that city on 7 meters with about 300 watts. It has five frequency-doubling stages after a crystal, modulation (grid) being in the last stage. The vertical doublet is about 50 meters above street-level, the increase from 35 meters gave surprising increases in reception. A map of the reception results from the Berlin area is given. Good, reliable loudspeaker reception with three stages of audio-frequency amplification is possible up to 15 km., at times (where the intervening area is relatively free of buildings) up to 20 km., and exceptionally (the receiver being on a hill) up to 60 km. No fading has been observed. The importance of directing the waves so as to reduce radiation upwards (waste) and downwards (interference with near-by normal broadcast reception) is emphasized.

The standard receiver has been battery fed, a regenerative detector coupled through an a.f. transformer to the pick-up terminals of any normal receiver. The chief problem, now solved, has been the adaptation of this receiver to mains supply, a tube with low inter-electrode capacity, smooth entry into oscillation, a large mutual conductance (3 mA./V) and a very rigid heater having been developed. The author considers that the difficulty of mutual interference between oscillating receivers may be overcome by "discipline"; also that if a good field-strength be attained it may be possible to lock the regeneration-control so that oscillations cannot be caused.

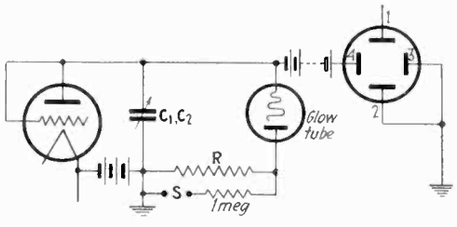
The proposed superheterodyne reception with a radiated heterodyning wave is being developed for television purposes. Interference has been chiefly from automobile ignition systems, but as a rule only when the receiver was on the ground floor.

A formula for the probable field-strength under simplified conditions is given, from which the importance of high receiving and sending antenna can be seen. No direct measurements of the coefficient of absorption have yet been possible, but comparisons with other conditions of reception make a rough estimate feasible, and, based on this, curves for the decrease in field-strength with distance from the transmitter for a given height of receiver antenna and various heights of transmitter antennas, and inversely for a given transmitter and various heights of receiving antennas, are given.—*E.N.T., Berlin, October, 1931.*

✦

Cathode ray time base

[G. I. FINCH, R. W. SUTTON and A. E. TOOKE, Imperial College of Science and Ferranti, Ltd.] Ignition-coil sparks produce trains of more or less damped oscillations repeating themselves at somewhat irregular intervals. When in the ordinary flashing circuit used to produce a linear time axis the filament current is increased beyond the saturation stage, a point is reached where the lamp starts to glow steadily. On going



back to lower current strengths flashes reappear at a lower value than that at which they merged into a steady discharge when the current was increased (hysteresis). In the case where the extinction potential itself is not far from these values, the lamp will not even restart flashing when the reduction is very sudden, but becomes extinguished and remains so until recharged. Such conditions obtain when C or R are fairly large (and what the author does not mention, when the gas pressure is suitable). By letting the circuit S in which recurring changes have to be studied apply a suitable potential to the circuit in which the steady discharge passes, the discharge is immediately stopped, the condenser starts to charge up and draws a linear time axis between one pair of electrodes in all but a short initial stage—*Proceedings Phys. Society, London, September, 1931.*

✦

Filament heating with r.f. currents

[MÖCKEL] Supplementary notes on this subject (these digests, Nov. 1931). This experimenter prefers the shorter waves (10 meters). He heats not only the receiving tubes but also the energizing oscillator filament by its own r.f. currents, a relay switching this from mains supply to r.f. as soon as it is oscillating, and the mains then supplying only plate current.—*Funk, Berlin, November 6, 1931.*

Filamentless radio tubes

[M. GUNTHER SCHULZE and F. KELLER, Dresden Institute of Technology and Osram Co.] Discharges are produced in helium, neon, argon, krypton, etc. at pressures of a few tenths of mm. mercury between a magnesium disk as plate and a nickel gauze (diameter of wires 0.3 mm., 1.4 mm. apart, 56 per cent empty surface). As third electrode, an iron disk is placed a short distance behind the nickel cathode. Even when this third electrode and the nickel cathode are given the same potential, an appreciable amount of current, about one-fourth and even more at lower pressures, reaches the iron collector. When the iron is made positive both the main and the collector current decrease rapidly, the collector current reverses its sign and from this point on both currents increase again. The changes are most marked as long as the potential differences between the gauze and the disk are small; a change of 6 volts of the collector reduces the main current from 12 to 3 m.a. even at 1,500 volts plate potential in nitrogen at 0.01 mm. mercury.

The principle to be followed in the construction of this type of filamentless radio tubes has been clearly stated by Kossel in 1921 in an article (*German Yearbook of Electronics and Radio Activity,* volume 18) who tried to develop these tubes for war-time use. The high sensitivity of the vacuum tube depends on the fact that when the electrons leave the filament their speed is very low; but the same is true at the cathode of a discharge tube filled with neon or helium, for instance, where electrons are set free by the impact of positively charged atoms instead of by heat. The positive ions seem to produce an increase in temperature at the spot (10^{-15} sq.cm.) where they strike the cathode so that the causes are really the same in both cases. The main thing is to protect the electrons set free from the influence of the voltage drop which is known to exist before the cathode and placing it somewhat behind the disk. When this part, made of aluminum or magnesium, is made positive with respect to the remainder of the disk, the plate current decreases, while the discharge potential remains unchanged. The mutual conductance has the same value as in vacuum tubes, but can also be made much larger. The difficulties are to maintain the gas pressure constant and to produce interchangeable tubes.—*Zeitschrift für Physik, October, 1931.*

✦

Third Italian radio show

[UNSIGNED] General review of this show and details of the individual exhibits, of value to those interested in this market.—*Radio Giornale, Milan, October, 1931.*

Direction-finding for aviation

[SCHWANDT] Survey of German methods, especially as regards the Luft-Hansa line, with description of the three most usual plane sets (Telefunken 10 and 70 watt, Lorenz 100 watt). Direction finding is almost exclusively carried out by the ground stations, and as a rule the plane advised of the course to steer rather than of its position. Errors of both "course" and "position" methods, affecting more particularly the latter, are dealt with. The less-used direction-finding from the plane itself is also described, as well as that based on the interference (audibly or visibly recorded on the plane) of two emissions, although this last is still in the experimental stage in Germany—*Funk, Berlin, October 16, 1931.*

✦

Amplitude and frequency modulation

[W. RUNGE, Telefunken Lab., N. F. HECHT, E. KAMMERLOKER.] While a modulation percentage meter usually is part of the equipment of a transmitting station, it does not indicate how much distortion is produced (*Electronics,* July, 1931, August, 1931). With ordinary methods it is difficult to make sure whether a given frequency has arisen in the transmitter or in the measuring device. But when in addition to the audio frequency "l" to be tested, an adjustable frequency is introduced, this mixture "squared" by means of a square law detector and allowed to act upon a galvanometer sharply tuned to a frequency below speech range (10 cycles per sec.) the original frequencies present in the transmitter are revealed as well as their amplitudes (see *Electronics,* July, 1931), because all the sums and differences of the original frequencies and the added frequency occur in the "squared" resultant. The instrument acts like an intermediate amplifier tuned to a low frequency.

While performing these measurements it was observed that the amplitudes of the two side-hands were very different, evidently because frequency modulation was present besides amplitude modulation owing to a slight wobbling to "ω" cycles below or above the carrier frequency "r." The modulated wave then becomes equal to

$$U = \sin\left(\mathrm{rt} - \frac{\omega}{\mathrm{l}}\,\omega\cos \mathrm{lt}\right)$$

or as ω is very small

$$U = \sin \mathrm{rt} - \tfrac{1}{2}\,\omega\,(\cos(\mathrm{r}+\mathrm{l})\,\mathrm{t} + \cos(\mathrm{r}-\mathrm{l})\,\mathrm{t}$$

in addition to the amplitude modulated wave (percentage "m")

$$U = \sin \mathrm{rt} - \tfrac{1}{2}\,\mathrm{m}\,(\cos(\mathrm{r}+\mathrm{l})\,\mathrm{t} - \cos(\mathrm{r}-\mathrm{l})\,\mathrm{t}$$

As a result the higher side hand is strengthened, and the difference gives the frequency variation.

Simple models showing how frequency (or better phase) modulation produces wider side hands than amplitude modulation are given by Hecht.

An improved method for determining the percentage of amplitude modulation uses the electronic oscillograph in which, however, in contrast to other methods, the deflecting plates need not be strictly parallel. The second pair of plates is made to give, l times per second, a linear time axis. On the screen a true picture of the contours of the modulated high frequency wave appears which can be photographed if desired. The degree of modulation is equal to (a — b) (a + b), where *a* and *b* are the highest and the least width of the curve—*Elektrotechn. Zeitschrift, October, 1931. Wireless Engineer, September, 1931. Elektr. Nachrichten Technik, October, 1931.*

✦

British national radio exhibition

THE STRAIGHT TUNED radio frequency set with capacity-coupled band filter, two or three screen-grid stages and power detectors were strongly in evidence. One set uses screened pentodes in addition to a mixed type of band-pass filter to prevent cross-modulation. A few receivers incorporate the new variable-mu tubes, MM4V and VMS4, the mutual conductance of the VMS4 being 1.1 m.a. per volt at minus 3 volts and 0.005 m.a. per volt at minus 40 grid potential. The price for an ordinary two-stage tuned r.f. set, with detector followed by push-pull output and built-in moving coil loudspeaker is around 20 guineas against 30 a year ago. The superheterodyne is beginning to take an important place, but about one-half of these sets are provided with a preliminary r.f. stage, and the lesser amount of intermediate amplification thus required reduces the tube-hiss. Two firms showed the stenode radiostat; but neither uses the crystal "gate," as the excessive sharpness would make tuning difficult.

In the matter of tubes the new two-volt Mazda pentodes Pen 220 and 220A are remarkable as they make available 40 to 50 per cent of the anode circuit power. The one-tenth amp. indirectly heated tubes are newcomers, the AC/S2 a screen-grid tube has a slope of 5, the output triode tubes 41MP and 41MXP 7.5 milliamperes per volt. The choice between triode and pentode becomes merely a choice between constant voltage or constant current output. The exhibition was visited by close to 200,000 persons. A large map showed them that over 98 per cent of the total population will soon be in the service area of one or more of the B.B.C. transmitters — *Wireless Engineer, November, 1931, Television, November, 1931, Electrician, October, 1931.*

Photoelectric cells and colorimetry

[H. E. IVES AND E. F. KINGSBURY] Bell Telephone Laboratories. Photoelectric colorimeters have recently been announced for which high accuracy is claimed. When the task is only one of sorting and selection, in which the nature of the colors concerned is known in advance, photocell methods are simple. For precision measurements of color three methods are used, either the color is compared with mixtures of red, green and blue, or with a mixture of a color and white, or the intensity is measured at various wavelengths. The second method is not susceptible of reduction to purely physical methods. Photoelectric devices could be used in the two other methods provided that photocells of constant and reproducible response were available sensitive throughout the visible spectrum. But due to the elaborate processes used to make cells color sensitive, they are subject in the present stage of development to a variety of uncertainties which are discussed and made clear with the help of a number of graphs. non-linear response due to gas content and high series resistance, effect of time of exposure, variation with time, difference between cells prepared in the same way, different voltage-current relation at different wavelengths, etc. Precision may be obtained where a substitution or balance method is employed.—*Journal Optical Society, September, 1931.*

✦

New television mirror-wheels

[SCHADOW] Study of the possibility of reconstructing an approximately rectangular image by mirror-wheel reception from a Nipkow-disk transmission. and of uses of a special wheel (in which each mirror is narrower and nearer to the axis than its neighbor) for ready changes in the size of the image. The possibilities of receiving transmissions having a differing number of points per line without structural change in the receiver is also studied, by the use of two mirror-wheels rotating at different speeds and with axes at right angles to each other, the light being reflected from one and then the other on its way to the viewing-screen.—*Funk-Magazin, Berlin, November, 1931.*

✦

Radio navigation

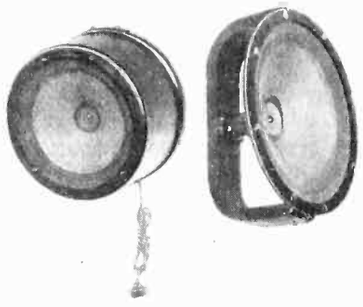
[BESSON] General study of the systems based on the audio interferences of the singles of two transmitters, leading to a full description of a system using a loop and a vertical antenna in combination, and of its applications to navigation (more especially marine).—*L'Onde Electrique, Paris, September, 1931.*

+ NEW PRODUCTS

THE MANUFACTURERS OFFER

Permanent magnet dynamic loudspeaker

AN ANNOUNCEMENT OF INTEREST from the research laboratories of the RCA Victor Company, Camden, N. J., is a permanent magnetic loudspeaker Type RL-43. This is one of the components now handled by the Engineering Prod-



ucts Division. One view in the accompanying illustration shows the speaker in its housing for auto-receivers and the other the mechanism only for use with console battery-operated sets. The same high quality reproduction is now claimed with this permanent magnet-speaker as with the conventional electro-dynamic speaker. No field supply is required, thus making it particularly desirable for use with sets operated from batteries, as it eliminates the objectionable extra load on the "A" battery. Other constructional features include the use of special treated, aged magnets, sturdy construction and an acoustically designed case.—*Electronics, December, 1931.*

