JANUARY, 1935

Radio Engineering

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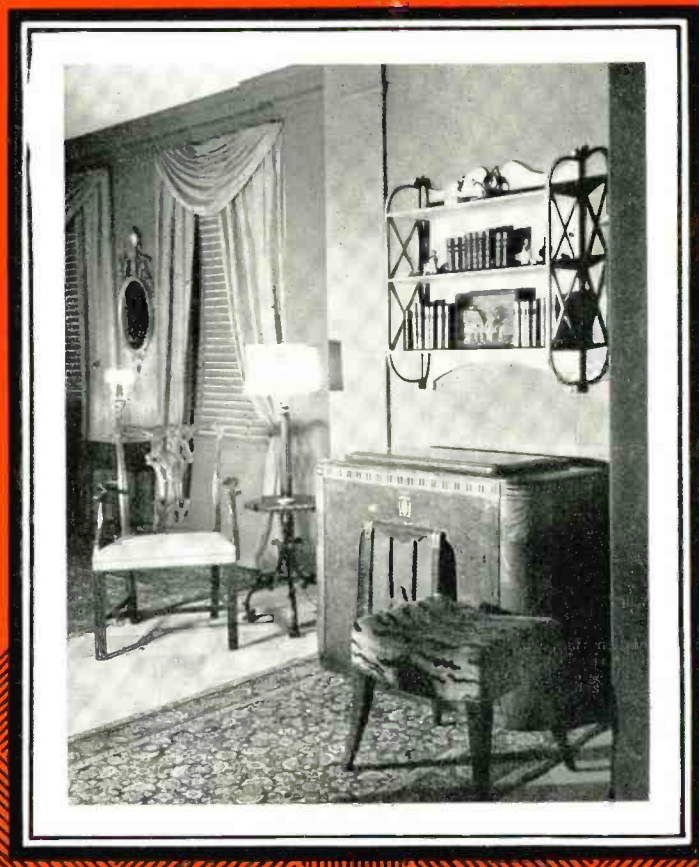

VOL. XV NO. 1

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The Journal of the Radio and Allied Industries

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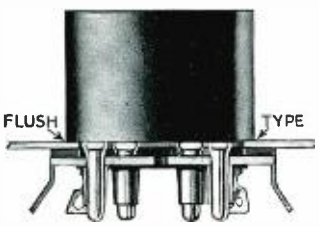

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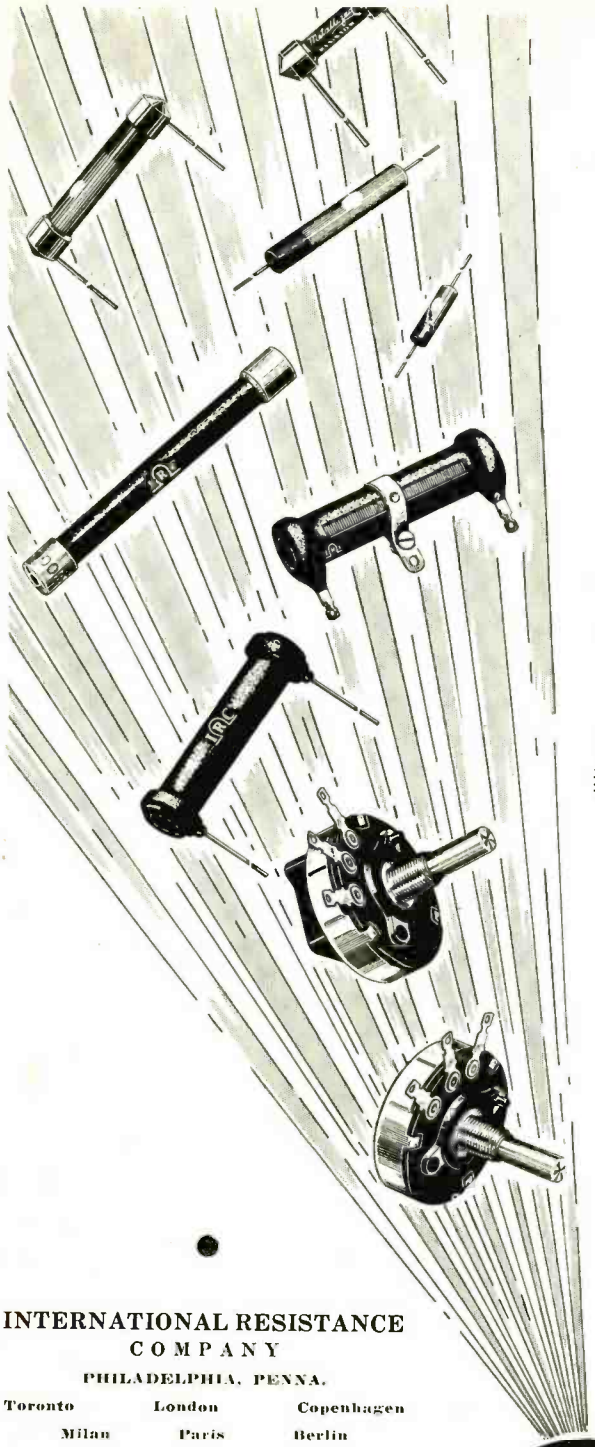

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FEATURES

DEPARTMENTS

VOL. XV NO. 1

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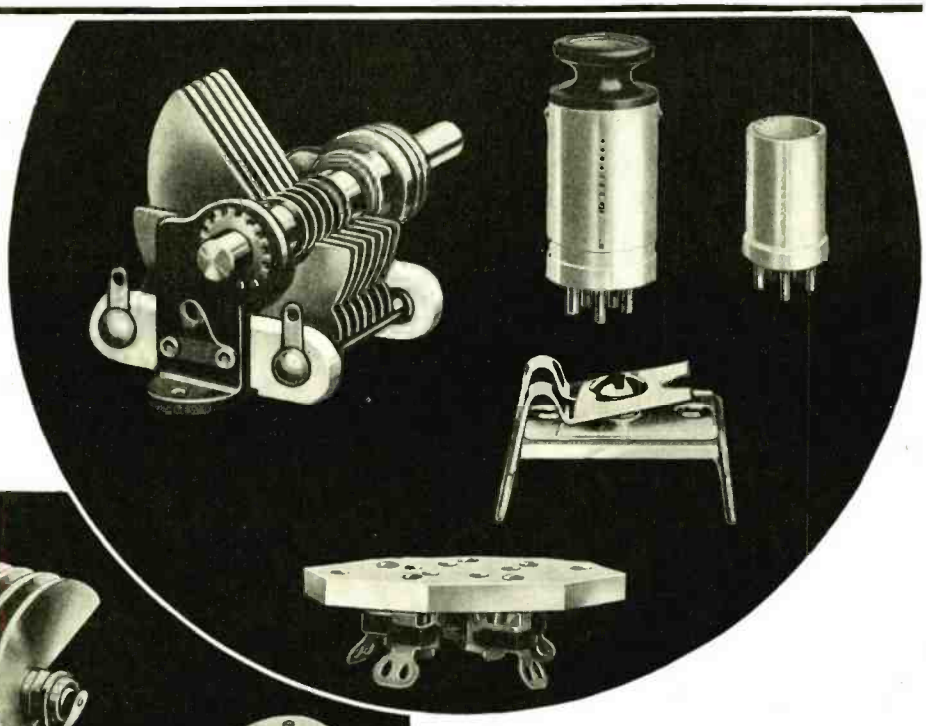

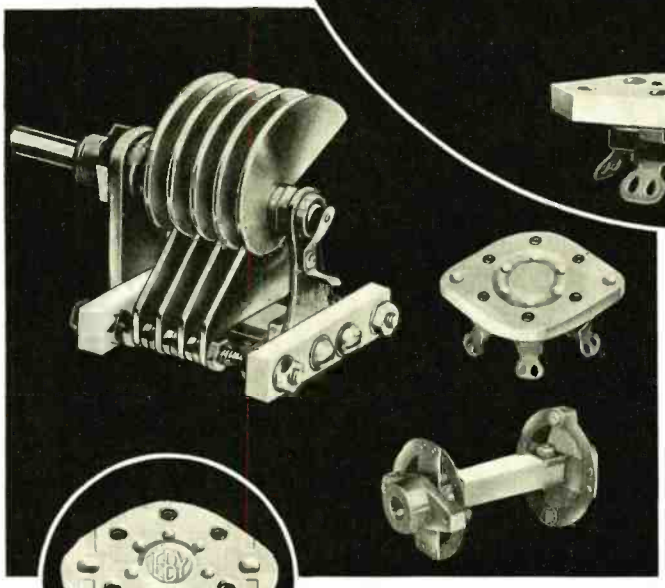

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EDITORIAL

THE NEW YEAR

CONSIDERING GENERAL BUSINESS conditions, the radio industry made a good showing for itself in 1934. More substantial increases seem evident for the new year.

According to reports from the recent New York Auto Show, spot sales were much greater than the previous year. This is a good sign as it indicates a change of public attitude. If automobile sales are on the upturn there is every reason to suspect that radio sales will also increase.

The radio business has a healthier aspect. We believe this to be due in part to the excellent work done by the Radio Manufacturers Association and in part to sound thinking by radio manufacturers. There is today more of the cooperative spirit. It has resulted in an industry more closely knitted and consequently more suited to meeting outside competition. There is also a new note of conservatism in evidence with regard to the industry's manner of dealing with the consumer—a conservatism in advertising presentation and in the handling of engineering developments. There are still offenders but by and large the industry has seen fit to suspend the ballyhoo and control such "engineering features" as are of doubtful value with respect to practical improvement in program reception.

A short while ago, the auto-radio receiver was the radio industry's headliner. During 1934, the all-wave receiver stole some of the limelight and will certainly prove the headliner during 1935, with the auto-radio receiver running second in importance. The midget, of course, will hold much of its ground, but returns so far received indicate that sales of console receivers are very much on the increase. This increase is due for the most part to the fact that, with a few exceptions, all-wave receivers are of the console type.

When we scan the recent engineering developments our feelings remind us of a remark made by a very, very young lady who, upon reading with great excitement the complete list of desserts on a menu, exclaimed, "Oh, so *many* lovely things to choose from!" Possibly we are just a bit over-optimistic but there are so many really worthwhile developments in the offing that there seems to be small chance of the industry running dry of satisfactory sales features. Moreover, there are opportunities for new markets providing advantage is taken of the progress made in the ultra-short-wave field.

Be that as it may, the sales tempo for 1935 is most assuredly "All-Wave." The surface has hardly been scratched. As a matter of fact, there are a surprising number of people in this country who haven't the slightest conception as to what an all-wave receiver may be, and many people who have never heard of an all-wave receiver. The sales possibilities are so good that it would pay the industry to put on a large-scale educational campaign featuring the scope of the all-wave receiver, what it has to offer in the way of entertainment, in distant reception, etc. The manufacturer's advertisements alone do not appear sufficient to create a nation-wide demand for these receivers. Bear in mind that the all-wave set is the first opportunity the industry has had since the advent of the light-socket-operated receiver to bring about the absolute obsolescence of existing receivers. The opportunity is too good to let pass with half-hearted attempts at selling the public on this new conception of program entertainment.

The engineering angle of the all-wave receiver should be taken into account with respect to advertising and publicity. The progress made in this character of design has been rapid and sound. With but a few exceptions, all bad kinks in all-wave receiver design have been eliminated. The new sets for this year will live up to claims the earlier sets were incapable of meeting. A point has been reached where the majority of manufacturers could well afford to provide some form of guarantee relating to foreign reception that would undoubtedly break down the last bit of sales resistance a prospective purchaser might hold.

RADIO ENGINEERING

FOR JANUARY, 1935

SCANNING 1934

A Review of Radio Broadcast Reception During 1934*

By R. H. LANGLEY
CONSULTING ENGINEER

THE YEAR 1934, so far as broadcast reception is concerned, has lived up to a number of the well-established traditions of the industry, and has marked a continuation of several of the pronounced trends of the past few years. Happily for the manufacturers, however, and probably for the public as well, it has managed to reverse at least one trend which could not have led to anything short of disaster if it had continued.

RECEIVER SALES

It is probably safe to say that the engineers who have been retained in the industry's first line trenches have never worked harder than during the past year. It is therefore all the more important to examine the results of their efforts, and to record their accomplishments. It is apparent, if it were not inevitable, that they have been addressing themselves to increasingly difficult problems, and that, at least in the main, the advances they have made lie buried beneath a maze of technical complication which their own executives, not to mention the public, do not and cannot fully appreciate. What the executives do understand and appreciate is that, while other industries continue to lag, the business of making and selling broadcast receivers is enjoying a healthy increase.

Each year since 1923 at least 20% of the firms in the industry have discontinued. 1934 has been no exception to this rule. At least 57 manufacturers of broadcast receivers which were active during 1933 failed to appear in 1934. This has been partly offset, as has also been the rule, by the appearance of a number of new firms, the actual number starting in 1934 being 36. The total number of receiver manufacturers as of December 1st was 110 as against 131 in 1933. In that year, 9 firms did 74% of the dollars business, leaving 122 firms to share the remaining 26%. The situation at the close of 1934 will not be widely different. Apparently there is no greater optimist in the world than a radio manufacturer.

NUMBER OF MODELS

In the first 11 months of 1934, a total of 1510 different models has been offered to the trade, an average of almost 15 models per manufacturer, and over 5 per day for every business day in the year. These figures are to be set beside the figures of 1933 which show 1557 models offered by 131 manufacturers, and then compared with the earlier years back to 1923, none of which show such large totals. The most profitable year the industry has known, 1929, had only 627 models. One can imagine the bewilderment of the intending radio purchaser if faced with the entire array of these 1500-odd models, occupying, as they would, an entire floor in a large department store.

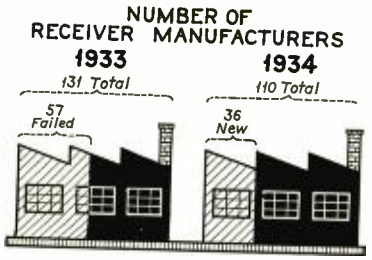
1934
DISTRIBUTION OF SALES

There are several reasons, of course, for this offering of 30 new models every week. But it seems safe to conclude that the underlying cause is our failure to determine, even after 14 years of broadcasting, just what a broadcast receiver should be. We are still changing the device in its basic specifications, and if with this has come refinement in electrical and mechanical design, these have been the necessary results of the changes we have made, rather than the principal accomplishment of our plans and policies. Some day we shall look back upon these years and see clearly our present lack of decision on the fundamental aspects of our products. It is the engineers who must make these decisions and who will soon come to see the necessity for them.

CONSOLE VERSUS TABLE MODELS

Trends of the past few years which are continuing in 1934, and which may ultimately lead to the solution of some of the problems on which experimentation still proceeds, must be recorded. Console models, for example, were 62% of all offerings in 1932. In 1933 they had fallen to 55% and in 1934 the figure will be about 36%. There is an unmistakable trend in the direction of the table model, in spite of its inferior acoustic properties. This can only be the result of public response to this type,

*Presented at the December 5, 1934, New York Meeting of the Institute of Radio Engineers as part of an annual review of radio developments.



since there has been ample time for an unfavorable reaction, if there was to be one. The increasing popularity of table models has its relation to the high-fidelity program, which will be discussed later.

It is to be noted that the table models as a group include both the so-called midget types, which made their first important demand for popularity in 1930, and the so-called chest types, which were unimportant before 1932. The smaller and cheaper forms of the chest type have pretty well disappeared, while the size and beauty of the midget types have increased. Thus the majority of table models are these better and larger midgets, and they represent a very considerable advance, not only in appearance but in technical detail, over similar models of earlier years.

OTHER RECEIVERS

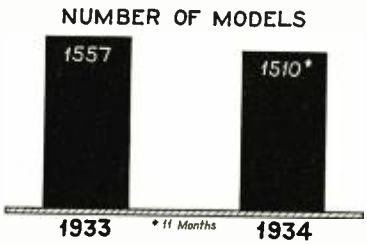
Other types which are appearing in increasing numbers are phonograph combinations, and battery models. The phonograph combinations are increasingly of the automatic type. At least 25% of the manufacturers have included phonograph combinations in their 1934 lines. This figure compares with 14% in 1932 and 19% in 1933. With the new efforts now being made to sell records, we may look for a further increase in phonograph combinations in 1935.

