electronics

radio, sound, communications and industrial applications of electron tubes . . . design; engineering, manufacture

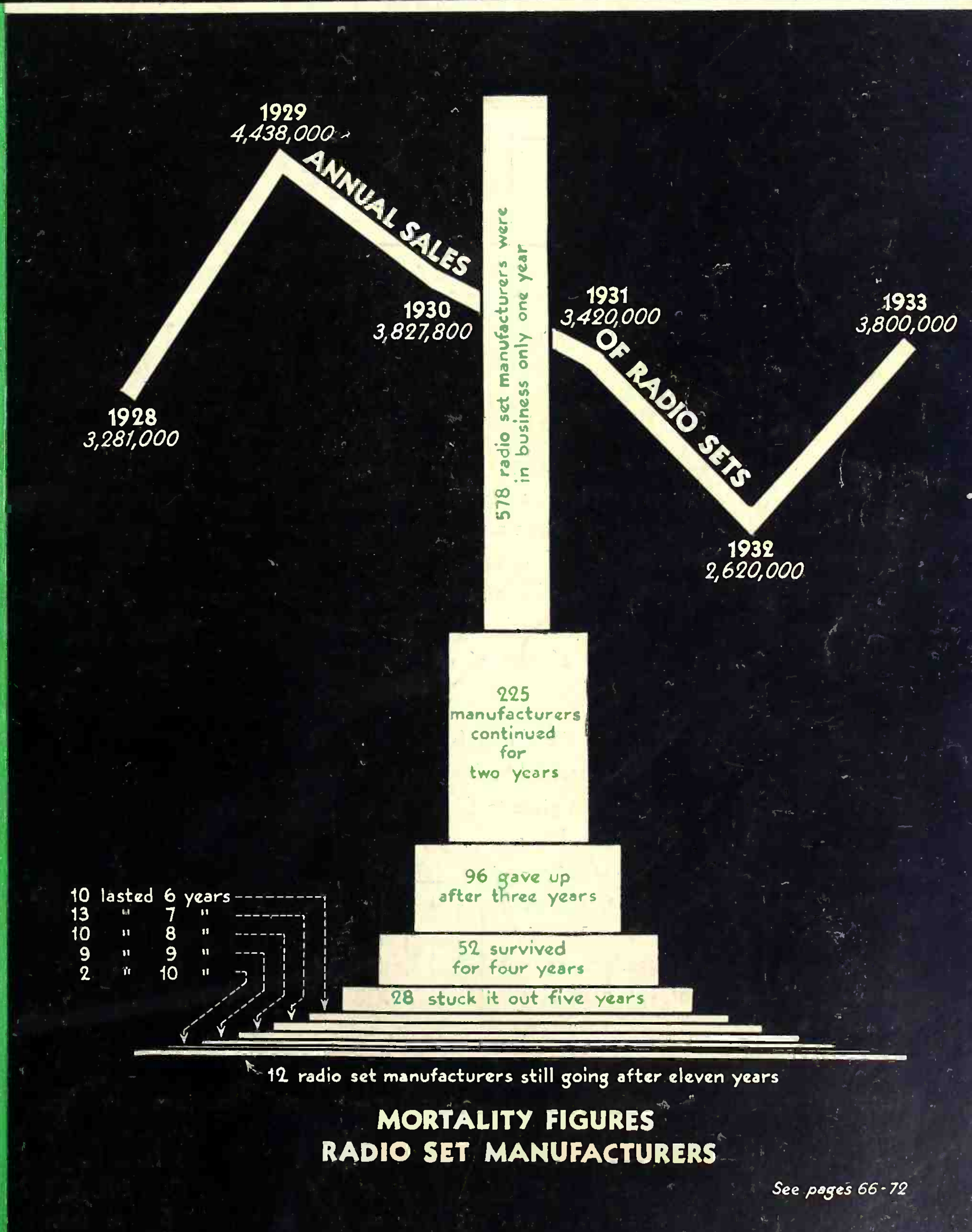
STATISTICS AND MARKETING

An analysis of broadcast modulation

Police radio systems

Filters for high radio frequencies

An electronic voltage relay



See pages 66-72

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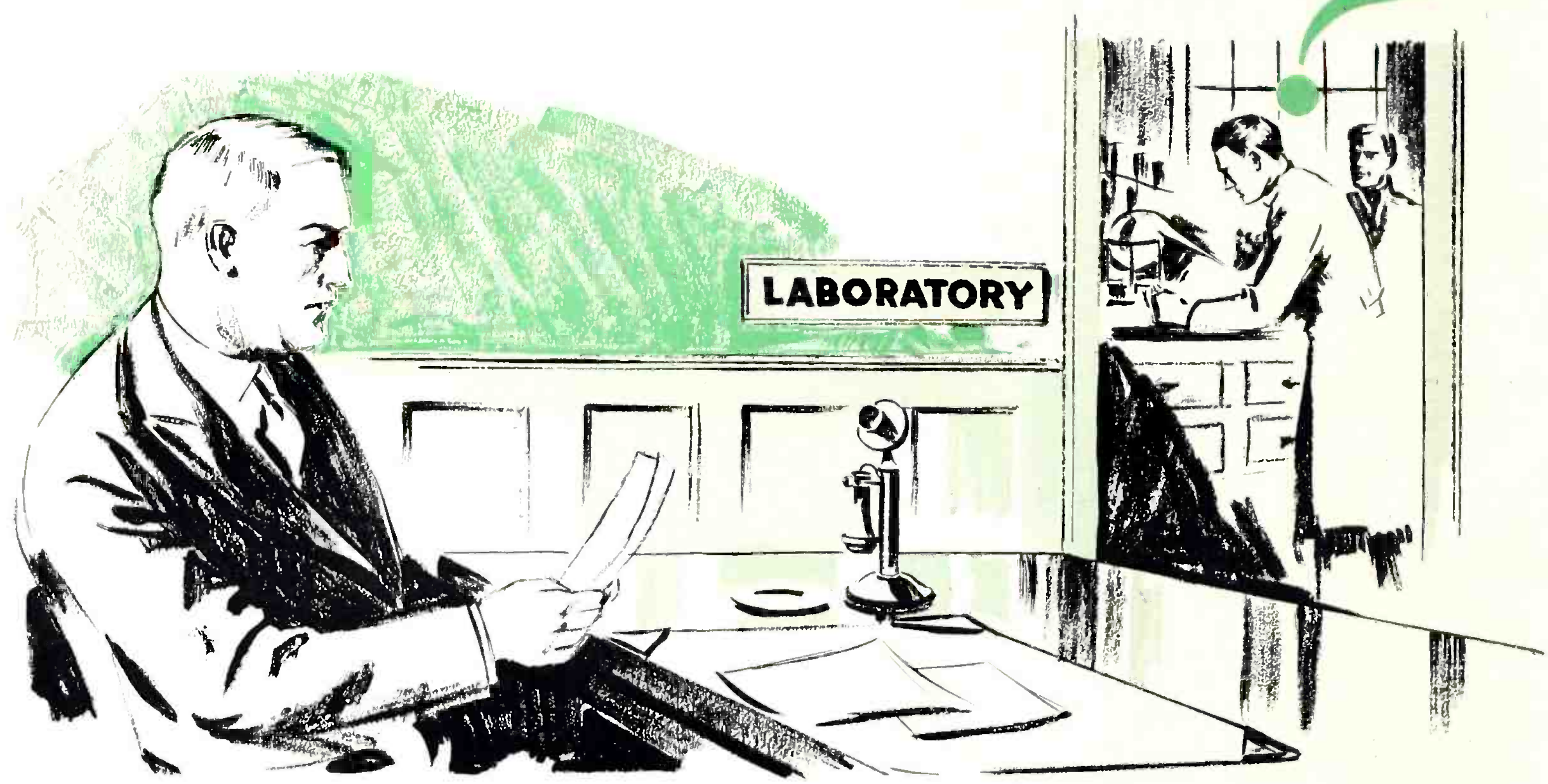
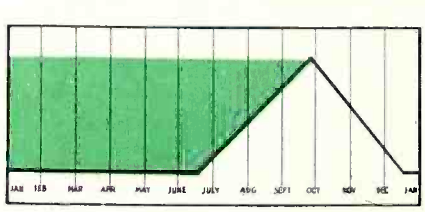


NOW, more perhaps than at any period in its history, the Industry must look to its engineers for the creative leadership that will alone make continued progress possible. The science of radio communication is today one of the most highly technical of all the sciences. Its practical application can be developed and expanded only through the minds of men of vision and ability.

Leaders agree that in 1934 the individual manufacturer and the Industry as a whole will be successful in direct proportion to the scope that management gives to the engineer and extent to which it accepts his recommendations. In view of this, a glance at the tube production chart reproduced here, reveals conditions that offer a wide open opportunity for intensive and productive engineering research. For the next few months production will be below average. After that it will tend to climb rapidly.



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electronics

O. H. CALDWELL
Editor
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McGRAW-HILL PUBLISHING COMPANY, INC.

NRA MEMBER U.S. WE DO OUR PART

New York, March, 1934

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

RADIO . . . and the Federal Communications Commission

● PRESIDENT ROOSEVELT has asked that a new Federal Communications Commission be set up to take over the functions of the Federal Radio Commission and the communication responsibilities of the Interstate Commerce Commission. Two bills accordingly have been introduced in Congress: Representative Rayburn's bill which would create the new Communications administration and set it in operation with the existing radio laws; and Senator Dill's bill which would repeal all present radio legislation and enact a wholly new law in its place.

● THE FEDERAL RADIO COMMISSION has been purely a traffic-regulating body. The new Commission of seven will handle ether traffic and in addition take over rate-fixing and the supervision of all charges made for interstate and international communication. Excepted from this, however, will be broadcasting advertising rates,—broadcasting being clearly defined by all parties as *not* a common carrier. Supervision of operating conditions by broadcasters will be continued by the new Communications Commission.

● WHILE THERE IS ALWAYS the hazard that a new group of seven political appointees will find work to keep themselves apparently busy and to build a vast bureaucracy as in the cases of other Washington commissions, it begins to be apparent that the force of the new communications administration will fall chiefly on the wire services where the vast bulk of the dollar volume lies. There is as yet little continental radio communicating service, and it can be carried on at rates needing little government paring. When the new FCC comes to fixing upon international radio rates, the dilemma is presented as to how the American commission can fix rates, when it has no authority over the various foreign governments which co-operate in the interchange of radio messages!

● ON THE OTHER HAND the FCC can play a great future part in co-ordinating American communication services and putting the Government firmly behind American operating companies, instead of leaving them as competitive units at the mercy of strongly-organized Europeans. Eventually the new Commission may lead to the unification of all communication service in the United States, effecting economies, and restoring America's former position as leader in world radio,—a position for which the British have been making strong contentions in recent years.

RADIO STATISTICS

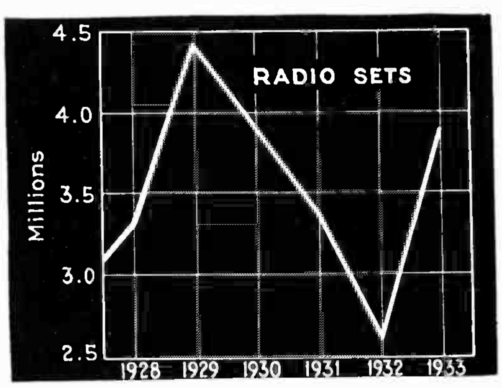
Sales of radio sets and tubes for 1933 show improvement over previous year

IN TERMS OF INCREASING VOLUME OF BUSINESS, *the year 1933 was a period of marked upturn for both the radio industry and the associated electronic arts. As shown by the several curves on these pages, the swing upward began in 1933 and there is every prospect that this growth will be continued in 1934, as the processes of Recovery proceed throughout general business and the life of the nation.*

New services, new developments, new inventions, continue to appear everywhere in the radio and electronic picture, so that it is now apparent that for our industries recovery will go forward on the thousand fronts which the ramifications of these arts now present,—making the upswing all the more impressive.

On this and the following pages the editors of ELECTRONICS *present a statistical review of the principal fields, followed by summaries of the outlooks for markets in these lines for 1934.*

THE most encouraging outlook which the radio set business has presented for years, is again evident in the situation confronting the receiver manufacturers. The present season has been excellent in volume of sets moved, the number



being exceeded substantially only by the peak year of 1929. The average price per radio set sold, retail, is still coming down, but increasing interest in the console and higher-quality models may swing this curve around during the next year. The advent of automobile radio has added a tremendous figure (724,000 sets in 1933) to swell the total, and this situation is treated more in detail under a following classification.

With the listening habits of the millions becoming more firmly established than ever, and with the broadcasters continuing to exhaust the possibilities of human ingenuity, money, and the picked talent of the world, to bring new features to the microphone, the radio-receiver business is on an increasingly substantial foundation. This means that more homes will be buying better sets during 1934, and that additional sets in each well-equipped home will be the regular thing of the future.

Higher fidelity and greater selectivity will be features of 1934 models which will help sell receivers to replace obsolete receivers. Fidelity standards during the past two seasons have been notoriously low, and manufacturers are now in a race to repair this deficiency which grew out of the price-chiseling era of the deep Depression days.

Styling of new cabinets along modern lines which has proven so effective in the new "streamline" automobile models, is now accepted in the radio industry, and a continuous outflow of radio cabinets with new "eye-value" is helping to speed the obsolescence of older models.

The all-wave feature in the new sets has brought back once again the thrills of DX hunting, and this may be counted on to add its appeal to move 1934 sets.

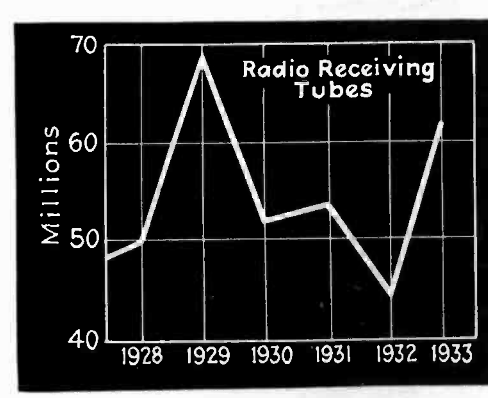
New services ahead also present a bright picture for radio's future. Particularly does the possibility of "facsimile" reception for the home listener open up new possibilities for radio manufacturer and the radio industry. With the broadcast stations and channels standing idle from 1 to 6 a.m., the day when homes will be actually receiving their morning tabloid newspapers over the air is not so far off. Already such transmission have been put on the air.

RADIO RECEIVERS

Unit Sales, 1933	**3,806,000**
Midgets	**2,226,000**
Consoles	**856,000**
Auto radio	**724,000**
Total value, retail (less tubes)	**$130,899,000**

RADIO TUBES

Tubes made, 1933	**63,295,000**
Exported	**7,690,000**
Sales in U. S.	**55,605,000**
Total value sales in U. S. at retail	**$56,599,000**



● Once more the sales curve of radio tubes turned upwards in 1933, despite the bitter competitive situation on price and discounts that prevailed during the year. A fairly large part of these 1933 tube sales went into initial equipment, sold to radio manufacturers. Sales of tubes to the public for replacing defective tubes in their receivers, increased somewhat to about 30,000,000 tubes a year, approximately the same as in 1932. Assuming 100,000,000 radio-tube sockets in the homes of America, this means a replacement of about 30 per cent annually, which falls far short of the recommendations in recent publicity campaigns,

AND MARKETS ++

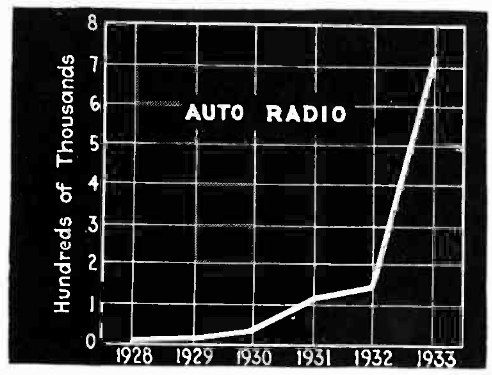
Unit prices remain low. Automobile radio sales prove to be bright spot of year

but is in accordance with the hard facts of tube renewals which are observed to obtain in most homes. Average retail selling prices of tubes sold to the public, weighted for the various popular types, have also remained almost unchanged during the past three years, after a continuous reduction in average retail price from the early days of the industry. The present average is about $1.10 retail, although this increased slightly as the result of the introduction of more complicated tube forms, only to fall again as improved manufacturing efficiency again brought down costs.

The vast expansion in the number of tubes in 1933 and the reversal of opinion regarding the efficacy of putting more than one tube in a single envelope were technical changes which did not improve the tube part of the industry, to say the least. Set engineers are now divided in their opinions regarding the use of these dual or triple purpose tubes, and it is likely that they will not appear or be used in such quantities during 1934 as in 1933.

The year 1933 saw vast improvement in the operating characteristics of many types of tube. In the automobile field the requirements for a power output upwards of one watt demanded tubes of high efficiency which in turn called for much closer spacing within the tube structure and resulted in greater mechanical manufacturing difficulties. During the year a new power output tube for high fidelity receivers and several new rectifiers were produced.

The year saw a gradual expansion in the use of the 6.3 volt tubes in sets for operation from alternating current. Thus the arguments that raged a year or more ago on the question of standardizing on a series of tubes that could be used interchangeably in either battery-operated or a.c.-operated receivers seems to be taking care of itself. The industry realizes that a single series of tubes serving both purposes would be infinitely better than duplicating lines of tubes, one for 2.5 volts for city home receivers and the other for 6.3 volts for automobile or other battery serviced sets.



AUTOMOBILE RADIO SETS

Units made, 1933 724,000

Value at retail

(average $39.50) $28,598,000

● The most startling and encouraging figure in the summary of the year's sales is that of automobile radio. Jumping from a figure of less than 200,000 in 1932, the sales in 1933 went to over 700,000, a tremendous and unexpected expansion. What caused such a marked increase in sales? There are several contributing factors. In the first place it is a new "gadget" and the radio purchaser has always loved a gadget. A radio for the car adds to the intrinsic usefulness and joy of motoring. And in 1933 the designers of auto-radio really got into their stride producing effective receivers of high sensitivity, easy to control, and delivering sufficient power output to make themselves heard in the average automobile.

It is difficult to evaluate the proportion of this nearly three-quarter million of sets that went into old or new cars, but it is safe to assume that they went into cars of recent vintage. Thus the market for a radio for the car or more than one year in age is as yet virtually untapped. This market has now become tillable because of the recent design of receivers making them simple to install, and not too costly.

Many thousands of the receivers sold in 1933 will need replacing in this year. Many of these were not of a sufficiently good quality to please the owner once he knows he can replace it with a better receiver, perhaps specially designed for his particular car. Many of these receivers caused almost immediate grief because of mechanical troubles, or because poor sensitivity made it practically worthless out in the country away from the immediate shadow of the broadcast stations.

This situation, calling for receivers more sensitive than are necessary in the home where an antenna of appreciable pick-up ability can be employed, will be remedied by the receivers now constructed.

Better acoustical design of auto-

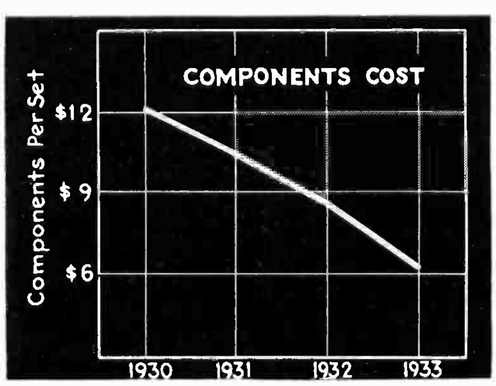
COMPONENTS FOR RADIO SETS

Components	Number per set 1930	1932	1933	Cost per set—dollars 1930	1932	1933
Sockets	7	8	5.25	0.35	0.176	0.136
A-f transformers	2	1	0.6	0.90	0.70	0.245
Power transformers	1	1	0.7	1.45	1.47	0.74
Power chokes	1	1.1	0.6	0.47	0.60	0.15
Loudspeakers	1	1.1	1	3.50	1.82	1.56
R-f coils	3	4	3	0.75	0.68	0.66
Condensers, tuning	1	1	1	1.50	0.65	0.73
Condensers, by-pass	10	9	10	0.96	0.81	0.45
Condensers, filter	2	2.5	2	1.15	0.83	0.50
Resistances, fixed	4	10	11	0.35	0.40	0.40
Resistances, variable	2	2	2	0.70	0.52	0.41
Total cost per set				12.08	8.65	6.08
Resonance indicators						0.51
Auto-radio vibrators						1.50

ANNUAL DATA SHOW

mobiles with better upholstery and tighter bodies shutting out more of the road noises, together with engines of more cylinders, and consequently quieter, enables the car owner to get along with his radio more pleasantly even though the ultimate power output could be increased with benefit.

Perhaps the average price for auto radios is too low; $39.50 does not seem like much to pay for a well engineered receiver which has so many chances to go wrong in the field. But this figure is low because of the many thousands of still cheaper units which were put on the market in such floods and which caused so much trouble, threatening for a time to give auto-radio a complete black eye.



RADIO SET COMPONENTS

Cost per set for selected parts . . . $6.08

Total annual market $22,000,000

● Perhaps nowhere in the statistics of the radio industry as in the prices of components is shown so clearly the economic pressure through which the industry has gone. Although the figures given here for 1933 are preliminary and subject to considerable revision as more data from additional manufacturers are secured, they show the decline of prices caused by chiseling tactics employed by purchasing agents responsible to their companies only for securing parts at the lowest possible prices, and caused by the extreme lack of caution on the part of set manufacturers regarding necessary factors of safety.

The advent and wide sale of the universal type of set operating without power transformer and with limited filtering has brought down the sum total cost of components for the average receiver. The loudspeaker remains the single most expensive item in the make-up of the radio receiver. During the year the price of electrolytic condensers went through a downward revision, especially at the end of the year when the volume of business going to the unlicensed manufacturers began to get under the skin of the licensed group.

Data below in tabular form showing the annual market for components is, again, a preliminary estimate, since they have not been fully weighted as to the number of manufacturers who build, in their own plants, various parts going into their products. The year, however, will show a continued trend away from the practice and show that set manufacturers are more inclined toward the benefits of purchasing components from manufacturers whose sole business is this type of construction. Thus the rapid changes occurring during the year must be borne by the component manufacturer rather than by the set manufacturer who, in general has his hands full of assembly problems and who needs as flexible an arrangement as is possible.

It is interesting to note the rapid rise during 1933 of small manufacturers who build nothing, but who purchase all parts and assemble them, in contrast to the old-line manufacturers, several of whom still insist on constructing their own parts. These quondam smaller manufacturers by virtue of their ability to move fast, have built up a very large business for themselves.

The figures showing volume of components business for 1933 disregard completely the fact that some parts are built in the set maker's plant and not purchased, and therefore these figures will be revised. In general, however, manufacturers whose data have been presented show only a small percentage of parts built instead of purchased.

The total cost per set figures shown includes only those parts given in the table and neglects such items as cabinet, chassis, screws, wiring, flexible shaft for auto radios, dials, tuning mechanism, etc.

Improved technique will better 1934 sales

● In addition to the lure of new services as additional sales stimulants for another year, there are other good technical reasons why unit sales figures for 1934 should go still higher and why the unit price for the year may be appreciably higher than in 1933.

There is good reason to believe that obsolescence of radio sets made and sold in 1933 will be very rapid, for not only was the average selectivity and fidelity of sets made in that year lower than for some time past but the components were not of a quality that will stand the test of time.

All manufacturers will undoubtedly endeavor to improve the technical features of their products in the year 1934. The agitation for higher standards of broadcasting will force even the cheaper sets to be engineered with an eye on product quality rather than that of cutting a few pennies off competitors' list prices. Higher power radiated from broadcast station antennas will force the selectivity problem into the open, and will make still more evident to thousands of users of antiquated receivers the fact that their sets are no longer able to cope with the present day higher field strengths.

DOLLAR VOLUME IN COMPONENTS

Component	1930	1932	1933
Sockets	$ 630,000	$ 400,000	$ 520,000
A-f transformers	1,070,000	1,820,000	930,000
Power transformers	2,800,000	3,820,000	2,810,000
Power chokes	577,000	1,560,000	520,000
Loud speakers	4,400,000	4,550,000	5,950,000
R-f coils	286,000	1,770,000	2,510,000
Condensers, tuning	1,040,000	1,690,000	2,780,000
Condensers, by-pass	910,000	2,080,000	1,710,000
Condensers, filter	2,300,000	2,140,000	1,900,000
Resistances, fixed	975,000	1,040,000	1,525,000
Resistances, variable	2,380,000	1,350,000	1,560,000
Total	$17,868,000	$21,220,000	$22,825,000

INCREASED RADIO SALES

Better short wave tuning and amplifying portions of the all-wave receivers will further complicate the set, make it more valuable and interesting to the user, increase the number and cost of components going into it and raise the list price.