✦

Aluminum horn

THE FIRST MODEL OF A FULL series of all metal trumpet horns has just been offered the sound projection trade by the Fox Engineering Company, Toledo, Ohio, manufacturers of horns and high-powered electro-dynamic units. These horns are 6 ft. long and have a bell diameter of 32 inches. They are of spun aluminum and free from lateral joints or seams. This construction makes possible a definite radial uniformity which the manufacturers claim account for the fine tone. This model is easy to set up and take down for temporary use, and when knocked down into its two integral parts is convenient for shipping.—*Electronics, December, 1931.*

Direct-reading illuminometer

THE ADVENT OF THE NEW Photronic light sensitive cell developed by the Weston Electrical Instrument Corporation, Waverly Park, Newark N. J., has made it possible to offer to illuminating engineers a new, unique, portable illuminometer known as the Weston Model 603. Measurement of light intensities with this new foot-candle meter is as simple and direct a procedure as the measurement of voltage in a circuit with a voltmeter. It is only necessary to turn the searching unit to the light to be measured and then read its value in foot-candles directly on the instrument scale. Model 603 illuminometer is very simple, consisting of only two parts, an accurate indicating instrument mounted in a carrying case and a searching unit or light target with a 6-foot cable permanently attached to the instrument. It is compact and convenient, weighing only 7 lbs.—*Electronics, December, 1931.*

✦

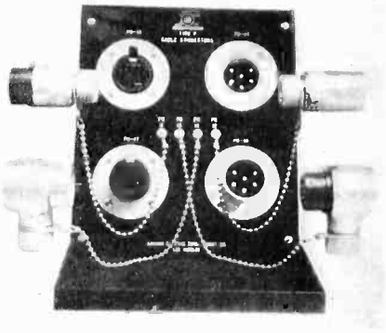
Air pressure public address system

THE HOOVENAIRE SOUND SYSTEM, 122, Fifth Ave., New York City, has developed a complete public address equipment for airports, stadiums and similar places requiring unusual volume out-

put. The receiver unit of the large horn operates under an air pressure of 22 lb. which is actuated by a small magnetic valve. This valve receives its impulses from the amplifier. It is claimed that projection of sound over a distance of approximately 15 miles with this system is possible. — *Electronics, December, 1931.*

Cable connectors for sound equipment

SEVERAL UNIQUE FEATURES are incorporated in the Type P plugs and receptacles designed by the Cannon Electrical Development Company, 420 West Ave. 33, Los Angeles, Calif. The plugs have solid prongs not depending on expanded slots to close the circuit. The receptacles are built from $\frac{3}{16}$ in. square brass drilled to clear the prongs. Contact is made by a rugged phosphor bronze spring plate set in a milled recess in the side of the receptacle, drawn down tight to the groove bottom and riveted, assuring a positive tension. This type of contact is positive, having a self-cleaning, wiping action the full



length of the prong travel. The warp of the bronze clip is so short that it will not fatigue and lose its tension. This line is designed particularly for news reel and portable sound equipment. Other types of plugs and receptacles are also available and bulletins describing them will be supplied upon request.—*Electronics, December, 1931.*

✦

Combination a.c. and d.c. generator

THE A.C. CARGEN COMPANY, 507 E. 16th St., Kansas City, Mo., has announced a combination a.c. and d.c. generator. The d.c. end is designed for charging automobile batteries and the a.c. end for furnishing the necessary current of radio or other sound equipment. These units are designed in various capacities up to 400 watts. They are useful in conjunction with public address systems of the portable type and also for radio sending and receiving sets on yachts, airplanes, automobiles, etc.—*Electronics, December, 1931.*

High gain amplifiers

TWO MEDIUM PRICED AMPLIFIERS of high gain have recently been announced by Wireless Egert Engineering, Inc., 179 Varick St., New York City. Model 503 high gain amplifier uses one 224 tube and one 227 tube. The voltage amplification depends on the transformers used at the input and output. Where the amplifier is used to feed from the plate of another tube and feeds into the grid circuit of another amplifier, the voltage gain is 18,000.

Model 504 high gain amplifier uses two 224 and one 227 tubes. Its characteristics are similar to Model 503 with a greatly increased amplification. These two models may be used to amplify frequencies between 40 and 10,000 cycles. The amplification is substantially uniform between these two points. The units are built into a steel cabinet and are neat in appearance. One hundred and eighty volts are used for the plate potential and 2.5 volts, either a.c. or d.c. for the filament.—*Electronics, December, 1931.*

✦

Electro magnetic counter

FOR USE IN CONJUNCTION WITH photoelectric cell relays, recording machines, remote counting of revolutions and similar purposes, Struthers-Dunn, Inc., 148 N. Juniper St., Philadelphia, Pa., has announced an electro magnetic counter. Two types are available, one non-resetting model having a designed speed of 75 impulses per minute and one having 350 impulses per minute respectively. In general these units may be used on any equipment where electrical contacts can be actuated.—*Electronics, December, 1931.*

✦

Low thermal expansion ceramic

CLAIMING TO POSSESS the lowest coefficient of thermal expansion of any known material, is Crolite No. 7, announced by Henry L. Crowley & Company of West Orange, N. J. The new ceramic has a two-to-one advantage in thermal coefficients over other alloys and a four-to-one advantage at 100 deg. (two-to-one at 1,000 deg.) over the ceramic employed for spark plug cores and other purposes. This new product is the result of extensive research in the Crowley laboratory. It has a coefficient of thermal expansion of 0.9 at temperatures ranging from 0 to 100 deg. C., and 1.2 from 0 to 200. At high temperatures, or up to 1,000 deg. C., the coefficient of thermal expansion is 2.7. The thermal expansion curve of Crolite No. 7 is smooth and uniform.—*Electronics, December, 1931.*

✦

Exposure meter

J. THOMAS RHAMSTINE, 501 East Woodbridge St., Detroit, Mich., has announced a photoelectric exposure meter of simple design. It is fully automatic giving a meter reading for variation in light intensity. "Electrophot," as this unit is called, has been developed along the same principles used in professional movies, color sorting, photometry, etc. The meter is 3½ in. in diameter and weighs about 1 lb. List price, $35.—*Electronics, December, 1931.*

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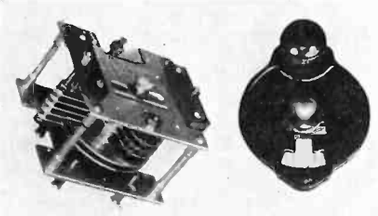
Band spread condenser

DESIGNED TO HAVE HIGH minimum capacity for use in frequency meters and amateur band-spreading circuits, the Type 35-70 condenser is announced by



the National Company, 61 Sherman St., Malden, Mass. The minimum capacity of this condenser is 35 mmf. and the maximum capacity 70 mmf. List price, $4.50. Also shown is the Type BM 3-in. dial, especially adapted for small receiving and transmitting equipment where space is limited—*Electronics, December, 1931.*

✦

Quartz photoelectric cell

G-M LABORATORIES, INC., of 1735 Belmont Ave., Chicago, announces the development of a quartz photoelectric cell to meet the many requirements for a light measuring instrument of high sensitivity in the ultra-violet portion of the spectrum. This cell is of the caesium oxide gas-filled type and has a clear fused quartz envelope in the region of the sensitive cathode plate. The cell is constructed so as to have extremely high electrical resistance when dark—that is, low leakage—due to the long glass beads surrounding the electrode support wires.—*Electronics, December, 1931.*

Special radio receiver

AMONG SOME OF THE recent equipment announced by the Western Electric Company, 50 Church St., New York City, is the No. 10A radio receiver. It has been designed especially for use with the Western Electric audio-frequency distribution system. This receiver is a tuned radio-frequency type employing three stages of screen-grid band-pass amplification, a detector and an automatic gain control tube. The circuits are tuned by a six gang variable tuning condenser. Fidelity of reproduction is stressed in this receiver and high quality reproduction is claimed with a minimum of variation in intensity over the entire broadcast spectrum. Bulletins covering a.c. operated audio amplifiers and Western Electric No. 9A speech input equipment have also been issued.—*Electronics, December, 1931.*

✦

Photoelectric cells

PHOTOCELLS IN SEVEN standard sizes designed to cover practically all uses are now available from Herman A. DeVry, Inc., 55 East Wacker Drive, Chicago, Ill. The operating voltage recommended for these cells is 90 volts though a variation form this voltage is allowed. A recent bulletin issued by this company gives complete details and may be obtained by writing the company direct.—*Electronics, December, 1931.*

✦

Wire calculator

DESIGNED TO COMPUTE complete wiring and motor data, the Square D calculator is now being offered to the trade by the Diamond Electrical Manufacturing Company, Ltd., 1320 E. 16th St., Los Angeles, Calif. The calculator is handy, fitting conveniently into the

pocket. Because of its substantial construction, rough handling cannot in any way upset its precise calculations. For this reason it may be used as effectively in the field as in the office.—*Electronics, December, 1931.*

U. S. PATENTS

IN THE FIELD OF ELECTRONICS

A list of patents (Dec. 1) granted by the United States Patent Office, chosen by the editors of *Electronics* for their interest to workers in the fields of the radio, visio, audio and industrial applications of the vacuum tube

Electronic Applications

Electro-acoustical musical instruments. An oscillating tube and a key to cut out additional tuning condensers, and thereby vary the tone generated. Jörg Mager, Berlin, Germany. No. 1,829,099.

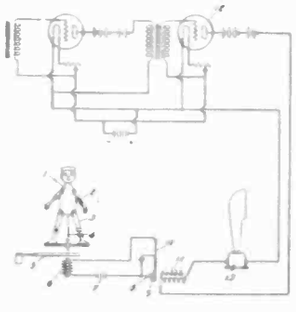
Recording electric current produced by living organisms. An amplifier-rectifier and oscillograph adapted to make records of the current produced by living organisms. Pierre Duchosal, Geneva, Switzerland. No. 1,829,267.

Detecting suspended matter in fluids. A photo-electric method of producing an alarm signal when suspended matter occurs in fluids. G. G. Freygang, assigned to Walter Kidde Company, New York. No. 1,828,894.

Radio Circuits

Radio system. Two controlling devices for determining a carrier wave frequency, and means to prevent the simultaneous control of the frequency by both devices. L. J. Wolf, assigned to Westinghouse E. & M. No. 1,829,465.

Radio toy. In series with the output of a tube is an inductance coil which opens and closes an electro-magnetic circuit, which in turn actuates a toy figure. R. F. Yates, assigned to Tobe Deutschmann. Re-issue No. 18,239.



Broadcasting system. A system for receiving messages simultaneously broadcast on several different wavelengths, while neutralizing any signals not common to all wave lengths. H. C. DeVore. No. 1,828,831.

Oscillating receiver. A normally non-oscillating receiver is permitted to oscillate during reception of signals. Sigmund Loewe. RCA. No. 1,830,611.

Superheterodyne circuit. Receiver with range of 500 to 1,000 kc. produces beat frequency of 300 kc. D. T. Simonds, G. E. Co. No. 1,830,965.

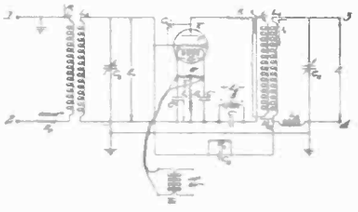
Zero-reactance primary interstage coupling. Multi-stage r.f. amplifier with primary of interstage transformer maintained zero reactive. Sylvan Harris, Stewart Warner. No. 1,830,542.

Reflex circuit. L. Etheridge, assigned to J. M. Rodgers, Louisville, Ky. No. 1,829,131.

Neutralizing system. A method for neutralizing radio transmitters employing a number of coupled thermionic tube circuits. L. A. Gebhard, assigned to Wired Radio, Inc. No. 1,829,273.

Voltage control. Use of carborundum crystals to an amplifier loud speaker system to maintain input voltages within predetermined limits. J. M. Kendall, G. E. Co. No. 1,833,750.

Balanced circuit. Amplifier of the balanced type. F. H. Drake and P. O. Farnham, RCA. No. 1,833,638.



Regenerative receiver. Incoming oscillations set into oscillation a local circuit, low frequency oscillations controlling the oscillation of local circuit. Fritz Fischer, G. D. T. No. 1,833,323.

Volume control. Resistance in the filament circuit. F. H. Drake, RCA. No. 1,833,639.

Volume control. Decreasing volume by reducing efficiency of tube until such point that pronounced curvature of the characteristic is encountered and then decreasing energy into receiver. V. C. MacNabb, Atwater Kent. No. 1,833,085.

Space charge grid circuit. Variations of space charge to change degree of regeneration for reception. J. T. McLamore, G. E. Co. No. 1,833,788.

Goniometer. Introducing into goniometer circuits a voltage opposite that existing there due to capacity between windings. I. F. Byrnes, G. E. Co. No. 1,833,735.

Radio compass system. Two receiving sets with independent antennas, a light source to be illuminated by the reception of signal energy by one apparatus. G. T. Royden, assigned to Federal Tel. Co. No. 1,831,465.

Television, Facsimile, Etc.

Scanning device. Use of a scanning disc having a series of square scanning openings and means for projecting a magnified image of each picture framed on the scanning disc, the openings in the disc being enlarged in proportion to the magnification of the image. C. F. Jenkins, assigned to Jenkins Laboratories. No. 1,828,867.

Electro-optical translation system. A carrier wave modulates the light variations which are transformed into a photo-capacitant variation, which in turn controls a tuned circuit voltage. C. H. W. Nason, assigned to Jenkins Television Corp. No. 1,828,875.

