electronics

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

Problems facing radio engineers

✦

Filamentless radio tubes

✦

Geophysical prospecting

✦

Zworykin's cathode-ray tube

✦

Radio and sound-picture conventions

Based on "Edison Effect" of 1883

See page 201

Total tube sales to 1931, $750,000,000
Total associated apparatus, $4,800,000,000

McGRAW-HILL PUBLISHING COMPANY, INC.

Price 35 Cents

NOVEMBER 1931

Quick Heater RECOGNITION

The quick-acting principle in a.c. tubes is now, more than ever, accorded full appreciation by set and tube manufacturers, jobbers, dealers—and, most important, consumers.

Arcturus pioneered *that* principle over three years ago, in May 1928—with the famous 7-second action tube.

This Arcturus contribution met with immediate success as users no longer were willing to tolerate the delay in getting reception caused by the old slow-heater. The demand for quick-heaters has become so insistent that the old slow-heater type has now been relegated to an inferior classification and must of necessity be priced appreciably lower. This difference in list price is evidence that the superior merits of the quick-heater are fully appreciated.

A lower price for slow-heaters is unimportant to set users. They will not sacrifice efficiency for price. So they demand quick-acting tubes.

Arcturus *Blue* Tubes are all quick-acting—the same as the original "7-second tube". Arcturus quick-acting tubes are positively not affected by "hum". Arcturus quick-acting tubes have become the standard of the industry.

ARCTURUS RADIO TUBE CO., Newark, N.J.

ARCTURUS

Electronics, November, 1931. Vol. 3, No. 5. Published monthly. McGraw-Hill Publishing Company, Inc., 330 West 42d Street, New York, N. Y. $3.00 per year, 35 cents a copy. Foreign Postage, $1 extra. Canada (including Canadian duty), $3.50. Entered as second-class matter April 4, 1930, at the Post Office at New York, N. Y., under the Act of March 3, 1879.

I·R·E·Members
who come to Rochester...

we expect you to visit our booth!

There you will find the many Ward Leonard products with which you are familiar and in addition many new items including the Midget relay.

Radio, Sound and Communication Engineers will be interested in our Attenuators, Faders, Sound Controls, Resistors, Relays and Laboratory Rheostats which we are exhibiting.

❖

WARD LEONARD PRODUCTS FOR THE ELECTRONICS FIELD

For Radio Set and Phonograph Manufacturing
- Vitreous Enamel Resistors
- Slide Wire Rheostats

For Sound Equipment
- Vitreous Enamel Resistors
- Volume Controls
- Faders
- T-Pads and H-Pads
- Attenuators
- Relays
- Dimmers and Arc Ballast Rheostats

For Broadcast and Point-to-Point Transmitters
- Relays
- Time Delay Switches
- Vitreous Enamel Resistors
- Attenuators
- T-Pads and H-Pads
- Faders

For Wire Communication and Wired Radio Systems
- Relays
- Vitreous Enamel Resistors
- Attenuators
- T-Pads and H-Pads
- Slide Wire Rheostats
- Volume Controls

For Industrial Control (Thyratrons, Photo-cell, Etc.)
- Relays
- Vitreous Enamel Resistors
- Volume Controls

For Laboratories
- Relays
- Slide Wire Potentiometers
- T-Pads and H-Pads
- Attenuators

WARD LEONARD ELECTRIC CO.

MOUNT VERNON, NEW YORK

ENGINEERS AND RESISTORS

Conscientious Engineers insist on good resistors.

Good resistors are resistors that are consistent in their electrical characteristics and are mechanically and chemically stable within their working range.

ELECTRICAL CHARACTERISTICS, if they are consistent, are not a factor in resistor quality.

Although their temperaments differ radically, a good polo pony and a good draft horse are both quality horses.

Electrical Characteristics are consistent when they manifest themselves in the same manner and in the same degree upon each repetition of given operating conditions.

A polo pony that unfailingly reacts like a polo pony is consistent. A draft horse that unfailingly reacts like a draft horse is consistent. A horse whose reactions range erratically from those of a polo pony to those of a draft horse, is a freak.

GOOD RESISTORS ALONE WILL NOT FILL PRESENT DAY RESISTOR REQUIREMENTS. A variety of good resistor types which offers a wide range of consistent electrical characteristics from which to choose, is the demand of the day. This is especially true in the progressive and refined art of radio circuit design.

Conscientious and Discriminating Engineers choose carefully, from among the good resistors offered, those which have the characteristics particularly suited to their operating function.

The Globar Corporation manufactures a line of good resistors more diverse with respect to special characteristics than that of any other manufacturing organization in the world.

Here are a few typical characteristic curves, each representing a special type of resistor manufactured by the Globar Corporation:

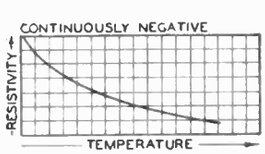


FIG. 1

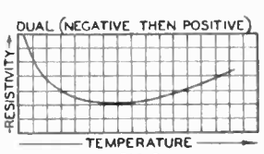


FIG. 2

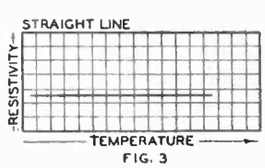


FIG. 3

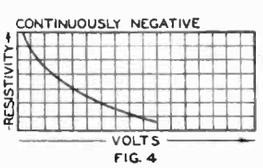


FIG. 4

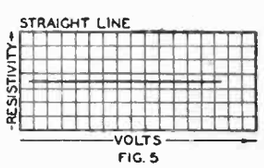


FIG. 5

Conscientious, Discriminating and Alert Engineers

Recognize the Value of Following

THE GLOBAR

A Subsidiary of The Carborundum Company

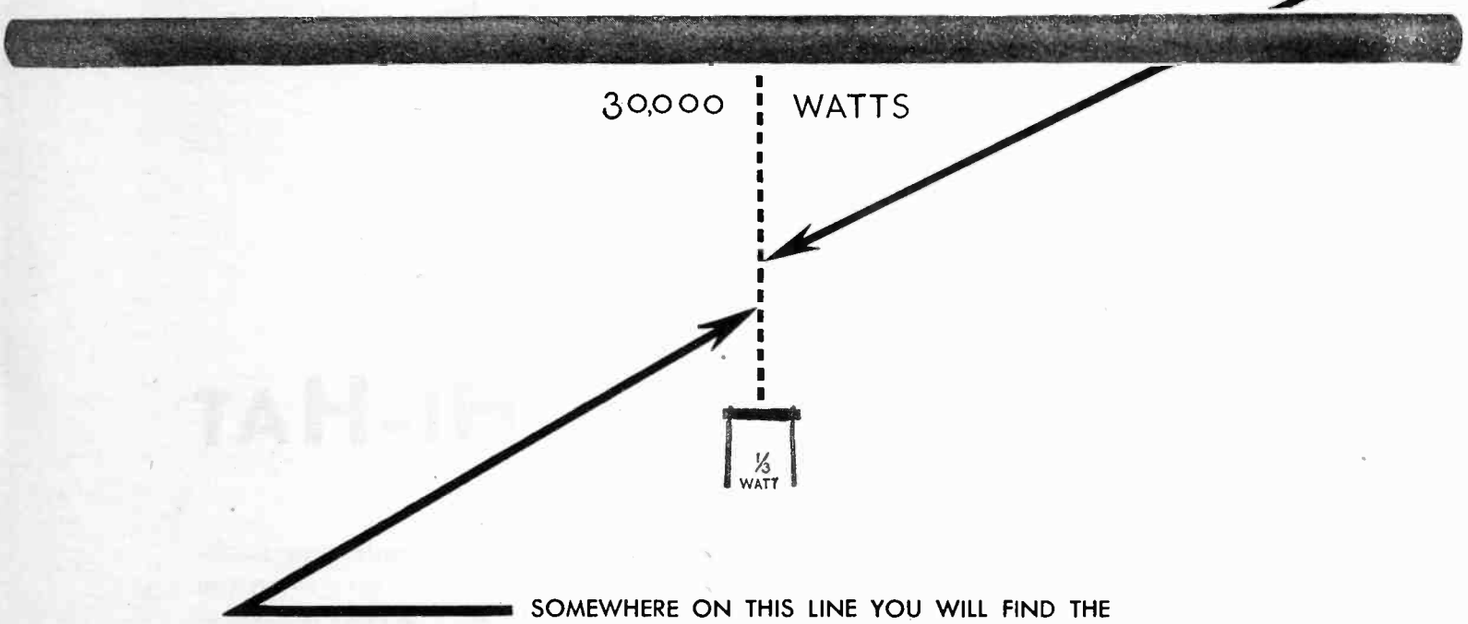
(GLOBAR IS THE REGISTERED TRADE NAME GIVEN TO NON-METALLIC ELECTRICAL HEATING AND RESISTANCE MATERIALS, AND TO OTHER PRODUCTS OF GLOBAR CORPORATION, AND IS ITS EXCLUSIVE PROPERTY)

Pacific Abrasive Supply Co., San Francisco and Los Angeles

Steinmetz & Company, Philadelphia

THE "GLOBAR" RESISTOR LINE

REG. U. S. PAT. OFF.



SOMEWHERE ON THIS LINE YOU WILL FIND THE RESISTOR WHICH FITS YOUR REQUIREMENTS . . .

The Globar Line of Resistors embraces types ranging:

IN SIZE—from 48" long and 1¾" in diameter to ⅝" long and ⅛" in diameter;
IN CAPACITY—from 30,000 watts each, to ⅓ watt each;
IN CHARACTERISTICS—from strongly negative to straight line with respect to both temperature and voltage. (See Figures 1 to 5 opposite page.)
The "Globar" Line includes the only dual characteristic type on the market. (See Figure 2.)

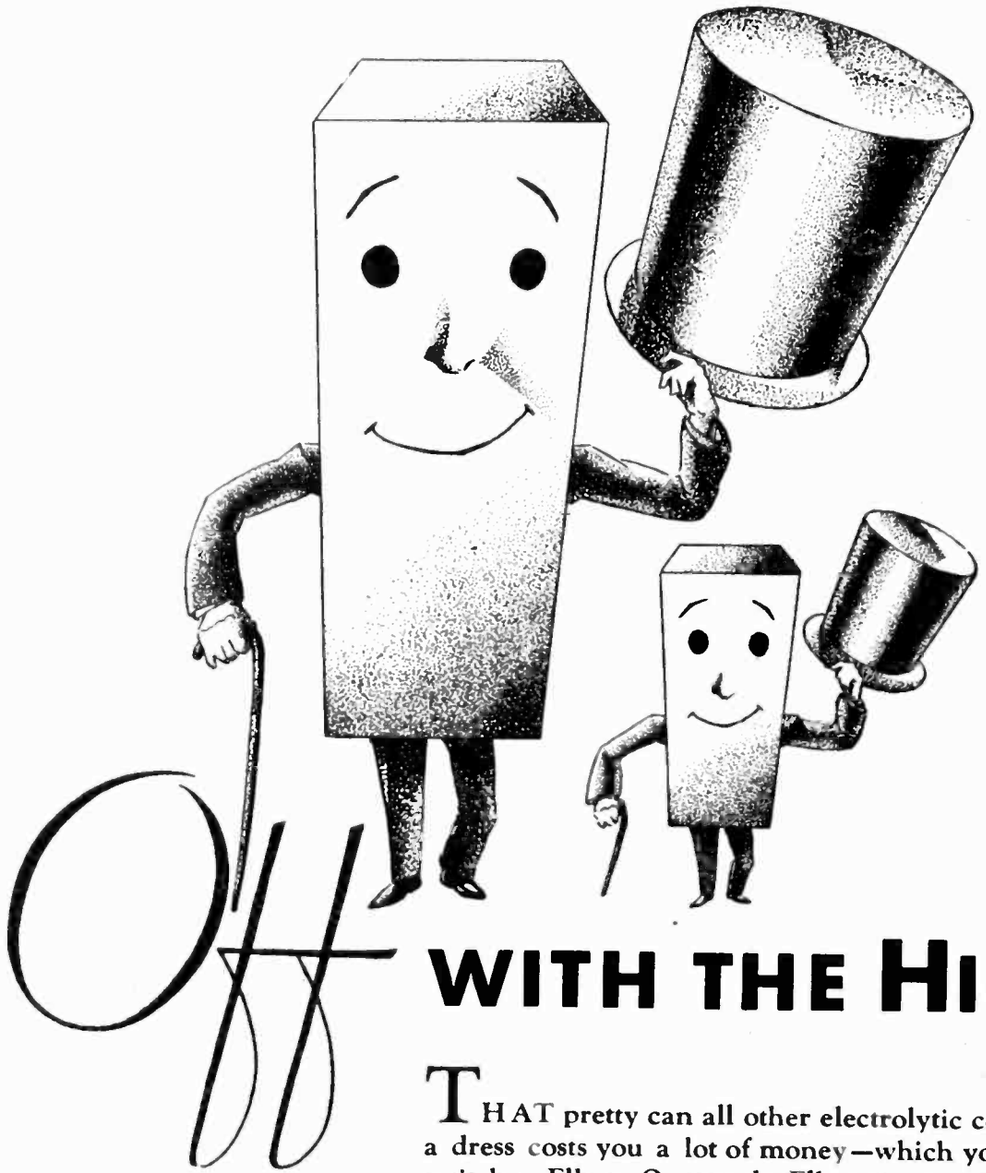
Resistors manufactured by the Globar Corporation are found in applications ranging from electric forging furnaces in which the resistors operate at temperatures up to 2750° F. —through lightning arrester applications in which the resistors are called upon to withstand tremendous, instantaneous voltages and high frequency oscillations—to radio and signal circuits in which the resistors are called upon to be highly specialized in their characteristics.

CORPORATION

NIAGARA FALLS, N. Y., U. S. A.

Williams & Wilson, Ltd., Montreal–Toronto, Canada

British Resistor Company, Ltd., Manchester, England



Off WITH THE HI-HAT

THAT pretty can all other electrolytic condensers use for a dress costs you a lot of money—which you save when you switch to Elkon. On parade, Elkon wears a can like the best of them. But for everyday hard work it uses sturdy paraffined cardboard overalls. Inside—the most efficient electrolytic condenser ever made. No free water*—low power factor—high working voltage—long life—stable. Furthermore Elkon has practically the same characteristics as paper condensers—but is *lower in cost and much less bulky* . . . and here's news—all of the above characteristics apply to our new Bi-pass condensers. 73 leading manufacturers have standardized on Elkon. A request today will bring you your sample tomorrow. Complete information will be sent to all members of your technical staff. Just send their names.

*—water of crystallization, of course—but no *free* water.

ELKON CONDENSERS

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COST LESS TO BUY AND LESS TO INSTALL

FERRANTI

COMPONENT PARTS!

FERRANTI TRANSFORMER

Weight: 2 lb. 10 oz.
Dimensions: 3 x 2¾ x 3¾ in.

In any electrical network the transformer is undoubtedly the most important of all the component parts. It is of no value to have a circuit which will successfully transmit all frequencies from 25 to 1000 cycles if the transformer in that circuit will only pass frequencies from 200 to 5000 cycles.

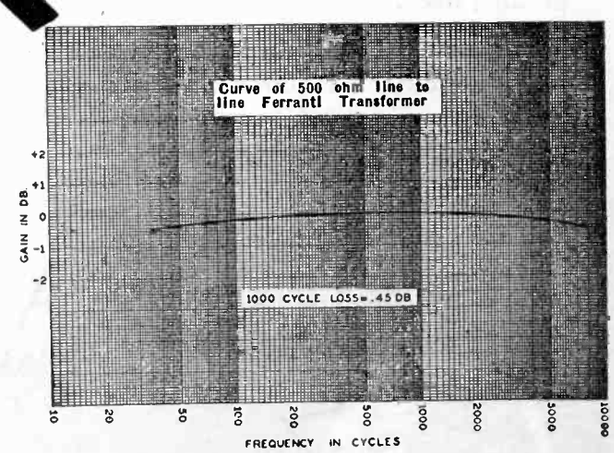
The superiority of Ferranti transformers lies in their ability to transmit efficiently all frequencies required for the natural reproduction of speech and music. This is accomplished by the special construction and coil design not used in any other transformer. Ferranti transformers are hand wound on telescoping composition forms, which in turn are divided into sections thus reducing the magnetic leakage and the self and mutual capacities to a minimum. It is this expensive type of construction which makes the Ferranti transformer the finest transformer on the market today.

No compound or paper is used in the construction hence the total weight of 2 lbs. 10 oz. is useful working material. Even the case acts as a shield, shielding each individual unit.

FERRANTI transformers are particularly suited for the exacting requirements of *Sound Studios, Communication Engineers, Broadcast Stations, Public Address Systems, Laboratories, Speech Transmission, Recording Devices* and all uses of vacuum tubes in their multitudinous applications.

A few of the numerous types of transformers which can be supplied in addition to standard audio and output, are microphone step-up, microphone mixing, microphone to line, pick-up, tube to line, line to tube, tube to speaker, special input, line to speaker, etc.

CURVE OF 500 OHM



FLAT RESPONSE CURVE

WRITE FOR OUR NEW 1932 CATALOGUE

130 West 42nd Street **FERRANTI, INC.** New York, N. Y.

electronics

McGRAW-HILL PUBLISHING COMPANY, INC.

New York, November, 1931

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radio
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facsimile
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receivers
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beacons
compasses
automatic processing
crime detection
geophysics

Engineers, components and parts

The Fall Convention, IRE

Rochester, N. Y., November 9 and 10

THE Fall Convention of the Institute of Radio Engineers has come to play an important part in the design of the next year's radio sets. This gathering of engineers, executives, and makers of parts and components, brings together at a critical time, the men and the materials which will profoundly affect the make-up of the radio offerings for the following season.

A chain can be no stronger than its weakest link. And a radio set can be no better than its weakest part. The last year or two have seen too much yielding in the direction of cheapening and weakening. Against reduction in quality, the great influence of the Institute's gatherings must now be organized and thrown determinedly in the direction of *building quality upwards,* insisting that every part be adequate and ample for its allotted task.

Meanwhile the pressure of every sales department continues inexorable, to *hold down* the overall price at which the finished radio set must be sold.

FROM this dilemma in which the set designer thus finds himself, he has one escape. He can turn for help to the makers of quality components and parts. Such specialists in manufacturing components have learned the lesson of getting maximum values at minimum cost. Their experience can be utilized by the set-maker—with marked saving of plant investment and increase of manufacturing flexibility. There is no need for each set-maker to go through the risk and expense of learning lessons that the component builder has long ago put behind him. There is no warrant for repeating, in radio, the classical incident of the Rolls-Royce engineers who carefully designed and built their own special horn push-button, at a cost for tools and dies of $12 per car,—and later found that a similar but better button could be bought on the open market at 10 cents!

"The greatest genius," said Carlyle, "is he who adapts and combines the best ideas of the greatest number." And the best radio designer, the sage might have added, is the one who draws on and skillfully assembles the existing experience of the best makers of components and parts.

PROBLEMS THAT FACE

Broadcast system and receiver must be regarded and designed as a unit

By VIRGIL
Executive Chairman, Fall Convention

FOR over a year attention has been focused on the problems involved in the design of very low-priced radio receivers. In the rush to supply the demand for such merchandise, many of the problems vital to satisfactory receiver operation have been overlooked or thrust aside. It is now the time for radio engineers to face these problems and give them consideration.

The future of the radio industry as well as the personal success of every radio engineer, depends on thoroughly studying the numerous questions pertaining to the "broadcasting system" considered from the *sound input into the microphone* all the way to the *sound output of the loudspeaker*.

The above statement sets forth one of the greatest present needs—that of viewing broadcast transmitters and broadcast receivers both as *parts of one system*. Previously, there has been practically no effort at correlating broadcast transmitter and receiver design. The transmitter engineers have gone their own way on apparatus design, and the receiver engineers have gone theirs. But at this critical period of the industry, both groups should now realize that the combined "system" exists as such, and should be so studied and engineered. The Broadcasting Committee of the Institute of Radio Engineers has undertaken to start this important work, and it should be the aim of every engineer to see what can be done to further the project.

The measurement of characteristics of radio receivers brings up a great number of problems. Now that the Institute of Radio Engineers has standardized on methods for measuring the electrical characteristics of chassis, radio engineers can make quantitative measurements which are understood throughout the profession. However, these measurements are the electrical characteristics of the chassis only, and are not the overall results of the chassis and its loudspeaker in a cabinet.

For instance, if a chassis with excellent measured characteristics is combined with a low-efficiency (electro-acoustically) speaker in a cabinet with insufficient baffle area, the results are the same as if a poor design of chassis were used, having low audio power output and bad fidelity.

This leads to a very great problem on which some work is being done, but which is not yet solved: standardization of a method of overall fidelity measurement of radio receivers from the modulated radio frequency input to the sound output. Such measurements have been made, but there seems to be no agreement among laboratories doing this work. As a matter of fact, there exists no standard method of loudspeaker measurement.

▼

How to measure over-all fidelity?

What degree of selectivity is desirable?

What should be the chassis power output?

