MAY, 1936

Radio Engineering

VOL. XVI NO. 5

DESIGN • PRODUCTION • ENGINEERING

Broadcast Receivers
Auto-Radio Receivers
Electric Phonographs
Sound Recorders
Sound Projectors
Audio Amplifiers
P-A Equipment
Electronic Control Devices
Testing and Measuring Equipment
Television Apparatus
Loudspeakers
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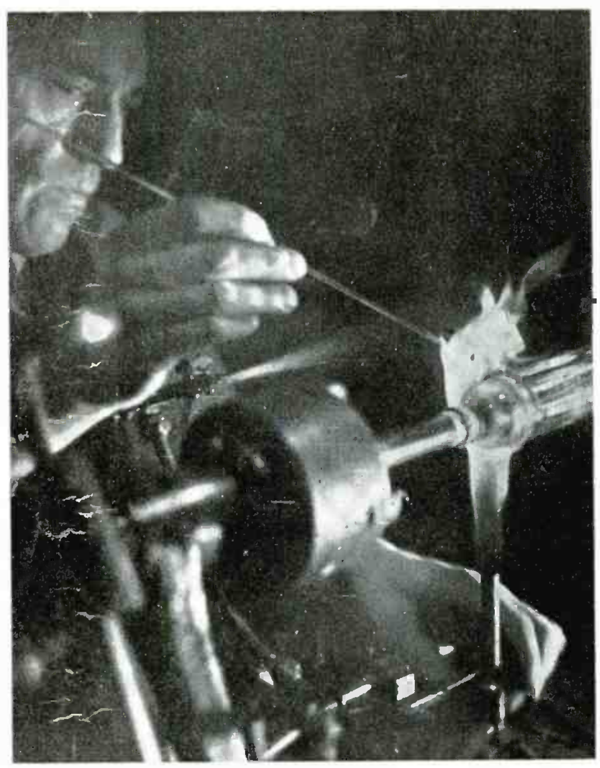

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The Journal of the Radio and Allied Industries

RADIO ENGINEERING

REG. U. S. PATENT OFFICE

W. W. WALTZ • Editor

CONTENTS FOR MAY

VOL. XVI *Member Audit Bureau of Circulations* NO. 5

COVER ILLUSTRATION

SEALING OFF AN EXPERIMENTAL VACUUM TUBE

(Courtesy, Bell Telephone Laboratories, Inc.)

PUBLISHED MONTHLY by the

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Editorial

IN THIS ISSUE

WE TAKE PLEASURE in presenting, on the following pages, the first complete report on the technical papers which were read at the IRE convention that just ended. Those papers which deal with the problems of greatest interest to the receiver engineers are, of course, given most space; our contemporary, COMMUNICATION AND BROADCAST ENGINEERING, has admirably covered the remainder of the field.

Getting these convention reports has necessitated a slight delay in publication, but we feel that there is sufficient reason for this delay to make apologies to our readers unnecessary. RADIO ENGINEERING would have been remiss had we neglected to give our readers, many of whom were unable to attend the convention, a complete survey of the always important convention papers.

• • •

METAL OR METAL-GLASS?

WE KNOW OF any number of set manufacturers who would give a lot to know the answer to that question. While it is true that the material from which the tube envelope is made has little bearing upon the final design of a receiver, there are enough elements of uncertainty in the present situation to warrant at least a slight anxiety.

In any event, the metal-glass tube is increasing in popularity. It will be interesting to watch further developments in this type.

• • •

EXTENSION SPEAKERS

ASTUTE RECEIVER MANUFACTURERS should give some thought to the idea of providing a terminal plate on the chassis to which extension speakers may be connected. The ever increasing use of permanent magnet dynamics will, sooner or later, come to the attention of the public with the almost inevitable result of creating a demand for additional speakers.

The power to drive the extra speakers is available from many sets. The point which the engineers will have to watch is that of insuring that a reasonably good impedance match is maintained between the output tubes and the speakers. Obviously, the answer lies in some kind of an arrangement of the terminal strip which will enable the user or service man to select various combinations of output transformer impedance as the number of speakers is increased.

There are several other points that may be troublesome—for instance, what to do about the condition arising from switching off one or more speakers of a group. Perhaps the loss occasioned by this mismatch will not be serious, but it is a point which should be given consideration.

• • •

LOCK-IN TUNING—AGAIN!

TUNING INDICATORS FOR auto radio have received the official condemnation of the committees of the RMA and SAE on Automotive Radio. The reason is quite obvious.

When auto radio first came into the picture, motor vehicle authorities set up an almost universal howl of complaint. Many dire predictions were made about the increase in an already serious accident record. Fortunately, most of these predictions failed to hold water.

But we believe that the committees have taken the proper step in the case of visual tuning indicators for car radio. Anything which will serve to take the driver's eyes from the road, even for a few seconds, can and will be the cause of many accidents. At the speeds used by many drivers, the distance traveled over by the car during the time required to tune in a station is great enough to bring about a crash from a situation not even remotely apparent when the driver turned his eyes to the tuning indicator. And, let no one think that speed maniacs are going to throttle down while they do their tuning!

The case for a workable lock-in tuning system becomes more obvious.

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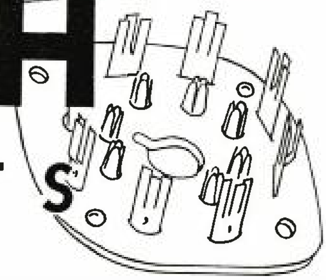
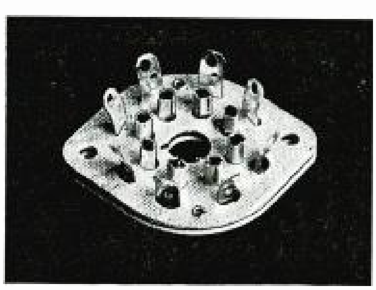


OAK TYPE MODEL

MODEL 33



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RADIO ENGINEERING

FOR MAY, 1936

I.R.E.—CLEVELAND

WITH AN ESTIMATED attendance of 500, the eleventh annual convention of the Institute of Radio Engineers opened at the Statler Hotel in Cleveland on the morning of May 11.

The official welcome was given by Messrs. Hazeltine (IRE President), Pierce (Chairman, Cleveland Section), and Banfer (Chairman, Convention Committee). Following these introductory remarks, a representative of the Cleveland Chamber of Commerce spoke briefly on the Great Lakes Exposition which is to be held at Cleveland from June 24 to October 4, 1936.

Prof. Alan Hazeltine, I. R. E. President.

TECHNICAL SESSION—MONDAY

High Speed Motion Pictures of Mercury Vapor Tube Operation. Presented by H. W. Lord, General Electric Co., Schenectady, N. Y., this paper discussed the motion of a cathode spot on the mercury pool of a thyratron tube used for welding purposes. Visual observation of this motion is handicapped because of the intensity of the light and the rapidity with which the spots move.

An Eastman high-speed camera, capable of taking as many as 2000 frames per second, was used in the investigation. The camera employed a continuous film; a prism arrangement insured that the image was always on the film. The shutter of the camera was open for one-fifth of the frame interval which, with the film speed mentioned, resulted in an exposure of 0.0001 second.

The slow-motion effect produced by the high film speed showed the formation of the cathode spots, their change with increasing and decreasing current, and the motion from the center to the edge of the pool.

Radio Transmission Anomalies. J. H. Dellinger gave the paper prepared by himself and Messrs. Kirby and Smith of the National Bureau of Standards, Washington, D. C. The subject covered various discrepancies noted in the transmission of broadcast band frequencies between Europe and this country. Field strengths considerably lower than had been expected were obtained. On the other hand, the fields of Argentine stations were about as anticipated.

High frequency signals were discussed in the second part of the paper. The correlation between the total disappearance of high frequency signals with flocculi and other disturbances on the sun was shown. These "fadeouts" may last for periods as long as fifteen to thirty minutes, and may be local or widespread over the sunlit hemisphere of the earth. The cycle of the "fadeouts" is 54 days.

Recent Investigations of the Ionosphere. This paper, by S. S. Kirby and N. Smith of the National Bureau of Standards, Washington, D. C., was presented by Mr. Kirby. It discussed the differences in the so-called critical frequency as observed over a period from October 1935 to January 1936. Comparisons with the same period of the previous year (1934-1935) were given.

Ultra-High-Frequency High-Power Transmitter Using Short Transmission Lines. John Evans of the RCA Victor Division, RCA Manufacturing Co., Camden, N. J., gave this paper showing the use of short transmission lines as the tuned-circuit elements of an oscillator, instead of the more familiar quartz plate. The transmission line consisted of a copper tube closed at both ends. Inside the tube, from the top, was suspended an invar rod which in turn supported, at its lower end, two copper conductors. The outside tube is grounded through a resistance, while the power tube connects to the inner copper conductors. Various arrangements are possible, including a push-pull connection.

Frequency-temperature curves were shown indicating a high degree of stability.

Modern Two-Way Radio. This paper by L. M. Leeds and Stewart Becker of the General Electric Co., Schenectady, N. Y., was read by Mr. Becker. The introduction discussed some of the operating features of the two-way system, i.e., one-way as two-way, and duplex as simplex. The desirable features of duplex operation were given as: (1) break-in; (2) shorter time element; (3) no switching; (4) car-to-car communication via headquarters station.

The transmitters were described as ranging in power from 15 to 150 watts, all except the smallest being crystal controlled.

The same type of antenna is used for cars and headquarters station, and for both reception and transmission. The receiving circuits are connected to the antenna through transmission lines which function as filters.

The car receivers are a combination of superheterodyne and super-regenerator; the superheterodyne i-f is of the order of 8 to 9 mc.—for a receiving frequency of 30 to 40 mc. This intermediate frequency is then stepped up to 25 mc. and fed into the super-regenerator.

In the discussion following this paper, the use of the 803 type tube was questioned. The authors answered the question by pointing out the relative efficiency of the tube—a filament type—in enabling the receiver to get on the air promptly.

A Multi-Tube Ultra-High-Frequency Oscillator was given by P. D. Zottu of the RCA Radiotron Division, RCA Manufacturing Co., Harrison, N. J. Mr. Zottu pointed out the difficulties of obtaining ultra-high frequencies from tubes and showed that it is a question of balancing "dissipating ability" against tube dimensions. The latter, if too great, may become comparable with the wavelength.

P. D. Zottu, of RCA Radiotron, with a model of the 120 cm oscillator employing eight tubes. This oscillator operates with an efficiency of 20 per cent.

A demonstration was given with equipment consisting of eight oscillator tubes mounted on a brass plate, each tube having its oscillatory circuit, connected between grid and plate, tuned to approximately 120 cm. In the center of the plate is mounted a low-loss circuit also tuned to 120 cm.; the eight tubes are coupled to this circuit, and due to the common coupling the eight oscillators are made to pull into step. With eight RCA-834 type tubes and 500 volts on the plates, power outputs of 80 watts were obtained with an efficiency of 20%; this is the same as obtained from a push-pull oscillator with RCA-834 tubes under the same conditions.

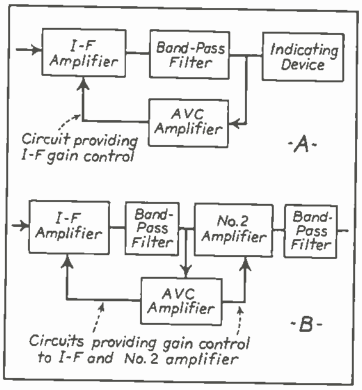


Fig. 1. A block schematic diagram of the setup for measuring the effect of avc upon receiver sensitivity.

TECHNICAL SESSION—TUESDAY

The Effect of Automatic Volume Control Upon the Measurement of Selectivity of Radio Receivers was presented by the author, D. S. Bond, RCA Victor Division, RCA Manufacturing Co., Camden, N. J. Several types of avc circuits were shown along with selectivity curves of the amplifiers, with and without avc. The simplest circuit consisted of an i-f amplifier with band-pass filter, the output of which was fed partly into an indicating device and partly into the avc amplifier which supplies the gain control biasing circuit (see Fig. 1A).

A second amplifier may be added, along with another band-pass filter (Fig. 1B). The characteristic in this case is sharpened by reason of the additional filter.

The need for sufficiently selective circuits ahead of the avc tap-off point is clearly demonstrated by the characteristics of the circuits discussed; of course, it has been a well-known fact that avc decreases the selectivity.

Automatic Tuning—Simplified Circuits and Design Practice. This was the long-anticipated paper from the RCA License Laboratories; prepared by Messrs. Seeley and Foster of that organization, it was read by the former. The introductory remarks pointed out the need for such a system (see editorials in this and April 1935 issues of RADIO ENGINEERING) and discussed past attempts to meet the situation by means of circuits tuned slightly above and below the desired frequency.

The action of the new circuits is such that any mistuning or any frequency drift in the receiver is automatically corrected by the incoming signal itself.

The basic requirements of such a system are a "discriminator," which differentiates between frequencies which are too high and those which are too low and which produces a steady current or voltage the polarity of which depends upon the direction of frequency departure from the predetermined point; the d-c voltage is then applied to the second element of the circuit, a "control element." This functions to cause a change in frequency in the local oscillator to bring the i-f signal of the receiver close to the correct frequency.

The principle of the discriminator is that of the 90-degree phase difference that exists between the primary and secondary potentials of a double-tuned loosely-coupled transformer at the frequency to which the two are tuned; as the frequency varies, the phase difference changes. Referring to Fig. 2, the voltages E_1 and E_2 may be added vectorially and the resultant in one circuit will be maximum below the resonant frequency and above the resonant frequency in the other.

In somewhat more detail—Fig. 3—if the resonant frequency, i.e., the intermediate frequency, is applied to the grid of the tube, equal amplified voltages appear between the points A and ground and between B and ground. These, rectified by the diodes, cause currents to flow in R_1 and R_2 *in opposite directions* with respect to ground; the net d-c voltages between point E and ground are zero. When the applied signal departs from resonance, the voltages across the diodes will differ in *magnitude*, unequal drops occur across R_1 and R_2, and a voltage will appear between E and ground; the polarity of this volt-

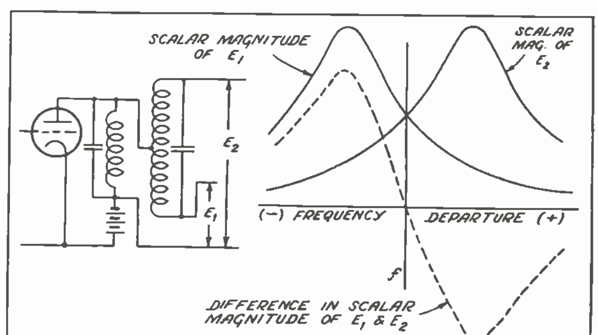


Fig. 2. The functional schematic and diagram of voltage relations of the so-called "discriminator" circuit.

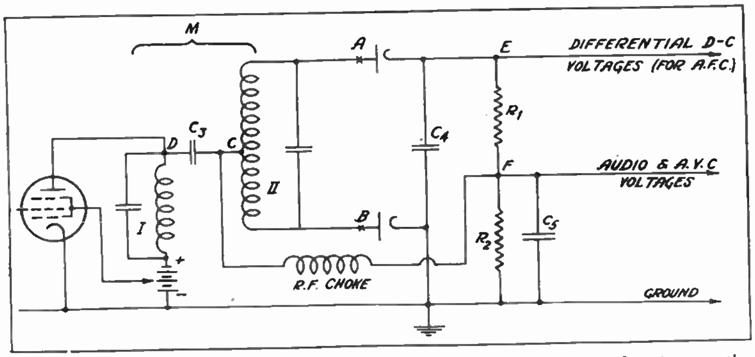


Fig. 3. The "discriminator" in greater detail. This circuit can also function as the detector and avc tube.

age will depend upon the direction of frequency departure. It was explained also that audio voltages may be obtained from point F of the circuit of Fig. 3, and that the d-c potential between F and ground will have the requisite polarity and proper ratio to the a-f voltage to function as avc voltage.

The voltages from the discriminator tube are then applied to the "control element." This circuit, shown in Fig. 4, uses two tubes, one as the actual control tube; the other is the oscillator of the receiver. In Fig. 5, these are T_2 and T_1, respectively. R_1 and C_1 across the oscillator tank circuit produce a voltage on the grid of T_2 in quadrature with that across the tank circuit. Variations in grid bias of the control tube, obtained from the discriminator, vary the control tube plate current. This plate current is in quadrature with the tank circuit voltage; hence, the control tube acts like an inductance across the tank circuit. The magnitude of the reactance of this fictitious inductance, and by reason of this, the oscillator frequency, are governed by the control tube bias.