The number of universal ac-dc models is slightly higher in 1934 than it was in 1933. The increase, however, is small, and seems to indicate that this type is receding in the direction which its technical limitations would make desirable.

VACUUM-TUBE STATISTICS

The statistics regarding vacuum tubes are interesting and encouraging. Only four new receiving tubes, and three new ballast tubes, were introduced during 1934. In 1933, which represents a peak in this particular class of experimentation, 41 new receiving types were produced, and in the receivers of that year 53 different types of tubes were employed. The extent to which last year's program of uncontrolled expansion still haunts the industry is reflected by the fact that radio service men are today calling for 216 different tubes. The engineers are to be congratulated upon the degree of co-ordination and cooperation between tube and set designers which has resulted in this marked reduction in the introduction of unnecessary tube types in 1934. This is only one example of the ways in which the engineers can and must concern themselves with industry policies, to the mutual advantage of all.

The trend toward a reduction in the number of tube types, with the possible future standardization on perhaps one-tenth of the number now being produced by the tube manufacturers, deserves the serious support of every engineer. The utilization of any one of the types now available must include a consideration as to whether that type is one which can ultimately be discontinued. The 1934 models do not show much regard for this aspect of the problem. There is an obvious tendency to use a different tube in every socket, and to increase the number in the largest receivers. The receivers of 1932 had from 4 to 15 tubes. In 1933 the spread



was from 2 to 17 tubes. In 1934 there are 1-tube models and there are 25-tube models. As against this, however, the average number of tubes per set is decreasing. The average 1933 receiver had 8 tubes, while the average 1934 receiver will have only 6 tubes. This is probably because for each new model having an increased number of tubes, several models with only a very few tubes make their appearance.

TUBE IMPROVEMENTS

The let-up in the race to produce new tube types has given the tube engineers time to produce important improvements in design and construction of the established types, and in production and testing technique. Notable progress has been made, for example, in the elimination of microphonic action. The dome-shaped bulb, introduced in 1931, has been utilized more effectively to provide rigid top support for the elements. Resilient mica pads or spring-wire clips fastened to the top mica spacer press against the dome walls. The support of the heater filament has also received attention, and new filament materials have been developed. Side hooks or damping wires are used in some types to arrest vibration. Improved automatic welders have been developed which greatly increase the reliability of the welds by almost completely eliminating the personal factor of the operator. These changes have resulted, not only in greatly reduced microphonic trouble, but also in the now almost universal practice of shipping the tubes in the sockets.

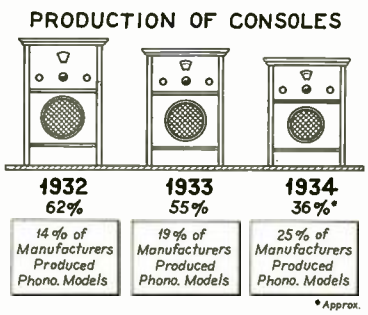
It is probably true that the tube manufacturers employ a larger number of engineers per unit of product than any other branch of the industry. More and more the performance of the broadcast receiver is being built into the tubes. It is no longer left as something to be coaxed out of the tubes by clever circuit design. The elimination of interelectrode capacity in 1929 marked the beginning of an effort to remove all those difficulties which arise in the tube. This effort has continued throughout 1934 and the cooperation between tube and receiver engineers has been increasingly intelligent and fruitful.

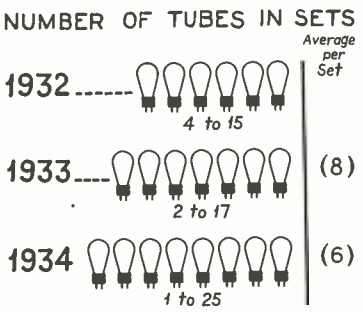
RECEIVER PRICES

The price of broadcast receivers has increased remarkably and most encouragingly, and this increase appears to have stimulated, rather than retarded sales. From the best figures available, it seems certain that 1934 sales, measured in units, will be at least 15% in excess of the 1933 total. Measured in dollars, the increase will be considerable greater, if Christmas sales come up to the expectation of the retail trade.

Average advertised prices, which of course do not take into account the actual number of each model sold, may be taken as the best measure of price changes available at this time. These figures show that the average price of all types of home receivers rose from $48.28 in 1933 to $59.60 in 1934, an increase of over 22%. The average of the lowest prices has increased only very slightly, the major portion of the advance having taken place in the medium and better grade models. The average of the highest prices in all lines, for example, is $110.40 as against $76.52 in 1933, an increase of almost 45%.

Models that cover only the broadcast





range have actually decreased in average price, and are selling approximately 10% below the 1933 figures. The great gain has been in the multiple-band receivers. The gain has also been particularly in the table models of the midget type, although the chest types also show a healthy upward movement. Average prices for console models, on the other hand, have increased only a little over 6%. Automobile receivers, not included in the figures just given, have increased in average price only a little over 4%.

MULTI-BAND RECEIVERS

The public response to the multiple-band types leaves no doubt that the engineer has achieved a very great increase in the performance capabilities of the instrument, and in the services and satisfactions to be derived from it, at only a very moderate increase in cost and price. The improvement is worth many times what it costs.

It is obviously impossible to discuss, except in the broadest outline, the technical features which distinguish 1500 different models, even if we note that the same chassis is used, on the average, in three models, and that there has been a marked tendency, this year, to use the same chassis in a table model and in a console. In many cases where this has been done, a larger speaker is employed in the console to provide better fidelity and to help justify the higher prices, without, however, any change in the chassis itself.

FREQUENCY-RANGE ADVANCES

In broad outline, then, the most notable technical advance in the receivers of 1934 has been in the expansion of the frequency range. This is no new feature, since extended-range receivers have been produced every year since 1926. But 1934 marks the first attempt to exploit world broadcasts as the main sales argument, and it has met with very gratifying success. It has its political and social implications, which are of great importance, and the public response to the all-wave types bespeaks an increasing world curiosity and consciousness which the radio engineer has fostered and fed, and which statesmen, the world over, must reckon with.

In 1932 only 47% of the manufacturers offered models covering more than the American band. In 1933, 75% of them had such models, and in 1934 only the smallest firms were still holding back, 91% of the lines including extended-band receivers. 75% of the 1934 models are multiple-band types.

The expansion of the frequency range has brought with it a host of new and difficult problems for the engineer. Not all of these have been finally solved in 1934, but such marked advances have been made that the year must be recorded as marking the conquest of the range from 500 kilocycles to 20 megacycles, with notable examples down to 140 kilocycles and up to 36 megacycles. The American broadcast frequency range has a ratio of less than 3 to 1. In the all-wave models, this ratio increases to 40 to 1, and in some models that ratio is as high as 250 to 1. Thus the frequency range has been expanded from 14 to 85 times, and the difficulty of the technical problems which the engineer has had to solve are probably roughly in proportion to these figures.

AVERAGE RECEIVER PRICES

	Average Low	Average High
1933	$48.28	$76.52
1934	$59.60	$110.40
Increase 1934 over 1933	+22%	+45%

COIL DESIGN

The first problem to be solved was that of coil design. It is one thing to choose values for a fixed inductance and a variable capacity which will tune over a 3 to 1 frequency range, and to develop an efficient inductance for this purpose. It is quite another problem, however, to redesign the inductance so that with appropriate switching it may be tuned over a 40 to 1 range with the same variable condenser. Yet in many of the all-wave models, this is the arrangement used.

SWITCH GEAR

The second problem was the design of suitable switch gear. Here the requirements were far more difficult than in any earlier radio switching mechanism. It was necessary, in an all-wave model, to accomplish at least twelve circuit changes with a single knob, and yet keep the capacities introduced by the switch itself, as well as its contact resistance, at very low values. This result was accomplished by building the switch in units, one of which could be located near each coil, the several units being operated by a common shaft with a suitable knob.

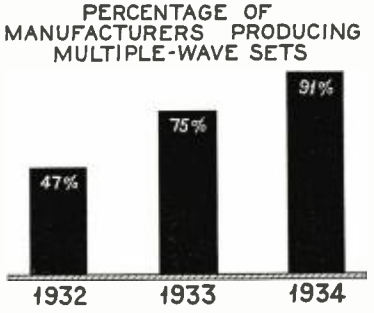
The varying ideas of the many designers, represented in the 1,500 models, made it necessary for the switch manufacturers to produce designs that were capable of almost limitless combinations in the circuit changes they could produce. This they have succeeded in doing, in ways that are not only electrically satisfactory but remarkably small and inexpensive as well. The problem was at least as much a matter of mechanical as of electrical design, and the ingenuity displayed speaks well for the mechanical skill of the industry's engineers.

INDICATORS

The indicator has been a problem in itself. When there were only the 96 channels of the American band to be shown, the expedient of frequency numbers, with a calibration of only reasonable accuracy, was sufficient. With the number of channels greatly increased, and the requirements for accurate frequency readings much more severe, it was essential that new types be produced. The answer, so far as the great majority of models is concerned, was the airplane dial. This was not new in 1934, because it had been used extensively in European receivers before that, and it has also appeared on a relatively small number of earlier American models.

The indicator and the drive gear were almost entirely a mechanical problem, as were the switch gear and the compact arrangement of a multiplicity of coils and trimmer condensers. The various mechanical necessities associated with the coverage of several frequency bands have caused a very high degree of skill in mechanism to be put into the 1934 designs. Moreover, perhaps as the result of the increased complexity of the apparatus itself, the excellence of the mechanical design throughout the receiver has increased noticeably in 1934. It has been said, probably with considerable justice, that radio was still mechanically crude. Much of the basis for this criticism has been swept away in the 1934 designs, and the year probably marks the greatest advance in perfection of mechanical detail that has so far been made.

1934 has seen the all-wave program



well launched. If the gains that have been made are to be consolidated, if public interest in international broadcasts is to be maintained, if the sale of all-wave apparatus is to continue to increase, then still further improvements and refinements must be made in 1935. Additionally, the number and quality of the short-wave programs must increase. Our neighbors across the sea are already taking advantage of listening American ears. They must go forward with this work. The engineer, who has created this new service, must carry on, until reception in the added bands is just as perfect, from a technical standpoint, as on the domestic frequencies.

HIGH-FIDELITY MODELS

Another and perhaps even more ambitious advance has been launched during 1934, although only a relatively small number of manufacturers have as yet offered models which include it. This is the "high-fidelity" program which has received so much attention in the Institute of Radio Engineers, in the Radio Manufacturers Association and in the radio press. The progress which has been made in the laboratories, but which has not as yet found its way into the product, cannot be here discussed, for obvious reasons. It seems safe to say, however, that increased audio-frequency response with negligible distortion will be among the chief features to be stressed in the 1935 sales campaigns.

The high-fidelity models already released provide some insight into the problems involved. It is apparent, for example, that flat response, even to 10,000 cycles, cannot be tolerated under all receiving conditions. This will be true at least until much has been accomplished in the broadcasting stations to improve the quality of the program as radiated. The requirement in the receivers, therefore, is that there shall be either manual or automatic control of band width, and preferably also of sensitivity, in addition to the usual level control and the quite common tone control. The result, in some of the models already released, is a marked increase in the number of control knobs, with labels to identify them. It seems safe to expect that this practice will again become common, but if present offerings are an indication, it can be done in such a way as to enhance, rather than detract from, the appearance of the instrument.

Since high selectivity and high fidelity are not compatible, so long as frequency assignments to broadcast stations are made on the present 10-kilocycle basis, expedients have been developed during 1934 to vary the admitted band width. Most of these are based on the principle of introducing absorption circuits to broaden the response in the high-fidelity position. Interesting networks of this type have been developed and are now in production.

LOUDSPEAKERS

Much progress must be recorded in the development of loudspeakers having a reasonably uniform extended range. These new speakers are of both single- and double-unit types. Several excellent demonstrations of the performance of these improved speakers have been given during the year, before the Institute of Radio Engineers and other bodies, and the results are already available. Acoustic treatment of the cabinet to develop the full capabilities of the new speakers is also a noteworthy step in the high-fidelity advance.

It must be remembered that the effort to secure high-fidelity reproduction did not begin in 1934. It has been going on for years, almost since broadcasting began. The importance of the present campaign lies not in any single technical advance, but rather in a coordinated and cooperative engineering program, in whose benefits all will share. The ideal performance is at last receiving systematic study, and all the factors which affect it, many of which are outside the receiver itself, are being examined. The progress toward the ideal can therefore be organized into a logical plan.

SOCIAL SIGNIFICANCE

This paper would not be complete if it failed to lay final emphasis upon the profound social significance of the advance into the realm of international broadcasts. The engineers, by making the all-wave receiver a commercial possibility, have made much more than a mere contribution to the prosperity of their industry. It is always an easy matter for the historian to look back upon the scientific advances of former years, and see what their effect has been. It is important for us, however, as we review the progress of 1934, to realize that with the increasing use of all-wave receivers there will come an increasing international understanding and good-will, that cannot fail to bear fruit in amity and peace.

The radio engineer first provided a new means of communication, that spanned the gap to previously isolated points. He made his great contribution to the safety of life at sea. Then came his entrance into the field of entertainment, with a new cultural influence that has made its lasting mark upon the ritual of the American home. He created, in the space of a few years, a new legion of music lovers, and he brought the satisfactions of music to thousands more who long had loved it, but to whom it was otherwise inaccessible. In the realms of domestic politics, he brought our great men to our firesides, so that we could learn to understand their personalities and policies. From these excellent beginnings, the radio engineer has turned his space waves to account in the work of the police and the detection of crime, in communication with aircraft and safety in aviation, and in many other needful and beneficent services. His is a glorious tradition.

But in his gift of international broadcasts, by which the soul of all the world is laid bare, and nations can no longer make a successful secret of their plans and ambitions, the radio engineer may well find his deepest satisfactions.

•

INCREASE IN BRITISH RADIO AUDIENCE

A RECENT REPORT published in Electrical Foreign Trade Notes No. 350 (December 5, 1934) indicates that the listening public in Great Britain is still increasing rapidly. At the end of October the total number of radio receiving licenses in force was 6,549,000. This represents a net increase of 76,000 during that month.

One year previous to that date the total was 5,768,000, making the increase during the twelve months 781,000. In October, 1934, also, there were 226 successful wireless prosecutions.

Under terms of the charter the Post Office deducts from each 10-shilling license fee a certain amount for administration expenses. Afterwards the British Broadcasting Corporation received for:

	Percent
First million	90
Second million	80
Third million	70
Further licences	60

The Broadcasting Corporation stated that after various deductions have been made, about 4s. 7d. of each 10s. is available for actual broadcasting purposes.

The revenue from 6,549,000 licenses is 3,274,500 pounds. Of this the Post Office takes 347,450 pounds for administrative expenses.

On the basis of the British Broadcasting Corporation's figure of 4s. 7d. of each 10s., the Corporation would receive about 1,500,800 pounds for broadcasting services. (*Alfred Nutting, Consulate-General.*)

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PUBLICATION NOTE

Due to space limitations, it has been found necessary to withhold the publication of the second part of the article, "Transformer Design," by Mr. Leo A. Kelley. It shall appear in the February issue without fail.—Editor.

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NEW RCA Cathode-Ray Tubes

THE RCA TYPE 907, like the type 908, is a high-vacuum, cathode-ray tube that has been designed with two sets of deflecting plates for the purpose of deflection control. The fluorescent viewing screen in the 907 has a diameter of five inches. This tube produces a highly actinic spot of short persistence suitable for moving-film recording of recurrent and transient electrical phenomena, and is therefore recommended for recording use in oscillographic applications where the above mentioned factors are of major importance. Information relative to these tubes has been furnished by the engineering department of the RCA Radiotron Co., Inc., Harrison, N. J.