What is most desirable image ratio?

What is cause of oscillator drift?

What is best method of testing shielding?

▲

Co-relating set and tube design

Before taking up the more detailed points of receiver design, there is a very important problem that should be considered and quickly solved. This is the correlation of the experimental and design work of receiver and vacuum-tube manufacturers. Two extreme conditions in the engineering of tubes and circuits are possible. The first is the condition where the receiver engineer is handed the tube in final form and he has to develop his circuits around it, having no say whatever in the design of the tube. In fact, he does not know what it is until it appears on the market. The other condition is where the receiver engineer develops circuits to operate with a tube of certain design, and then turns the design over to the tube manufacturer to build. This condition, of course, would breed a great and unnecessary number of types of tubes, if carried to extremes.

Of course, either condition is bad for the industry if carried too far, although at the beginning of the broadcast receiver business, the first condition prevailed almost universally. Fortunately, however, that has now changed and receiver and tube engineers are beginning to work together. But there must be found some way to guard against a swing to the extreme of the second condition. How to do this is a great problem now facing engineers. Obviously, it means some sort of engineering liaison between the two groups to coordinate receiver and tube designs without cramping the circuit development, and without having a multiplicity of types of tubes. Is it more desirable to accomplish this objective through an engineering organization than through a commercial or business group? Would it be better for the engineers to work together as individuals rather than as representatives of companies?

Radio engineer should decide

Chassis design problems are numerous as well as very important. The radio engineer is the one to make the decisions on such questions, rather than the commercial men. The engineers, having a broader viewpoint, can arrive at a more logical and final decision with all factors properly weighted.

Always facing the design engineer is the "limit" of sensitivity. Receivers increase somewhat in sensitivity every year, but surely there must be a practical and economical limit. Therefore, an engineering decision should be made. Receivers with extremely high sensi-

THE RADIO ENGINEER

Sets and tubes need to be correlated without cramping or complicating either

M. GRAHAM
Institute of Radio Engineers

tivity have sometimes made use of "tone controls" to reduce the noise accompanying reception. Is this a proper expedient or not?

As regards selectivity, there is the question as to what degree of selectivity is necessary for satisfactory operation. If extreme selectivity is desirable, what about its effect on fidelity? Can this effect be completely or partially compensated in the audio system? Is it sound from an engineering standpoint to use an extremely high apparent selectivity with highly sloped audio? What happens if the receiver becomes detuned very slightly due, for instance, to oscillator drift? Some engineers criticize the term "selectivity" as not being correct and object to the standard method of measurement as not showing the characteristic desired. Probably there is room for argument, but those dissenting will undoubtedly have to produce a better term and a more satisfactory method of measurement before the radio engineers will change from a term and method used for several years.

Power output of chassis

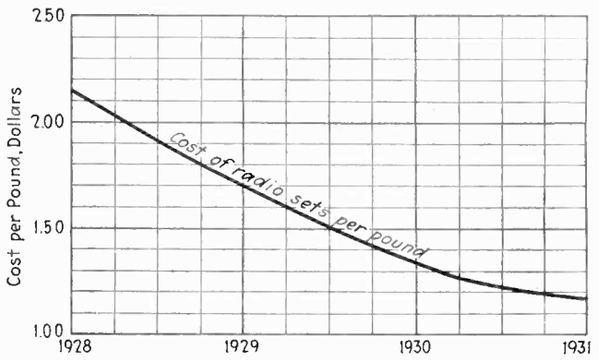
A question of importance at present is the power output of the chassis. What is a suitable limit? There has been a tendency to increase the power output of the chassis, and to decrease the electro-acoustical efficiency of the loudspeaker. Is this economical and sound engineering practice? If so, when is the limit reached? Must the increase in audio power from the chassis go on to an absurd point with the speakers becoming poorer and poorer?

Coming to the overload characteristics, there is the question of what should be the lowest percentage modulation that will overload the output tubes before the detector or automatic volume control fail.

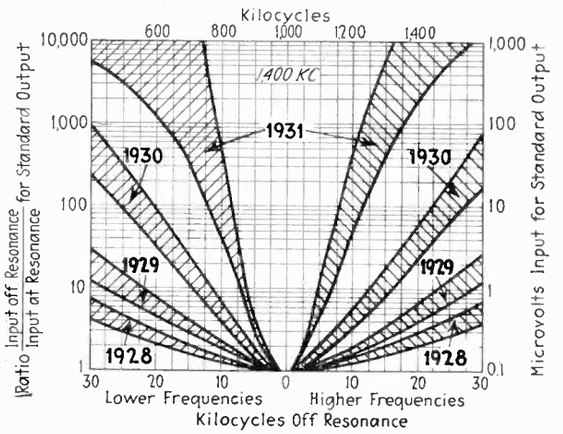
Radiation is a very serious problem accompanying the superheterodyne. While the preventative remedies are well known, they are not by any means universally applied to receiver designs. This is something that the engineer must think about, and realize the potential trouble for the industry that lies in each radiating chassis.

One characteristic of superheterodynes which apparently has received little attention is the frequency drift of the oscillator during the period of heating. There are several questions which present themselves about this characteristic. First, is the drift due to the tube, circuit, or both. What degree of drift necessitates retuning to prevent distortion and other undesirable results? What degree of drift is allowable on remotely controlled receivers where tuning is made to a fixed point for each station?

There is still another superheterodyne feature that has had more study than the oscillator drift, but there is



Radio engineers have steadily given the public more for its money—as the above curve shows



Selectivity of radio receivers has varied between approximate limits shown above in last three seasons

considerable disagreement among engineers as to its importance. This is the image ratio. One design laboratory feels that a fairly low image ratio is completely satisfactory, while another says that it should be extremely high. What is the proper minimum value for a three-gang capacitor set, and what is it for one employing a four-gang capacitor? Is there a value beyond which it is not desirable to design?

Shielding is a very important factor in the modern radio receiver not only from the standpoint of prevention of radiation, but also from the fact that the measured selectivity is not realized near a powerful station if the shielding is not adequate. Is it possible to arrive at a standardized method of testing the effectiveness of the shielding in this respect?

Is it possible that the design engineers are not well enough acquainted with each other to freely discuss the broad, general problems of the profession? A few years ago nearly every engineer called the others by their first names, and there was a great mutual benefit resulting from these friendships. Of course, these friendships still exist, but the personnel in the various organizations has shifted so that many of these men are now in executive positions or are on different work, and there is a new group of design engineers now functioning. Is it not possible to bring about a condition where these men know each other well, and are willing to discuss problems of the profession?

IRE members meet in Fall Convention

AT THE Fall Convention in Rochester, Nov. 9-10, members of the Institute of Radio Engineers gave manufacturers of component parts entering into the production of radio receivers, an opportunity to extoll the virtues of their individual products. Such was the feature of the fall meeting which has become a fixed part of the IRE annual program of events. An exhibit of components, tubes, and measuring equipment gave opportunity for makers and buyers of components to get together.

Below will be found abstracts of a majority of the technical papers delivered at the meeting. Others indicated on the program were not delivered to *Electronics* in time to the included. Several of the papers will be published in the *Proceedings* or elsewhere.

Advances in ultra-short wave communication

EDUARD KARPLUS, *General Radio Company*

The paper dealt with the electromagnetic waves shorter than those at present applied to commercial radio communication. The possibilities of generating the waves, which lie between 10 meters and the optical waves at the limit of visibility (one-thousand millimeter) were discussed and some methods of generation were explained. Methods of detecting and measuring the waves as well as the characteristics of the waves and some of their applications were discussed.

Results of recent experiments in Berlin were brought to the attention of the engineers as were illustrations of some of the receivers constructed there for ultra-short wave reception. *(See page 205 this issue, Electronics)*

Battery design problems of the air cell receiver

F. T. BOWDITCH, *Research Labs., National Carbon Company, Inc.*

This paper considered special receiver design problems concerned with the most economical utilization of the "A" and "B" batteries with the new Air Cell receivers.

When the Air Cell "A" battery is used as the source of filament power for receivers employing the new two-volt tubes, only a fixed series resistor is required, thus eliminating the danger of applying excess filament voltage. At the same time, the voltage discharge curve of the Air Cell battery is flat enough to permit the complete utilization of its energy at usable levels of filament voltage. The value of series resistance is rather critical and the data enabling its calculation were given in the paper.

From a "B" battery standpoint, a discussion of design features enabling the more complete utilization of "B" battery energy to very low cut-off voltage was given. Methods of grid voltage reduction were discussed, as well as the necessity of providing adequate filtering in the audio circuits to guard against regeneration induced by normally increased "B" battery resistance at the lower voltages.

Receivers designed with battery characteristics in mind can and have been made which are directly comparable in all respects with the better a.c. receivers, the power pack requiring no replacement and but little attention for a period of approximately one year.

An examination of selectivity

R. H. LANGLEY, *Consulting Engineer*

A review of the literature on selectivity including the important recent contributions, shows the necessity for co-ordination of the results and clarification of the definitions. Present selectivity requirements were developed and the mathematical treatment was revised to meet them. The criterion for uniform discrimination was established in the paper. The relation of the selectivity curve as now drawn, to the actual performance of the receiver was discussed, and the central portion was compared mathematically with the fidelity characteristic.

Suppressor grids in radio tubes

E. W. RITTER, *Development Engineer RCA Radiotron*

Some years ago D. C. Prince made studies of the division of cathode current between the electrodes of a positive-grid three element tube. In order to avoid the effects of secondary emission from the plate when the plate is at the same or lower voltage than the positive grid, an auxiliary electrode was inserted to suppress this secondary current. The advantages of this same sort of suppressor grid are utilized in the well known power pentode design.

An r.f. amplifier tube of this type has the advantage of greater gain on low voltage supply sources, more uniform characteristics over the whole characteristic range, a greater uniformity between tubes, and a flexibility in use not present in the typical four electrode tube, all of these advantages being due to the suppression of secondary emission from the plate.

Mica condensers in high-frequency circuits

I. G. MALOFF, *Engineering Department RCA Victor Co.*

Mica condensers are widely used in construction of high frequency apparatus. Their main features are: To store electrical energy, to block direct current, to by-pass alternating current, and to reduce ripple in rectifier networks. They are characterized by low power factor, very high operating voltages and very high current carrying capacities. To calculate the tank condenser for a vacuum tube oscillator, the power output of the tube is divided by the estimated power factor of the whole circuit; the result, which is the total circulating energy, is divided by the estimated r.f. voltage, giving tank current. The ratio of the latter two determines the reactance and capacity of condensers and current and voltage requirements. Mica condensers are rated on the basis of the number of series sections, each capable of withstanding a certain voltage; the casing capable of dissipating a certain number of watts; and volume of mica capable of storing a certain amount of circulating energy without damaging the impregnation.

Glow-lamp noiseless recording

By E. H. HANSEN
Chief Sound Engineer
Fox Film Corporation, Hollywood, Calif.

UNDER normal conditions unmodulated sound track has a noise ratio, depending mainly on the amount of transient opacities interspread on the track. The levels of these transients vary as the ratio of the density of the unmodulated track to the transients, as represented on the print by dirt, scratches, oil, wax, etc. It being beyond the ability of any electrical circuit to discriminate between desired signal and acoustic background noise, it is apparent that no effective results can be obtained in the elimination of acoustical noises. This paper describes the general principles of surface noise reduction as applied to recording glow-lamps. The circuits and film data represented are classical rather than those in use or applied by any producing company using this type of recording.

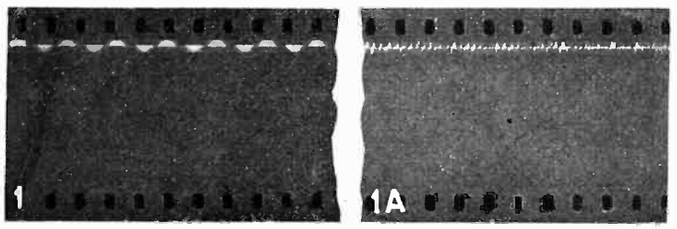


Fig. 1—Fifty-cycle modulation with zero center line recording, 1A speech and music modulation

The first requirement in the making of a film record is that the fidelity of the density indicated on the print does not noticeably deviate in relationship from the applied sound pressure on the microphone diaphragm.

In considering the design of noise reduction circuits, whether they be intended for application with variable density or variable area, the work to be accomplished is the same in both instances, i.e. that for such periods of no modulation extreme opacity will be interposed between the light beam and the photocell of the projector.

It might be well at this point to consider what constitutes an ideal sound-track with regard to the elimination of surface noise as represented on the film. Obviously, a sound-track, wherein the speech signal is totally transparent and is surrounded by complete opaqueness, will constitute an ideal track. Such a track is shown in Fig. 1, and is a record made of a 50-cycle wave. It will be noticed that this negative track is opaque in portions of the track occupied by the signal and is completely transparent in the unused area. It will be noticed that the signal does not modulate a carrier exposure such as used in variable area records. It will also be observed that the positive half of the cycle lies above an imaginary center line and the negative half lies below this point. A print from this negative track will reverse the conditions and give us a signal that is transparent with a surrounding area completely opaque. Such a track is inherently noiseless and is made without the use of secondary exposure control devices.

Methods of noise reduction

Although the example is of the variable area type, such a principle is equally applicable to variable density. Such a negative variable density track would have exposure only during the signal period, reverting to clear transmission at all other times. The above ideal is varied in general practice by an attempt to provide the maximum opacity around the speech envelope in the print, rather than an attempt to fill in between every cycle or component thereof. In the variable area method two devices have been employed, one wherein the center line is varied, and the other where the center line remains in its usual position in the sound track, and then a secondary exposure surrounds the speech envelope.

In the variable density method the unmodulated exposure is varied according to the strength of the speech signal, and ranges from the normal density of the unmodulated track when fully modulated to the maximum density for the weakest speech signal. The above conditions apply naturally to the print.

Although it is possible to make variable area records with a glow-tube by actually photographing the expansion and contraction of the glow itself, the usual type of recording with the glow tube is of a variable density character.

Figure 2, shows a typical glow-lamp recording circuit and consists of microphone pickup, control for same, a main amplifier having a gain of approximately 80 to 100 db., and then depending upon the number of recording cameras used, bridging amplifiers connected to the glow lamp control circuits, the usual glow-lamp control circuit consisting of a voltage supply connected to the

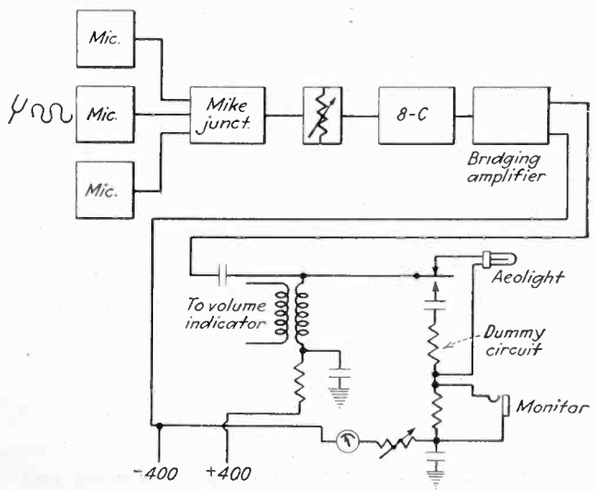


Fig 2—Typical glow-lamp recording circuit with associated equipment

glow-lamp through a control and ballast resistor, and a coupling condenser to the speech circuits which modulate this direct current flowing through the glow lamp. Additional means are provided for monitoring and also a dummy circuit so that the volume indicator will read correctly during such periods as it is desired to conserve the glow-lamp.

Operating characteristics of the lamp

In operation the value of a d.c. current flowing through the glow-lamp is determined by the light efficiency of the glow-lamp with respect to the film emulsion characteristics. This value is chosen so that the unmodulated transmission will fall midway on that portion of the film characteristic to be used.

Either "toe" or "straight line" characteristics may be used in processing film for glow-lamp recording. Both methods of processing are possible and have proportional linear characteristics, otherwise they would be unusable due to the loss of fidelity.

In general, the quality and quantity of light emitted by a glow discharge tube depends upon the electrode spacing, the type of gas, the pressure of gas, and the applied potential. From life and operating requirements it is usual to excite the glow lamp below maximum output. While this amount of light, when using positive emulsion, falls below that required for straight line *H* and *D* recording, it is more than ample for toe processing. When straight line *H* and *D* characteristics are desirable, it is usual to use a film having greater speed. In the last few months, so-called composite stocks have been developed by the film companies wherein the speed lies between that of the positive and negative emulsions, and is ample for straight line recording with glow discharge tubes. Negative stocks, such as orthochromatic, panchromatic and super-panchromatic, are capable of giving perfect straight line records with low light intensities. With the super-speed films, such as super-panchromatic, it is possible to work with very limited amounts of light and to fully modulate over the straight line *H* and *D* portion of the film.

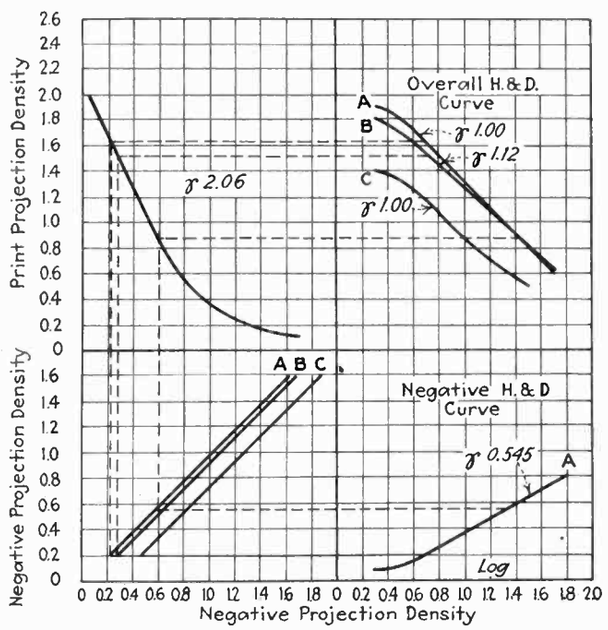


Fig. 3—Characteristic curves for exposures and processing with positive stock using glow-lamps for recording

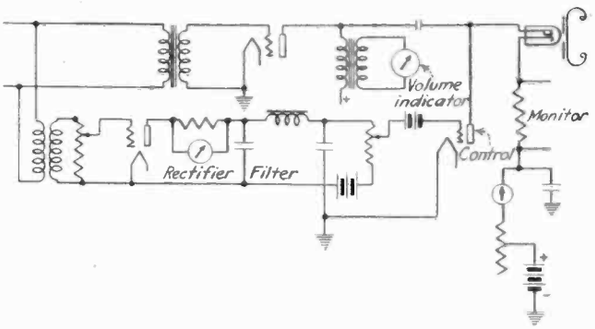


Fig. 4—Modification of circuit in Fig. 2 to meet special requirements of the biasing circuit

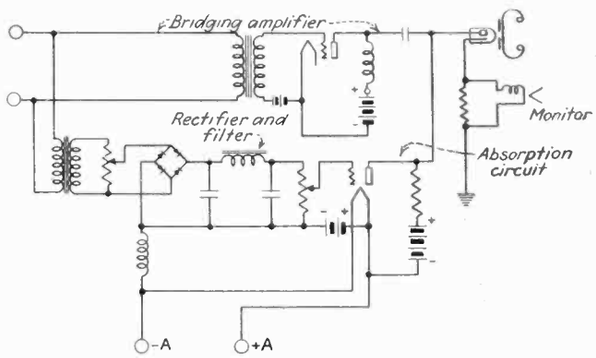


Fig. 5—Simplified circuit using a full wave contact rectifier in place of thermionic rectifier

The question of cost, however, must be considered. In the major studios, where from 50 to 75 productions a year are to be made, it is roughly estimated that approximately one hundred thousand feet of sound negative will be required per production for recording. In the case of the 50 production per year company, five million feet of sound negative are required. The price differential between positive and negative stocks is in the ratio of four to one. There is also an advantage in the use of positive stocks, due to their lower speed having greater stability and ease of handling, and this, in addition to the yearly saving, makes it desirable to employ that type of emulsion.

In the making of studio productions, it is common practice to use the double system of photography and recording, that is, a separate sound and separate picture negative. In the case of a single system, such as employed in newsreels, wherein sound is simultaneously recorded with the picture, the question of emulsion is necessarily determined by the photographic requirements. This usually calls for the panchromatic and super-panchromatic types. The requirements of photographic processing determine that of sound, and is necessarily straight line.