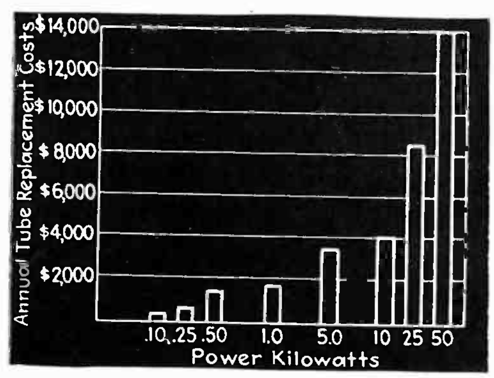
It is probably true that a new group of tubes smaller in all physical dimensions will make their appearance this year. These are demanded by explorers in the regions of the lower wavelengths. Although the numbers of receivers for commercial purposes that can be sold in the spectrum below 10 meters is not so large as the broadcast market, it is a potential field of vast dimensions and one of the best tools with which to cultivate it would be a new set of tubes, perhaps three in number, which would enable some amplification to take place at 5 meters and below. The frequency could then be changed and amplified in conventional manner.

Whether 1934 will see the placement of a radio in every car of some few lines remains unpredictable at the present time. It is certain, however, that the market will continue to expand as technical improvements come along and as purchasing power continues to increase. Designers have added so much worth and beauty to the automobile receiver that purchasers of the new beautifully designed cars will find themselves easy prey to the salesman of automobile radios.

Another open question is whether radio set manufacturers will continue to struggle to get mass orders from auto manufacturers for radio sets at prices very close to, or actually below, cost hoping to build up sufficient volume in this manner to make a profit on their other lines. The dubious prospects of such maneuvering are become more apparent as time goes on.

The year 1934 should see further expansion of the farm market for receivers which would boost the sales of 2-volt tubes designed for special batteries for this field. As soon as set manufacturers realize that the farm set should cost no more than a city set, and because of the lack of power-supply should cost considerably less, the rural dweller will get the kind of receiver he wants at a price he can pay.

It is expected that new batteries of various types, new and old, will make their appearance for this market during 1934. The old-line storage battery companies have been working on the problem of supplying economical long life power for the rural radio listener. It is encouraging to note that in 1933 approximately 60,000 batteries designed especially for this use were sold, indicating an expanding market. Radio set manufacturers are reported to be interested in the band of frequencies on which aviation weather reports are given at regular intervals during the day. While these reports are gathered and announced for special use of aviation they could easily be useful to the farmer still further making important his keeping a radio receiver in workable condition.



BROADCAST STATION TUBE COSTS

Annual market *$1,000,000*

Other replacements *$150,000*

● One of the largest markets for vacuum tubes and rectifiers of power size is the broadcast station; and the chart shown here portrays the average expenditures of stations in various power brackets. Thus it is seen that the cost of tube replacement, which is by far the largest item in the maintenance budget, runs from a few hundred dollars annually for the small station to an expenditure of over one thousand dollars per month for stations in the 50-kw. class.

Other items of annual expense include repair and replacement of transformers, resistances, batteries, etc., but in general these figures do not amount to over 15 per cent of the tube cost. During the year, of course, stations purchase new equipment, such as modulation meters, measuring equipment, microphones, etc. At the moment it is not possible to give data on purchases of this type. The proposed campaign to improve all aspects of the broadcast system should improve the 1934 market.

THE RADIO INDUSTRY OF THE UNITED STATES

	Total Investment	Annual Gross Revenue	Number of Employees	Annual Payroll
Radio manufacturers,[1] distributors, etc.	$150,000,000		[2]75,000	$80,000,000
Broadcasting stations	$30,000,000	$75,000,000	9,000	$30,000,000
Listeners' sets (18,000,000 homes)	$1,800,000,000			[3]$210,000,000
Commercial radio stations	$30,000,000	$10,000,000	15,000	$4,000,000

[1] Radio set manufacturers now number 165.
[2] Employees at peak of seasonal employment.
[3] Annual operating expense of listeners' sets for tube replacements, electricity, batteries, servicing, etc.

Suppressor resistors and their effects on automobile operation

THERE have been many opinions on the effects of suppressor resistors on automobile performance. These opinions have run the gamut from flat statements that resistances increase starting difficulty or decrease gasoline mileage to the opposite extreme that suppressors improve the car performance. The following notes are from a well-known engineer whose knowledge of the subject is quite complete.

There are several groups of people affected by the use of suppressors—the car owner, the service agency and the car manufacturer. A comprehensive survey of the service agencies has disclosed almost as many different stories as the people interviewed. One report indicated that the use of resistors greatly increased starting difficulty. Another stated that the suppressors cut the gasoline mileage almost in half. Another advised that the gasoline consumption per mile decreased. Some service men complained of poor idling and others reported difficulties at high car speeds.

In contacting electrical engineers of the motor car manufacturers, however, quite a different story was encountered. The general opinion among these experts is that the use of suppressors does not affect in any detectable manner the operation of a normal healthy engine. Dynamometer tests do not show any difference whether the resistors are used or not, tests in cold rooms running as low as 30 degrees below zero showed no noticeable difference in starting when the suppressors are used.

What is the true effect of suppressors on automobile operation?

It must be recognized, of course, that the use of suppressor resistors reduces the maximum current value that may be reached when the spark plug gap breaks down. According to a great many ignition experts, however, the actual ignition of the charge occurs at the first breakdown of the gap when the current has not built up to its maximum value. Inquiries have brought out clearly that there is a lot to be learned about the mechanism of ignition. It is true that the average garage mechanic insists on a hot spark but how much of this is due to advertising propaganda is impossible to estimate.

Ignition phenomena may be compared to the burning of a newspaper spread out on the floor. It will take just as much time to burn the paper, and the same amount of heat will be liberated, if the corner is ignited by a match or by the hotter flame of an acetylene torch. Under the latter condition burning may start sooner, but this adjustment is merely a matter of timing. If, therefore, there is no actual misfiring no difference will probably be noted when suppressors are used other than those changes which may be easily adjusted by proper timing changes.

There is one point which may contribute to the feeling that resistors cause misfiring. In an engine in which there are no resistors, oscillations may persist for some time after the initial spark. This continued oscillation keeps the gap broken down longer than if a highly damped spark takes place, as is true when suppressors are employed. In the latter case the spark passes only for a brief period of time. During this time there may be no good gas present; but such fuel may arrive a little later to be ignited by the continued oscillation in the non-suppressor case. At idling speeds, therefore, and with engines having poor turbulence and equipped with suppressors, trouble may be experienced.

Practical investigations indicate that with proper adjustment of the carburetor and with modern engine designs the turbulence is good enough that no difference will be noted with or without resistors.

The engine must be properly tuned up

In the light of these diverging opinions and because of other data it seems that the following statements must sum up the situation. Probably the great majority of motor cars now on the road are operating under conditions of very poor adjustment. Many cars are running around with carburetors incorrectly adjusted, with leaky valves, and with fouled spark plugs. When suppressors are added to such cars trouble will undoubtedly be experienced. For example it is admitted that on a car with suppressors misfiring will occur sooner due to fouling of the spark plugs than if the car is not so equipped. This is due to the fact that the resistance of the spark plug and the resistance of the suppressor in series constitute a voltage divider. The spark plug is, of course, in shunt with the leakage resistance. If this leakage resistance is too low the voltage across the plug will not be high enough to jump the gap; consequently misfiring results. It is apparent, therefore, that the faulty operation of the car after the suppressors are installed indicates that the leakage resistance of the spark plugs has reached too low a value.

It has been stated many times that many of the anti-knock fuels such as Ethyl gasoline deposit material on the porcelain of the spark plugs which causes the leakage resistance of the porcelain to fall to a low value. Furthermore it has been found extremely difficult to effectively clean the insulator of this undesirable material.

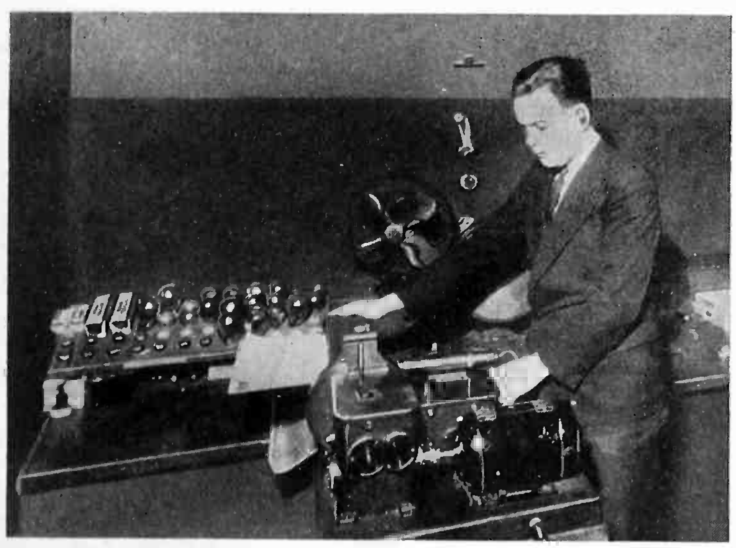
There is another factor which causes trouble. This is the storage battery. In current motor designs there are many things to be desired in the design of ignition and starting equipment. It is most certainly true that in most cases the average car battery is not in a good state of charge when the car is equipped with a radio. A depleted storage battery materially reduces the cranking speed and reduces the voltage available in the primary of the ignition coil during the cranking or starting period. In warm weather or when the carburetor and other adjustments are correct this depleted charge condition may not cause trouble. But when these adjustments get out of line, low cranking speeds and low primary ignition voltages result in trouble.

All of this investigation seems to lead to the point that if trouble is experienced when suppressors are added, the engine must be properly tuned up. If this tuning is done by a competent man, no trouble will be had with modern cars.

The Berlin-London facsimile circuit. Interior of transmitting room of the German Reichspost service which works co-operatively with the British Post Office, Paris, and Rome, by wire

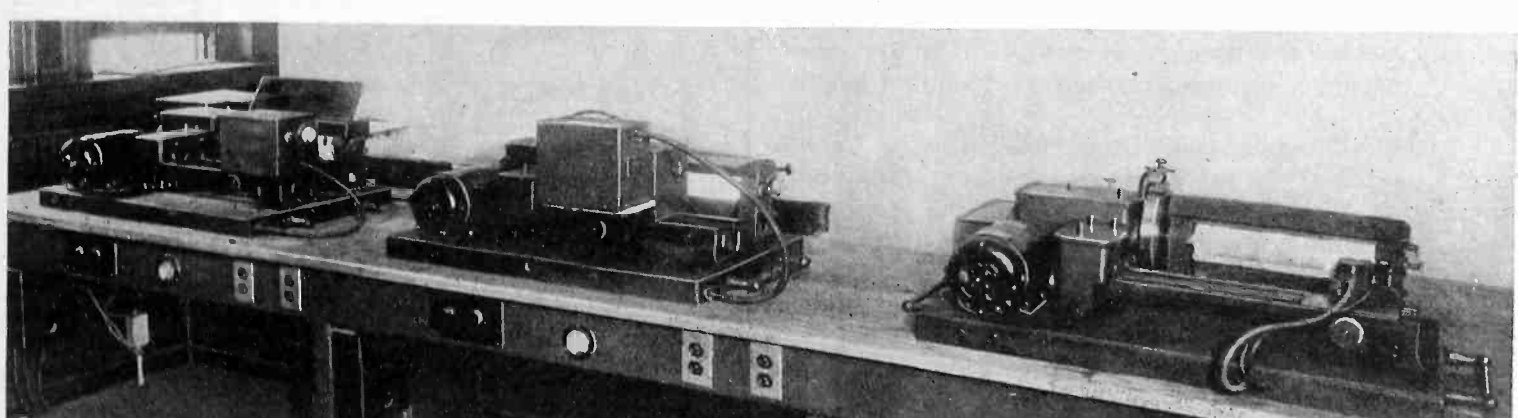
COMMERCIAL FACSIMILE APPARATUS

Equipment used in Europe and America for transmission of pictures and written messages by wire and by radio



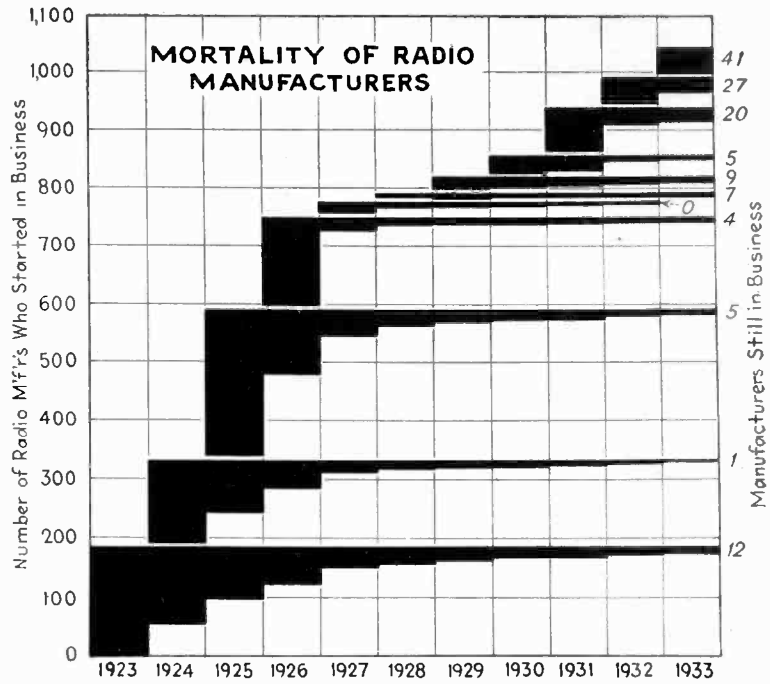
One of the new RCA inter-city facsimile receivers showing operator taking a message off the photographic-type machine in dark-room. This is the standard receiver for commercial messages used at present

A Westinghouse facsimile transmitter in one of the big scout planes of the U. S. Army. Flying over the enemy's lines, photographs and maps can be made, and then transmitted back to headquarters by radio



Facsimile apparatus at Radio Central of RCA-Communications, New York. At the left are two transmitters, with box-like housings for the photo-cell scanners. The right-hand machine is a spray-type ink-paper receiver, which operates in ordinary light using ordinary paper. The ink-paper and photographic receivers are operated in parallel, and are now in service from London, Berlin, Buenos Aires and San Francisco

Eleven years of radio receiver manufacture



As in all youthful industries, the mortality of pioneers in the radio industry has been high

MANY studies have been made of the radio industry, but none, perhaps, show in such graphical form as those presented here, the rise of an infant business, its growth to maturity, its rapid changes in number of manufacturers, multiplication of models, and recent steady decline in the prices charged for the product.

The charts shown here, through the courtesy of Mr. Ralph Langley, consulting engineer, 165 Broadway, New York City, are the result of a vast amount of work carried out for the Hazeltine Corporation which has given permission for publication in *Electronics*. The data have been assembled largely from the advertising pages of trade and "fan" publications catering to the radio industry during the years 1923-1933. They include only companies which have actually advertised their products, and the prices are the first advertised list prices of the models under consideration. Thus the charts give a good picture of the entire radio receiver business showing especially the high mortality among manufacturers, characteristic of new enterprises.

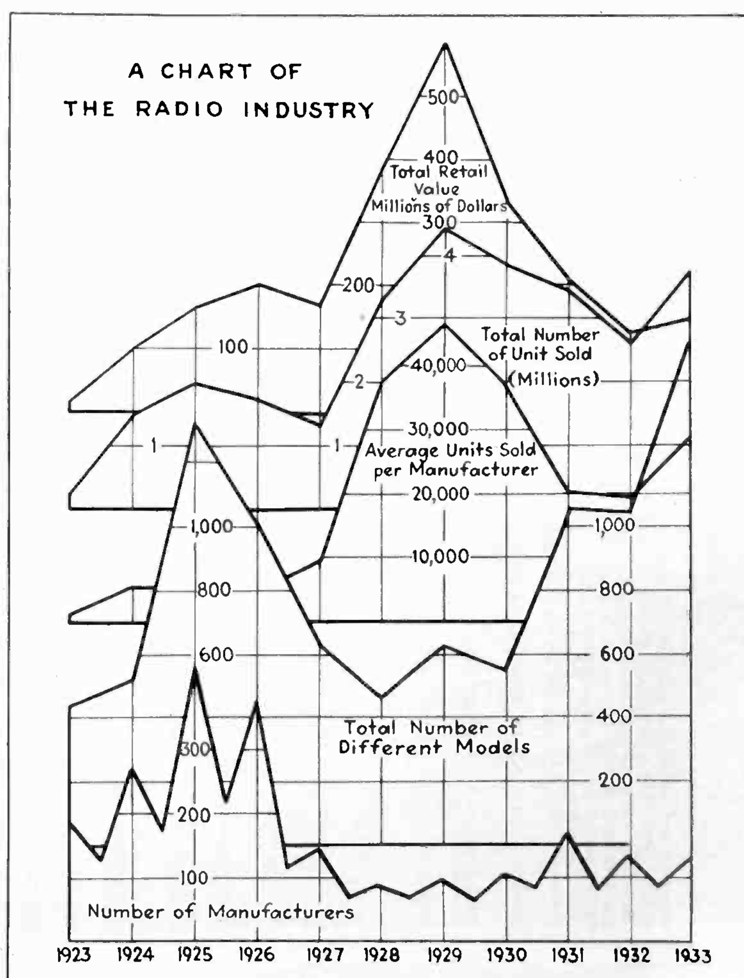
The front-cover chart

The chart on this page showing mortality among radio manufacturers, is in many respects similar to the diagram on the front cover of this issue of *Electronics*, although the front-cover chart shows the information in another way. In the front-cover diagram, the width of the several bars is proportional to the number of years (one year, two years, etc.), during which radio concerns continued in business. The height of the bars, measured vertically, shows the number of firms which were engaged in the radio business for the corresponding length of time.

Thus the front-cover chart becomes a sort of a "monument" diagram, the tall shaft representing the rapid mortality of "single season" firms, while the blocks of increasing stability lower down represent the numbers of radio manufacturers which continued in business over longer periods of time, up to the full span of radio broadcasting, eleven years, shown graphically by the bottom horizontal block, with 12 manufacturers still in business.

A somewhat less striking and different presentation which, however, gives more detailed information as to the calendar years during which the manufacturers were in business, is that reproduced herewith, on this pair of pages.

In the "necrology chart" above, the vertical axis gives the number of manufacturers and the horizontal axis, the calendar years. The group of new manufacturers that came in each year is shown, added to those who remained from the previous year. For each group, starting in each year, the number dropping out and the number remaining in each year of the following years is shown.



An eleven-year chart showing graphically the number of manufacturers, models, and retail value

For any given year, the height of the topmost black block shows the total number of different manufacturers who have produced radio receivers between 1923 and the given year.

The price chart

For example, in 1923 there were 185 manufacturers. In 1924, of this group only 92 were left. In 1925 this group had decreased to 87, in 1926 to 61 and so on across. The history of this 1923 group of manufacturers is shown at the bottom of the chart.

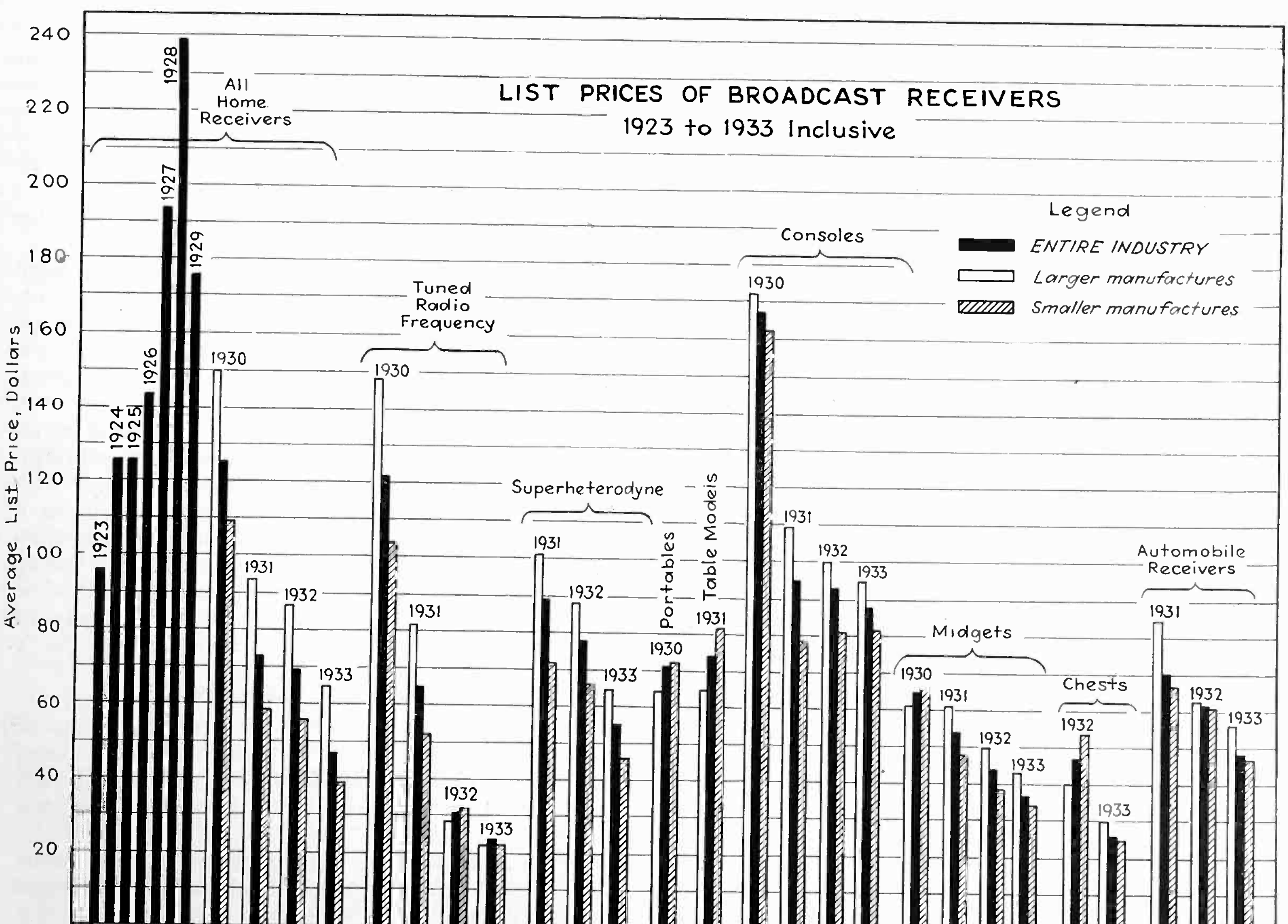
It is interesting to note that in the large price chart given at the bottom of this page, Mr. Langley has divided the receivers advertised into several distinct groups according, not only to circuit used, for example, tuned radio frequency and superheterodyne,—but also as to size of cabinet, for example consoles, midgets, etc. —and finally as to purpose. Thus the automobile receiver and the portable are tabulated as to price.

The prices shown here will differ somewhat from the McGraw-Hill average figures because the latter are obtained by securing the total number of receivers sold, and average prices, through surveys of individual manufacturers and data presented by the large licensing organizations while Mr. Langley's prices are the first advertised list prices—which in nearly every case was subsequently reduced either by the manufacturer or by the distributing agencies. For this reason the average prices shown in this chart will be higher than the McGraw-Hill average prices. This is well shown by the 1933 figures. The chart shows the average price of all home receivers in 1933 was $48.28 and for automobile receivers $48.23. It will be noted on other pages of this issue of *Electronics* that the McGraw-Hill average prices for the same types of set, with tubes, are respectively $39.50 and $44.50.

The prices of receivers made by the larger companies are those of 38 well known firms advertising nationally.

The eleven-year chart

The uppermost two graphs "Total retail value" and "Total number of units sold" are compiled from McGraw-Hill figures collected annually and published by *Radio Retailing* and *Electronics*. For the "Total number of different models" graph and that representing the "Number of manufacturers" Mr. Langley used his own definitions and drew upon his own sources of information. The figures for the graph entitled "Average units sold per manufacturer" were the result of dividing the total number of units sold by the number of manufacturers. Mr. Langley defines a radio manufacturer as one doing advertising, and giving a printed record of his models. The Langley compilations therefore cover only such advertised or catalogued items, and differ from other compilations where all responsible manufacturers doing business have been included.