The amount of control is proportional to the G_m and E_c. Since high sensitivity is essential—i.e., greatest frequency change for a given bias change—a short cut-off type of tube is indicated.

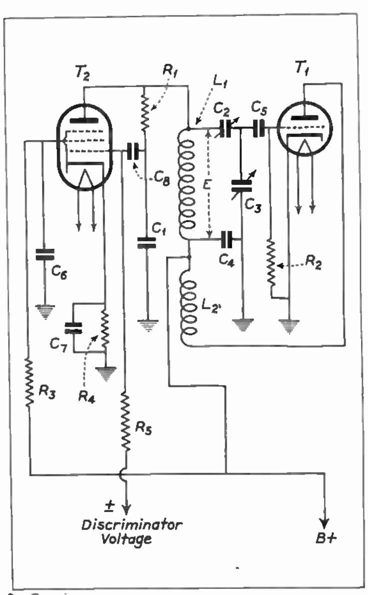
The frequency control readily obtainable by this circuit is of the order of 9.5% of the oscillator frequency in the broadcast band and 1.5% in the region of 10 megacycles.

In a receiver it has been found that a discriminator sensitivity of 100 volts per kc and a control sensitivity of 7 kc per volt can be easily obtained, so that an overall control ratio of 700 to 1 results. A tuning midadjustment of 7 kc will therefore result in only a 10 cycle shift of the intermediate frequency.

The use of afc on the short-wave bands has the very much needed advantage of making the tuning operation easier. The tuning control has to be moved only until the frequency is close enough to resonance that the discriminator will develop sufficient voltage to bias the control tube the amount required for the departure from resonance. Short-wave stations are thus "spread out" on the dial, making them easier to locate and easier to hold.

Aural Compensation, prepared and presented by C. M. Sinnett, RCA Victor Division, RCA Manufacturing Co., Camden, N. J., indicated the reasons for, and the means of studying the amount of compensation necessary to insure satisfactory reproduction. The degree of compensation for various frequencies may be found from curves of aural response, but these do not give a complete picture. It is necessary to consider such matters as the response characteristic of the loud-speaker under different acoustic conditions, etc. This was accomplished by means of an amplifier containing compensating networks which permit various frequency bands in the audio range to be emphasized.

Fig. 4. The "control element" of the afc system. Voltages from the discriminator control the receiver oscillator frequency via the circuits below.



MEDAL OF HONOR AND MORRIS LIEBMAN MEMORIAL PRIZE

At the annual banquet of the Institute, which was held Tuesday evening, May 12, the Medal of Honor was presented to Dr. George A. Campbell for his contributions to the theory of electrical networks. Dr. Campbell, who retired from active service with the Bell Telephone Laboratories last December, is the inventor of the electric wave filter which has had much to do with the phenomenal advance of the radio art.

The Morris Liebman Memorial Prize was presented to B. J. Thompson of the RCA Radiotron Division, RCA Manufacturing Company, in recognition of his development of the "acorn" tube.

TECHNICAL SESSION—WEDNESDAY

A New High-Efficiency Power Amplifier for Modulated Waves. W. H. Doherty, Bell Telephone laboratories, Inc., New York City, presented his paper.

In order to provide peak power, the high power stages of transmitters are usually run at about 33% efficiency. The linear power amplifier described in the paper has an efficiency of about 65%. Modulation is accomplished at low level which, in addition to eliminating high power modulating equipment, has an advantage in the ease by which high power amplifiers can be added.

Briefly, the system incorporates two power tubes: one supplies power up to that equal to the carrier power, and the other furnishes the additional power required when the modulation is such that the carrier power is insufficient.

For complete details of this interesting paper the reader is referred to the May issue of COMMUNICATION AND BROADCAST ENGINEERING.

Simplified Methods for Computing Performance of Transmitting Tubes. W. G. Wagener, RCA Radiotron Division, RCA Manufacturing Co., Harrison, N. J. A slide was shown of a simple tube circuit in order to develop the terminology; then various equations were derived for tubes in both telephone and telegraph transmitters. By the combination of tube equations and tube characteristics, the performances of the tubes was shown for plate and grid modulation.

Shunt-Excited Antenna. J. F. Morrison and P. H. Smith, Bell Telephone Laboratories, Inc., New York City; presented by Mr. Morrison. The advantages of a grounded antenna were discussed and the results of a test made on a typical installation were given. Two different methods of operation were described, and curves were given showing reactance, resistance, and current distribution, as well as polar field strength diagrams.

Some Notes on Amplifier Transients. C. W. Carnahan, Hygrade Sylvania Corp., Salem, Mass. The author indicated the interest in amplifier transients as the result of television. The transient state was more difficult to arrive at than the steady state, although not as rigorous. It could, however, be approximated by a Fourier series.

Electron Optics of Television Cathode-Ray Tubes. D. W. Epstein, RCA Victor Division, RCA Manufacturing Co., Camden, N. J. This paper discussed the analogy between the action of electrons in a cathode-ray tube and that of light waves in lenses.

A Cathode-Ray Time Axis for High Frequency. L. M. Leeds, General Electric Co., Schenectady, N. Y. This paper discussed the use of a cathode-ray oscilloscope capable of operating at frequencies as high as 30 mc. The sweep circuit functions on only a part of the cycle so as to sweep in only one direction across the screen.

Application of Conventional Vacuum Tubes in Unconventional Circuits. F. H. Shepard, Jr., RCA Radiotron Division, RCA Manufacturing Co., Harrison, N. J. An interesting collection of various applications of vacuum tubes to perform unusual functions which would not ordinarily be considered within tube capabilities. Included among these were: a metal tube capacity operated relay with a-c power supply; a sensitive light intensity indicator; a variable range variable sensitivity light variation

Recipient of the Medal of Honor—Dr. George A. Campbell, inventor of the electric wave filter.

indicator; a simple two-stage a-c operated photo amplifier relay circuit; a vacuum tube multiplier circuit for small currents from a high impedance source.

The last two circuits mentioned are shown in Figs. 5 and 6, respectively. Fig. 5 shows a single two-stage photo-amplifier relay circuit operating directly on the a-c line. The simplicity of the circuit is illustrated by the fact that the complete list of circuit parts includes only one voltage divider resistor, one plate load resistor and three condensers. The circuit consists of a high-impedance phototube feeding through a voltage amplifier or buffer stage into a power output stage. The filament voltage of the buffer stage has been reduced to reduce the temperature of and, hence, the electron emission from the grid. The plate current of the buffer stage is kept at a minimum so as to reduce the electron bombardment of the gas molecules within the tube and hence the gas current to the grid. The bias to the grid of the buffer stage is obtained by means of the rectifying action of the grid itself. This method of obtaining the grid bias keeps the effective bias or plate current of the tube constant regardless of large fluctuations in contact potential between the grid and the cathode. The impedance of the condenser C_1 acts as a load impedance for the phototube; i.e., condenser C_1 as just explained is charged up to a definite negative potential on one half of the a-c cycle and is allowed to discharge through the phototube on the other half of the cycle. The amount that is discharged by the phototube determines the working potential on the grid of the buffer stage. The size of C_1 can be set to any desired value to control the desired sensitivity range of the relay.

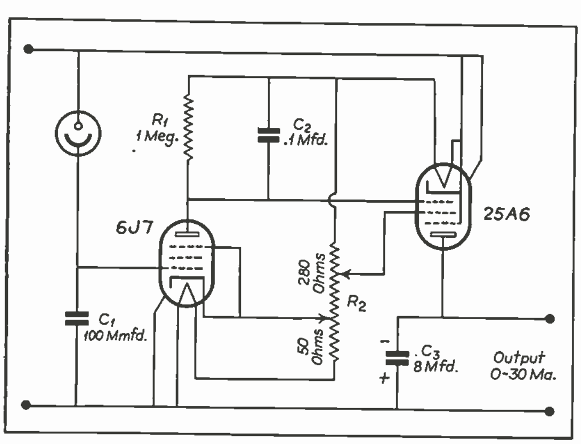
As the 6J7 conducts on only one half of the a-c cycle it acts as a rectifier and so a negative d-c potential is built up on its plate; this negative d-c potential is suitable for use as bias and signal for the output stage. The plate of the 6J7 is returned through its load to a point on the voltage divider (one side of the heater of the 25A6) so that it will not be necessary for the 6J7 to be cut off to obtain a zero working bias on the grid of the 25A6 output tube. This allows the 6J7 to be operated about the center of its characteristic.

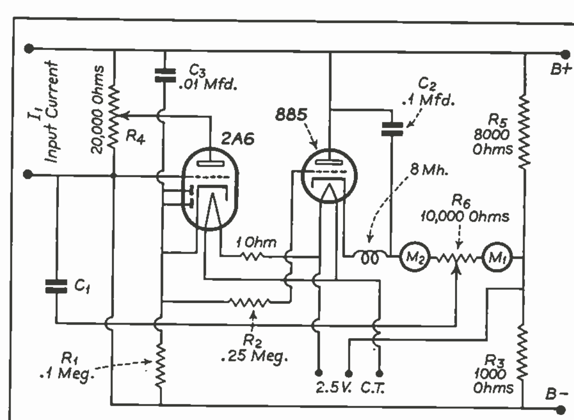
As the output of the 6J7 buffer stage has relatively low impedance it is suitable for driving the grid of the 25A6 power output stage, which in turn is capable of handling relatively large amounts of power to operate a relay.

This circuit finds its principal use in applications where relatively small

(*Continued on page 20*)

Fig. 5 (left). A single two-stage photo amplifier relay circuit. Fig. 6. A vacuum-tube current multiplier.





COIL FORMS

by S. W. PLACE*

The completed form.

BEFORE THE INTRODUCTION of single control tuning, no great precision was required in the manufacture of radio coils. As long as all of the coils of a tuned-radio-frequency receiver had the same or approximately the same number of turns, it mattered little, since each circuit was individually tuned by the operator. Single control tuning, however, whether in a t-r-f or superheterodyne receiver, requires radio coils matched in inductance values. Of course, the oscillator coil in a superheterodyne has a lower value of inductance than the other r-f coils because it operates on higher frequencies, but once this value of inductance is determined, it must be carefully matched with the proper values of antenna and r-f input coil inductances to insure alignment of the tuning condensers throughout the tuning band. The necessary accuracies of inductance values vary from plus or minus 1/10% to plus or minus 1%. Many radio manufacturers feel that since there may be slight inaccuracies in condenser construction, inductances need not be held to the extreme accuracy of 1/10%, and that inaccuracies of capacity and inductance may be compensated for by the adjustable end plates of the variable condenser.

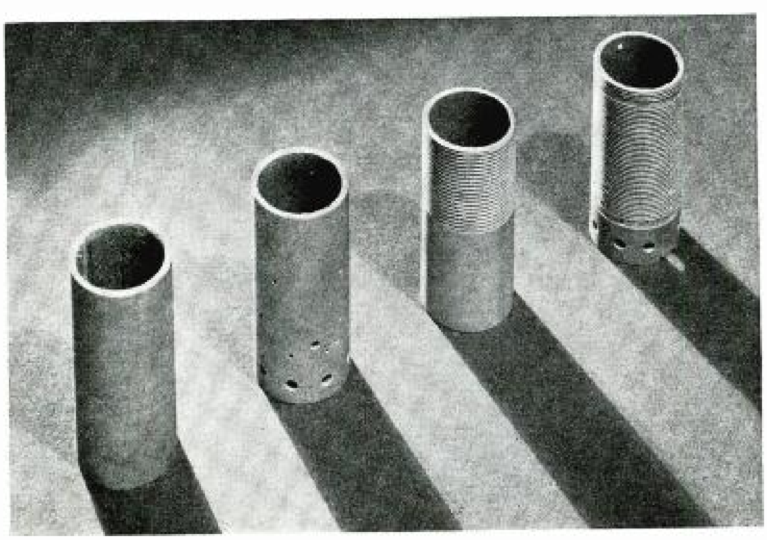
Radio coils are generally wound on laminated bakelite tubing, although other coil-form materials, such as paper or ceramics, are occasionally used. The requirements of a good coil form are: (1) good electrical properties; (2) low moisture absorption; (3) accuracy of diameter; (4) ease of machining and (5) low cost. Paper tubing has good electrical properties as long as it can be kept free from moisture absorption due to high humidity. However, even though the whole coil form be wax impregnated it may still be susceptible to some moisture absorption in damp climates. Ceramics have unquestionably excellent electrical properties and in most instances very satisfactory water absorption properties. Ceramics, on the other hand, cannot be machined and are apt to break in winding and eyeletting operations. The costs are probably comparable to those of laminated bakelite coil forms, although there is an initial mold cost to consider in a ceramic coil form. Laminated bakelite seems satisfactorily to fulfill all of the requirements for good coil-form material. Laminated bakelite coil forms may be had in diameter tolerances of plus or minus .001" to .002" for outside diameters ranging from ½ to 1 inch. The importance of this tolerance may be estimated from the small tolerance allowable in inductance variation. Where inductance tolerances of plus or minus ½% are allowable, it has been found that no individual adjustment of the turns is necessary, provided the coils are grouped into 2 or 3 groups and made up into sets consisting possibly of low, medium and high range coils. The laminator can be of service to the coil winder in this connection by grouping coil forms according to their measurement plus or minus from the required dimensions.

Radio coil forms are usually supplied in diameters ranging from ½" to 1¼" and in wall thicknesses from 1/32" to 1/16". Wall thicknesses of 1/32" are permissible in the smaller coil forms, but 1/16" wall thickness should be used for the larger diameter coils. The coil-form material must not be too hard or brittle; rather, it should be capable of being punched and eyeletted close to the edge without danger of cracking or splitting. Where quantity production of coil forms is feasible it is economical to punch the holes rather than drill them. As against an initial die cost of $150.00

(Continued on page 20)

*Synthane Corp.

Stages in coil form processing.



FLUXES AND SOLDERS . . .

Conclusion

by E. R. WAGNER, Ph.D.

"Corrosive" and "Non-Corrosive" Acids

We may roughly sub-divide soldering fluxes into two classes, water-soluble and water-insoluble. The latter class, in general, will not cause or permit the joint to corrode at any time after the heat has been removed.

Common examples of water-soluble fluxes are hydrochloric (muriatic) acid, phosphoric acid, zinc chloride and ammonium chloride (sal ammoniac). Common examples of water-insoluble fluxes are rosin, stearic acid, other fatty acids and substances which contain them, such as beeswax, lard, cottonseed oil and tallow, the earliest of all soldering fluxes.

The water-insoluble fluxes are non-corrosive because they consist of acids that will not attack metals at ordinary temperatures. Even at the temperature of soldering, when they react with the metallic oxides, they have little if any effect upon the metals themselves. Moreover, they form water-repellent films over the joint, and so protect it against moisture and corrosive fumes which may exist in the atmosphere.

The water-soluble fluxes, on the other hand, are substances which react with many metals, particularly at the point of junction between two different metals, if only a little moisture be present. They do not seal off the moisture of the air, but, to the contrary, are in some cases hygroscopic and attract such moisture. When used in soldering an electrical connection, they must be carefully and thoroughly removed when the operation is finished, or neutralized by application of other chemicals (as, for example, ammonia in the case of muriatic acid).

To be of greatest value, the flux must not only remove the foreign matter originally present, but must remove it in such manner that the resulting combination or solution of oxide and flux is also non-corrosive. Likewise, the flux should form a layer sufficiently viscous, at the temperature of soldering, to remain in place, yet not so viscous as to prevent penetration and mixture of the metals to be joined—which might happen if some phosphates, for example, were used in ordinary low-temperature soldering.

Considerations in the Choice of a Solder

The five important details in the choice of a solder, for any specific work, are: melting point; fluidity at working temperature; rate of solidifying; hardness, and tensile strength. All of these considerations, of course, are subject to the assumption that the solder used is one which will alloy with the metals to be soldered.

In all radio production work, a melting point among the lower ranges is chosen, since the chief criterion is the speed with which the work can be done. For other types of work, as explained below, it may be desirable to choose an alloy of higher melting point despite the loss of time involved.

Melting points for all common solders may be determined by reference to the following tabulation (*American Society of Testing Materials Specifications B 32-31*):

Lead	Tin	Antimony	Melting Point
37.0-33.0	63.0-66.0	0.12-1.00	190°C
48.5-46.0	49.0-51.0	2.50-3.00	190
59.0-56.5	39.0-41.0	2.00-2.50	190
70.0-67.3	29.0-31.0	1.00-1.70	190
60.0-57.0	40.0-43.0	0.12-0.40	195
5.0- 4.0	94.5-95.5	.50-0.00	220
*50.5-48.5	49.0-51.0	.50-0.00	225
67.0-64.0	33.0-36.0	.30-0.00	230
71.0-69.0	29.0-31.0	.30-0.00	275

(* "half and half")

It will be noted that four different soldering alloys have identical melting points. The difference in their action is found in their physical properties during the process of solidifying.