Referring again to the common practice in studio production work, positive stock is utilized generally, necessitating the toe method of processing when using glow-lamps for recording. The characteristic curves of such exposures and processing are shown in Fig. 3. The lower right-hand quadrant shows the negative characteristics of dynamic glow-lamp current plotted against negative projection density. The lower left-hand quadrant represents printer points, and the upper left-hand quadrant shows the characteristic of the printer curve having the negative projection density plotted against the print transmission. The upper right-hand quadrant shows the overall recording characteristics, and this

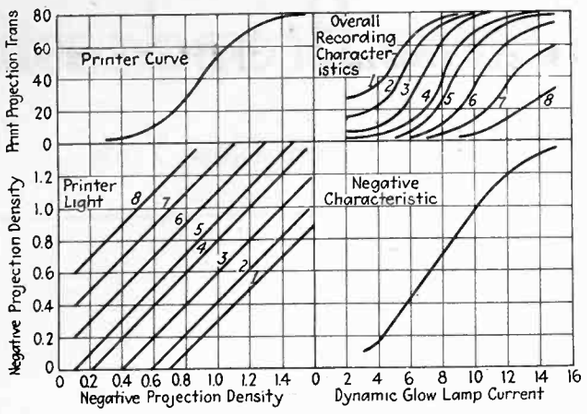


Fig. 6—Film characteristics when using straight line recording and processing

should be chosen so that the original requirement of proportionality is carried out. In normal toe practice a print having an unmodulated transmission of between 40 and 45 per cent is specified.

Operating limits for film exposure

The design and operation of biasing circuits, in connection with glow-lamp recording, depends upon the film characteristics to be utilized. It is obvious that the increase of opacity in the negative must not be carried beyond a point where there is film curvature. An examination of the negative characteristic in Fig. 3 shows that the straight line region extends from approximately 65 per cent transmission to 15 per cent transmission. In practice then we would place the unmodulated exposure half way between these peak limits, or aproximately 40 per cent. At this point we can swing the film transmission with our signal 50 per cent without incurring noticeable deterioration of fidelity. This representing our highest modulating level, it is now necessary to pick a point further down the scale where a minimum signal will not overswing into the curved region of the emulsion. Allowing 10 per cent for this minimum swing, we pick a point wherein the unmodulated transmission for this value of signal will be 20 per cent. This minimum operating point, allowing a swing of 5 per cent plus or minus, is well within the safety zone and permits sounds of increasing intensity and flat wave front to be recorded without distortion. This is necessary due to a characteristic of the biasing circuit, which will be pointed out later, wherein a requirement of time for operation is essential.

It is now necessary that we change our fundamental circuit, as shown in Fig. 2, to one similar to Fig. 4, the requirement of our biasing circuit being that for a minimum signal transmission of approximately 20 per cent unmodulated value shall be increased to a transmission of 40 per cent for our fully modulated signal. It is, therefore, necessary to make the control of the d.c. current flowing through the glow-lamp automatic and vary with the strength of the impressed speech signal. In Fig. 4, the d.c. path through the glow-lamp is controlled by the plate filament resistance of the control tube which is in series to ground. This control tube in turn has its grid potential varied by the output of a rectifier tube, and this rectifier tube in turn is energized by diverting a part of the speech current used to modulate the glow lamp.

It is possible upon the proper calibration of such a circuit, to vary the impedance in the glow lamp circuit in such a way as to change the d.c. component in accordance with the speech level impressed upon this circuit. It is necessary that means be provided so that the control tube will not modulate the d.c. component in accordance with low frequency speech currents. This is provided for in the filter timing circuit between the rectifier tube output and the grid of the control tube. The period of this timing depends upon the values of the tuned filter circuit, and is usually between one-fiftieth of a second, and one-hundredth of a second, which permits the control tube to function only in relationship to the envelope of the speech current.

Variation in circuits used

There are many variations in the type of biasing circuit to be used, and just so that they contain the three essential units, i.e. rectifier, filter timer, and control tube, properly adjusted, the results will not vary. Fig. 5 shows the circuit that has been simplified by the introduction of a full wave contact rectifier in place of the thermionic rectifier. In addition, in place of the control tube being in series with the glow lamp, it is shunted across the resistor, supplying the d.c. current to the glow lamp, and provides an absorption control in place of

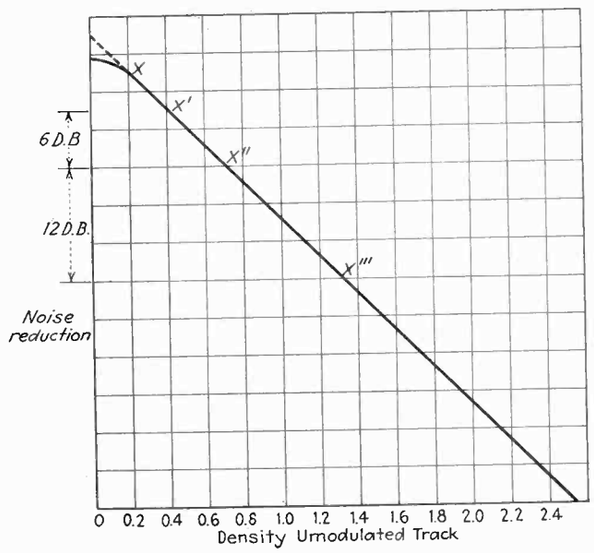


Fig. 7—Density of the unmodulated sound track plotted against relative noise reduction

series. One advantage of this method is that saturation may be properly controlled. Saturation is a double safeguard against overrunning the film limiting characteristic.

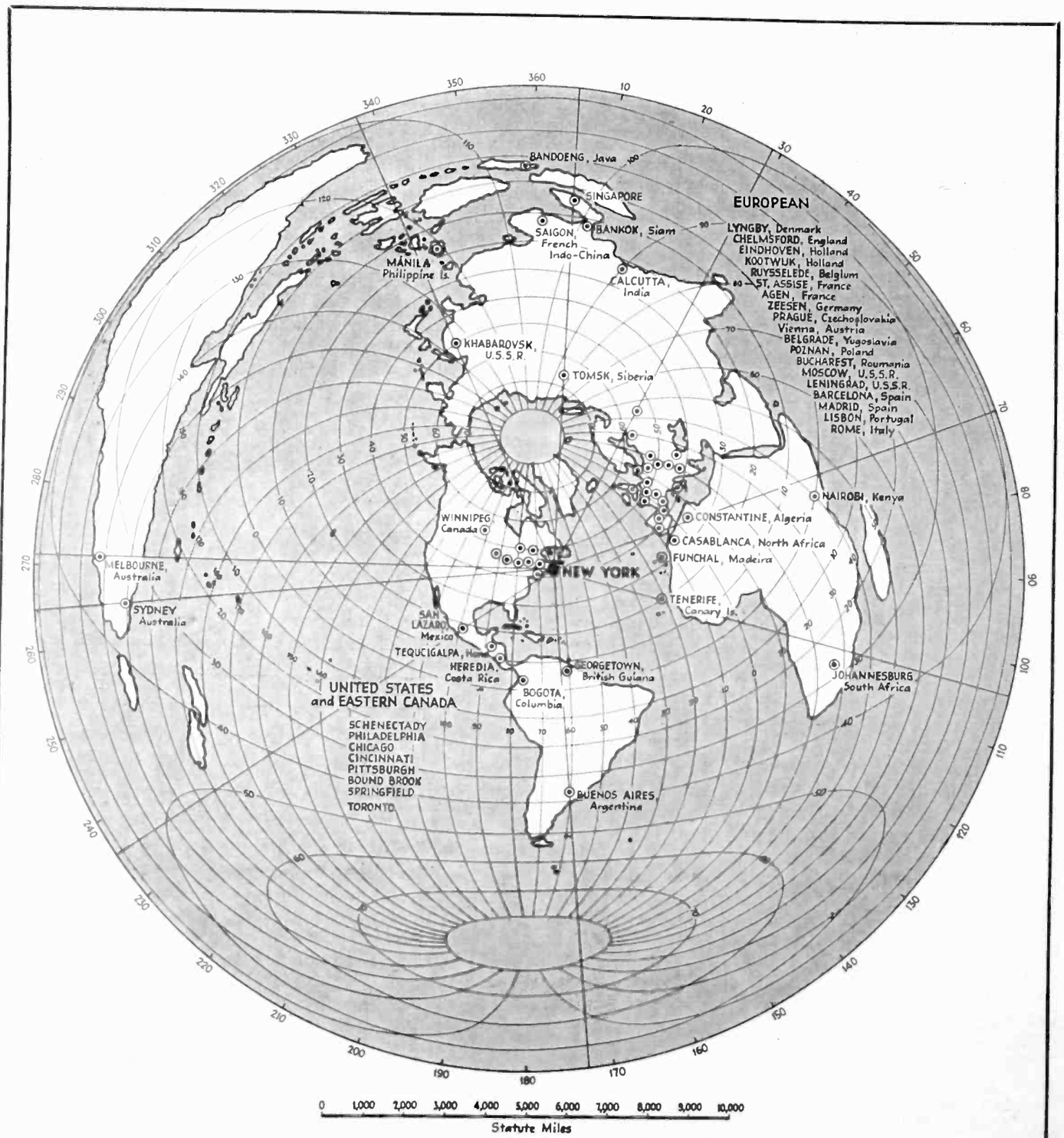
Fig. 6 represents film characteristics when employing straight line recording and processing. It will be noted that the negative characteristic is such that the optimum unmodulated transmission for full modulation is approximately 20 per cent. This value inherently gives this type of processing a reduction of 6 db. in ground noise over normal toe processing due to the halving of the unmodulated transmission. It will be further noted that it is possible to increase the print density to values as low as 4 per cent and 5 per cent.

In order to fully understand the effect of noise reduction in relationship to toe and straight line processing, reference is made to Fig. 7. In this the density of the unmodulated sound track is plotted against relative noise reduction. It will be noted that in the upper regions of

[*Continued on page 214*]

Short-Wave Broadcasting

A map showing true bearings and shortest distances from New York



With New York as center, the entire world has been drawn as a map on which the great circle bearings and true distances are shown. A listener in New York hearing a program originating in Buenos Aires can easily determine that the distance is roughly 5,000 miles and the bearing is almost due south.

Stations of the World

A list of stations operating in the region above 2800 kc.

International broadcast bands { 6,000– 6,150 kc. / 9,500– 9,600 kc. / 11,700–11,900 kc. / 15,100–15,350 kc. / 17,750–17,800 kc. / 21,450–21,550 kc. }

This list shows stations used only in broadcast commercial service. Radiotelephone and radiotelegraph stations that transmit special broadcast programs occasionally are not included.

FREQUENCY	CALL	STATION
2830	VE9AK	Red Deer Alberta, Canada
2998	.....	Manaos, Brazil
3080	.....	Australia
3088	.....	Soro, Denmark
3150	.....	Australia
3446	.....	Haifong F.I.C.
3480	.....	Australia
3529	H9XD	Zurich, Switzerland
3560	RW65	Portable U.R.S.S.
3650	.....	Australia
3750	I2RO	Prato 'Smeraldo (Rome), Italy
3930	.....	Australia
3998	PK1AA	Batavia, Java
4040	.....	Australia
4262	F8GC	Paris, France
4273	RW15	Rhabarovsk U.R.S.S.
5000	XCTE	Shanghai, China
5030	.....	Surabaya, Java D.E.I.
5145	OK1MPT	Prague, Czechoslovakia
5170	PK1BR	Bandoeng, Java
5514.7	RW38	Moskva Mosps U.R.S.S.
5552	.....	Berlin
5720	.....	Australia
5740	.....	Australia
5870	AIN	Casablanca Morocco
5968	HVJ	Vatican City, Vatican State
5996	PK2AF	Djokjakarta, D.E.I.
6000	EAR25	Barcelona, Spain
6000	ZL3ZC	Christ Church A. Z.
6000	RW59	Moscow Stchelkovo U.R.S.S.
6005	HRB	Tegucigalpa, Honduras
6005	VE9CU	Calgary, Alberta, Canada
6005	VE9DN	Montreal, Canada
6010	.....	Australia
6020	VE9AO	Toronto, Ont., Canada
6020	W9XF	Downers Grove (Chicago), Ill.
6020	.....	Konigswusterhausen, Germany
6030	OK1MPT	Prague, Czechoslovakia
6030	VE9CA	Calgary, Alberta, Canada
6035	YNA	Managua, Nicaragua
6040	W2XAL	Coytesville, N. J.
6040	.....	D.E.I.
6050	VE9CF	Halifax, N. S., Canada
6057	OXO	Copenhagen, Denmark
6060	W3XAU	Philadelphia, Pa.
6060	V8XAL	Mason, Ohio
6060	VE9CL	Middle Church (Winnipeg), Canada
6060	.....	D.E.I.
6061	YV2BC	Caracas, Venezuela
6065	SASH	Motala, Sweden
6070	VE9CS	Vancouver, B. C., Canada
6070	ZTJ	Johannesburg, U. of S., Africa
6072	UORQ	Wien, Austria
6080	W9XAA	Chicago, Ill.
6080	TIR	Cartago, Costa Rica
6090	OXY	Skamlebok (Copenhagen), Den.
6090	VE9BJ	St. John, N. B., Can.
6095	VE9GW	Bowmanville, Ont., Canada
6100	W3XAL	Bound Brook, N. J.
6100	.....	D.E.I.
6100	.....	Japan
6110	VUB	Bombay, India
6110	VE9CG	Calgary, Alberta, Canada
6110	.....	Prangins, Switzerland
6115	.....	Warsaw, Poland
6119	.....	Saigon, Indo China
6120	NAA	Washington, D. C.
6120	W2XE	Jamaica, N. Y.
6120	F3ICD	Chi. Hoa (Saigon), F.I.C.
6130	VE9BA	Montreal, P. Q., Can.
6130	.....	Prangins, Switzerland
6140	.....	Australia
6140	KZRM	Manila, P. I.
6140	WOXK	East Pittsburgh, Pa.
6150	VE9CL	Middle Church (Winnipeg), Canada
6150	CFTS	Toronto, Ont., Canada
6170	HRB	Tegucigalpa, Honduras
6230	.....	Australia
6522	.....	.....
6250	HKC	Bogota, Colombia
6383	CT3AG	Funchal, Maderia
6420	RW62	Minsk, Russia
6440	REN	Moscow, Russia
6520	.....	D.E.I.
6522	EAR96	Barcelona, Spain
6580	.....	Australia
6630	.....	Warsaw, Poland
6662	PK3CH	Surabaya, D.E.I.
6667	IIAX	Rome, Italy
6667	XFD	Mexico City, Mexico
6680	.....	Australia
6800	VO82	St. Johns, New Foundland
6832	VRY	Georgetown, British Guiana
6849	HJN	Bogota, Colombia
6877	.....	Rabat, Morocco
6977	XFA	Mexico City, Mexico
7005	F8KR	Constantine, Tunis
7055	VS3AB	Johore, Malay States
7143	PT1AA	Lisbon, Portugal
7210	EAR58	Las Palmas, Canary Islands
7260	VS1AB	Singapore, St. Settlements
7300	HSP2	Bangkok, Siam
7300	CM6DW	Cienfuegos, Cuba
7300	NSP2	Bangkok, Siam
7313	PK6KZ	Makassar, D.E.I.
7317	F8GC	Paris, France
7317	HHP2	Bangkok, Siam
7463	.....	Lyon, France
7495	.....	Tenarife, Madagascar
7590	JFAB	Taihoku, Japan
7688	HKF	Bogota, Colombia
8111	RV19	Tomsk, Russia
8761	F2BD	Agen, France
9091	XFD	Mexico City, Mexico
9125	HAT	Szekesfehrervar, Hungary
9130	HB90C	Furich, Switzerland
9225	VK2BL	Sydney, Australia
9369	3LO	Melbourne, Australia
9375	H9XD	Zurich, Switzerland
9375	.....	Berne, Switzerland
9375	FL	Paris, France
9375	VUC	Calcutta, India
9410	PLE	Bandoeng, D.E.I.
9488	OXZ	Copenhagen, Denmark
9500	HSP-2	Bangkok, Siam
9510	VK3ME	Melbourne, Australia
9515	.....	Prangins, Switzerland
9520	OXY	Skamlebon (Copenhagen), Den.
9520	.....	D.E.I.
9530	YNA	Managua, Nicaragua
9530	W2XAF	So. Schenectady, N. Y.
9540	.....	D.E.I.
9545	.....	Prangins, Switzerland
9550	NAA	Washington, D. C.
9550	.....	D.E.I.
9550	.....	Japan
9560	.....	Konigswusterhausen, Germany
9565	VUB	Bombay, India
9570	KZRM	Manila, P. I.
9570	W1XAZ	East Springfield, Mass.
9570	W8XK	East Pittsburgh, Pa.
9575	VUC	Calcutta, British India
9580	.....	Australia
9580	.....	D.E.I.
9580	.....	Prangins, Switzerland
9580	VE9DN	Montreal, Quebec
9584.7	ZTJ	Johannesburg, U. of S., Africa
9590	PCJ	Hilversum, Holland
9590	VK2ME	Pennant Hills (Melbourne), Australia
9590	W3XAU	Byberry (Philadelphia), Pa.
9595	.....	Prangins, Switzerland
9640	VP7LO	Narobi Kenya, British E. Africa
9734	.....	Heredia, Costa Rica
9761	F2BD	Agen, France
9772	EAM	Madrid, Spain
9835	SR1	Poznan, Poland
9840	J1AA	Tokio, Japan
10000	.....	Belgrade, Yugoslavia
10110	.....	Leningrad, Russia
10111	.....	.....
10169	HS2PJ	Bangkok, Siam
10350	.....	Russia
10520	VK2FC	Sydney, Australia
10801	UOR2	Vienna, Austria
11700	YB4BV	Valencia, Venezuela
11705	VE9BA	Montreal, P. Q., Canada
11705	FYA	Pointoise (Paris), France
11710	.....	Australia
11720	CJRX	Middle Church (Winnipeg), Canada
11720	SAS	Karlsborg, Sweden
11720	.....	Monte Grande
11720	.....	Pointoise, France
11740	HRB	Tegucigalpa, Honduras
11750	G5SW	Chelmsford, England
11760	.....	Konigswusterhausen, Germany
11760	SAS	Karlsborg, Sweden
11770	.....	D.E.I.
11774.2	HHP-2	Bangkok, Siam
11780	VE9DR	Drummondville, Que., Can.
11800	W2XAL	Coytesville, N. J.
11801	UOR-2	Vienna, Austria
11810	I3RO	Rome, Italy
11810	VE9GW	Bowmanville, Ont., Can.
11820	PRAA	Rio de Janeiro, Brazil
11840	KZRM	Manila, P. I.
11840	W2XE	Jamaica, N. Y.
11840	W9XAA	Chicago, Ill.
11860	.....	D.E.I.
11860	VE9CA	Calgary, Alberta, Canada
11870	VUC	Calcutta, British India
11880	W8XK	East Pittsburgh, Pa.
11880	.....	Australia
11890	YNA	Managua, Nicaragua
11905	.....	Pointoise, France
12000	I2RO	Prato S'meraldo (Rome), Italy
12110	.....	Kaiserslautern, Germany
13593	.....	.....
15120	HVJ	Vatican City, Vatican State
15130	VE9DR	Drummondville, Que., Can
15150	.....	D.E.I.
15160	.....	India
15190	VE9BA	Montreal, P. Q., Canada
15200	.....	Konigswusterhausen, Germany
15200	.....	Japan
15210	W8XK	East Pittsburgh, Pa.
15220	PCJ	Hilversum, Holland
15245	FYA	Pointoise (Paris), France
15250	W2XAL	Coytesville, N. J.
15275	.....	Warsaw, Poland
15280	W2XE	Jamaica, N. Y.
15290	.....	India
15300	.....	D.E.I.
15300	DXZ	.....
15310	.....	Australia
15340	W2XAD	So. Schenectady, N. Y.
15760	J1AA	Tokio, Japan
15789	EAJ1	.....
17640	PLF	Malabar, D.E.I.
17760	.....	.....
17760	.....	Japan
17760	.....	Konigswusterhausen, Germany
17775	PHI	Huizen, Holland
17780	W8XK	East Pittsburgh, Pa.
17780	W9XAA	Chicago, Ill.
17780	.....	Warsaw, Poland
18860	PLE	Bandoeng, D.E.I.
19800	J1AA	Kemikawa (Tokio), Japan
21460	W2XAL	Coytesville, N. J.
21480	.....	Warsaw, Poland
21520	.....	Japan
21540	W8XK	East Pittsburgh, Pa.
24380	VE9GW	Bowmanville, Ont., Canada

A "cold" filamentless radio tube

Already built in many experimental forms. Operates as amplifier, modulator, detector, oscillator

By CLINTON W. HOUGH
*President, Wired Radio, Inc.**
60 Broadway, New York City

Editors' foreword

Widespread interest was created by the announcement in "Electronics" for September of the development of an entirely new type of cold radio tube that operates without filament or A-battery supply. Editors of "Electronics" visited the laboratory at Ampere, N. J., and witnessed the operation of the new tube, both as an amplifier, and as a modulator. Later visitors report having listened to a three-tube radio broadcast receiver which used these filamentless tubes exclusively.

Since the appearance of "Electronics" item, inquiries have poured in from all parts of the country, and a number of prominent radio men have already visited the laboratory and inspected the tube in operation.

Dr. Hund has had in preparation for "Electronics" an exclusive article giving the characteristics of the new tube, but since some of the patent applications for latest forms of the tube were not finished as this issue goes to press, he has preferred to delay publication of his complete article to a later number. In his place, President Hough has contributed the following statement.