Again, statistics for the eleven-year period 1923-1933 are shown. The price data have been broken down into large and small manufacturers as well as types of circuit, size of cabinet, and purpose of the receiver, for example, home sets and units for automobile use.

Some aspects of police radio communication

By HARRY E. THOMAS

United American Bosch Corp.
Springfield, Mass.

INITIAL attempts at unifying police organizations by electrical communication were made between 1880 and 1890; the first devices were the familiar patrol boxes whereby patrolmen on duty could signal or call for help. This type of system has been improved in many cases by addition of an officer's recall device and also with provision for giving a police alarm by a citizen in distress. The telephone made possible verbal report by patrolmen at stated intervals. Otherwise the fundamental patrol box system of communication has remained in its old form of thirty years ago. The teletype is a later development serving chiefly as a link with distant cities or between divisions of a large police department.

Since 1920 the speed of all movement has materially increased through greater use of automobiles; crime also has struck more swiftly and the getaway is rapid. Better highways and transportation have led more city workers to reside in suburbs, thus requiring police coverage of greater area and in less thickly populated sections. Police were forced to use motor vehicles and although the interval of report from the patrol box became smaller constant contact with the officers on duty is the ultimate desideratum. Also, more distress signals come direct from citizens over telephone; if the interval of officer's report happens to be twenty minutes, real distress can not be answered unless a special trip is made by a patrol wagon which is often too far from the scene of trouble to be of immediate value. Not more than a five minute interval between the time a distress signal arrives at headquarters and the appearance of a policeman at the source of trouble is now allowable. In many cases even such a delay proved too great.

Radio communication with the patrolling police automobiles was logically decided upon as the answer; its development through experience and its generally accepted use gives tribute to its merit.

The radio system within three years has undergone a technical development that places it as a necessary part of the police communication network of large cities. Over seventy cities and five states now operate radio controlled departments with results that make the value to public safety undoubted.

Officer in charge of Hoboken, N. J., 8-meter, two-way system (REL) converses with mobile force

Detroit, in 1923, was the first municipality of any size to successfully use radio; the first transmitters and receivers were homemade and the operation was below present day standards. However, the basic facts of police radio operation were noted and a very valuable background established. Between 1924 and 1930 the progress was somewhat slow—only 11 cities installing such systems.

The year 1930 saw automotive radio in its first popularity; 50,000 sets were sold to the public during that year and in 1931, 18 police departments installed police radio systems. More prevalent use, standardized parts and tubes, together with general interchange of information between cities, advanced the art notably.

Although the radio was a tool of exceptional value, the rigid demands for reliable and exceptional performance (which any link in a police system must have) soon made apparent the inadequacy of motor-car radio as it then existed. Greater sensitivity was needed than could then be supplied; there was no compensation for fading or loss of signal strength, the power output was too low for automobile speeds necessary and the economy of operation was a problem.

Design and operation

1933 is a year in which police radio technique attained a new plateau of advancement; performance is no more a drawback as in 1930; tube development presents greater economy and the elimination of B batteries is now possible.

We may note renewed interest by police departments and the report issued by the Federal Radio Commission upon operational aspects in 60 cities removes doubt that the radio is a necessary adjunct to any police system.

In any police communication system the fundamental features are speed, reliability and secrecy. Of these speed is the most important and the most aptly provided by radio. Reliability, present in the wired part of a system, should be also present in the radio part of the link. Receiver and transmitter design has worked toward this end and final acceptance by police departments is at last achieved. Secrecy cannot be preserved when radio communication is broadcast, scrambling of speech is too expensive while directional transmission is somewhat unfeasible. The broadcast drawback, however, is not a serious one.

The functions of such a system are as follows: (1) direct communication with the public, preferably by calling a single telephone number and going through division or district headquarters before it reaches main headquarters; (2) direct communication of headquarters with patrolmen on duty. This feature, not existent today, is certain to come as the art advances; (3) liaison of the police department with other large cities and with adjacent municipalities, by telephone and teletype systems; (4) accurate records of each call placed, of action upon it, and of its ultimate disposal.

The radio communication system can be studied in its two component parts, that is, the transmitter and the radio-equipped automobile fleet. The usual police radio transmitter has from 50 to 500 watts power. In coverage it should deliver at least 20 microvolts field strength over an area from 5 to 10 sq.mi. In larger cities specific conditions alter requirements where large buildings or unusual terrain influence the field strength contours. A city of one half million inhabitants requires on the average one 500 watt transmitter; smaller cities would require less. Newest transmitter designs are very compact and efficient; they operate from a power service line with single unit power supply, speech input, and main oscillator, each self-enclosed. Their development has paralleled the broadcast transmitter; their operation and technical features are therefore not as new nor as close to the experimental as the radio receivers and their adaptation to police automobiles.

The primary requirements of a police radio transmitter are:

1. Sufficient power to cover the district served with at least 20 microvolts field strength. 2. A stable crystal-controlled frequency source. 3. At least 30 per cent modulation of the carrier wave by an audio system having essentially flat response between 100 and 8,000 cycles per second. 4. Easy and efficient connection of the microphone circuits with the main dispatcher and headquarters. 5. Reliability, ease of operation, and ease of service. A recent design has a single metal cabinet completely enclosing a 100 watt transmitter; it is necessary only to bring power and microphone lines to the box and to install the antenna and ground system. The usual 400 watt transmitter can be set completely on an average size office desk.

Police transmitter frequencies are allocated on a zone basis by the Federal Radio Commission; city departments operate at either 1712 kc. or on the zone frequencies between 2414 kc. and 2470 kc. State departments are given two zone frequencies—1574 and 2506 kc. Power allocations are based on the official population figures as follows:

Population	Power Watts	Population	Power Watts
Under 100,000	50	400,000-500,000	250
100,000-200,000	100	500,000-600,000	300
200,000-300,000	150	600,000-700,000	400
300,000-400,000	200	Over 700,000	500

Exceptions to the above assignment are sometimes made where coverage is not possible because of abnormal geographic conditions. Due to the scarcity of frequencies all cities within one area must use one zone frequency; this forms quite a desirable liaison between the central municipalities where crime is most likely to originate and the suburbs through which criminal flight must be made. This arrangement also aids centralization of dispatching and police supervision for one metropolitan area.

Recent police radio transmitter of Westinghouse. Photo shows J. L. Seibert adjusting controls

The requirements of automobile police radio installation are: 1. Adequate sensitivity under all conditions. 2. Ruggedness, simple and reliable operation. 3. Complete automatic volume control. 4. Sufficient intelligible audio output power. 5. Ease of service adjustment and economy of operation. 6. Adequate selectivity.

A sensitivity of better than one microvolt is necessary. With the effective height of a car antenna equal to one meter and a transmitter field strength of not less than 20 microvolts sufficient leeway is allowed for irregularities that occur during use. It is also necessary that this sensitivity be automatically controlled to insure full amplifier gain in outlying districts and without overload when receiving close to the transmitting antenna. Dual-function tubes have made this possible by combining detection and audio amplification.

Mechanical sturdiness is necessary in 24-hour use of a receiver; tuning must require a minimum of time and have a maximum duration. Waterproofing, freedom from the effects of heat and humidity, long life, are other factors adding to reliability. Ease of installation and replacement are also important.

Audio output requirements vary with conditions; suburban areas, where the average car speed is greater than in cities, demand at least 2 watts output; particularly is this true with open cars and when officers desire to go temporarily a short distance from their automobile. In some cities one watt power output from a magnetic speaker has proved enough.

The above points must, however, be balanced against economy of operation; since 24 hour service is necessary, high power output may not be worth the added expenditure for plate circuit power. Here we come to recent tube developments: Before 1931 the filament consumption of tubes in automobile receivers was quite high and a renewed interest and a notable advance in automobile receiver design came with the advent of the so-called 6.3 volt automobile tubes consuming 0.3 ampere compared to the old tubes using 1.75 amps. at 2.5 volts. They have better plate circuit efficiency and can be used directly from a 6-volt storage battery under all variations of potential due to charge and discharge. With the power pentode, tubes with the new filament are now possible giving over a watt of output power as compared to the one-half watt possible with old tubes.

The battery eliminator and class B amplification

Coincident with this development in tubes is the inclusion of automatic volume control in almost all commercial radio receiver designs. This operating feature gave the finishing touches to another step forward in police automotive radio.

Two other developments were bound to come after the renewed interest resultant to the tube and circuit advances of 1931:

Operation of the plate circuits upon dry B batteries was the most costly item of maintenance. With replacement every two months of three or four batteries, over one-half the total cost of upkeep was taken by battery supply. The battery box was a clumsy and often inaccessible unit which often gave installation difficulty through lack of space for mounting under the floorboards. Battery eliminators have gained favor and after a year's experience are now one of the requisites to police radio installation. Through careful elimination of friction and use of a permanent magnet field the rotating type runs as high as 50 per cent efficiency while

Compact 5-meter receiver-transmitter (RCA) for portable use

the vibrator-rectifier type give efficiencies as high as 60 per cent.

As development progressed more audio power was demanded; one watt not being enough at higher automobile speeds. Furthermore permanent magnet dynamic speakers used for better low frequency audio response were less efficient than the previous magnetic type and required more power to actuate them. Answer to these

London policeman listens to headquarters, his attention called by a bell under his coat

difficulties came in the form of class B amplification, approaching the ultimate 50 per cent efficiency. Two such tubes consuming no more plate battery power than two pentodes could deliver from 3 to 5 watts against less than 2 watts from pentodes.

Other developments aiding compactness of design and economy of operation are the duo-diode-triode tube which combines the function of detection and audio amplification in one tube, the combination of two sets of class B tube elements in one tube, and the performance of the dual function of detection and oscillation by one tube. At present a police radio need have no more than 5 tubes to adequately possess the features of sensitivity, power output and economy.

Installation service and maintenance

The usual police automobile installation has a wire mesh antenna located in the top of the car body. Such antennas have from one-half to one and one-half meters in effective height and are the most efficient of any type thus far used. Mounting of the radio chassis itself is usually under the dash at a minimum distance from the control mechanism on the steering column. The loudspeaker may also be mounted here if space permits although attachment overhead to the car roof has proved successful. This latter space is particularly convenient for magnetic speakers of shallow depth.

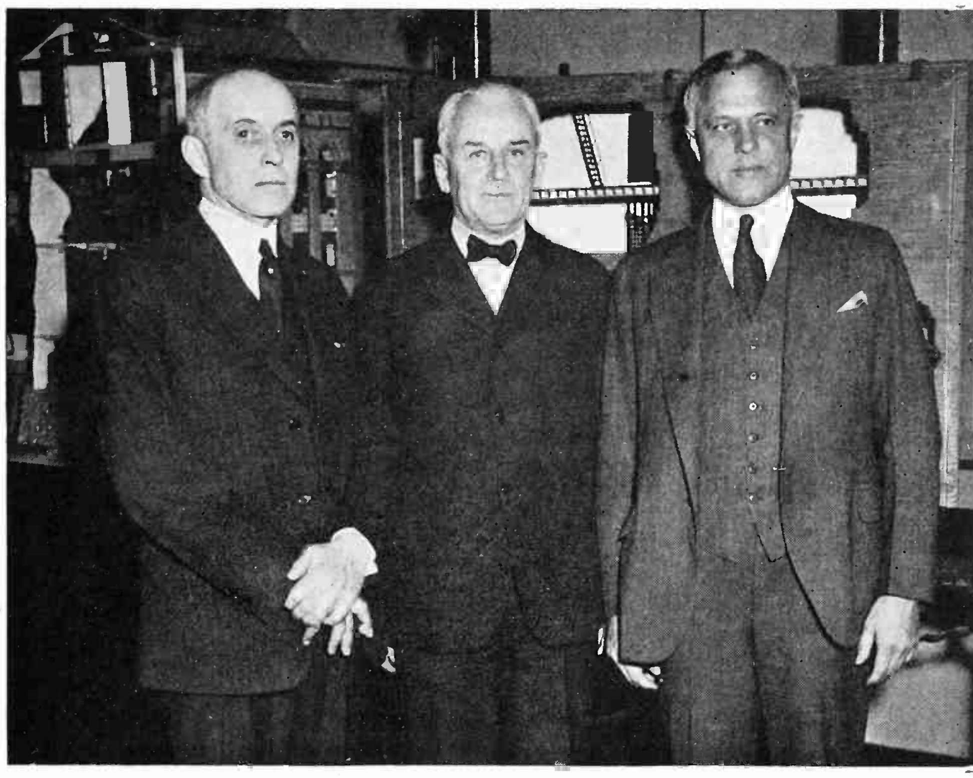
Freedom from spark noise must of course be cared for in installation. In the beginning it was very much a problem but with advance of the shielding art and knowledge of characteristics of ignition interference now make this point one of routine.

Police receiver designs are practically all of fixed tuning for two reasons: to preserve rigidity of adjustment as long as possible; and to preclude human error in individual adjustment by patrolmen that might lead to the missing of calls. Adjustment, although not difficult, is cared for only by the service men in charge.

[*Continued on page 90*]

Science makes jobs

Drs. Jewett, Millikan and Compton show how research creates employment



F. B. JEWETT R. A. MILLIKAN KARL T. COMPTON

EVERY READER of *Electronics* has been asked: "But don't these new electronic inventions put men out of work, and so aggravate the world's troubles of unemployment?"

The answer, definitely to the effect that science and electronic inventions *build new industries and so create jobs*, rather than destroy employment, was made by a group of outstanding American scientists whose names are also synonymous with electronic discovery and application, during a joint meeting of the New York Electrical Society and the American Institute of Physics in the Engineering Auditorium, New York City, Feb. 22, at which the editor of *Electronics* presided, as head of the Electrical Society. Messages were read from President Roosevelt and Owen D. Young. In connection with the meeting, the speeches were put out to a nation-wide audience through the electronic means of sound-pictures, and NBC and Columbia broadcast hook-ups.

Following are pointed paragraphs from the discussions:

President Franklin D. Roosevelt

• The value to civilization of scientific thought and research cannot be questioned.

The idea that science is responsible for the economic ills which the world has recently experienced can be questioned. It would be more accurate to say that the fruits of current scientific thought and development, properly directed, can help revive industry and markets for raw materials.

Dr. Karl T. Compton

Chairman, U. S. Science Advisory Board. President, Massachusetts Institute of Technology

• The idea that science takes away jobs, or in general is at the root of our economic and social ills, is contrary to fact, is based on ignorance or misconception, is vicious in its possible social consequences, and yet has taken insidious hold on many minds.

The spread of this idea is threatening to reduce public support of scientific work, and in particular, through certain codes of the NRA, to stifle further technical improvements in our manufacturing processes. Either of these results would be nothing short of a national calamity,—barring us from an advanced state of knowledge and standard of living and soon placing us at an economic disadvantage in respect to foreign countries which have not let themselves be swayed by such a short-sighted point of view.

Dr. Robert A. Millikan

Director California Institute of Technology

• Every labor-saving device creates in general as many,—oftentimes more,—jobs than it destroys. And the new jobs are in general better for the individual affected, and much better for society as a whole, than the old ones. Labor-saving devices do not in general destroy the jobs that demand intelligence. They cannot do it. The heavy grinding, routine, deadening jobs are the ones that machinery destroys. In a word, the world's drudgery that used to be done by human slaves, is now done by soulless, feelingless iron slaves, and the human is freed for the more interesting jobs of building, running and keeping in order the machines of his creation, or of rendering the public service which the existence of these machines has made necessary.

Dr. Frank B. Jewett

President Bell Telephone Laboratories

• In normal times, there are one-half million people employed in the operation of the telephone business in this country. If we subtract what we have learned through scientific research in the last fifteen years, if we go back to the close of the World War—the utility of the telephone as an instrument in our social and economic life would decrease so much as to cut the magnitude of its force to less than half of what it is now. We would have no radio broadcasting, no radio talking pictures—we would have nothing of these industries which have grown up within recent years and which have given employment to large numbers of people directly employed—or those indirectly employed, in these industries which resulted from scientific research and development.

In my thirty years of activity in industrial research, I cannot find a single instance where a scientific achievement has resulted in a reduction in employment. In nearly every case, more work has resulted and there has been a betterment of living conditions. The benefits of scientific research flow to all classes of the population, and even the least competent of the people find themselves a step further from the starvation line. . . .

If one is willing to look at facts in broad perspective, one cannot but see that history, in the last 150 years at least, has proven that scientific research, applied to the forces of life, has resulted in better living conditions and an increase of employment.

Owen D. Young

Chairman General Electric Company

• In America obsolescence—not wear-out—has been the thing which has kept our people at work and at the same time has produced more and better things at less cost for us all to use.

Science is the mother of obsolescence, and to the extent we paralyze it we will limit employment, wages and our standard of living.

An analysis of efficient modulation

By E. N. DINGLEY, JR.

IN the following article, the author desires to point out, not a new system of modulation but a method by which the well-known constant current system may be made to modulate a greater oscillator input wattage to a given modulation percentage.

Figure 1 is a block diagram of the usual circuit connections for constant current plate modulation wherein L is a choke coil which is assumed to have infinite inductance and zero resistance. The block marked oscillator is usually a radio frequency power amplifier stage

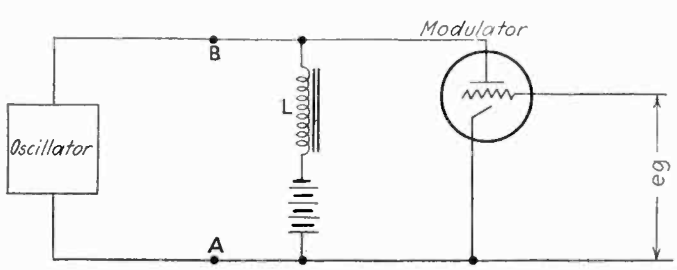


Fig. 1—Block diagram of constant current modulation system

but may be an oscillator and is so called herein to coincide with the arbitrarily chosen term "oscillator input watts per modulator tube," by which modulators are rated.

After the oscillator has been adjusted for the best operating conditions, a d-c ammeter placed in the plate lead at A will read the d-c plate current (I_{po}) supplied to the oscillator. It is assumed that the oscillator is equipped with r-f chokes and suitable by-pass capacitors so that all r-f is confined within the oscillator block. The d-c plate potential E_p is measured at the battery or between the points AB.

If the choke resistance is not negligible, measurement between the points AB is necessary to obtain the true plate potential. This measurement should be made with the modulator tube drawing normal plate current but unmodulated.

It is evident that the oscillator has an apparent d-c resistance R_o

$$\text{Where } R_o = \frac{E_p}{I_{po}} \tag{1}$$

An equivalent expression for the oscillator resistance is in terms of the oscillator input watts, thus

$$R_0 = \frac{E^2_p}{W_0} \tag{2}$$

Where W_0 is the oscillator input $E_p\, I_{p0}$.

Now, the audio frequency output of the modulator cannot pass through the infinite reactance of L, hence the total plate load (R_L) of the modulator tube is the apparent resistance of the oscillator tube R_0, or

$$R_L = R_0 = \frac{E^2_p}{W_0} \tag{3}$$

Figure 2 is a further simplification showing $R_o = R_L$ as a resistance load in the plate circuit of the modulator.

In Fig. 2, the r.m.s. plate current is given by:

$$i_{pm} = \frac{\mu\, e_g}{r_p + R_L} \tag{4}$$

Where μ is the amplification factor of the tube, e_g is the r.m.s. value of the grid signal and r_p is the plate resistance of the modulator tube. The value of $e_g \sqrt{2}$ must not exceed the value of the grid bias; that is, the peak positive grid swing must not be sufficient to drive the grid positive.

The r.m.s. voltage e_{pm} developed across R_L is given by

$$e_{pm} = i_{pm}\, R_L = \frac{\mu\, e_g\, R_L}{r_p + R_L} \tag{5}$$

It must be noted here that the value of e_{pm} thus obtained is approximate but not exact because the values of μ and r_p are variable throughout the cycle. The absolute value of e_{pm} developed across R_L together with the per cent distortion present may be obtained by laying off on the plate family curves of the modulator tube a line passing through the operating point and having a slope equal to $R_L = R_o$.

The modulation factor of the r-f oscillator output signal can be closely expressed as the ratio of peak a-c voltage, developed across the load R_0, to the d-c plate potential, or

$$m = \frac{\sqrt{2}\, e_{pm}}{E_p} \quad \text{hence} \quad e_{pm} = \frac{m\, E_p}{\sqrt{2}} \tag{6}$$

substituting (3) and (6) in (5):

$$\frac{m\, E_p}{\sqrt{2}} = \frac{\mu\, e_g \dfrac{E^2_p}{W_0}}{r_p + \dfrac{E^2_p}{W_0}}$$

Simplifying:

$$W_0 = \frac{\sqrt{2}\, \mu\, e_g\, E_p}{m r_p} - \frac{E^2_p}{r_p} \tag{7}$$

Where:

- μ = Amplification factor of modulator tube
- e_g = r.m.s. value of grid signal ($\sqrt{2}\, e_g < E_c$)
- E_p = Plate potential of oscillator and modulator tube
- m = Modulation factor desired
- r_p = Plate resistance of modulator tube

In other words, W_o represents the oscillator input wattage which can be modulated by the factor m when using a specified modulator tube under normal operating conditions. In tube specifications, the factor m is usually taken as 0.6 = 60 percent. Thus a modulator rated as "4 oscillator input watts per modulator tube" is able to modulate an oscillator input of 4 watts by a factor 0.6. This is based on the assumption that a common plate potential is supplied to both the oscillator and modulator tubes and that they are coupled by means of an a-f choke.

As an example, assume a modulator tube having the following characteristics:

$$E_p = 350 \qquad e_g = 31/\sqrt{2}$$
$$E_c = -31 \qquad r_p = 5000$$
$$\mu = 8 \qquad \text{Desired } m = 0.6$$

then

$$W_0 = \frac{\sqrt{2}\,(8)\,(31/\sqrt{2})\,350}{(0.6)\quad 5000} - \frac{(350)^2}{5000} \qquad \text{(from 7)}$$

$$W_0 = 4.43 \text{ watts}$$

As the oscillator plate potential is 350 volts, an oscillabor input of 4.43 watts represents an apparent resistance of

$$R_0 = \frac{E^2_p}{W_0} = \frac{(350)^2}{4.43} = 27{,}652 \text{ ohms} \qquad \text{(from 2)}$$
$$R_0 = R_L = 27{,}652$$

The plate load of the modulator is therefore 27,652 ohms and, as the modulation factor is 0.6, the peak a-c potential developed by the modulator tube across this plate load is $\sqrt{2}\,e_{pm} = m\,E_p = 0.6\,(350) = 210$ volts (from 6)

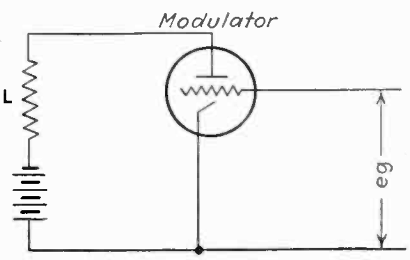


Fig. 2—Equivalent circuit of modulation circuit

The modulator tube data books provided by some manufacturers contain curves showing the modulation factor obtainable at various plate potentials for various values of oscillator input watts; and also curves of the grid bias and grid signal to be used for various values of oscillator input watts.

These curves are obtained by assuming various oscillator input powers and, from the known oscillator plate voltage, calculating the apparent oscillator resistance. A distortion rule is then placed on the plate family curves of the modulator tube with a slope equal to the apparent oscillator resistance. The distortion rule is then moved about over the plate family curves, always maintaining the proper slope, until a position is found which will produce the greatest output voltage without exceeding 5 per cent distortion. From this line is taken the proper value of grid bias to be used and the value of the voltage output obtained. The ratio of the peak a-c voltage output to the d-c plate potential is the modulation factor.

It will be noted that the smaller the oscillator input watts, the larger will be the apparent oscillator resistance which acts as the plate load of the modulator. Larger modulator plate loads tend to diminish the harmonic output and permit a larger grid bias and signal to be used with consequent larger voltage output or increased modulation factor.

A modification of Fig. 1 is shown in Fig. 3 wherein the impedance coupling device has been replaced by the transformer L_1-L_2.