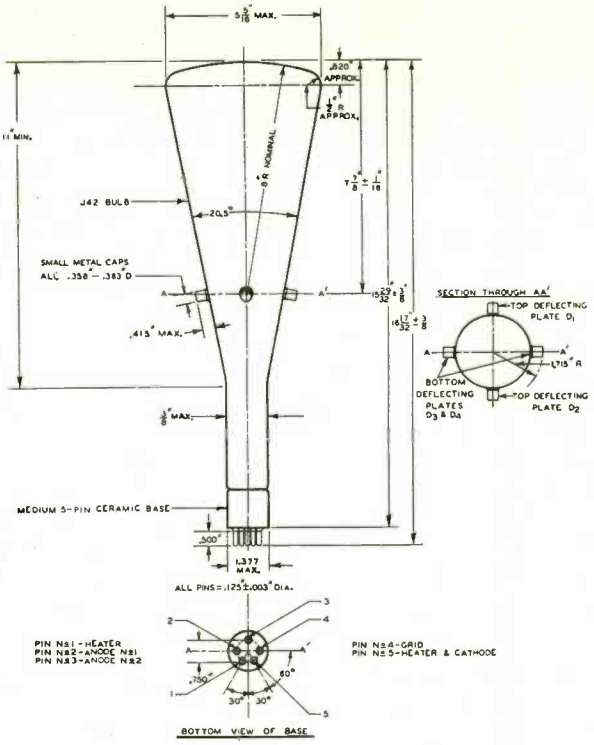

Fig. 1. Outline drawing of the Type 907 cathode-ray tube. Bottom view of base is included, with pin designations.

FUNDAMENTALS

Fundamentally, an indirectly-heated cathode acts as the electron source, and in combination with the control electrode (grid) and focusing electrode projects a beam of electrons upon the fluorescent viewing screen, the resulting luminous spot being controlled in size and intensity by the choice of electrode voltages. Beam deflection is accomplished electrostatically through the use of two sets of deflecting plates whose fields are at right angles to each other. However, the distinctive feature of the 907 lies in the fact that mechanical means for the timing control can be employed.

The Type 908 cathode-ray tube differs from the 907 mainly in the size of its viewing screen and in the additional means of obtaining beam deflection. The fluorescent viewing screen of the 908 is of the three-inch type, and hence features compactness. Deflection of the electron beam in this latter unit may be accomplished either electrostatically or electromagnetically.

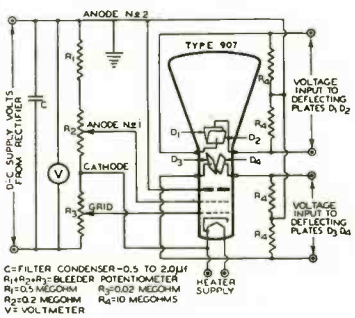

Fig. 3. Typical oscillograph circuit for the Type 907 cathode-ray tube.

CHARACTERISTICS

The tentative ratings and characteristics of the 907 and 908 tubes are given in the accompanying tables. More detailed information concerning dimensions, tube bases and the like may be obtained from the outline drawings of the 907, shown in Fig. 1, and the 908, shown in Fig. 2.

TENTATIVE RATING and CHARACTERISTICS
TYPE 907

General	
Heater Voltage (ac or dc)	2.5 Volts
Heater Current	2.1 Amperes
Direct Interelectrode Capacitances	
Grid to All Other Electrodes	10.0 max. mmfd
Deflecting Plate D_1 to Deflecting Plate D_2 (Top Set)	3.0 max. mmfd
Deflecting Plate D_3 to Deflecting Plate D_4 (Bottom Set)	1.5 max. mmfd
Overall Length	16-17/32" ± 3/8"
Maximum Diameter	5-5/16"
Bulb	J-42
Caps (Four)	Small Metal
Base (Refer to Fig. 1.)	Medium 5-Pin Ceramic
Characteristics	
High-Voltage Electrode (Anode No. 2) Voltage	2000 max. Volts
Focusing Electrode (Anode No. 1) Voltage	600 max. Volts
Grid Voltage	Never positive
Grid Voltage for Current Cut-off** (Approx.)	—40 Volts
Fluorescent-Screen Input Power per sq. cm. (Av.)	10 max. Milliwatts
Typical Operation:	
Heater Voltage	2.5 Volts
Anode No. 2 Voltage 1000	2000 Volts
Anode No. 1 Voltage (Approx.) 200	400 Volts
Grid Voltage *	* Volts
Deflect. Sensit'y (Plates D_1 and D_2) 0.38	0.19 Mm/Volt dc
Deflect. Sensit'y (Plates D_3 and D_4) 0.46	0.23 Mm/Volt dc

*Adjusted to give suitable luminous spot.
**With approximately 400 volts (to focus) on Anode No. 1.

TENTATIVE RATING and CHARACTERISTICS
TYPE 908

General	
Heater Voltage (ac or dc)	2.5 Volts
Heater Current	2.1 Amperes
Direct Interelectrode Capacitances	
Grid to All Other Electrodes	10 max. mmfd
Deflecting Plate D_1 to Deflecting Plate D_2 (Top Set)	4 max. mmfd
Deflecting Plate D_3 to Deflecting Plate D_4 (Bottom Set)	3 max. mmfd
Screen Persistence, Brightness negligible in less than 25 μ seconds	
Overall Length	11-15/32" ± 3/8"
Maximum Diameter	3-1/16"
Bulb	J-24
Base (Refer to Fig. 2.)	Medium 7-Pin

Characteristics				
High-Voltage Electrode (Anode No. 2) Voltage			1000 max.	Volts
Focusing Electrode (Anode No. 1) Voltage			300 max.	Volts
Grid Voltage			Never positive	
Grid Voltage for Current Cut-off** (Approx.)			—40	Volts
Fluorescent Screen Input Power per sq. cm. (Av.)			10 max.	Milliwatts
Typical Operation:				
Heater Voltage			2.5	Volts
Anode No. 2 Voltage	600	800	1000	Volts
Anode No. 1 Voltage (Approx.)	120	160	200	Volts
Grid Voltage	*	*	*	Volts
Deflect. Sensit'y (Plates D_1 and D_2)	0.55	0.41	0.33	Mm/Volt dc
Deflect. Sensit'y (Plates D_3 and D_4)	0.58	0.44	0.35	Mm/Volt dc

*Adjusted to give suitable luminous spot.
**With approximately 400 volts (to focus) on Anode No. 1.

OSCILLOGRAPH CIRCUITS

Fig. 3 shows the fundamental circuit for the use of the 907 in an oscillograph. The electrode voltages for the 907 are obtained from a bleeder circuit connected across the high-voltage supply of a rectifier system. The potentiometers in this bleeder circuit are for adjusting the voltages on Anode No. 1 and on the control electrode or grid.

Similarly, Fig. 4 shows the fundamental circuit for the use of the 908 in an oscillograph. The electrode voltages are obtained in a similar manner, and the potentiometers have the same function as they do in Fig. 3. However, it is interesting to note in the 908 the manner in which the two sets of deflecting plates have been connected inside the tube.

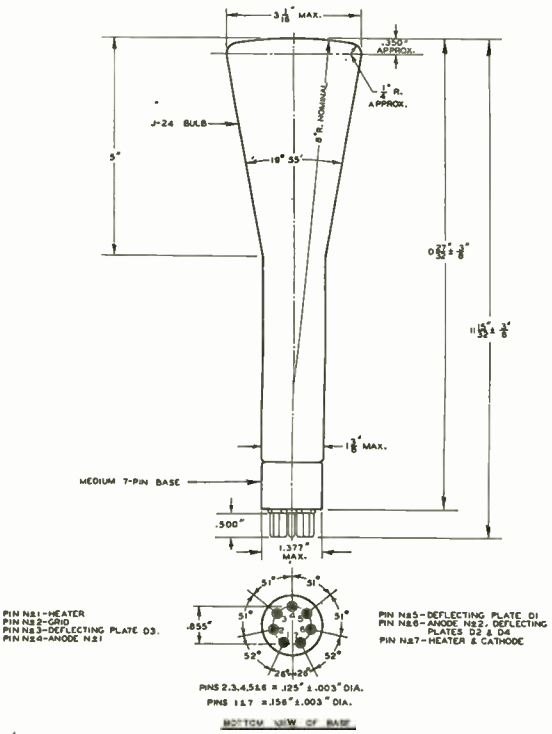

Fig. 2. Outline drawing of the Type 908 cathode-ray tube. Bottom view of base is included, with pin designations.

DEFLECTION AND FOCUSING

As has been stated, deflection of the electron beam in both the 907 and the 908 may be accomplished by two electrostatic fields at right angles to each other. In operation, one field is controlled by the phenomena under observation and the other one is used for timing control, the latter field serving to spread the tracing across the screen.

However, when it is desired to use two electromagnetic coils with the 908, for deflecting the beam along one axis, these coils should be placed opposite each other, as close to the bulb neck as practical, and should be concentric with the diameter of the bulb neck passing through the centers of the top set of deflecting plates. The free plate of the bottom set is then connected to Anode No. 2 socket terminal. Positioning of the coils in this manner locates the axis of the electromagnetic field so that it intersects the axis of the electron beam and is perpendicular to it. Furthermore, the deflection caused by the electromagnetic field is at right angles to that produced by the electrostatic field.

Focusing of the light spot produced by the beam is obtained by adjustment of the ratio between the voltages on Anodes No. 2 and No. 1. In general, this voltage ratio should be about 5 to 1.

SPOT SIZE AND INTENSITY

Spot size and intensity may be regulated by varying Anode No. 2 current and/or voltage. The current to Anode No. 2 can be increased by decreasing the bias voltage applied to the control electrode. This procedure increases the spot size and intensity. Raising the voltage applied to this anode, on the

(*Continued on page 20*)

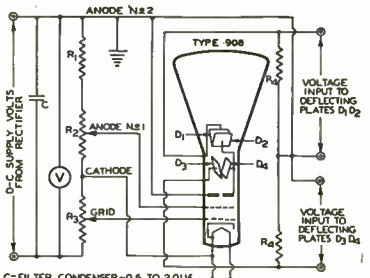

Fig. 4. Typical oscillograph circuit for the Type 908 cathode-ray tube.

Radio Market Looking Up

SALES OF RADIO SETS ATTAIN ALL-TIME HIGH DURING 1934

THE BEGINNING of the fifteenth year of radio broadcasting finds the "era of ether" entrenched so deeply in all the ramifications of modern life that few pause to realize that it was only on November 2, 1920, that the opening of the first station started a movement which has revolutionized the thought and action of the entire world. In its development, the production and distribution of radio-receiving sets have founded an industry, the rapid progress of which is without parallel in contemporary commercial achievements. Even from the last few years of economic difficulties, the industry has emerged with the interest in its products at a new high pitch, manufacturers having proven their versatility and resourcefulness by rising above the adverse circumstances encountered.

During the current year there has been an almost uninterrupted month-to-month gain in sales, with demand impervious to the usual period of Summer dullness, due to the extended popularity of automobile and portable sets. The introduction of the all-wave set at a price within the easy reach of the multitude has been one of the outstanding contributions to the new peak levels set by distribution. Broadcasting stations also have furnished bolstering support to the wider use of the radio, as never in the history of the industry have programs of such comprehensive variety and recognized quality been provided to hold the listeners' interest at all hours of the day and night and to bring additional followers into the growing "audience of the air." Although all previous records were outdistanced during 1934, current indications reveal a stronger uptrend of demand during the first quarter of 1935, with some new peaks to be established during the last six months of that year, according to a survey of the radio industry, which has just been completed by Dun & Bradstreet, Inc.

SALES AT NEW PEAK

In spite of the encouraging progress made during the first six months of the current year, the increase in sales has been abrupt since the new models were displayed early in the Fall. In the comparison with the totals for the corresponding period of 1933, losses were reported in no parts of the country, while the increases ranged from 25 to 100 percent. The cheaper sets have been bought freely, but the proportion is not so large as it was last season, as there has been a decided shift to the higher-priced all-wave sets during the last three months. Based on the returns for the elapsed eleven months, with the returns of the Christmas season yet to be tallied, it is estimated that sales for the country, as a whole, averaged 40 per cent larger than for the comparative period of 1933. This would bring total sales for 1934 around 5,350,000 sets, as compared with the previous peak of 4,438,000 units set down for 1929.

From 60 to 65 per cent of the units sold represented replacements, which is about the same ratio as in 1933, as new enthusiasts are being added daily to the country's radio audience. Considerable replacement business has been received from agricultural districts, where sales had been few more than three years, owners now turning in their old sets for the new all-wave models. The many pay-offs during the year, which gave consumers money which had been considered lost, the higher prices for cotton, tobacco and the general run of farm products, which placed more cash in agricultural districts than in five years, and the steadier trend of employment have permitted deferred desires for radio ownership to be satisfied to the freest extent possible since 1929.

WIDER INTEREST IN BROADCASTS

The increased hours of leisure, the perfection of the all-wave receivers, and especially the improvement and extension of broadcasting programs have been responsible for the unprecedented expansion which interest in the radio has attained this year. Unquestioned proof of the growing popularity of this form of entertainment and instruction is provided by the record sums of money being spent for time on the major networks of the country.

In October, the highest sales in broadcast history were reached at $4,527,000, a gain of 59.0 per cent over the 1933 comparative figures, and 49.1 per cent higher than in October, 1932. For the ten months of 1934, these sales amounted to $33,780,000, or 38.8 per cent ahead of the 1933 comparative figures, and 2.2 per cent in excess of the 1932 total, which represented the all-time high. This increase has enabled some of the broadcasting companies to declare extra dividends, while others are planning to take care of accumulated dividends, as profits now generally have replaced the losses of 1932 and a part of 1933.

PRICE TREND UPWARD

Wide fluctuations in prices have been absent since last Spring, and the current level is holding steady at 10 to 25 per cent higher than at this period a year ago. The present firmness, however, is inclining upward, and advances already have taken place in some of the medium and better grades of console types of all-wave sets. The popularity of the smaller radio sets, however, apparently is waning, as the price inclination in this division is downward. Manufacturers thus far have succeeded in withholding from retailers most of the increases which have resulted from the higher operating costs under the code. As this policy, however, has made heavy inroads on profits, substantial upward revisions may become necessary next Spring.

The status of general collections is reported as the most satisfactory that has obtained since 1929. In the retail division it has been particularly satisfactory, and wholesalers have received payment in full on some old accounts which were carried over from last year. Collections on deferred-payment sales have been kept up to date in most districts, with repossessions the fewest in many years.

FAILURES DROP TO NEW LOW

The stronger financial position which all members of the industry now have achieved, as compared with their condition during the three preceding years, has brought bankruptcies almost to a complete stop. For the eleven months of 1934 only 6 manufacturers failed, with the involved liabilities $526,630, as compared with 25 defaults entailing a loss of $3,719,519 for the twelve months of 1933.

Among the wholesalers and retailers the reduction in the number of bankruptcies was even more decisive, the total dropping from 109 for the twelve months of 1933 to 33 for the eleven months of 1934. The sum of the involved liabilities, however, was little changed in this division, as one large wholesaler had a defaulted indebtedness of more than $1,000,000, which pushed the total for the eleven months up to

(*Continued on page* 20)

A High-Fidelity A-F AMPLIFIER

Design of a 15-Watt Unit Using a Phase Inverter and Resistance-Coupled Push-Pull Stages

By HUBERT L. SHORTT
Chief Engineer
WHOLESALE RADIO SERVICE CO., INC.

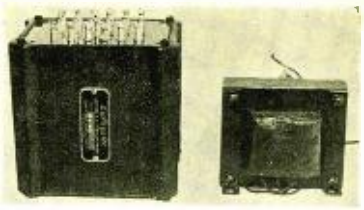

Fig. 3. "You pays your money and you takes your choice." A comparison between the small transformer (right) that gave Curve 3, Fig. 1, and the big brute that flattened out the line as shown in Curve 2 of the same figure.

IN VIEW OF THE current interest in high-fidelity reproduction, of both radio and mechanical music, the writer was gratified by the considerable response accorded his article in the October, 1934, issue of RADIO ENGINEERING, dealing with the problems encountered in the design and construction of a high-fidelity pre-amplifier for p-a applications.

The experience gained with this pre-amplifier was applied to the design of a 15-watt power amplifier. However, the latter presented some problems and puzzles of its own, and perhaps the manner in which they were solved will be of further interest to engineers working with similar systems.

HIGH-FIDELITY AMPLIFIER REQUIREMENTS

The requirements for a high-fidelity amplifier for ordinary commercial applications may be summarized briefly as follows: (1) frequency range of at least 40 to 12,000 cycles; (2) power output of at least 12 watts; (3) gain in order of 70 db; (4) negligible hum; (5) low harmonic content; (6) compact in size to permit mounting in radio receiver cabinet; (7) net price to purchaser $50 or less.