IN *Electronics* for September, 1931, page 89, appeared the first announcement of a new type of tube which is being developed at our research laboratories at Ampere, N. J., by Dr. August Hund. In that article it was stated:

"A new filamentless radio tube now being developed by large independent interests, will apparently do everything the three-electrode vacuum tube can do—as amplifier, rectifier and oscillator.

"Such tubes have a high amplification factor, are simple and easy to make, and can be manufactured for a few cents each. Already they have been applied exclusively in a three-tube radio set with satisfactory results. They have also been employed in test transmitters. Having negligible internal capacity, they can be worked directly on short waves even below one meter. Fortunately this invention is in strong independent hands, where it can be administered for the benefit of all concerned."

In response to the request made to us by the editors of *Electronics* for additional information regarding these new tubes being developed in our laboratory by Dr. Hund, at the moment there is not much more to be said. The editors and other visitors have seen the tubes operating as oscillators, modulators, detectors and amplifiers. There are several types of these new tubes, and they perform all of the functions of the various types of vacuum tubes.

An interesting feature of the new tubes is the complete elimination of all filaments and heaters. The tubes function on the usual B-battery or plate-voltage supply only, controlled by signal impulses. The tubes also function

DR. AUGUST HUND

Dr. August Hund and his "cold tube" photographed in his laboratory at Ampere, N. J. Dr. Hund is widely known among radio men for his work while with the U. S. Bureau of Standards

*Subsidiary North American Company.

HOW WIRED RADIO, INC., CAME TO DEVELOP FILAMENTLESS TUBE

Wired Radio, Inc., a subsidiary of the North American Company, one of the largest owners of electrical utility companies in the United States, is developing a system for broadcasting music, speech and general entertainment over the electric light wires by means of multiple carrier-current channels superimposed on the regular lighting frequency. It has some 1,600 patents on radio, audio and carrier-current inventions. At Ampere, N. J., it employs a staff of 200 engineers, physicists and mechanics. Wired Radio, Inc., also controls many important musical copyrights which return it a seven-figure income from royalties.

The parent North American Company controls the electric lighting companies in Cleveland, Detroit, Washington, St. Louis, Milwaukee and a number of other cities, with properties making up a total valuation of nearly a billion dollars. Into these cities it is eventually planned to introduce "wired radio" programs over the electric light wires on a monthly rental basis without advertising in the programs.

instantaneously. There is no waiting for a filament or heater to reach operating temperature.

Some types of the new tube amplify at very high frequencies, their amplifying factor increasing with the frequency. This is useful in the construction of highly efficient amplifiers for very short wavelengths.

The new tubes have been made in a wide variety of sizes,—for example, from the dimensions of a peanut kernel, up to 30 watts output capacity. They have also been used in various types of receiving sets.

Radio transmitters are now in use with the new tubes operating as oscillators, modulators and amplifiers.

One interesting development is a single oscillating tube which is simultaneously generating three frequencies carrying three wired radio programs.

This new development in radio tubes, for which full credit should go to Dr. Hund, has so many new features that radio engineers now have a new device with which to accomplish additional wonders.

The new tubes seem to have an indefinite life, with uniform action throughout. They operate cold, they work without a vacuum, and they are inexpensive to manufacture.

Dr. Hund has had under way for *Electronics* a paper describing fully his new tube and it is our wish that he disclose its details and operating characteristics so that engineers who are interested may have first-hand and reliable information. In the meantime, I hope the above general information will be of interest to *Electronics* and its readers.

▼ ▼ ▼

COLD TUBES IN GERMANY—DR. SEIBT'S PATENTS

CONSIDERABLE work has been done in Germany by Dr. Georg Seibt of Berlin. Patents recently issued to him in England (Nos. 341,061-2-3-4 and others) give some idea of his experiments. In general the idea of a gaseous discharge furnishing the plate current through ionization is disclosed in his patents.

For example a glow discharge taking place between cathode and anode is used in place of a heated filament. The electrons starting from the glow discharge pass to a second anode and en route are acted upon by a controlling electrode.

If, as an example, the glow discharge takes place between two electrodes which are negative with respect to a surrounding, grid-like, element, electrons leaving the glow discharge area will be attracted toward this grid-like element which acts as cathode for the remainder of the elements, which are, as in a triode, a control grid and an anode.

It has been said that such tubes would be noisy in operation, due to the gaseous discharge, but such noise would not modulate a signal being amplified unless some non-linear part of the characteristic were used. It has also been suggested that little power can be secured from such tubes. The statement above which explicitly indicates that as much as 30 watts can be secured, from Dr. Hund's tube, shows that the low power limitation has been overcome.

Dr. Seibt uses neon, among other gases, at a pressure of about 6 mm, and the gas should be as pure as is possible to obtain it, he states.

Hopes for cold-cathode tubes have been voiced many times by radio, vacuum tube, and telephone engineers. In the telephone plant there are probably 100,000 repeaters (amplifiers operating at audio and carrier frequencies). These repeaters have an average of three tubes, each consuming approximately one-half ampere of current at about 4 volts, or about 2 watts. Here, then, is a power consumption of 600,000 watts. This is expensive power because it now comes from storage batteries which must be kept charged and in condition.

Methods used in electrical prospecting

By JOSEPH I. HELLER
Chief Engineer, Electronic Applications Company
New York City

THE diverse fields into which the electronic tube fits are so specialized that engineers, experts in one direction, are often unfamiliar with what other engineers are doing although they may use the same tools and electronic apparatus. For example, not many radio or sound-picture engineers are familiar with what has been accomplished in the field of geophysics through the application of electrical—and often electronic—principles and apparatus.

The equipotential method

There are a number of schemes in use today. The equipotential is the simplest in the way of apparatus and operation. It is intended mainly for reconnaissance and for work in locations where a deposit is suspected to be very near the surface of the ground. The method is substantially as follows:

An insulated wire is run out some 2,000 ft. or less, and leads of bare cable are projected at right angles from the insulated wires, parallel with each other. The layout is diagrammatically shown in Fig. 1. The bare cable is laid directly on the ground and connection to the ground at all points is assured by driving long copper staples into the ground. Tests are then conducted for the location of equipotential points.

The apparatus used to find equipotential points consists of a simple two-electrode pickup system composed of two pointed copper rods maintained at the same distance apart by the connecting wire leading to an amplifier or a pair of phones. One of the electrodes is pushed into the earth while the other is moved around until a point is found where no signal is heard. The operator either plants stakes at these points, or is followed by a surveyor who notes the position of the points as soon as they are found.

If there is no disturbance in the ground these lines will appear in the shape of the dotted lines in Fig. 1. In places where a disturbing body is to be found, the equipotential lines will appear as the solid lines in Fig. 1 over the cross-hatched figure representing the hidden ore. Sulphides, usually of copper, lead or zinc are readily found with this method. The driver usually consists of a buzzer and battery connected at the mid-point of the insulated wire. The frequency of the buzzer is adjusted to be in the neighborhood of 200 to 500 cycles per second. It can be readily understood from inspection of Fig. 1 that currents will flow from one bare wire to the other through the earth. There will also be a magnetic field set up by the connecting insulated wire. This magnetic component is not usually in phase with the earth currents, and a condition will often arise where a signal heard in the telephone is made up of two components, i.e., the earth current and the magnetic wave. In such cases the equipotential points cannot be placed with the accuracy that the earth currents themselves would allow, and therein lies the chief disadvantage of this system. Different means have been suggested for overcoming this difficulty by means of coincident artificial lines and similar arrangements. However, when conditions warrant closer setting of equipotential points, one of the methods following is most generally used.

The potential ratio method

In those cases where the phase shift mentioned above becomes high enough to prevent readings to a close enough value, or at places where the ore body is at a greater depth, the "potential ratio" method is usually used to get points to greater accuracy (Fig. 2). In this method the buzzer or oscillator is placed near one electrode, and the other electrode run some distance back and connected to the buzzer with an insulated wire. The pick-up instrument used in this method is unique in its ease of operation, and was developed by Mr. Zuschlag, of the Swedish-American Prospecting Co.

Because of the fact that one of the greatest sources of error is brought about by the use of grounded electrodes some means of either measuring or compensating for the contact resistance must be included when taking potential measurements. The instrument designed by Mr. Zuschlag compensates for contact potentials and also balances for phase. The entire circuit arrangement may not be published at this time; however the principle of operation of the contact resistance compensation will be outlined below.

In Fig. 3, A and B represent the ground potentials between the electrodes, a, b and b, c respectively; x and y are the contact resistances, and r_1 and r_2 are known variable resistances. The resistances r_1 and r_2 are adjusted for zero current through M, which may be a telephone or amplifier.

$$\frac{A}{B} = \frac{r_1 + x}{r_2 + y}$$

If we then change r_1 to some other value such as r_1', and readjust r_2 to a new value r_2' for a null reading of M,

$$\frac{A}{B} = \frac{r_1' + x}{r_2' + y}$$

Substituting x of (1)

$$\frac{A}{B} = \frac{r_1' + \frac{A}{B}(r_2 + y) - r_1}{r_2' + y}$$

$$\frac{A}{B} = \frac{r_2' - r_2}{r_1' - r_1}$$

The ground potential ratio can now be directly computed from the values of resistances.

In the actual survey work three electrodes are pushed

[*Continued on page 214*]

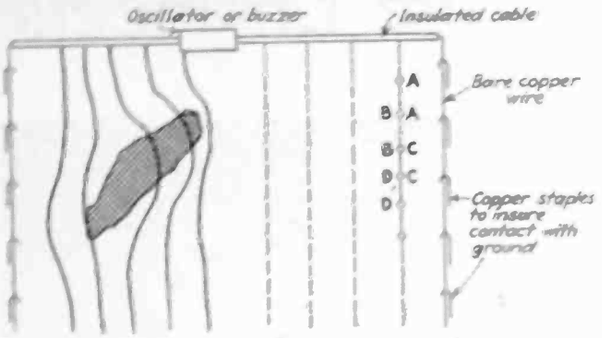


Fig. 1—Location of underground body by equipotential method

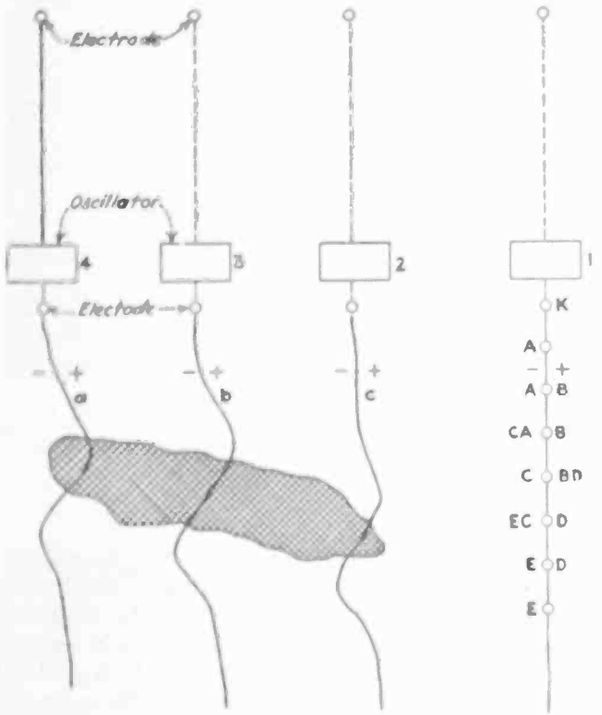


Fig. 2—Potential ratio method of prospecting electrically

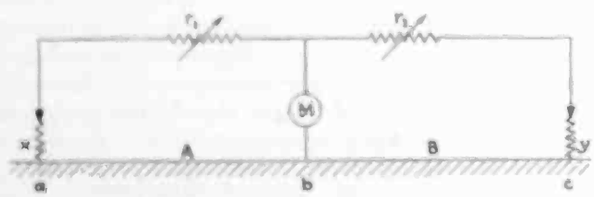


Fig. 3—Compensation for contact resistance in potential ratio method

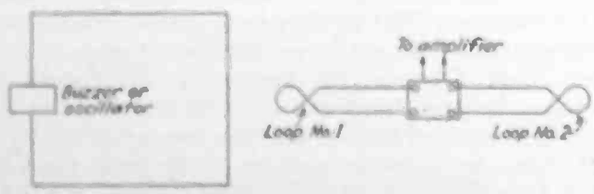


Fig. 4—Diagram of electromagnetic ratio method

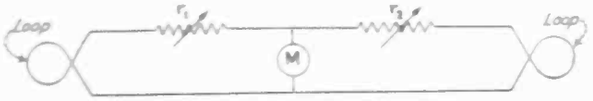


Fig. 5—Disposition of the two loops and balancing instrument

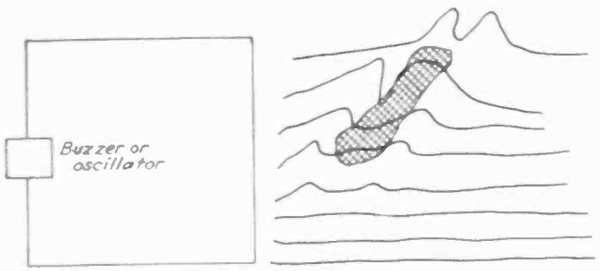


Fig. 6—Appearance of lines in electromagnetic ratio method

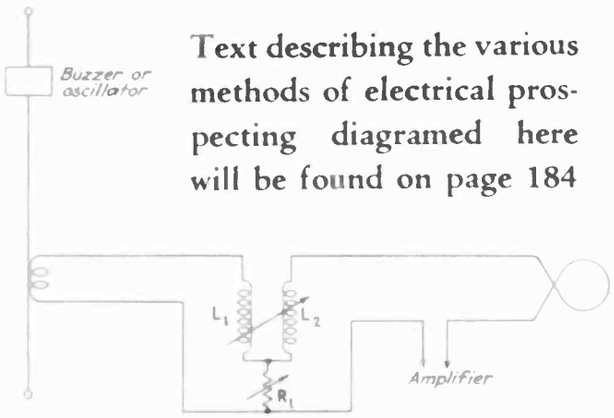


Fig. 7—Electromagnetic compensation method

Text describing the various methods of electrical prospecting diagramed here will be found on page 184

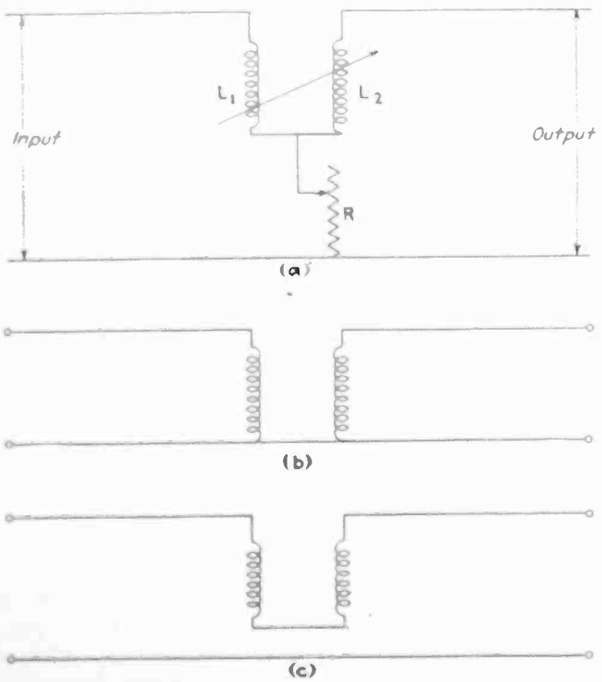


Fig. 8—Fundamental diagram of the phase balancer

Society of Motion Picture Engineers discuss current problems

THE fall meeting of the Society of Motion Picture Engineers, held at Swampscott, Mass., Oct. 5-8 inclusive, brought out many papers, covering the latest advances and changes in the industry during the past months. New officers of the society elected for the coming year, include Dr. Alfred N. Goldsmith, president; E. I. Sponable, vice-president, while J. H. Kurlander was re-elected secretary, and H. T. Cowling, treasurer.

Some of the high points of the papers presented at this meeting are summarized below—

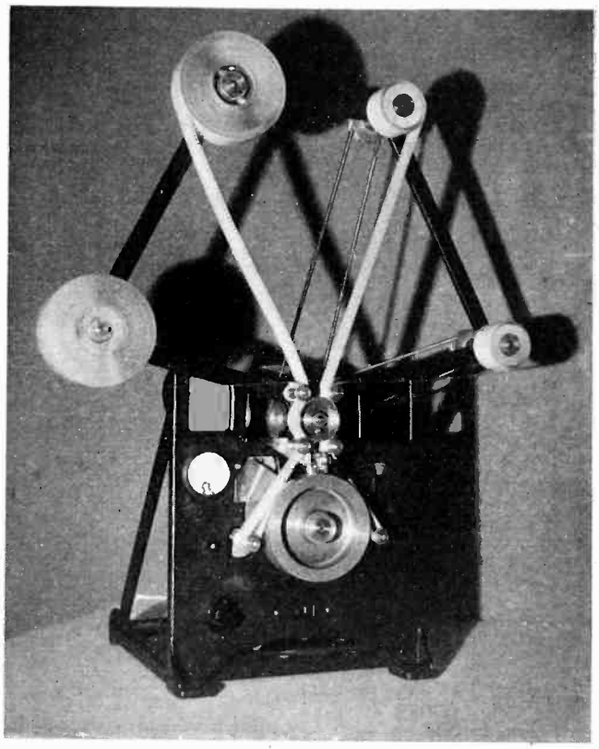
In the paper by C. J. North and N. D. Golden, chief and assistant chief of the Motion Picture Division, Bureau of Foreign and Domestic Commerce, Washington, D. C., on "The European Film Market," Mr. Golden stated that competition from European sound film producers is rapidly decreasing American screen play dates, which in the silent days were dominated by American product.

European producers will offer some 450 feature pictures during 1931. Leading producing countries are Germany, offering over 150 German dialogue pictures, England some 140 sound features and France over 100 French dialogue films for the year 1931. Europe is rapidly wiring its theaters as indicated in the 10,400 wired theaters during 1931 as against the 4,950 theaters wired during 1930, over 100 per cent increase in the short space of one year.

Elimination of legislation detrimental to American interests took place in France during 1931 and a somewhat tightening-up of quota legislation was continued in Germany. Agitation to increase the quota percentage to 50 per cent in the United Kingdom gained very little headway, while other countries which have become picture conscious are trying to encourage their own production through subsidiaries, contingents or taxes as the case may be. Coupled with the problem of European production competition and the artificial trade barriers set up by European governments, is that of supplying European countries with dialogue pictures in their native tongue.

Thermionic tubes in theater lighting

The development of thermionic tubes has opened an entirely new field in the control of theater lighting according to Burt S. Burke of the Westinghouse Electric and Manufacturing Co. This development has made possible the obtaining of pre-set dimming, proportional dimming and a small compact switchboard such as has been heretofore impossible. The pre-set dimming feature allows an operation whereby a board may be set up for any desired number of effects in advance, so that those effects may be called for at the will of the operator by operating a single control. This feature might be termed an ability of the switchboard to learn effects and bring them out when called upon by its master, the operator.



Sound-printer designed by J. S. Watson and R. V. Wood which automatically compensates for film shrinkage and reduces high-frequency losses

Proportional dimming, a new feature, allows the lights to be controlled in a manner so that they may be dimmed out in combinations and obtain the same color tone throughout the dimming process. The third desirable feature is that a small compact control board may be arranged so that it can be placed as desired in the orchestra pit, or some similar location so that the operator becomes a light-artist, taking his place in the performance along with the organist or other artists.

Acoustics of large auditoriums

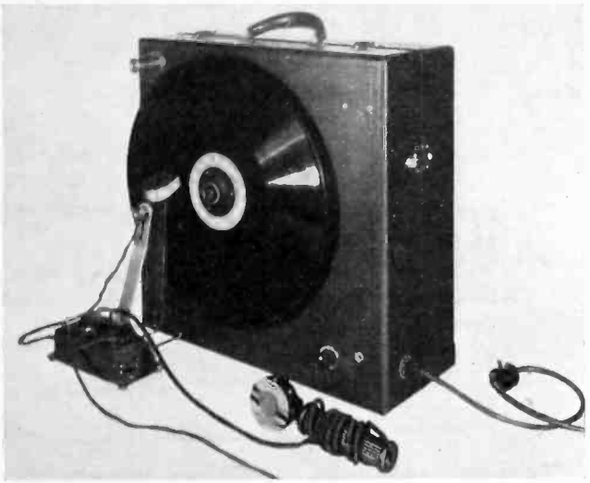
In a paper by S. K. Wolf of Electrical Research Products, Inc. the conclusion was reached that, extremely large auditoriums present acoustic difficulties which do not readily yield to the customary methods of analysis and correction. This is illustrated by measurements of reverberation time made in Madison Square Garden, New York City, which revealed a considerable discrepancy betwen theoretical expectations and the times actually measured throughout the frequency range. At 500 cycles, for example, analysis of the auditorium indicated a decay period of 35.5 seconds, where at the time actually measured by the spark chronograph reverberation meter was only 7.65 seconds.