By selecting a suitable ratio of L_1/L_2, the apparent resistance R_o of the oscillator may be made to appear to be any desired load R_L in the plate circuit of the modulator tube. Thus allowed complete freedom as to the value of

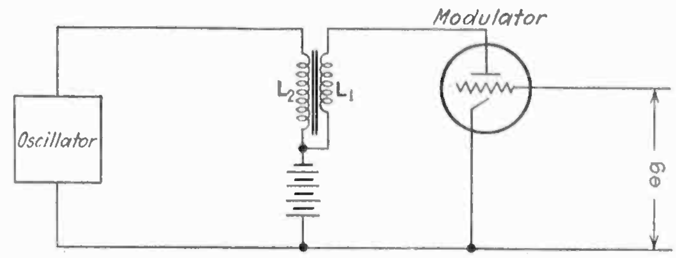


Fig. 3—Modified constant current system

the modulator plate load, the distortion rule previously mentioned can be used to best advantage in determining the value of load which will produce the greatest modulator output power for a given percent distortion.

This maximum power output can best be determined directly from the plate family curves but can also be found from the relationship.

$$i_{pm} = \frac{\mu\,e_g}{r_p + R_L} \qquad (4)$$

$$W_m = i^2_{pm} R_L \qquad (8)$$

or

$$W_m = \frac{(\mu)^2\,(e_g)^2\,R_L}{(r_p + R_L)^2} \qquad (9)$$

Where W_m = modulator power output

Assuming no losses in the transformer L_1-L_2, the modulator power output W_m is applied to the apparent resistance R_o of the oscillator and will develop a potential e_{po} across R_o

$$e_{p0} = \sqrt{W_m\,R_0} \qquad (10)$$

From (2) $\quad R_0 = E^2_p / W_0$

therefore

$$e_{p0} = E_p \sqrt{\frac{W_m}{W_0}} \qquad (11)$$

From (6)

$$e_{p0} = \frac{m\,E_p}{\sqrt{2}}$$

(e_{pm} is replaced by e_{p0} in this case)

therefore

$$\frac{m\,E_p}{\sqrt{2}} = E_p \sqrt{\frac{W_m}{W_0}}$$

or

$$W_0 = \frac{2\,W_m}{m^2} \qquad (12)$$

substituting (9) in (12)

$$W_0 = \frac{2\,(\mu)^2\,(e_g)^2\,R_L}{m^2(r_p + R_L)^2} \qquad (13)$$

Using the same constants as in the previous example except that the transformation ratio is arranged so that $R_L = 10{,}000$,

$$W_0 = \frac{2(8)^2\,(31/\sqrt{2})^2\,(10{,}000)}{(0.6)^2\,(5{,}000 + 10{,}000)^2}$$
$$W_0 = 7.59 \text{ watts}$$

Thus, by suitably matching the loads, the same modulator tube is enabled to sixty percent modulate an oscillator input 71.33 percent larger than is possible when the loads are not matched as was the case in Fig. 1. It is possible that reference to the plate family curves would have shown that the value of R_L might well have been chosen smaller without exceeding the distortion limits of the modulator tube and thus an even greater allowable oscillator input per modulator tube would have been obtained.

[*Continued on page 81*]

An electronic voltage relay

By J W. GRAFF
Alabama Power Company, Birmingham, Ala.

THE following is a description of a thermionic device developed by the writer to give a control indication at some predetermined critical voltage. It performs the functions of a highly sensitive voltage relay, or contact making voltmeter; and with it a very sensitive setting is possible. In common with other electronic equipment, the only maintenance necessary is the replacement of bad tubes.

The device is essentially a two-stage amplifier, operated entirely by alternating current. It is arranged to amplify the unbalance voltage of a bridge circuit and thereby operate a small, inexpensive contactor which may fulfill any prescribed control function.

The bridge circuit is arranged with two opposite arms (*a* & *c* Fig. 1) of some resistor material with a very low temperature coefficient of resistance. The other two arms (*b* & *d*) are tungsten lamps operated at a voltage at which their resistance is sensitive to voltage changes. This corresponds to about one fourth their voltage rating. Figure 2 shows the variation of the resistance of a tungsten lamp with voltage. Figure 3 shows the unbalance produced across the bridge circuit for various line voltages. Theoretically, this unbalance, which is about 1/3 volt per volt, could be increased by using resistors with a negative coefficient in the arms *a* and *c*, but the gain thereby does not warrant using the

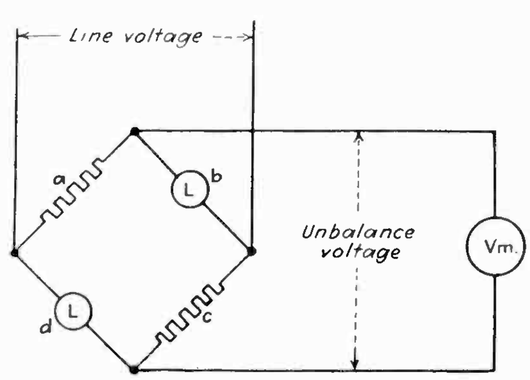


Fig. 1—Bridge circuit composed of resistances and lamps

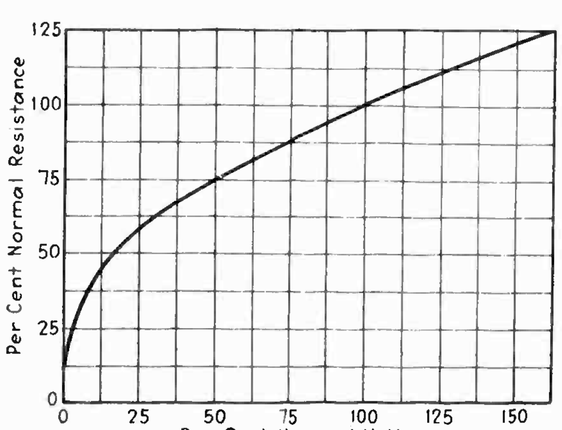


Fig. 2—Voltage-resistance curve—25 watt tungsten lamps

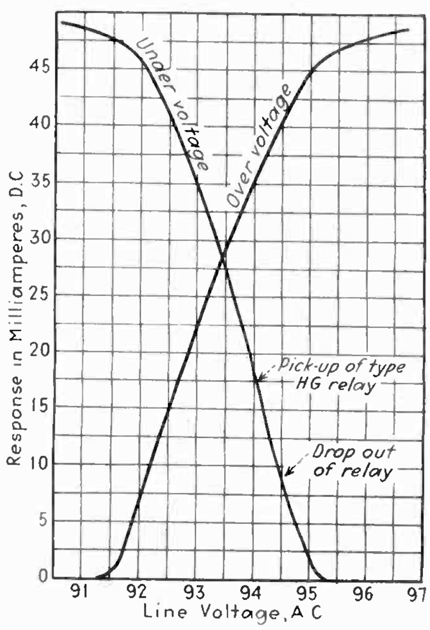


Fig. 3—Response curves of lamp bridge circuit using two 25-watt, 120-volt tungsten lamps

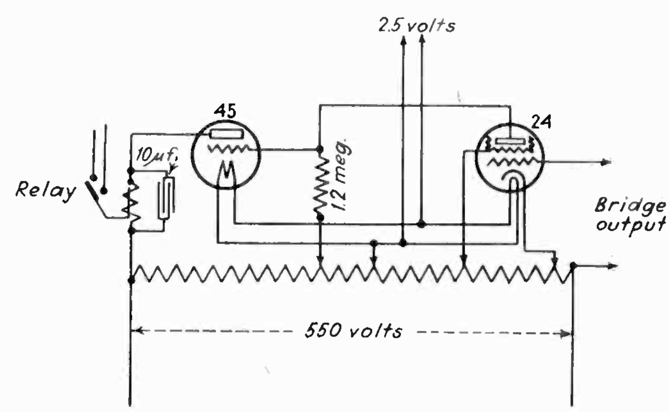


Fig. 4—Elementary diagram of voltage relay

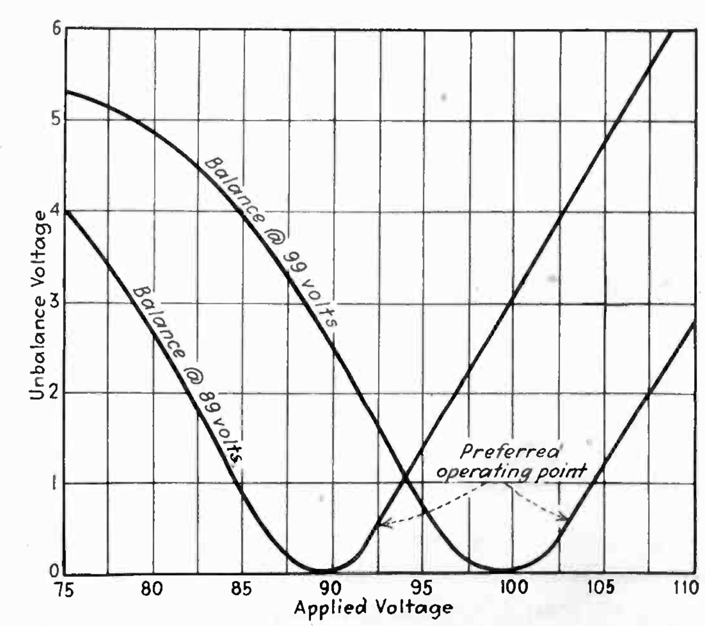


Fig. 5—Response of electronic voltage relay

carbon lamps, the most common resistor of this type.

Thus, if 1/2 volt sensitivity is required, the voltage impressed upon the amplifier input is about 1/6 volt, at about 110 volts across bridge. This voltage is quite large enough to operate a screen-grid tube. Should a higher sensitivity be required, it is most practical to step up the voltage supplying the bridge. If an attempt is made to step up the unbalance voltage of the bridge by means of a small audio transformer, phase angle errors are introduced which actually reduce the sensitivity. In some cases special precautions must be taken to keep the controlling grid in phase with plate and bias voltages.

Fig. 4 shows the amplifier circuit. It will be noted that the plates of both tubes are fed from an a-c source, being in effect half wave rectifiers. This gives it a polarity discriminating property, since it will respond only to grid voltages in phase with the plate supply. An unbalance across the bridge caused by high voltage (above balance) has the reverse polarity of that caused by low voltage (below balance) and thus it discriminates between high or low voltage. To insure that all input grid voltage shall be in phase with plate and bias voltages, resistance coupling is used throughout. This greatly simplifies the equipment as well. Both tubes are biased to their "cut off" point. The most sensitive adjustments are such that the grid bias of the first stage is the sum of a fixed grid bias plus the input from the bridge circuit. By this means, the bridge circuit can be made to operate along the steep portion of its curve. It will also be noted that the grid bias of the output tube is altered by the plate resistor drop of the screen-grid tube, and for this reason the grid tap of the former is made positive with respect to its filament. The output of the type 45 tube will be found quite ample to operate a relay such as General Electric Company type HG. The high capacity condenser across the relay coil is essential, as it reduces the impedance of the output circuit to half wave pulsating current, and delivers current to the relay during the interval when the plate current is zero.

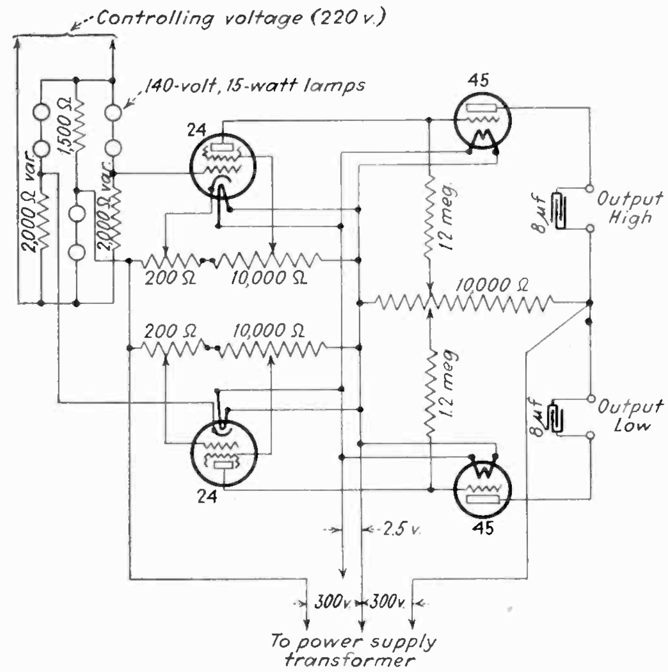


Fig. 6—Double-acting electronic voltage relay

Figure 5 shows response curves of an experimental equipment. Both forward and reverse curves are given. The reverse curve is obtained simply by reversal of the leads from the bridge circuit. The curves shown are for average sensitivity equipment, and show far less sensitivity than the practical limit. Very reliable relay operation can be obtained with sensitivities down to .25 volt. Two such equipments (Fig. 6) can be made to operate on any deviation of voltage from any value.

This equipment can readily be rearranged to operate from a current indication and will be found useful in numerous automatic control applications, such as sensitive over or under voltage protection, or accurate current control. It can be assembled from standard radio parts and will cost much less than a mechanical relay.

An analysis of efficient modulation

[*Continued from page 79*]

The turns ratio of the transformer is given by

$$\frac{T_2}{T_1} = \sqrt{\frac{R_L}{R_0}} = \frac{1}{E_p}\sqrt{R_L W_0} \qquad (14)$$

In the above example the turns ratio should be

$$\frac{T_1}{T_2} = \frac{1}{350}\sqrt{10{,}000 \times 7.59} = 0.787 = \frac{1}{1.271}$$

A further important advantage of transformer coupling is that the two windings may be so connected that the magnetic fields produced in the transformer by the d-c components of the two plate currents may be made to partially counterbalance each other and thus reduce the core saturation.

In the example cited, the oscillator plate current is

$$I_{p0} = \frac{W_0}{E_p} = \frac{7.59}{350} = 21.69 \text{ ma.}$$

The modulator d-c plate current (I_{pm}) taken from the plate family curves is 17 ma.

Therefore $\phi_1 = (f)\, T_1 \times 17$
$\phi_2 = (f)\, T_2 \times 21.69$

where ϕ = magnetic flux due to d-c flowing through the transformer windings

but $T_2 = 1.271\, T_1$

therefore $\phi_1 = (f)\, T_1 \times 17$
$\phi_2 = (f)\, 1.271 \times T_1 \times 21.69 = (f)\, T_1 \times 27.57$
$\phi_2 - \phi_1 = (f)\, T_1 (27.57 - 17)$
$= (f)\, T_1 (10.57)$

Had an auto-transformer been used as the coupling device or should the transformer be connected so that the d-c fields are additive, the total core saturating flux would have been

$$\phi_2 + \phi_1 = (f)\, T_1 (27.57 + 17) = (f)\, T_1 (44.57)$$

hence the ratio of the two fluxes is $\frac{10.57}{44.57}$ or the saturating flux would be increased more than four fold by using an auto-transformer or by having the transformer fields connected so that the fields were additive.

Another advantage of transformer coupling is found in the ability to 100 per cent modulate the oscillator. Complete modulation cannot be accomplished when using regular impedance coupling regardless of the number of modulator tubes used. This is readily ascertained by substituting m = 1 in equation 7. If, however, m = 1 is substituted in equation 13 it is found that the modulator tube will 100 per cent modulate an oscillator input of 2.73 watts.

HIGH LIGHTS ON ELECTRONIC

Illuminometer helps sell paint

THE SHERWIN-WILLIAMS COMPANY of Cleveland, Ohio, and Newark, N. J., has been making use of a photo-cell illuminometer, a spray gun and a small amount of paint, to demonstrate to prospects, the great increase in illumination resulting from a coat of its paint. A corner or a small room of a dingy plant is used for the experiment, the paint is sprayed on, and the amount of light on the working plane measured both before and after painting. The better seeing with the newly painted wall, as measured by the photometer, then affords the best possible argument for a complete repainting job throughout the whole plant.

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Visual indicator for orchestral levels

A NEW TYPE VISUAL INDICATOR of sound intensity, for special use in broadcasting symphonic concerts, has been designed and developed especially for Leopold Stokowski, conductor of the Philadelphia orchestra. During the past year, experimental work on this new instrument has been conducted in the research laboratories of WCAU by Ivan Eremeeff, Russian inventor and experimenter, and John G. Leicth, technical supervisor of WCAU.

The instrument is now being used by Mr. Stokowski in conducting the Philadelphia Orchestra concerts, broadcast on Friday afternoons, and the daily fifteen-minute Chesterfield programs over the coast-to-coast network of the Columbia Broadcasting System.

During rehearsal prior to the daily broadcasts, Mr. Stokowski and the engineer determine the peak levels of each composition and set the gain control at a fixed point. With the visual indicator placed in front of Stokowski, he is able to control the volume of the orchestra according to the visual color indication on the instrument and it is not necessary for the engineer to change the fixed level.

The visual indicator consists of a specially constructed galvonometer, carrying a very light shutter, which interrupts a light beam, and projects it by means of an optical system on a 30 in. glass screen or indicator, placed immediately before Mr. Stokowski. The light beam, as projected, is about $\frac{1}{2}$ in. in width and varies from a sharp point to approximately 24 in. for full-scale deflection. The damping of the instrument may be adjusted so that it will cover a wider range than the standard volume indicator and it can also be adjusted so that the response is not in direct proportion to the voltage applied. By doing this, an appreciable deflection will be accomplished on a signal of very low intensity and still have the full scale deflection occur at a point where overloading of the radio equipment is reached. This enables Mr. Stokowski to use as great an intensity range as possible and to know definitely when the overload point is reached and when the intensity of the sound from the orchestra falls to a level where line and other types of noise may become apparent.

Light of three colors is projected on the glass scale, the colors representing sound respectively of low, medium and high intensity. This is done in order that the conductor may, at a glance, determine the approximate position of the music in the dynamic range. Oftentimes, the approximate level on the orchestra is all that the conductor wishes to know throughout somewhat extended musical passages and this may be easily determined by the color of the light without the conductor's attention being distracted from his score, rather than by observing the exact level on a numerically calibrated scale.

The shielding hood in which the calibrated glass scale is mounted is made in such a fashion that the engineer and production man, seated before the conductor, have the same indication of intensity from the back of the instrument, as that available to the conductor, in front of it.

Dr. Stokowski leading his orchestra with the aid of his new intensity-level indicator. The length of the bar of light shows the exact intensity, while the color of the beam gives an approximate indication in three rough steps

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Four thousand police radio cars in 128 cities

THE PROGRESS AND EXPANSION of radio police systems represents one of the real dramas of radio. So successful were the operation of the early cars, that the Radio Commission three years ago assigned 9 frequencies for police use, one year ago that number was increased to 11; and now under the 1934 new plan 20 channels will be immediately available for state and municipal radio systems in the United States.

There are now 128 municipalities and eight states equipped with their own radio police communication systems. More than 4,000 police cars are equipped with receiving sets, and, judging by the success of recent experiments, it is conceivable that many of them will eventually be equipped with transmitting sets permitting two-way communication.

There is no rule at the present moment specifying the maximum power that may be installed at state police stations. It was therefore decided that as a matter of policy the maximum power be limited to 5 kw. day, or 1 kw. night, and that the states be encouraged to install a number of transmitters of less power rather than one or two transmitters of maximum power.

DEVICES IN INDUSTRY + +

Small churches to get recorded sermons

RECORDED SERMONS and religious organ recitals for churches, financially unable to have regular pastors, are being projected by the Congregational and Christian Church Extension Board, according to the Rev. Dr. Ernest M. Halliday of New York, general secretary.

The recorded sermons and recitals will be reproduced on a specially made instrument similar to a phonograph. Each disk will contain a thirty-minute church service and both sides of the record will be used. Each side will contain fifteen minutes of the church service.

Present plans call for the first distribution in the mountain regions of the Southeastern part of the United States.

"The recorded sermons will be preached by leading theologians of the United States, such as the Rev. Dr. S. Parkes Cadman of Brooklyn," said Dr. Halliday. "The recitals will be played by well-known church organists. All of the sermons and recitals will be recorded in one of the Eastern studios of a phonograph record manufacturer and the expenses of distribution will be borne by the board."

Although the records will be the basis of the services in small churches, the congregations will conduct their own Scripture reading and singing of hymns.

"The records will circulate among the small churches somewhat on the order of books in a library," said Dr. Halliday. "The New York offices of the board will be the distribution centre."

Dr. Halliday said as far as he knew the Congregational and Christian Church record project was the first of its kind in this country.

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Sound systems aid in serving beer

THE RETURN OF REAL BEER has stimulated business in many unexpected directions. Radio men and public-address engineers report a number of profitable sound-system installations in beer gardens, restaurants, soda stores and other places where thirst is quenched.

In many of these places, microphones are installed in convenient locations, so that orders may be conveyed accurately and rapidly to a central serving point. In other places, the public address system is also used for entertainment purposes to supply music.

A typical sound system was recently completed at the Picadilly Restaurant, 117 Liberty St., New York City. This restaurant has a long soda-fountain bar. When a customer at the bar places his order for food, the waitress transmits the order directly to the kitchen by talking into a microphone. Several Loft candy stores have also used the same method, to avoid locating bulky soda fountains in valuable positions in the store.

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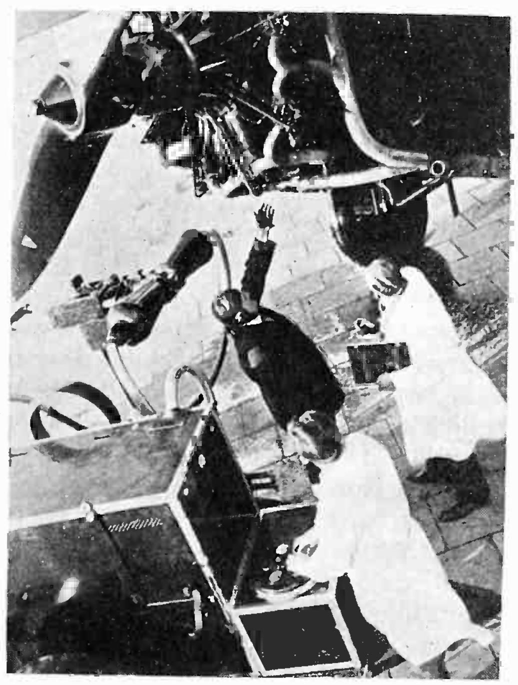
PORTABLE X-RAY



At the Fuhlsbuttel aerdrome near Hamburg, Germany, a portable X-ray outfit can be wheeled out onto the field and used to inspect propellers, engine parts, and gear, detecting flaws invisible to the eye

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Oscillator detector

FLAWS AND CRACKS in tungsten or molybdenum wire, and similar materials, are detected by a new vacuum-tube oscillator being also successfully used in the General Electric shops at Schenectady, N. Y., to find flaws in copper tubing. In both cases, flaws are detected by means of eddy current induced in the material inspected.

The tubing test is based upon the change in electrical resistance of a small section of tubing, which occurs when a defect is included in it. Eddy currents are induced in a small portion of the tubing by passing it through a coil connected in an oscillator circuit. Two of these oscillators are coupled together and connected through an amplifier to a loudspeaker and a meter. Each of the oscillators is provided with a coil either or both of which may be used as test coils through which to pass the tubing. With a good section of tubing in the test coils, the oscillators are both tuned to the same frequency. Then, as the tubing is passed through the coils, a flaw will change the induced current sufficiently to change the frequency of one of the oscillators and cause a beat note in the loudspeaker and a deflection of the meter.

The equipment in its present form detects local flaws and sudden changes in characteristics of the material. By using one test coil instead of two, however, it may be used to detect gradual changes in characteristics or to compare the material with a standard.

+

Portable radios aid forest-fire fighters

PORTABLE RADIO SETS AIDED the United States Forest Service in quick reporting and communication during fire emergencies in several national forests this summer.

The Forest Service has been experimenting with the possibilities of radio communication since 1927, and last year its investigators developed specialized sets suitable for the rigorous requirements of national forest use. This year it has had 150 new sets in use in national forests in the West, supplementing the existing forest telephone system.

One type of set developed by the Forest Service is strictly portable, and weighs only about 10 pounds, complete. Its effective radius of communication is 10 miles or more, messages being received by voice, and sent by code. Sets of this type will be carried by fire crews and by "smoke chasers" traveling the roads and trails, constantly on the lookout for fires, "firebugs," and persons careless with matches or tobacco.

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Radio-fog-horn gives mariner's distance

IN THE ENGLISH COMBINATION of fog-horn and radio station, sound is sent out through the air, while a phonograph record at the radio station simultaneously starts counting out miles and tenths of miles at the rate at which the sound travels. This radio count reaches the mariner instantly as it proceeds and he listens until he hears the air-borne sound of the fog-horn. The radio count at that instant gives him the distance of his ship from the sending station. In the United States no such system is yet in service.