The twin characteristics of fluidity and rate of solidifying may advantageously be considered together, with the help of the curve shown in Fig. 1, in which alloys of tin and lead are plotted against melting points. The extreme right hand of the diagram shows the melting point of pure tin, *232° C*: the extreme left hand ordinate represents that of pure lead, *327°*. It will be noted that the melting points of alloys of these metals do not follow a straight line, but dip to a "eutectic," or lowest melting point, which occurs at *63%* tin-*37%* lead, and is 181 degrees. At the temperature shown by the area above the melting point curve all the alloys are liquid and, in the case of these metals, of practically equal fluidity. Addition of a small percentage of zinc will have very little effect upon the melting point curve, but will substantially reduce the fluidity of the molten alloys.

The choice of a solder for practical purposes depends not so much upon its fluidity when molten as upon its characteristics when solidifying. Referring again to Fig. 1, the areas between the melting point curve and the dotted lines represent the intermediate stage of "mushiness" which solder passes through in cooling. It will be noted that this area is greater to the left of the eutectic point than to the right of that point, indicating that the high-lead solders—except those that are practically pure lead, stay "mushy" over a greater range of temperature than the high-tin solders. In radio production work a composition close to the eutectic point should be chosen, since it combines the advantages of low melting point and sharp transition from liquid to solid, decreasing the chance of failure of the joint after the soldering iron has been removed. Furthermore, the range of fluidity, which begins above the melting point curve, is greater, and at the same temperature a "eutectic" mixture will be somewhat more fluid than any other.

However, in joining the metal sheaths of telephone cable—or in old-fashioned plumbing work—or for any "wiped" joint—a high-lead solder is necessary, inasmuch as the prolonged "mushy" stage through which the solder passes in cooling is required. A solder with short transition stage between liquid and solid state would not stay pasty long enough to be wiped.

Antimony is included in some solders because it creates a slight expansion upon solidifying, and hence is advantageous in castings or in type metal. It neither adds to nor subtracts from the value of electrical solders.

Any of the alloys listed above will be satisfactory in all standard radio work from the point of view of hardness and tensile strength. Full details on these factors can, however, be found in "Metals and Their Alloys," by Vickers, published by Baird and Co., New York.

These alloys are often avoided in soldering aluminum, although any of them will give excellent results if the proper flux is employed. That fact was not generally realized when aluminum first came into use, and special aluminum soldiers were developed. Some of them are advantageous for definite types of work, although not of especial value for electrical connections. They are usually high-tin solders, to which may be added substantial percentages of zinc, aluminum and / or cadmium, with smaller amounts of lead, copper, antimony or phosphorus. They may be helpful where higher melting points and greater tensile strength are desired. A typical formula is Bureau of Standards Type SN No. 3, consisting of 86% tin, 5% aluminum, 9% zinc and 0.25% phosphorus. A number of excellent aluminum solder formulas are listed by the Bureau of Standards. Study of these specifications reveals an even wider range of composition than in the softer solders, indicating the enormous variety of alloys that will work or can be made to work.

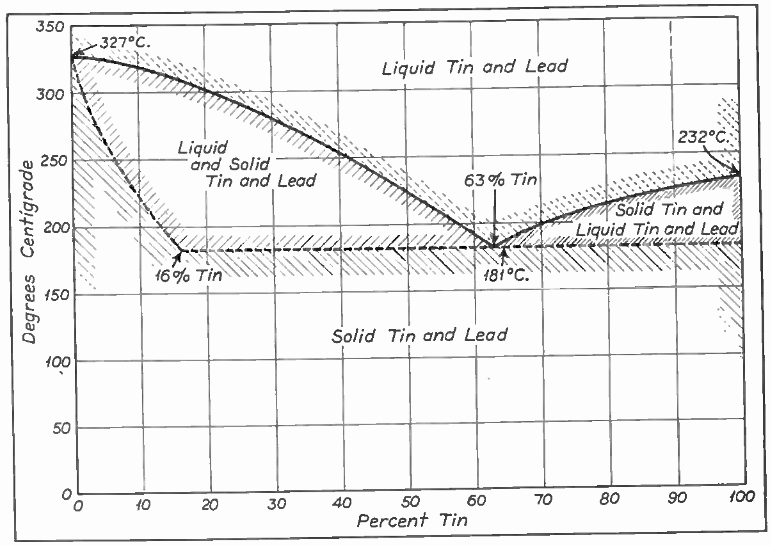


Fig. 1. Curves showing the various stages of solidity and fluidity as a function of the percentage of tin.

The so-called "hard" solders are described hereunder, in connection with brazing and welding operations, which in principle are altogether analogous to ordinary soldering, the difference being only a question of the temperature at which the work is done.

Considerations in the Choice of a Flux

The list that follows includes all the commoner fluxes, including those used for brazing and welding:

Water-Soluble	***Water-Insoluble***
Hydrochloric Acid (Muriatic)	Rosin
Phosphoric Acid	Stearic Acid
Lactic Acid	Palmitic Acid
Ammonium Chloride (Sal Ammoniac)	Oleic Acid (Red Oil)
Ammonium Phosphate	Tallow
Ammonium Lactate	Lard
Zinc Chloride	Beeswax
Aluminum Chloride	Spermaceti
Borax	Fatty Oils
Cryolite	(Cottonseed)
Sodium Cyanide	(Linseed)
Sodium Carbonate— plus Boric Acid	(Olive) etc.

The water-soluble fluxes dissolve the commoner oxides readily. Phosphoric acid may cause some trouble if much oxide is present because of the insolubility of most phosphates. Its special value lies in the formation of a highly viscous layer of flux that stays in place very well; and in its low volatility.

Lactic acid is somewhat more volatile than the phosphoric. It is a heavy syrup and acts quickly.

Ammonium salts serve as fluxes because they are all decomposed, by heat, into ammonia gas and the acid from which they were made. Thus, ammonium phosphate gives free phosphoric acid, and ammonium lactate free lactic acid. The acid, as said, is the true fluxing agent, the salt being merely a convenient form in which to apply it. Similarly, ammonium chloride goes to ammonia and hydrochloric acid.

Zinc chloride, however, may either serve as a source of hydrochloric acid in the presence of water, or in the molten condition act as a flux in its own right.

Hydrochloric acid is the quickest acting solvent of all, but is so volatile that it leaves the hot zone too soon. Hence it is customary to add a salt such as ammonium chloride or zinc chloride, which carries on by serving as a source of the acid, until the water itself is all gone. When that occurs, the ammonium chloride continues to give off hydrochloric acid by thermal decomposition, while the zinc chloride fuses and in that form itself behaves as a solvent.

Since effective washing away or neutralizing of these fluxes is impractical in most radio work, and since they are undesirable they cannot safely be allowed to remain. Even the least corrosive, which is lactic acid, can and will cause trouble in any humid atmosphere. The water-insoluble fluxes are, therefore, always to be preferred.

These fluxes consist of fatty acids, or of fats or waxes which yield free acids when heated to soldering temperatures. The acids, moreover, require such temperatures to dissolve the oxides, and under ordinary circumstances are substantially inactive. Excess flux may be left in place, even upon those parts which normally become heated in use, and, as has been said, is beneficial in protecting the joint against atmospheric moisture.

Rosin is primarily abeitic acid, $C_{19}H_{29}COOH$. Tallow, lard, olive oil and so on are combinations of fatty acids and glycerine. When heated, fats give some free fatty acid and an acrid-smelling volatile product known as acrolein, which results from the thermal decomposition of the glycerine. Waxes, such as beeswax, contain both fatty acids and combinations from which such acids are liberated upon application of the heat. The product of the reaction between the metallic oxide and the fatty acid is a metallic soap (such as aluminum stearate for example) which is dissolved in the excess flux. The traces of water formed during the reaction are vaporized by the heat.

Ordinary metals, such as copper, nickel, brass, monel metal, etc., are readily soldered by use of any of the water-insoluble fluxes.

Aluminum is easily soldered with a stearic acid flux, such as free stearic acid, tallow, or a mixture of these with rosin. No special precautions are necessary, and ordinary solder can be used. The superficial film of oxide reacts readily with the flux to form aluminum stearate and aluminum resinate (although rosin alone is not satisfactory as a flux). These aluminum soaps are immediately dissolved in the excess flux.

Iron and steel are more difficult to solder owing to the low reactivity of the oxide layer, and a hydrochloric

(*Continued on page* 14)

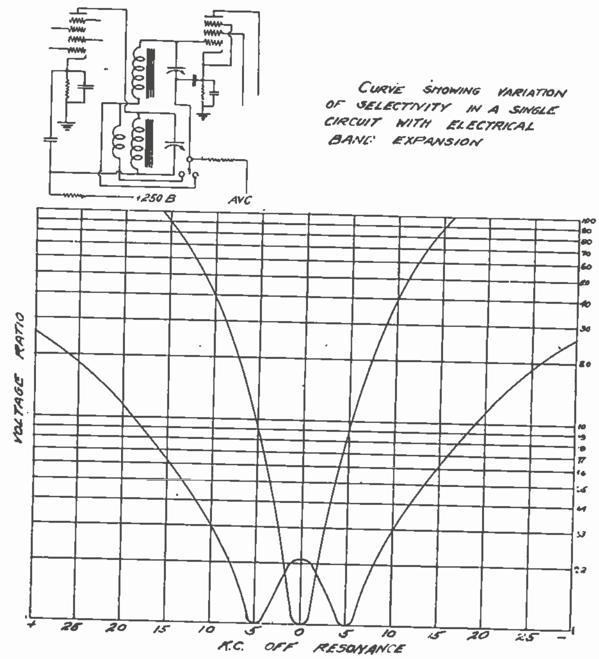


Fig. 1.

VARIABLE

THE TREND TOWARD higher fidelity of radio broadcast signals has created a new problem for the receiver engineer. The selectivity of the average superheterodyne gives a tremendous attenuation to the higher audio frequencies; therefore, the signals coming from the receivers sound little like the original production in the broadcasting studios. The cheaper sets with poor selectivity often reproduce the higher audio frequencies better than the more expensive receivers which have good adjacent channel selectivity.

Broadcasting stations in the United States are separated by 10 kc. This permits a 5 kc audio range before adjacent channel interference is noticed. In some foreign countries stations are separated by only two or three kc which limits the audio range to approximately 1.5 kc before intercepting side-band interference. High-fidelity response is most practical for local reception where adjacent channel interference is not bothersome and noise is over-ridden by the station power. Good selectivity is necessary to separate the more distant stations from the locals. A modern receiver must possess both of these features.

The first step toward the accomplishment of both of these features was made with a split stator condenser connected in shunt with the plate and grid condensers of one of the i-f transformers. The condensers when rotated increased the capacity of one circuit and decreased the capacity of the other,

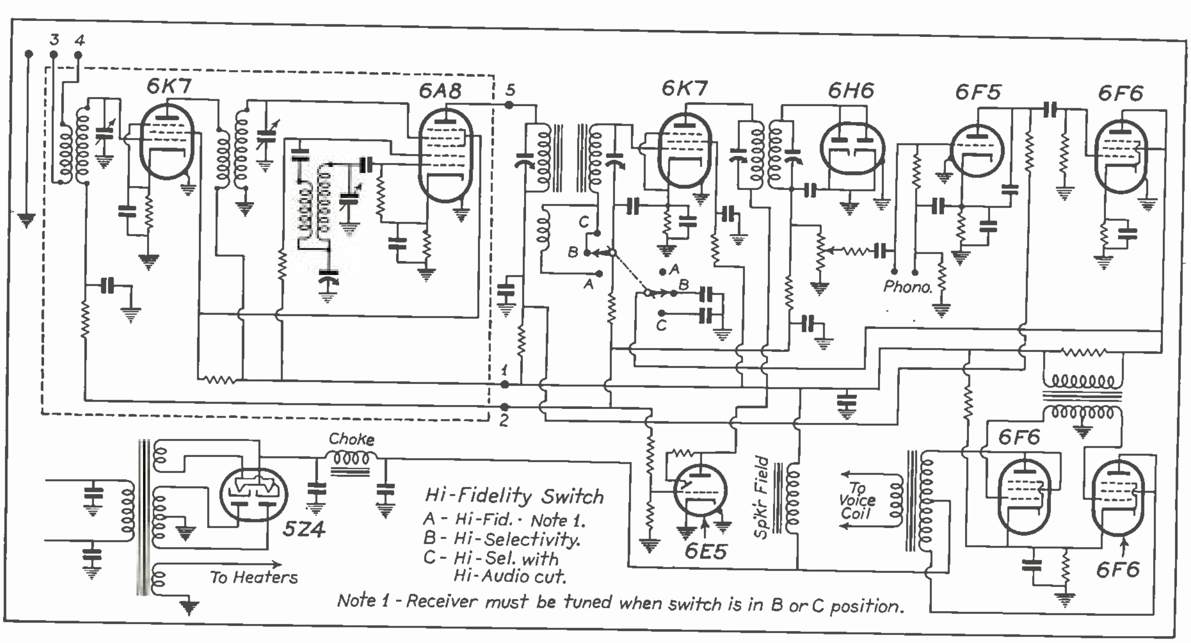


Fig. 2. A circuit employing variable selectivity i-f transformers.

SELECTIVITY

by H. J. BENNER*

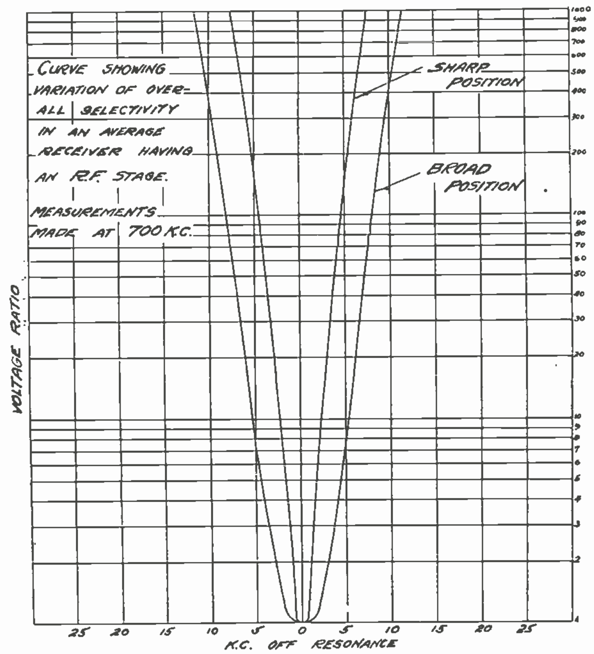


Fig. 3.

thus tuning one circuit to a higher and the other to a lower frequency. This system proved unsatisfactory due to the lengthy leads required in critical circuits such as the grid and plate. This resulted in unsymmetrical response curves and undesirable regeneration. The gain of the i-f transformer dropped very rapidly with the change in tuning and some means of compensation, such as decreasing the grid bias, had to be made when detuning the circuits. Inaccuracies in tuning and normal variations which can occur in the field discouraged further work along this line.

The next attempt to provide a variable selectivity was to move the coils mechanically to vary the coupling between them. A 0.375" movement was found to over-couple the circuits enough to widen the bandwidth of the i-f channel satisfactorily. This system was excellent in operation, but was too expensive to include in the average receiver.

One step necessary to reduce the cost of a band-expansion system is the removal of moving parts from the transformer assemblies. This can be accomplished electrically and adds only a switch to select circuits. A very small coil is coupled to one of the transformer windings. This is switched in or out of the second tuned circuit to change the coupling. The detuning of the second circuit by the addition of a small coupling coil is negligible with careful design. The symmetry of the wide passed band is entirely satisfactory for high-quality audio response with diode detection. Iron-core coils provide the selectivity needed to separate distant stations.

Due to considerations to be taken up later, it is impossible to vary coupling in the transformer feeding the diode detector; thus in a single-stage amplifier only the first transformer may be so treated. The circuit arrangement and selectivity variation of a single transformer is shown in Fig. 1. The small coupling coil is wound on top of the primary or plate coil. It is so connected that when switched in series with the secondary or grid coil, the mutual inductance between the circuits is increased to bring the necessary over-coupling for a wide passed band. In the narrow passed band this coil is completely out of the circuit. Variation in gain between the two conditions is slight. This is a feature of this particular design. Selection of proper individual coil Q and transformer coupling effect this result. The transformer in this case was well under-coupled when switched in the highly selective position.