Synchronizing system. A method of synchronizing apparatus, used in the facsimile transmission, which is unaffected by static. R. H. Ranger, assigned to RCA. No. 1,829,420.

Double modulation television transmission. E. L. Nelson, BTL. No. 1,830,173.

Picture transmission. Receivers tuned to various wave lengths have their outputs assembled in a common picture receiving system. E. F. W. Alexanderson, G. E. No. 1,830,586.

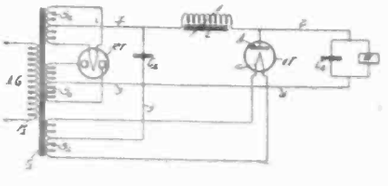
Television system. A gas tube is subjected to the modulation envelope of the television signal, through the inductive influence of the modulated carrier current, and means for scanning this envelope. D. E. Trouand, assigned to Westinghouse E. & M. No. 1,832,672.

Generation, Amplification, Etc.

Piezo crystal receiver. Use of a Piezo electric crystal to control the frequency and the regenerative energy in a receiver, and a means of disconnecting the Piezo element without interrupting the regeneration of the circuit. E. R. Hentschell, assigned to Wired Radio, Inc. No. 1,830,837.

Coupling circuit. A combination of a tuned circuit and an untuned circuit, resonant at a frequency slightly below the tunable range. H. A. Wheeler, assigned to Hazeltine Corp. No. 1,831,431.

Power supply system. A method of protecting the load circuit from the fluctuating component of the source, by means of a three-element tube, the plate-filament circuit of which is connected in parallel with the load. B. F. Miessner, assigned to RCA. No. 1,832,646.



Regenerative amplifying systems. A Rice-neutralized amplifier is coupled to a regenerative detector. In the plate circuit of the detector is a series tuned circuit, for lessening energy transfer at high frequencies. V. B. Landon, assigned to Westinghouse E. & M. Co. No. 1,832,640.

Control circuit. A three-element tube has a light-sensitive cell between its grid and plate, and a capacity between grid and a neutralizing winding, to neutralize the grid plate capacity. A. W. Hull, assigned to G. E. Co. No. 1,832,707.

Frequency modulation. Piezo electric control oscillator in whose plate circuit is a means for periodically varying the tuning. A. H. Taylor, assigned to Wired Radio. No. 1,831,933.

Detection of frequency or phase modulation. A high frequency signal is received adjacent to the transmitter point. The received signals are sent along two paths, one of which has a delay in it. R. K. Potter, assigned to A. T. & T. No. 1,831,881.

Interstage coupling device. A network containing series and parallel branches, the final voltage supplied to a following tube is taken off a variable inductance in series with a variable capacity. W. B. Roberts, assigned to RCA. No. 1,831,640.

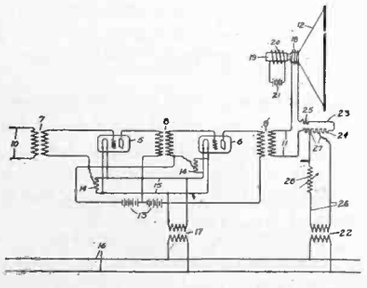
Electrical musical instruments. A number of circuits, each containing a glow-discharge lamp and a resistance and condenser, an amplifier and a loud speaker. Nicholas Langer, Budapest, Hungary. No. 1,832,402.

Air-driven tuning fork.. R. H. Ranger and T. E. Nelson, assigned to RCA. No. 1,831,638.

Amplification measuring. The output of an amplifier connected to the output through a network; means to determine whether the system is in oscillation or not. Torbern Laurant, Stockholm, assigned to Ericsson. No. 1,381,744.

Load current control. Use of two triodes to control current to a load. H. W. Brown, assigned to G. E. Co. No. 1,833,821.

Hum reducer. To the voice coil of a dynamic speaker is applied hum voltage of proper phase and amplitude to buck out hum coming from amplifier. L. W. Thompson, G. E. Co. No. 1,833,762.

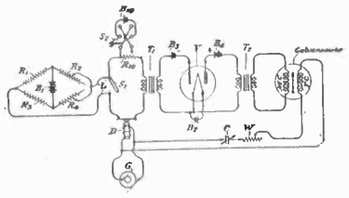


Stabilizing circuit. By means of an external circuit, two grid circuits of an amplifier are connected toegther in such a manner that undesired oscillations are prevented. T. H. Burns, Newark, N. J. No. 1,831,340.

Modulating system. Modulating system in which the upper and lower side bands are segregated into separate circuits. R. B. Stewart, Washington, D. C. No. 1,831,516.

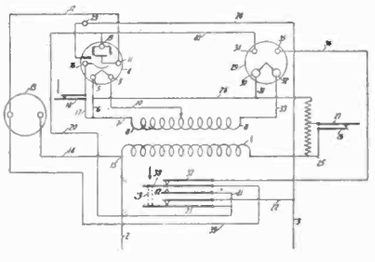
Interference eliminator. The use of an auxiliary circuit for decreasing undesired signals in a receiving set, including a feed-back circuit for decreasing the damping in this auxiliary circuit. George von Arco, assigned to G.D.T. No. 1,829,204.

Galvanometer bridge circuit. Method of connecting galvanometer to bridge through a vacuum tube amplifier. P. G. Edwards and H. W. Herrington, A. T. & T. Co. No. 1,832,969.



High frequency generator. A method of getting very high frequencies by a push-pull input stage, parallel output circuit in which the input capacity of the tube is in series with an output inductance. R. L. Davis, assigned to Westinghouse E. & M. Co. No. 1,832,621.

Tube testing circuit. A tube testing device in which a meter is used to indicate any leakage between filament and cathode. P. F. Jackson, assigned to Radio Products Co., Dayton, Ohio. No. 1,829,448.



Short wave antenna. A radiation current meter is placed in the mid-point of an antenna, and the direct current leads from this meter are carried through a metallic tube to the transmitter room proper. D. K. Martin, assigned to A. T. & T. No. 1,831,921.

Uniform gain amplifier. A method of compensating for non-uniform amplification in a radio receiving system. F. A. Kolster, assigned to Federal Tel. Co. No. 1,830,948.

Radio beacon system. A method of producing a radio beacon for the guidance of aircraft, comprising directing upward a hollow beam of radio energy and a solid beam of differently characterized radio energy within the hollow beam. F. A. Kolster, assigned to Federal Tel. Co. No. 1,831,011.

Radio receiver. A 3-stage r.f. amplifier has its interstage coil secondaries coupled to a tuned inductance. Tuning this common circuit is sufficient to tune the individual stages. F. J. Trainor, Daytona Beach, Fla. No. 1,831,519

Frequency modulation. Counteracting losses in magnetic frequency wobbler. C. W. Hansell, RCA. No. 1,830,166.

Automatic field control. Opening field of a generator at a desired interval after generator is not in use. N. E. Lindenblad, RCA. No. 1,830,170.

Frequency wobbled superheterodyne. Wobbling carrier between certain frequency values at several rates. R. H. Ranger, RCA. No. 1,830,242.

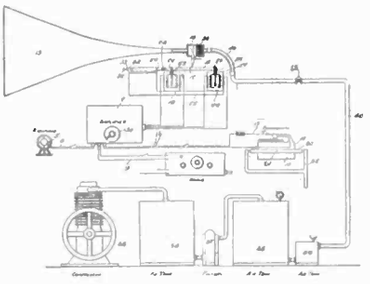
Piezo-controlled beat frequency oscillator. August Hund, Federal Tel. Co. No. 1,830,322.

Voltage regulator. Use of neon tube to control working voltage. P. M. G. Toulon, Puteaux, France. No. 1,830,450.

Piezo-resonator. Method of making visible oscillations of a piezo-electric crystal by means of gas-filled vessel. H. Eberhard, Berlin. No. 1,830,532.

Acoustic Apparatus Amplification, Etc.

Compressed air loud speaker. Specifications of the Hoovenair loud speaker. F. L. Hetzel, assigned to C. E. Hooven, Hamilton, Ohio. No. 1,829,991.



Recording apparatus. Method of maintaining light sensitive surface in beam of light in a recording mechanism. T. R. Harrison, Brown Instrument Co. No. 1,827,520.

Picture transmission system. Biasing Kerr cell to higher volt-light characteristics. R. D. Kell, G. E. Co. No. 1,828,667.

Picture transmission. Modulating flaming arc, and projecting light through scanning disc on screen. I. Langmuir, G. E. Co. No. 1,828,571.

Adjudicated Patents

(D. C. N. Y.) Colpitts patent, No. 1,128,292, for electric-wave amplifier, *Held* valid and infringed. *Western Electric Co.* v. *Wallerstein,* 51 F.(2d) 529.

(D. C. N. Y.) Lowenstein patent, No. 1,231,764, for telephone-relay, *Held* invalid. *Western Electric Co.* v. *Wallerstein,* 51 F.(2d) 529.

(D. C. N. Y.) Mathes patent, No. 1,426,754, for circuits for electron-discharge devices, claim 25 *Held* valid and infringed. *Western Electric Co.* v. *Wallerstein,* 51 F.(2d) 529.

(D. C. N. Y.) Blattner patent, No. 1,483,273, for circuit for heating the filaments of audions, *Held* not infringed. *Id.*

(D. C. N. Y.)—Arnold patent, No. 1,504,537, for power-limiting amplifying device, claims 17, 18, 20, 33-36 *Held* valid and infringed. *Western Electric Co.* v. *Wallerstein,* 51 F.(2d) 529.

BRITISH PATENTS

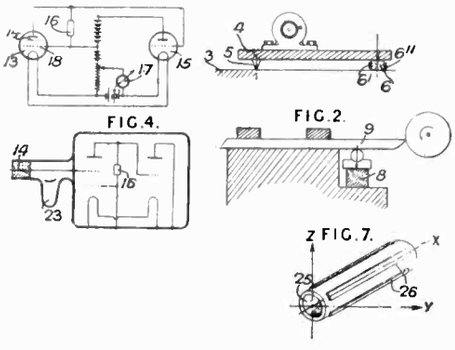
IN THE FIELD OF ELECTRONICS

Because patents are issued in Great Britain some months before issuance in the United States, and because British patents reflect what is going on in Europe better than the American Patent Gazette, the editors of *Electronics* choose representative disclosures each month for this page.

Electronics Applications

Remote metering system. When a meter needle moves, it carries a card which shuts off more or less of the light from a light source, and which, through a lens system, shines into a photo-electric cell. Thus the current output of the cell is varied in accordance with the movements of the meter needle, and this current can be used to actuate a similar needle at a distance. T. R. Warren, assigned to Associated Electrical Industries. No. 353,591.

Piezo-electric shock measuring. A method of measuring such physical qualities as acceleration, shocks, temperature, magnetic permeabilities, etc., by causing the application of a stress to be applied to a piezo-electric crystal, the electric potential of which is applied to the grid of a tube having a total emission current of not more than 10^5 amperes, with a plate voltage of not more than 8. A. T. Lincke and R. A. J. Kluge, Berlin. No. 352,051.



Light and heat control apparatus. Devices for automatically laying guns, etc., or for steering torpedoes, in which an image of the target is distributed on one or more light- or heat-sensitive cells connected in a balanced circuit. The out-of-balance current produced by this image actuates steering apparatus. K. Tihanyi, Budapest. No. 352,035.

Radio Circuits

Improving quality. A method of increasing, at the transmitter, overtones of audio frequencies to improve the musical quality. Telefunken. No. 340,060.

Directional receiver. Improving the directional characteristic of a receiving aerial by one or more pre-detector frequency doubling stages. Marconi Co. No. 340,182.

Remote control system. Remote control for radio receivers. Kolster-Brandes, Ltd. No. 340,259.

Superheterodyne receiver. A method of increasing the effective amplitude of the beat frequency by applying to the first rectifier a grid bias so that current flows only during the peak of the local oscillations. Standard Telephones & Cables. No. 340,569.

Fixed tuning system. A push-button-operated receiver, arranged to be adjusted to one or more selected wave length settings. W. P. Crilly, Los Angeles. No. 341,464.

Tetrode circuit. An electrode of large surface compared with the control electrode is near the latter. Radiotechnique, Paris. No. 349,237.

Hum preventer. Two tubes heated by a.c. with output arrangement to neutralize hum; only one of the tubes is used to detect or amplify signals. Marconi Co., assignee of W. Van B. Roberts, Princeton. No. 343,499.

Differential amplifier. Tube grids in parallel and placed in push-pull or vice versa, and a volume control means. Radio Frequency Labs. No. 343,999.

Super-regenerative set. The input is applied to a pair of tubes in parallel, having quenching frequencies applied to their grids in phase opposition. Marconi Company, assignee of W. Van B. Roberts, Princeton, N. J. No. 341,786.

Superheterodyne. The grid bias of the first detector is controlled by the low frequency detector. Standard Telephones & Cables, Ltd. No. 342,305.

Frequency control. Use of a long line to control frequencies. The long line may be a single layer or bank wound coil. Marconi Company, assignee of J. L. Finch and J. W. Conklin, Rocky Point, N. Y. No. 342,976.

Radio frequency amplifier. An amplifier made up of tubes having two grids, one of which has smaller dimensions than the other, and has an effect on the electronic emission opposite to that of the control grid. Arcturus Radio Tube Co., assignee of S. Ruben. No. 343,250.

Interstage coupling. High frequency coupling device comprising a low resistance primary and a high resistance secondary connected in parallel, having a common iron core. The arrangement is stated to give increased signal strength. C. J. Craker, South Norwood, London. No. 344,543.

High frequency generator. A condenser discharge system. J. Brettmon, Paris. No. 348,955.