On the basis of the measured time, 47,000 sq.ft. of

1-inch rock wool was installed. This material was distributed in a manner calculated to suppress undesirable discrete reflections as well as to reduce the general reverberation time. The result was a reduction in the measured time to 3.50 seconds and the complete elimination of acoustic difficulties. Present reverberation formulae do not possess sufficient generality to justify application to enclosures which are extremely typical in size or shape. Until such formulae are developed, reliance must be placed on actual measurements.

Vertical cut sound records

Recent fundamental advances in the method of cutting waxes was covered in a paper on "Vertical Sound Records" by H. A. Frederick of the Bell Telephone Laboratories. Both theoretical and experimental investigations indicate that a phonograph record cut with vertical undulations instead of the more usual lateral undulations possesses fundamental advantages. The principal improvement comes from a marked increase in the volume and frequency range over which faithful reproduction may be obtained. A higher volume level can be recorded for the same groove spacing and speed. More playing time can be provided with a given size



Animatophone 16 mm. sound projector with vertical record and tone-arm which operates on the pendulum principle

record and volume level since, for these conditions, both the groove spacing and speed may be reduced.

Improvements in methods of processing the stampers and in the record material give a large reduction in surface noise and hence a corresponding increase in the volume range. With these improvements the frequency range which can be satisfactorily reproduced can be extended nearly an octave to 8,000 or 10,000 cycles. Other improvements incidental of the improvements noted above include improvement in the quality of reproduction obtainable directly from a soft "wax" record and a great extension in the life of the hard record.

In the demonstration following the presentation of this paper, sample records were played with a low-pass filter system for cutting out frequencies in steps from 3,500 to 11,000 cycles. The fidelity of music and speech was greatly improved with the new records.

Stereoscopic moving pictures

The problem of projecting motion pictures in relief was presented in a paper by Dr. Herbert E. Ives. The essential conditions for producing pictures in stereoscopic relief are two: First, separate pictures must be made from different points of view, corresponding to the two eyes; second, each eye of the observer must receive its appropriate view. No compromise with these fundamental requirements appears possible.

If stereoscopic projection is to be achieved in such a form that a large group of observers may simultaneously see the projected picture in relief, the distribution of the appropriate views to the two eyes must be accomplished for each observer. There are just two places where the distribution may be made; the first is at the observers' eyes; the second is at the screen on which the picture is projected.

If the first method is employed, two separate images must be provided on the screen, and every observer must have means for directing one image to the right eye and one to the left eye. Such means comprise special spectacles equipped with deflecting mirrors or prisms, spectacles equipped with polarizing prisms, spectacles equipped with glasses of complementary colors, or spectacles carrying sector discs operated by synchronous motors. In each case the two images upon the screen must be differentiated in the correspondingly appropriate manner, that is, they must be projected side by side, they must be projected with light polarized in two planes, with colored lights, or alternately.

It appears that from the theoretical standpoint that the problem of relief projection is entirely solvable, and experimental tests of still picture projection have been successfully made. Practically the solution of relief projection of motion pictures will depend upon the use of apparatus involving excessive speeds of operation, great multiplicity of taking or projecting units, projection screens containing minute ridged reflecting or refracting elements of extreme optical perfection, projection lenses of extraordinary defining power, microscopic accuracy of film positioning and photographic emulsions of speeds at present unknown.

Continuous motion picture projector

A principle of motion picture projection without a shutter and with the film moving continuously through the projector was described by H. E. Edgerton of the Massachusetts Institute of Technology.

The adaptation of intermittent light using mercury-arc lamps for taking motion pictures was illustrated by examples. There are in general two methods of using the intermittent light. One method is used to take moving pictures where the light is caused to flash for each frame and the film runs at a continuous speed. The second is used to take stroboscopic moving pictures of rapidly moving objects by causing the light frequency to approach the frequency of the motion of the object. Examples of the latter method were demonstrated, these being stroboscopic movies of a crude motion picture claw mechanism operating at 30 f.p.s. and of the surges in the valve springs of a gasoine engine running at 1930 r.p.m.

A new sound-printer

A new sound-printer was described by J. S. Watson, Jr. and R. V. Wood which uses a film movement that automatically compensates for any shrinkage in the negative film. This movement eliminates sprocket noise in the sound print and reduces the high frequency losses. This printer is considered valuable in printing 16 m.m. film where the definition required is three times that of 35 mm. film.

Improvements in cathode-ray tube design

By Dr. V. K. ZWORYKIN*
Westinghouse Research Laboratories

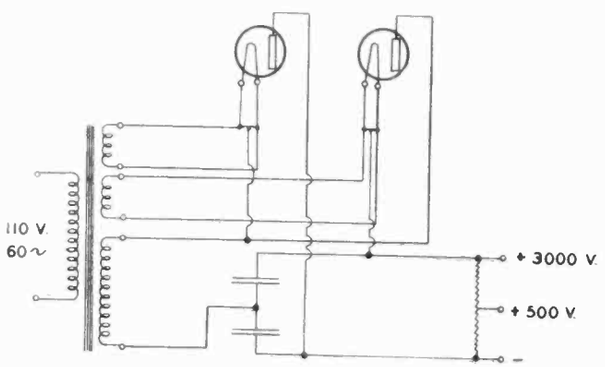
THE application of cathode-ray oscillographs for engineering and scientific purposes has increased very rapidly during recent years. Improvements in design and performance have stimulated the interest of practical engineers in this device. This in turn has enhanced the development of still better oscillographs and a number of various types are now available.

It is convenient to classify the existing oscillographs according to the velocity of the electron beam which is a function of the accelerating voltage. As is known, the electron velocity in centimeters per second is equal to $6.0 \times 10^{-7}\sqrt{E_a}$, where E_a is the accelerating voltage used. This ranges from 90 to 60,000 volts. High voltages are necessary for phenomena of extremely short duration while the low ones are employed when sensitivity of deflection is desired. The sensitivity of deflection is inversely proportional to the square root of the accelerating voltage and is of the order of 1 cm. per volt in the most sensitive types. For photographic recording, the velocity of the electron beam must be high and the sensitivity of deflection is, therefore, sacrificed. When lightning phenomena of a few micro-seconds' duration are photographed, the recording is usually done by letting the electron beam fall directly on the photographic film, often specially sensitized for the purpose. The recording ability of the beam grows with the increase of the voltage, but even at that, potentials as high as 60,000 volts are needed. The necessity of inserting the photographic film inside the oscillograph, where a certain degree of vacuum is required for producing an electron beam, determines the peculiar features of design of commonly used recording oscillographs. As developed by Dufour,[1] Rogowski,[2] Norinder[3] and others, this type is of a demountable metallic construction with a special chamber for convenient insertion of the photographic picture; sometimes, an automatic film reloading device is incorporated. This type necessitates continuous pumping which is usually accomplished by molecular or diffusion type pumps backed up by oil force-pumps.

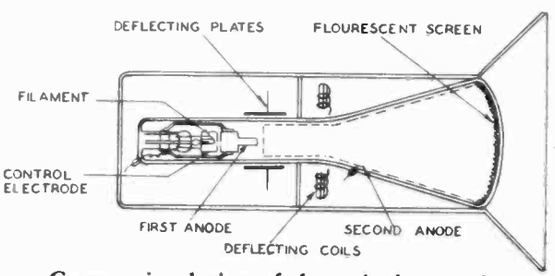
The electron beam is generated by a cold cathode discharge, which requires a definite low pressure of the residual gas. This is obtained usually by pressure control regulated by a special valve. The construction has been highly developed in recent years, but is still inherently complicated and costly. Some simplification is obtained by the use of hot cathodes which eliminates the necessity of a definite low air pressure, requiring on the contrary as high a vacuum as possible. It is true that no extremely high vacuum can be obtained with a demountable construction even with continuous pumping, 10^{-4} mm. mercury is probably the limit. The life of the hot cathode, therefore, in these assemblies is quite limited. The oscillographs of Wood[4] for medium voltage and Rogowski[5] and George[6] for high voltages are representative of this class.

There are many instances, however, where the use of the complicated demountable oscillograph is inconvenient. The Western Electric Company's simple sealed-off oscillograph can be advantageously employed under such conditions.[7] This oscillograph, however, is of a low voltage type due to the pressure or argon gas which is used for focusing purposes. It is normally operated at 350 volts, which means that the amount of light emitted by the fluorescent screen under the electron beam bombardment is very limited. The oscillograph is very useful for observation of repeating or low frequency phenomena.

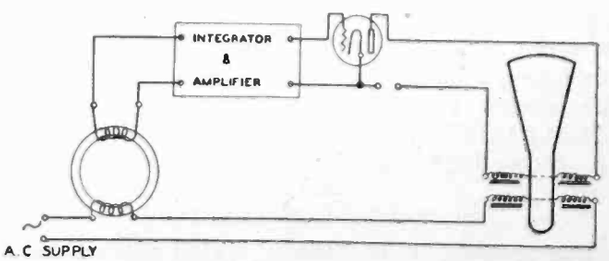
The new oscillograph, described in this paper, was developed to fill the gap between the two mentioned



Arrangement of circuits for supplying necessary voltages for operating oscillograph from a.c. mains



Cross-sectional view of the cathode-ray tube showing detail assembly



Elementary circuit adapted for the cathode tube used for hysteresiograph

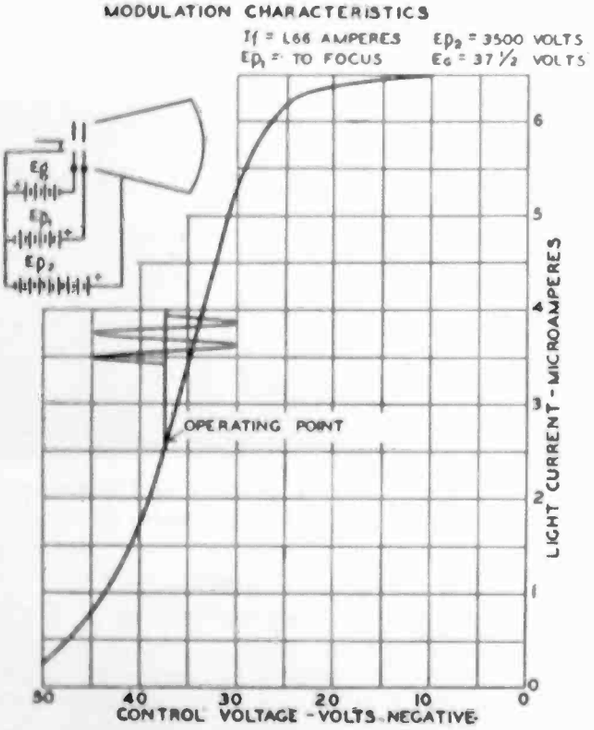
*Now with the RCA Victor Company, Inc., Camden, N. J.

types. It was decided to develop an oscillograph of a vacuum sealed-off type, giving an image sufficiently bright for observation of high frequency phenomena and also, in some cases, for photographic recording.

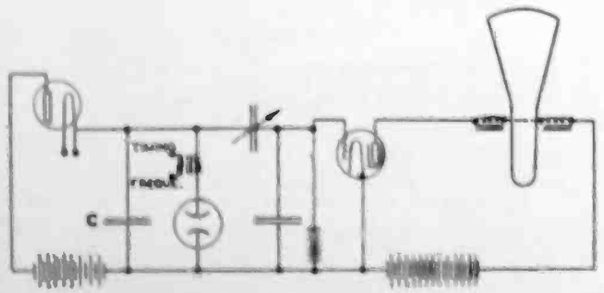
Method of assembly

The oscillograph has a hot filament as a source of electronic emission. The filament is of the indirectly heated type, permitting operation on a.c. supply. Interference of the magnetic field, caused by the filament supply current, with the electron beam is also avoided by special construction. A coiled tungsten filament is mounted within a nickel sleeve having a cup-shaped depression on one end. This depression is coated with barium-strontium oxide as in the case of ordinary radio-tube filaments. The cathode is almost completely enclosed in a cylindrical control electrode, the emitting end of the cathode being located just opposite a small hole in the face of the control element. Co-axial with this element and separated from it by a short gap, another cylinder is mounted. This is closed on both ends, holes being provided in line with the hole of the control element.

All these three elements are assembled on a single



Modulation characteristics of the tube with operating voltage limits indicated



Circuit for linear time coordinate to observe repeating phenomena

THIS is the first paper describing a new type of cathode-ray oscillograph developed by Dr. Zworykin. It is of the hot-cathode, high-vacuum type. Focusing of the spot is accomplished electrostatically by means of a double anode structure. A special electrode is provided which gives undistorted control of the intensity of the spot, affording many new applications of the oscillograph, including its use as a television receiver.

▲

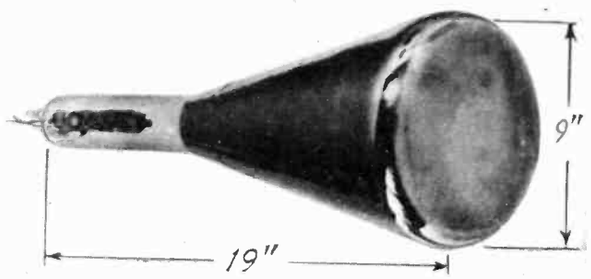
four-wire press as shown in the cross-sectional view. Such an arrangement permits using degasification methods similar to those in production of ordinary radio tubes.

The complete assembly is sealed in a cone-shaped bulb with a narrow neck. The inside of the conical portion and part of the neck is silvered. The silvering is in electrical contact with a lead-in wire sealed inside of the cone. The base of the cone, approximately seven inches in diameter, is internally coated with a fluorescent screen made of wellemite. In order that an electric charge does not accumulate on this screen and repel the electron beam, the fluorescent coating is made slightly conductive and electrically connected to the silvering. The whole interior of the bulb presents, therefore, almost a completely enclosed conductive surface which serves as a second anode.

Operating voltages 500 to 15,000

This second anode gives a final acceleration to the electron beam and at the same time focuses the beam into a small spot on the fluorescent screen. The focusing is accomplished apparently by an interaction of the electrostatic field between the first and second anode and the magnetic field of the electrons in motion. The focusing is very positive and can be simply controlled by adjusting the ratio between the potentials of the first and second anode. The focusing does not depend on the presence of residual gas and is better for higher vacuum. By changing slightly the ratio between first and second anode potential it is possible to make the point of concentration of the beam closer or farther from the first anode. The actual focusing is obtained by bringing this point to coincide with the surface of the fluorescent screen.

The whole arrangement is very flexible, permitting the use of the oscillograph with a very wide range of voltages, say from 500 to 15,000 volts, depending on the requirements. For instance, under the conditions of television application, the second anode potential has been chosen as +2,000 volts, the first anode potential about +400 volts, while the control electrode is at —45 volts. The normal filament current is 1.6 ampere at 2 volts. Applying varying potential to the control electrode, the second anode current can be changed and consequently the intensity of the fluorescent spot can be controlled. The characteristic curve of the control for the potentials given above is shown in the curve indi-



Complete tube with overall dimensions indicated

cating voltage vs. light current in microamperes. Since the controlling potential is very small when compared with that of the second anode, the control of the intensity does not affect the deflection of the beam. This accounts for the successful use of the tube for reception of television pictures without distortion, even for strong contrasts of intensities.

The cathode ray tubes described are usually not provided with deflection plates, but are operated by magnetic fields. The deflecting fields are applied close to the first anode where the velocity of electrons is comparatively low. This makes the tube quite sensitive for deflection. However, when magnetic deflection is impossible, electrostatic deflection, by means of deflecting plates, may be used.

By a proper dimensioning and spacing of electrodes, the efficiency of the cathode ray beam at the screen is made quite high and the spot is very brilliant. Observation of low frequency phenomena such as hysteresis loops, power phase distortion, circuit-breaker functioning, voice modulation, etc., can be done in a normally illuminated room without precaution of darkening. Photographic recording by means of an outside still or moving picture camera is also possible in many cases. A particularly convenient method of recording is to place the photographic film on the outside surface of the screen. Since the glass wall is very thin (about $\frac{1}{16}$ in.), the recording is almost as good as taken with the photographic film inside of the oscillograph. Biasing of the control electrode provides a simple means of timing the exposure and obviates fogging of the film.

Possible applications of the tube

A convenient arrangement for supplying all the necessary voltages for operating the oscillograph from a.c. mains is shown in a separate diagram. Possible applications of the cathode ray oscillograph will be mentioned under three characteristic groups.

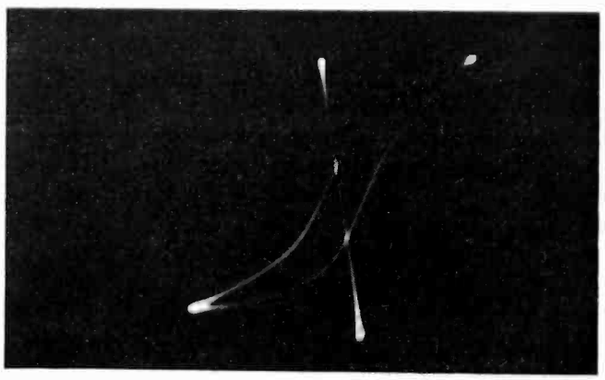
A. Observation and recording of repeating phenomena.

The study of magnetic properties of metals is an excellent example of this group. A very illuminating article by Johnson[10] gives a description of the Braun Tube Hysteresiograph. The elementary circuit adapted for this tube is shown in another view. A permanent record of the hysteresis loop can be made very easily with an outside camera with short exposure. Still shorter exposure is required when using a photographic film directly on the glass of the screen as mentioned above. The study of hysteresis by this method can be done at practically any frequency. A sample of photographic recording of a hysteresis loop by means of an outside camera is shown in a separate cut. Some of the repeating phenomena require the deflection of the beam with constant speed in order to provide a time coordinate. A circuit very well suited for this purpose is shown in an accompanying diagram. A condenser *C* is charged through a current-limiting device, such as a two-electrode tube operating beyond saturation voltage. Its charge therefore increases linearly with time, and resulting potential is applied through a voltage dividing arrangement to the screen of a screen-grid tube. The plate current of this tube supplies the timing current to the deflecting coils of the oscillograph. To provide for the intermittent return to the origin of coordinates, there is a glow tube across the condenser *C* which is discharged when a controlling impulse is applied through a transformer in series with the tube.

With such an arrangement quite a large variety of phenomena can be observed and recorded. A gas engine indicator with a cathode ray tube is such an application.[11] Here the gas pressures are converted into deflecting voltages by means of a carbon pile and a linear amplifier. Study of vibration phenomena[12] is another illustration.

B. Observation and recording of continuous phenomena.

The study of distortion in audio-frequency amplifiers and the phase relations in a.c. circuits are good examples of application in this group. An additional refinement in the conventional circuit employed for this purpose is the use of the time frequency applied to the control element giving exact duration of various parts of observed curves.



Sample of photographic recording of a hysteresis loop obtained by means of an outside camera

C. Observation of transient phenomena.

For such observations, the starting of the beam should be synchronized with the beginning of the phenomena. For this purpose automatic biasing of the control electrode provides an excellent means. Characteristics of lightning arresters have been studied visually even though the duration of the complete cycle was less than 50 microseconds. The second anode potential employed in these observations was only 3,000 volts.