In a single-stage amplifier, there is a definite limit to the over-coupling permissible for high-fidelity response. It was found during the development of the system that the diode transformer

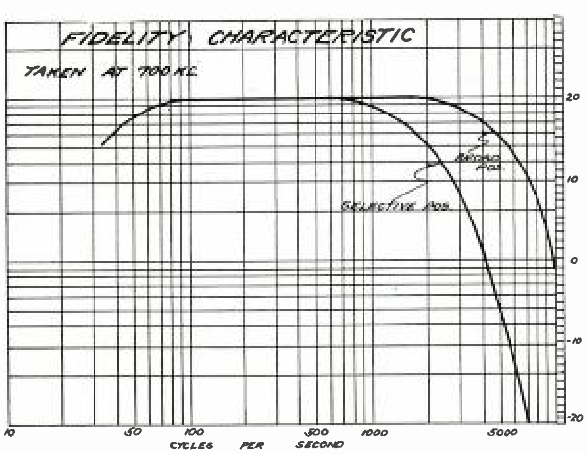


Fig. 4.

* F. W. Sickles Co., Springfield, Mass.

and r-f pre-selector of the receiver played an important part in the overall results.

It has been previously shown[1] that this overall selectivity curve or passed band should have an essentially flat top. In order to attain this it is necessary to rely on the diode and r-f selectivity to fill in the valley between the peaks of the expanded curve of Fig. 1. If we consider the r-f selectivity to be a fixed quantity, then the diode transformer must be designed expressly for each degree of expansion of the interstage transformer. As this expansion increases the diode selectivity must decrease, so that if carried too far the maximum overall selectivity is impaired. A compromise must be reached which permits both good selectivity and good audio quality. In the receiver used for this discussion the iron-core interstage transformer of Fig. 1 was used in conjunction with several diode transformers. When an iron-core transformer was employed in the diode circuit a triple peak resulted in the overall curve. The diode transformer selectivity showed up as a narrow nose between the extended peaks of Fig. 1. A broad diode transformer—single-tuned, air-cored—broadened the selectivity too much in the sharp position. The final diode transformer uses the familiar air-core high-Q coils in a double-tuned circuit.

The circuit diagram of a receiver using this electrical band expansion is shown in Fig. 2. The set consists of an r-f tuning unit in which two tubes are made integral with the unit to keep leads short. The tuning range of 535 kc, to 18 megacycles is covered in three steps. All unused coils are shorted to prevent dead spots. The selectivity of the units satisfies image requirements without expressively increasing overall receiver selectivity. This permits easier design of the expanding i-f. The audio circuit consists of a 6H6 diode followed by a 6C5 resistance coupled to feed a 6F6 driver triode connected. The output stage uses two triode connected 6F6 tubes in Class AB.

The schematic shows a resistance capacity filter in the plate return of the 6A8 tube and also shows the avc bypass of the 6K7 returned to cathode. These circuit arrangements reduce regeneration and are essential to proper operation of an expanding i-f.

Fig. 3 shows the overall selectivity curve and Fig. 4 the fidelity. Both curves were taken at 700 kc.

[1]High Fidelity Receivers With Expanding Selectors, by Wheeler & Johnson. Proceedings I.R.E. Volume 23. Pages 594-609.

FLUXES AND SOLDERS

(*Continued from page* 11)

acid-zinc chloride flux is often used. This, of course, is objectionable in radio work, and is totally unnecessary in any circumstances. All that is needed is to touch the surface to be soldered with a camel's hair brush or cloth that has been dipped in 2% copper sulphate solution. A thin and adherent layer of copper plating is formed instantly, upon which rosin flux and ordinary solder can be used precisely as upon copper metal. The iron or steel surface of course must be free from grease, and more uniform results are obtained with cold rolled steel, since iron and hot-rolled steel may be pitted with impurities and require filing of the surface before wholly satisfactory results can be obtained. This simple procedure is applicable to chassis grounds, condenser frames, etc.

Zinc-coated steel, whether galvanized or electro-plated, is difficult to solder only when an overheated soldering iron brings about too great a degree of oxidation of the surface. It is not necessary to trouble about the temperature of the soldering iron, however, but only to use a rosin-stearic acid flux (50-50), which is a more effective solvent for zinc oxide than rosin alone. This flux is a solid, but may be made into a paste by adding oleic acid or any fatty oil to give the fluidity desired.

Vaseline and parafine are often added to flux materials to form soldering pastes. They are inert materials of no particular value, and if present in considerable excess, may interfere. Equally pasty mixtures can be obtained by use of suitable proportions of the fatty oils, waxes, etc., which will not be encumbered by the presence of inert matter.

Soldering Iron Tips

Soldering iron tips of monel metal or of solid nickel are superior to copper tips because they tin more easily and pit less readily. They require less attention, not being subject to scaling to the extent that copper is. These features may offset their increased cost.

Brazing and Welding

Brazing solders consist essentially of alloys of zinc and copper, varying from 20 to 60 percent zinc, and from 80 to 40 percent copper, with melting points ranging from 960 to 820 degrees centigrade. Other hard solders are silver solders—mixtures of silver, copper, zinc and tin, with melting points 700-800 degrees Centigrade. Since these solders require such temperatures of this order, they cannot be used with the fluxes suitable to soft solders. Those fluxes, especially the water-insoluble class, would be decomposed or ignited. Mineral (inorganic) fluxes are used, especially combinations of borax and boric acid, preheated to remove water; sodium carbonate and boric acid; cryolite mixed with zinc chloride or barium chloride to lower the melting point, and in some cases sodium cyanide is used as a flux. All of these combinations, in the molten form, dissolve iron oxide very readily.

Welding is still the same operation in principle, carried out at somewhat higher temperatures than brazing, and using the same fluxes.

Physiological Considerations in Soldering Work

In a closed or poorly ventilated space, injury may result to the worker who inhales the fumes of soldering operations over long periods of time. Among the commoner fluxes, zinc chloride is poisonous, caustic to the skin, and may, when hot, evolve some gaseous hydrochloric acid, which is very irritating to the lungs. Ammonium chloride is relatively harmless, but when present in large amounts will yield annoying, choking fumes, irritating to nose, throat and lungs. Ammonium phosphate gives off ammonia gas, one of the most powerful of all irritants to the mucous membranes. All of these, in sufficient quantity or over a sufficient period of time, may result in permanent injury by lowering the natural resistance of the membranes and of lung tissue to bacterial attack, especially by pneumonia and tuberculosis.

The water-insoluble fluxes are all nonpoisonous in themselves, but if an overheated soldering iron is used, appreciable amounts of carbon monoxide may form, resulting in headaches and decreased personal efficiency. If a fat is used instead of the free fatty acids, the acrolein evolved will prove a powerful eye, nose and throat irritant. Lead fumes from the solder, and the traces of arsenic ever-present in commercial leads and zincs, are cumulative poisons.[1]

[1]In connection with these remarks on soldering fumes, reference should be made to the article "Production Line Ventilation," by W. A. Murdock, RADIO ENGINEERING, April, 1936.

MAGNETIC CIRCUIT CALCULATIONS

A Review of the Principles of Calculating Magnetic Circuits—A Subject of More Than Academic Interest Since the Advent of the New Alloys

by H. H. FRIEND*

SEVERAL PERMANENT MAGNET materials of such remarkable characteristics as to make them useful for many applications where previous materials were uneconomical or unusable are now available to design engineers. It is the purpose of these notes, which are collected from many sources, to point out some of the properties of permanent magnets, show how they may be compared with each other, and to indicate a method of calculating the required magnet size of a given material to accomplish a definite result.

By careful design and the use of the available material which is best suited to the particular project, there is no reason why many devices now employing electromagnetic excitation should not be improved by the use of permanent magnet excitation. The advantage of permanent magnets in loudspeakers is well known, particularly when the speakers are to be used in battery radio sets for farm and auto use. Such speakers are also indispensable in centralized radio installations. But there are many other applications for permanent magnets in toys, small motors, light-weight generators and magnetos, certain types of relays, meters and microphones which have hardly been touched by design engineers.

The properties of any magnetic material are best shown in curve form, Fig. 1 showing a typical magnetization curve and hysteresis loop. Along the horizontal or XX axis the magnetizing force H, is plotted, the units being Oersteds or Gilberts per centimeter. Along the vertical or YY axis the resulting induction, B, in the material is plotted, the units being Gausses. Because practically all the necessary information concerning a magnetic material may be read from that part of the curve in the 2nd quadrant, enclosed by +B, O and —H, usually only that portion of the hysteresis loop is shown, as in the left-hand portion of Fig. 2, and since this curve is obtained while the sample is being demagnetized, it is usually designated as the Demagnetization Curve of the material. The one shown as Fig. 2 is of a hypothetical material, drawn only for explanation and is not meant to represent any actual magnetic substance.

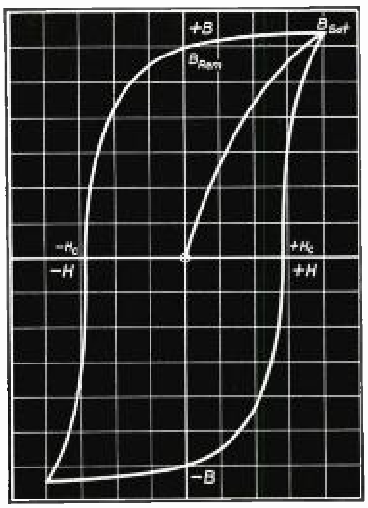


Fig. 1. A typical magnetization curve and hysteresis loop for a magnetic material.

The right-hand portion of Fig. 2 shows what is usually known as the BH_{max} curve for this same material. The BH_{max} curve is obtained by taking several points on the demagnetization curve, shown on the left, and for each point calculating the value of B times H for that point, then plotting this product on the BxH scale. For instance, point (a) has the product of its B and H values plotted at (b), while (c) has the product plotted at (d) and so on. At some point the BxH curve will reach a maximum value as indicated at BxH_{max}. This maximum indicates the maximum available energy for that particular material to provide magnetic flux in an air gap and the most efficient point at which to work the material in order to obtain the required flux density with the least volume of metal. A line drawn horizontally through BH_{max} will intersect the B axis at B_m and the demagnetization curve at (e). A vertical line through (e) will intersect the H axis at H_m. B_m and H_m then represent the values of flux density and field intensity in the metal which will result in the most economical magnet design.

There is one other value in relation to a magnetic material which might be required, namely the point to which to magnetize a sample in order that the sample might retain a magnetization of value B_{rem} shown on the curve when the

*Ciraudagraph Corp., Stamford, Conn.

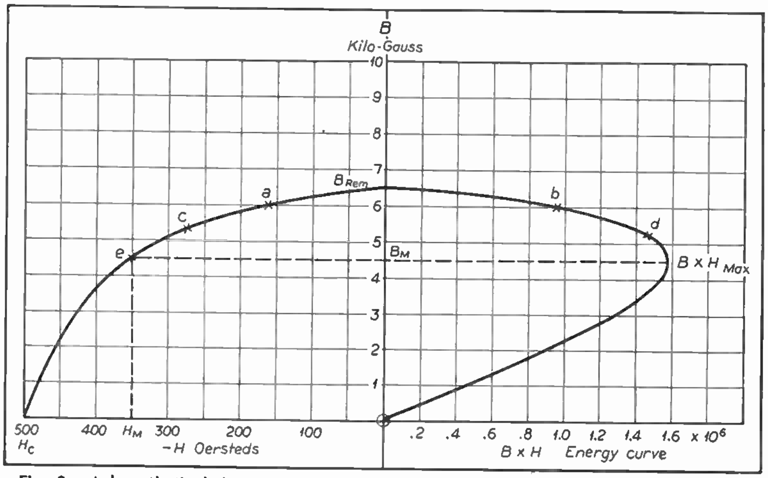


Fig. 2. A hypothetical demagnetization curve and BH_{max} curve for a permanent magnet material.

magnetizing current is discontinued. This value, B_{sat}, can be readily obtained from the demagnetization curve, as shown in Fig. 3. Through B_{rem} a horizontal line is drawn and through H_c a vertical line is drawn, the two intersecting at M. Some point, P, on the demagnetization curve is picked, and through it vertical and horizontal lines are drawn as before, intersecting at N. Through M and O a line is drawn, while through Q and N another line is drawn and the two lines so drawn will intersect at some point R. A horizontal line through R intersects the B axis at B_{sat}.

For practical work it is also possible to find BH_{max} quickly by this method. If the point M is located as before, and the line OM drawn, this line will intersect the demagnetization curve at T which is the point at which BH_{max} occurs.

The significance of the values of these various points will no doubt be of interest. B_{sat}, as before stated, represents the value of magnetization which must be applied to a material in order to have it retain a value of magnetization B_{rem}. B_{rem} is the Remance or Retentivity, and is the amount of magnetization which the magnetic material retains after the magnetizing force has been removed. H_c is known as the Coercive force, and shows the amount of reverse magnetizing force which must be applied to a magnet in order to overcome the magnetism retained by it. Thus H_c is a measure of the ability of a magnet to withstand outside influences such as heat, mechanical shocks and stray electric fields. For most applications, the highest possible value of Coercive Force is desirable.

Using the nomenclature listed below, simple equations can be derived from which permanent magnet sizes can be readily calculated.

Let:

Φ = Total flux required from the magnet

B_m = Value of B in steel at BH_{max}

A_s = Area of magnet steel, sq. cms.

L_s = Length of magnet steel, cms.

mmf = Magnetomotive force in magnet

H_m = H at BH_{max}

B_g = Value of B required in gap

L_g = Length of gap, cms.

A_g = Area of air gap, sq. cm.

R = Reluctance of gap

F = Leakage factor for area

f = Leakage factor for length

The cross-sectional area of the magnet may be found as follows:

Total flux, Φ = Gap flux density x area of gap x leakage factor
= B value of steel at BH_{max} x area of steel

or, $B_m \times A_s = B_g \times A_g \times F$

hence

$$A_s = \frac{B_g \times A_g \times F}{B_m} \quad \ldots\ldots\ldots\ldots (1)$$

The length of the magnet steel may be found as follows:

Total flux in the gap = Magnetomotive force in magnet + reluctance of gap

also, $= B_g \times A_g \times f$

hence

$$B_g \times A_g \times f = \frac{\text{value of H at } BH_{max} \times \text{length of magnet steel}}{\text{length of gap} \times \dfrac{1}{\text{gap area} \times \text{permeability of gap}}}$$

$$= \frac{H_m \times L_s \times A_g \times 1}{L_g}$$

from which

$$L_s = \frac{B_g \times L_g \times f}{H_m} \quad \ldots\ldots\ldots\ldots (2)$$

In the above equations, the leakage factors, F and f, depend upon the magnetic material, the size and shape of the magnet, the magnetic path surrounding the magnet, and the nature of the air gap. In practice, it is customary to calculate the size of a magnet to give a certain field in a certain gap, employing reasonable values for the leakage factors. The magnet of the calculated size is then cast and the resulting field measured in the gap. The leakage factors may then be revised to coincide with the values shown in the actual casting.

Suppose that it is desired that a magnet be calculated to give 7,000 lines per square centimeter in a circular air gap 1 inch inside diameter by 50 mils wide by 3/16 inch thick. Remembering that all the equations are based on the centimeter unit, the various quantities thus become: A_s, area of the steel and L_s the length of the steel are to be found. B_m, from curve Fig. 2 = 4,500; H_m from the same curve = 350; B_g = 7,000 lines; A_g = 3.79 sq. cm.; L_g = 0.127 cm.; F = 2.0 and f = 1.3, assumed values.

Substituting these values in the equations, (1) and (2):

$$A_s = \frac{B_g \times A_g \times F}{B_m} = \frac{7{,}000 \times 3.79 \times 2.0}{4{,}500}$$

$$= \frac{53{,}060}{4{,}500} = 11.7 \text{ sq. cm.}$$

and

$$L_s = \frac{B_g \times L_g \times f}{H_m} = \frac{7{,}000 \times 0.127 \times 1.3}{350}$$

$$= \frac{1155}{350} = 3.3 \text{ cm.}$$

In designing permanent magnets, it is essential that the demagnetization curves used should be true curves made on production castings, and not laboratory curves made of specially handled bar samples. It is also important that all precautions be taken to assure that the leakage factors should be kept as small as possible in order to conserve the magnetic material.

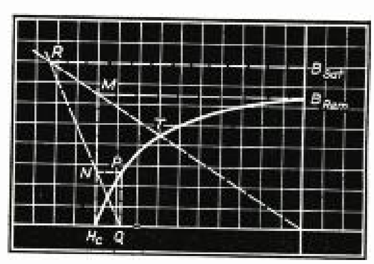


Fig 3. Showing how to obtain B_{sat} and BH_{max} from the demagnetization curve by graphical means.