Reflector. A parabolic reflector for very short waves; the distance from the apex to the focus is a multiple of the wave length. Telefunken. No. 349,043.

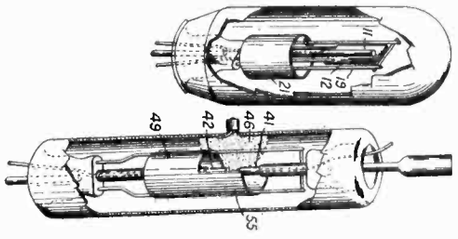
High frequency valve. The interaction of two or more streams of electrons sets up oscillations in a conductor such as the anode. Standard Telephones & Cables. No. 344,448.

Short-wave generator. A push-pull generator for a very high frequency. A. Esau, Jena, Germany. No. 348,461.

Directive transmission. A system of ultra short-wave broadcasting. Telefunken. No. 348,784.

Photo-Electric Cells, Etc.

Thorium-sensitive cells. A photo-electric cell with a cathode of thorium, sensitive only to radiation of wave lengths below 3,900 angstroms. H. C. Rentschler, assigned to Westinghouse Lamp Co. No. 353,555.



Alkali cell. Manufacturing patent dealing with method of manufacturing caesium type cells. Westinghouse Lamp Co. No. 345,043.

Light-sensitive cell. Method using zenon, krypton or a mixture of these gases, to which a quantity of hydrogen may be added. M. A. Pressler, Leipzig, Germany. No. 345,189.

Gas type cell. A cell in which the distance between the grid and the cathode is equal to or less than the path of an electron. The grid is positive about 1 to 5 volts, to prevent electrons returning to the cathode. Philips, Holland. No. 347,544, also 347,660.

Screen-grid cell. A photo-electric cell with a shield grid surrounding the anode. Westinghouse E. & M. Co. No. 348,693.

Positive ion collector. A grid maintained at a negative potential collects positive ions in a photo-electric cell. A.E.G. No. 349,042.

Infra-red sensitive cell. A method of preventing deterioration of cell due to atmospheric action. Telefunken. No. 342,055.

Light valve. An electrostatically responsive crystal used as a light valve in which interference effects between the reflected and transmitted lights are set up by dimensional changes in the crystal. Marconi Co., assignee of W. L. Douden, Brooklyn, N. Y. No. 342,219.

Combination of thermionic and photo-electric cell. Lissen, Ltd., 342,900.

Kerr cell. Using a high bias on a Kerr cell. For example, where the difference between the plates of the Kerr cell is 0.02 in., and its length is 1.2 in., the bias voltage of 2600 volts is applied where previously a voltage not exceeding 1200 volts was used. Thomson-Houston. No. 343,416.

Compensating temperature changes. Effects of changes of temperature on light sensitive cells are compensated by changing the resistance of the electric circuits including these cells. W. Engelke and H. L. Read, London. No. 343,885.

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January to December issues, inclusive, 1931

McGraw-Hill Publishing Company

330 West 42nd Street, New York City

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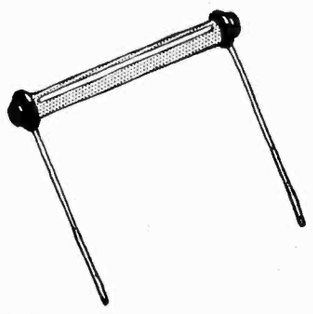

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AUTHORS' INDEX

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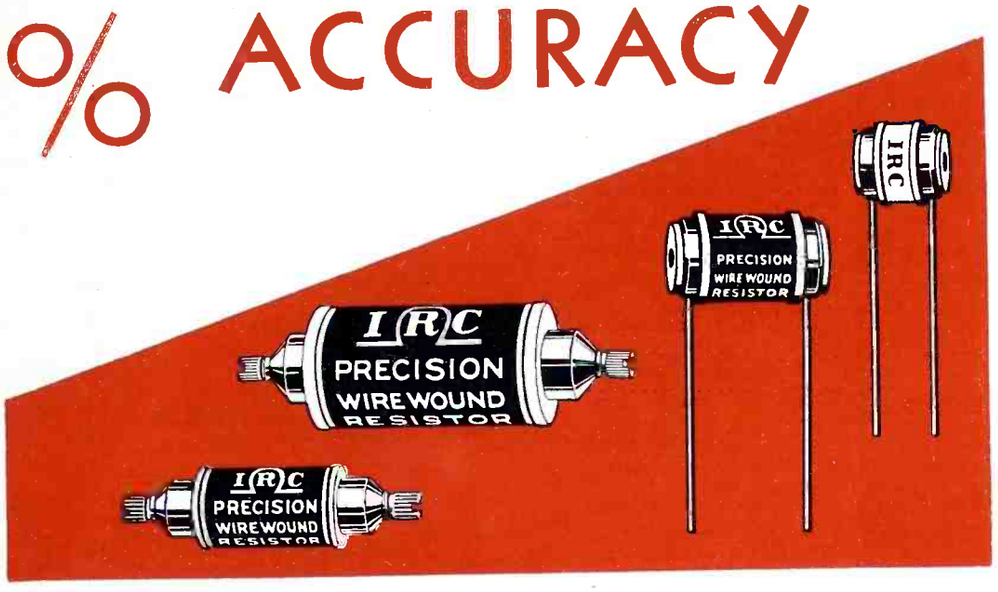
BUILT FOR EQUIPMENT THAT AIMS AT 100% ACCURACY



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Pentode tubes used as triodes

[*Continued from page 227*]

age (B + C voltages) of about 325 volts in order to deliver the same power output as the 245 does with 300 volts applied. The average plate current for 300 volts on the plate and screen-grid with minus 25 volts on the control is 27 m.a. The d.c. power when used as a triode under the above conditions is 8.1 watts compared with a total power of 9.9 watts in the plate and screen-grid when used as a pentode.

The input voltage required is only about half of that required by the 245 tube. The per cent second harmonic is rather high so that its use as a single output tube connected as a triode is not recommended. It does, however, appear to offer some advantage when used in push-pull as a triode, namely a 50 per cent reduction in input voltage over that required by a 245 for about the same power and less matching difficulties than if it were used as a pentode.

The following conclusions may be reached:

1. The maximum obtainable power output efficiency is the same with either ideal pentode or ideal triode.

2. Ideal pentode characteristics under the conditions that voltage input will not exceed the negative grid bias may be realized practically much closer than ideal triode characteristics.

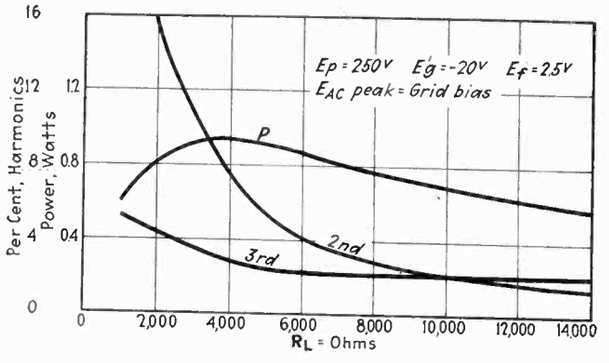


Fig. 5—Pentode used as triode; screen-grid tied to plate

3. Ideal triode characteristics may be realized approximately by imposing no limitations on grid voltage swings.

4. A single pentode output tube is not as satisfactory as single triode as regards distortion taking into account output impedance variation with respect to frequency.

5. Good results as to quality may be obtained by pentode push-pull operation by matching so that the load impedance variation due to variation in speaker impedance with frequency will fall within the proper range.

6. Push-pull operation is more satisfactory than parallel operation.

7. The 247 type tube has some advantages for use as a triode with push-pull connections.

The Review *of* Progress

CLAROSTAT

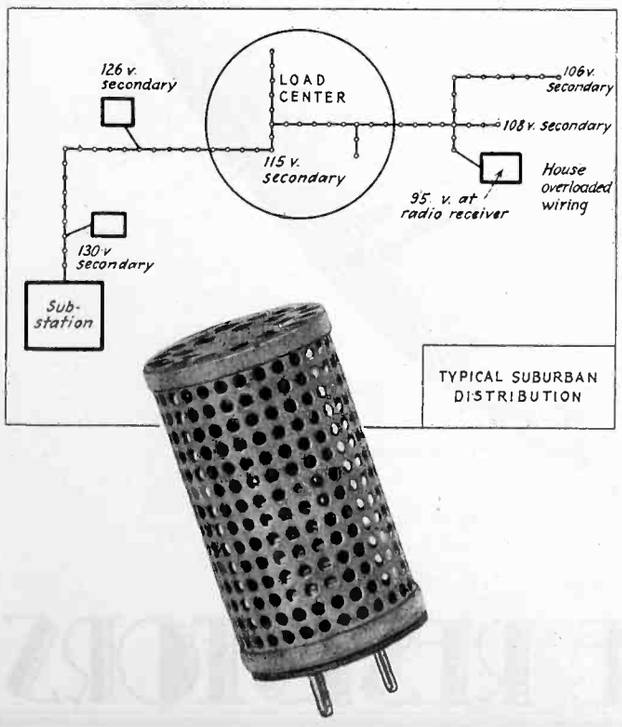
Standard Voltage Supply

The foreign manufacturer of radio receivers is confronted with as many as a dozen different voltages and frequencies. In the United States 115 volts, *where maintained,* is practically standard.

***EVERY** step in electronic development has been anticipated by Clarostat engineers in their art of control design . . . They now offer a device which provides correct constant voltage for radio receivers.*

IN all but a few large cities "radial" or dead end feeder systems are used.

An average feeder voltage of 115-v. is usually maintained by means of moving coil transformers within the sub-station. These are operated from a potential lead taken at the "load center." To maintain 115-v. at the load center, feeder areas before the load center often run 10% higher. Feeder areas beyond load centers usually are much lower than 115-v. "Load centers" shift with changing loads. Overloaded housewiring also causes excessive voltage drop.



Though power companies do their utmost to regulate voltage, the uncontrollable factors of voltage drop on long feeders and overloaded housewiring, plus shifting load centers, render a constant 115-v. socket supply a matter of extreme chance.

A typical survey (illustrated) showed voltages from 95-130 in twenty-four hour tests. This explains why poor operation often prevails even in well-built sets and why dealers in certain areas often lose sales as a result of poor demonstration.

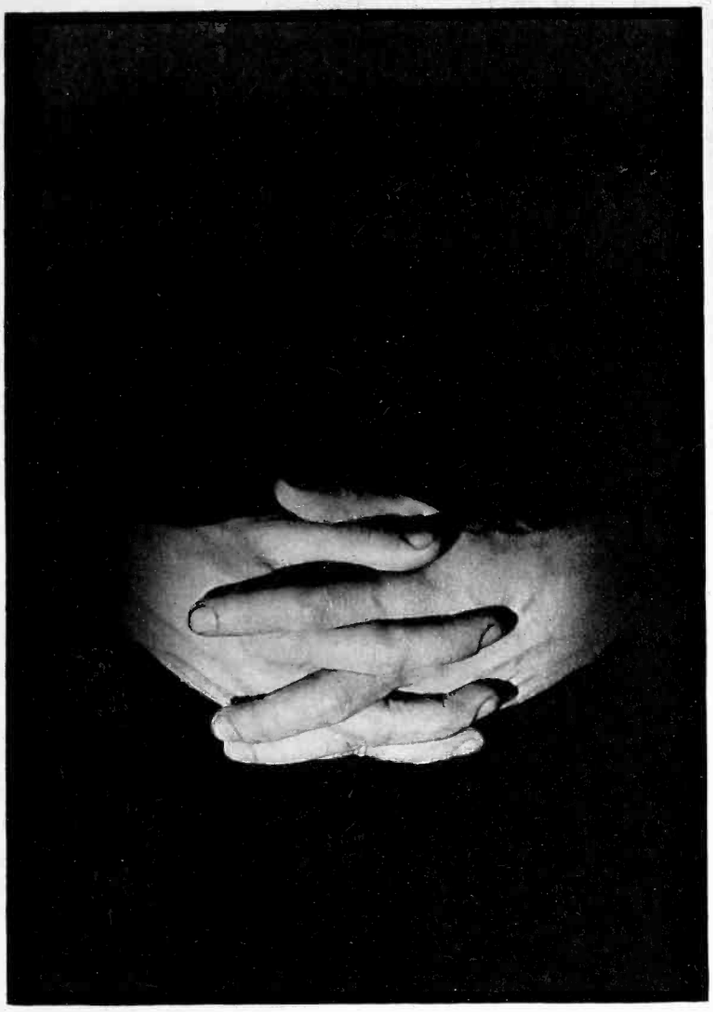
In the light of these operating conditions Clarostat developed their Line Ballast. It is designed to raise line voltage where it is low, as well as lower line voltage where too high. The Line Ballast is built to order for each receiver manufacturer's specifications, some manufacturers having special specifications for different districts.