To fulfill the first requirement as economically as possible, it was decided at the start to eliminate expensive permalloy type interstage transformers, and to use power tubes with low input capacities to minimize losses at the higher audio frequencies. In checking the available commercial tubes, it was found that with the exception of the pentodes (which we certainly didn't want because of their well-known propensities toward distortion), practically all types had very high input capacities due merely to the physical size of their elements and also to the additional effect of the mu of the tube influencing the effective C value. This little appreciated effect was treated in the first article mentioned.

DIRECT-COUPLED POWER TUBES

The tube that finally proved ideal for the purpose was the comparatively new and unused 2B6. This consists of a very small driver triode, with extremely low input capacitance, with its cathode connected internally to the control grid of a much larger triode section in the same element. The effective input impedance of the second triode (the power section) is the value of the biasing resistor used with the first and smaller triode, in this case only 10,000 ohms; hence the input side of the power triode presents no problems so far as frequency discrimination is concerned.

Tubes of the 56 type were chosen as additional driver amplifiers because of their stability and reliability as voltage amplifiers and also because of their favorable ratio of input capacity to mu.

PHASE INVERSION

As it was desired to eliminate all interstage transformers (for the sake of minimum hum pick-up as well as economy), our only alternative was to use resistance-capacitance coupling between the 56's and the two 2B6's in the output stage, with some form of phase inversion between the signal source and the input side of the push-pull 56 driver stage. The type 53 tube, which consists of two identical triodes in one envelope, was found to be just the thing. The operation of this system may be reviewed briefly as follows, with the aid of the schematic diagram of the whole amplifier (see Fig. 2):

The input signal on the first grid G1 produces a signal on the corresponding plate P1 with a magnitude determined by the amplification factor of the whole first triode system, and 180 degrees out of phase with the input signal. A por-

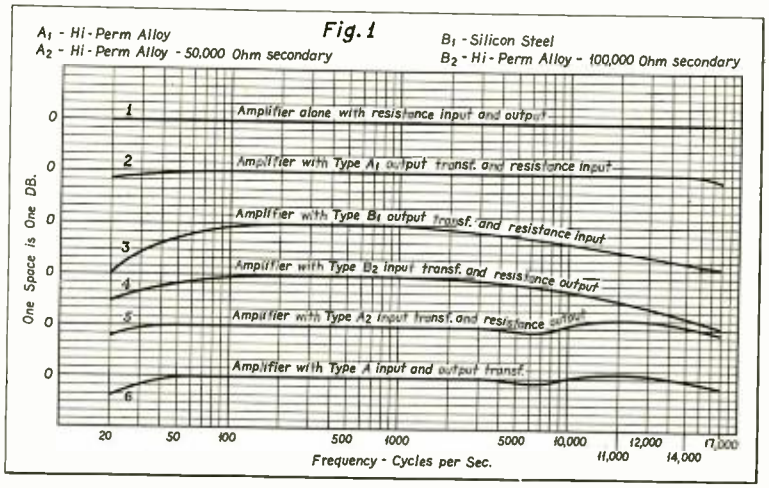

Fig. 1. Frequency curves of Lafayette Hi-Fidelity Amplifier with various input and output transformers.

tion of this amplified voltage is taken off the grid load R1 and fed back into the second triode grid G2; this voltage has the same magnitude at all times as the original signal on G1. The respective voltages on the plates P1 and P2 are thus always equal in magnitude but 180 degrees out of phase, and the grids of the 56's drivers are operated in true push-pull fashion.

The successful operation of this phase inverter depends on the maintenance of the correct ratio between the output voltage of P1 and the input voltage of G2; in this case, 25:1 for the simple reason that the effective gain per stage is in the order of 25.

It will be noted from the diagram that 1-mfd. coupling condensers are used between the plates of the 53 and the grids of the 56's. These are necessary to minimize losses at the low frequencies because of the low order of grid load, the latter being necessary for the sake of stability in the phase inverter stage. Between the 56's and the 2B6's, 0.1-mfd condensers are sufficient since the input impedance to the latter tubes is about one megohm, as compared to 250,000 ohms for the former.

The author demonstrates the Lafayette Hi-Fidelity Amplifier described at length in the accompanying article. The ac-operated pre-amplifier was treated in an article in the October, 1934, issue of RADIO ENGINEERING.

FREQUENCY CHARACTERISTICS

On direct measurement, it was found that the frequency characteristics of the phase inverter section were practically linear. Excluding the output transformer temporarily for the sake of argument, it can be stated that the frequency characteristics of the amplifier are limited by two factors: (1) losses at high frequencies due to the shunting effect of distributed capacities, and (2) at low frequencies to losses due to series reactances of coupling and bypass condensers. To minimize (2), the resistance-capacity filters in the various plate circuits have high resistance and high capacity, and the coupling condensers are of high value.

With resistance input and output loads (the output transformer again ignored for the time being), the frequency discrimination of the whole amplifier was found to be less than .1 db from 20 to 17,000 cycles, or the limits of the RCA type TMV 52E oscillator employed. This is shown by Curve 1, Fig. 1, or rather it isn't shown because .1 db is too small a change for the graph paper. Under these ideal conditions we have obtained a response beyond our requirements. Now, the response of the final amplifier system will depend entirely on the input and output equipment.

THE OUTPUT TRANSFORMER

In choosing the output transformer, we are influenced by two factors, desired frequency response and cost. If the amplifier is to be used with a radio receiver, the response should be plus or minus 2 db from 40 to 8,000 cycles, since this is "high fidelity" for radio reproduction. For p-a "high fidelity" applications the response should be 40 to 12,000 cycles. Hence for radio work, we can get by with a medium-priced transformer, say about $4.50 net. A typical transformer in this class gives the response shown in Curve 3 (Fig. 1). The 40-10,000-cycle coverage is fully adequate for radio work.

Curve 2 (Fig. 1) shows what is obtained with a permalloy type output transformer netting for about $12. The response varies less than ½ db from 30 to 15,000 cycles, being down only .7 db at 17,000 and 1 db at 20 cycles, from a 1,000-cycle reference level. This performance is better than that of any commercially available acoustical device that will be used for input. These measurements were made with resistance input and 500-ohm output.

Any further frequency discrimination is limited by the input device: for instance, in radio reception by possible sideband cutting or attenuation of the signals themselves in transmission, and in phonograph work by the pick-up and the records.

THE INPUT TRANSFORMER

The losses due to any input transformer are greatly reduced as the turns ratio is decreased. Curve 4 of Fig. 1 represents the amplifier with resistance

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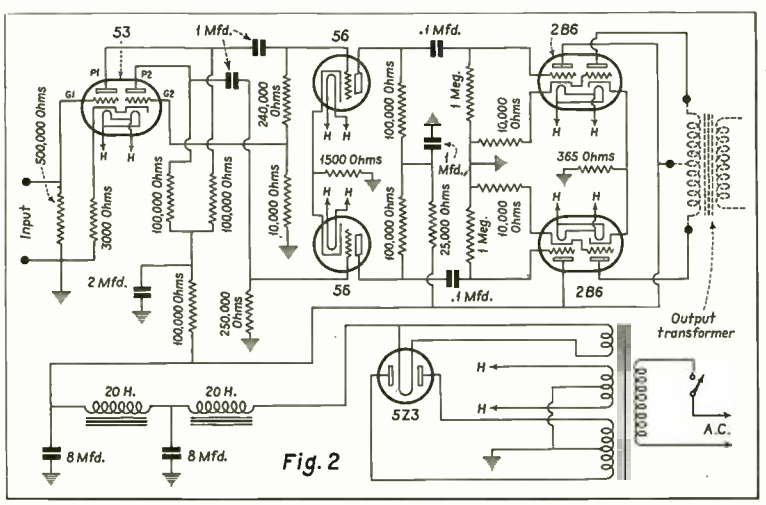

Fig. 2. Complete circuit of the high-fidelity amplifier described in the article.

Oscillographic Tube Characteristic Curves

By H. N. KOZANOWSKI and I. E. MOUROMTSEFF
WESTINGHOUSE RESEARCH LABORATORIES

A THOROUGH KNOWLEDGE of plate and grid current in a vacuum tube as function of the two variables, plate and grid potentials, is indispensable to the design engineer. Thus, for instance, the familiar charts of plate characteristics available for all standard tubes, allow the calculation of tube constants, such as voltage factor, *mu*, plate impedance, tube transconductance; they also furnish all the necessary information for choosing the best dynamic characteristic for a tube used as Class A amplifier. However, the ordinary charts fail to reveal sufficient information, if the same tube is intended for Class B or Class C operation. Indeed, for securing a reasonably high output from a tube with good efficiency, one must drive its grid well into the region of positive grid potentials, which implies the necessary, fairly high, instantaneous values of plate current. But as a rule, just this region is never covered by the ordinary charts. A similar reproach can be made regarding the grid current charts: they are usually confined to the narrow premises of relatively low positive grid and plate potentials.

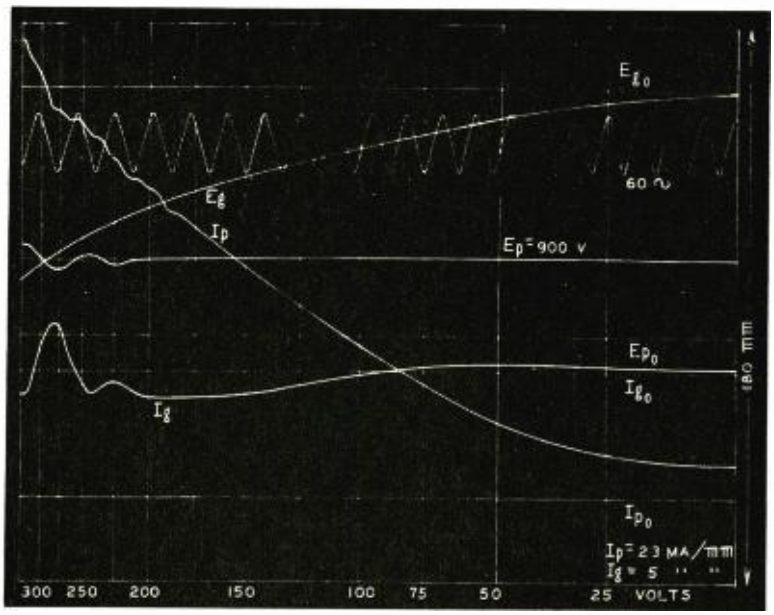

Fig. 2. Typical oscillographic record for EX-50 tube.

NEW METHOD REQUIRED

This lack of necessary information is well explained by the very nature of the method normally employed for preparing static characteristics of a tube: all four variables, two currents and two voltages, must, first, be adjusted and, then, read on measuring instruments, for every recorded point. This requires a definite minimum time, during which the total power supplied to the tube is dissipated as heat in the plate and grid, thus raising their temperature, and endangering the tube. Hence, one finds a definite upper limit for the application of the static method, which decidedly prevents the extension of characteristic curves into the most interesting and important region. Thus, the design engineer is left to draw on his experience and on cut and try methods.

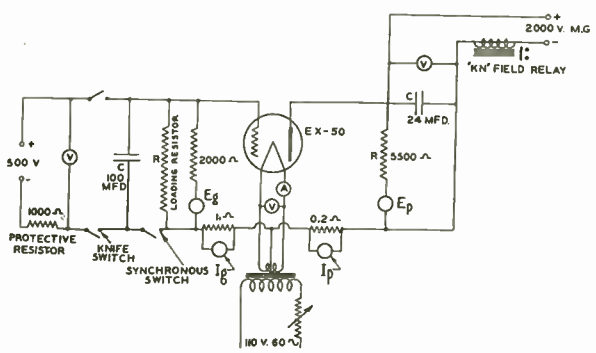

Fig. 1. Oscillograph circuit for recording triode characteristics in positive grid region.

LOGARITHMIC EXTRAPOLATION METHOD

Certainly, there is a possibility of filling out the statically unexplorable region by a method of logarithmic extrapolation of the static curves. These are mathematically expressed by the basic vacuum tube equation:

$$I_t = 1/k.\ (E_p + mE_g)^a$$

If plotted on log/log paper, with the composite voltage, $E_p + mE_g$ as independent variable, the graph of this equation is a straight line with the slope, *a*, and intercept, 1/k. Its extension, then, furnishes values of the total current, I_t for any combination of plate and grid potentials, assuming that *mu* is constant.

A DESCRIPTION OF THE "CONDENSER DISCHARGE OSCILLOGRAPHIC METHOD" OF OBTAINING COMPLETE CHARACTERISTICS OF TUBES FOR CLASS B OR CLASS C OPERATION WHERE ORDINARY GRAPHS FAIL

Though very simple, this method is open to the following criticisms:

1. The amplification factor is not constant.

2. The slope, *a*, is not necessarily a constant: it varies in the region of low plate current and also as saturation region is approached.

3. The equation and its logarithmic extrapolation, although giving the value of the total current, do not indicate how the current is divided between the plate and the grid.

4. Secondary emission, which is always present in every tube, and which may greatly affect plate and, particularly, grid currents, does not appear in the picture at all.

A logical verdict: logarithmic extrapolation can be used as an auxiliary for the checking of results obtained by other methods but not as a basic procedure.

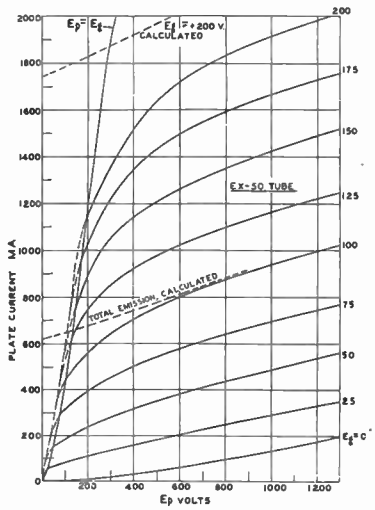

Fig. 3. Plate characteristics from oscillographic data.

OSCILLOGRAPHIC METHOD

A possible way to overcome the difficulties, inherent in both methods discussed, appears to be the application of an oscillographic-recording method.

However, it has always been assumed to be too expensive, too complicated, and inadequate for the purpose. But about a year ago, in response to the request of a certain group of design engineers for better charts of tube characteristics, a simple and reliable method, which can be described as *"Condenser Discharge Oscillographic Method,"* has been developed by this laboratory.

The new method can be briefly outlined as follows: A high-capacity high-voltage condenser, C (Fig. 1), which can be rapidly thrown across the grid and filament of the tube studied, is first charged to any desired potential, and then discharged in a comparatively short time-interval through the tube. During the discharge the decaying grid potential is always positive. A constant plate voltage is supplied by a dc generator with a filter condenser, C_1, across it.

Four oscillograph elements suitably placed give deflections proportional to the instantaneous values of grid voltage, plate voltage, grid current and plate current. These deflections are simultaneously recorded on the same film with the same time axis. The fifth element is used for recording a 60-cycle timing wave, which aids in checking and adjustment of the discharge time. The latter is governed by the time constant of the grid-condenser discharge circuit.

In this type of oscillogram it is important that the beginning of the grid excitation coincide with the beginning of the exposure. This can easily be arranged by a suitable system of relays.

In the manner described, with a single exposure one has a permanent record of all four quantities necessary for plotting

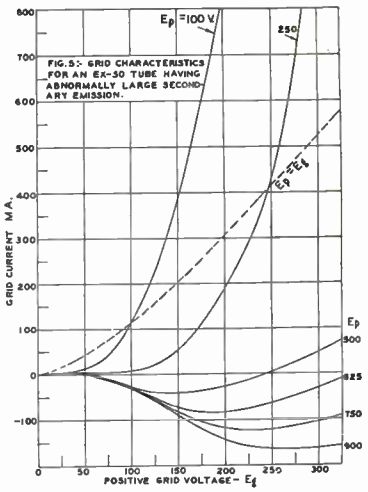

Fig. 5. Grid characteristics for an EX-50 tube having abnormally large secondary emission.

tube characteristics for a continuous range of positive grid voltages from the chosen maximum to zero value, and for a constant plate voltage.

Experiments have shown that a very complete record of characteristic curves of any radiation cooled tube, such as the UV-203A or UV-849, can be obtained with six exposures using six different plate voltages. With the apparatus once set up and calibrated, a complete set of data for plotting a complete chart of characteristics for an individual tube can be recorded in 20 or, even, 10 minutes.