Electric wave filters for high frequencies

By CARL L. FREDERICK

Engineering Physics Corp., Hackensack, N. J.

IN ORDER that several messages such as speech and music may be transmitted simultaneously over the same wire or over the air, without interference, means must be provided for selecting desired currents or voltages and discriminating against others which are different because of their frequency. In the frequency range below about 200 kc., it is customary to employ for this purpose electric wave filters, consisting of a network of coils and condensers so designed and proportioned that frequencies in a definite range are allowed to pass with a uniformly low loss while those outside this range are highly attenuated. At frequencies above 200 kc. a number of simple tuned circuits in tandem, each containing one coil and one condenser, have been used ordinarily.

Several facts are responsible for this difference in practice. At low frequencies a simple tuned circuit will pass only a very narrow band of frequencies uniformly, but as the frequency increases such a circuit will pass a band sufficiently broad for speech and music with approximately uniform loss. Also, as the frequency increases, it becomes more difficult to build a satisfactory filter. Some of the reasons for these facts can be made clear by a comparison of the two types of structure.

In a tuned circuit the lowest loss occurs at the single frequency where the coil and condenser are resonant, assuming, of course, that if the coil and condenser are in series they are used in series with the line, and if they are in parallel they are connected across the line. At other frequencies the loss is increasingly greater the further they are removed from the resonant frequency. Consequently the curve of loss, plotted as a function of frequency has somewhat of a "V" shape as shown in Fig. 1. The sharpness of the "V" depends upon the value of the inductance of the coil, and the dissipation factor, called the Q of the coil at the resonant frequency. Q is defined as the ratio of the reactance of the coil to the effective resistance of the circuit at the frequency it is desired to transmit.

Tuned circuits versus filters

In contrast, the electric wave filter allows a definite band of frequencies to pass with nearly equal loss and discriminates quite abruptly against the unwanted frequencies. Plotting the loss as a function of frequency the filter gives a "U" shaped curve. The steepness of the sides of the "U" depends on the number and kind of filter sections employed. How square the bottom of the "U" is, depends largely on the Q of the coils and condensers.

With the steadily increasing refinement of the telephone art occasions arise which require apparatus for selecting both narrow and wide high-frequency bands with sharp discrimination and little variation of loss in the band. For these reasons, the "V"-shaped characteristic of the tuned circuit cannot always be tolerated, and

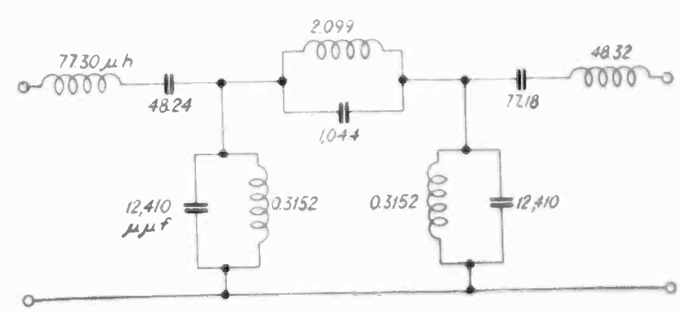


Fig. 2—Schematic of a high frequency filter designed by methods employed at low frequencies.

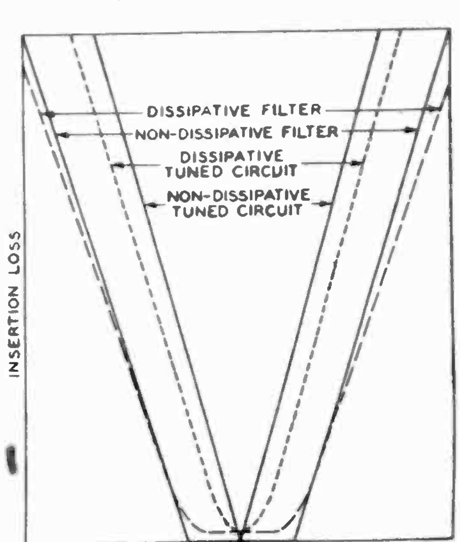
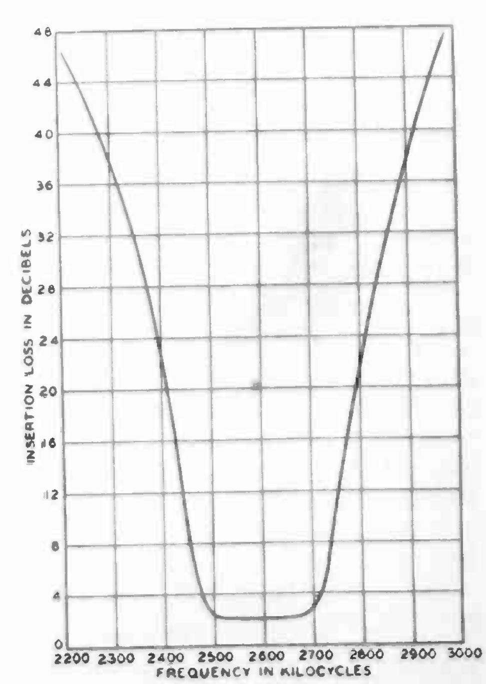


Fig. 1—(left) Loss characteristics of dissipative and non-dissipative tuned circuits and filters. Dissipation is due to effective resistance in the coils and condensers.

Fig. 3—(right) Computed insertion loss characteristic of the high frequency band pass filter shown in Fig. 2.



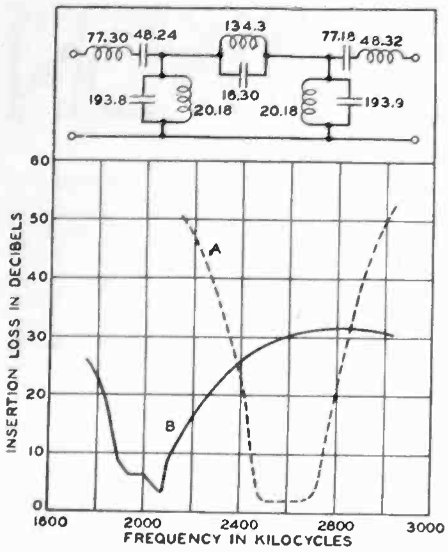


Fig. 4—(left) Modification of L and C of Fig. 2, so that the resonance frequencies are the same as before, changes the characteristics of the filter from A to B.

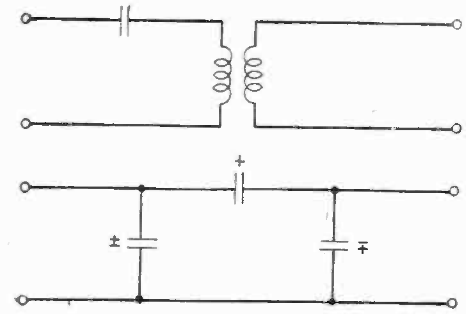


Fig. 5—(right) An ideal transformer (above), with a condenser in series, is electrically equivalent to a "π" shaped configuration of condensers (below) of which one of the shunt members is negative

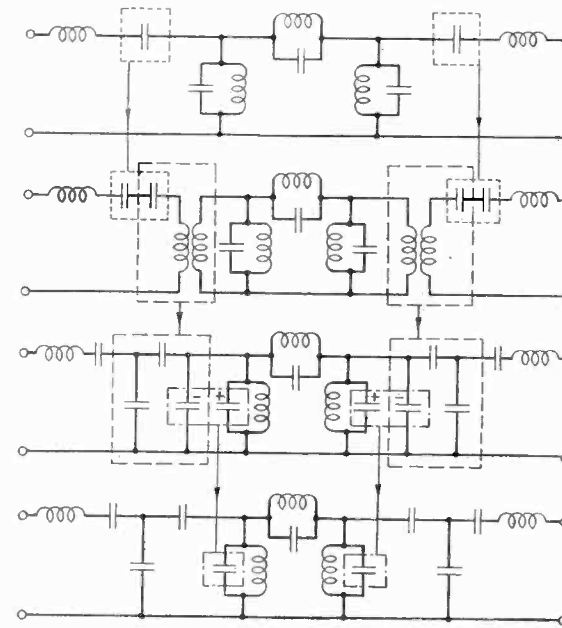


Fig. 6—Design steps for transforming at each end the impedance of the filter diagrammed in Fig. 2 by the artifice shown in Fig. 5

it has been necessary to solve the many problems which beset the construction of filters for high-frequency operation.

One difficulty encountered in the design of high frequency filters is in the realization of lumped impedance elements of suitable size. In building filters for use below 200 kc., it is possible to approximate closely the lumped inductances and capacitances which are dictated by the computation of the theoretical design. As the frequency at which the filter is designed to operate increases, however, the values of the coils and condensers computed by the usual filter mathematics become progressively smaller until at a million cycles some of the coils required are practically impossible to construct.

The theoretical design shown in Fig. 2, of a filter to work at 2,600,000 cycles per second with the loss characteristics shows in Fig. 3, shows what ridiculously small coils the theory may prescribe. The required inductance of 0.3 μ h. corresponds to that given by a straight wire only a few inches in length and 2 μ h. would be given by one or two turns of wire on a cylindrical form 1 inch in diameter. Evidently the inductances of the wiring would be of the same magnitude as the inductances required by the filter, and thus make it practically impossible to build a filter with a predicted characteristic.

Since it is possible to build condensers smaller than those prescribed, it is often asked why the coils in the shunt arms could not be simply made larger, and the condensers in parallel with them smaller, so that the resonant frequency of each pair would be the same as before. The answer is that this procedure would change the shape of the impedance characteristics of the arms with frequency. This in turn would cause an internal mismatch of impedances, which would degenerate the desirable loss curve shown in Fig. 4A to that shown by Fig. 4B.

To rematch the impedances, there are necessary "step up" devices, for example transformers, at appropriate points. The ratio of impedance transformation in each case will be the ratio by which the inductances have been increased and the capacitances diminished. At the high frequencies under consideration, however, the use of actual transformers in this manner is not as simple and flexible as the method shown in Fig. 5.

It can be demonstrated[1] that an ideal transformer, in series with a condenser, is equivalent to a "π" shaped configuration of three condensers, one of which has a negative capacitance. A condenser with a negative capacitance is, of course, unrealizable by itself, but when its position in the theoretical circuit is in parallel with a positive capacitance of larger absolute value[2], a single condenser can be used to provide the equivalent positive capacitance which is the sum of the two. These design steps, applied to the structure of Fig. 2, are shown in Fig. 6. In the first step, the series capacitances at the ends of the filter are divided, and a transformer is inserted between each and the body of the filter. As a second step, each transformer and an adjacent condenser are replaced by the equivalent "π" network of condensers. Finally the "+" and "—" condensers in parallel are replaced by a single positive condenser. The overall electrical characteristics of the final structure in Fig. 6 are the same as the initial structure, but it has the advantage that the elements are all of suitable value.

When impedance transformations have brought the values of the coils up to practicable figures, the values of the condensers may be very small. The difficulty then to be overcome is that of concentrating the stray capacities at certain points in the filter structure so that they can be used as a part of the theoretically desired capacities. This is best accomplished by double-shielding the series impedance arms in such a way that the capacity between the shields forms a part of the total capacity required in the shunt arms of the filter. A schematic of the final circuit and shielding, derived from the circuit of Fig. 1 by application of the procedures described is shown in Fig. 7. The condenser values range from 12 to 154 μμf. and the coils range from 20 to 134 μh.

[*Please turn to page 90*]

+ + NOTES ON ELECTRON

Electronic voltage control of d-c generators

By W. P. Koechel

It is possible to control accurately the output regulation of a d-c generator by a comparatively simple electronic unit. One of these has been installed at the Ken Rad plant in connection with a 250-volt generator and has given entirely satisfactory results. It uses an indicator meter, a photocell, and an electronic tube. This tube should preferably be capable of carrying the entire field current of the generator to be controlled, but if a single tube is not sufficient, any number of tubes required may be run in parallel.

In place of the usual field rheostat there is substituted the plate impedance of the tube (or bank of tubes). As the plate impedance of such a tube is determined by the amount of bias applied to the grid, it is evident that the grid bias will indirectly control the output voltage of the generator.

A photocell mounted behind an indicating voltmeter controls the amount of bias applied to the vacuum tube. The voltmeter is connected directly across the output of the generator. At that point on the dial of this meter which corresponds to the voltage at which the generator is to be held, there is an aperture. A source of light is located in front of the aperture together with a spherical mirror for centering the beam at the proper spot. Thus with the aperture uncovered the maximum of light will impinge on the photocell behind the meter. However, when the indicating needle of the meter is reading at the correct voltage, the light beam will be obstructed and the cell dark. With maximum light going through the aperture, the photo-electric cell will pass the maximum bias to the grid of the tube. This in turn will cause the plate resistance of the tube to assume its maximum value, (this being infinity) and decrease the voltage output of the generator. Minimum bias on the grid of tube (caused by the cell being dark) will give minimum impedance of the tube (or bank of tubes) and act to increase the output voltage of the generator.

The summarized overall effect of this circuit is therefore as follows. A totally covered aperture will act to increase the output of the generator to its maximum value and a totally uncovered aperture will reduce the output voltage to zero. Therefore, the controlled output voltage values will range between the two values represented by the width of the slot used for entrance of light. If the width of the slot represents the distance which the indicator moves for a change of one volt, the output voltage of the generator regulated by this circuit will maintain a constant voltage of plus or minus one-half volt from any specified value.

As this circuit involves no mechanical relays or moving parts, the quickness of action is limited only by the field characteristics of the generator. The degree of accuracy to which the output voltage can be held will depend only on the accuracy and type of indicating meter used.

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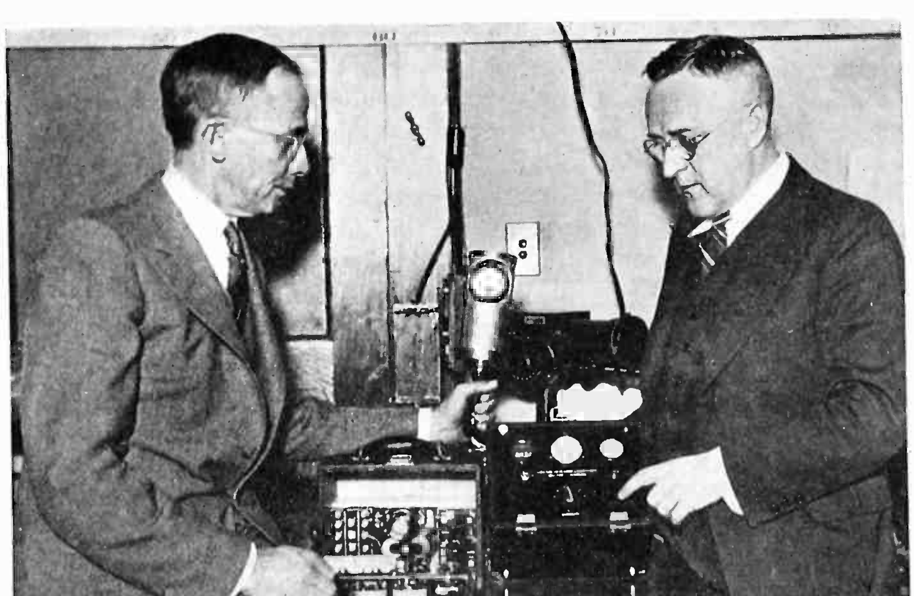
ULTRA-VIOLET RADIATION METER



A photocell, held by A. H. Taylor activated by UV passes current into a condenser where it is stored to be released in spurts to be counted. This electronic device was developed by Mr. Taylor and Dr. Matthew Luckiesh of Nela Park

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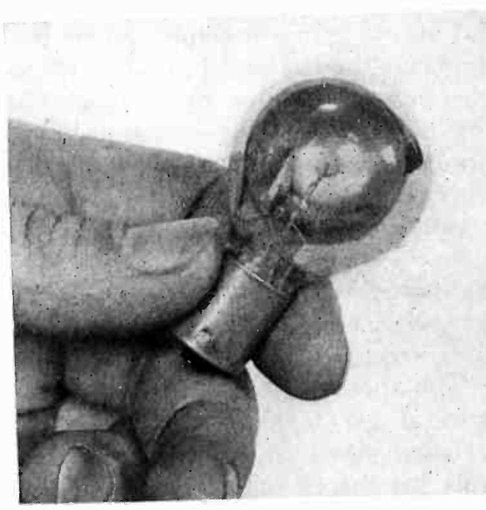
A 35-μa per lumen vacuum cell

A vacuum type phototube with the sensitivity of the better gas cells has been developed and put on the market by the General Electric Company. This tube,



known as the FJ-114 is made in an automobile headlamp bulb and therefore is much smaller than the average tube. The active surface is caesium deposited on oxidized silver, enhanced by other special treatments which not only contribute to the high sensitivity (35 microamperes per lumen) but produces a high sensitivity in the infra-red.

The tube will respond to the heat from a body that is not even glowing in the dark (a wavelength of 12,000 angstroms or a temperature of about 500° C or 900° F.). With an automobile headlamp as the light source (2600° C or 4700° F) the new tube gives a five or six per cent response through a heat-transmitting filter compared to a response of about 0.5 per cent from the usual phototube.

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With permission to publish—

In accepting a gold medal from the American Institute of the City of New York presented to the General Electric Company for "pioneering in industrial research," Dr. W. D. Coolidge spoke of his pride in a company policy which is markedly different from that existing in many other large, and small, organizations and which permits these

TUBES AND CIRCUITS + +

companies to hide under a bushel the light of countless persevering scientists and engineers.

Dr. Coolidge said, in part, "we have been free to publish our results and have been encouraged to do so; we have had the satisfaction of knowing that we were making real contributions to the sum total of fundamental scientific knowledge and were gaining the respect and confidence of fellow scientists in academic circles."

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Colloidal graphite in electronics field

By Raymond Szymanowitz
Technical Editor, Acheson Oildag Co., Port Huron, Mich.

In addition to being unctuous, graphite is unusually inert chemically, is a conductor of electricity, possesses a fairly high black body factor and when colloidalized has a huge surface per unit of mass. Aqueous dispersions of colloidal graphite, when applied to solids, and permitted to dry, form tenaciously adsorbed, homogeneous, opaque films which retain the original properties of graphite. These films are utilized in the making of radio and other electronic tubes where they are applied to the walls of the glass envelopes. The opaque surfaces formed are photoelectrically poor and are capable of conducting to ground stray charges which may otherwise tend to accumulate thereon.

The graphite films formed with colloidal-graphited water also find utility in thermopile design. Here, use is made of the black body properties of graphitic carbon.[1]

It is common practice in the radio tube industry to spray the grids of certain varieties of tubes with colloidal-graphited water to discourage the emission of secondary electrons. In this connection, some manufacturers prefer to lubricate the molybdenum grid wire with colloidal graphite as the metallic thread passes through the winding machine. This practice not only minimizes breakage of the wire, but gives the same a graphite coating which makes unnecessary the spraying of the finished grids.

One of the difficulties in selenium cell production is the tendency of the selenium to form selenides with the metal used for electrodes. When the latter are composed of graphite, produced with colloidal-graphited water, this trouble is eliminated.[2] Even in photoelectric cells employing the alkaline metals graphite films find employment because of their ability to take up caesium and similar light sensitive materials.[3]

Colloidal dispersions of graphite in distilled water, when highly diluted and applied to fibre, paper or ceramic bodies, produces coatings having low electrical conductivity. Utilization of these films are involved in the manufacture of grid leaks, tone controls, volume controls and other types of fixed and variable resistors.

It is possible to obtain colloidal-graphited water in such a high state of concentration that it changes from a free flowing liquid to a viscous fluid. In this state, it enjoys utility as a clamping paste or carbon cement and is valuable for fastening the carbon filaments of therapeutical and similar lamps to the metallic lead-in wires. In some instances, manufacturers of incandescent lamps take advantage of the huge surface possessed by colloidal graphite by using it for "getter" purposes.

[1]F. A. Firestone, *Rev. of Sci. Instruments*, July 11, 1930.
[2]German Patent, No. 522,291.
[3]U. S. Patent No. 1,843,728. British Patent No. 317,209. British Patent No. 319,734.

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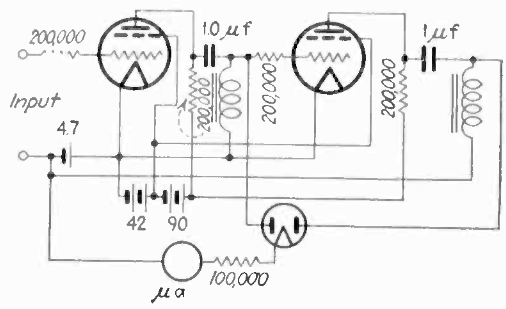
Logarithmic voltmeter

As pointed out by Ballantine (*Electronics*, January, 1931) variable-mu tubes provide a means of making a vacuum tube voltmeter with a logarithmic response. An extension of the range of the early voltmeters of this type has been described by F. V. Hunt of Cruft Laboratory, Harvard University. In the *Review of Scientific Instruments*, December, 1933, he describes several voltmeters of this type based on the fundamental circuit composed of a tetrode amplifier working into a diode rectifier.

A single variable-mu stage with its diode detector will have a linear characteristic between 5 db. below and 15 db. above 1 volt and will have only slight curvature between — 10 db. and



+ 20 db. Two stages with two diodes are linear between — 40 db. and + 20 db. and a three-stage amplifier-voltmeter is linear between — 60 and + 20 db. below and above 1 volt. This represents a range of 10,000 to 1, or between one millivolt and 10 volts. Each of the stages has a diode rectifier. By the time the second or third stages begin to overload with a droop in the output of rectified current, sufficient input has been applied to earlier stages so that the rectifier corresponding to these stages begins to contribute to the total rectified current.

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ULTRA-SHORT WAVE AIRBEACON CONTROL

A new method of remotely controlling radio beacons by wavelengths of the order of 5 meters has been developed by engineers of the Department of Commerce. The apparatus here is under control of G. Muehl, who simply dials to stop or start the Washington beacon

electronics

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New York City

O. H. CALDWELL, *Editor*

Volume VII —MARCH, 1934— Number 3

Research keeps business going

NOT only does research make jobs, but research is the factor that builds new strength into a business and keeps that business going.

Interesting testimony on this point is supplied by one manufacturer of allied technical equipment, who reports that over a long period of years his concern has come to realize that it must add at least 15 per cent of new product in terms of net sales, if the plant is to be kept running on an even keel. The creation of this new product, of course, involves research and development work.

To get $1,000 worth of new product into its factory, based on yearly sales, this manufacturer finds he must spend about $200 on research and development. This, combined with the first figure, means that to maintain a million dollars worth of sales, $30,000 worth of development work is necessary during the year.

25-mile-per-hour radios

IT IS a fact that many radio listeners cannot utilize a high-fidelity, wide-band receiver. It is also a fact that many automobile owners do not reside near roads which will permit a mile-a-minute clip. And yet automotive manufacturers do not restrict all users of cars to a low speed just because the majority do not want, or cannot use, a faster car.

Why, therefore, cannot receiver manufacturers sell a wide-band instrument to the listener who can utilize it? Must all listeners be penalized to the present low order of fidelity just because the industry has not concentrated its energy on cleaning up man-made noise by demanding and securing higher power for broadcast stations, or in cleaning up the distortion that exists in transmitters and receivers?

There are countless thousands of listeners residing in high field strength areas who could enjoy a receiver good out to 7500 cycles. Would it not be reasonable, and perhaps profitable, for every manufacturer in 1934 to have at least one high-fidelity model which can be operated wide open when conditions permit—and not restrict all owners to a 25-mile per-hour mediocrity?

International Congress of Electro-Radio-Biology

TO institute among physicists, chemists, biologists, naturalists and doctors a close collaboration for the advance of radio-biology considered not as a branch of radiology or of biology, but as a separate science in itself, the International Society of Radio-Biology is now preparing the organization of the first International Congress of Electro-Radio-Biology, to take place in Venice, in the Ducal Palace, in September, 1934, under the chairmanship of Count Volpi di Misurata, Italian Minister of State.

All subjects concerning oscillatory and corpuscular phenomena in relation to biology will be examined; ultra-sounds, electric waves, infra-red, light, ultra-violet, radium, penetrating radiation in its probable influences on the various manifestations of organic and organized matter; photodynamic actions, long-distance actions of metals, Gurwitsch rays, phenomena of luminescence, radiations of radioactive salts in organic combinations; electric states of the atmosphere; spectography; influences of radiating energy on heredity, etc.