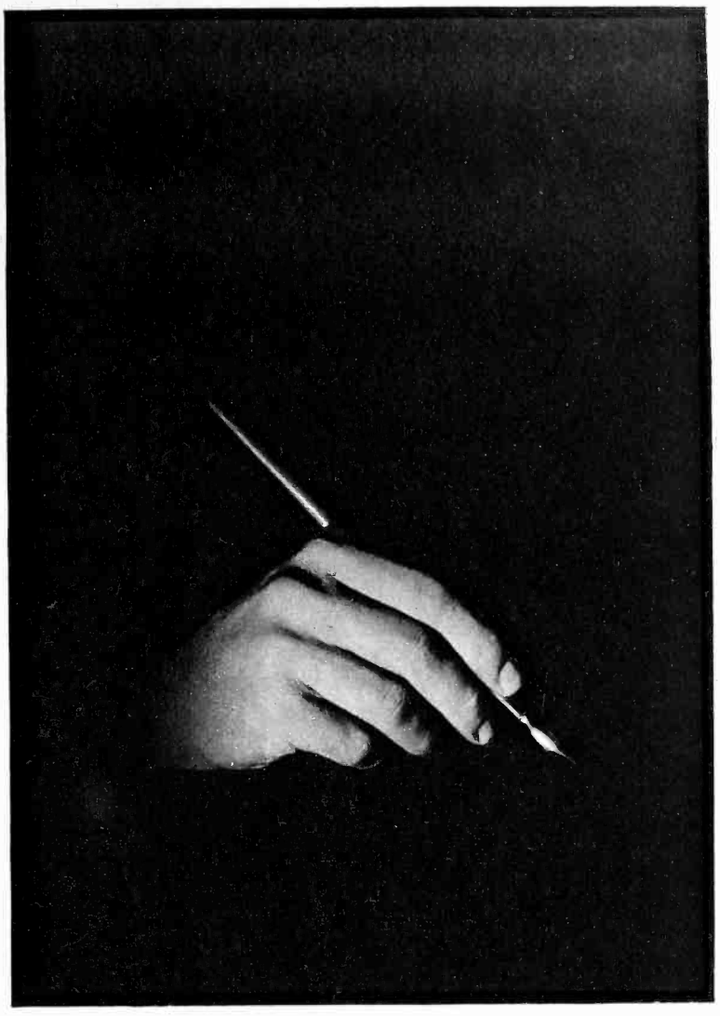
The cost of the Clarostat Line Ballast is offset by the saving effected in widely oversized-power packs. Proof of improved set performance is offered in the form of reduced noise, less service and constant volume characteristics. Clarostat can provide the Line Ballast to meet your special requirements.

Clarostat service to the electronic arts includes volume controls, voltage regulators, rheostats and resistors.

Clarostat Manufacturing Co., Inc.

285 North 6th Street, Brooklyn, N. Y.





INDIFFERENCE or ACTION

It is acknowledged that the product which offers more is met with orders, while indifference blocks the path of the unfit. By offering a better product —Synthane creates orders for itself. By using Synthane, manufacturers better their own products and—increase orders.

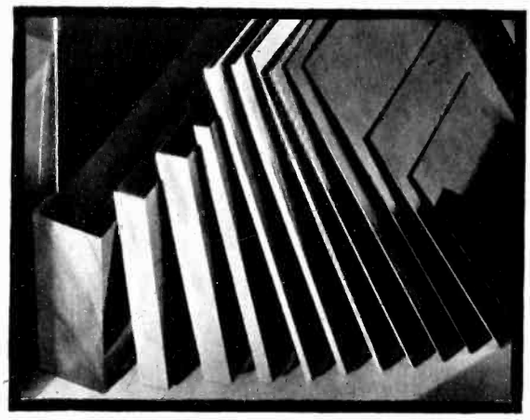
Positive uniformity, the constant characteristic of Synthane, makes for smoother production, less waste, and dependable performance. These are facts—capitalized every day by present users of Synthane. Are you familiar with Synthane? The reverse side gives more information.

SYNTHANE
Laminated Bakelite

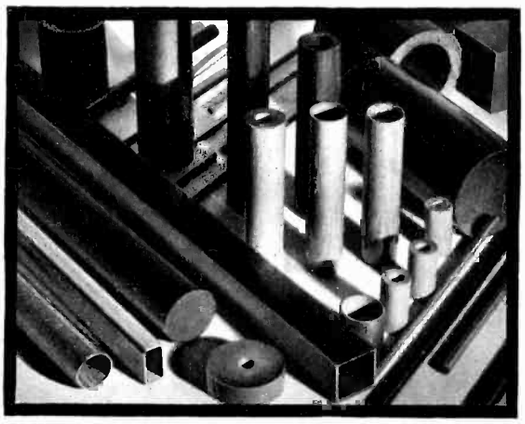
SHEETS—RODS—TUBES—FABRICATED PARTS—STABILIZED GEAR STOCK

SYNTHANE *LAMINATED BAKELITE*

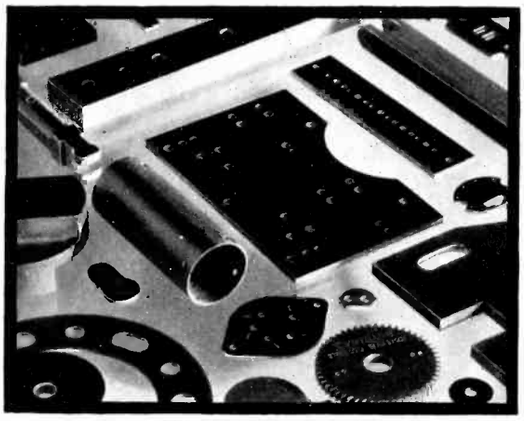
FOR EVERY SPECIFICATION



SHEETS



TUBES & RODS



FABRICATED PARTS

STABILIZED GEARS

No matter what your requirements, you will find a grade of Synthane specially designed to meet them.

Special grades made at no additional cost. All standard grades of Synthane, listed according to N. E. M. A. standards, are ready for immediate shipment.

GRADE X. For General Use where low moisture absorption and good machining and electrical properties are required. Paper base. Will punch up to 1/32" cold, and when heated, to greater thicknesses. Machines readily. See "Sheets", "Tubes".

GRADE XX. For Extremely Low Moisture Absorption and High Dielectric Strength. Paper base. Good machining qualities. Low moisture absorption. See "Sheets", "Tubes", "Rods".

GRADE XP. For Punching Operations. Paper base. Punches and shears cold up to 3/32"; punches and shears in thicker sizes depending on design of die and temperature of material. See "Sheets".

GRADE C. For Exceptional Structural and Impact Strength. Canvas base. Punches and machines readily. For use where high impact and transverse strength are required in connection with good insulating properties. See "Sheets", "Tubes", "Rods", "Gears".

GRADE L. For Fine Machining. Linen base. Usually required not over 1/8". See "Sheets", "Tubes", "Rods".

SHEETS. Size—36" square. Thickness—.010" upwards to 8". Color—Natural, Chocolate Brown and Black. Finish—Dull, High Gloss. Grades—X, XX, XXX, XP, C, L. Special as required.

TUBES. Length—36". Diameter—Inside diameter from 1/8" upwards. Outside diameter as required. Color—Natural and Black. Finish—Dull, High Gloss. Stocks—Round, Square, Rectangular. Grades—Wrapped X, C, L; Molded X, XX, C, L. Special as required.

RODS. Length—36". Diameter—1/8" upward. Color—Natural, Black. Finish—Dull, High Gloss. Stocks—Round, Square. Grades—Molded XX, C, L.

FABRICATED PARTS. Complete fabricated parts made to specifications in any of the above grades. Prompt deliveries to customers' requirements.

SYNTHANE STABILIZED GEAR STOCK for Silent Gears. Standard sheets 36" square. Thickness—upwards to 8". Easy to machine, strong, resilient and light. Gear blanks of any diameter in stock for immediate shipment.

SYNTHANE does not crack, break, dent, swell, warp, or cold flow. It has high dielectric strength, low moisture absorption, low surface leakage, good punching qualities, easy machineability, and high resistance to oils and chemicals. Genuine Bakelite resins, high-grade raw materials, specially designed machinery, controlled processes and supervised workmanship insure absolute uniformity of all Synthane products.

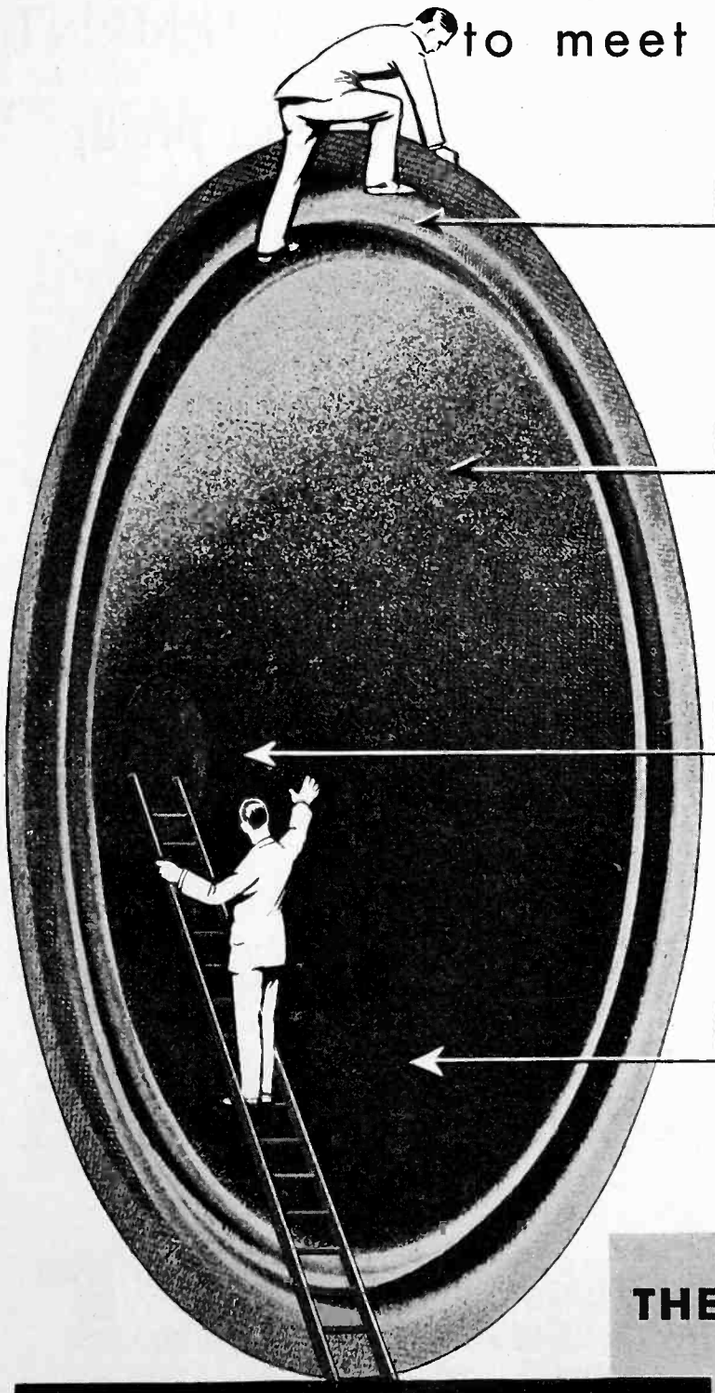
SYNTHANE

CORPORATION **OAKS · PENNA**

NEW YORK — CHICAGO — BOSTON — DAYTON — LOS ANGELES — SAN FRANCISCO

Only the Hawley Process

can produce speaker diaphragms to meet these 4 specifications



1 Flexibility

The most critical part of the diaphragm is the flexing ring. The Hawley one-piece moulding process produces a mounting flange, flexing ring, and diaphragm in one piece. Subsequent treatment after moulding provides extreme flexibility in the flexing ring and thus furnishes a support for the diaphragm rim which is so uniformly flexible that perfect tone quality is obtained.

2 Light Weight

Hawley diaphragms are moulded by the special Hawley process. The Hawley diaphragm is a marvel of light weight and great strength. The diaphragm is devoid of inherent strains. The usual tonal distortions produced by "pasted-up" diaphragms are eliminated.

3 Rigidity

The apex has extreme rigidity in the area surrounding the voice coil. Response to harmonics is improved and greater realism in tone quality is obtained.

4 Special Design for Each Speaker

Hawley diaphragms are engineered and moulded to individual specifications for each speaker. Hawley acoustic engineers are at your service. Follow the example of world's leading radio manufacturers and standardize on Hawley Moulded Diaphragms. Submit your specifications for a Hawley quotation, today.

THE HAWLEY HALL OF FAME

These famous radio set and speaker manufacturers equip their speakers with Hawley Moulded Diaphragms

Magnavox	Jenson	Majestic
Utah	Rola	Stromberg-Carlson
Stewart-Warner	American Bosch	Crosley
Operadio	Trans. Corp. of Am.	Melber (Germany)
Lansing	P. Smith Stamping	Sachenwerk (Germany)
Colonial	Oxford Radio Products	Feldman (Germany)
Northern Engraving	Angsten	Neufeldt & Kuhnke (Germany)
Best	Quam-Nichols Co.	Platon Texido (Spain)

HAWLEY MOULDED DIAPHRAGMS

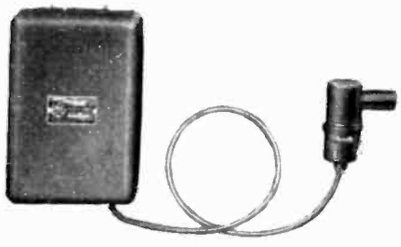
PRODUCTS AND PROCESSES FULLY COVERED BY PATENTS AND APPLICATIONS

HAWLEY PRODUCTS COMPANY, 203 N. FIRST AVENUE, ST. CHARLES, ILLINOIS

There's a job in your plant for "fingers of light"

G-E PHOTOELECTRIC EQUIPMENT

Photoelectric relay unit CR7505-D3, indoor type, for the automatic control of factory, office, school, or residence lighting



Photoelectric relay unit CR7505-A2, a general purpose, indoor-type device for counting and controlling applications

Indoor-type light source CR7500-A2 furnished either with or without separate low-voltage transformer

Use it for protection and profit

Haven't you a routine counting operation that you would like to simplify, and at the same time be sure of precise results? Wouldn't you like to set up equipment that would accurately regulate, and divert, the flow of packaged or bulk materials on your conveyor systems? Has the control of artificial illumination through the automatic turning on and off of lights at the proper time regardless of season become a question of improving product and working conditions?