FILTER-COUPLED GLOW DISCHARGE OSCILLATORS

by W. E. KOCK, Ph.D.*

THE CHARACTERISTICS OF the intermittent glow discharge oscillator with an inductance inserted in the condenser arm were recently reported.[1] When such an oscillator was operated in the neighborhood of resonant frequency, the frequency stability against fluctuations in the applied voltage, resistance, and tube characteristics was increased, and the voltage across the condenser became sinusoidal. It is the

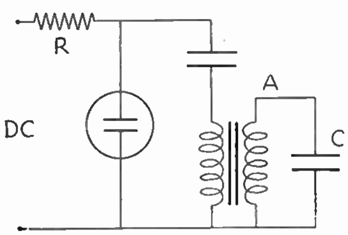


Fig. 1. The filter-coupled inductive glow discharge oscillator.

purpose of this paper to present a new stabilizing effect, brought about by the introduction of a second tuned circuit, thereby replacing the simple control circuit of inductance and capacity by one comprising a multi-section filter.

The circuit diagram of the new stabilized oscillator is given in Fig. 1. In place of the simple inductance in the control circuit, the primary of a high impedance transformer was used, and a small condenser C, of about 500 mmfd, was connected across the secondary. This presents a second tuned circuit, A, having a definite resonant frequency of its own, and due to the mutual inductance of the transformer, this second tuned circuit will influence the characteristics of the main oscillator circuit. Fig. 2 shows the curve of frequency *versus* voltage for such an oscillator. As the applied voltage is increased, instead of the frequency continually increasing as in the ordinary intermittent glow discharge oscillator, or instead of the frequency gradually approaching the resonant frequency as in the inductive glow discharge oscillator, it is observed that a stepwise increase of frequency results. In Fig. 2, if we take the frequency of the lowest step to be 120 cycles, its sixth harmonic would be 720

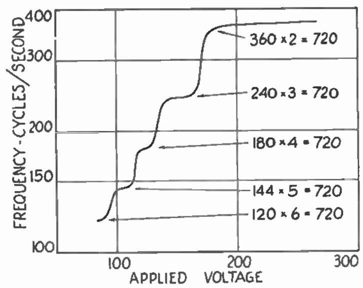


Fig. 2. Frequency-voltage characteristics.

cycles. For the second step at 144 cycles, its fifth harmonic would be 720 cycles and so on as the table indicates to the topmost step, whose second harmonic corresponds to 720 cycles per second.

It is thus evident that the second tuned circuit, whose reflected frequency (considering the mutual inductance and the primary circuit impedance) apparently lies around 720 cycles, is exerting an influence on the main oscillator to tend to cause it to oscillate at one of the sub-harmonic frequencies of this reflected resonant frequency.

Fig. 3. shows the extent to which stabilization can be carried out when optimum values of the self and mutual inductances are selected. For purposes of comparison, curves of the frequency-voltage characteristic of the intermittent glow discharge oscillator (Curve A) and of the inductive glow discharge oscillator are also given (Curve B). In all three cases, the identical neon tube

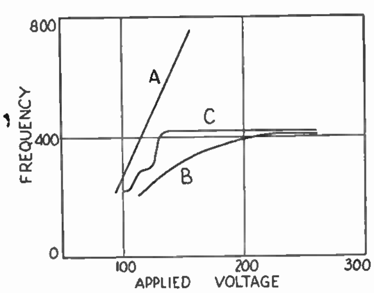


Fig. 3. Comparison of the frequency characteristics of glow discharge oscillators.

was used and the three curves were plotted from data taken on actual tests.

When a large inductance is used in the main oscillator circuit it is found that a similar effect can be obtained by placing a small condenser directly across the main inductance and dispensing with the secondary circuit. However, this sometimes leads to erratic performance which is not observed in the filter-coupled circuit, due probably to the flexibility introduced by the inductive coupling. The stepwise increase was also noted when certain large inductances were employed either in the pri-

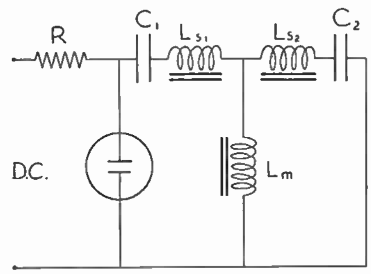


Fig. 4. Equivalent circuit of the filter-coupled glow discharge oscillator.

mary or in the secondary circuit, but without a fixed condenser shunting them. The effect was no doubt due to the distributed capacity of the inductance acting to produce the same result as a fixed condenser.

The equivalent circuit diagram of the filter-coupled oscillator is given in Fig. 4, where L_m represents the mutual inductance, L_{s1} the self-inductance of the primary and L_{s2} the equivalent secondary inductance. It is observed that the circuit represents a two-section band pass filter with the output terminals short circuited. The inductive glow discharge oscillator would be represented by a one-section filter with a short circuit across L_m. It is evident that a two-section filter can be adjusted to give sharper resonance than a one-section filter so that the main oscillator will be held to the given frequency over a larger range of voltage.

A circuit set up according to the equivalent circuit of Fig. 4, with actual inductance replacing L_{s1}, L_{s2} and L_m, likewise gave the stepwise increase of frequency with voltage. When L_m was replaced by a condenser, i. e., when capacitative coupling was substituted for inductive coupling, it was observed that increasing the tightness of coupling by increasing the size of the condenser resulted in an increase in the flat portion of the frequency curve.

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[1] "The Inductive Glow Discharge Oscillator," W. E. Kock, RADIO ENGINEERING, April, 1935. See also: Physics 4, 359 (1933), Zeits. f. Tech. Phys. 15, 377 (1934).

Design . . NOTES AND

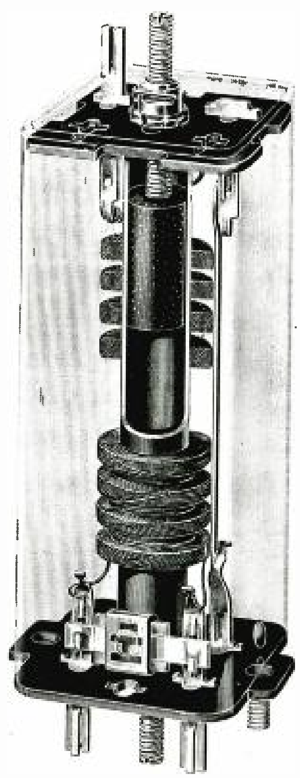
MAGNETITE-CORE I-F COILS

AS EARLY AS 1902 Lee and Colpitts used synthetic magnetic oxide of iron in inductance coils for audio circuits. J. S. Stone suggested the use of finely divided iron molded with a suitable binder for r-f circuit cores in 1903. In 1924-26, thin laminated iron was used extensively in r-f and i-f transformers of superheterodyne receivers. For years the Western Electric Company have employed powdered permalloy cores in telephone circuits.

In recent years similar products have been commercially exploited for r-f and i-f circuits. These products have had one drawback; namely, high cost, which has seriously retarded their general application to radio circuits.

The Advanced Development Section of RCA Victor has solved the problem of producing a low-cost molded core by employing, as the main core ingredient, the natural ore magnetite, a magnetic oxide of iron, $Fe_3 O_4$, ground to the particle size required.

The RCA Magnetite Core I-F Transformer.



One application will be described to illustrate the benefits derived from utilizing magnetite cores in radio-frequency circuits. Heretofore, it has been customary to design i-f transformers with variable tuning condensers and fixed inductances. With magnetite cores, the inductance can be made variable and the coils smaller in size. The tuning capacities can be made fixed and also smaller in size.

The ultimate practical result of adding magnetite cores to i-f transformers is to reduce the combined cost of coils and associated condensers more than the cost is increased by adding the cores. Another result is the elimination of adjustable mica trimmer condensers, the electrical constants of which change more with humidity, temperature and aging than any other part of a conventional i-f transformer. A still further improvement obtainable is lower loss tuned circuits (higher Q), which results in higher gain and greater selectivity. This advantage can be converted into still lower cost and smaller size units by closing down on the size of the shield and coil assembly until the circuit losses are the same as for previous standard air-core i-f designs.

The accompanying picture is of a new standard 460-kc transformer designed for RCA Victor 1936-37 broadcast receivers. The cutaway section shows the position of magnetite core in relation to the secondary winding. There is a similar core inside the primary winding. The small fixed mica condensers, one in the foreground at the base of the unit, and the other at the top of the unit and on the opposite side of the coil tubing, are shunted across the primary and secondary windings, thus completing the resonant circuits. Coil and condenser tolerances are compensated for by adjusting the cores relative to the universal-wound sectional coils. Tuning is accomplished by screw-driver adjustment of the brass screws protruding at the two ends of the transformer. The screws are molded into the ends of the magnetite cores.

To avoid serious changes in mutual coupling between primary and secondary, the constants are chosen so that in adjusting the cores they need never penetrate the coil section nearest the associated primary (or secondary) winding.

W. L. Carlson,
Receiver Division, RCA Mfg. Co.

TELEVISION

THERE IS LITTLE if any need for receiver manufacturers to become excited about television for the time being, according to some remarks by R. R. Beal, director of the RCA television committee. The occasion was a demonstration of television "staged" at the RCA laboratories in Camden, N. J., for the benefit of a group of about thirty newspaper and magazine writers.

Serving as a pre-view of what RCA hopes to do in the tests to be started on June 29 from the Empire State Building in New York City, the demonstration plainly indicated that much remains to be done before home television receivers become an actuality. As was pointed out by everyone concerned with RCA's television, nothing is known about what will happen when the visual programs are put on the air for distances greater than that covered by the Camden equipment—one mile. The most optimistic engineer would not venture to guess that the theoretical seventeen-mile radius of the Empire State Building transmitter would be effectively covered by the program material.

From the standpoint of the receiver, there is also much work to be done. The receivers used at Camden employed some thirty-three tubes and fourteen controls, although a few of these, once set, may not have to be changed except at infrequent intervals. The receiver is actually two receivers in a common cabinet; this is apparent when one considers that sound and speech are necessary accompaniments to the visual portion of the broadcast. Separate channels are, of course, necessary for the speech and visual components of the program.

Newspaper comments on the Camden demonstration mentioned that present-day television is about in the stage represented by the crystal detector and headset of early radio. This is perhaps as good an example as can be drawn. The picture on the receiver screen was about five by seven inches, necessitating that the audience be compactly grouped about the receiver if any detail at all was to be seen.

Some misconceptions regarding the television image have evidently found their way to the public. The image cannot, under present conditions, be enlarged for projection on to a larger screen, nor does the prospect of such an enlargement appear to be imminent.

However, one person's guess is almost as good as another's. Television may be ready in a remarkably short time—and, again, it may be years in the future. In any event, RCA's licensees are not being stampeded into preparations for manufacturing television receivers.

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A RECORDER FOR LISTENER SURVEYS

THERE IS ONE infallible way to determine accurately the radio listening habits of a particular family. That method is to attach to the family radio set an instrument which will register each time the set is turned on and off and record precisely the station tuned in and the listening time to that station.

Such an instrument has been perfected by Professors R. F. Elder and L. F. Woodruff of the Massachusetts Institute of Technology, and is now in practical commercial use. Its major features are:

(1) A synchronous motor driving a record tape at constant speed. This serves to keep a constant and accurate record of time.

(2) A pencil so mounted and operated by an electro-magnetic device that it draws a line on the record tape when the set is on and leaves no mark when the set is off.

(3) A mechanical connection to the tuning mechanism of the set so that the position of the mark on the record tape indicates the setting of the dial on the radio set.

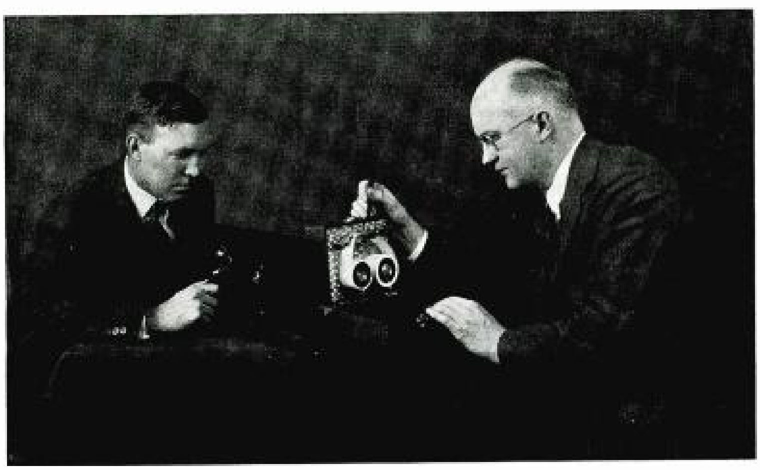
The instrument is attached to a particular set and the record tape is calibrated by marking the positions of the key stations for the area. When the recorder is started the exact time is also noted on the tape opposite a starting mark. After the recorder has operated for the desired length of time, the finishing time is noted opposite another mark, and the instrument is removed.

Proper operation of this method also requires a mechanical device to facilitate reading the recorder tapes. Such a device has been developed and is in use. It records in days, hours, and minutes. In reading a record tape, the time scale is set to synchronize with the time when the recorder was started. The station scale is adjusted to the calibration marks on the record tape. Reading the tape in terms of days, hours, and stations is then extremely simple.

Once having solved the problem of making a precise record of the listening habits of a single family, the next problem is to devise a plan for using the recorder to determine the general listening habits of all families living in a specific area.

Here we avail ourselves of the well-accepted principles of sampling. If we secure records of radio listening from a sufficient cross-section of the families living in an area, we can safely assume that we have a good picture of the listening habits of all families in that area. How accurate our picture is depends upon how large our sample is and how truly it represents a cross-section of the entire population.

Professors R. F. Elder (left) and L. F. Woodruff with the Listener-Recording Device.



The initial audience survey made by this method was conducted in the Greater Boston area, and covered a ten-week period from early November to the middle of January of this year. A New York City and adjacent New Jersey.

The results of course cover the entire 24-hour period each day, and allow breakdown of the analysis by economic classification, telephone and non-telephone families, and other refinements not heretofore possible.

L. F. Woodruff,
Massachusetts Institute of Technology.

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ELECTRONIC MUSIC INSTRUMENTS

AT THE MAY 6 meeting of the I.R.E. in New York, B. F. Miessner presented a paper on, and demonstration of the new electronic music instruments, whose recent commercial development has set a phenomenal first year's sales record exceeding $2,000,000. Guitars, banjos, ukules, violins and organs have been sold in considerable numbers. It is strange that the radio industry has given such scant attention to this the youngest member of the electronic family. All indications point to a revolution in the methods of generating and controlling musical tones and the future of this infant industry is exceedingly promising.

Miessner, a pioneer inventor in this field, traced the evolution of electric tone production, pictured the important developments with lantern slides, and demonstrated a number of the new instruments.

He stated that the U. S. Patents alone in this field already number about 300, and that these are rapidly increasing, that the normal incubation period of forty years for radically new inventions had already transpired and that commercial activities are now well under way.

Among the instruments demonstrated were the Hammond Electric Organ, the Telefunken Trautonium, the Rickenbacher Guitar, and a new electronic organ developed by Miessner, using air-blown harmonium reeds as the original vibration sources and fitted with electrostatic pickup devices for converting these vibrations into electric voltages.

I. R. E. — CLEVELAND

(*Continued from page* 8)

amounts of light are available and where the light variations last not less than one-tenth of a second.

Fig. 6 shows a vacuum-tube current multiplier circuit that will multiply a small direct current from a high-impedance source by a definite factor that is practically unaffected by the tube characteristics or by supply voltage variations. Essentially the operation of the circuit is as follows:—the signal current I_1 is used to discharge condenser C_1; after the charge on C_1 has been reduced to a certain value the potential on the grid of the buffer stage will be such as to allow the current through the buffer stage to be sufficient to create enough voltage drop across the cathode load resistor to decrease the bias on the 885 gas triode enough to cause the tube to break down. When this occurs condenser C_2 is discharged and then charged in the opposite direction (in a manner known to those familiar with the operation of gas triode relaxation oscillators—see RCA 885 bulletin) to a value equal to E_1 minus the tube drop (15 volts) times two. This exact current value is unimportant.

A study of Noise Characteristics. V. D. Landon, RCA Victor Division, RCA Manufacturing Co., Camden, N. J. For purposes of analysis, noise may be divided into two classes. The first type is smooth noise such as that due to thermal agitation or tube hiss. The second type is noise due to impulse excitation from widely separated impulses.