Fig. 2 gives a replica of a sample oscillogram belonging to a tube of the UV-203A type. One can easily identify in it the recorded curves of grid voltage, grid current, plate voltage and plate current. Each curve is referred to a zero line of its own. The timing wave is also seen in the oscillogram. The vertical lines correspond to the arbitrarily selected grid potentials, for which

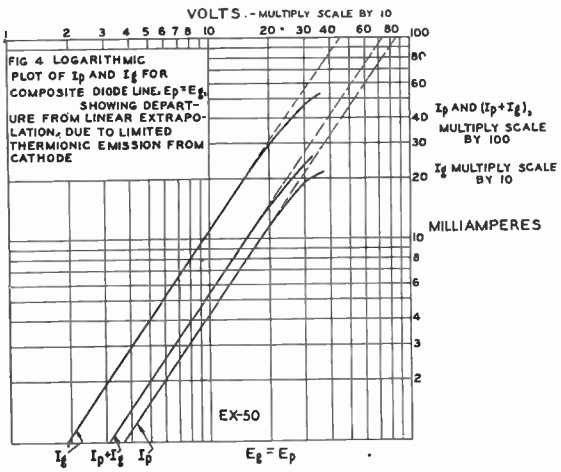

Fig. 4. Logarithmic plot of Ip and Ig for composite diode line, Ep-Eg, showing departure from linear extrapolation, due to limited thermionic emission from cathode.

the individual static curves are to be plotted in the chart.

It is interesting to note:

1. That not only the magnitude, but also the direction of the grid current indicating presence of secondary emission is directly seen in the oscillogram.

2. That plate voltage, after two or three timing cycles, is sensibly constant. Without the filter condenser, just mentioned, it can vary throughout the entire exposure. Although this does not invalidate the exposure at all, it makes its interpretation tedious.

3. That the total time of discharge is about 20 timing cycles, or ⅓ of a second.

ANALYSIS OF RESULTS OBTAINED

Fig. 3 gives a complete chart of plate characteristics taken by the described method for a tube quite similar to the UV-203A tube (the slight difference is in a somewhat greater amplification factor). First, it is interesting to note that peak current of 2 amperes at a plate voltage of 1,000 volts, which corresponds to a plate dissipation of 2 kw, has been recorded without any injury to the tube, although the rated plate dissipation limit is only 100 watts.

The line at the left, indicated by $E_p = E_g$, which we may call *the composite diode line,* is quite useful in plotting complete charts. It can easily be recorded oscillographically in the same manner, with the plate and grid tied together; it helps to verify the characteristics in the region of low plate voltages. To the left of this line the various static curves almost coincide with each other and, at the same time, depart but little from the diode line itself. Therefore, the diode line represents the practical extreme boundary for all tube oscillation paths. These will be represented by approximately straight lines passing through their cut-off points somewhere on the voltage axis, at the right, and rising to the left toward the diode line. It can readily be seen that there is little to be gained by allowing the grid and plate to swing beyond the diode line into the region of grid-higher-than-plate voltages, as such conditions considerably increase grid dissipation and driving power, without contributing to the power output.

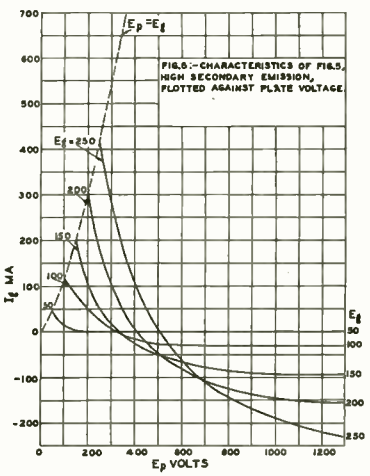

Fig. 6. Characteristics of Fig. 5, high secondary emission plotted against plate voltage.

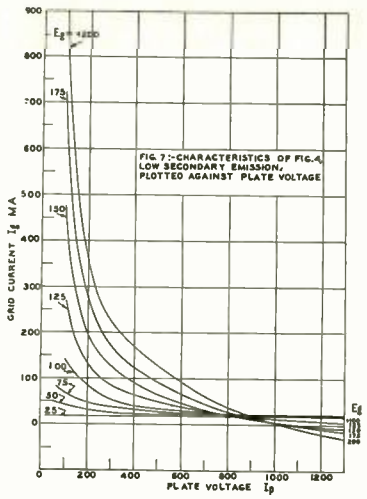

Fig. 7. Characteristics of Fig. 4, low secondary emission plotted against plate voltage.

It is interesting to note that the ordinary chart of plate characteristics, if replotted to the scale of this complete chart, is squeezed into the narrow space between the grid zero line and the voltage axis.

In the same picture the values of the plate current calculated from logarithmic extrapolation are plotted in broken lines for grid voltages + 100 and + 200. One can note that the discrepancy between the calculated and actually recorded curves is more pronounced in the upper part of the chart due to the saturation effect. This begins with plate current as low as 1.5 amperes, and even 1.3 amperes, although the total emission of the filament is rated above 3 amperes. The saturation in this chart is revealed by a greater crowding of the curves. But it is particularly clear from the comparison of logarithmically extrapolated diode line (Fig. 4) with actually recorded line.

Fig. 5 shows a grid chart for the same tube. The effect of secondary emission from the grid is quite evident. The same data are replotted in Fig. 6 in a more useful form for a design engineer. The next, Fig. 7, gives a similar family of grid curves for a UV-203A tube with a graphite anode. As a rule, secondary emission with such tubes is considerably reduced.

CONCLUSION

The complete charts, recording the real picture of the internal relations between the voltages and currents within a tube, over the whole region of feasible tube applications, can actually be of great service to the design engineer, who, using only his slide rule and pencil, can pre-calculate from them tube output, distortion, driving power, in short, all important data for any pre-conceived operating conditions.

The oscillographic method seems to be the only one, which can furnish sufficient information regarding grid current; it can be well adapted to the study of the more complicated phenomena in multi-grid tubes. Quite recently, it was successfully applied to the investigation of 20- and 100-kw water-cooled tubes.

In addition, one can state that this method can be utilized not only to obtain the conventional tube charts, but can be a very useful tool for other studies, such as grid emission; total emission from dull emitters; and, no doubt, for various other problems, connected with vacuum tubes.

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A HIGH-FIDELITY A-F AMPLIFIER

(*Continued from page* 15)

output and a high permalloy type input transformer with a 200-100,000-ohm impedance ratio, or a voltage ratio of 22:6. Curve 5, Fig. 1, shows what happens when the same type of input transformer with 200-40,000-ohm impedance ratio is used or a voltage ratio of 14:1. Obviously, there is quite a difference. Curve 6 represents the overall response of the commercial amplifier that was the original objective in the design problem. This was obtained with high permalloy type transformers in both the input and output positions. The db variation is less than 1.5 from 20 to 17,000 cycles, measured from 200-ohm input to 500-ohm output.

The two 2B6's give a power output of 15 watts, with only 5% distortion. The hum level is 75 db below maximum output, which affords a full 70-db volume range. This quietness of operation was obtained by the use of cathode tubes throughout, high L and C in the filters, choke input in the power supply, and generally careful mechanical placement of the parts and wiring.

The convenient size of the chassis makes mounting simple; the whole amplifier measures only 16 inches wide, 7 inches deep and 8 inches high.

The circuit as shown in the diagram is so simple that detailed explanation is unnecessary. The amplifier itself is almost all resistors and condensers, while the reliable 5Z3, a power transformer, two chokes and two condensers form the power supply.

NEW SYLVANIA Cathode-Ray Tube

THE H7-2 CATHODE RAY is a general purpose oscillograph tube equipped with two sets of deflecting plates. It may be used for observation and photography of many transient and recurrent electrical phenomena.

The two sets of deflecting plates, which have one common connection, provide two electrostatic fields at right angles to each other for deflecting the electron beam. Ordinarily, one set is used to reproduce the voltage under observation; the other is used for suitable timing control.

Electromagnetic deflection along one axis may also be used with the H7-2. In this case, the electromagnetic field should be placed so that the deflection produced by it is at right angles to that produced by the set of deflecting plates farthest from the anode.

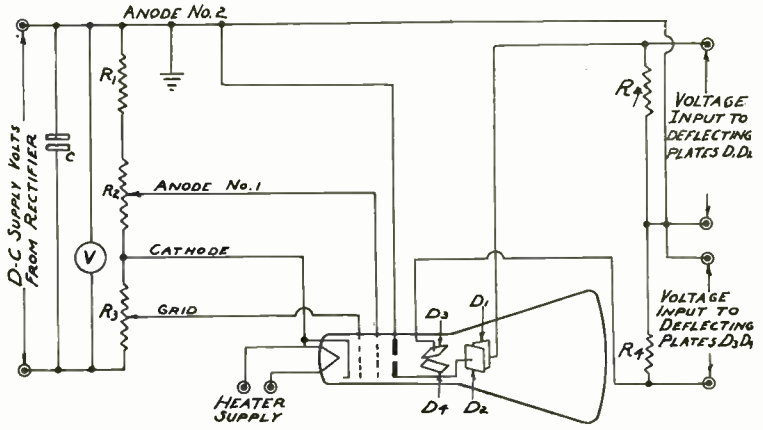

Fig. 2. Typical oscillograph circuit for the Type H7-2 tube. C is 0.5- to 2.0-mfd filter condenser; R-1, R-2, R-3 is bleeder potentiometer, R-1 being 0.5 meg, R-2, 0.2 meg and R-3, 0.02 meg. R-4 is 10 megs.

BULB

The bulb of the H7-2 should be enclosed, except for the viewing screen, in a grounded case. This will screen the tube from extraneous electrostatic fields, will reduce the possibility of accidental breakage, and will prevent flying glass, should the tube in some way be broken. A soft iron case may be used for shielding against extraneous magnetic fields, but care must be taken that this is not permanently magnetized.

CATHODE CIRCUIT

The filament may be operated at any voltage (ac or dc) within a maximum rating of 2.5 volts, according to the intensity of beam required. Conservative operation of the cathode will increase the life of the tube. *If the H7-2 is operated with anode No. 2 grounded, it is important that the heater transformer secondary be insulated to withstand the maximum anode No. 2 voltage of 1200 volts.* Grid and anode returns should be made to cathode.

GRID CIRCUIT

Decreasing the negative voltage between the grid and cathode will increase the intensity of the luminous spot and also its size. For best resolution of a screen pattern, the negative grid voltage should be increased until the spot is just easily visible. Because the control grid is a part of the focusing system, it is necessary to refocus the spot when the grid voltage is changed.

ANODE CIRCUIT

The dc supply voltages may be obtained from a rectifier system employing a high-voltage rectifier tube. Since the current demand of a cathode-ray tube is very small, half-wave or voltage-doubling rectification may be used. Little filtering is required for the same reason, a 0.5- to 2.0-mfd shunt condenser being all that is necessary.

The anode voltage is dangerous, and care should be taken that the operator is guarded against these voltages. It is recommended that the positive high-voltage terminal be grounded, leaving the cathode terminal below ground. In this way the dangerous potentials can easily be made inaccessable.

DEFLECTING PLATES CIRCUIT

One plate of one set of deflecting plates is connected to one plate of the other set, and these two plates are further connected to Anode No. 2 within the tube. In order that the free plates

General	
Heater Voltage (ac or dc)	2.5 Volts
Heater Current	2.1 Amperes
Heating Time	0.5 Min. (Approx.)
Direct Interelectrode Capacitances	
Grid to all other Electrodes	15.0 Max. mmfd.
Deflecting Plate D1 to Deflecting Plate D2 (Top Set)	4.0 Max. mmfd.
Deflecting Plate D3 to Deflecting Plate D4 (Bottom Set)	3.0 Max. mmfd.
Maximum Length	11-15/32"
Maximum Diameter	3-1/16"
Bulb	J-24
Base (See Fig. 1)	Medium 7-Pin

Characteristics	
High Voltage Electrode (Anode No. 2) Voltage	1200 Max. Volts
Focusing Electrode (Anode No. 1) Voltage	250 Max. Volts
Grid Voltage	Never Positive
Grid Voltage for Current Cut-off (with approx. 200 Volts on Anode No. 1)	—35 Approx. Volts

Typical Operation				
Heater Voltage			2.5	Volts
High Voltage Electrode (Anode No. 2) Voltage	600	800	1000	Volts
Focusing Electrode (Anode No. 1) Voltage	135	155	190	Volts
Deflection Sensitivity (Plates D1 and D2)	0.53	0.35	0.30	Mm/Volt dc
Deflection Sensitivity (Plates D3 and D4)	0.55	0.38	0.32	Mm/Volt
Current to Anode No. 1	0.012	0.023	0.045	Ma
Current to Anode No. 2	0.003	0.004	0.005	Ma

be maintained at essentially the dc potential of Anode No. 2, each of the free plates should be connected to Anode No. 2, through a 5- to 10-megohm resistor. This prevents distortion due to an accumulated charge on a free deflecting plate.

Magnetic deflection of the electron beam may often be used with advantage where there is not sufficient voltage for deflection. The few turns of wire needed to produce the magnetic field may, in many cases, be added to a circuit without undue distortion of its conditions. Sometimes fields already available in the circuit may be used, e.g., oscillator tank coils. The field should be applied in the vicinity of the upper deflecting plates, and should be as concentrated as possible. Deflection due to a magnetic field is at right angles to the lines of force of the field.

APPLICATION

Fig. 2 illustrates the essential circuit for the use of the H7-2 as an oscillograph. The electrode voltages are obtained from a bleeder circuit connected across the high-voltage supply of a rectifier system. By means of potentiometers in the bleeder circuit, the voltages for Anode No. 1 and for the grid can be adjusted for operating conditions.

In normal operation, 1000 volts are put on Anode No. 2, and the voltages of Anode No. 1 and the grid are adjusted to give the desired spot size and brilliancy. The action of Anode No. 1 is to focus the beam, and this is accomplished by varying the ratio of the voltages on Anodes No. 2 and No. 1. This ratio will generally be approximately 4.5 to 1. The spot size may be decreased in two ways, by increasing the voltage of Anode No. 2, keeping the grid bias constant, or by keeping Anode No. 2 voltage constant, and increasing the negative grid bias. The deflection sensitivity will change with Anode No. 2 voltage as shown in the table of characteristics, and the intensity of the luminous spot will change with the grid voltage, increasing with decreasing grid bias.

A stationary spot of high intensity will burn the fluorescent screen if allowed to remain in one spot too long. For this reason, it is advisable always to keep the beam in motion on the screen. If this is not possible, arrangement should be made for decreasing Anode No. 2 voltage, or increasing the negative grid bias, when the beam is not in motion.

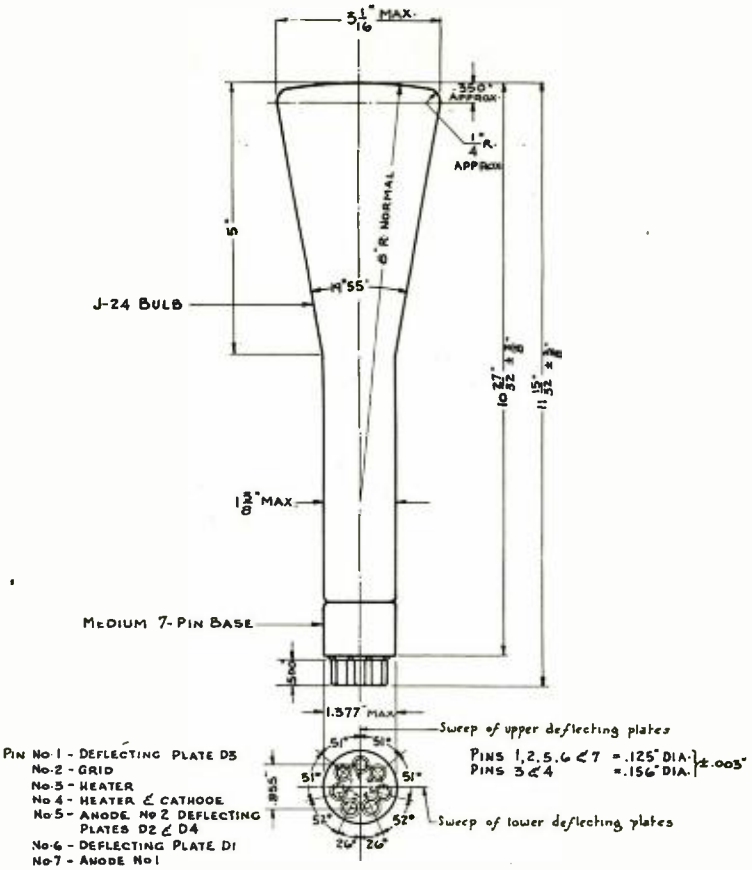

Fig. 1. Outline drawing for the Type H7-2 cathode-ray tube, together with bottom view of base and the pin designations.