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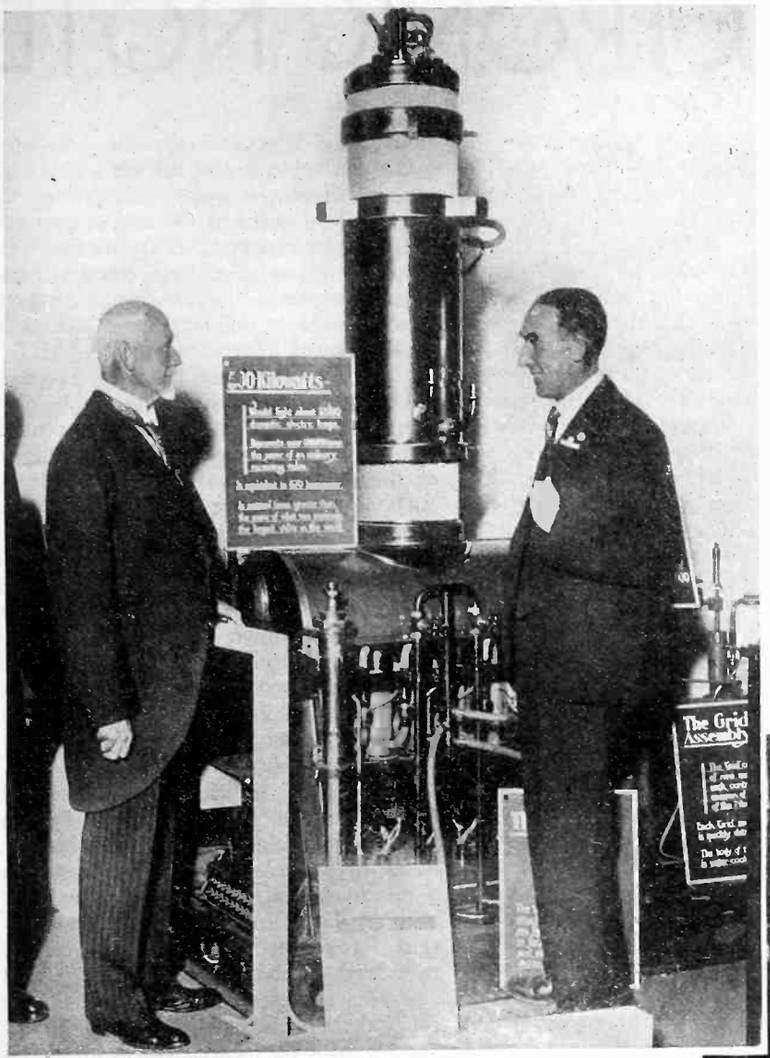
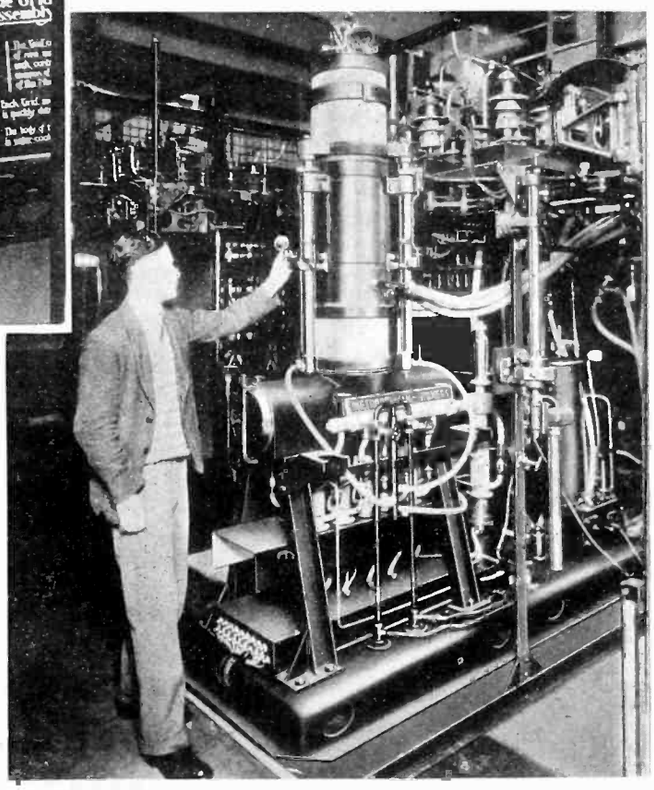
WORLD'S LARGEST TUBE

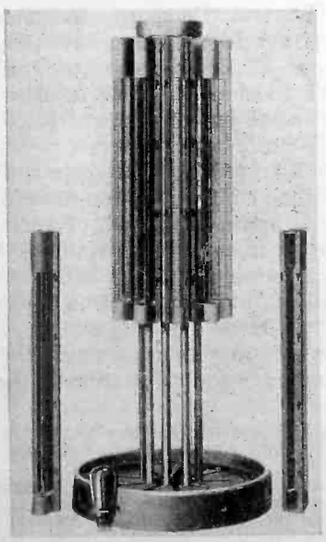
500 KW.

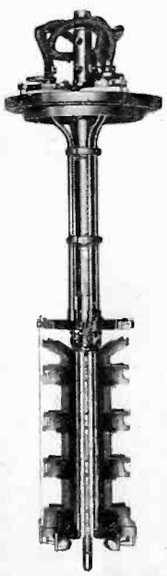


General Jan Smuts (left) and Colonel Vignoles, Electrical Association of London, inspect Metropolitan-Vickers' new continuously-pumped triode to replace a bank of tubes at the Rugby station

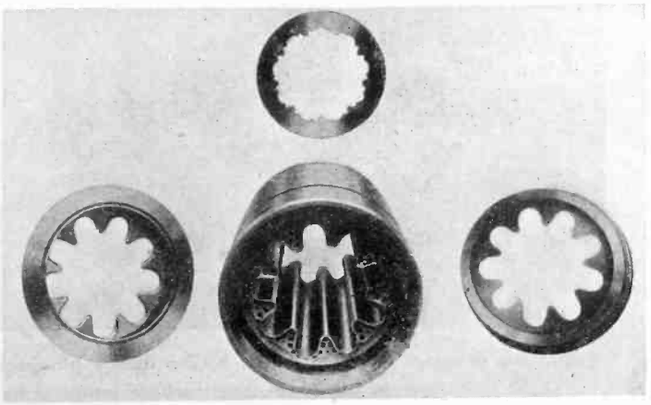


Nine-section water-cooled grid controlling emission from nine filament wires





Support for the nine filament wires requiring 500 amperes of current and emitting 160 amperes



The steel anode at the right accounts for 300 of the 2,000 pounds which this huge electronic tube weighs

+ + + ELECTRONIC NOTES

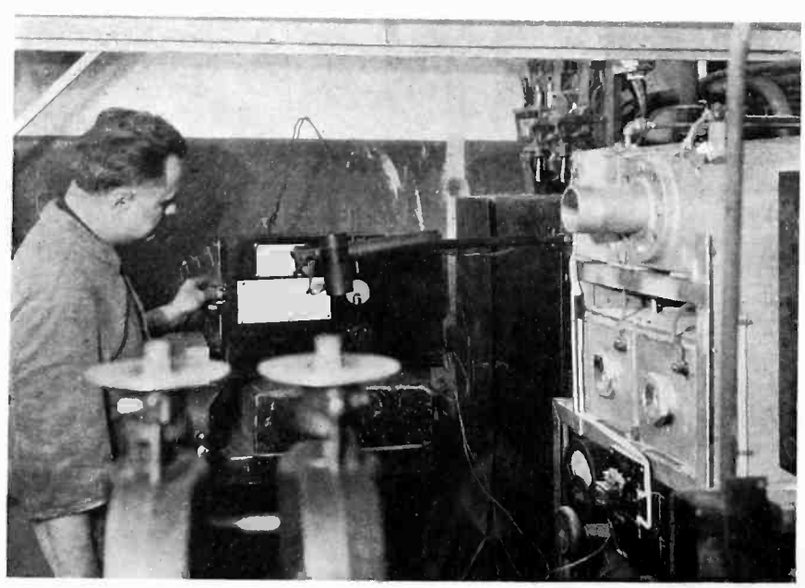
Phototubes control furnace temperatures

IN THE PAST it has been difficult to read the high temperatures required in special furnaces used for industrial and laboratory purposes, and it has been exceedingly difficult to control these furnaces or maintain a set temperature.

At a recent meeting of the American Chemical Society in Buffalo, Dr. L. R. Koller, of the General Electric research laboratory at Schenectady, announced a solution for the problem in using the photoelectric tube to measure the visible energy radiated by the hot body, and thereby its temperature. The photoelectric tube, with a suitable optical system, looks at the furnace wall or some object in the furnace. The current through the tube depends on the amount of light falling upon it, and accordingly varies with the brightness of the surface observed. Since the radiation from a hot body varies much faster than its temperature, the photo current is a very sensitive measure of temperature.

The photoelectric current is amplified by means of vacuum tubes and recorded on a meter calibrated in terms of temperature. The same current operates a Thyratron tube, and the latter acts as an extremely sensitive relay which controls the supply of fuel or electricity to the furnace. The photo tube pyrometer described by Dr. Koller can be used at temperatures as low as 1,000° C., and has no upper limit. It does not deteriorate due to the action of any products in the furnace, nor is any part of the apparatus itself in the furnace. The control mechanism may be varied to suit individual needs, and by the use of two Thyratrons, both upper and lower limits of temperature may be set.

The apparatus includes a long photoelectric tube housing mounted on a hinged bracket which the operator can swing to one side in order to get at the furnace. As much as three or four feet may separate the tube from the furnace proper. The bracket is provided with a worm gear for ease in making adjustments. A small opening in the housing makes it possible to observe a light spot and make sure that it is centered on the diaphragm placed in front of the tube.



Apparatus developed by Dr. L. R. Koller uses a phototube and amplifier system for controlling furnace temperature

✦

Definition of standard reference systems

BY J. K. HILLIARD

IN ORDER TO EVALUATE the order of magnitude of electric power, current or voltage at different points in a circuit used for the transmission of telephonic currents, a comparison system has been established. Before the introduction of the vacuum tube to communication, the reference point chosen was the electrical output of a standard subscriber's telephone set when an average speech energy is impressed upon the diaphragm of the transmitter. Such a point was designated as zero level. The electrical output of the transmitting sub-set used in the Master Reference System[1] has been called zero level.

With the introduction of the vacuum tube and its associated circuits constituting the telephone repeater, it was found desirable to use for zero level, an amount of power which was related to the overload point of the last stage tube used in the repeater. Terminating the plate circuit with a load equal to the plate impedance, it was found that it was possible to deliver into this load a speech power approximately 10 M.S.C.[2] higher than the output of the average subscriber's set without noticeable distortion. A volume indicator was used to measure the speech level at the output of the repeater and it was calibrated in such a manner that a reading of plus 10 M.S.C. on the volume indicator corresponded to a point where the output of the vacuum tube became distorted to the ear. Zero level was then taken as 10 M.S.C. down from this power.

When the decibel was adopted as the unit of measurement of power, reference volume was substituted for zero level which was an ambiguous term and should not be used.

The volume indicator which is used in the measurement of power in speech circuits is a high impedance voltmeter designed to measure the power level in a circuit having a 500-ohm impedance without disturbing the voltage and current relationship in the circuit measured. Reference volume as defined above is indicated when the needle of the galvanometer swings up to 30 divisions with fluctuating levels of speech and music at approximately the rate of once every ten seconds, provided the dial switch and key are on zero.

The actual sine wave power of a single frequency required to give noticeable overload in the circuit described above is 60 milliwatts. A power 10 db. down from this value is then 6 milliwatts which is known as reference power level. This reference power level of 6 milliwatts is then the basis of calibration of a power level indicator. The volume indicator as made by the Western Electric Company indicates reference power level at approximately —2.5 db. or 22 divisions of the full scale of 60 divisions. Power level indicators as made by the General Radio Company indicate this reference power level at the zero point on the scale with the tap on the artificial line set on zero. The scale is figured in terms of r.m.s. values rather than average values of the rectified output so that it will compare with a.c. instruments which are calibrated in terms as r.m.s. values. Hence it is necessary to use a single frequency sine wave for calibration if the

[1]Master Reference System For Telephone Transmission, *Bell System Technical Journal*, July, 1929.

[2]Abbreviation for Miles of Standard Cable. One M.S.C. equals approx. .95 decibel. For reference see K. S. Johnson, *Transmission Circuits*, Chapter 2, page 12.

instrument is to read r.m.s. values correctly. For any other wave form the error will be in accordance with the deviation from a true sine wave.

The method used to check the calibration of these instruments is given in the February issue of *Electronics*, pages 506-507.

A standard testing power of one milliwatt is used in transmission measurements in circuits where the volume indicator is not used. The equipment used is known as a transmission measurement set. This value of power was chosen primarily because it was sufficiently low to preclude the possibility of overloading circuits and equipment and yet high enough to allow for accurate measurements above the noise level of the circuit. This testing power is —7.7 db. from 6 milliwatts so that reference power level is higher than standard testing power by 7.7 db.

The unit of noise which is used to evaluate noise in terms of the interfering power of 1,000 cycle tons is defined as follows:

Noise level in decibels with respect to standard testing power (.001 watt)

$$= -20 \log_{10} \frac{N.U.}{10^6}$$

where *N.U.* is the number of noise units as measured with the standard noise shunt and associated equipment. Roughly, one million noise units is equal in interfering power to .001 watt at 1,00 cycles per second.

✦

Manufacturing spray shield tubes

By Robert O. Lewis*

The use and construction of spray-shield tubes while originally a European development, is now being introduced in this country by the Grigsby-Grunow Company.

Present high gain radio amplifying circuits must be shielded against electrostatic and electromagnetic fields. Inasmuch as the tubes themselves are integral parts of the circuits, they should be so constructed as to be impervious to the effects of surrounding conditions. This is particularly true when it becomes apparent that the tubes themselves can carry the necessary shielding, without the necessity of building super structures around them, which cost more than a shield carried by the tube.

The necessity of building a separate shield economically, limits the location of the tube on the chassis and complicates the design of the receiver, often increasing the number of by-pass condensers, decoupling resistors, choke coils, etc.

Spraying operation during the manufacture of spray shield tubes in the plant of Grigsby-Grunow Company. The machine is automatic and uses zinc wire for making metal spray

The use of spray shield tubes was suggested by R. M. Arnold, chief engineer of the Radio Receiver Division as an economical means of producing a high gain, selective radio receiver, and development work in the laboratory has borne out his belief. In most cases the use of external shielding has been done away with and the over-all results are quite satisfactory.

The process involved in the spraying operation involves sand blasting the bulb, then spraying the metal on the bulb by means of a metal spraying process. A wire is connected to the cathode terminal and pulled out between the bulb and the base in such manner that the spray shield makes contact to the wire. In this manner the shield is connected to the cathode terminal of the tube.

An automatic machine is provided for sand blasting the tubes. After sand-blasting the tubes are ready for spraying. The accompanying illustration shows the spraying operation. The machine is automatic, it being necessary only to supply it with acetylene, oxygen, air and metal in the form of zinc wire. The adjustments, however, must be made with great care in order that the metal shall have the proper adhesive qualities as well as appearance. The spray head oscillates along a vertical line as the tube rotates about its own axis. The table rotates and indexes the tubes in the proper position.

During the sand blast and spraying operations the tubes are capped and inserted in holders to protect the parts which are not to be sprayed.

The effect of the spray shield on the tube characteristics are as follows:

1. The tube input capacity increases 1.2 micro-microfarads.
2. The output capacity increases 0.75 microfarad.
3. The grid-plate capacity is slightly decreased.
4. The other electrical characteristics are practically unaffected.
5. The tube operates at a lower temperature than it does when enclosed in an external shield.

*Chief Research Engineer, Grigsby-Grunow Company.

✦

Vacuum tube microvolt meter

By E. Woehlisch.

For measuring small amounts of heat, for instance, the heat set free when a muscle works, the most sensitive and at the same time quick-acting voltmeters are required. The current given by the thermocouple put in contact with the muscle is very weak and changes irregularly; the potentials are of the order of one-tenth microvolt. But by interrupting regularly, one hundred times per sec. say, the currents flowing from the thermocouple, it is possible to amplify them by means of a familiar tuned audio-frequency one stage amplifier using high permeability transformers. It is thus possible to increase the sensitivity from 30 division per microvolt to 200 divisions and to use a meter with a natural period of 1/100 sec. instead of 7 sec. (*Zeitschr. fuer Instrumentenkunde*, June 1931).

Light-sensitive relays now on the market

INDUSTRY, at last, seems to be making the discovery that a beam of light, in itself requiring no power, and no space for its location when not in service, can be made to control machinery consuming vast quantities of power and housed in considerable space, or instead of controlling power, this same light beam can be used economically to save power by turning off illumination at predetermined conditions of natural light.

New manufacturers of light-sensitive equipment entering the field, and increased interest on the part of general industry in apparatus already on the market are indications of the increasing consciousness of the engineering public that a new medium of control and a new machine for economy is at hand, a beam of light and a light-sensitive relay.

Newcomers to the field are Allen-Bradley of Milwaukee who have engineered a light-sensitive relay in which a phototube under stimulation of incident light disturbs a balanced circuit so that glow tubes, normally passing no current, operate a relay. Struthers Dunn of Philadelphia has announced a light sensitive relay in which the phototube output is connected to a triode in whose plate circuit is the relay. Burgess has recently developed a selenium bridge unit for industrial purposes. Weston has put on the market a dry form of photovoltaic cell which developes considerable current under the action of light. In full daylight about five milliamperes are available in a fairly low resistance circuit. The cell develops about one microampere for each foot-candle of incident illumination without the necessity of batteries. The possibility of an illumination meter and of exposure meter is evident, and such products will undoubtedly be added to the Weston line of measuring equipment.

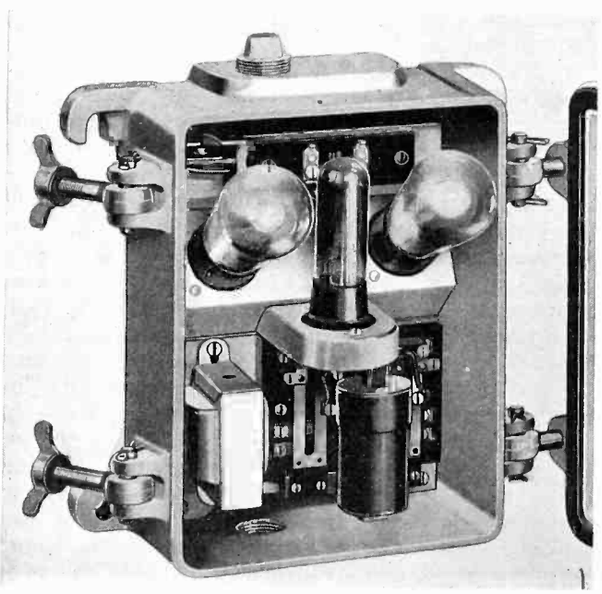
Light-sensitive equipment has been on the market for some time from several other manufacturers, notably G-M Laboratories, Chicago.

Photocell apparatus

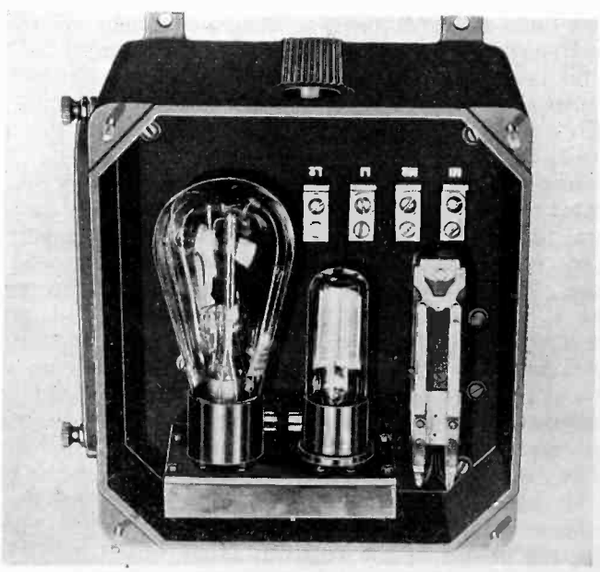
Light-sensitive relays consists of the phototube, or other light-sensitive element whose output voltage or current changes. This change is used to control the plate current of a triode, or to trigger off a glow tube, or to disturb a balanced circuit; or in the case of the photovoltaic cells, to release a certain amount of current which may be sufficient to operate a sensitive relay. The photoelectric effect is one of voltage change, the photovoltaic is a current effect. The latter are low impedance devices, the former are high impedance units. Phototubes must not be at any great distance from the circuit they control. On the other hand, the photovoltaic cell can be at considerable distance from the controlled circuit whether an amplifier tube, or a directly operated relay.

The quantity of power a light sensitive relay can control is usually small because of the limited size of the relay the vacuum tube or photovoltaic cell can control. This relay, however, can control another relay which in turn will control any given amount of power either directly or through intermediary relays.

The work which such units will do, while obvious to electronic engineers, is only recently becoming apparent to industrial people. When it has been demonstrated, however, that what was once laboratory or "stunt" equip-



Allen-Bradley equipment in which phototube controls glow tubes



Westinghouse relay for the control of illumination or industrial processes

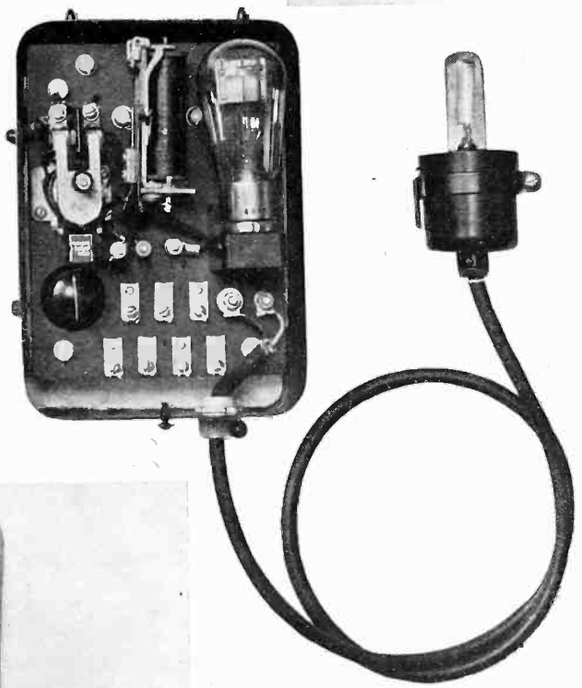
ment can be used to control the massive apparatus with which mechanical engineers are familiar, the phototube and accessory apparatus finds ready acceptance.