There are also noises which cannot be placed in either classification having characteristics midway between the two types. This kind of noise is the most difficult to deal with both analytically and practically.

It is well known that with smooth noise of the thermal agitation or tube hiss type, the energy is uniformly distributed throughout the radio frequency spectrum. Hence, the hiss power output of a radio frequency amplifier is proportional to the frequency bandwidth (at a given amplification). It follows that the r-m-s voltage output is proportional to the square root of the bandwidth. The variation of peak amplitude with band-width is not so easy to predict.

It is important to note the apparent discrepancy in the results for the two types of noise. For both types, the r-m-s amplitude is necessarily proportional to the square root of the band width. With smooth noise, the peak amplitude is also proportional to the square root of the band width giving a constant crest factor. However, the noise consisting of isolated impulses with decay trains not overlapping, the peak amplitudes are proportional to the first power of the band width. This difference is due to the fact that the decay trains do not overlap for the second class of noise.

Another interesting factor brought out by the analysis is that the decay train due to a single impulse has a time duration which is inversely proportional to the frequency band width. This fact is of the greatest importance in the design of noise reducers of the limiter type.

The analysis of impulsive noise brought out an important point in regard to noise reduction by wide band frequency modulation also. It is generally agreed that the frequency modulation system is inoperative if the noise peaks exceed the signal in amplitude. Widening the band improves the performance on smooth low amplitude noise, but may make it worse if the noise peaks are of about signal amplitude.

Cathode Ray Oscillograph Applications Other than Radio. H. J. Schrader, RCA Victor Division, RCA Manufacturing Co., Camden, N. J. The author illustrated with slides the application of the use of a cathode ray oscillograph in conjunction with: Rochelle salt crystal pickup to measure vibration; a simple induction alternator mounted on a shaft to measure torsional twist; a quartz crystal to measure pressures.

A Potentiometric Direct-Current Amplifier and Its Applications. R. W. Gilbert, Weston Electrical Instrument Corp., Newark, N. J. The system described was basically an automatic null potentiometer, but is classifiable as an amplifier because of its high speed characteristic and the fact that the indication is given as the value of an output current. Null potentiometric comparison of input to output by means of a fixed resistor or resistors, and the use of a sensitive null device assures independence of circuit variables and a degree of stability far beyond that of conductively coupled amplifiers.

COIL FORMS

(*Continued from page* 9)

to $250.00 there is a considerable saving in the cost of punching over drilling.

Short-wave coil forms are generally threaded to a given pitch diameter and the coils wound between holes placed either by a punch and die or drill jig. The pitch diameter can be gauged accurately by a thread gauge where the threading is continued to the end of the coil form. Otherwise, pitch diameter is controlled by placing a given size wire around one complete revolution of the thread and then taking an overall micrometer measurement to include the wire and coil form. Due to the fewer turns of wire on short-wave coil forms, small variations of spacing and diameter become increasingly important on account of their greater percentage effect on inductances of small values. For this reason, threading is almost always employed. The depth of thread varies from .010" to .030" or more, and is usually of the 60-degree V type.

Power factor, dielectric constant and loss factor are the electrical properties with which the radio engineer is most concerned. Power factor is a measure of the percentage of r-f power lost in the dielectric which forms the capacitance. Therefore, it is desirable to have a low capacitance as measured by the dielectric constant, as well as a low power factor. The product of the two is the loss factor. It has been found that power factor and dielectric constant values do not vary over very wide limits with frequency. Most power factor measurements for the sake of convenience are made at one megacycle. Power factors at other frequencies within the radio spectrum do not vary widely from those obtainable at one megacycle.

More important than actual power factor and dielectric constant is the stability of power factor and dielectric constant over wide variations of temperature and humidity. Tests conducted on coil-form materials include immersion in water for 24 hours to one month or more, as well as exposure to 90-100% humidities for 96 hours or longer to indicate not only the percentage of water absorbed, but also changes in power factor and dielectric constant that may occur due to this absorption. Small percentage changes of power factor and dielectric constant are highly desirable because of like changes produced in the Q and capacities of associated tuned radio circuits.

Good coil-form material is generally satisfactory from the standpoint of surface leakage resistance, the main requirement being a surface that is not capable of absorbing or holding any appreciable quantity of moisture. Low values of surface leakage resistance may cause noise generation in r-f circuits, or in extreme cases, appreciably affect the Q of the tuned circuit.

RMA NEWS

FTC HEARING ON TRADE PRACTICES

A MOST FAVORABLE reception and practically unanimous endorsement of the trade practice rules for radio set manufacturers, sponsored by the RMA, marked the public hearing of the Federal Trade Commission at Washington on April 7. Strong support for the proposed rules was given by representatives of the Federal Communications Commission, the U. S. Department of Commerce, U. S. Bureau of Standards, the National and Washington Better Business Bureaus, as well as RMA. The public hearing was concluded in about two hours and was well attended. The Commission then took the proposed rules under advisement.

The hearing was conducted by Judge George McCorkle, director of trade practice conferences of the Commission. The RMA presentation was in charge of its special committee, including James M. Skinner of Philadelphia, chairman; James L. Schwank of Philadelphia, E. F. McDonald, Jr. and A. S. Wells of Chicago, and George A. Scoville of Rochester, N. Y., and assisted by John W. Van Allen of Buffalo, RMA general counsel, and other Association officers. Arrangements for the RMA presentation of the proposed rules at the Commission hearing were made at a preceding meeting of the Association's Board of Directors in Washington on April 6.

Chairman Skinner of the RMA Committee opened the hearing with a detailed statement regarding the proposed rules, emphasizing their effect to properly advise the buying public and also the beneficial results expected in radio merchandising. He stressed that the proposed definitions for "all wave" and other sets were based upon allocations of the Federal Communications Commission, were correct, in general use and generally understood by the public as well as the trade. The latter, he said, might be expected to follow the improved merchandising standards provided under the rules for the manufacturer.

Similar results in radio merchandising were predicted and commended by H. J. Kenner of New York, representing the National Better Business Bureau. He recommended to the Commission that the RMA rules be approved as a distinct aid to better merchandising of radio. Mr. Kenner also suggested addition of a rule to prohibit disparagement of competitors.

Complete approval also for the proposed rules was given to the Commission in a letter from Secretary Daniel C. Roper of the U. S. Department of Commerce. This was presented personally by Andrew W. Cruse, Chief of the Electrical Division of the Department. Secretary Roper recommended that the RMA rules be "adopted without change," adding that the Department itself was interested in the nomenclature proposed for receiving sets and that the RMA definitions had been used by the Department of Commerce representatives throughout the world.

From the Federal Communications Commission also came endorsement of the proposed rules. Representing the Communications Commission, Mr. R. Clark, associate engineer, stated that the proposed definitions for "all wave" and other sets were "satisfactory standards and commercially satisfactory." He presented the letter of Andrew Ring, Acting Chief Engineer of the Communications Commission, to the RMA, stating that its definition of the "all wave" receiver was proper at this time. Mr. Clark stated and the RMA representatives agreed that with subsequent development of the art the definition and service would require expansion.

RMA CONVENTION IN JUNE TO PLAN SALES EXTENSION

SALES PROMOTION, NATIONAL and in export trade, together with plans for improved radio merchandising will feature the RMA Twelfth Annual Convention at the Stevens Hotel, Chicago, June 17-19. An unusually interesting program is being arranged by President Leslie F. Muter of the RMA and the Convention Committee of which A. S. Wells of Chicago is chairman.

Another "RMA Cabaret" dinner for Association and membership guests, following the success of a similar feature at last year's Convention, will be held. A large attendance at the Association's June Convention is expected. However, there will be no displays of merchandising during the Convention which will be confined to RMA membership.

MARCH EXCISE TAXES

INTERNAL REVENUE BUREAU collections of the federal 5 percent excise tax on radio in March 1936 were $336,043.04, only 4 percent less than the collections of $350,334.03 in March 1935. March excise taxes on mechanical refrigerators were $778,309.04, compared with $495,553.75 in March 1935.

There was an increase of 44.5 percent in radio excise tax collections for the first quarter, January to March inclusive, 1936, over the same first quarter period of 1935. Comparative data on radio tax collections during the past four years follows:

	1936	1935	1934	1933
Jan.	$ 601.144.68	$398.177.40	$415.358.83	$283.425.27
Feb.	423,673.38	193.467.30	272,335.09	173,987.28
Mar.	336,043.04	350.334.03	268.136.45	139,859.66
	$1.360.861.10	$941,978.73	$955.830.37	$607.272.21

FEBRUARY, 1936, EXPORTS

A SUBSTANTIAL INCREASE in exports of radio tubes, but a decrease in set and parts exports during last February is reported by the Bureau of Foreign and Domestic Commerce, U. S. Department of Commerce. Total radio exports for February were $1.828.844, compared with $1.920,395 in February 1935. This included 45,383 receiving sets valued at $1,145,272, against 46.470 sets worth $1,262,556 in February last year.

Tube exports last February were 535,780 units worth $225.738, compared with 403.141 tubes valued at $183.602 in February 1935.

LABOR INDICES DURING JANUARY AND FEBRUARY

SEASONAL RECESSIONS IN several industries, including radio, were recorded in the latest reports for January and February 1936, of the U. S. Department of Labor, Bureau of Labor Statistics. Radio factories reported an employment decrease in January of 7.3 percent compared with the previous month of December 1935, but this employment was 11.9 percent above January 1935. January employment in radio factories also was 113.1 percent above the three-year official average of 1923-25.

Radio factory payrolls reported in January 1936 were 12.9 percent higher than January 1935 but 12.2 percent less than the previous month of December 1935. Radio payrolls last January were 26.2 percent above the three-year average of 1923-25.

Average weekly earnings in radio factories reported in January 1936 were $18.37, a decrease of 5.2 percent from the previous month of December 1935, but 0.9 percent above January 1935. Average weekly earnings during January for all durable goods industries were $23.17.

Average hours worked per week in radio factories during last January were 33.5 hours, a decrease of 5.6 percent from the previous month of December, but 4.8 percent higher than January 1935.

Average hourly earnings during January of radio factory employees were 54.9 cents, an increase of 0.3 percent over average hourly earnings during December 1935 but 3.3 percent less than January 1935. Average hourly earnings last January in all durable goods industries were 61.6 cents.

The February report of the Bureau of Labor Statistics, released April 30, showed further seasonal declines in radio factory employment. The February reduction in radio employment was 8 percent compared with January, but 5.4 percent above February 1935, and 96 percent above the official three-year average of 1923-25.

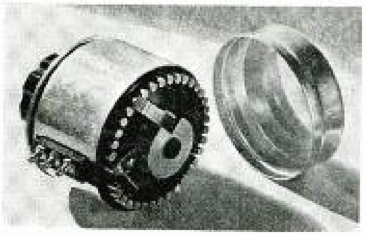
Radio factory payrolls in February 1936 were down 9.7 percent below the previous month of January, but were 10.4 percent above payrolls of February last year, and 14 percent above the three-year average of 1923-25.

Average weekly earnings in radio factories last February were $18.04, a decrease of 1.7 percent from the previous month of January, and 5 percent higher than February 1935. Average weekly earnings during February for all durable goods industries were $23.36.

Average hours worked per week in radio factories last February were 32.7 hours, a decrease of 2.5 percent from the previous month of January, but 6.8 above February 1935.

Average hourly earnings during February of radio factory employees were 55.2 cents, an increase of .6 percent over the previous month of January, but 1.5 percent less than February 1935. Average hourly earnings in February in all durable goods manufacturing were 61.5 cents.

NEW PRODUCTS



VOLUME CONTROLS

The General Radio type 653 volume control has been redesigned according to an announcement from the manufacturer. The new model is said to have several improvements which increase its usefulness in speech circuits. Full information may be obtained from the General Radio Company, Cambridge, Mass.

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NEW TUBES

The RCA Radiotron Division of the RCA Manufacturing Co. has announced the following additions to their line of tubes: The 1F6, having a 2.0-volt filament and an ST-12 glass envelope, is intended for sue in battery-operated receivers. The 1F6 is a duplex-diode pentode.

The 6N7 metal tube, which is similar in application to the glass types 6A6 and 53.

From the Triad Manufacturing Co., Pawtucket, R. I., comes data on a series of glass tubes having octal bases and electrical characteristics similar to the familiar 6-volt glass tubes. This new series includes:

6A8-G, a pentagrid converter similar to the 6A7.
6B6-G, electrically similar to the type 75.
6C5-G, medium gain detector-amplifier; also useful as oscillator in superheterodyne circuits.
6F5-G, high gain triode similar to triode section of type 75.
6F6-G, power output pentode with electrical characteristics the same as type 42.
6H6-G, duplex-diode.
6J7-G, detector-amplifier pentode with sharp cut-off characteristic of type 77.
6K7-G, r-f pentode with remote cut-off characteristic like type 78.

Other types include: 6L7-G; 6N6-G; 6Q7-G; 6R7-G; 6X5-G; 5Y3-G; 25A6-G and 25Z6-G.

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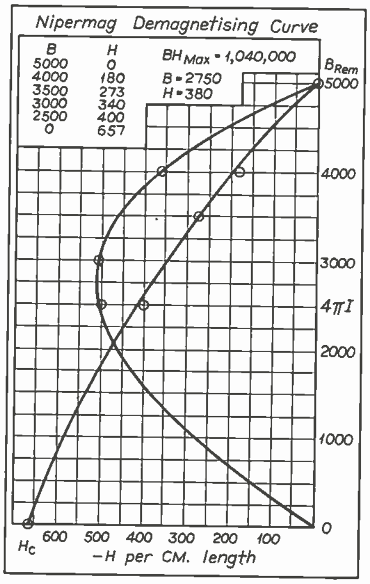
IRC LOW VALUE RESISTORS

A completely insulated wire-wound ½- and 1-watt resistor, similar in size and appearance to the IRC insulated metalized units, has just been announced by the International Resistance Company, of Philadelphia. This new "BW" resistor is fully described in a resistor catalog recently issued, which may be had by writing the International Resistance Company, 401 N. Broad Street, Philadelphia.

NIPERMAG TO BE AVAILABLE

The Cinaudagraph Corporation, Stamford, Conn., has announced that their magnetic alloy, Nipermag, is to be made available to manufacturers of electrical equipment. This alloy, with characteristics as shown by the accompanying curves, should be useful in many applications requiring a constant magnetic field. It is said that Nipermag can successfully withstand the effects of extreme temperature variations, mechanical shock and stray magnetic fields. H. H. Friend is in charge of the Nipermag Division of Cinaudagraph Corp.



INDUSTRIAL ANALYZER

A self-contained d-c analyzer, particularly adapted to the testing of motors and control equipment, has been announced by Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.

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IMPACT STRENGTH OF MOLDED PARTS NEARLY DOUBLED

General Plastics, Inc., N. Tonowanda, N. Y., announces an extra strength Durez molding material which combines machining qualities with higher impact strength, the material being known as 1544. Developed especially for molded parts such as telephone handles, machine parts requiring higher than ordinary strength plus machinability, 1544 combines these qualities in a material which molds on regular cycles and which performs automatically without difficulty. The impact strength has been increased and the finished moldings can be machined, sanded, buffed or wire-brushed without uncovering filler spots. Subsequent buffing of the machined areas will bring up a rich black finish of unusual smoothness and lustre. In addition, the material is light in weight, weighing 22.4 gms. per cu. in.

DRY-DISC PHOTOELECTRIC CELLS

Self-generating photoelectric cells in a great variety of sizes and shapes are offered under the trade name "Electrocell" by Dr. F. Lowenberg, 10 East 40 Street, New York City, distributor for the United Sates. These cells are of the dry-disc barrier-layer type and consist of a selenium compound deposited on an iron disc and overlayed by a semi-transparent platinum film. Thus, the cells have the form of plain, coin-like metal discs without any fragile parts, such as glass bulbs, etc.

The main characteristic of the "Electrocell" elements consists in their sensitivity and power output, the current delivery being 480 microamperes per lumen and the maximum voltage 0.6 volt. The round sizes range from ⅜ inch to 2⅝ inches diameter, rectangular shapes being available up to 1½ x 2 inches.

The cells give continuous service under any light for any length of time, their permanent stability being assured by a special pre-aging process, it is stated. The color sensitivity extends from the visible range into the invisible part of the spectrum.

The time lag of "Electrocell" elements is said to be negligible and they are claimed to follow faithfully light fluctuating at a frequency as high as 6,000-8,000 cycles, which makes them applicable to sound recording and reproduction.