NEW RCA HIGH-VACUUM CATHODE-RAY TUBES

(*Continued from page* 12)

other hand, has the effect of decreasing the spot size and intensity.

APPLICATIONS

Due to the short time of phosphorescence of the screen, which is less than 25 microseconds, the 907 and 908 are adapted especially for applications where it is desirable to supply timing by mechanical means external to the tube . . . such means may be the use of a recording film moving at constant speed or a system of mirrors rotated at a uniform rate.

Photographs may be taken by focusing a camera on the screen for a suitable length of time. The time of exposure naturally depends upon the speed of the camera lens, the kind of film, and the brightness of the pattern. Where transients are to be photographed, maximum brightness and rapid exposure are required; where recurrent waveforms are to be photographed, low brightness can easily be compensated for by longer exposure.

Besides the study of electrical wave forms and transients, the measurement of modulation, adjustment of radio receivers, determination of peak voltages, and tracing of vacuum-tube characteristics are a few of the many other uses that can be conveniently performed by means of these cathode-ray oscillograph tubes.

RADIO MARKET LOOKING UP

(*Continued from page* 13)

$1,621,283, or only slightly under the $1,813,980 recorded for 1933.

The complete insolvency record of the radio industry since 1930, including January to November, inclusive, of 1934, as compiled by Dun & Bradstreet, Inc., shows:

Manufacturers

Year	*Number*	*Liabilities*
1930	40	$3,522,400
1931	15	4,088,445
1932	23	1,826,995
1933	25	3,719,519
1934*	6	526,630

Wholesalers and Retailers

Year	*Number*	*Liabilities*
1930	217	$2,071,392
1931	160	4,979,359
1932	170	1,978,678
1933	109	1,813,980
1934*	33	1,621,283

(*) January to November, inclusive.

News of the
RADIO MANUFACTURERS ASSOCIATION

CODE OPERATIONS OF CABINET MANUFACTURERS

AN EFFORT TO unsnarl and definitely fix the NRA code status and operations of radio cabinet manufacture is being made by the NRA, the RMA and the furniture industry. A special hearing on the radio cabinet matter was held by the NRA on December 4 and by the furniture code authority in Washington on December 12. The matter now goes before the general board of NRA for a final ruling so far as specialty cabinet and furniture manufacturers are concerned, as the electrical code will continue applicable to radio set makers who manufacture their own cabinets.

At the NRA special hearing on December 4 the radio cabinet and furniture interests were unanimous in opposing the provision in the furniture code requiring time and a half wages for extra labor shifts. This would penalize manufacturers and increase costs during peak production required to fill orders for radio cabinets. The interests of radio set manufacturers and their needs for cabinet deliveries during the regular peak seasons were presented at the NRA hearing by Arthur T. Murray of Springfield, Mass., chairman of the RMA Set Division; N. P. Bloom of Louisville, Ky., chairman of the RMA Cabinet Committee; Bond Geddes, RMA Executive V. P.-General Manager, and several specialty radio cabinet manufacturers. They urged the necessity of exempting outside cabinet and furniture companies from the extra shift penalty of the furniture code which was designed solely to prevent furniture over-production. Some cabinet manufacturers have been operating under the furniture code and some under the President's voluntary agreement, while some set makers produce their own cabinets under the electrical code.

The entire furniture code authority on December 12 reviewed the complicated problems involved but denied application of the specialty cabinet makers for exemption from the extra shift penalty of the furniture code, some of the code authority believing that this might lead to evasion and also set a precedent.

The governing board of NRA is now moving to assume jurisdiction of the entire matter and determine the future code position and operations of cabinet specialty and furniture manufacturers engaged in making radio cabinets.

RMA RECEIVING SET AND TUBE STANDARDS REVISED

NOMENCLATURE OF radio receiving sets and also of tube numbering standards have been perfected by the RMA General Standards Committee, of which Virgil M. Graham of Rochester, New York, is chairman. In revising the industry definitions of receiving sets, the RMA General Standards Committee, meeting at Rochester, November 12, 1934, revised two standards, as follows:

"A Standard Broadcast Receiver is one which will respond to the entire broadcast frequency range of 540 kilocycles (555.2 meters) to 1600 kilocycles (187 meters)."

"An All-Wave Receiver is one whose tuning ranges will respond to all frequencies between 540 kilocycles (555.2 meters) and 18,000 kilocycles (15.6 meters)."

Definition of the "Standard and All-Wave Broadcast Receiver" is having further study by RMA committees with a view to a better definition.

The General Standards Committee has also adopted as RMA standards the "Requirements on Power-Operated Receiving Appliances" of the Underwriters' Laboratories. This action is to effect adoption of these standards by the American Standards Association for establishment in pending ordinances of New York City and other municipalities in local regulation.

The new tube standards adopted by the General Standards Committee provide for designation of types of receiving tube bases by a system of three digits, the first, being a letter, indicating the size and type of base shells; the second digit, being a figure, indicating the number of pins, and the third digit, a letter, indicating the pin arrangements. Details of the new standards are being supplied RMA members.

RMA PATENT FOLDER DISTRIBUTED

TO PROVIDE A permanent file for the weekly RMA patent bulletins, loose leaf folders have been distributed to all RMA members. Any member not receiving the folder is requested to advise the RMA offices. The RMA Board of Directors ordered the patent bulletin folder as a convenience to members in view of the many expressions received of the value of the RMA patent service and its permanence similar to the engineering, credit information and other Association services for which manuals have been provided.

"BUY RMA" CAMPAIGN

STEADY GROWTH in the "Buy RMA" plan under which Association members give preference in their purchases to fellow members of the RMA is reported among receiving set and also parts and accessory manufacturers. Several new applications for RMA membership have been received and are pending for the next meeting of the RMA Board of Directors. President Muter of the RMA, reinforcing the efforts of Chairman W. S. Symington and the Membership Committee, has written a personal letter in support of the membership campaign and the results of the "BUY RMA" plan, instituted during the last year, are said to have been most satisfactory to parts and accessory members as well as set manufacturing companies of the Association.

FACSIMILE DEVELOPMENT

FACSIMILE EXPERIMENTS have reached the point where organized development is being undertaken by the RMA Engineering Division. A special committee on facsimile, headed by E. W. Engstrom of Camden, N. J., as chairman, has been organized by Dr. W. R. G. Baker, chairman of the Engineering Division, and Virgil M. Graham of the Standards Committee. The new Facsimile Committee has begun to function, starting work on nomenclature and standardization. Four facsimile circuits, between New York and San Francisco, London, Berlin and Buenos Aires, are now in operation by RCA Communications Inc.

The romantic appeal as well as the service aspects of facsimile are both being considered by the RMA engineers in directing scientific progress toward eventual development of a practicable facsimile broadcasting system. The drum type of facsimile apparatus is now in use but eventual development of a continuous type of recorder, taking its paper from a feed roll, is regarded as the ultimate practical solution for broadcast facsimile recording. Higher speed also is an engineering goal.

RMA DIRECTORS MEET

INDUSTRY PLANS for the new year, including final determination of the NRA-code status of radio manufacturers, are on the docket of the RMA Board of Directors for a meeting January 10. President Leslie F. Muter has called the Association's directors together to launch 1935 activities of the RMA. The directors' meeting January 10 will be held at the Union League Club in Chicago and precedes a meeting January 15 at Washington, on the radio industry code matter, with NRA and NEMA.

Progress on the RMA national sales promotion project, which is now developing rapidly under Chairman Powel Crosley, Jr., will be reported to the directors on January 10 and they will also consider tax, radio, labor and other legislation coming before Congress and many State Legislatures in 1935.

NRA APPROACHES FINAL DECISION

THE FINAL STAGE of negotiations on the long pending NRA-code status of radio manufacturers has been reached. The radio industry code matter has been placed at the top of the NRA calendar. A conference at Washington on January 15 of the RMA Code Committee and other leading radio manufacturers with the NEMA Committee has been called by the National Recovery Administration. Captain William Sparks of Jackson, Michigan, chairman of the RMA Code Committee, and President Leslie F. Muter will head the RMA conferees.

The purpose of the January 15 conference is to conclude negotiations and reach a decision for separate and independent code operations of the radio industry following the formal agreement made August 21 by NEMA and RMA with the National Industrial Advisory Board. This agreement provides for separate and independent code status and operations for radio manufacturers, with a radio code authority reporting directly to NRA but with continued operation, if possible, through the electrical code. A pending alternative is the separate radio industry code submitted last June by the RMA to NRA.

Pending the NRA decision on the radio industry code matter, it now appears certain that NRA will defer action, as requested by RMA, on two supplemental codes proposed by NEMA. The first supplemental code relates to manufacturers of transmitting and public-address apparatus and commercial receivers, and the second

(Continued on page 24)

CATHODE-RAY OSCILLOGRAPH DESIGN

THE USE OF A cathode-ray tube as an oscillograph permits a visual study of most any type of electrical function with the result that the precise adjustments necessary in radio equipment may be made with more assurance than is provided by other forms of visual indicators.

The cathode-ray oscilloscope has long been used in conjunction with receiver development work and in connection with production testing. However, the earlier types of oscilloscopes, as helpful as they were, had a number of disadvantages which have since been eliminated. The cathode-ray tubes have been improved considerably so that screen images are more reliable, and accessory equipment has been refined to the point where a complete cathode-ray oscilloscope, with power supply, amplifier, sweep oscillator, etc., may all be contained in a case both small and light in weight.

PORTABLE UNIT

RCA Victor have developed a compact, ac-operated cathode-ray oscilloscope of portable type having a number of new features. As an example, it includes two power supplies, one for the cathode-ray tube and one for the amplifiers. The unit includes vertical and horizontal amplifiers, synchronizing frequency generator and six tubes, including the new Type 906 cathode-ray tube.

Through the use of two wide-frequency-range high-gain amplifiers, the sensitivity is equivalent to 2 volts dc per inch for both vertical and horizontal deflection. The amplifiers have flat frequency characteristics between 20 and 90,000 cycles plus or minus 10 percent, with an amplifier gain of approximately 40.

Fig. 1. Panel view of RCA Cathode-Ray Oscillograph.

SAW-TOOTH OSCILLATOR

A linear saw-tooth synchronizing frequency oscillator with a special locking circuit is an integral part of the oscillograph, having a frequency range from 20 to 15,000 cycles. This permits the examination of a single cycle up to 15,000 cycles or the examination of six cycles up to the limit of the amplifier—90,000 cycles. Suitable switching is provided so that either the internal oscillator, 60-cycle ac from the power mains, or an external synchronizing source, may be connected to the horizontal plates.

OSCILLOGRAPH CONTROLS

A panel view of the cathode-ray oscillograph is shown in Fig. 1. The bezel in the upper center surrounds the 3-inch screen of the Type 906 cathode-ray tube. Slightly to the left and below the bezel is the intensity control for regulating the light on the fluorescent screen. This knob also controls the power switch when turned full counter-clockwise. The amplifier "A" switch, directly below the intensity control, permits input to be connected directly to the vertical deflecting plates or to the vertical amplifier. At the bottom of the panel is the vertical amplifier gain control for regulating the size of the screen image.

Directly below the tube screen is the saw-tooth oscillator range switch which gives choice of light frequency range for synchronizing. The synchronizing selector switch—marked "Timing" on the panel—is directly below the range switch, and connects either the internal saw-tooth oscillator, 60 cycles ac, or external synchronizing voltage, to the horizontal deflecting plates.

At the upper right of the panel is the focusing control which adjusts the voltage on plate No. 1, thereby focusing the electron beam on the screen. Below this is the amplifier "B" switch which permits the amplifier to be connected to the saw-tooth oscillator, to the horizontal deflecting plates or to be disconnected so that an external timing voltage may be used. At the right bottom of the panel is the horizontal amplifier gain control which regulates the horizontal deflecting voltage.

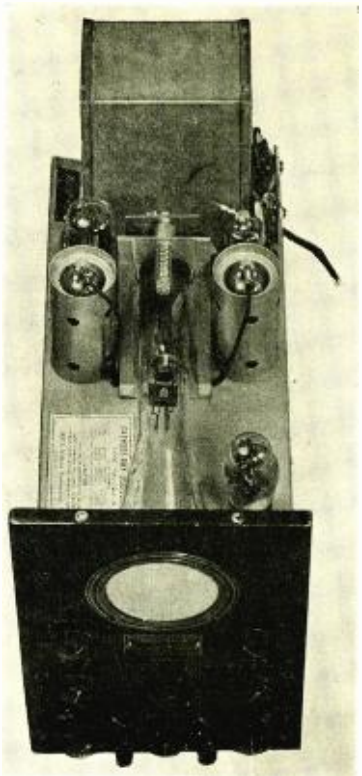

Fig. 2. Interior view of the RCA Cathode-Ray Oscillograph, showing the amplifier tubes at the rear, the cathode-ray tube, and the saw-tooth oscillator tube near the front of the panel.

To the left and just below the center range switch is the synchronizing voltage control which adjusts the output of the saw-tooth oscillator. To the right of this control is the synchronizing oscillator fine adjustment which permits adjustment of frequency between each point of the center range switch.

The input binding posts to which are connected the voltage to be observed, are on the left side of the panel, while the binding posts for external synchronizing voltage are on the bottom of the panel. Another pair of binding posts are mounted on the right side of the panel for accommodating the external deflecting voltage.

TUBE COMPLEMENT

An internal view of the cathode-ray oscilloscope is shown in Fig. 2. The case mounted at the rear of the chassis is the power transformer which supplies power for all tubes and rectifier circuits. Directly in front and to the left of the power transformer is the type 80 tube which supplies the high-

voltage dc for the amplifiers. On the right side is the Type 879 high-voltage rectifier which supplies 1000 volts to the cathode-ray tube. The two tubes in the shields are type 57's, the one to the left being the vertical amplifier and the one to the right the horizontal amplifier. Between these two tubes is mounted the spring-type socket for the cathode-ray tube. The tube mounted toward the front of the chassis is a Type 885 gas triode which functions as the saw-tooth timing axis oscillator.

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CATHODE-RAY TUBE DESIGN

DURING THE PAST several years considerable progress has been made in improving the electrical characteristics of the cathode-ray tube. More recently, special attention has been given to the mechanical characteristics as well.

ELECTRODE MOUNTING

To cite an example, in Fig. 3 is shown a new design which has been evolved. This construction consists of a hollow annular member to which the deflection electrodes and the accelerating electrode are attached, inside of which the electron-generating and focusing electrodes are mounted. It will be seen that as the leads to the electrodes are exceedingly short, no spacers are necessary, yet the tube is stronger and will stand considerable shock. It will also be noticed that as the high-voltage leads are all taken from the top of the annular member and the low-voltage leads from the bottom, that it is possible to use high voltages without fear of breakdown. Another important feature of this construction is the fact that the distance between the screen and the deflection plates is large compared with the length of the tube, allowing maximum sensitivity. It will be noticed in this connection that the first electrode is placed directly at the base of the tube.

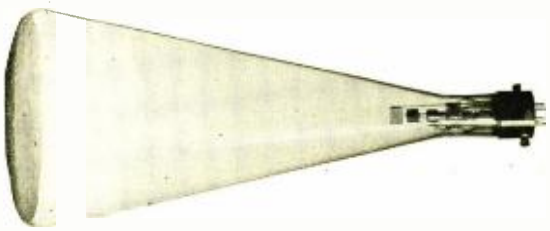

Fig. 3. DuMont Cathode-Ray Tube having a new type of construction which improves sensitivity and obviates voltage breakdown.

HIGH-FREQUENCY OPERATION

This new type of construction permits the tube to be used at higher voltages and frequencies. The tube shown is of the high-vacuum type utilizing electron lense focusing and can be operated up to 100 megacycles. This same construction can be adapted to the gas focus tubes which have certain advantages at the lower frequencies.

The many uses to which the cathode-ray tube is being applied, such as aeroplane and ship direction finding, vibration studies and television, has led to this development with the idea in mind to get the shortest tube possible and still have high sensitivity and ruggedness.