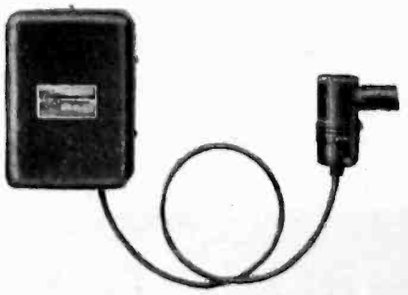
For jobs like these, and for hundreds of others in which counting, regulating, or controlling operations are involved, there's a place where G-E photoelectric equipment can be used to protect both individuals and machines and to derive greater profits.

More than two years of sound engineering experience covering design, manufacture, and application are behind G-E photoelectric equipment. Take advantage of this experience. Control specialists in your nearest G-E office will be glad to coöperate with you.

Photoelectric relay unit CR7505-C2, a general-purpose outdoor type for counting and controlling applications

Photoelectric relay unit CR7505-H1, outdoor type for the automatic control of street, and sign lighting

Outdoor light source CR7500-B1 with self-contained transformer



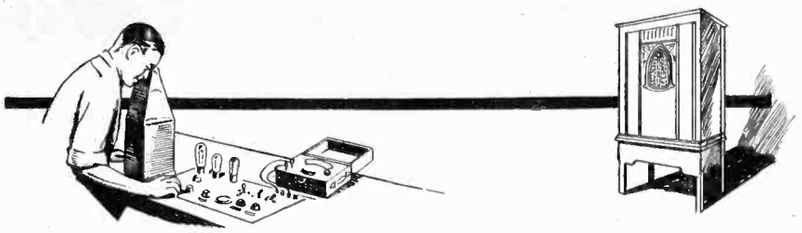
Photoelectric - Thyratron relay unit Type CR7505-G5 for high-speed control

301-90

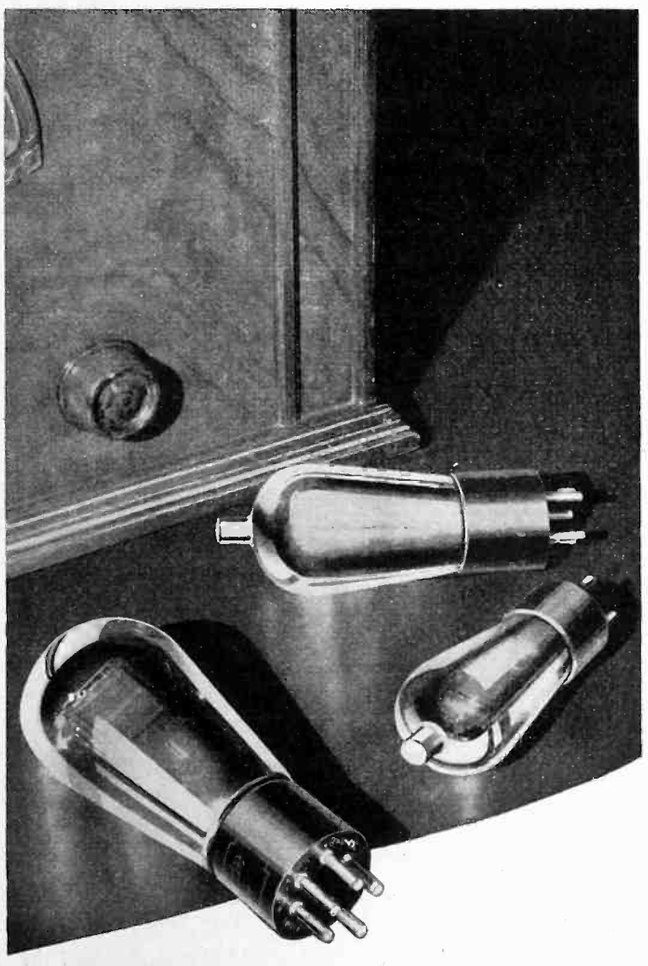
GENERAL ELECTRIC

SALES AND ENGINEERING SERVICE IN PRINCIPAL CITIES

PRODUCTION FACILITIES



IN LINE WITH THE SET MANUFACTURER'S NEEDS:



HYGRADE SYLVANIA HAS PRODUCTION FACILITIES IN LINE WITH THE SET MANUFACTURER'S NEEDS

As evidence of its unusual ability to serve set manufacturers who must have a dependable source of supply of radio tubes —

Hygrade Sylvania presents these qualifications:

Experience

Not only has Hygrade Sylvania made a comprehensive study of the needs of set manufacturers, it has already had a wide experience filling them.

Production Facilities

Capable of taking on stiff production schedules and meeting them.

Financial Strength

Financial strength, the result of sound and successful methods has made Hygrade Sylvania one of the outstanding companies in its field.

Engineering Skill

This same financial strength makes it possible to maintain at all times an engineering department representative of a high degree of skill.

HYGRADE SYLVANIA CORPORATION

HYGRADE LAMP DIVISION
SALEM, MASS.

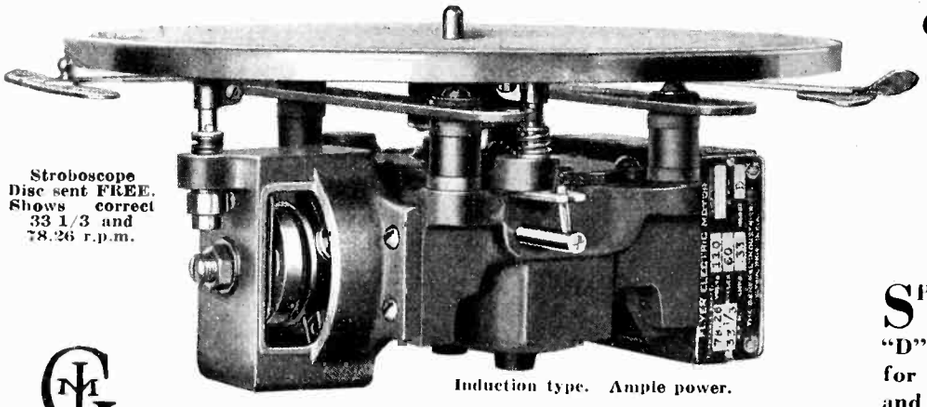
SYLVANIA DIVISION
EMPORIUM, PA.

Now the Model "D" Two-Speed

33 1/3 and 78 r.p.m.

Governor-Controlled

GREEN FLYER



Stroboscope Disc sent FREE. Shows correct 33 1/3 and 78.26 r.p.m.

Induction type. Ample power.

SPECIALLY designed for perfection of dual service, the new Green Flyer Model "D" Electric Motor with turntable provides for playing the new 33 1/3 r.p.m. records and also those recorded at 78 r.p.m. Shifts from one speed to the other by pushing a convenient lever.

Furnishes positively uniform speed under severe variations of voltage and record drag. Governor control provides a 10% range of speed adjustment as desired.

All gears, completely enclosed and running in oil, are spiral cut and made of laminated Bakelite. No hum. Long oversize self-lubricating bearings. No overheating in closed case or cabinet.

For all voltages and frequencies; also supplied for 110 or 220 volts d.c. Furnished complete with turntable, speed regulator dial and speed change escutcheon. Automatic stop is optional. Please specify voltage and frequency required.

The GENERAL INDUSTRIES CO.
3145 Taylor Street, Elyria, Ohio

AN OPPORTUNITY

to acquire sole rights in U. S. A. for Radio's finest profit maker.

U. S. A. Patent App.

The SHERLOCK HOLMES of RADIO

The Pifco "All-in-One" Radiometer makes an instant hit with radio owners wherever it is displayed. It enables anybody to carry out the most comprehensive tests of any circuit, tube, battery or component in a few minutes, and is an absolute necessity for every owner, novice or expert. The sales opportunities are limitless and the sole U. S. selling rights are now open. Retail price in U. S. $3.00.

Write or cable. Patentees Pifco Ltd., High Street, Manchester, England.

PIFCO ALL IN ONE RADIOMETER

SHALLCROSS

Super AKRA-OHM

RESISTORS

Non-Inductive Wire-Wound Resistance Units

that are carefully designed to insure an accuracy of one per cent. and a constant permanency of calibration.

The radio, audio, visio and industrial applications of the electron tube and photo-electric cell require the highest grade resistors of absolute accuracy to control the many complex circuits employed in engineering and research laboratories.

Shallcross Resistors are built to meet these very exacting requirements and are being used with success everywhere for the most precise work.

They are especially adapted to converting milliammeters and microammeters into multi-range volt meters.

Bulletin 150-K describes the many uses for Shallcross Wire-Wound Resistors and contains many valuable charts and diagrams.

Bulletin 900-K describes the Shallcross Megohm Decade Boxes from 1.1 megohms up.

Bulletin 200-K gives full data on the measurement of very high voltages.

Any or all of the above Bulletins may be had for the asking.

ALWAYS Super AKRA-OHM ACCURATE

Shallcross Mfg. Company

ELECTRICAL SPECIALTIES

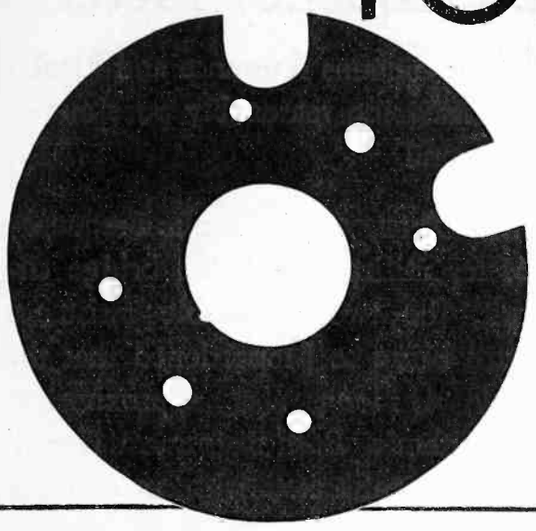
700 PARKER AVENUE

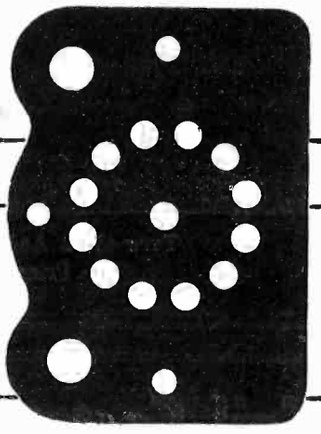
Collingdale, Pa.

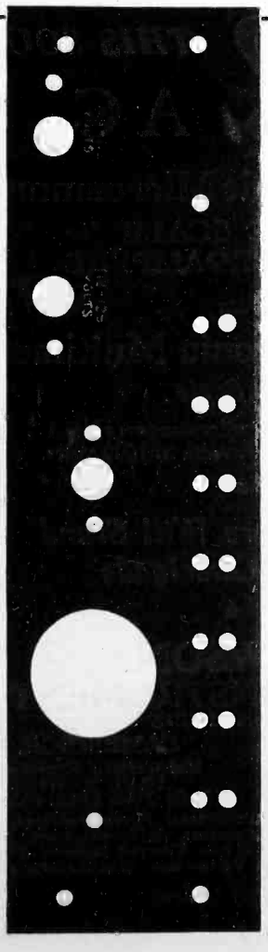
(NEAR PHILADELPHIA)

Accurate NON-INDUCTIVE WIRE WOUND RESISTORS

FOR 18 YEARS A HIGH QUALITY INSULATION • • •







STEADY improvement in methods of making laminated phenolic insulation has gone on in the Formica laboratories for the past 18 years.

Some of the leading users—companies whose engineering and production staffs rank among the best in the world—have used the material steadily ever since it has been available.

There is a type of stock for every requirement. It may be had in full sheets for fabrication in the customer's own plant or it will be delivered worked to your blue prints and ready to assemble.

Ask us to quote on your requirements.

THE FORMICA INSULATION COMPANY
Spring Grove Avenue, Cincinnati, Ohio.

FORMICA

Pioneers

in manufacturing equipment for Broadcast Transmission . . .

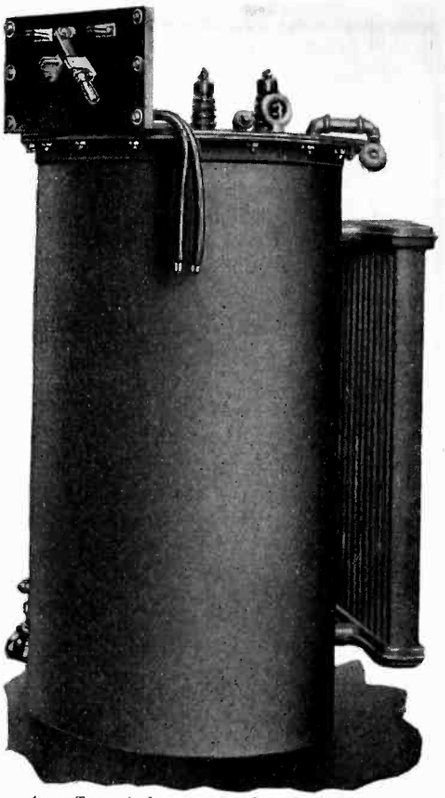
Before broadcasting was thought of—in fact, since 1903 — AMERTRAN has supplied transformers for radio transmission. Furthermore, to-day our apparatus is used by many of the World's best-equipped stations.