In addition to many famous European figures, the following from America are expected to be present at the Congress and to speak: Arthur Compton, Chicago; W. D. Coolidge, Schenectady, N. Y.; Glasser Otto, Cleveland, Ohio; C. D. Haskins, Schenectady, N. Y. and R. W. Wood, Baltimore, Md. Those who desire detailed information should address Dr. Giocondo Protti, Venice, Italy, Canal Grande—S. Gregorio 173.

NEWS NOTES

Prall succeeds Starbuck on Radio Commission—Anning S. Prall, representative from New York, was appointed by President Roosevelt to the place on the Radio Commission vacated with the expiration of the term of William D. Starbuck. Mr. Prall has been in Congress since 1923; he was formerly president of the Board of Education of New York City and a commisisoner of taxes and assessments of the city.

Industrial Electronic Tube Section, NEMA—The recently organized Non-Radio Electronic Tube Section of the Specialties Product Division of the National Electrical Manufacturers Association has been renamed the Industrial Electronic Tube Section. Dr. H. A. Jones of the General Electric Company, Schenectady, N. Y., is chairman, and also acts as member in the Supervisory Agency for the Specialties Product Classification. A meeting of the new section was scheduled for March 1, at NEMA headquarters, New York City.

W. R. G. Baker and J. C. Warner go up in RCA—W. R. G. Baker has been appointed vice-president and general manager of the RCA-Victor Company, Camden, N. J., and J. C. Warner has been given the same title with the Radiotron and Cunningham companies at Harrison, N. J. E. W. Ritter has been appointed manager of the research and development laboratory at Harrison, and D. F. Schmit heads up the engineering division, incorporating the development, application, commercial and standardizing sections.

Radio Transmitter Section, NEMA—In addition to the radio receiving-tube section of the National Electrical Manufacturers Association, a special section devoted to other radio applications has been formed, with G. W. Henyan, General Electric Company as chairman, and H. W. Young, Western Electric Company, as secretary. About twenty concerns are members, and the full title of the section covers specifically the fields of "radio transmitting apparatus, public-address and musical distribution, radio transmitting tubes, commercial radio receivers, and radio direction finders."

Former Bureau of Standards men form research group—Following the elimination of a number of radio and scientific specialists from the Bureau of Standards, under the Economy Act, some of these men have been organized into the Washington Institute of Technology, by Col. S. F. Mashbir. Radio patents obtained by this group will be manufactured in future by the Westinghouse company, according to an agreement reached with Walter C. Evans, manager of the Westinghouse radio department. The Institute men are now working in a laboratory at the College Park airport, near Washington. Two new developments are the "direct-aire" direction finder, and the "air-track" blind landing system.

Russians plan twenty million radios by 1937—According to the Soviet organ Pravda, plans being developed by the Russian Commissariat for Communications contemplate a four-year Soviet program for production of twenty million receiving sets with present and enlarged manufacturing facilities and with twenty scientific research institutes of Russia now engaged thereon. By the end of 1937 it is hoped to develop a large radio manufacturing industry to work present plants at full capacity and complete ten new plants, to cost 130,000,000 rubles, for manufacture of sets, tubes, amplifiers and batteries. In Russia there are now only sixty-two radio stations, but twenty-nine new stations are now building.

"URSI" at Washington, April 27—A joint meeting of the American Section of the International Scientific Union and the Washington Section, Institute of Radio Engineers, will be held at the National Academy of Sciences, 2100 Constitution Avenue, Washington, D. C., beginning 10 a.m. Friday, April 27. Dr. J. H. Dellinger of the Bureau of Standards, is vice-chairman of the American Section of URSI. Following are the papers to be presented:

The development and characteristics of 9-cm radiation. C. R. Kilgore (Westinghouse Company).

Vacuum tubes for generating frequencies above one hundred megacycles. C. E. Fay and A. L. Samuel (Bell Telephone Laboratories).

Facsimile radio observations during the 1932 eclipse. E. F. W. Alexanderson (General Electric Company).

Notes on propagation at a wavelength of 73 centimeters. B. Trevor and R. W. George (Radio Corporation of America).

Some recent work on the ionosphere in Canada. J. T. Henderson (Canadian National Research Council).

Studies of the ionosphere by multifrequency automatic recording. T. R. Gilliland (Bureau of Standards).

Ionosphere measurements at low altitudes. L. V. Berkner and H. W. Wells (Carnegie Institution of Washington).

High frequency ammeter. H. M. Turner (Yale University).

The thermal method of measuring the losses in a vacuum tube. F. P. Cowan (Harvard University).

Frequency standard and monitor stations of Canadian Radio Commissions. Col. W A. Steel (Canadian National Research Council).

A method of measuring noise levels on short-wave telegraph circuits. H. O. Peterson (Radio Corporation of America).

Relative daytime intensities of atsmospherics. K. A. Norton (Bureau of Standards).

Developments in automatic sensitivity control. G. E. Pray (Signal Corps Laboratories).

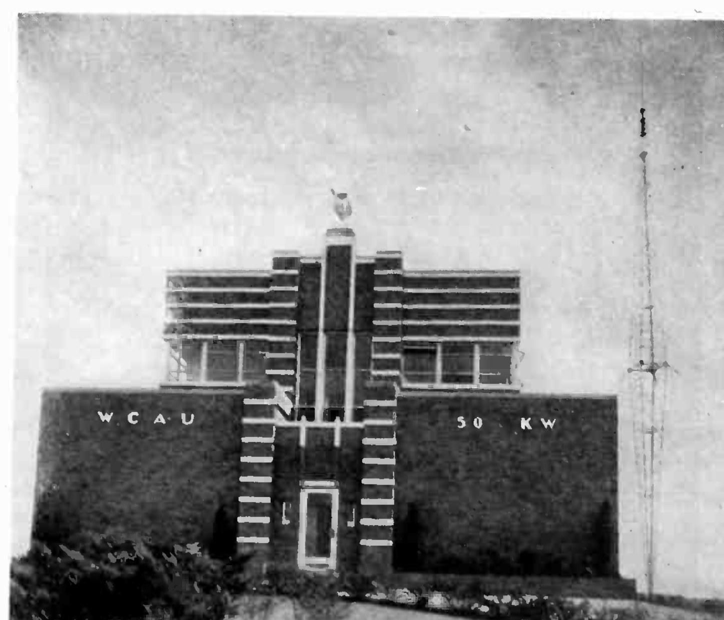
Phase angle of vacuum tube transconductance at very high frequencies. F. B. Llewellyn (Bell Telephone Laboratories).

A new method of obtaining the operating characteristics of power oscillators. E. L. Chaffee and C. N. Kimball (Harvard University).

A short-cut method for calculation of harmonic distortion of modulated radio waves. I. E. Mouromtseff and H. N. Kozanowski (Westinghouse Company).

Space-charge effects in piezo-electric resonators. W. G. Cady (Wesleyan University).

STYLING THE TRANSMITTER HOUSE, TOO



With the artists and stylists who have streamlined the nation's automobiles now at work on the radio sets, it remained for Dr. Leon Levy, owner of WCAU, Philadelphia, to apply modern design to the exterior of his new 50-kw transmitter house, also.

Police radio communication

[*Continued from page 76*]

Variable condensers have proven very troublesome in keeping this adjustment, particularly in superheterodyne design. The familiar "book" type is almost universally used; these have a mica dielectric and are kept in adjustment by constant tension present on the phosphor bronze adjusting plate.

With such control there need be only volume control and "off-on" switching in the control mechanism located on the steering column; in some cases these are located on the chassis itself where mounting is convenient.

Station and motorcycle receivers

Generally the operational features governing design of the station receiver are the same as for the mobile police unit. Economy is of course not so important since such receivers operate from relatively cheap 110 volt a-c power. In outlying districts, however, where the receiver must be operated at fairly high sensitivity noise enters by the antenna and over the electric lines. Since the receiver must operate throughout the whole day this noise must be constantly endured and may prove somewhat disagreeable. A form of automatic volume control has been devised to care for this difficulty. Its action is that of a very sharp valve so adjusted that it snaps from practically "off" position of the receiver to full sensitivity directly the signal frequency is received. Adjustment is such that transient noise impulses even of greater magnitude than the signal impulse do not trip the circuit and quiet operation between signals exists.

The latest developments indicate encouraging progress toward ultimate two-way communication between station and patrol cars. Advantages of such operation at frequencies around 10 meters are:

1. The facilitating of "answer back" by the patrol car and through keeping constant control of all patrol car movement. An efficient and workable transmitter of these frequencies can be installed in a movable car whereas at lower frequencies this would not be feasible. 2. Confining the range of transmission to a local area thus simplifying the allocation of zone frequencies and eliminating interference with other zones on the same frequency. 3. Low-power transmitters may be used with very good coverage; complete interlocking of a municipal system is possible through a radio central telephone connection to outlying district transmitters covering particular areas.

The value and utility of police radio communication may well be reviewed in the figures issued by the F. R. C.'s report for April, 1932. Of 50 large cities using radio one arrest was made for every ten calls broadcast and an average of $250.00 worth of property was recovered per department per day. The efficiency of supervision and betterment of personal safety is undoubtedly improved with radio as a communicating link. Economy is ten-fold enhanced when we note that one car with two patrolmen can cover 10,000 people swiftly and expeditiously whereas under foot patrol supervision one man is allowed for, on the average, 600 inhabitants.

The same figures approximately apply to 12 cities of less than 100,000 people with the added inference that suburban areas are even more efficiently covered. Where the population is thinly spaced radio controlled automobile cruisers give infinitely closer supervision than the old foot patrol.

■ ■ ■

High frequency filters

[*Continued from page 85*]

The coils used in the construction of high frequency filters such as these are especially designed to obtain a high Q over the desired pass band and also so as to be little affected by changes in temperature and humidity. The air condensers are especially designed to obtain a very small temperature coefficient and so as not to change their setting while being locked in position. The fixed condensers used have one set of plates completely shielding the other plates and capacities to ground.

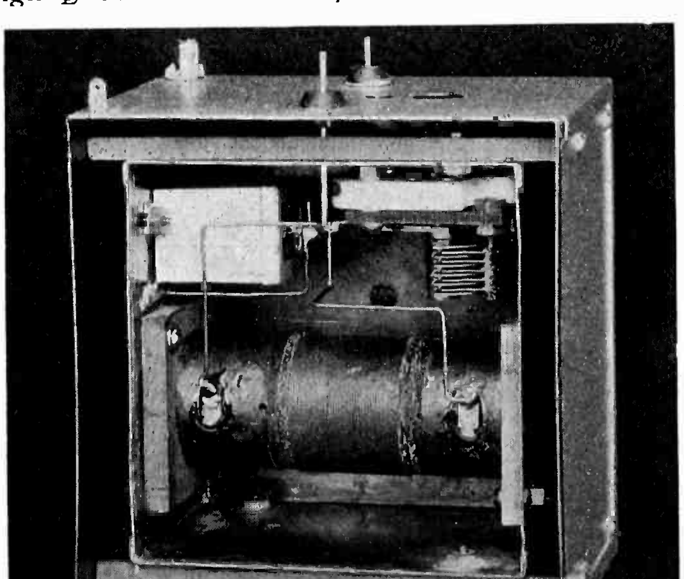


Fig. 7—One of the double-shielded series arms of the filter (Figure 8, Number 1)

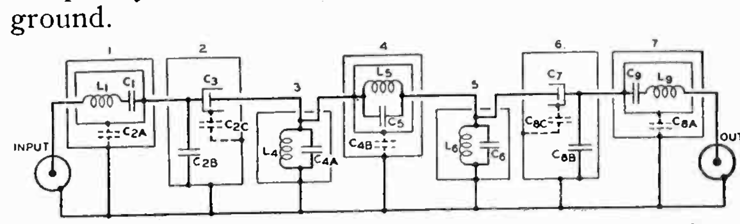


Fig. 8—Final filter circuit with desired characteristics

Parts of typical filters built according to this schematic are shown. To reduce interference, the connections between the impedance arms of the filter are made by means of very short straps, and the connections to the input and output of the filter are made by means of coaxial conductors.

The measured characteristics of filters built according to these principles have closely approximated those theoretically calculated. Filters such as those just described offer a promising means of making available for high quality message transmission an increasing range in the frequency spectrum.

[1]Mathematically, by equating the open and short-circuit impedances of the two structures; see "Transmission Networks and Wave Filters," by T. E. Shea, p. 327. (D. Van Nostrand Co., New York.)

[2]Or in series with a positive capacitance of smaller absolute value.

++ BOOKS ++

FOR ENGINEERS USING ELECTRON TUBES

Electrons at work

By C. R. Underhill, 1933. McGraw-Hill Book Company, New York. (320 pages, 220 illustrations. Price $3.)

IN THIS BOOK MR. UNDERHILL has rendered an important service to all engineering and lay readers who wish to "catch up" on the new developments built around the electron and electronic devices. For the man who wants to clarify his understanding of the teeming new art and science of electronics, this volume goes back to the fundamentals and gives the student a fresh start on his grasp of basic electron phenomena, so that he is equipped to understand the commercial and industrial applications that are also described in the book. It is this fortunate arrangement, and the simplicity of presentation of technical and physical facts, that will make the book especially serviceable to a wide audience of readers.

Manufacturing executives will find here an enumeration of the ways electronic devices can improve production and effect economies. Practical men who want to prepare themselves for an understanding of industry's new tools, will get many stimulating suggestions from the chapters. The author has succeeded in his effort to "take the mystery out of electronics." The appearance of the book constitutes a milestone in the more general understanding of electronic methods and the possibilities ahead.

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Elektrische gasentladungen, ihre physik und technik

By A. V. Engel and M. Steenbeck. Julius Springer, Berlin. Price 24 r.m.

IT IS KNOWN THAT the introduction of gas into a radio tube or phototube, or the presence of vapor in the thyratron leads to the complication that positive ions are produced by swift electrons hitting the gas molecules and also by other agencies so that both electrons and ions travel towards the electrodes where they give off their charges. The book is accordingly divided into three parts: (1) the production of electrons and ions (140 pages; (2) the motion of the charges among the neutral atoms (60 pages) and (3) the neutralization of the charges (20 pages).

As an introduction to the first section of the book, the laws of impact between neutral particles of different mass and velocity are discussed, a novelty in a book dealing with electric discharges and perhaps not of immediate usefulness. The experimental results obtained in the work on ionization by fast charged particles in the field-free space as well as in electric fields, ionization by ultra-violet and X-rays in gases and from solid boundaries, and thermal ionization are then taken up with a thoroughness that leaves little to be desired. No attempt is made, however, to establish a connection between the ionization by a beam of electrons and the ionization in a mixture of electrons and ions (Townsend discharge) as little progress has been made in this field. The very precise treatment of the problem of thermal ionization is quite unusual and welcome in view of the part which engineers have assigned to it in arc discharges.

While the material in the first part is presented more or less along conventional lines, the section on the motion of the charges is novel in its logical arrangement of the material. It is the more to be regretted that little is said in this place about Langmuir's investigations.

The much shorter section on recombination reflects the scarcity of information on this subject; it is also known that the part it plays in discharges is less important than was formerly thought.

Of the 30 tables and 120 figures given in the book at least 30 are new, 20 have been taken over or adapted from articles published in 1931 or 1932, and close to 50 relate to information published within the past five years. The insistence upon the most recent contributions is certainly a welcome feature although there is some danger that unconfirmed results range themselves side by side with established facts. Thus there are discrepancies not only between Figs. 12 and 13, but also between these figures and Fig. 11 and tables 2 and 3, and it is also somewhat difficult to reconcile Figs. 16 and 17.

The book unlike others in this field is more than a reliable compilation of the recent information, and is well worth its price. It does not hide difficulties where they are important and gives a vivid picture of the world of the light electrons and that of the heavy ions.

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Braunsche Kathodenstrahlroehren und ihre anwendung (Cathode ray oscillographs and their uses)

By E. Alberti, Julius Springer, Berlin. 214 pages, 158 figs. Price $5.10.

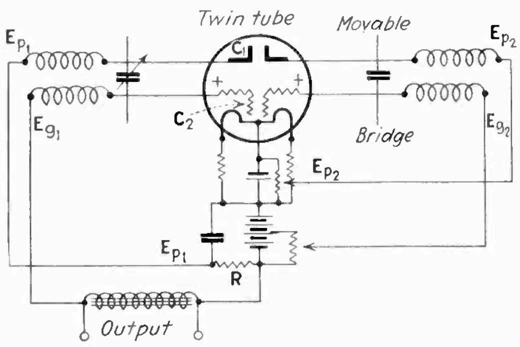
THE INTRODUCTION TRACES step for step—the author is an official of the patent office—the development of the cathode ray tube. It dates from the year 1897 when J. J. Thomson succeeded in showing that the discharge obtained in a vacuum is deflected by an electrostatic field. In the same year Braun used the tube for studying the wave-form of alternating currents. In 1905 Wehnelt replaced the cold cathode by an oxide-filament. Since then the frequency response and the sensitivity have been steadily improved.

In the second chapter the methods used for recording or rendering the trace of the beam visible are discussed on the basis of the most recent scientific investigations on the blackening of photographic plates by electrons.

The different types of construction are described in the third part as far as they differ in principle, and the means by which the beam can be concentrated are discussed. Nearly 50 pages are then devoted to the methods of obtaining a time deflection axis for continuous recording of wave shapes. In the fifth and last chapter a number of applications are illustrated; studies of high frequency waves, magnetization curves, power factors, resonance curves, tube characteristics, modulation, location of faults in cables and television, many of these uses having been described in *Electronics*. The book, the first treatise on cathode ray tubes or electronic oscillographs is remarkably complete, giving 292 references to the literature (among which Appleton's name is missing, however), but its high price is a disadvantage. It might have gained in usefulness had a section on standard tubes been added.

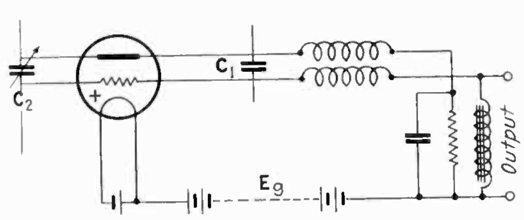
Barkhausen circuit for ultra-short wave reception

[H. E. HOLLMANN, Heinrich Hertz Institute, Berlin] Tubes with highly positive grid have often been used near the point where they break into oscillation for detecting ultra-short waves without paying attention to the details of its working. When the E_p-I_p char-



First tube is adjusted to give good detection; second tube works near resonance

acteristics of a tube with reversed electrodes are plotted it is seen that detection is due to the curvature of the characteristic and effective at very high as well as at ordinary broadcast frequencies. The resistance offered by the plate grid space, which is the seat of the rectified potential, is of the order of a few thousand ohms, and the load inserted into the plate filament lead ought not to exceed this value. It is indeed better to take the output from the grid filament circuit which is near saturation (infinite resistance). Grid potential and heating current have a marked influence upon



Ultra-short wave circuit with output in grid-filament path

the output for two reasons: first, because of the possible approach to resonance at various frequencies, and second, on account of possible feed back. The two effects add to the amplification, but do not go hand in hand, and the best solution is to use two separate tubes, one working near resonance, the other near regeneration, or two separate electrode systems in the same tube. The result is a ten to hundred fold increase in strength.—*Hochfr. El. Ak. 42: 89-99. 1933.*

The crystal oscillator of Pierce

[K. HEEGNER] The paper contains a treatment of the "linear theory" of a crystal oscillator. Experiments were conducted to show that the variations in grid-cathode-capacity, depending upon space charges, cause fundamental discrepancies with the "linear theory." It is concluded that the deductions from this theory are not sufficient to describe the observed phenomena.—*Elektr. Nachr. Technik, 10,* 357-71, 1933.

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Harmonic distortion and characteristics of amplifying tubes

[A. GEHRTS, Laboratory of German Post Office] In contrast with vacuum tubes having filaments of pure tungsten, tubes with oxide-coated or thoriated emitters give slightly curved characteristics, and when expressing the plate current changes as a function of the grid voltage changes in a Taylor series, it is necessary to take into account the second derivative with respect to grid and plate voltages. By reducing end losses the 3/2 law is closely approached. Deviations from the law are encountered in oxide coated filaments, where they are caused by the voltage drop across the oxide coating.

The curvature of the characteristic causes amplitude frequency distortion. The usual definition of harmonic distortion does not apply to the tube as it leaves out the combination tones produced when two frequencies act simultaneously upon the grid. It is preferable to use as a measure of distortion the percentage change of the grid plate conductance of the tube when it is carrying a load, or the harmonic distortion as usually understood multiplied by four times the reciprocal of the grid voltage amplitude.—*El. Nachr. Techn.* 10: 436-445. 1933.

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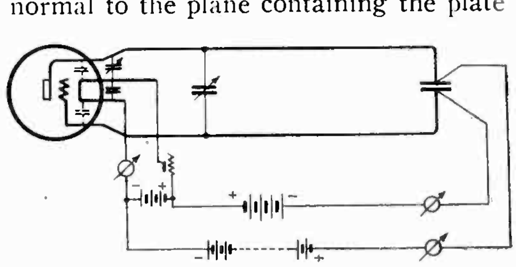
Variable oscillator (3-10 m) without choke coils

[G. RENATUS, Dresden Institute of Technology.] The main thing is to watch that no a-c potential differences exist between the points to which the d-c sources are connected (cathode, grid and plate) and between these points and the earth. The geometrical center of the wire loop connecting grid and plate is put to earth near the point where the condenser is inserted and where there is a voltage node. A large condenser is used. One side of the condenser is connected with the negative of the C battery, the other with the B battery or the corresponding sources. By adding a small variable condenser *C* between plate and filament or cathode, the filament to grid and the filament to plate capacity are rendered equal, forming a balanced bridge with the two half-loops serving as inductance. The frequency is varied by means of an additional variable condenser between plate and grid. The battery leads are placed in a plane normal to the plane containing the plate



and grid inductance. The negative end of the A battery is joined to the negative of the B battery and the positive of A to the positive of C.—*H. F. Techn. El. Ak.* 43:12-15 January, 1934.

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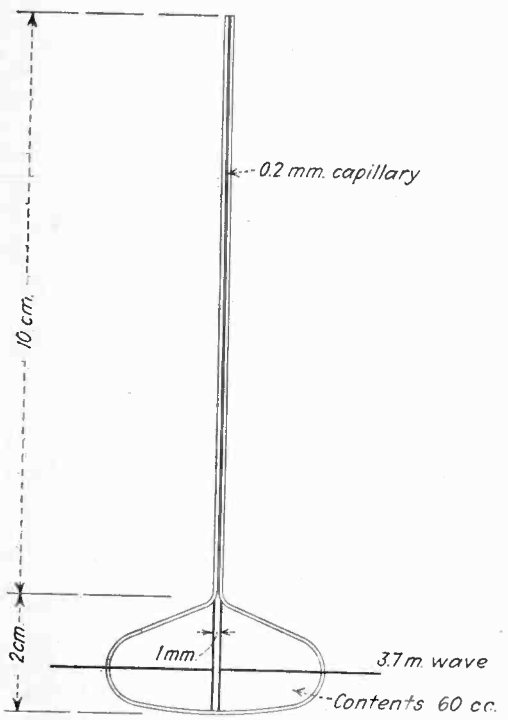
Copper cuprous oxide cells

[W. BULIAN, University of Berlin] To protect the cuprous oxide coating formed in a muffle furnace at 960 deg. C. upon copper sheets 4 by 6 cm., the hot piece of copper is placed in a graphite retort which contains powdered coal and is covered with coal. When its temperature has dropped to 100 deg. C. the piece is thrown into standing water, then bathed in a concentrated solution of potassium cyanide and etched for 30 seconds in 30 per cent nitric acid. A metal electrode is finally deposited upon the cuprous oxide by means of cathode sputtering at low pressure. The same disk is observed to give a reverse photo effect over part of its surface (mother copper taking on a positive charge), or an obverse effect (mother copper negative, see *Electronics*, October, 1932) over the remainder, depending upon the thickness of the metal film, but not when a mercury arc is used, suggesting, therefore, that the result is due, at least in part, to the absorption of light by the metal films. Silver coatings 0.4 millionths cm. thick upon cuprous oxide films 0.01 cm. thick are found to give the most consistent results.—*Phys. Zeits.* 34: 745-756. 1933.