ALLEN B. DUMONT,
Allen B. DuMont Laboratories.

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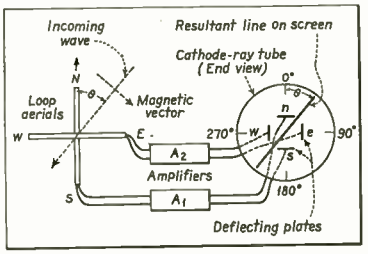
CATHODE-RAY DIRECTION FINDER

THE RADIO RESEARCH BOARD of Australia have conducted rather extensive investigations on atmospherics with particular regard as to their causes and effects on radio communication in that country.

The research has for the most part been carried out through the utilization of cathode-ray direction finders, and descriptions are given of the principal and characteristic features of these instruments, and of the procedure adopted in their installation, calibration and use in Bulletin No. 68 of the Radio Research Board, Report No. 5, on Atmospherics in Australia. Regular observations of the directions and intensities of individual atmospherics have been taken and the origin of atmospherics have been located as far as 1,500 miles from the observation points.

The schematic of the cathode-ray direction finder employed in this work is shown in the accompanying diagram and is almost self-explanatory. Emf's applied across the two pairs of parallel plates (n, s, w, e) set up electric fields, at right angles to each other, that control the cathode-ray beam, and hence control the resulting figure on the fluorescent screen. Now it will also be noticed that two identical loops are employed, the axes of these loops being horizontal and at right angles to each other. Referring to the figure it will be seen that voltages induced in the loops from the incoming wave (see dotted arrow in the figure) will be amplified and applied to the two pairs of deflecting plates. As a matter of fact these voltages will both be amplified by the same amount and applied in the same phase relationship to the plates. If this incoming wave makes an angle Θ with the plane of the N-S loop the voltage induced in this same loop will be proportional to the Cos Θ. This results in a voltage proportional to the amplitude of Cos Θ deflecting the cathode-ray beam. In a like manner the beam will be affected by a voltage proportional in amplitude to the Sin Θ from the W-E loop. The resultant effect is to produce a trace on the screen which for a normally polarized wave will be a straight line, the direction of this line corresponding to the direction of the incoming wave.



Circuit of the cathode-ray direction finder.

As long as the magnetic vector is horizontal the above conditions will hold true and do not depend upon whether the wave is a horizontal ground wave or a sky wave inclined to the horizontal. The same will be true for a combination of these waves. But, if the incoming wave is inclined to the horizontal and does not have a horizontal magnetic vector the horizontal component of the vector is not perpendicular to the direction of travel of the wave and the direction indicated on the oscillograph will not be correct, i. e., the direction finder will really indicate the direction of this component.

Now if we have two horizontal magnetic fields of the same frequency but from different directions, the resulting field will be rotating unless it so happens that the two components are in phase. Naturally this will produce an ellipse on the fluorescent screen of the direction finder. Since an atmospheric can be considered to be composed of a number of different frequencies, there will result a number of rotating fields, and these will appear on the screen as a blurred ellipse.

RMA NEWS

(*Continued from page 21*)

relates to "specialty transformer" manufacturers including those of radio transformers. In a brief filed December 17 against the first supplemental code and in a subsequent protest against the proposed "specialty transformer" supplement, the RMA vigorously insisted that both supplements be delayed until the code status of the entire radio industry is determined and subsequently NRA called the radio code conference for January 15.

The RMA brief against the proposed supplemental code for radio transmitting apparatus. public address and commercial receiver manufacturers, signed by Chairman Sparks of the RMA Code Committee, and Bond Geddes, executive vice president-general manager, denied that the NEMA group presenting the supplemental code was "truly representative" as required by law. That the supplemental code was an effort to dismember parts of the radio industry also was charged by the RMA.

Manufacture of commercial radio receivers, including police, aircraft and other types, is an esential part of the radio industry, the RMA brief asserted, and a large majority of such manufacturers are identified with the RMA.

In promoting interests and sales of radio transmitting apparatus and tubes, the RMA in both domestic and export fields has had many activities while NEMA has had virtually none, the RMA brief recited. Transportation rate reductions also have been secured by RMA for manufacturers of tubes, public address, loudspeaker and other members, while NEMA has done nothing in this respect. In Federal and State taxation of radio, the RMA has frequently appeared before Congress and the Treasury Department, as stated in the RMA brief, while NEMA has done nothing in such interests, while many other services are provided by RMA to the member manufacturers concerned.

NOVEMBER EXCISE TAXES

LARGE INCREASE IN radio sales during the final quarter of 1934 are reflected in official government reports of radio excise tax collections. Such collections during November 1934 were $462,638.47, an increase of 87.7 per cent over the taxes of $246,526.75 collected in November 1933. while the taxes of November 1932 were $298,577.86.

For eleven months of 1934 ending in November, the total excise taxes collected were $2,952,000, an increase for the eleven months of about $300,000 over the entire excise taxes of the whole calendar year of 1933. December sales and taxes have been uniformly larger, occasionally double those of November, and the tax returns indicate the excellent business enjoyed by the radio industry during the past year.

1934 A GOOD YEAR

By Bond Geddes, RMA Exec. V.P.-Gen. Mgr.

GENERALLY, THE RADIO industry in 1934 enjoyed its best business since the depression. In total volume of receiving sets, tubes and parts and accessories and also in unit value there were substantial increases during 1934, largely due to introduction and wide public acceptance of the new modern dual-wave and all-wave receivers.

Estimates of 1934 sales are now coming from many quarters prior to compilation of final statistics. The best information now available indicates that 1934 sales of receivers totaled at least 4,500,000 and tubes around 65,000,000. This compares with estimated 1933 sales of 3,800,000 sets and 55,600,000 tubes. Dun & Bradstreet have issued an estimate that receiver sales in 1934 will even reach 5,500,000.

The 1934 set industry was marked by a decreasing ratio in sales of midget sets and increased public demand for more extensive console sets, and there was a widened trend in sales of the larger cabinet or mantel type. Steady demand for automobile sets also continued in 1934.

Only four new receiving tubes were introduced in 1934 as compared with forty-one new tubes in 1933, a stabilizing influence for both set and tube manufacturers.

It is estimated that the average retail price of all types of home receivers rose from about $48 in 1933 to nearly $60 in 1934.

In technical advance in engineering development of receivers, 1934 was marked by expansion of the frequency range. Two years ago less than half of the set manufacturers presented models covering more than the American band while now over ninety per cent of radio lines include extended-band receivers, while seventy-five per cent of 1934 models were multiple-band types.

RADIO EMPLOYMENT INDICES

INCREASED SEASONAL production in the radio industry is reflected in the October 1934 report of the U. S. Department of Labor, Bureau of Labor Statistics, on radio factory employment. During October 1934 fifty-one radio and phonograph establishments reported employment of 39,335 employees and the October statistics do not include reports from a number of manufacturers previously reporting. Wage increases affecting 511 employees were reported during October by two manufacturers.

While national factory employment increased 3.8 per cent from September to October 1934, and national payrolls increased 48 per cent. largely due tc settlement of textile labor difficulties, there was reported increase of 1.7 per cent in radio factory employment during last October, but a decrease of 6.1 per cent from radio employment in October 1933. The general index of average radio employment for the three years, 1923-25, was 223.6 per cent during October 1934. There was a payroll increase of 9.3 per cent in radio factories last October, with the three-year average of 1923-25 at 138.8 per cent during October.

Per capita weekly earnings of the reporting companies in October were $19.87, an increase of 7.6 per cent over the preceding month, and 3.7 per cent over those of October 1933. Average hours worked per week during October 1934 were 35.9, an increase of 9.1 per cent over the previous month, but 1.1 per cent below October 1933.

Average hourly earnings of radio employees during October 1934 were 52.7 cents as compared with 53.3 cents in the previous month, a decrease of 1.1 per cent, but were 9.9 per cent larger than Oct. 1933.

RADIO LEGISLATION IN CONGRESS AND MANY STATE LEGISLATURES

THE JANUARY MEETING of the new Congress will open the doors to much future radio legislation. Forty-four State Legislatures also convene in January or soon thereafter and the RMA is preparing for appropriate action in interests of radio. A busy legislative season looms for the RMA Legislative Committee, headed by Paul B. Klugh of Chicago, and the various State Legislative Committees of RMA and also the National Association of Broadcasters with which the RMA cooperates.

Radio legislation in Congress will not come soon, probably not before spring. The congressional committees handling radio legislation are reorganizing and committee chairmen have decided to await formal reports of the new Federal Communications Commission. An important Commission report due February 1 is that on broadcasting, in connection with the demand of special interests for special broadcast allocations and to which it is predicted the Federal Commission will be adverse. General reallocation of broadcast facilities seems unlikely. Senator Wheeler, Democrat of Montana, will be the new Senate Committee chairman in charge of radio legislation. Representative Oscar Bland, Democrat of Virginia, continues as chairman of the House Merchant Marine and Fisheries Committee which handles radio legislation, but there is some discussion of a new radio committee in the lower House.

In addition to general industry legislation such as continuation or revision of NRA, the renewed 30-hour week bill of Senate Black of Alabama, and other general industrial matters in which the RMA is concerned, the 5 per cent federal excise tax on radio is a matter of primary importance. Scheduled to expire by limitation next June, it appears probable that the radio excise tax must be continued because of financial necessities of the Treasury. At the opening of Congress congressional leaders appeared to be veering toward continuation of all excise taxes, including radio taxes. Government revenue from radio is comparable in importance with that from playing cards, matches, automobile products, automotive parts and accessories, automobile tubes and the total collection of club dues, according to the last Internal Revenue returns. Gasoline, tobacco, beverage, electrical energy, theatre admissions and telegraph and telephone messages are the principal excise tax sources, but the radio taxes are a substantial part. The sentiment in Congress apparently favors repeal of all such "nuisance" taxes, but federal revenue needs are so large that it now appears the excise taxes, including those on radio, will be continued.

The forty-four State Legislatures now convening are expected to adopt sales taxes rather widely. General sales taxes in the States have not been opposed by the RMA, but it has vigorously and thus far successfully opposed any special "luxury" taxes on radio. Regulation of automobile receivers capable of receiving police broadcast and other radio legislation also is expected to develop from the new State Legislatures. The RMA through its Board, Legislative Committee and State Committees is prepared to act in all radio interests as the new national and state legislative programs get under way.

P.W.A. BUYS SOME RADIO

SOME BUSINESS FOR the radio industry has come from expenditures of the Public Works Administration under Secretary Ickes of the Department of Interior. The radio business amounts to only about one per cent of P. W. A., purchases in its construction program aggregating $555,000,000 but is substantial. Total P. W. A. purchases of radio apparatus and supplies have aggregated $584,892. during the fifteen-month period covered by the P. W. A. activities.

News Of The Industry

AMERICAN ELECTRO METAL CORP. PURCHASES NEW MACHINERY

Unusual activity is reported at the plant of the American Electro Metal Corporation in Lewiston, Me.

Not only is this concern increasing its working force, but it has recently signed contracts for the rebuilding of part of its factory.

According to Mr. Rudolph Lowit, General Manager of the company, this rebuilding is for the purpose of taking care of the large amount of new equipment which has been purchased and part of which has already been received. Although declining to say the exact use to which this new machinery is to be put, Mr. Lowit stated that it consisted of the very latest types of generators, transformers, motors, electric furnaces, hydraulic presses and forming and swaging machines.

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RCA VICTOR-RADIOTRON CONSOLIDATION

Consolidation of the activities of the RCA Radiotron Company with the RCA Victor Company into a single organization to be known as the RCA Manufacturing Company, Inc., January first, entails no changes in any of the sales, advertising or management policies of either of the two former companies, nor any change whatever in the products or trademarks heretofore used, according to Mr. E. T. Cunningham, President of the new RCA Manufacturing Company.

"The formation of the new Company is the final step in the process of centralization which has been going on for more than a year in the interests of greater operating economy and efficiency," Mr. Cunningham said. "As in the past, the RCA Victor Division and the RCA Radiotron Division will operate independently of each other as their different problems warrant. The same, separate sales organizations and advertising programs will be maintained. The RCA Victor, the RCA Radiotron, the RCA Photophone and other widely known RCA trademarks which have through the years accumulated a vast amount of public good-will and acceptance will continue to be featured in the new Company's advertising and labeling. RCA Victor products will continue to be developed and manufactured at Radio Headquarters, in Camden, New Jersey; and RCA Radio Tubes will continue to be developed and manufactured in the Harrison, New Jersey, plant."

Mr. Cunningham also made public the complete list of Board of Directors and officers of the new company, as follows:

Mr. David Sarnoff, Chairman of the Board; Mr. E. T. Cunningham, President and Director; Mr. G. K. Throckmorton, Executive Vice-President and Director; Mr. W. R. G. Baker, Vice-President in charge of the RCA Victor Division and Director; Mr. J. C. Warner, Vice-President in charge of the RCA Radiotron Division and Director; General James G. Harbord, Director; Mr. M. H. Aylesworth, Director; Mr. Edward M. Harden, Director; Mr. DeWitt Millhauser, Director; Mr. Frederick Straus, Director; Mr. James R. Sheffield, Director; Mr. Cornelius N. Bliss, Director; Mr. E. J. Nally, Director.

Mr. Lawrence B. Morris, has been appointed Vice-President and General Counsel of the RCA Manufacturing Company; Mr. J. D. Cook, Treasurer; Mr. P. G. McCollum, Comptroller; Mr. F. H. Corregan, Secretary; Mr. J. W. Burnison, Vice-President in charge of Manufacturing for the RCA Victor Division; Mr. J. M. Smith, Vice-President in charge of Manufacturing for the RCA Radiotron Division; Major J. T. Clement, Vice-President in charge of the Washington (D. C.) office; Mr. F. S. Kane, Assistant Secretary; Mr. David Mackay, Assistant Secretary; Mr. C. B. Meyers, Assistant Secretary; Mr. E. F. Haines, Assistant Treasurer; Mr. F. H. Troup, Assistant Treasurer and Assistant Secretary.

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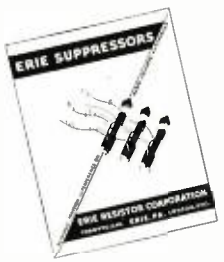
ERIE BULLETIN

The Erie Resistor Corporation has recently issued a four-page bulletin describing the complete line of Erie Suppressors for eliminating high-tension ignition interference on radio-equipped automobiles.

This bulletin is shown in the accompanying illustration and includes technical data



on the electrical characteristics of these units and discusses the results of recent research which shows conclusively a definite relationship between voltage coefficient and suppression efficiency.

Copies of this bulletin may be secured by writing the Erie Resistor Corp., Erie, Pa.

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KEN-RAD ANNOUNCEMENT

The Ken-Rad Corporation, Owensboro, Kentucky, recently made an announcement to the effect that they are now making types 15, 6A6 and 25S tubes. Information regarding these tubes may be obtained from the above organization.

•

GENERAL CABLE ANNOUNCEMENT

The General Cable Corporation, 420 Lexington Avenue, New York City, announce that for a considerable period they have observed the increasing tendency of coil users to establish their own winding departments, necessitated in some instances by the character of the product in which these coils are used, and recognizing the existence of this situation they have made their plans accordingly, closing their Coil Winding Department on December 31, 1934.

The General Cable Corporation, wish to express their appreciation to those who have favored them with their orders for finished coils in the past and will be glad to offer every assistance toward insuring continuity of their supply.

This change in policy pertains to finished coils alone. Their departments for production of magnet wires of all types will be continued. By intensive research, engineering studies, exhaustive analyses and improvements in equipment they shall continue to produce wires of the highest quality, they state.

•

CELLULOID DISC SHIPMENTS

Paul K. Trautwein of the Recording Supply Company, 58 West 25th Street, New York, announces that effective January 2, 1935, they will be able to make shipments of the Celluloid Disc for recording purposes. Shipments will be made the same day that the order is received. Price schedules will be furnished upon request to the Recording Supply Company.

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TECHNICAL BULLETIN ON SVEA METAL

The producers of Svea Metal are now publishing regularly a small bulletin under the title "Svea-Onics." This bulletin is published monthly with occasional extra issues whenever special data of interest is developed. It is strictly technical in nature and devoted to a specific outline of the proper methods of application, treatment and use of the metal in radio-tube engineering practice.