Counting operations and illumination control are perhaps the simplest applications of the light sensitive unit. Control of the intensity of illumination by photoelectric apparatus is more complicated but equipment is ready for introduction for this purpose now. Delay circuits have been arranged to prevent on-and-off illumination control units from being affected by momentary changes in light intensity. Such delay features may be brought about by biasing the phototube with a small permanently burning lamp or by electrical circuits.

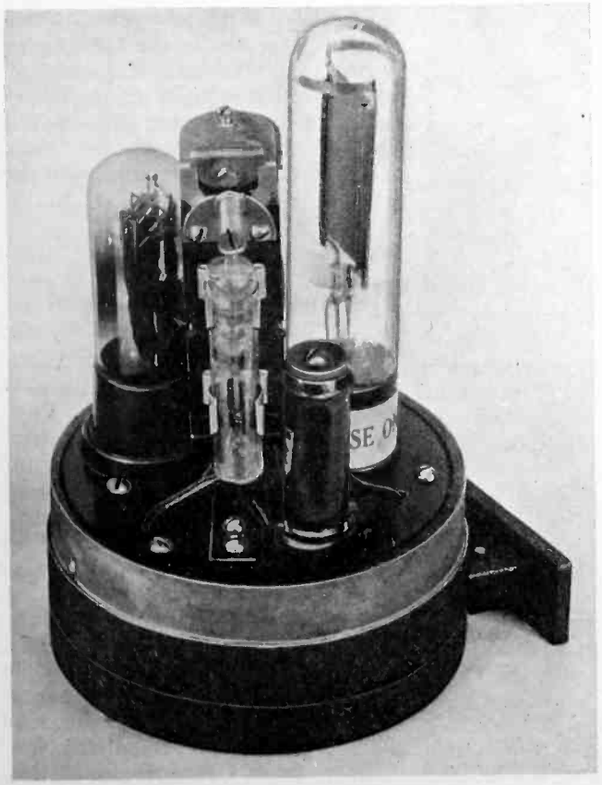
Such devices will provide automatic control of lights in office buildings, schools, and show windows, as well as street lighting, floodlighting, airport lighting and navigation lighting installations. In typical installations it has been found that one-half of the power ordinarily used has been saved by automatically turning off the signs, or other illumination, when natural light reached the proper value, or by means of a time switch.

The cost of light-sensitive units varies from around $30 to $100 or more. Sources of light by which to operate the units through interrupting the beam in counting operations, for example, are available from the manufacturers of the relay equipment. In some cases the photocell equipment also contains the source of light producing a beam which is reflected back to the phototube from a mirror at a distance. The counting operation, or other control function, is effected by interrupting either the projected or the reflected beam of light. In other cases the operation consists in projecting a beam of light, from a separate light source, into the light-sensitive cell some distance away. This beam is interrupted by the objects to be counted.

In the Struthers Dunn relay shown above the phototube is located at the lower center



The General Electric unit has a portable phototube making it possible to house the relay and amplifier tube at some distance from the operation under control



Burgess selenium bridge, triode and relay apparatus

Apparatus of the type illustrated above is of the self-contained a.c. operated type. Apparatus is available for d.c. operation or for the use of batteries. In the a.c. type the phototube acts as rectifier passing current only when the anode is positive, merely to upset a balanced voltage condition. In all devices of this nature the electrical circuit can be arranged to open or close when a light beam is interrupted. The power taken from the circuit by the devices is extremely small compared to the power they will control. For example the G-M Laboratories relay will open or close 0.5 ampere at 110 volts or by means of a mercury contact switch the light sensitive relay will handle 20 amperes at 110 volts or 10 amperes at 220. Time delay relays are available which delay the action for definite periods.

HIGH LIGHTS ON ELECTRONIC

Control of carton wrapping

D. E. LEWELLEN of the Lewellen Manufacturing Company, makers of variable-speed transmissions and other power transmission appliances, Columbus, Ind., has successfully applied photocells to carton-wrapping machines.

The purpose of the photocell control in this case is to position the printed parchment in which the carton is wrapped, in relation to the cutter knife and also in relation to the position of the design of the carton. In other words, since the parchment paper wrapper is printed in a continuous roll, it is necessary to control the feed rolls to compensate for any slippage at the feed rolls and also for stretching or shrinkage of the paper and in addition to this it is necessary to position the wrapper so that the design will be properly spaced on the side of the carton.

✦

Steel bars cut to length by photocell

STEEL BARS, as they leave the rolls, are now cut to proper length with the aid of the photoelectric eye at the Bethlehem Steel Company's plant in Lebanon, Pa.

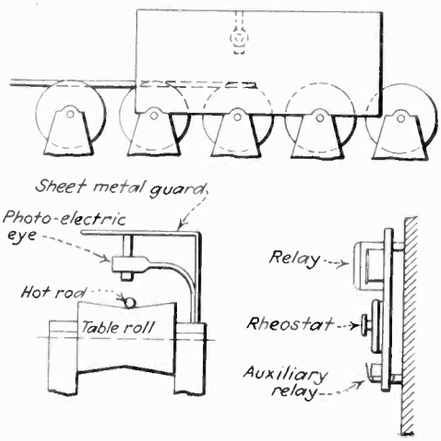
The bar leaves the rolls traveling at a maximum speed of 1,200 feet per minute, or nearly 15 miles an hour. A photoelectric tube, sensitive to very slight changes in light intensity, is located above the patch of the red-hot bar as it moves along the rolls of the "run-out" table. When the end of the hot bar passes under the General Electric tube, the change in light sets up a weak current in the tube. This current, amplified, sets up a chain of operations which are not finished until the bar is cut to length.

When the photoelectric relay is energized, a contactor closes and a 220-volt circuit is established. This circuit closes two larger contactors, one of which starts the motor which drives the cutting shear. By the time this shear is ready to cut, the bar has passed along the rolls the predetermined distance and the cut is made at the right place every time.

The other large contactor, meanwhile, has started another relay working. This relay measures off a predetermined length of time and then closes a circuit to operate another contactor. As a result, a "kick-off" device operates at just the right time to push the bar sideways off the rolls, thus making way for the next bar.

But the cycle is not yet complete. After the bar is removed from the rolls it drops upon a "bed rocking" mechanism whose function is to move the rod slowly sideways, giving it time to cool, until it drops off at the discharge point of the mill.

Once the machine is set, all the bars are cut off at the same length. To change the length of the cut it is merely necessary to move the photoelectric tube to another point above the "run-out" table.



A photo-tube above the red-hot bar, operates relays and a cut-off saw, cutting bars in even lengths

✦

Banks prevent mistakes by stopping noise

BANKS ARE NOT SUPPOSED to make mistakes and one way to stop making them, say acoustical engineers of the Johns-Manville Company of New York City, is to reduce noise. New banking quarters of the City Bank Farmers Trust Company, on Wall Street in New York City, have been equipped with noise-absorbing materials installed on walls and ceilings wherever necessary to deaden the usual office clatter due to voices, telephone bells, typewriters and other noise makers. Thus "there is no more strain on the nervous system of employees," the experts state, and "accuracy is the result."

The effect of quiet offices in lessening the number of mistakes is by no means confined, it is asserted, to the kinds of mistakes caused by imperfect hearing, like telephone conversations misunderstood because of a noisy room. Purely individual mistakes, such as those in filing or bookkeeping, also are fewer in quiet surroundings.

Comparative tests in the Rike-Kumler department store at Dayton, Ohio, also showed, it is said, a reduction of 24.5 per cent in errors when 85 per cent of the noise was stopped. Not only are noisy surroundings distracting to office workers and thus increase carlessness but noise increases strain and fatigue, causing more mistakes. Mistakes cost American businesses billions of dollars every year.

All offices some day will be equipped, acoustic experts predict, with noiseless machinery, noise-proof windows, noise-absorbing walls and ceilings and other devices for quiet,—not as a luxury but as a proven good investment in reducing the cost of blunders.

✦

Iron mine plants use photocell control

HOW THE MONTREAL MINE near Ironwood, Mich., successfully employs photocells to signal the passage of skip hoists, is explained by A. H. Hubbell in a recent issue of *Engineering and Mining Journal*.

The No. 5 shaft house makes use of a photoelectric cell on the headframe members, which signals the hoistman whenever a skip goes into the dump or comes out of it. The skipways are spanned by a beam of light, the ray projector and the receptor being on opposite sides of the shaft, so that one cell serves both skips. Whenever a skip intercepts this beam, a lamp lights up on the hoistman's panel. "This is the second of two applications of the photoelectric cell that I noted recently in the Iron Country," writes Mr. Hubbell, "the other being at an ore-sintering plant in Minnesota, at which one of these cells is used to control the speed of the sintering machine to assure a bed of even depth."

✦

Thermionic tube to heat steel furnace

A THERMIONIC TUBE apparatus is being constructed in Manchester, England, by the Metropolitan-Vickers Electrical Company, for use as source of oscillations in heating a 150-lb. steel-melting furnace in Sheffield. It will be the first of its kind to be used for industrial purposes, and will replace the usual high-frequency generator. It is expected that this installation will be completed in about four months. The tube will operate on the same principle as the 500-kw. continuously evacuated radio tube, the largest of its kind in the world, recently completed for the British Post Office radio station at Rugby.

DEVICES IN INDUSTRY + +

Photocell saves 10 per cent by accurate counting

A NOVEL INSTALLATION of photoelectric relays is in use in the Chicago factory of the Container Corporation of America. This is employed for counting butter cartons. Previously, the company had sold its butter cartons by weight, but owing to the fact that the wax on these butter cartons varied, it was always necessary to allow 10 per cent overweight to make sure that the customers were getting the proper number. The use of a photoelectric cell relay now counts out the exact number and saves the Container Corporation of America considerable money. The equipment used was furnished by the G.M. Laboratories of Chicago.

✦

Machine throws out bad beans

BY B. S. HAVENS

THIS BEAN-SORTING machine, designed by the firm of Hammerslag & Tinkham of Grand Rapids, Mich., in association with the General Electric Company, "looks over" navy beans and throws out all those which do not meet the required standard of whiteness.

Brown or otherwise discolored beans are considered a poor grade. To sort them from the white ones has always been an expensive and unsatisfactory job. Not only are many such beans actually bad but there is also a psychological prejudice against dark beans. As a result the new machine is expected to be of great value to the industry.

By means of the photoelectric tube the machine inspects the beans one by one as they pass on their way to be packed. As long as white beans pass in review, the eye of the machine is unaffected. But the appearance of a dark bean sets up a veritable electronic storm —a relay clicks and a metal finger reaches out, deflects the bean and causes it to drop into a separate container.

In operation, beans to be sorted are fed into a hopper on the machine. Passing under this hopper is a drum with a number of small apertures around its circumference, and with a constant suction drawing air through the holes. Beans are thus picked up by suction and carried around on the edge of the drum. On their way to the sorting eye they pass a mechanical "patter" which adjusts them to the correct position so the electric eye can view them properly.

The viewing chamber in which the electric eye watches the beans is so arranged that intense light falls on each bean as it passes in front of the photoelectric tube. The revolving drum moves in small jumps, pausing a moment between jumps, and thus there is a brief period during which each bean rests in front of the sorting eye without movement, thus preventing any shadows from interfering with the accuracy of the device.

Commercial application of the new device is expected to be made by the Electric Sorting Machine Company, a new corporation formed to introduce the machine to the bean sorting industry. A new elevator will be built near the bean district which will house a battery of two hundred of the photoelectric bean sorters. It is estimated that such a quantity of machines will easily sort at least a carload (approximately 40,000 lb.) of beans a day.

✦

Closed throat opened by short-wave heating

By DR. E. E. FREE

A MAN WHOSE THROAT was opened by radio waves after ordinary surgical methods had failed was reported recently to the Academy of Sciences, in Paris, by the veteran experimenter in this field, Professor J. A. d'Arsonval, as a case treated by Dr. Bordier. The victim had drunk a strong solution of caustic potash or "potash lye." The result was a severe corrosion of the tissues of the throat and esophagus so that the latter tube, connecting the mouth with the stomach, closed up entirely. The surgeon in charge of the case then made an opening directly into the stomach and the patient was kept alive by liquid food supplied through this opening. In this condition, with the esophagus altogether closed so that swallowing was impossible, the patient came to Dr. Bordier. For a period of twenty minutes each day Dr. Bordier passed through the chest at the spot where the esophagus had grown together, powerful currents of high-frequency currents. After four days a tiny passage opened through the obstruction caused by the caustic scar. In a few more days the esophagus opened altogether. The cause of the remarkable cure, Dr. Bordier and Professor d'Arsonval believe, is that local heat created by the radio currents in the part of the esophagus damaged by the caustic liquid, brought much more fresh blood to the parts and aided the absorption of the scar tissue so that the esophagus opened again.

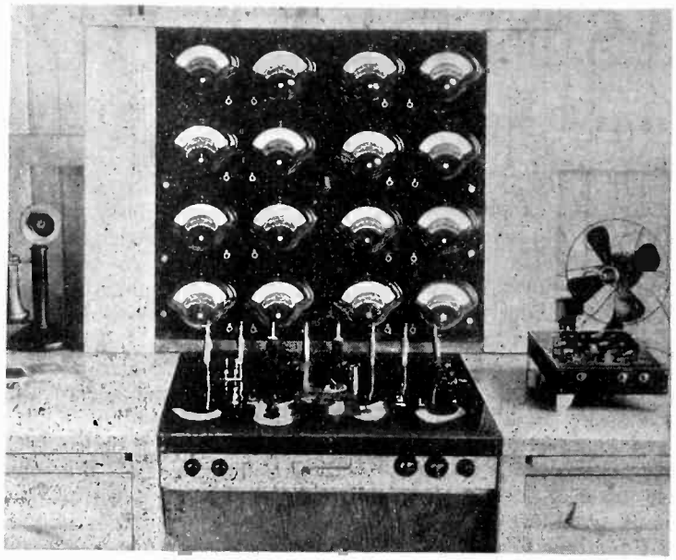
✦ ✦ ✦

ONE OF 200 PHOTOCELL BEAN SORTERS

Two hundred of these photo-electric sorters are to be installed to comb over a carload of beans a day

Universal tube test equipment

By O. H. BREWSTER and KARL F. MAYERS
Engineering Department
Ceco Manufacturing Company



Entire tube test apparatus is installed in a standard office desk making an examination for defects a simple and time-saving procedure

DURING the past year, developments in radio tube design have been of such a nature as to necessitate complete revamping of all test equipment. For laboratory use, it is essential to have available test equipment which can be readily set up to accurately measure all standard types of tubes, and at the same time, the equipment must be so designed as to permit set-ups not ordinarily used in connection with routine characteristic checks. With the above in mind, the authors worked out an extremely flexible board which can be set up for any routine test by plugging in the proper meters and setting the selector switch for the type under test. Moreover, by the use of the unused sections of the selector switch, it will be possible at any future date to re-arrange test circuits to accommodate other conditions which may arise.

The testboard shown in the photograph, is made up of four distinct units, all of which may be easily removed from the main unit.

Power supply and battery charger

Three independent power supply systems are used to supply screen voltage, plate voltage, and grid voltage. The regulation of the plate and screen voltages is obtained by a carbon pile resistor which is a part of the voltage divider system. To obtain maximum voltage with minimum regulation, the new type 280 M mercury vapor rectifier tubes are used in the plate and screen units. Grid bias is supplied by a separate unit and regulation is obtained through a 2,500-ohm potentiometer connected across a section of the voltage divider. An additional resistor is used in series with the potentiometer to act as a vernier adjustment.

Power supply units are built up on one chassis with all leads brought out to a terminal strip. The chassis is mounted directly below the main control panel.

In the compartment on the left of the desk, a complete "A" battery supply is installed. Batteries are constantly being charged while the board is not in use, by means of an 866 mercury vapor rectifier tube which is connected in series with an incandescent lamp to regulate the charging rate. The entire unit is arranged on a steel angle-iron tray so that the complete battery unit may be easily removed for inspection.

On the upper right-hand side of the desk is a compact short-circuit checker and pre-heater. There are six sockets for 5-prong types, and two sockets for 4-prong types. A small single-pole double-throw switch changes the voltage from $2\frac{1}{2}$ to 7 to take care of the preheating of the new automotive series, types 236-7-8. Short circuits are indicated by a series of lights along the front of this unit.

Meter and control panel

All meters, with the exception of the gas meter, are brought out to single circuit jacks located at the side of each meter. The eight meters on the left are volt meters to cover every range from a fraction of one volt to 300 volts. Similarly, the meters on the right cover all current ranges.

The control panel acts simply as a switching unit to set-up various circuit connections. Switching is greatly simplified by the use of a Jewel gang switch which makes it possible to use only two sockets, a four and a five prong, and by means of the switch, set up any connection to the sockets which may be desired.

The anti-capacity switch to the left of the gas meter is used to change the grid polarity from negative to positive, and the anti-capacity switch at the right of the gas meter changes the circuit from emission to plate current and gas test. In order to protect all meters against overload and short-circuited tubes which might carelessly be placed in the socket, a double relay system has been used. The three-knobs on the right-hand side of the main panel regulate the sensitivity of the relays in series with the plate, screen, and emission current circuits.

Cathode to filament short test

For each set-up, the relay sensitivity is adjusted so that the meter will be shorted out the instant full scale deflection is reached.

In addition, series cut-out relays are used in the plate and screen voltage supply lines to disconnect the high

voltage supply when the load exceeds the safe carrying capacity of the power supply.

A rather unique method of detecting a short between the heater wire and the cathode, has been used in this board. The coil of a relay is connected in series with a single flashlight battery, and one side of this circuit is connected to the heater while the other side is connected to the cathode. If a tube is inserted in the socket which has a short from cathode to heater wire, the relay closes, ringing an alarm. This method of testing has been found far superior to visual methods, due to the fact that from the cathode to heater a short is extremely rare, and consequently test operators might carelessly overlook an occasional defect.

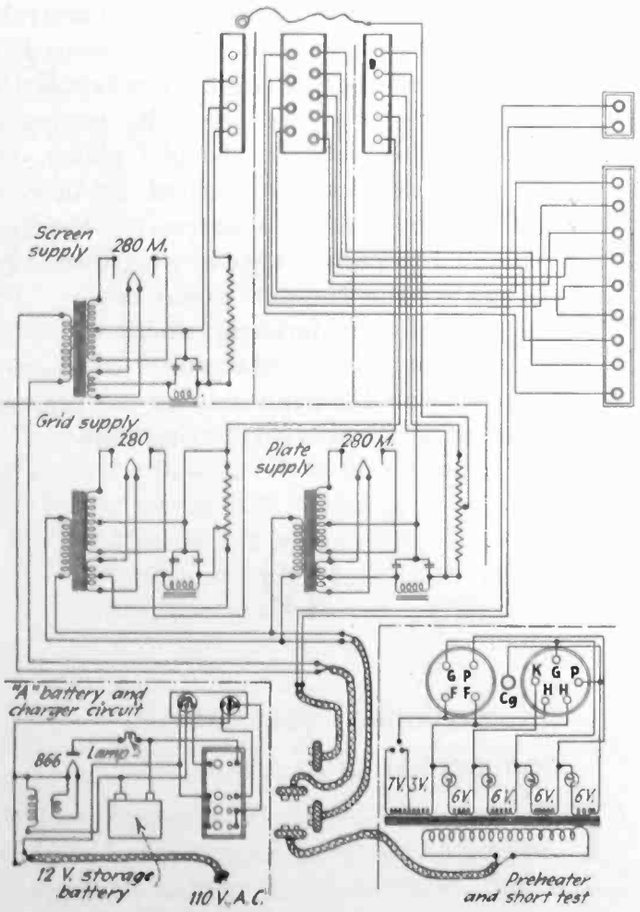
Grid emission and ionization test

To test for grid emission in cathode type tubes, a single-pole snap switch is located alongside the plate current emission switch. When this switch is open, the gas meter will read any current which flows directly from the grid to the plate.

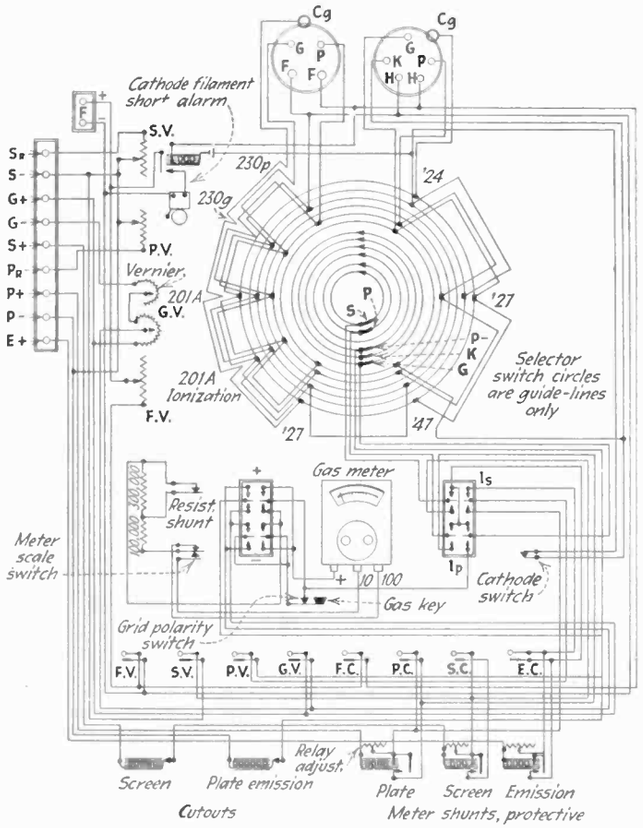
In testing low filament current tubes for emission and gas, the so-called ionization method is superior to the regular emission method. In this test the grid is maintained at a positive potential, and the plate is made negative. A milliammeter in series with the grid measures the emission current, and a micro-ammeter in series with the plate, measure the gas current. All that is necessary to make the ionization test with this equipment is to turn the selector switch to the position marked 201A ionization and apply the desired voltages to the plate and grid of the tube.