Radio frequency losses in liquids

[(1) H. Haase, Laboratory of Physics University of Jena; (2) P. Debye, Laboratory of Physics University of Leipzig.] Strong absorption in liquids at certain ultra-short r.f. is caused as a rule by substances in which each molecule is a small dipole nearly free to move in the field of radiation traversing the liquid. Friction and inertia prevent



the molecules from completely following the rapid changes of the applied field and the lag produced causes losses and heating beyond that due to the mere passage of the current. Not being able to move in step the dipole molecules appear to have an average electric moment which depends on the time of relaxation, that is on the readiness with which the molecules are able to rotate in the liquid. Conversely, when the increase in temperature produced by the passage of high r.f waves is measured which are applied to two electrodes of 1 cm. radius and spaced 1 mm. in the bulb of a thermometer, the time of relaxation can be deduced from a theory developed by Debye for great dilutions of the dipole substance. Times of the order of one million millionth second result. Molecules in which the moment is compensated (para-dichlorobenzene) as against ortho-dichlorobenzene given no heating effect.—(1) *Phys. Zeits.* 35: 68-76. Jan. 15, 1934. (2) *Phys. Zeits.* 35; 101-106. Feb. 1, 1934.

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Factors affecting adoption of electronic control

[C. Stansbury, Cutler-Hammer, Inc.] The conventional magnetic relay has little competition to fear from the electronic relay (that is, relays using vacuum tubes), provided power of one watt or more is available and the permissible operating time not less than 1/20 sec. In power apparatus control by tubes seems to be limited either to very small or very large motors. A notable power application is resistance welding. Replacing regulating apparatus, such as field regulators, control by gaseous tubes is not advisable at present on account of the high price and the fairly frequent replacement of tubes. Electronic tubes extend the range of automatic control from a sequence of purely mechanical events to events depending on light and sound and other minute forces.—*El. World,* 103: 154-158, Jan., 1934.

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Synchronizing for television

[F. Okolicsanyi, Television Laboratory of the Tekade.] The sweep circuits for synchronizing lines and pictures represent an unnecessary complication of present-day receivers. The remedy is to use one sender having a frequency of 40 Mc. for the transmission of the picture proper (which requires a band 0.5 Mc. wide when there are 180 lines and 25 pictures), and a second sender having a frequency of 42 Mc. for carrying the sound and the two sawtooth waves for bringing pictures and lines into place. A saw tooth wave consists of the fundamental and an infinite number of overtones, but it will be sufficient to transmit only the frequencies below the thirtieth overtone. This represents a band between 25 and 800 cycles for the picture changes and a band between 4.5 and 140 kc. for changing the lines. The second transmitter is directly modulated with the broad frequency spectrum corresponding to the lines, whereas the second frequency is first composed with a 200 kc. wave, the picture frequency with a 250 kc. wave and then impressed upon the second sender.—*Ferns. Tonfilm* 4: 71-73. 1933.

News notes from England

Radio exports increasing. Official figures issued by the Department of Overseas Trade show that Britain is slowly increasing her radio export trade. From a 7.5 per cent share of the world radio trade in 1931 she has risen to a 12.5 per cent share in 1933. Of the four big radio exporting nations, only Britain and Holland have shown increases since 1931. The United States trade has fallen slowly and Germany's has dropped enormously.

One reason for the latter was the imposition of protective tariffs by Britain which resulted in an adverse radio trade balance of £1,120,000 in 1931 being converted to a favorable balance of £560,000 last year.

Philco expands. Extensions to their factory at Perivale, Middlesex, England, are a preliminary to an onslaught on the components market by the Philco Radio and Television Corporation of Gt. Britain Ltd.

A shadow tuning device at 15s., fixed condensers and resistors are already available to Philco agents. Several new valves are also on the way.

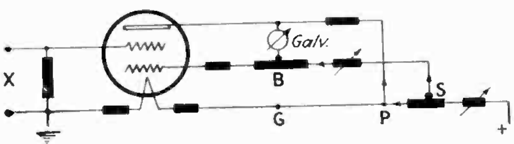
Carleton L. Dyer, the young Canadian-born managing-director of the British arm of the Philco company, left on a short visit to the United States on Thursday, Feb. 15. With him was Douglas Carrington, the chief designer of the Carrington Mfg. Co., who make Philco cabinets and are one of the biggest British cabinet makers.

Auto radio in England. A car radio produced at a cost of £10,000 is about to be placed on the British market by British Radiophone, the retail sales organization of the Plesszy Co. Ltd. It is known that the receiver is a superhet and that the control box on the steering column itself contains the miniature tuning condensers. Other details are still secret. Twelve months' research, during which 300 models have been built and destroyed, are said to have preceded the final receiver, which has now been on test three months.

Export trade chart compiled by British Department of Overseas Trade

Compensated d-c amplifier

[G. Barth, Laboratory of Physics, Dresden Institute of Technology.] As in Soller's improved circuit the proper control grid bias and plate potential (for the FP-54 or an equivalent tube T-113) are obtained by tapping off from the resistances which are in series with both sides of the filament. The control grid operates at a positive potential (space charge grid) the current which it draws being several times as large as the plate current. Over a certain range plate and



grid current have a constant ratio when the filament current fluctuates so that the grid current (in place of the filament current) can be balanced against the plant current. When the resistances are removed from the space charge circuit and the lead shifted from S to G, and the plate lead P to S, the simple bridge circuit is obtained; this circuit is always used in setting up the compensated arrangement. When point P is shifted to S the compensated circuit becomes practically identical to the Du Bridge and Brown circuit and the same equations apply. See *Rev. Scient. Instr.* 4: 432-536, 1933.—*Zeit. Phys.* 87: 399-408. 1934.

Receiving tubes with high internal resistance

[M. J. O. Strutt, N. V. Philips' Research Laboratory. Eindhoven.] The curve showing the plate current against the grid voltage E for variable tubes is most simply represented by a sum of a few exponential functions Ae^{bE}. Various forms of distortion produced in tubes with a very high internal resistance such as harmonics of low frequencies of carrier waves (whistling), cross-modulation and detection giving a second intermediate frequency are readily calculated. Among the examples given is the behavior of the detector to the grid of which is applied the frequency of the local oscillator together with a carrier frequency of amplitude E, the plate circuit being tuned to the difference between the two frequencies. The ratio of the a-c plate current to E is computed and found to be in agreement with experiment. The exponential functions are conveniently expressed as series of Bessel functions of increasing order.—*H. F. Techn. El. Ak.* 43: 15-22, Jan. 1934.

New British television system

A new television system in which two principles, divergent until the present, have been united, was described before the British Institution of Electrical Engineers on February 7 by two members of the research laboratories of A. C. Cossor Ltd., the tube makers.

The engineers, L. H. Bedford, M.A., and O. S. Puckle, told how they investigated the possibilities of variable-speed scanning and were impressed by the comparative simplicity of the system. Lack of detail in the darker parts of the image, however, led them to introduce a degree of intensity modulation.

In the final system, a film is scanned by a light spot from a cathode ray tube. On the other side of the film is a photocell which provides a modulated output. This output is fed back to the time base circuit of the cathode ray tube. The result is that the ray "lingers" over the bright parts of the film—the parts where there is most detail—and hurries over the darker, more obscure areas.

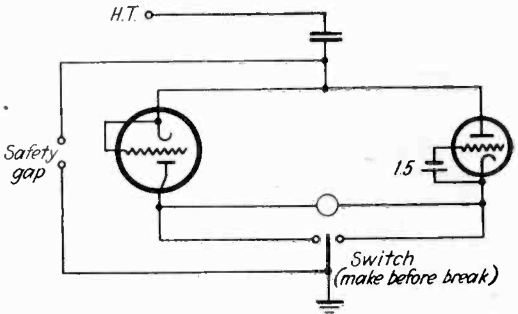
It was found, however, that as soon as a high contrast ratio was attempted the loss of detail in the dark places became objectionable and it became impossible to obtain a satisfactory transition without using an unduly wide frequency band. The solution the engineers found was to transmit a velocity-modulated picture at low contrast level and superimpose intensity modulation upon it at the receiving end.

The full advantage of the brighter light intensity given by velocity scanning is retained because light is only taken from the darker parts of the picture.

Although so far an ordinary cathode ray tube has been employed, the engineers state that the system has reached a practical footing. A special tube designed to avoid the origin distortion effect and to have a shorter after-glow is now being developed.

The rectifying peak voltmeter

[A. S. Starr, Research Laboratories of Callender's Cable and Construction Co., London.] The use of bias batteries in series with each triode suppresses the emission current, and over-biasing, far from being undesirable, reduces the errors caused by the tube impedances to a very small amount. The high voltage is applied across the air condenser and the parallel arrangement of the two vacuum tubes which are of the indirectly



heated type. In one tube the grid is connected to the cathode while in the other a grid-bias of about minus 1.5 volt is used, although 1.1 volt would be sufficient to interrupt the flow of current. The over-biased voltmeter will read accurately from 2,000 to 500,000 volts with a condenser of 246 $\mu\mu$f. With 2,000 volts the galvanometer reads 70 μa., the condenser current is 155 μa. (r.m.s.) and the voltage across the diodes about 15.—*Proc. Phys. Soc. London*, 49: 35-46, Jan., 1934.

PRESIDENT ROOSEVELT RECOMMENDS A FEDERAL COMMUNICATIONS COMMISSION

To the Congress:

I have long felt that for the sake of clarity and effectiveness the relationship of the Federal Government to certain services known as utilities should be divided into three fields: Transportation, power, and communications. The problems of transportation are vested in the Interstate Commerce Commission, and the problems of power, its development, transmission, and distribution, in the Federal Power Commission.

In the field of communications, however, there is today no single Government agency charged with broad authority.

The Congress has vested certain authority over certain forms of communications in the Interstate Commerce Commission, and there is in addition the agency known as the Federal Radio Commission.

I recommend that the Congress create a new agency to be known as the Federal Communications Commission, such agency to be vested with the authority now lying in the Federal Radio Commission and with such authority over communications as now lies with the Interstate Commerce Commission—the services affected to be all of those which rely on wires, cables, or radio as a medium of transmission.

It is my thought that a new commission such as I suggest might well be organized this year by transferring the present authority for the control of communications of the Radio Commission and the Interstate Commerce Commission. The new body should, in addition, be given full power to investigate and study the business of existing companies and make recommendations to the Congress for additional legislation at the next session.

Franklin D. Roosevelt.

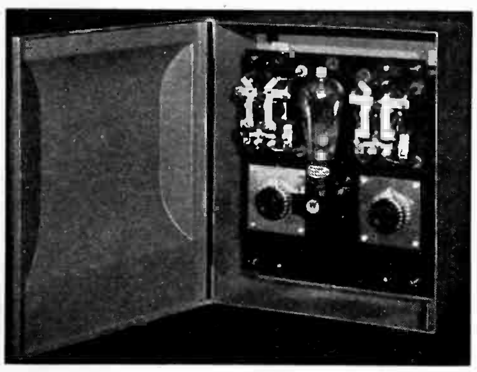
The White House, *February 26, 1934.*

+ NEW PRODUCTS

THE MANUFACTURERS OFFER

Electronic timer

WESTINGHOUSE announces its Type HA electronic timer which measures out a present length of time and closes or opens its contacts for that time after the initiating impulses given from a push button, foot treadle, or cam-operated switch. The device is used for such operations as the timing of spot and projection-welder current flow, X-ray timing, and other similar applications requiring an easily adjustable and accurately maintained time delay. The time measured out is continuously



adjustable from 1/10 second to 45 seconds. It can be applied to any spot or projection welding machine now in service which is equipped with a magnetic main contactor. The electronic timer is unusually rugged, as the industrial grid glow tube is designed for sturdiness and long life and operates the contactor directly without delicate intermediate relays. The grid glow tube is free from any effects of wide temperature changes.

The contactor in the unit has a contact capacity of 10 amperes at 115 volts and 5 amperes at 220 volts alternating current.—*Electronics.*

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Auto-radio plate supply

THE PIONEER GEN-E-MOTOR CORPORATION of 1160 Chatham Court, Chicago, Ill., has just announced a new rotary power supply device for auto-radio receivers, declared to be the smallest power supply unit that has ever been offered to manufacturers, regardless of type.

Of like importance is the fact that its output voltage is unidirectional and flat except for a commutator ripple that is only several per cent of the total voltage. Thus the filtering problem is simple, requiring small condenser cost and assuring a very smooth voltage that allows excellent audio reproduction. —*Electronics.*

Vibrator-type converter

THE KATO ENGINEERING COMPANY, Mankato, Minn., has just placed its new vibrator-type 32-volt Konverter on the market. This unit is very efficient —drawing about $2\frac{1}{2}$ amperes from a 32-volt lighting plant when operating a radio set with rated consumption of 70 watts. The vibrator assembly is separately housed and easily accessible for adjustment. It is so simple in construction that it can be serviced by the user by following the instruction manual furnished with each Konverter.

Tests that have been given the vibrator points indicate that they will last easily from 1,500 to 2,000 hours.

The list price is $29. The Konverter comes complete with attachment cord and radio receptacle—making it unnecessary to do any wiring to install. This Konverter is recommended for sets requiring 80 watts or less.—*Electronics.*

✦

B eliminator

DECLARED TO BE THE SMALLEST rotary type B eliminator ever designed with full power output, the new unit now being placed on the market by the Carter Motor Co., 361 West Superior St., Chicago, is only $2\frac{7}{8}$ in. wide, 4 in. high, and 5 in. long, and weighs $6\frac{1}{2}$ pounds. Being so compact and light in weight, it can be easily placed in either the radio set or speaker case. The unit is completely enclosed and shielded and requires no adjustments whatever. It is priced at $16.50.

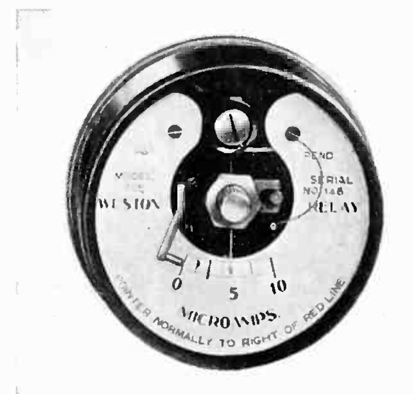
The new type thrust ball bearings used do not require oiling, and permit the unit to operate at highest efficiency in any position.

The unit consists of a newly designed motor-generator with a reflex filter circuit and operates from a 6-volt storage battery delivering voltages up to 350.

When used as an Auto B Battery Eliminator, separate filters and chokes are not required as the new reflex filter system uses the motor field coil for part of the filter.—*Electronics.*

Supersensitive relay

THE WESTON ELECTRICAL INSTRUMENT CORPORATION of Newark, N. J. announces a new Model of Supersensitive Relay that has many fields of application. This is known as Model 705.



The relay will make contact on values down to three microamperes or one millivolt and its contacts are capable of handling five watts at 110 volts.

This relay will have many applications when used with the Weston Photronic Cell for industrial control purposes and when used with thermocouples for the control of temperature in electric furnaces.—*Electronics.*

✦

Crystal microphone

THE BRUSH DEVELOPMENT COMPANY, 3715 Euclid Avenue, Cleveland, Ohio, has placed on the market a new crystal microphone designed particularly for use on the stage in theatres, schools, etc. The microphone is small, and is so designed that a number can be strung along the stage by the footlights. It is particularly recommended for large theatres where four to six of these can be used in two groups operating through separate amplifiers and loudspeakers in order to produce the so-called "binaural" type of sound reproduction.

The output level of the microphone is such that it can be used with the ordinary two-stage preamplifier and power amplifier or can be used directly into a high gain amplifier. Used in this way as a booster system for the stage production, it is extremely effective in aiding sound reproduction in large theatres and auditoriums, especially in such places where the acoustic properties are not of the best quality. Tests have shown that the microphone is extremely sensitive to sounds produced on the stage and has a very wide pickup range. Inasmuch as it is set flat on the floor, it is thus provided with an infinite baffle.—*Electronics.*

High-frequency magnetic material

THE NEW MAGNETIC core material, Ferrocart, which has caused wide comment abroad, will soon be available on production in the American market. In Europe it is now used by twenty-four licensees among leading radio-set and coil makers in eleven countries.

Ferrocart is an iron core material made by a unique process which gives it extremely high efficiency, favorable permeability and very low core losses, with advantages for intermediate frequency and carrier frequency coils.

Offices have been opened in New York City by an American company for the purpose of placing Ferrocart promptly on a production basis and in the proper form and design for direct application in American types of high frequency coils.

Full information may be obtained from the Ferrocart Corporation of America, 12 E. 41st Street, New York City.—*Electronics.*

✦

Resistor

D. T. SIEGEL, general manager Ohmite Manufacturing Company, 636 N. Albany Ave., Chicago, Ill., announces a new radio resistance unit, known as the Wirewatt, having a one-watt rating. It is the same size as the ordinary one-watt composition unit and may be used both in original equipment and for replacement work where the resistance value is not over 25,000 ohms.

Tests conducted by independent radio engineers show that wire-wound units are preferable as they have no temperature or voltage characteristics, and are absolutely noiseless under all conditions. These tests also show that in resistors below 30,000 ohms the inductive effect is so slight that it may safely be disregarded in all broadcast receiver circuits.—*Electronics.*

✦

Theater amplifier

THE WHOLESALE RADIO SERVICE COMPANY, 100 Sixth Ave., New York City, announces a new theater amplifier known as the Lafayette Model P15763.

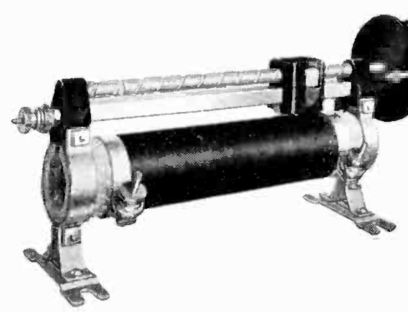
This is a four-stage job using a '57 in the first stage, a '56 in the second stage, a '59 in the third stage and two '59's in push-pull in the output stage. Resistance coupling is employed between the first and second and second and third stages. Class "B" transformer coupling is used between the third stage and the output.

There is provision for smooth changeover from one projector to another and the amplifier also has a very efficient gain control. If a microphone is to be used, this is wired up with a standard mike input stage and one of the wires from the input stage is connected to the ground terminal of the amplifier and the other to the cap of the 57 tube. The amplifier is furnished with shielded leads which fit in the shielded receptacles at the side wall making connection to the photo cells of the projectors. Incorporated within the amplifier is a fusing arrangement which takes care of underwriters requirements in theaters.—Price, without tubes, $74.50.—*Electronics.*

✦

Sliding-contact rheostats

WARD LEONARD ELECTRIC COMPANY, Mt. Vernon, N. Y., has designed its new sliding-contact-tubular rheostats for the accurate control of currents up to 25 amperes. The rheostats are arranged for potentiometer connection



and may be obtained with non-inductive or tapered resistance windings.

Three sizes—8 in., 16 in. and 20 in. lengths—cover very wide range of resistance values. A feature of the latest design is its single-point silver contact. Rheostats equipped with micrometer drive are provided with a clutch which readily permits single hand adjustment of the slider.—*Electronics.*

✦

Carbon and condenser microphones

A COMPLETE LINE OF microphones and electro dynamic sound equipment has been brought out by The Lifetime Corporation of 1306 Dorr St., Toledo, Ohio. Representation of the line is Model No. 88, a double-button carbon microphone, finished in chrome plate. This model is 3 in. in diameter, 1½ in. thick and weighs 1½ lb. It has a stretched duraluminum diaphragm 0.002 in. thick, gold spots, gold contact buttons of 200 ohms each, 80-mesh carbon granules, and a frequency response of between 30 and 7,500 cycles within 4 DB. This model is especially recommended for public-address work, music reproduction and general broadcasting. Price to trade, $9.95.

The No. 77 condenser microphone and amplifier uses a hard duraluminum diaphragm, 0.001 in. thick. The head amplifier is housed in a black crystal cylinder. Price to trade, $37.50. — *Electronics.*

✦

Test instruments

NEW UNITS FOR TESTING, locating and determining causes of trouble in radio receivers, audio amplifiers or any type of apparatus which employs vacuum tubes, have been designed by the Sound Engineering Corporation, 416 N. Leavitt St., Chicago, Ill. Each unit is a complete self-contained and highly useful instrument in itself and all through combine to form the very latest thing in analytical test sets.

The No. 90 test unit is a multi-range universal A.C.—D.C. voltmeter, milliameter and ohmeter, providing 7 voltage ranges and 3 resistance ranges as well as means for measuring inductance, capacitance and impedance.

The No. 91 analyzer effectively utilizes the extraordinary versality of the No. 90 tester in providing a simple, direct point to point suitable for rapidly testing and locating trouble in radio receivers, audio amplifiers and vacuum tube apparatus in general. It also provides means for tube testing. Every critical point in the set under test can be separately checked—that is, voltage, current and resistance conditions at any critical point can be directly determined.

The No. 92 oscillator is a modulated *electron coupled* signal generator, 110 volt A.C. and covers frequencies 90 to 1,600 KC without use of harmonics. When required, harmonics may be used to cover the higher frequencies.—*Electronics.*

✦

Suppressors for auto radio

A COMPLETE NEW LINE of molded bakelite suppressors is now offered by Continental Carbon, Inc., of Cleveland, Ohio. In addition to all standard terminal designs, Continental has a new Flexo-Terminal universal suppressor with a spring bronze spark-plug connector that may be bent to allow easy installation on any motor. Thus, a receiver shipped from the factory with Flexo-Terminal suppressors may be installed on any car without the dealer having to exchange or stock any special suppressor types.—*Electronics.*

✦

Tracer for radio interference

A NOISE LOCATOR designed to meet the need of public utilities, municipalities, manufacturers and engineers for a portable instrument to be used in tracing radio noise to its point of origin and in locating such line faults as give evidence of their presence by causing radio-frequency disturbances has been announced by the Tobe Deutschmann Corporation, Canton, Mass. — *Electronics.*

U. S. PATENTS

IN THE FIELD OF ELECTRONICS

Electron Tube Applications

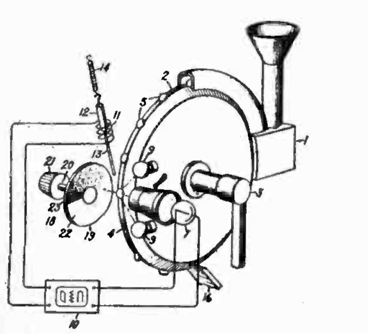
Interval timer. A short interval timer comprising two photo-electric tubes, vapor electric discharge device, etc. For a description see *Electronics,* October, 1932. H. W. Lord, G. E. Co. No. 1,946,290.

Cathode ray tube device. Method of using cathode ray beam as a source of electromotive force. W. P. Mason, B. T. L. No. 1,946,223.

Flaw detector. Method of using a rectifier-amplifier for detecting flaws in tubular hollow conductors such as lead sheaths of cables, by passing current through the cables and detecting variations in the current caused by fissures. F. D. Braddon and F. H. Shepard, assigned to Sperry Products, Inc. No. 1,946,189. See also 1,946,196, also to the Sperry Products, Inc.

High frequency apparatus. Equipment for therapeutic and sterilization purposes employing two oscillators. P. C. Rawls, Technical Equipment Co. No. 1,945,867.

Sorting system. A photoelectric device for sorting objects. W. D. Cockrell, G. E. Co. No. 1,945,395.



Light control. Photoelectric system for regulating the amount of illumination in a given area contributed by several light sources. F. W. Lyle, W. E. & M. Co. No. 1,944,751.

Magnetic testing. The property of a magnetic material is tested by bringing an oscillating circuit to a condition approaching resonance, introducing a piece of the material to be tested into the field to vary the tuning of the circuit, and detecting such variation in the tuning. W. A. Mudge and C. G. Bieber, Huntington, W. Va. No. 1,943,619.

Amplification, Rectification, etc.

Filter system. Across the choke of a filter system is a variable condenser and variable resistor to maintain current through an amplifier tube free from pulsations. B. F. Miessner, assigned to RCA. No. 1,947,218.

Pentode circuit. A reactive impedance in the screen grid circuit to counteract the effect of a load in the plate circuit whose impedance decreases with increasing frequency. R. A. Braden, RCA. No. 1,947,184.

Neutralizing circuit. Method of and means for reducing retroactive currents in a three-electrode amplifier. Stuart Ballantine, application April 3, 1923. No. 1,946,662.

Directional circuit. Receiving antenna comprising a principal and auxiliary antenna each a half wave length long, a three-winding transformer, etc. Edmond Bruce, B.T.L. No. 1,947,247.

Modulation system. Method of using a cathode ray tube having an anode provided with several circularly arranged openings therein and means for deflecting a beam of rays from said cathode in a circular path across the opening, which comprises varying the diameter of the circular path at a modulating frequency to vary the proportion of beam intermittently passing through the openings. R. M. Heintz, assigned to Heintz & Kaufman. No. 1,941,303.