We illustrate a unit of AMERTRAN equipment now being installed by a prominent mid-western station. This is one of three identical plate-supply transformers for use with a three-phase rectifier in a new 50-kw. broadcast transmitter. It is an oil-immersed, self-cooled unit of the indoor type.

Other AMERTRAN units supplied for the same installation are two plate retard coils, one filament retard coil, and one small three-phase plate transformer.

AMERTRAN Engineers are thoroughly familiar with radio power problems. Let them recommend equipment to satisfy your requirements.

American Transformer Co., 172 Emmet St., Newark, N. J.



AmerTran indoor-type, plate-supply transformer. Sizes 5 to 500 kva.

AMERTRAN TRANSFORMERS

SCRANTON FOR 50 YEARS SB BRAND BUTTON

A·R·C Molded Radio Coil Bobbins

. . . the peak of perfection

The fine detail work demanded in radio coil bobbins, filament wire shipping bobbins and similar molded parts for radios, requires keen accuracy . . . and in them, as in all other molded products, A. R. C. achieves perfection!

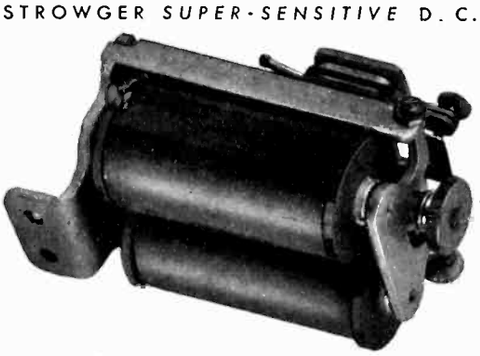
AMERICAN RECORD CORPORATION

ARC

SCRANTON, PA.

NEW YORK: 1776 Broadway — 645 Washington Blvd., CHICAGO
DETROIT: 145 Eastlawn Ave. — 4900 Euclid Bldg. CLEVELAND
HOLLYWOOD, CAL.: 933 Seward St.

NEW STROWGER *SUPER-SENSITIVE* D. C. RELAY



WE BUILT THIS SPECIAL RELAY FOR

YOUR ELECTRONIC WORK

You will want to know more about the application of the new Strowger Super-Sensitive D. C. Relay to your electronic work. This remarkable relay *will operate on direct currents as low as ½ milliampere.* It is ruggedly built, like all Strowger relays, for long and dependable use. Can be supplied in several combinations of coil resistance and spring contacts. Suitable for "plate-circuit" or other vacuum tube applications. Let us send you detailed information.

Automatic Electric Inc.

1034 W. Van Buren Street, Chicago, U. S. A.

On duty 24 hours every day . . .

. . . . *in services where tubes must be absolutely dependable!*

Western Electric tubes are noted for their long life, sturdiness and uniform characteristics. That's why the No. 251-A radio telephone power tube—backed by the 1000-hour-life guarantee—is used by governmental organizations and by 22 police departments in as many different cities!... 175 radio broadcasting stations from coast to coast use Western Electric equipment exclusively, including tubes. A large number of radio stations with composite equipment also use Western Electric tubes . . . For amateurs licensed by the Department of Commerce there are radio telephone transmitting tubes and for laboratory work there are special tubes such as the cathode ray oscillograph and the vacuum thermocouple. Whatever your electronic needs—rely on Western Electric, maker of Bell Telephones since 1882!

The No. 251-A . . . double-ended, radiation-cooled, one-kilowatt tube. Backed by standard 1000-hour-life guarantee.

Filament Voltage	10 Volts
Filament Current	15.9 ± 0.8 Amperes
Average Characteristics on plate voltage of 3,000 and grid bias of −200 volts	
Plate Current	.275 Ampere
Plate Resistance	2200 Ohms
Amplification Factor	10 to 11
Approximate Direct Inter-electrode Capacities	
Plate to Grid	9 Microfarads
Plate to Filament	6 "
Grid to Filament	10 "
Max. Operating Plate Voltage	3000 Volts
Max. Safe Plate Dissipation	750 Watts
Max. Radio Frequency Grid Current	10 Amperes
Peak Plate Dissipation	1000 Watts
Maximum Overall Length	20⅞ inches
Diameter of Bulb	6 inches

Our engineers recently made a field intensity survey in Cleveland, picked a new site for WGAR—signal now much clearer! Let us study your broadcasting problems.

Western Electric

ELECTRONIC EQUIPMENT

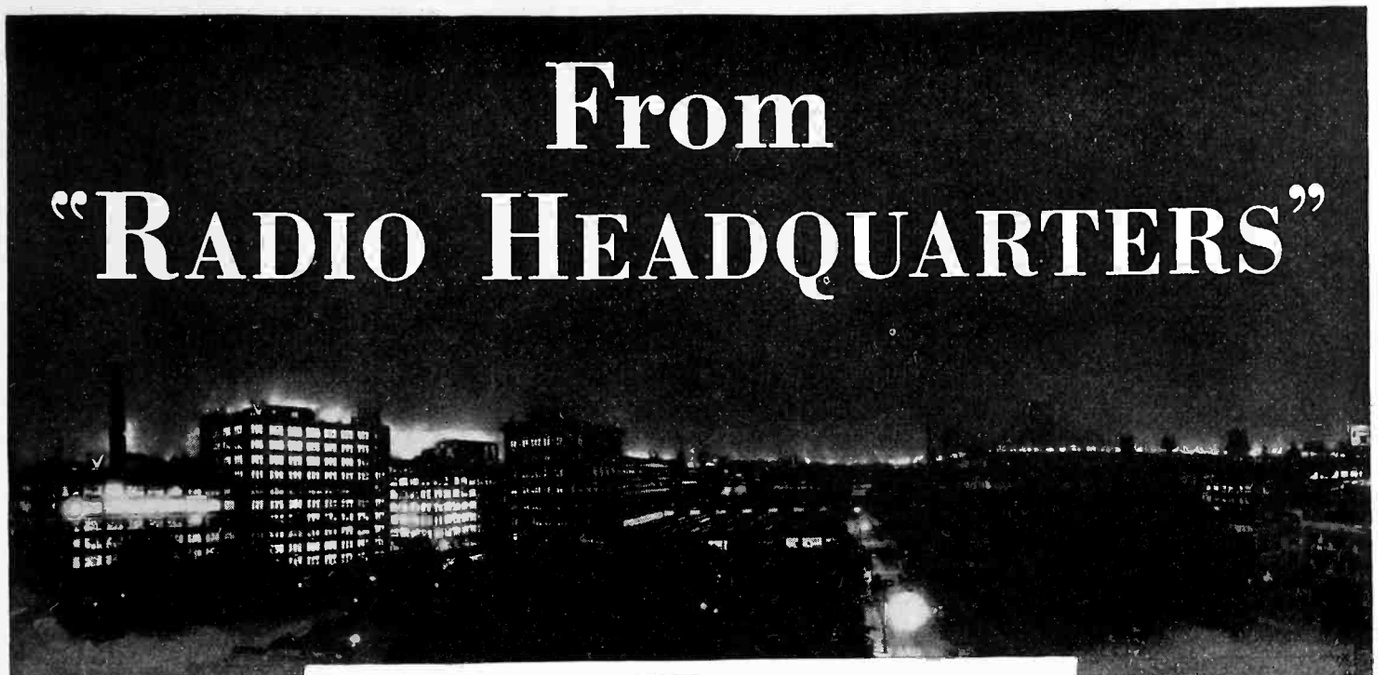
Distributed by* GRAYBAR *Electric Company

GRAYBAR ELECTRIC CO. E12-31
Graybar Building, New York, N. Y.
Gentlemen: I would like information on the following electronic equipment: .....

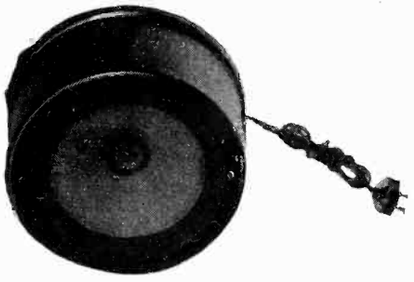
Tubes I am now using are: .....

NAME .....
ADDRESS .....
CITY ..... STATE .....

From "RADIO HEADQUARTERS"



SIGNAL GENERATORS. For general laboratory use where known value of R. F. voltage is required.

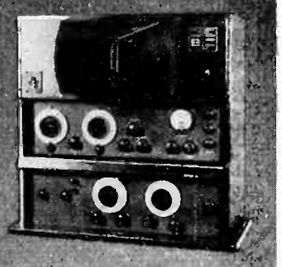


Now—a low priced Permanent Magnet Dynamic Loudspeaker Type RL-43

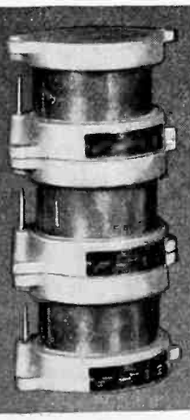
Available to manufacturers of automobile or battery operated radio sets. The same high quality of reproduction obtained with electro-dynamic speakers. No field supply required, thus eliminating the objectionable extra load on "A" battery or other field supply source.

Available with housing shown above for installation in automobiles, or speaker mechanism separate for installation in cabinets. Suitable output transformers can be supplied for desired application.

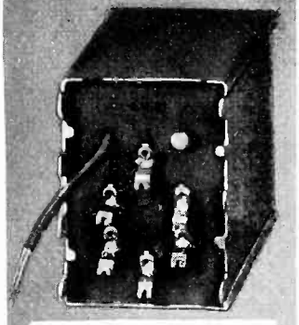
Write us today for complete information.



VISUAL TEST SETS. For accurate alignment and test of Intermediate Frequency Amplifiers and Component Parts.



FARADON CAPACITORS. For dependabilty.



PAPER CAPACITORS. For efficient filters and by-passes.

MAGNETIC PICKUP and INERTIA TONE ARM. For faithful reproduction.

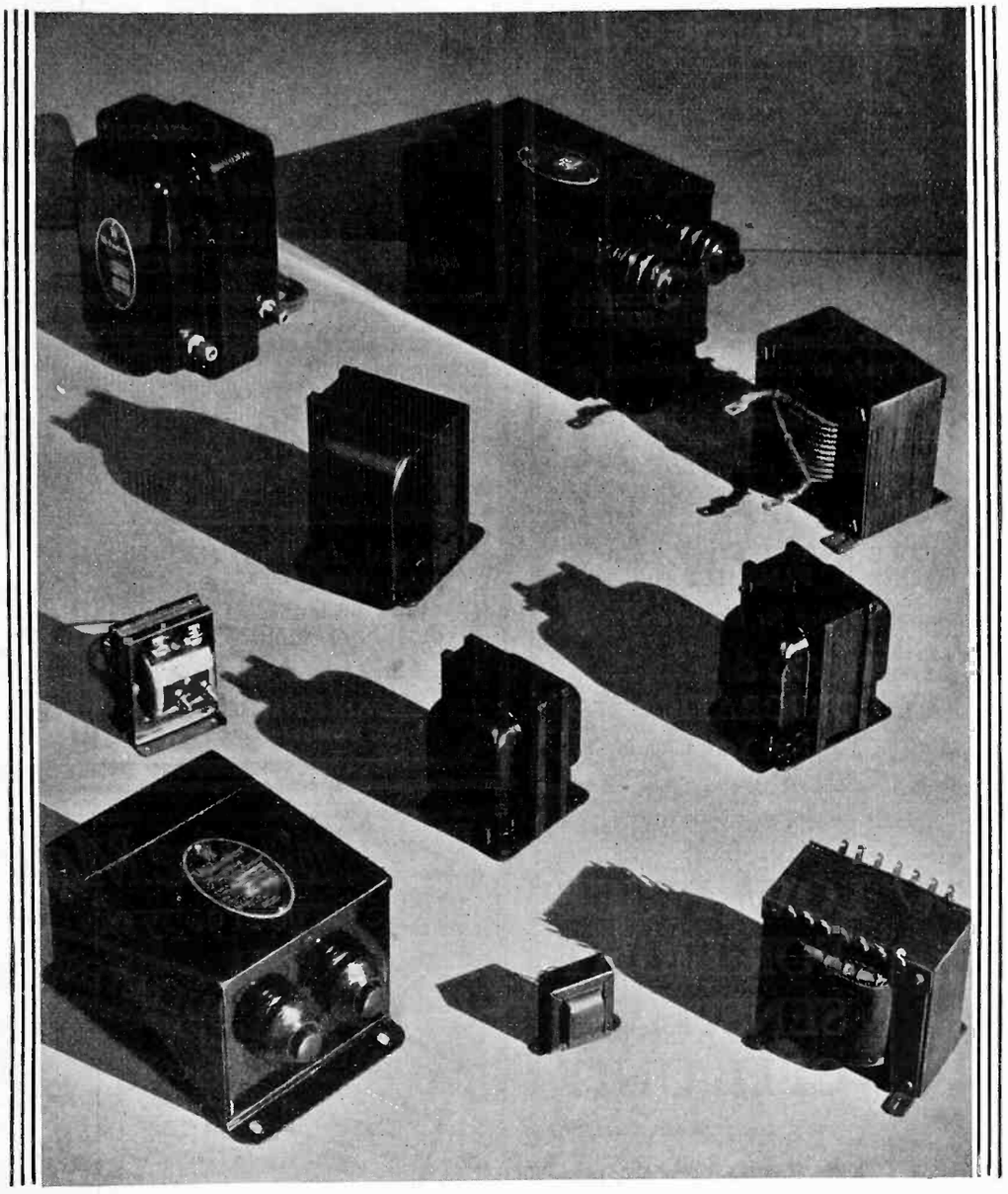
AUTOMATIC RECORD CHANGERS. Offering long periods of carefree entertainment from either 78 or 33⅓ records.