Thus far the following bulletins have been published for distribution:

1—Cleaning Parts.
2—Storing of Parts.
3—Firing.
4—Bombarding.
5—Oxidation.
6—Getter Cups.
7—Mica Strapping.
8—Higher Quality *vs.* Cost.
9—Bombing—Additional Data.
10—Exhaust Set-up Changes.

Any one or all of these bulletins may be obtained free upon request. The company will also be glad to add names to its regular mailing list upon application. Requests should be addressed to Swedish Iron and Steel Corporation, 17 Battery Place, New York City.

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CARROLL, SYLVANIA REPRESENTATIVE

T. G. "Tom" Carroll, who has been Hygrade Lamp Sales Representative for Hygrade Sylvania Corporation in the Cincinnati territory for the past three years, has also recently been given charge of Sylvania Tube Sales in the same territory. In commenting on this announcement, Stanley N. Abbott, Hygrade Sylvania Sales Manager, said. "Carroll is very favorably known among lamp jobbers, because of his helpful attitude toward merchandising problems; and it is to be expected that tube jobbers will find him equally cooperative."

G. R. Wannen, who has handled Sylvania Tube Sales in Cincinnati territory since September 1, 1934, has been transferred to the eastern seaboard, where he will act as Special Sales Advisor, working with leading Sylvania distributors in that area. For the next several months, he will make his headquarters in Washington, D. C., and in Baltimore.

HEADS OWN COMPANY

Albert W. Franklin, known as the former Vice-President in Charge of Development, Engineering & Production of The Freshman Radio Corp., is back in radio as President of his own company, Albert W. Franklin Mfg. Corp., with a plant at 137 Varick Street, New York City.

Mr. Franklin's new company will manufacture radio and electrical parts for both domestic and foreign trade. Most of the items offered the industry will be designed by Mr. Franklin, personally.

During the past five years, Mr. Franklin has devoted his time and attention to invention and research, his latest development being a new radio tube socket.

It permits the tube prongs to move smoothly into position in the socket and allows the base of the tube to rest flush with the top surface of the chassis.

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RCA BOARD OF DIRECTORS MEETING

Following the meeting of the Board of Directors of the Radio Corporation of America, General James G. Harbord and Mr. David Sarnoff, Chairman of the Board and President, respectively, issued the following statement:

"The Committee of the Board of Directors of the Radio Corporation of America, which was requested to study the subject of a readjustment of the capital structure of the corporation, reported to the full Board at its regular meeting.

"The Committee recommended against the adoption of any plan of recapitalization at this time and the officers and directors of the corporation unanimously concurred in this recommendation."

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WESTINGHOUSE ELECTS THREE VICE PRESIDENTS

Following a recent meeting of the Board of Directors of the Westinghouse Electrical & Manufacturing Company, President F. A. Merrick announced the election of three vice-presidents, Roscoe Seybold, formerly comptroller; William G. Marshall, formerly assistant to vice-president; and Ralph Kelly, formerly director of budgets. They will make their headquarters in East Pittsburgh.

•

"HOW TO USE ELECTRONIC TUBES IN INDUSTRY"

An illustrated 217-page zincograph pamphlet, presenting a fundamental treatment of the operation and application of electronic tubes in industry, is offered for sale by the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

The treatment is non-mathematical, starting with electronic phenomena and the mercury arc, passing to high-vacuum tubes and the grid-glow family, thence to photo-responsive electronic devices and cathode-ray tubes and ending with the specific technique of a variety of applications.

As a supplement to the above course, a "Manual of Experiments" may also be purchased. In this series of twenty-four tests, the apparatus needed, method of set-up, procedure to be followed, and results to be obtained, are fully explained.

This parallels the course of study and demonstrates the types and characteristics of the various electronic tubes described. The two form a very complete schedule in this subject of both classroom and laboratory work. Advertising and propaganda have been carefully avoided so that the material can be used as an accurate and unbiased text, it is stated.

SPECIFICATION SHEET ON WELDS

Due to the recent increase in production schedules of cathode-ray and similar special-purpose tubes, the Callite Products Co., Union City, N. J., have been called upon to furnish many types of two- and three-piece Dumet and copper-clad welds.

For hard-glass tube manufacture, a specially prepared Tungsten to Kulgrid "C" wire has been required in a wide variety of sizes and shapes, it is said.

All radio-tube engineers and executives may have a copy of the new, handy, illustrated specification sheet describing various types of welds. This company is also prepared to make on short notice formed radio-tube parts of Tungsten, Molybdenum and metals to specifications.

•

NEW UNIVERSAL MICROPHONE

An aero-type handi-microphone for use in airplanes and police-radio cars was placed on the market early in September by the Universal Microphone Co., Inglewood, Cal.

It has been designed substantially the same as the popular handi-mike manufactured at the same factory. The mouthpiece is rubber cushioned. It will come equipped with or without the on and off switch and in single or double button.

The new product has been fashioned especially to do away as much as possible with air stream and motor noises, and is built to withstand rough usage, it is stated.

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HARD-OF-HEARING P-A SYSTEM

A Public-Address System for those people who are hard of hearing has recently been introduced by the Webster Company, 3825 West Lake Street, Chicago, Ill. The equipment offered is the result of over a year and a half of study in a large chain of theatres, numerous churches, etc., to ascertain requirements, it is stated.

A complete system is offered and all of the component parts are intended for operation as a system. These components consist of the following: A standard two-button microphone, mounted in a desk stand with 25 feet of microphone cable; an amplifier with a rising characteristic for the high frequencies; a specially shielded No. 18 stranded cable; jack box and volume control; and standard type headphones.

Complete information will be furnished on requests addressed to the Chicago offices of the Webster Co.

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NEW AMERTRAN CATALOG

The American Transformer Co., 178 Emmet Street, Newark, N. J., have recently issued a new catalog on Transformers for Audio Amplification and Transmission. This 32-page catalog is well illustrated and contains a great deal of helpful and interesting information and technical data on the AmerTran line of transformers.

Included in this AmerTran catalog are: Mixing transformers, line-to-grid transformers, interstage transformers, interstage driver transformers, plate-to-line transformers, output transformers, line-to-speaker transformers, bridging transformers, audio reactors, equalizers, plate-filament transformers, filter reactors, filament transformers, plate transformers, rectifier circuits, power-supply units.

Copies of this catalog, Bulletin No. 1002, will be sent on request to the above company.

Also available is a De Luxe Edition of this catalog which is 8½ x 11 inches and printed by letterpress on 80 lb. coated stock. There is a minimum charge of 10c on this latter catalog to cover the costs of postage and mailing.

•

ROLLER-SMITH CATALOG

The Roller-Smith Company, 233 Broadway, New York, N. Y., have recently made available Catalog No. 10 covering the Kathetron Out-Voltage Regulator. Oscillograms, curves, and technical data are included in the catalog on this regulator, which is a device that may be used for customers' premises and industrial applications where the input line voltage is reasonably constant but where objectionable delivered voltage drop is caused by relatively heavy sudden demands.

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READRITE ANNIVERSARY

The Readrite Meter Works, Bluffton, Ohio, recently enjoyed its thirtieth anniversary. The celebration, conducted by the employees, was an unusual event, some 500 being present at the banquet and double that number at the following program. Numerous messages of congratulations and regrets of inattendance were read, while messages from sales force in attendance were also presented.

Moving pictures were shown of the plant operations and routine of business, all the scenes being taken in the plant. Demonstrations of public interest were made by the engineering department covering broadcasting and receiving, sensitive relays in conjunction with photo-electric cells, and the like, the purpose being to show some of the practical applications of instruments made by the Company.

An address was followed by the presentation of a diamond ring to Mr. R. L. Triplett in appreciation of his long service as Manager of the Company.

•

NEW ATLAS BULLETIN

The Atlas Resistor Co., 423 Broome Street, New York, N. Y., have just issued an 8-page bulletin covering their line of resistors. Included is data on pack wound resistors, adjustable voltage dividers, bleeder resistors with center taps, fixed resistors, and replacement voltage dividers. Included also is a chart giving type of sets, total resistance, resistance sections, and list price for their standard replacement voltage dividers. Further information may be obtained from the above company.

•

RCA VICTOR BULLETIN 45

The RCA Victor Company, Camden, N. J., recently released Bulletin 45 on Remote Pickup Equipment, Type OP-4. This 8-page bulletin is profusely illustrated and contains information on their Type OP-4 portable speech-input system. Briefly, some of the information included is on the importance of outside pickups, quality, the complete and self-contained features, the portability of the equipment, assembly and housing, electrical design, three-position studio-type mixer, non-microphonic high-gain amplifier, interstage volume control, adjustable-level volume indicator, metering, monitoring, and their inductor microphone (including specifications).

Further information may be obtained by addressing the Transmitter Section of the RCA Victor Company.

MOVING-COIL MICROPHONE

Audio Research, Inc., 105-107 East 16 Street, New York City, have a moving-coil microphone designed to meet the requirements of ease of operation, ruggedness, maintenance cost, and high tonal fidelity necessary for use in recording, broadcasting, and public-address services.

Connections are made to three terminals at the back. The case diameter of the unit is 3⅜" and the depth 1¾" . . . the weight is 2¼ pounds.

This microphone has a voice-coil impedance of 30 ohms. The output level is minus 55 db for normal speech at a distance of two feet. While this is about 20 db less sensitive than the conventional carbon-type microphone, it is substantially more sensitive than the other types, it is stated.

The response of this unit is substantially constant from 30 to 9000 cycles. For further information address the above company.

•

NEW SHORT-WAVE CONDENSER

The new No. C-140 Na-Ald Victron "AA" Short-Wave Condenser which is insulated with the new material Victron "AA" has a power factor of 0.0002 at 877 kc which actually improves with an increase of frequency, it is stated. This unit is manufactured by the Alden Products Company, 715 Center Street, Brockton, Mass.

Two solder lugs on both rotor and stator, which are insulated from mounting bases yet may easily be grounded, are provided for convenient wiring. The two point

suspension mounting is reinforced by soldered brass plates located with uniformity of spacing, and silver pressure contact to rotor instead of resistance grease film or oxidation skin as in the bearing contacts, is used. Further, the universal mounting is adaptable to single hole, base, panel, stand-off and base stand-off mounts with the rotor grounded or insulated from the chassis.

•

WRIGHT-DeCOSTER REPRODUCER

The Model S. W. 429, Wright-DeCoster reproducer has been designed by Wright-DeCoster, Inc., St. Paul, Minn., for use in shortwave reception. Its power handling capacity and its sensitivity makes the Model S. W. 429 suitable for the smallest laboratory or for a really good-sized room or small hall, it is stated.

This unit has a 10-inch cone, the outside measurement of cone bracket being 12⅛ inches, the depth 8¾ inches, the height 14 inches and the width 14 inches.

NEW CIRCUIT BREAKER

Westinghouse announces a new low-voltage "De-ion" breaker, similar in general to the standard 600-ampere, 600-volt AB breaker brought out several years ago, with the major exception that the new breaker has an interrupting capacity of 20,000 amperes. The new AB-20 is totally enclosed, being mounted in the standard 600-ampere molded case. It is available in all ratings from 50 to 600 amperes, complete with standard tripping accessories and motor mechanism.

To secure a heavy-duty AB-20 breaker it was necessary to double the interrupting capacity of the standard AB breaker. This was accomplished by a complete redesign of the contact structure and major modifications in the "De-ion" chambers and operating mechanism.

•

NEW TYPE 80 TUBE

National Union has just perfected a new type 80 rectifier tube which is said to be a marked improvement on the type 80 as previously used in the dome shaped S-14 envelope.

Since the elements of the 80 tube had to be inserted from the bottom the plate area was increased by corrugating them, thus permitting the lowering of the operating temperature. The result is a tube that is different in design and operation. It will replace any 80 in any set.

It is said that the new National Union corrugated plate 80 will give equally as long life at 150 milliamperes drain as the old one at 125 milliamperes.

THE Group Subscription Plan for RADIO ENGINEERING enables a group of engineers or department heads to subscribe at one-half the usual yearly rate.

The regular individual rate is $2.00 a year. In groups of 4 or more, the subscription rate is $1.00 a year. (In Canada and foreign countries, $2.00.)

Remember this Group Plan when *Your* Subscription Expires

INDEX TO ADVERTISERS

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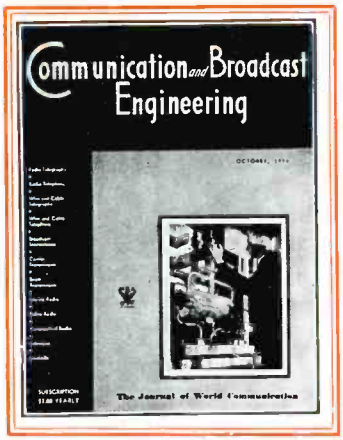
The engineering departments of hundreds of manufacturers in the radio and allied industries have used this Group Plan for years, in renewing their subscriptions to RADIO ENGINEERING.

Each subscriber should print his name and address clearly and state his occupation—whether an executive, engineer, department head, plant superintendent, or foreman, etc.

Remember this Group Plan when *Your* Subscription Expires

(Radio Engineering)
BRYAN DAVIS PUBLISHING CO., Inc.
19 East 47th Street, New York, N. Y.



NEW 100 WATT STATIONS

5 METER DEVELOPMENTS

NEW COMMERCIAL TRANSCEIVER MARKETS

INCREASED RURAL TELEPHONE, TELEGRAPH AND RADIO FACILITIES

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Radio Telephony
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Wire and Cable Telegraphy
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Wire and Cable Telephony
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Broadcast Transmission
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Carrier Transmission
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Beam Transmission
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Marine Radio
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Police Radio
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Aeronautical Radio
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Television
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Facsimile

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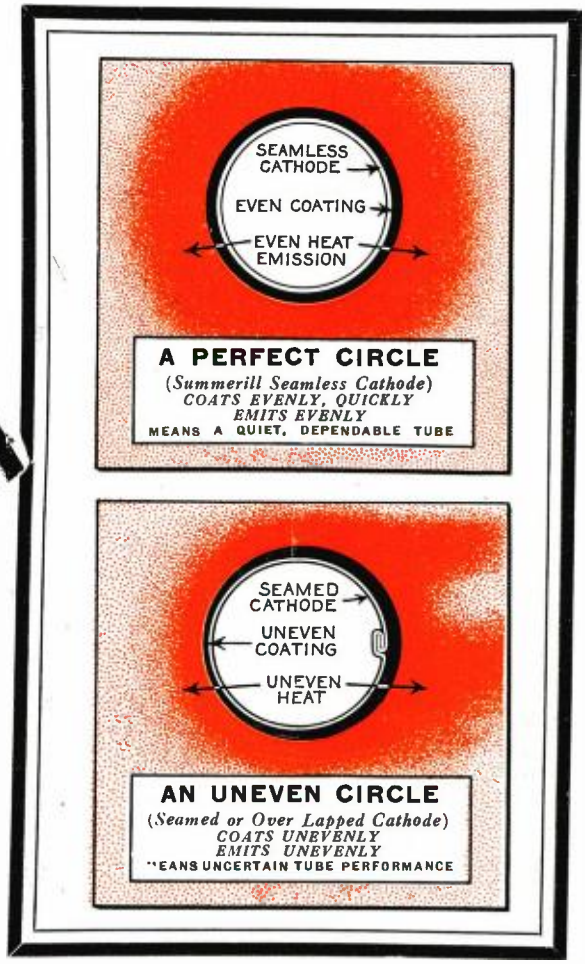
A close-up of several

SUMMERILL ADVANTAGES

In Radio Tube Manufacture



It will pay to study the accompanying illustrations. Notice how uniformly a Summerill Seamless Cathode takes the emission coating and how evenly heat is emitted.

This assures a quieter, more effective tube.

Compare this with the seamed cathode sleeve characteristics . . . an overlapped tube cannot be evenly coated and does not emit uniformly.

1935 production schedules of "heater type" tubes will exceed that of any previous year. Your production cost for this tube component is a very important factor. On a production basis, Summerill Seamless Cathode Sleeves cost no more than the overlap type.

Our engineers can show you why.

Pure Nickel Seamless Tubes available for Radio and other electrical applications in full range of sizes—
Outside diameters . . . . .020" to ½"
Wall thickness . . . . . .0015" to .050"
Ask for booklets on "Summerill Specialties" and "Processes in Cold Drawn Tubing"

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