•

RCA SPECIAL PURPOSE OSCILLOGRAPHS

To meet the demand from certain territories and for special applications, the RCA Parts Division has announced the addition of two new types of oscillograph instruments to its standard line of test equipment. These are: a model operating on 25-cycle alternating current and a special "sweep" model. Both are identical to the standard RCA oscillograph except that one operates on the 25-cycle alternating current in use in some areas, and the other has a special sweep oscillator which extends from 4 cycles to 18,000 cycles.

•

SOLAR ANALYZER

Ten outstanding advantages are claimed for the newest analyzer unit from Solar Mfg. Corp., 599 Broadway, New York, N. Y. This is a capacitor analyzer and resistance bridge, planned to meet the needs of engineers as well as service men; it employs a modification of the well-known Wien bridge. All readings are obtained from a color-coded panel, saving time and trouble often required in cross-referring to charts and graphs.

(*Continued on page 26*)

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The continuous growth of this organization both in volume and scope has been achieved without sacrifice of personal contact with the field. The members of the firm are in constant touch with the trade. Individual orders are frequently followed up by a personal visit. It is in this spirit of personal service that we offer our products. Whether your requirements are large or small, our unbiased recommendation and helpful service are yours for the asking at any one of the convenient branch offices located in Chicago, Detroit, Cleveland, Rochester, or Hartford.

Descriptive literature supplied upon request.

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BRAND
• INSULATION •

News Of The Industry

ENGINEERING ANSWERS TO RESISTANCE PROBLEMS

Convenient and unusually complete engineering answers to most resistance problems are provided in a collection of loose-leaf bulletins just issued by Clarostat Mfg. Co., Inc., 285 North 6th St., Brooklyn, N. Y. These bulletins are arranged in groups covering fixed resistors, adjustable resistors, and automatic resistors or ballasts, the entire collection being bound in a neat loose-leaf binder. Future bulletins can be added as issued. The data is of particular value to engineers and designers, since it includes complete electrical and mechanical characteristics for each type of resistor, rather than mere sales talk. The complete set of bulletins may be obtained by writing on your business letterhead, requesting Bulletin RE.

•

ALLEN-BRADLEY NEW YORK OFFICE MOVES

Business increases during the past year have made it necessary for the New York office of the Allen-Bradley Company, Milwaukee, manufacturers of motor control equipment, to move to larger quarters in the Underwood Building at 30 Vesey St., New York City. The telephone numbers, Cortlandt 7-4660-1 will not be changed. For years the Allen-Bradley New York office had been located at 50 Church St..

•

KEN-RAD BULLETIN

An 8-page engineering bulletin telling of Pentagrid Converter Oscillator Considerations has been issued by The Ken-Rad Corporation. This bulletin has been written to bring the attention of the circuit engineer to some of the facts that will be of benefit in future set designs.

Those wishing a free copy of "Pentagrid Converter Oscillator Considerations" should write to The Ken-Rad Corporation, Owensboro, Ky.

•

T. P. BEGY JOINS G-E RADIO

T. Phil Begy, who has been associated with the radio industry since its inception, has joined General Electric as district radio specialist for the Buffalo territory, it has been announced by R. J. Cordiner, manager of the G-E Radio Division, Bridgeport, Conn.

•

CORNELL-DUBILIER CATALOG AND CONDENSERS

A catalog listing of the more important electrolytic condensers recently developed by their laboratories, is available from Cornell-Dubilier Corporation and will be furnished on request to the company at 4377 Bronx Blvd., New York City.

Announcement is also made of two new lines of tubular condensers.

AUDAK GETS LARGE GOVERNMENT ORDER

The Audak Co., 500 Fitfth Avenue, New York City, has just been awarded a contract for 5,000 Audax magnetic pickups by the United States Government. These units are to be distributed to libraries throughout the country to be used in conjunction with reading machines for the blind.

•

TUBE BASE CONNECTIONS

Tube base diagrams showing more than 60 different prong arrangements and connections are shown in a folder just issued by the Weston Electrical Instrument Corporation, Newark, N. J. Base connection diagrams for octal base tubes, both metal and glass, are included. A convenient table in the folder classifies more than 300 makes and types of tubes according to their tube base connections as shown on the charts.

•

CORRECTION

Due to a typographical error, the business affiliation of M. E. Fagan, author of "Coil Manufacturing Costs," which appeared in our April issue, was incorrectly given. Mr. Fagan is associated with the Universal Winding Co., Boston, Mass.

•

R. M. COBURN ADVANCED BY NATIONAL UNION

Mr. S. W. Muldowny, Chairman of the Board of National Union Radio Corporation of N. Y., has announced that, effective May 1, Mr. R. M. Coburn will assume the post of assistant sales manager for the company.

Mr. Coburn has seen many years of service in the radio industry, having served as district manager for the Kolster Radio Corporation, general sales manager for Ware Radio Company, and in the early days of radio he built his own custom-made receivers.

•

NEW HICKOK INSTRUMENT CATALOG

The Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio, have just issued a new catalog of electrical indicating instruments and radio testing instruments. Many new instruments are illustrated featuring new cases, designs, ranges, sensitivities and prices. Meters are made in the following sizes: 2⅝" round, 3¼" square, 3½" round, 4¼" round, 5" edgewise, 5½" round.

New designs include high sensitivity microammeters, expanded scale thermocouple meters, non-magnet aircraft instruments, sliding scale double and triple range instruments. The catalog also includes a complete new line of portable instruments for all classes of testing and laboratory standardization work.

ATLAS REPRESENTATIVES

Mr. Arnold A. Sinai of 26 Ninth Street, San Francisco, represents Atlas Sound in the California area; Northwestern Agencies of 2603 Third Avenue, Seattle, act as Atlas Sound representatives for the northwest, which includes the states of Washington, Oregon, Idaho, and Vancouver in British Columbia.

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NEW PRODUCTS

(Continued from page 24)

HARMONIC SUPPRESSORS

The Radio Engineering & Manufacturing Co., 26 Journal Square, Jersey City, N. J., has announced a harmonic suppressor which is said to meet all of the requirements of the FCC. This equipment is made up in a standardized mechanical form; they may be used with single and balanced antenna feed lines.

•

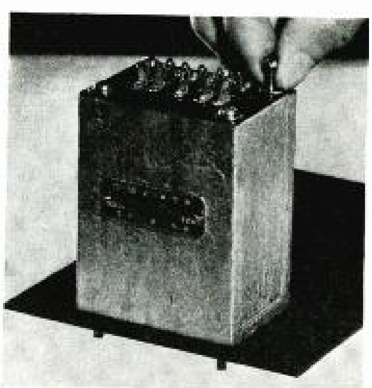
FERRANTI SERIES B

Ferranti Electric, Inc., announces a new series of audio transformers and reactors known as Ultra-High-Fidelity—Series B. These units have a frequency response of ± ½ db from 30 to 16,000 cycles.

Each unit is housed in the new Ferranti completely reversible case with through-type mounting and is supplied with four 8/32 bolts and nuts.

To illustrate the completeness of the new Ferranti line a few of the unusual transformers listed are—a unit for coupling a photocell to an adjustable line. High Q reactors where a Q of 35 can be obtained in a standard unit, as well as a "distorter" transformer which may be used in conjunction with broadcast work to obtain telephone sound distortion effect.

The transformers are fitted with electrostatic shields between windings and are designed for extremely low insertion loss.



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in sizes up to ½ inch,
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Norristown, Penna.

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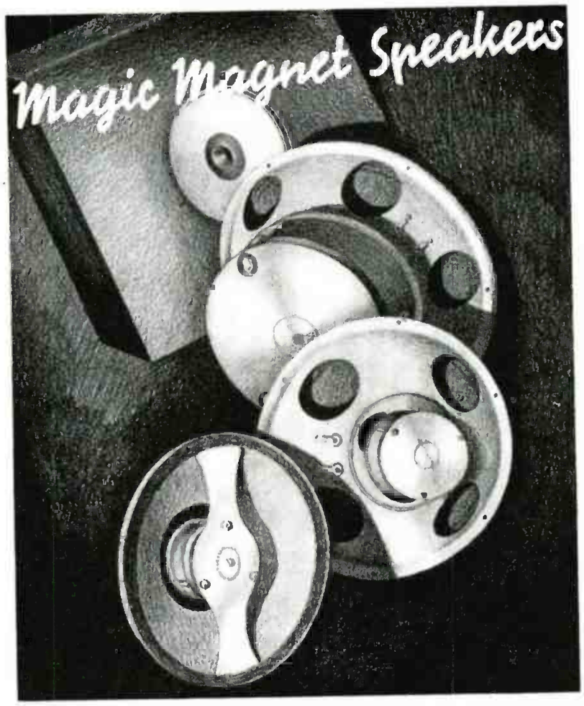

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Speaker Division, Dept. E — STAMFORD, CONN.

CINAUDAGRAPH

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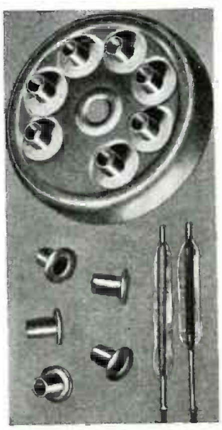
FOR
GLASS-TO-METAL SEALS



Kovar is a specially developed alloy with a coefficient of expansion matching that of hard clear-sealing glass, for forming permanent metal-to-glass vacuum seals. Kovar can be supplied in all fabricated forms, such as eyelets, cups, headers and lead-in wires for metal or glass vacuum tubes, and in rods, tubes and wire. Glass seals can be furnished to purchaser's specifications.

Kovar is sold by the makers of Stupakoff low-loss ceramic insulators, rods and spacers for the electronic industry.

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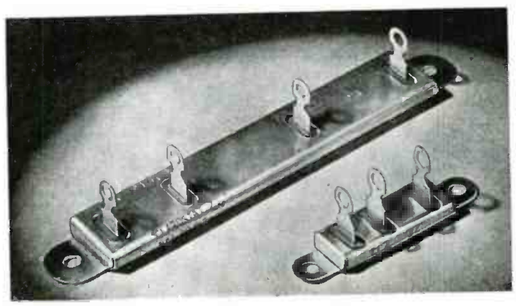

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A continuous, indexed recording of the reliable sources of supply of

Materials—Component Parts

ALLOYS, RESISTANCE
AMERICAN ELECTRO METAL CORP., Lewiston, Maine
CALLITE PRODUCTS DIV., 542 39th St., Union City, N. J.
Cleveland Wire Cloth & Mfg. Co.
Driver Company, Wilbur B.
Driver-Harris Company
Fansteel Metallurgical Labs.
Hoskins Mfg. Co.
Jelliffe Company, C. O.
Prentiss & Company, Geo.
NEWARK WIRE CLOTH CO., Newark, N. J.

ARRESTORS, LIGHTNING
Birnbach Radio Corp.
Knox Porcelain Co.
Johnson Co., E. F.

BASES, VACUUM TUBE
AMERICAN LAVA CORP., Chattanooga, Tenn.
American Phenolic Corp.
American Record Corp.
ISOLANTITE, INC., 233 Broadway, N. Y. C.
Kurz-Kasch Co.
RCA MFG. COMPANY, INC., Camden, N. J.
Westinghouse Lamp Co.

BINDING POSTS
BANKS INTER-AIR PRODS., Woodside, N. Y.
Eby Mfg. Co., H. H.

BRASS—COPPER
AMERICAN BRASS CO., THE, Waterbury, Conn.
ANACONDA COPPER CO., 25 Broadway, N. Y. C.
Baltimore Brass Co.
Bristol Brass Corp.
Ryerson & Son, Inc.
Scovills Mfg. Co.
WATERBURY BRASS GOODS BR., Waterbury, Conn.

CABINETS—WOOD
Adler Mfg. Co.
Alden Corp.
EXCEL WOODCRAFT CORP., THE, Columbus Rd. at Leonard St., Cleveland, Ohio
Peerless Cabinet Co.
Superior Cabinet Corp.

CATHODES (See Tubing, Seamless Cathode)

CATHODE RAY—TUBES
DUMONT LABORATORIES, ALLEN B., 542 Valley Rd., Upper Montclair, N. J.
General Electric Co.
HYGRADE-SYLVANIA CORP., Clifton, N. J.
RCA MANUFACTURING CO., INC., Camden, N. J.
WESTERN ELEC. CO., 195 Broadway, N. Y. C.
Westinghouse Elec. & Mfg. Co.

CATHODE RAY—OSCILLOGRAPHS
CLOUGH-BRENGLE CO., 1134 W. Austin St., Chicago, Ill.
DUMONT LABORATORIES, ALLEN B., 542 Valley Rd., Upper Montclair, N. J.
RCA MANUFACTURING CO., INC., Camden, N. J.
WESTERN ELEC. CO., 195 Broadway, N. Y. C.

CERAMICS
AMERICAN LAVA CORP., Chattanooga, Tenn.
American Phenolic Corp.
Colonial Insulator Co.
Crowley & Co., Henry L.
Dielectric Products Co.
ISOLANTITE, INC., 233 Broadway, N. Y. C.
Kirchberger & Co., Inc., M.
Mycalex Corp. of Amer.
STUPAKOFF LABORATORIES, INC., 6627 Hamilton Ave., Pittsburgh, Pa.

CHOKES
ACME ELECTRIC & MFG. CO., 1440 Hamilton Ave., Cleveland, Ohio
AMERICAN TRANSFORMER CO., 175 Emmet St., Newark, N. J.
General Transformer Co.
HAMMARLUND MFG. CO., 424 W. 33rd St., N. Y. C.
Kenyon Transformer Co., Inc.
UNITED TRANSFORMER CORP., 72-74 Spring St., N. Y. C.

COIL MACHINERY
UNIVERSAL WINDING CO., Providence, R. I.

COILS—POWER
ANACONDA WIRE & CABLE CO., Muskegon, Mich.
ACME WIRE COMPANY, 1255 Dixwell Avenue, New Haven, Conn.
American Enameled Magnet Wire Co.
Belden Manufacturing Co.
COTO-COIL CO., INC., Providence, Rhode Island
GENERAL ELECTRIC COMPANY, Schenectady, N. Y.
Roebling's Sons, John
Westinghouse Elec. & Mfg. Co.

COILS—RADIO RECEIVER
ALADDIN RADIO INDUSTRIES, INC., 466 W. Superior St., Chicago, Ill.
ALDEN PRODUCTS CO., Brockton, Mass.
Automatic Winding Co.
COTO-COIL CO., INC., Providence, Rhode Island
ELECTRICAL WINDING CORP., 22-26 Wooster St., N. Y. C.
General Mfg. Co.
GUTHMAN & CO., INC., Edwin I., 1036 W. Van Buren St., Chicago, Ill.
HAMMARLUND MFG. CO., 424 W. 33rd St., N. Y. C.
Meissner Mfg. Co.
National Company
Sickles Company

COILS—SPEAKER
ACME ELECTRIC & MFG. CO., 1440 Hamilton Ave., Cleveland, Ohio
AMERICAN TRANSFORMER CO., 175 Emmet St., Newark, N. J.
ANACONDA WIRE & CABLE CO., Muskegon, Mich.
Chicago Transformer Corp.
Dongan Electric Mfg. Co.
GENERAL TRANSFORMER CORP., 502 S. Throop St., Chicago, Ill.
Halldorson Company
JEFFERSON ELECTRIC COMPANY, Bellwood, Ill.
Kenyon Trans Co., Inc.
RCA MANUFACTURING CO., INC., Camden, N. J.
STANDARD TRANSFORMER CORP., 854 Blackhawk Street, Chicago, Ill.
Thordarson Elec. Mfg. Co.
UNITED TRANSFORMER CORP., 72-74 Spring St., N. Y. C.

CONDENSERS, FIXED PAPER
ACME WIRE COMPANY, 1255 Dixwell Ave., New Haven, Conn.
AEROVOX CORP., 90 Washington St., Brooklyn, N. Y.
CORNELL-DUBILIER CORP., 4388 Bronx Blvd., N. Y. C.
CURTIS CONDS. CORP., 3088 W. 106th St., Cleve., O.
ELECTRONIC LABORATORIES, INC., Indianapolis, Ind.
Flechtheim & Co., A. M.
Girard-Hopkins, Inc.
Magnavox Co., Ltd.
MALLORY & CO., P. R., Indianapolis, Indiana
Micamold Radio Corp.
Polymet Mfg. Co., Inc.
SOLAR MFG. CORP., 599-601 Broadway, N. Y. C.
Sprague Specialties Co.
TOBE DEUTSCHMANN CORP., Canton, Mass.