Push-pull amplifier. A neutralized push-pull amplifier in which a capacity goes from the anode of each tube to the grid of the other to neutralize the grid-plate capacity. Application June 5, 1926. G. M. Wright and S. B. Smith, R.C.A. No. 1,940,986.

Hum eliminator. Method of connecting between the positive plate voltage supply source and the center point of the filament system, a variable resistance, capacity and inductor. B. F. Miessner, R.C.A. No. 1,940,723.

Oscillator. A method of balancing out undesired changes in frequency arising out of changes in applied potential. V. J. Andrew, W. E. & M. Co. No. 1,940,833.

Frequency modulation. Method of straightening the sides of the resonance curve of the analyzing circuit tuned to a frequency at one side of the main frequency of a frequency-modulated wave, in a frequency modulation detector to obtain linear response, which includes regeneratively coupling the input and output circuits of the detector with respect to the radio frequency energy. C. W. Hansell, R.C.A. No. 1,938,657.

Band pass amplifier. An interstage coupling system in the tuned circuit having tuned primary and secondary coils coupled to produce a double hump characteristic and having a low amount of damping, and a second pair of tuned circuits combining with the first to produce an amplifier over-all band characteristic substantially flat. K. Posthumus and T. J. Weyers, R.C.A. No. 1,938,639.

Power Applications

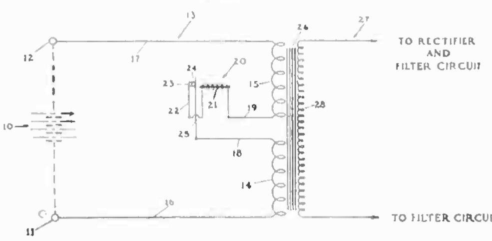
Electron tube commutator. For transmitting energy between direct and alternating current circuits under any desired power factor conditions. A. H. Mittag, G. E. Co. No. 1,946,292.

Regulating system. Speed control device for a direct current motor using gaseous three-element tube. L. R. Quarles, W. E. & M. Co. No. 1,944,756.

Voltage regulator. An a-c generator energized from a d-c generator. The frequency of the a-c from the alternator varies directly as the speed. Rectifier connected to the output of the alternator, having an input circuit tuned to reject frequencies below the normal operating frequency of the alternator as a means of maintaining the output voltage of the generator constant. L. A. Hyland, assigned to Eclipse Aviation Corp. No. 1,943,320.

Commutator. Two patents, No. 1,943,904 and 1,943,905, to B. C. von Platen and G. A. Grubb, Stockholm, Sweden, on an electron tube means of commutating a generator.

D-c a-c system. A method for producing alternating current from a direct current source comprising a transformer with a tapped primary in which is inserted a mechanical circuit interrupter. D. H. Mitchell, assigned to P. R. Mallory & Co., applied for Sept. 27, 1932. No. 1,943,183.



Phase shifting device. An electron tube method of continuously shifting the phase of an alternating current. W. A. Marrison, B. T. L., Inc. No. 1,942,483.

Interference rejector. A method of reducing undesired response in superheterodyne reception produced by the heterodyning of at least two undesired carriers differing by substantially the operating intermediate frequency. W. S. Barden, R. C. A. No. 1,944,117.

Negative resistance circuit. Dynatron having a capacitive load, capacity coupling, plate and control grid, etc. P. O. Farnham assigned to R. F. L. No. 1,943,471.

Voltage regulation. Application of a three element tube in a circuit combined with a source of a.c., a load, a transformer interposed between load and source, in which the voltage varies as a function of the load. L. H. Von Ohlsen and F. W. Godsey, assigned to Safety Car Heating & Lighting Co. No. 1,943,463. See also 1,943,464.

Electron Tubes, etc.

Tube tester. Plate and filament circuits are energized from an a-c source and the magnitude of plate current is read for various grid alternating voltages. J. C. Daley, Jewell Instrument Co. Aug. 10, 1925. No. 1,945,802.

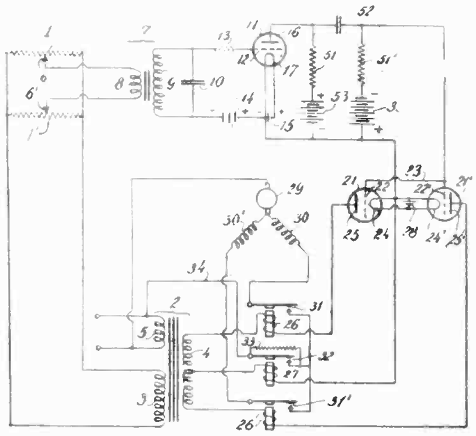
Cathode. Construction of uni-potential cathode tube. E. A. Lederer and J. W. Marden, Westinghouse E. & M. Co., Nov. 16, 1927. No. 1,945,746.

Ballast tube. A long iron wire within an envelope encased in a shield of chromium with an inert gas surrounding the wire; a reflecting surface on the envelope whereby heat from the wire is reflected back into the envelope. C. P. Brockway, assigned to World Bestos Corp. No. 1,945,726.

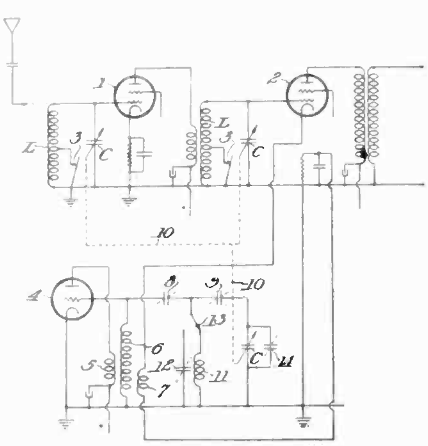
Cathode ray tube. A focusing system for cathode rays producing a narrow beams of electrons in the absence of appreciable gas ionization. C. M. Slack, Westinghouse Lamp. No. 1,937,849.

Radio Circuits

Remote control system. Comprising a reversible drive mechanism, an alternating current electrically balanced bridge network, sources of voltage, etc., whereby a follow mechanism operates by virtue of phase differences. V. E. Whitman, assigned to Hazeltine Corp. No. 1,942,587.



Dual band system. An amplifier system adapted for operation in more than one band of frequencies. C. J. Franks, assigned to R. F. L. No. 1,943,790.



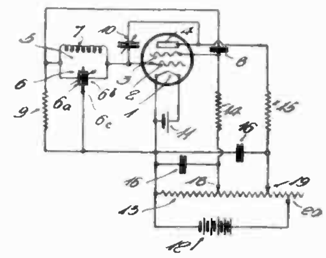
Navigation system. A radio system comprised of two co-planar coil antennas connected in series, an independent coil connected at right angles, electron tubes, etc. J. A. Willoughby, Washington, D. C. No. 1,942,526.

Interstage system. Two tuned circuits each including adjustable resistance and magnetic coupling between circuits, with means for simultaneously adjusting the coupling and the effective magnitudes of resistances. P. O. Farnham and H. F. Argento, R. F. L. No. 1,943,789.

Multirange receiver. A superheterodyne which receives signals in different bands by providing a different but constant intermediate frequency for each band of received signals, and employing with each band of progressively higher frequency range a progressively higher intermediate frequency. P. O. Farnham, R. F. L. No. 1,943,788.

Short wave receiver. A super-regenerative ultra short wave circuit adapted to function on waves below ten meters. Paul Hermanspann, assigned to Telefunken. No. 1,943,730.

Stablized oscillator. A circuit employing a two-grid tube with means for compensating for changes in the frequency of oscillation arising from variations in the voltage of the main supply of energy, utilizing the second grid. J. B. Dow, Alexandria, Va. No. 1,943,302.



Copper oxide rectifier. Circuits for use in radio receivers. W. P. Place, assigned to Union Switch and Signal Co. No. 1,937,783 to 1,937,785, inclusive.

Radio beacon. E. S. Donovan, assigned to Ford Motor Co. No. 1,937,876.

Recording Apparatus, Television, Etc.

Kerr cell. Two flat and parallel plates of material transparent to polarized light separated a distance of the order of 5/1000 millimeter, and means carried by one of said plates for impressing an electrostatic field on a beam of light passing through the cell. V. K. Zworykin, WE&M Co. No. 1,939,532.

Sound film apparatus. Sound film recording equipment involving movie film, projecting beam of light, photoelectric cell, etc. W. R. Goehner and W. Herriott. B.T.L., Inc. No 1,938,694.

Patent Suits

1,815,768, A. Georgiev, Electrolyte filed Nov. 13, 1933, D. C., S. D. N. Y., Doc. E 76/392, Aerovox Corp. v. Polymet Mfg. Corp.

1,141,402, R. D. Mershon, Electrolytic apparatus employing filmed electrodes, D. C., E. D. N. Y., Doc. E 6173, R. D. Mershon et al. v. M. Pickson (K. P. Radio Co.). Decree for plaintiff Nov. 10, 1933.

1,710,073, 1,714,191, S. Ruben, Electrical condenser; 1,891,207, same, Electrolytic condenser, filed Nov. 13, 1933; D. C., S. D. N. Y., Doc. E 76/398, Ruben Condenser Co. et al. v. Fischer Distributing Corp., Doc. E 7111, Ruben Condenser Co. et al. v. J. Finkel et al.

1,673,287, L. L. Jones Electron discharge tube amplifier system, filed Nov. 27, 1933. D. C. Minn., 4th Div., Doc. E 2742, Art Metal Works, Inc., v. The Dayton Co.

1,874,111, R. D. Mershon, Electrolytic condenser, filed Nov. 28, 1933, D. C., S. D. N. Y., Doc. E 77/22. R. D. Mershon v. Condenser Corp. of America.

1,696,263 C. E. Bonine, Radio apparatus: 1,673,287, L. L. Jones, Electron discharge tube amplifier system; 1,713,130, same, Method of and means for controlling energy feed back in electron discharge devices; Re. 17,915 (of 1,713,132), same, Radio frequency amplifying system; 1,732,937, same, Transformer and coil system; 1,770,525, same, Radio receiving apparatus; 1,779,881, same, Amplifier; 1,788,197, same, Radio frequency circuit; 1,791,030, same, Radio receiving system, appeal filed Nov. 29, 1933, C. C. A., 2d Cir., Doc—, Technidyne Corp. et al. v. McPhilben-Keator, Inc.

Re 17,355, W. G. Cady, Piezo-electric resonator; Re 17,245, Re 17,247, same, Method of maintaining electric currents of constant frequency, filed Nov. 13, 1933, D. C. N. J., Doc. E 4573, Radio Corp. of America v. Hygrade Sylvania Corp.

1,537,708, W. Schottky, Thermionic vacuum tube; 1,696,103, G. Siebt, Electric discharge tube, filed Nov. 13, 1933, D. C. N. J., Doc. E 4752, Radio Corp. of America v. Hygrade Sylvania Corp.

1,195,632, W. C. White, Circuit connections of electron discharge apparatus; 1,239,852, F. K. Vreeland, Receiver of electrical impulses; 1,544,081, same, Transmitting intelligence by radiant energy; 1,251,377, A. W. Hull, Method of and means for obtaining constant direct current potentials; 1,297,188, I. Langmuir, System for amplifying variable currents; 1,573,374, P. A. Chamberlain, Radio condenser; 1,728,879, Rice & Kellogg, Amplifying system; 1,820,809, E. W. Kellogg, Electrical system, D. C., S. D. N. Y., Doc. E 76/266 Radio Corp. of America et al. v. H. Antin et al. (A. H. Grebe & Co.). Consent decree for plaintiff (notice Dec. 8, 1933).

1,231,764. F. Lowenstein, Telephone relay, 1,618,017, same, Wireless telegraph apparatus; 1403,475, H. D. Arnold, Vacuum tube circuit; 1,432,022, R. A. Heising, Circuit connections of electron discharge apparatus; 1,465,332, H. D. Arnold, Vacuum tube amplifier; 1,507,016, L. de Forest Radio signalling system; 1,507,017, same, Wireless telegraph, and telephone system, 1,811,095 H. J. Round, Thermionic amplifier and detector; Re 18,579, Ballantine & Hull, Demodulator and method of demodulation, D.C., S. D. N. Y., Doc. E 76/265, Radio Corp. of America et al. v. Antin et al. (A. H. Grebe & Co.). Consent decree for plaintiff (notice Dec. 8, 1933).

1,244,217, Re 15,278, I. Langmuir, Electron discharge apparatus and method of operating same; 1,558,437, same, Electrical discharge apparatus; 1,758,803, O. W. Pike, Vacuum tube; 1,855,885, A. W. Hull, Electron discharge device filed Nov. 20, 1933, D. C. N. J., Doc. E 4757, General Electric Co. v. Hygrade Sylvania Corp.

1,231,764, F. Lowenstein, Telephone relay; 1,618,617, same, Wireless telegraph apparatus; 1,403,475, H. D. Arnold, Vacuum tube circuit; 1,465,332, same, Vacuum tube amplifier; 1,403,932, R. H. Wilson, Electron discharge device; 1,573,374, P. A. Chamberlain, Radio condenser; 1,702,833, W. S. Lemmon, Electrical condenser, filed Oct. 30, 1933, D. C., S. D. N. Y., Doc. E 76/369, Radio Corp. of America et al. v. Travelton Radio Corp.

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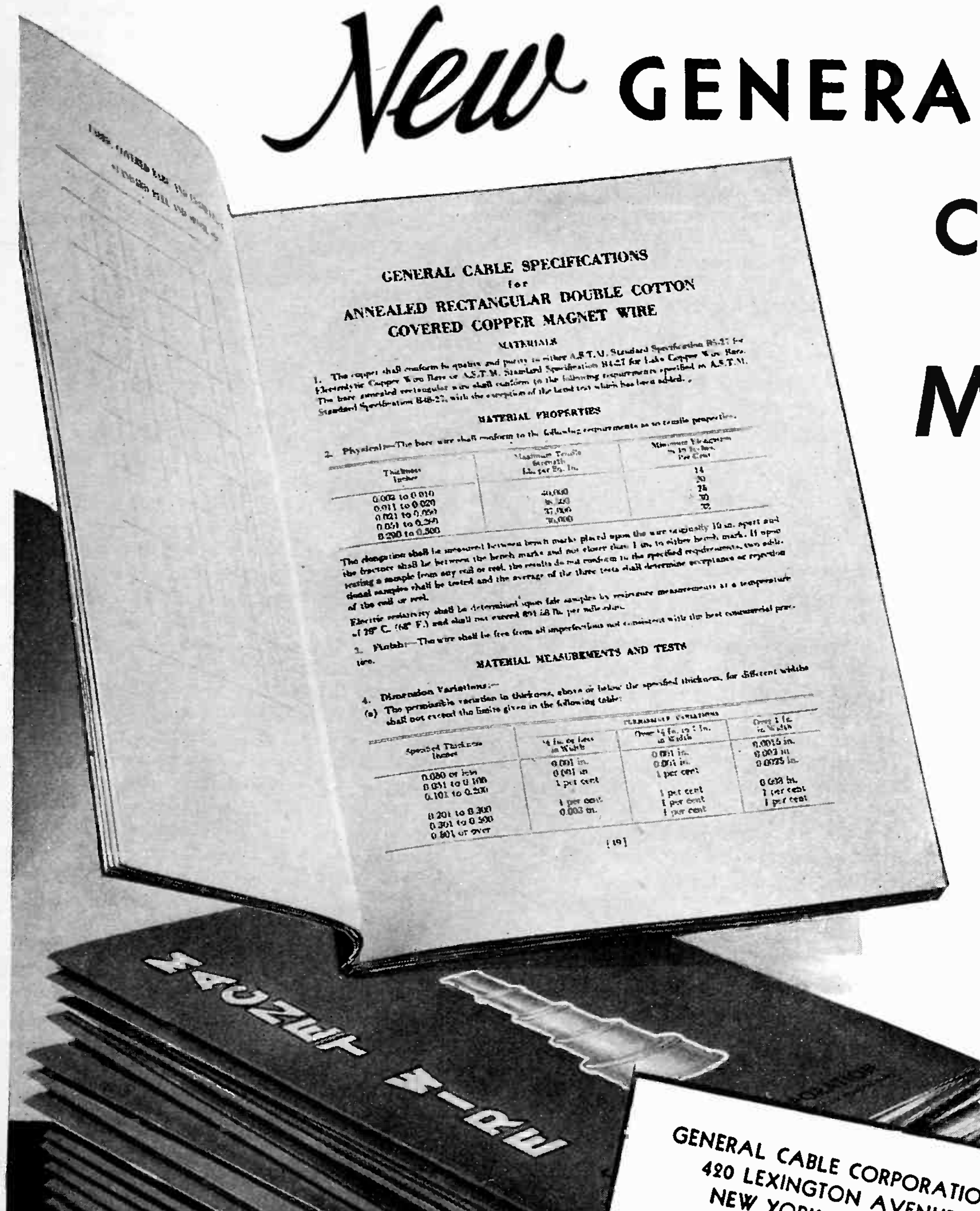

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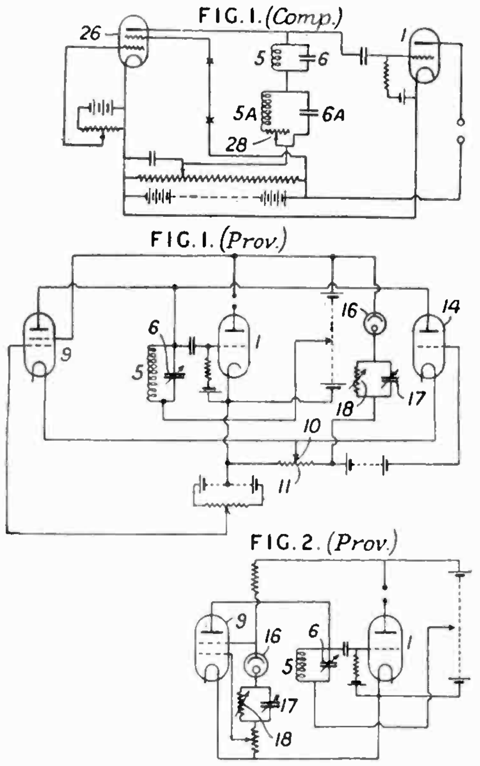
BRITISH PATENTS
IN THE FIELD OF ELECTRONICS

Radio Circuits

Super-regenerative receiver. Quenching oscillations are derived from a screen grid tube adusted to oscillate around the bend at the end of the downward sloping portion of its characteristics. Marconi Co. No. 400,268.



Phase modulation. Two components of the same carrier wave phase displaced by 90 deg. are radiated simultaneously from separate aerials after being modulated by signal currents in phase opposition. For reception it is necessary to supply a local oscillation of the same frequency, but de-phased from the incoming carrier so that the signals cause minimum interference with any normal type of receiver. G. W. Walton, London. No. 400,273.

Oscillator circuit. The output of an oscillator employing a screen grid tube as a negative resistance is maintained substantially constant by rectifying its output and applying the resultant voltage as a bias to the grid of the oscillator. Marconi Co. No. 400,995.

High frequency oscillator. An ultra short wave oscillator comprising a discharge device having an anode and cathode so arranged and dimensioned that the time of flight of an electron to the anode is substantially one-half, or an odd multiple thereof, of the period of oscillation of the anode and any extension of it. Marconi Co. No. 400,319.

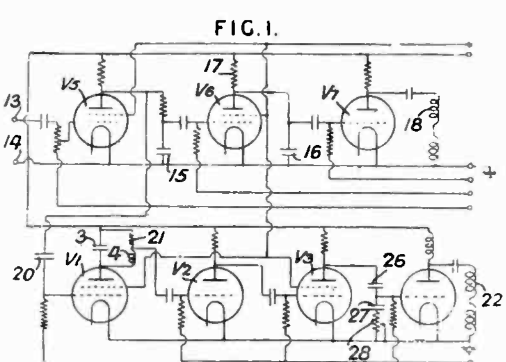
Television system. Five adjacent lines of a picture are scanned simultaneously, scanning beam being reflected by mirrors on the five adjacent cathodes of a photolectric cell. The receiver has a five element Kerr cell on which the light beam of the elliptical sections is condensed by cylindrical and spherical lenses. Banks; Baird Television, Ltd. No. 401,311.

Direction finding system. Method of eliminating night-effect and similar errors by means which cut out from the receiver any "repeated" signal impulses due to space waves reflected from the Heaviside layer. The normal interval between the primary or direct-wave signal and its repetition by the space wave is taken to be 0.00015 second. An interrupter at the transmitter is timed to radiate signal pulses lasting 0.00015 second at intervals of 0.01 second. S. B. Smith and T. L. Eckersley, Marconi Co. No. 397,524.

Short wave oscillator. In generating short-wave oscillations by the Barkhausen-Kurz method, the damping action of the grid current which is normally out of phase with the anode current, is avoided by so arranging the electrodes of the tube and the connections that the grid is located substantially at a potential-node in the main oscillatory circuit. E. W. B. Gill, Marconi Co. No. 397,555.

Ultra-short wave system. Carrier waves for the two directions have their planes of polarization displaced by an angle sufficient to prevent interference between one transmitter and the nearby receiver. The two directions may use the same wavelength and transmitting and receiving aerials of each station may be disposed in the same reflector without interference. Pintsch Akt.-Ges. Berlin. No. 397,620.

Television. This patent relates to the production of current of saw-tooth wave forms for scanning television. Electric & Musical Industries, Ltd. No. 401,634.



Automatic tone control. Combining manual tone compensation applied to the low-frequency stages of a receiver in combination with automatic volume control applied to the high-frequency stages, with the object of correcting the natural tendency of the ear to accentuate the middle frequencies as compared with the higher and lower notes, particularly at a low level of sound-output. L. E. Barton, Marconi Co. No. 397,763.

Control system. The action of an electric signaling or control system is determined by the direction from which the source of radiant energy impinges on a responsive device. Tagliabue Mfg. Co. No. 397,861.

Electron Tubes

Thermionic cathodes. In making incandescent cathodes for radio valves, Röntgen-ray tubes, rectifiers, etc., by treating a conducting or non-conducting core with alkaline-earth metal vapor such as barium, the core is given a preliminary coating of compounds from one or more of the following groups: (1) oxygen compounds of metals of high melting-point in such a state of oxidation that reaction with the vapor does not produce alkaline earth salts containing the metal of high melting-point in the acid radical; (2) phosphorus, arsenic, nitrogen, and like compounds of metals producing similar compounds of alkaline earth metals on reaction with the vapor, and (3) iso- or hetero-polyacids containing tungsten, molybdenum, arsenic, phosphorus, vanadium or other elements of the fifth group of the periodic system, these acids reacting with the vapor to form alkaline earth oxides, arsenides, phosphides, etc., or mixtures of these. The preferred compounds of group (1) are the lower oxides of tungsten, molybdenum, chromium and vanadium, particularly tungsten dioxide or pentoxide, molybdenum dioxide and vanadium dioxide or tetroxide. The vapor reacts with these to form alkaline earth oxide and free metal. The latter acts as a binding agent for the oxide, and may alloy with the excess of alkaline earth metal. The compounds and any metal resulting from reaction with the vapor have low vapor tensions *in vacuo*. The final coating may be a mixture of barium and barium oxide containing an excess of barium. The compounds may be applied in monomolecular layers and from solutions or by reactions. The alkaline earth vapor may be produced by heating the metal or the azide or suboxide. Prior processes of treating with barium a tungsten core oxidized to form the trioxide are referred to. N.V.g-F. Radium No. 401,637.

U. S. Patent Suits

1,707,544. A. L. Thuras, Electrodynamic device; 1,707,545, E. C. Wente, Acoustic device, D. C., N. D. Ohio, W. Div., Doc. E 981, Western Electric Co., Inc., v. Maiden-Fox, Inc., et al. Dismissed without prejudice Oct. 16, 1933.

1,881,324, H. E. Metcalf, Signal reproducer, D. C., N. D. Ill., E. Div., Doc. 13092, The Magnavox Co. v. Premier Electric Co. et al. Consent decree granting injunction Sept. 28, 1933. Same, filed Mar. 22, 1933, D. C., N. D. Ill., E. Div., Doc. 13104, The Magnavox Co. v. Quam-Nichols Co. et al. Doc. E. 13105, The Magnavox Co. v. Arlab Mfg. Co. et al.

1,879,863, H. A. Wheeler, Volume control, D. C., E. D. N. Y., Doc. E 6873, Hazeltine Corp. v. R. E. B. Service Corp. et al. Decree for plaintiff Oct. 30, 1933.

1,900,629, R. P. Wuerfel, Radio circuit, filed Oct. 12, 1933, D. C. Del., Doc. E 1040, International Radio Corp. v. U. S. Radio & Television Corp.