RCA Victor Company, Inc.

INDUSTRIAL PRODUCTS SECTION

CAMDEN, N. J.

WEBSTER ELECTRIC CO.



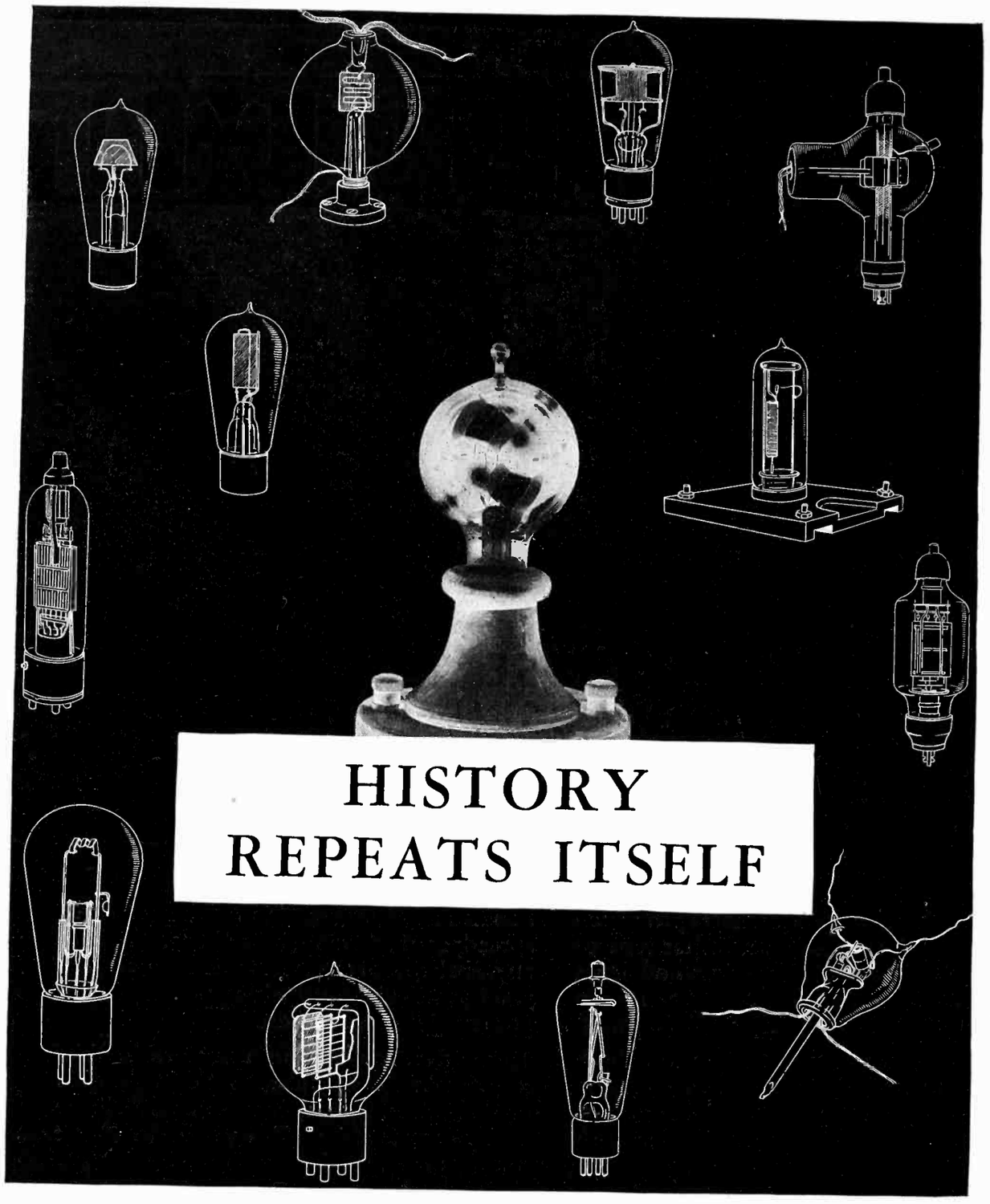
BECAUSE of their excellent performance characteristics, Webster Electric transformers, chokes and electrical windings lend themselves to widespread application throughout the radio and electronic field . . . . Many successful manufacturers have found the reputation of this company for excellence of workmanship and ethical business practice, to be their guarantee of a stable and economical source of supply . . . . Webster Electric sales engineers will lend their assistance in developing special designs or in adapting Webster Electric products to your product.

Webster Electric Company

ESTABLISHED 1909

Racine Wisconsin

Webster Transformers . . . . Webster Electric Pick-ups . . . . Webster Power Amplifiers



THE growth of "radio" in the last decade can be considered phenomenal. Five billions has been spent by the American public because of the harnessing to man's desires of a silent electronic stream.

Those pioneers who have lived with the radio industry since 1921 are now facing new vistas of accomplishment. Through new tubes, circuits and applications, they have accomplished the technical development of a host of new products (light relays, counters, thyratron controls, television, home talkies, talking books, ad infinitum). Broad commercial development will surely follow, and in many instances is already on the way.

In 1932, more than ever, alert component and material manufacturers will cater to these new growing markets . . . for, the broader the application of a product, the wider its sale.

A B C **ELECTRONICS**

McGraw-Hill Publishing Company, Inc., 330 West 42nd Street, New York

PROFESSIONAL SERVICES

AMY, ACEVES & KING, Inc.
Consulting Engineers
Inventors of The Multicoupler Antenna System for apartment houses.
Specializing in Radio Design—Test—Development.
11 W. 42nd St., New York City
'Phone: Longacre 5-6622

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Index to Advertisers

Professional Services 31

Searchlight Section—*Classified Advertising*

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$3 per year. 35 cents per copy class matter Oct. 14, 1911, at Y., under the Act of March 3,

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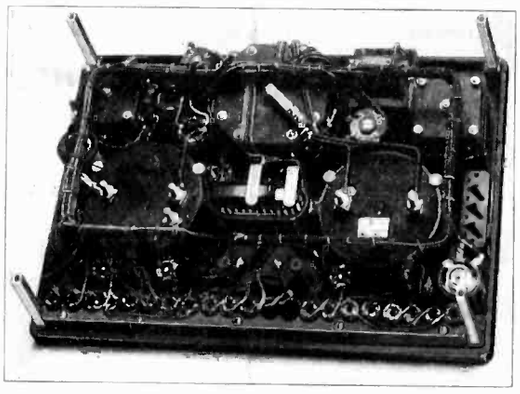
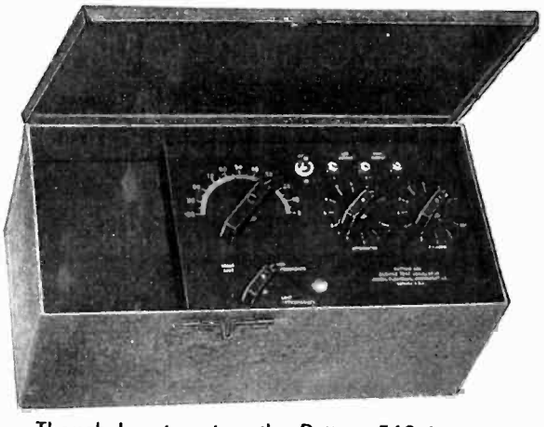
What Price Accuracy?

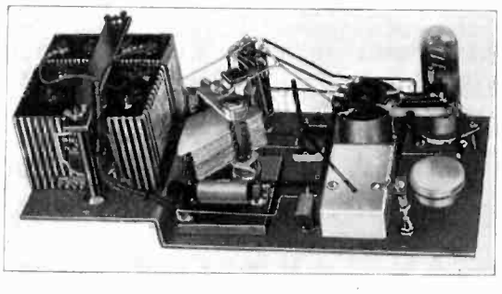
Simplicity of operation is achieved in the Pattern 444.



This view shows the compact design of the Pattern 444, which allows adequately for future expansions.



Though low in price, the Pattern 563 is complete in every respect.



Permanency of calibration is achieved in the Pattern 563 by "battleship" construction.

From the radio manufacturers' viewpoint, instruments for servicing radio receivers have one outstanding function—to assure the most accurate servicing of their product.

Accurate service work can be done only with instruments that are accurate and have the stamina to retain that accuracy under continued severe usage.

Jewell Radio Service Instruments embody every necessary quality of accuracy and dependability; yet remarkably low prices have been achieved by experienced design and large production.

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Unusual Features of the Pattern 444 Set Analyzer

Heavy molded bakelite panel and over 50 other molded parts.

Selector switches with wear-proof ball ratchets.

Indicating instruments accurate to 2% of full scale values.

Long meter scales and knife edge pointers.

Non-shatterable glass meter covers.

All wiring cabled to prevent loosening.

Zero adjuster on panel allows compensation for battery voltage change in resistance measurements.

Socket test cord removable at the analyzer panel—easily replaced when worn.

Test leads equipped with molded right angle tips.

Unusual Features of the Pattern 563 Test Oscillator

Entire instrument encased in metal for durability and effective shielding.

Oscillator coil separately shielded.

Rugged variable condenser with self aligning, ball bearing supported rotor.

Radio frequency circuit wired point-to-point with bus type connectors.

Adjustable to any point in three frequency ranges—550 to 500 K. C., 125 to 185 K. C., and 175 to 300 K.C.

Output continuously variable from zero to maximum.

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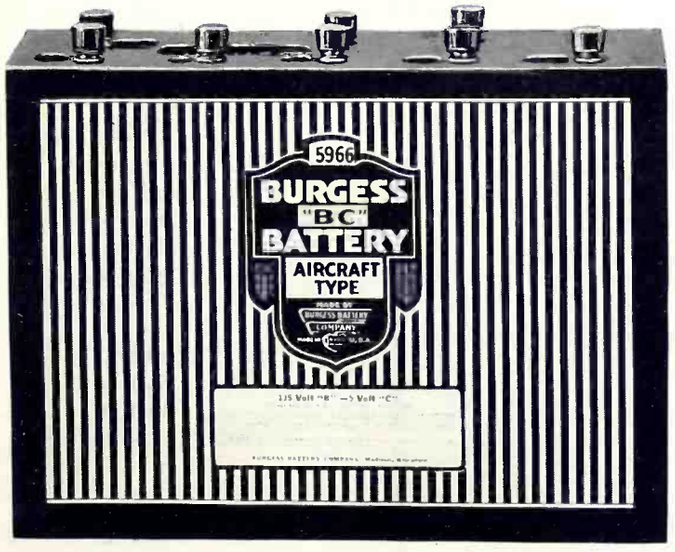

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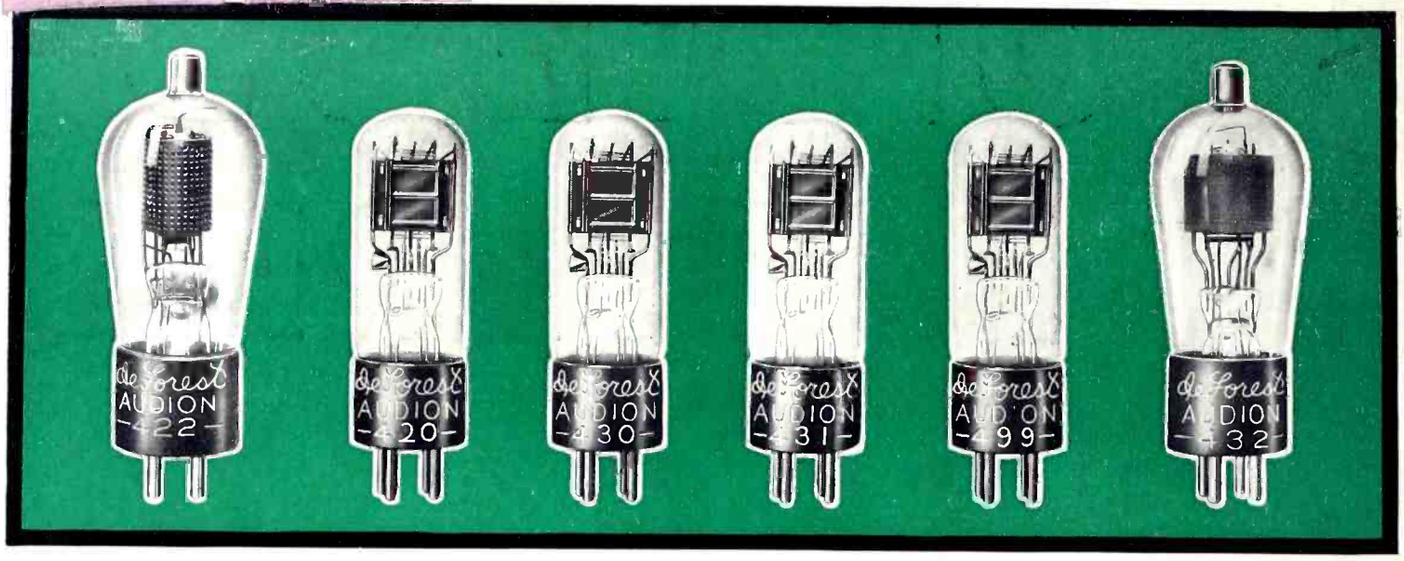

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which means

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longer service life
greater efficiency

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more accurate alignment
more uniform tension

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