CONDENSERS, FIXED ELECTROLYTIC
AEROVOX CORP., 90 Washington St., Brooklyn, N. Y.
Condenser Corp. of America
CORNELL-DUBILIER CORP., 4388 Bronx Blvd., N. Y. C.
CURTIS CONDENSER CORP., 3088 W. 106th St., Cleveland, Ohio
Magnavox Co., Ltd.
MALLORY & CO., P. R., Indianapolis, Indiana
Micamold Radio Corp.
Polymet Mfg. Co., Inc.
SOLAR MFG. CORP., 599-601 Broadway, N. Y. C.
Sprague Specialties Co.

CONDENSERS, ADJUSTABLE
DeJur-Amsco Corp.
HAMMARLUND MFG. CO., 424 W. 33rd St., N. Y. C.
Meissner Mfg. Co.
SOLAR MFG. CORP., 599-601 Broadway, N. Y. C.
TOBE DEUTSCHMANN CORP., Canton, Mass.

CONDENSERS, VARIABLE
CARDWELL MFG. CO., ALLEN B., 81 Prospect St., Brooklyn, N. Y.
DeJur-Amsco Corp.
General Instrument Co.
GENERAL RADIO CO., 30 State St., Cambridge, Mass.
HAMMARLUND MFG. CO., 424 W. 33rd St., N. Y. C.
OAK MFG. CO., 711 W. Lake Street, Chicago, Ill.
Precise Mfg. Co.
Radio Condenser Co.
Reliance Die & Stamping Co.

CONTACTS, METAL
Baker & Co., Inc.
CALLITE PRODUCTS DIV., 542 39th St., Union City, N. J.
General Plate Co.
General Tungsten Mfg. Co.
MALLORY & CO., P. R., Indianapolis, Indiana
Wilson Co., H. A.

CORES, RESISTANCE COIL
AMERICAN LAVA CORP., Chattanooga, Tenn.
Colonial Insulator Co.
ISOLANTITE, INC., 233 Broadway, N. Y. C.
Steward Mfg. Co.

CORES, TRANSFORMER
THOMAS & SKINNER STEEL PRODS. CO., 1100-1120 E. 23rd St., Indianapolis, Indiana

CRYSTALS, QUARTZ and ROCHELLE SALT
BLILEY ELECTRIC CO., 237 Union Station Bldg., Erie, Pa.
Boonton Research Labs.
PREMIER CRYSTAL LAB., 55 Park Row, N. Y.
RCA MANUFACTURING CO., INC., Camden, N. J.
BRUSH DEVELOPMENT CO., E. 40th St. & Perkins Ave., Cleveland, Ohio
SCIENTIFIC RADIO SERVICE, University Pk., Hyattsville, Md.

DIALS, ESCUTCHEONS
Crowe Nameplate Co.
KAY PRODUCTS OF AMER., INC., 560 DeKalb Ave., Brooklyn, N. Y.
Magnavox Company, The

DIAPHRAGMS, SPEAKER
Hawley Products Co.
Masland Mfg. Corp.
UNITED PRESSED PRODUCTS CO., 407 S. Aberdeen St., Chicago, Ill.

ELECTRODES, NEON
EISLER ELECTRIC CORP., Union City, N. J.
EISLER ENGINEERING CO., INC., 747 So. 13th St., Newark, N. J.
SWEDISH IRON & STEEL CORP., 17 Battery Pl., N. Y. C.

EYELETS
Platt Bros. & Co.
STUPAKOFF LABS., INC., 6627 Hamilton Ave., Pgh., Pa.
United Shoe Mach. Co.
WATERBURY BRASS GOODS BR., Waterbury, Conn.

FIBRE, PHENOL and VULCANIZED
Bakelite Corp.
Brandywine Fibre Products Co.
Continental-Diamond Fibre Co.
Formica Insulation Co.
Franklin Fibre-Lamitex Corp.
General Electric Co.
National Vulcanized Fibre Co.
Resinox Corporation
SYNTHANE CORPORATION, Oaks, Penna.
TAYLOR & CO., INC., Norristown, Pa.
Westinghouse Elec. & Mfg. Co.
Wilmington Fibre Co.

FLEXIBLE SHAFTING
Fischer Spring Company, Chas.
White Dental Mfg. Co., S. S.

FUSES
LITTELFUSE LABS., 4244 Lincoln Ave., Chicago, Ill.

GENERATORS
CARTER MOTOR COMPANY, 373 W. Superior St., Chicago.
ELECTRONIC LABORATORIES, INC., 122 W. New York St., Indianapolis, Ind.
MALLORY & CO., P. R., Indianapolis, Indiana
ONAN & SONS, D. W., Minneapolis, Minn.
PIONEER GEN-E-MOTOR CORP., 466 W. Superior St., Chicago, Ill.

GETTERS (See Nickel Tube Parts)

GRAPHITE
ACHESON COLLOIDS CORP., Port Huron, Mich.

HORNS
ATLAS SOUND CORP., 1449—39th St., B'klyn, N. Y.
FOX SOUND EQUIP. CORP., 3120 Monroe St., Toledo, Ohio
HOPE MFG. CO., 98 Park Place, N. Y. C.
RACON ELEC. MFG. CO., 52 E. 19th St., N. Y. C.
WRIGHT-DECOSTER, INC., 2253 University Ave., St. Paul, Minn.

INSTRUMENTS (See Meters or Cathode Ray)

INSULATION, BEADS
AMERICAN LAVA CORP., Chattanooga, Tenn.
ISOLANTITE, INC., 233 Broadway, N. Y. C.
Kirchberger & Co., Inc., M.
Steward Mfg. Co.
STUPAKOFF LABORATORIES, INC., 6627 Hamilton Ave., Pitts, Pa.

INSULATION, CERAMICS (See Ceramics)

INSULATION COMPOUNDS
Candy & Co., Inc.
Dolph Co., John C.
Glenn & Co., J. J.
Mica Insulator Co.
STUPAKOFF LABS., INC., 6627 Hamilton Ave., Pgh., Pa.
ZOPHAR MILLS, INC., Court, Lorraine and Creamer St., Brooklyn, N. Y.

INSULATION, LAMINATED BAKELITE
Franklin Fibre-Lamitex Corp.
SYNTHANE CORPORATION, Oaks, Penna.

INSULATION, MOLDED
American Insulator Corp.
AMERICAN LAVA CORP., Chattanooga, Tenn.
American Phenolic Corp.
American Record Corp.
Chicago Molded Prods. Corp.
Formica Insulation Co.
Kurz-Kasch Co.
Macallen Co.
STUPAKOFF LABS., INC., 6627 Hamilton Ave., Pgh., Pa.

INSULATION, FABRIC TUBING
BENTLEY HARRIS MFG. CO., Conshohocken, Pa.
BRAND & CO., WM., 276 Fourth Ave., N. Y. C.
Glenn & Co., J. J.
Mica Insulator Co.

IRON, SWEDISH (Tube Parts)
SWEDISH IRON & STEEL CORP., 17 Battery Pl., N. Y. C.

LACQUER, PAINT, VARNISH
ACME WIRE COMPANY, 1255 Dixwell Ave., New Haven, Conn.
Dolph & Co., John C.
Irvington Varnish Co.
Maas & Waldstein
ZAPON COMPANY, 60 E. 42nd St., N. Y. C.
ZOPHAR MILLS, Court, Lorraine and Creamer Sts., Brooklyn, N. Y.

LAMPS, GLOW
LITTELFUSE LABS., 4244 Lincoln Ave., Chicago, Ill.

LUGS
CINCH MFG. CORP., 2335 W. Van Buren St., Chicago, Ill.
Thompson-Bremer Corp.
WATERBURY BRASS GOODS BR., Waterbury, Con-
ZIERICK MACHINE WORKS, 68 E. 131 St., N. Y. C.

MAGNETS

THOMAS & SKINNER STEEL PRODS. CO., 1100-1120 E. 23rd St., Indianapolis, Indiana.

MELTING POTS

STA-WARM ELECTRIC CO., Ravenna, Ohio
Trent Co., Harold E.

METERS; TESTING INSTRUMENTS

BURTON-ROGERS CO., 755 Boylston St., Boston, Mass.
CLOUGH-BRENGLE CO., 1134 W. Austin Ave., Chicago, Ill.
FERRIS INSTR. CORP., Boonton, N. J.
GENERAL RADIO COMPANY, 30 State St., Cambridge A, Mass.
HICKOK ELEC. INSTRU. CO., Cleveland, Ohio
JACKSON ELEC. INSTRU. CO., Dayton, Ohio
RCA MFG. CO., INC., Camden, N. J.
RADIO CITY PRODUCTS CO., 28 W. B'way, N. Y. C.
RADIO PRODUCTS CO., 145 Sunrise Pl., Dayton, Ohio
READRITE METER WORKS, Bluffton, Ohio
SOLAR MFG. CO., 599 B'way, N. Y. C.
SUPREME INSTRUMENT CORP., Greenwood, Miss.
TRIPLETT ELEC. INSTRU. CO., Bluffton, Ohio
TRIUMPH MFG. CO., 4017 W. Lake St., Chicago, Ill.
WESTERN ELECTRIC CO., 195 Broadway, N. Y. C.
WESTON ELEC. INSTRU. CORP., 612 Frelinghuysen Ave., Newark, N. J.

MICA

BRAND & CO., WM., 276 Fourth Ave., N. Y. C.
Macellen Co.
Mica Insulator Co.
New England Mica Co.

MICROPHONES

American Microphone Co.
AMPERITE CORP., 561 Broadway, N. Y. C.
ASTATIC MICROPHONE LAB., INC., 830 Market St., Youngstown, Ohio
BRUSH DEVELOPMENT CO., Cleveland, Ohio
Color-tone, Inc.
EASTERN SOUND CO., 94 Portland St., Boston.
ELECTRO-VOICE MFG. CO., INC., South Bend, Indiana
RADIO RECEPTOR CO., INC., 106 7th Ave., N. Y. C.
RCA MFG. COMPANY, INC., Camden, N. J.
SHURE BROS. CO., 215 W. Huron St., Chicago, Ill.
SOUND SYSTEMS, INC., 6545 Carnegie Ave., Cleveland, Ohio
TURNER COMPANY, Cedar Rapids, Ia.
UNIVERSAL MICROPHONE CO., LTD., Inglewood, Calif.
WESTERN ELECTRIC CO., 195 Broadway, N. Y. C.

MOLYBDENUM

AMERICAN ELECTRO METAL CORP., Lewiston, Maine
CALLITE PRODUCTS DIV., 542 39th St., Union City, N. J.
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Fansteel Metallurgical Labs.

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AUDAK COMPANY, THE, 500 Fifth Ave., N. Y. C.
PROCTOR & CO., B. A., 17 W. 60th St., N. Y. C.
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ELECTRONIC LABORATORIES, INC., Indianapolis, Ind.
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HALLDORSON COMPANY, THE, 4500 Ravenswood Ave., Chicago, Ill.
JEFFERSON ELECTRIC CO., Bellwood, Illinois
Kenyon Transformer Corp.
RCA MFG. COMPANY, INC., Camden, N. J.
STANDARD TRANS. CORP., 866 Blackhawk St., Chi., Ill.
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Crescent Insulated Wire & Cable Co.
General Cable Corp.
Holyoke Company, Inc.
Hoskins Mfg. Co.
Phosphor Bronze Smelting Co.
Roebling's Sons Co., John A.

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CORNISH WIRE COMPANY, 30 Church St., N. Y. C.
General Cable Corp.
Holyoke Company, Inc.
Roebling's Sons Co., John A.

WIRE, COPPER CLAD

American Braiding Company
CALLITE PRODUCTS DIV., 542 39th St., Union City, N. J.

WIRE, FILAMENT and GRID

AMERICAN ELECTRO METAL CORP., Lewiston, Maine
CALLITE PRODUCTS DIV., 542 39th St., Union City, N. J.
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Driver-Harris Co.
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Prentiss & Co., Geo. W.
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American Steel & Wire Co.
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Belden Mfg. Co.
CORNISH WIRE COMPANY, 30 Church St., N. Y. C.
General Cable Corp.
GENERAL ELECTRIC COMPANY, Schenectady, N. Y.
LENZ ELECTRIC MFG. CO., 1751-1757 N. Western Ave., Chicago, Ill.
Rockbestos Products Corp.
Roebling's Sons Co., John A.

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American Enameled Magnet Wire Co.
American Steel & Wire Co.
ANACONDA WIRE & CABLE CO., 25 Bway., N. Y. C.
Belden Mfg. Co.
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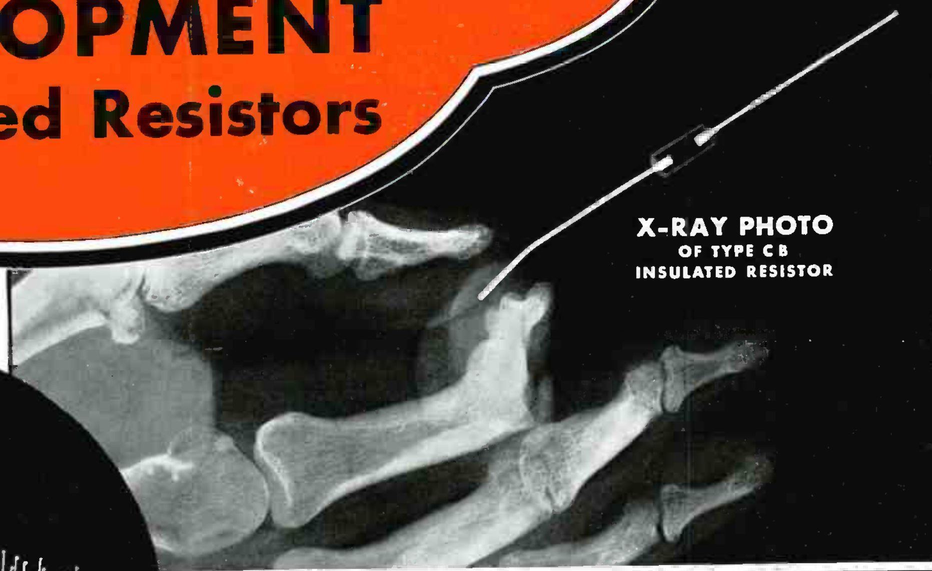
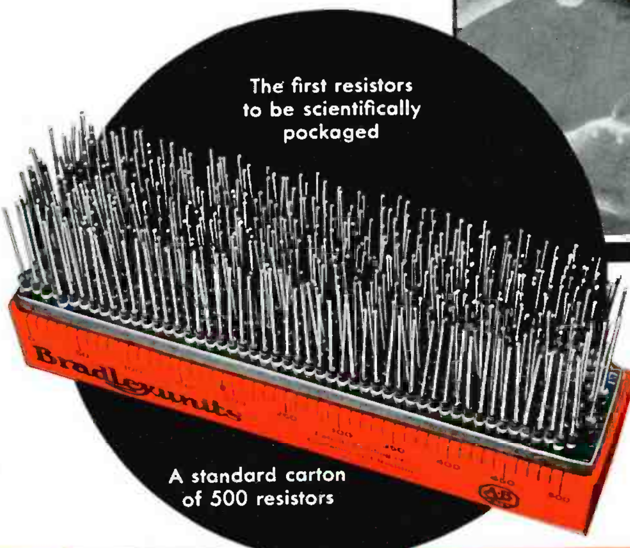
A NEW, SPECTACULAR DEVELOPMENT in Molded Resistors





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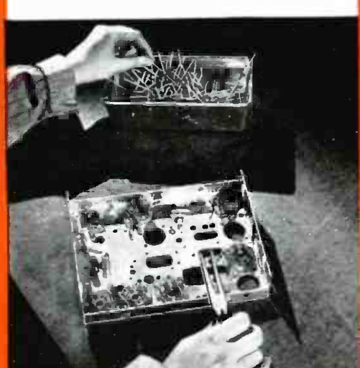
THE NEW WAY—Scientific packaging eliminates resistor fumbling and speeds up the production of radio equipment.



THE OLD WAY—Jumbled resistor stocks cause delays in production lines and introduce soldering troubles.

TYPE E SOLID MOLDED RESISTOR (Non-Insulated) with straight-line leads molded into the resistor. No sprayed-copper connections—no soldered joints—no inductive, coiled lead ends around the resistor. Leads are specially tempered to prevent sharp bends at the resistor. Rating, 1/3 watt.

TYPE CB MOLDED INSULATED RESISTOR has each and every advantage of the Type E resistor, plus molded bakelite insulation. Rating, 1/2 watt.

SCIENTIFIC PACKAGING. The new Allen-Bradley indexed carton—graduated to provide an instant inventory of resistors in storerooms or production lines. Delays, due to counting and weighing of resistors, are eliminated.

Allen-Bradley Company, 126 W. Greenfield Ave., Milwaukee, Wis.

ALLEN-BRADLEY

PIONEERS IN RADIO RESISTOR ENGINEERING