Dynamic characteristics

Although this test equipment is designed primarily for static tests, dynamic characteristics may be obtained by plotting a family of curves, and computing from the data so obtained, plate resistance, mutual conductance, amplification factor, undistorted power output, etc.



Power supply equipment for the tube testing board. Leads are brought out to a terminal strip connecting with similar terminals on the testing panel proper



Sixteen meters protected by relays, on the upright panel and a gas current meter in the desk top are controlled by jacks and switches to test all modern tubes

For precision laboratory measurements of all characteristics, the test equipment described in this article used in conjunction with an accurately calibrated dynamic bridge, offers a rapid and efficient method of testing all types of tubes.

The arrangement of the apparatus in an office desk puts all the meters within easy view of the operator; the control jacks and switches can be easily reached. The entire equipment is designed to speed the testing of tubes.

The circuit diagrams shown above give the essential connections of the various pieces of apparatus including power supply system, protective relays for the meters, etc.

Although the ideas set forth in this article are basically fundamental, it is the belief of the authors that the equipment is unique in that it incorporates many ideas heretofore never assembled in a single piece of test equipment.

electronics

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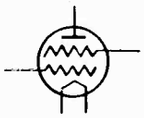


Three little electrons

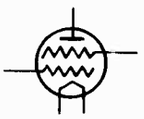
ONCE again the world of business and international finance is wracked as the value of gold changes, and the prices of commodities consequently drift downward. We went through upheavals in 1914, again in 1918 and in 1921.

The world we live in seems forever out of pace with its yardstick, the glittering metal, leaving us all always at odds,—debtors and creditors, employers and employees, buyers and sellers. For always our financial yardstick tends to expand or contract in exactly the opposite direction from that in which the rest of commodities are moving, compounding the instability.

It is as if a carpenter working in a changeable climate were forced to measure and order his building material using a footrule that *contracted with temperature,* while the material itself expanded. The simplest-minded mechanic would, in such a case, at least insist on a footrule that expanded and contracted *with* the material to be measured, not oppositely. Yet this is more than our masters of finance have yet grasped, apparently. And certainly they seem to have ended up to date in just about the same mess as would the builder who used similar measuring methods.

Undoubtedly we shall get out of our present unsettlement of the value of gold. But what will happen when comes that inevitable day when the three extra electrons will be knocked off the lead atom, leaving gold, (for the electronic "solar systems" of the two are identical, except for three little electrons in the outer orbit)? Synthetic gold will then be simply a matter of Lenard-ray tubes and high voltages; its amount merely a question of kilowatt-hours. The world's whole stock of gold today is not large—only a cube 30 feet on a side, no more.

The high priests of international finance may some day have something else to think about, than simply shuffling back and forth the *existing* stock of the world's 79-electron metal.



Counting objects without photocells

PHOTO-SENSITIVE devices have heretofore had the field of counting and detection all to themselves. But Mr. W. C. White of Schenectady suggests the interesting possibility of applying pure electrostatic amplifier apparatus to this purpose, utilizing the new low-grid-current tube, which can indicate current flows down to 10^{-17} amperes and accurately measure to 10^{-15} amperes. (See *Electronics,* Sept. 1930, page 290).

Such a tube can detect the faintest conceivable changes in electrostatic fields. The approach of a slightly charged body at several feet is sufficient to work positive relay contacts. By setting up electrostatic fields between charged plates, and passing the articles to be counted or detected through this "electrostatic gateway," the tube would respond to each change in electrostatic potential, and so the counter would count. The presence of light or darkness would of course have no effect on this non-photoelectric indicator. Its operation would depend only on the presence or passage of electrically-conducting objects.

"Radio knife" goes into commercial production

THE sensation of the 1931 Congress of the American College of Surgeons, at New York last month, was the large number of high-frequency surgical knives exhibited and offered for sale. The aisles of the great exhibit rooms in the new Waldorf-Astoria were studded with demonstrations of beefsteak used to show the many

possibilities of the new "radio-knife" surgery,—for deep cuts and light incisions, for cutting under water and through mucous, for coagulating, and for desiccating malign growths. Inquiry among physicians and surgeons attending the meetings, showed a decided swing toward the new electronic technique, and a willingness to abandon the sharp steel scalpel which has been the surgeon's tool since the dawn of history. Particularly were the doctors impressed with the single-wire method, by which the surgeon's body radiation provides the return circuit.

The high-frequency knives shown ranged in price from $250 to $1500, and are offered in all sizes, from portable units to hospital outfits. It was estimated that 2000 "radio knives" are now in regular use, and that eventually a large proportion of the nation's 150,000 doctors will purchase sets of this kind as regular office equipment.

Country life— with electronic refinements

GATES in bridle-paths have always been troublesome to open and close, for riders on horseback. Either the rider must dismount, or must wheel his horse through awkward gyrations, as he swings the gate open, and then pushes it shut from the other side. But a horse-lover in Greenwich, Conn., has solved all this with the help of a photo-electric cell. When he canters up to the gate, the shadow of his horse operates a relay and motor mechanism, which opens the gate for a few seconds, then automatically closes it again, ten seconds after the shadow is removed. In this way any number of riders coming up, will have the gate held open until the last man has gone through.

Another Greenwich estate owner had trouble with his dogs barking in the night, waking the neighborhood. As the kennels are a little distance from the house, he had his radio dealer install a microphone at his bedside, with amplifiers and loud speakers in the dog-houses. Now, a gentle low admonition from the bedroom, becomes a crisp commanding shout in the canine apartments, and the blooded hounds, hearing their master's unmistakeable voice, cower and quickly subside.

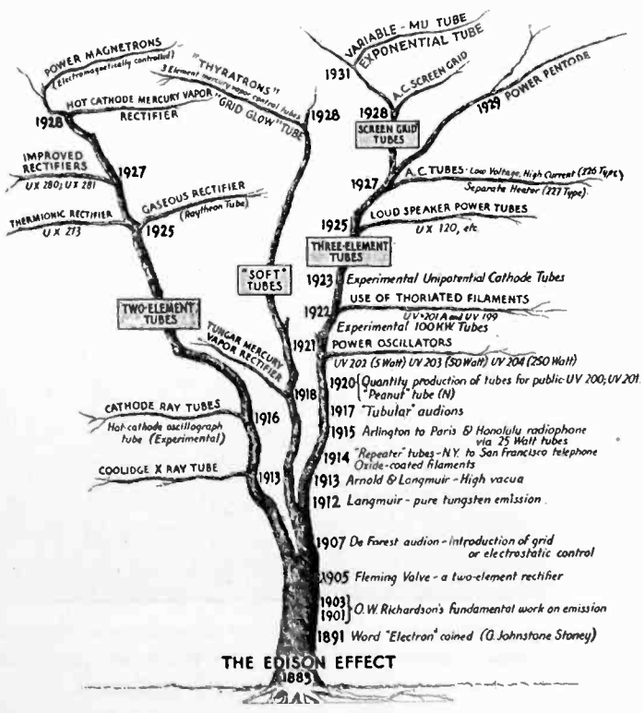
The Wizard's greatest discovery —the Edison Effect

THE greatness of the inventor of the incandescent lamp, the phonograph, the microphone, the moving-picture mechanism and a host of other revolutionary inventions, has been extolled in the press these last few weeks.

Yet Mr. Edison's greatest contribution is still surprisingly little known to the public. It was his discovery of the Edison Effect or flow of electrons from the hot filaments of his early lamps. Indeed the busy young inventor of 1883 even went so far as to build some bulbs with plates alongside the filaments in vacuo, and measured the current which flowed in these pioneer electronic rectifiers.

But too many other interests were pressing him, so the electron-flow bulb was simply "noted" and put aside. Then for twenty years this pregnant principle lay idle and unused, until finally in the early 1900's it was made the basis for the now diversified family of tubes which underly all radio, broadcasting, long-distance telephony, sound pictures, television, rectification and inversion, the hot-filament X-ray, high-frequency surgery, electronic musical instruments, and a myriad of other latter-day devices.

Undoubtedly posterity will rank the discovery of the feeble flow of electrons in vacuo—the Edison Effect—as the most epochal in all the Wizard's eventful career.



The march of the electronic arts

RMA trade show in Chicago next May

PLANS FOR THE 1932 annual convention and trade show of the RMA have been made so that full advantage may be taken by the entire radio industry of the sales increases expected next year from the national presidential campaign. Announcement is made by B. G. Erskine of Emporium, Pa., chairman of the show committee of the RMA, of plans to hold the Seventh Annual Convention and Trade Show of the association at Chicago during the week beginning May 23, 1932. The Stevens and other hotels on Michigan Ave. will again be official headquarters.

✦

General Gibbs now president I. T. T.

RETIRING AS CHIEF of the Army Signal Corps less than four months ago to become vice-president of the International Telephone and Telegraph Company in charge of its telegraph, cable and radio subsidiaries, Maj. Gen. George S. Gibbs, authority on coordinated communicaitons, has been elected president of the Postal Telegraph-Cable Company, succeeding Clarence H. Mackay, who becomes chairman of the board. He will have charge of the various expanding radio services of the I. T. and T., including the Mackay Radio and Telegraph Company.

RADIO A LA CARTE

Guests at the new Waldorf-Astoria may obtain one of these speakers for plugging in the "radio socket" in each room by calling radio service

✦

Higher power broadcasting

INCREASED RADIO SALES in many sections of the country, especially in southern states and metropolitan areas, are expected to follow the decision announced Oct. 1, by the Federal Radio Commission granting greatly increased power to fifteen of the most representative broadcast stations.

When the fifteen new high-power stations are equipped, reception conditions will be improved in many areas, with resulting increases in sales of radio products. It is expected that some sections, notably in the south, where sales have lagged because of poor radio reception, there will be substantial new markets open to the radio industry. The higher power also is expected to greatly reduce interference in metropolitan and other districts and make available the best and improved broadcasting to millions of more homes.

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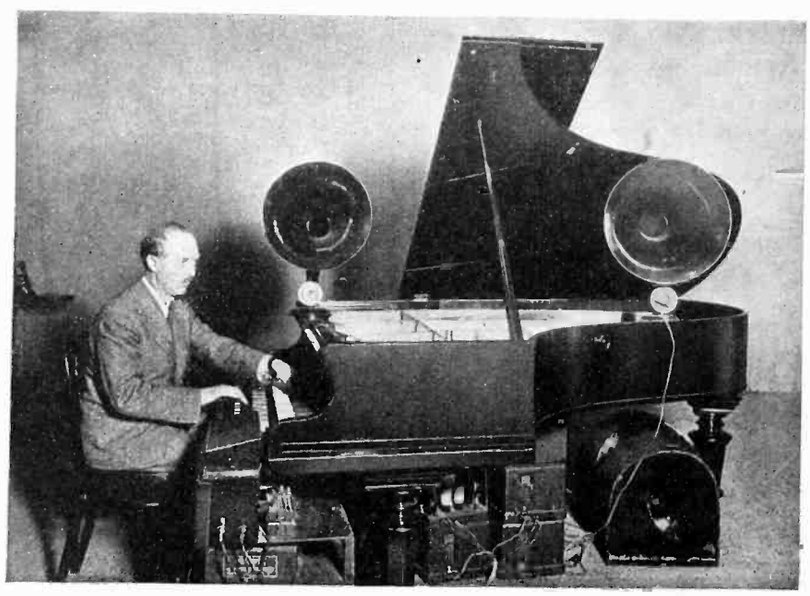
HELLERTON ELECTRIC PIANO



The sensation of the Munich Congress on electrical music was this electric piano from which the tones are produced by true audio-frequency oscillations

✦

High intensity low voltage tubes

CLAUDE NEON LIGHTS, INC., announces the conclusion of agreements with the Electrical Products Corporation of Los Angeles and with the Claude Neon Displays, Inc., of Buffalo, for the manufacture and sale of the new high-intensity low-voltage neon and other rare gas products.

The new product is available at present in three colors—red, blue and green. The red tubes have from eight to ten times greater intensity and brilliancy, and the blue and green tubes, three to four times the intensity of the present neon tubes. These tubes will operate on standard 110-220-volt electric current, for both alternating and direct current. The largest outdoor installation has been erected on the roof at 32nd St., and Broadway, New York City, for the John David stores. For several months the Claude Company has had small signs available and the present announcement of plans is made following the success of these installations.

✦

Motorcar radio

MANY MANUFACTURERS expect radio receiving sets to be standard equipment on most automobiles within another season or two of the automotive industry. The Nash and Hupp Companies, according to recent reports, will equip all future models with radio sets. Other motor manufacturers are reported to be planning similar initial radio installations in their coming models.

Several important manufacturers report increased sales of motorcar radio sets, but the initial factory equipment by important automobile manufacturers is expected to set the pace for widespread adoption of motorcar radio. Tube manufacturers also are expected to share largely in the new market.

Television expected to use ultra-short waves

WHETHER VISUAL BROADCASTING, or television, is ultimately destined to go to the ultra-short waves will be known within the next year, in the opinion of well informed official and unofficial observers. Although it is too early to gauge the results already achieved on the extremely high frequencies between 43,000 and 80,000 kilocycles (about 7 to 3.75 meters) some observers are already convinced that those will soon be the channels regularly assigned for the transmission of images by radio.

Their opinions are based on the fact that the present experimental television wave-bands, all in the continental frequency group and each 100-kilocycles wide, are too few and now too crowded to permit of much further occupancy. Much remains to be learned about the ultra-short waves, hitherto the "No Man's Land" of radio, but experiments so far have been highly promising.

✦

Station elimination to be fought in higher courts

REVERSING THE RECOMMENDATIONS of chief examiner Ellis A. Yost, the Federal Radio Commission has ordered WIBO, Chicago, owned by the Nelson Brothers Bond and Mortage Company, and WPCC, also Chicago, owned by the North Shore Church, off the air to make way on the 560-kilocycle channel for WJKS, Gary, Ind., controlled by Ralph Atlass.

The Commission's decision follows lengthy hearings before Mr. Yost at which the relative public service merits of the several stations were argued on behalf of WJKS on the one hand by Mrs. Mabel Walker Willebrandt and on behalf of WIBO by Levi Cooke. Both are promient Washington attorneys, Mrs. Willebrandt being the former Assistant Attorney General in charge of prohibition cases.

An injunction to keep the stations on the air, pending appeal, has been sought by station WIBO. This case is creating considerable interest because of the important precedents it involves, both as to the Commission's exercise of power and the test it will bring to General Order 102 covering quota allotments.

✦

Radio City buildings to rise in year

CONTRACTS FOR ERECTION of three of the gigantic buildings to rise in Radio City, and said to cost in excess of $50,000,000, have already been executed.

Six thousand men will be employed on the three buildings. In November, work is to begin on the International Music Hall, "the world's largest theater," to be operated by Radio-Keith-Orpheum under "Roxy" Rothafel. It will be 31 stories high. At the same time work is to begin on a sound motion picture theater seating more than 3,500 persons. These buildings are scheduled for completion by Oct. 1, 1932.

About Dec. 1, work begins on the central unit of the whole project, a 66-story office building containing 2,723,000 square feet of space, more than that of any other building in the world.

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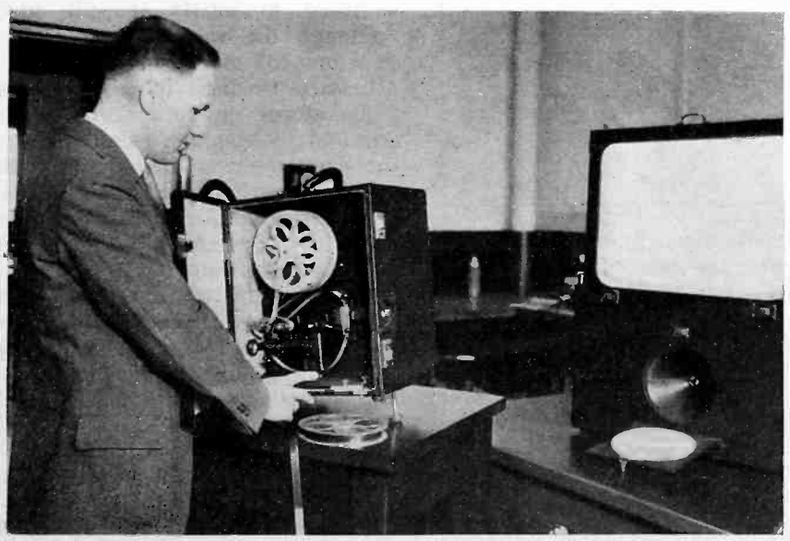
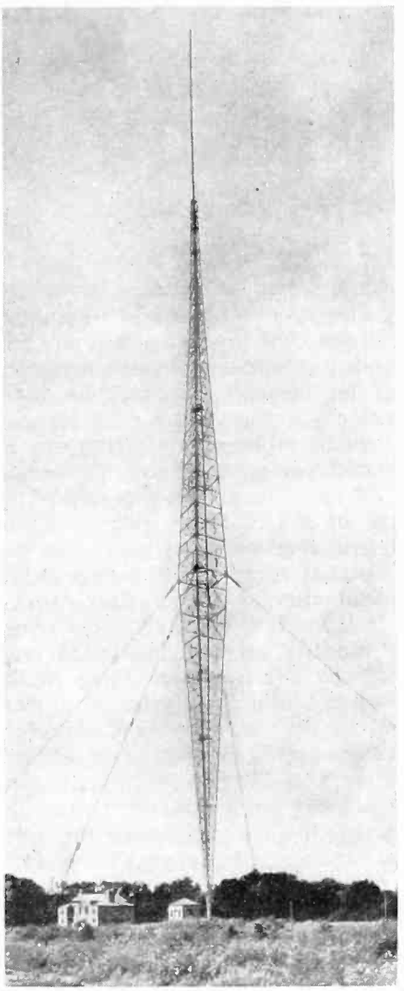
16 MM. SOUND-ON-FILM PROJECTOR



Projection equipment which uses 16 mm. sound-on-film with sprocket holes on one side only. Designed by the Westinghouse Research Laboratories and later turned over to RCA Victor for commercial development

676 FEET HIGH



Vertical antenna of station WABC, Wayne, N. J., is the tallest structure of this type

✦

75,000 watt Mexican station considered serious problem

INTERNATIONAL COMPLICATIONS that involve the radio administrations of the three largest nations of North America are developing from the fact that Dr. John R. Brinkley, deposed Kansas medico-broadcaster and candidate last year for governorship of Kansas, has made good his threat to build a powerful radio station in Mexico in order to reach his old American audience.

American and Canadian government agents have been watching with keen interest the erection of the new 75,000-watt station at Della Acuna, Province of Coahuila, Mexico, just across the Rio Grande from Del Rio, Texas. The station has been testing on 735 kilocycles with the call letters KER. With 75,000 watts, it is destined to be the most powerful station in the western hemisphere.

Though it is admitted that the station has been built with Brinkley capital, its erection has been authorized by the Mexican government and licensed to a Mexican corporation.

REVIEW OF ELECTRONICS LITERATURE

HERE AND ABROAD

High frequency and superconductivity

[J. C. McLennan, A. C. Burton, A. Pitt and J. O. Wilhelm] An oscillating circuit consisting of a lead coil and a condenser made of lead disks separated by insulating spacers of small diameter was placed in a flask containing helium. The natural frequency of oscillation corresponded to a wavelength of 27.2 m. The circuit was excited by means of a UX 112-A tube oscillator with grid condenser and leak. The coil was placed about three inches below the lead circuit. The temperature in the flask was lowered to the point where lead becomes superconductive; at resonance the electromotive force in the lead circuit would be inversely proportional to the resistance and therefore enormous when the resistance of lead disappears at 72° absolute temperature. The induced current would reduce the amplitude of oscillations in the tube. But the plate current changed only from 5.5 to 5 milliamp. Even when liquid helium appeared in the flask no abrupt change was observed so that the conclusion was drawn that superconductivity does not exist for high frequency currents even near the absolute zero. In calculating the results phase relations were neglected and the condensers supposed to be perfect.—*Philosophical Magazine and Journal of Science, September, 1931.*

✦

Graphical study of maximum output

[Kammerloher] Description of a simple and rapid method for the exact fixation of maximum available output from a loudspeaker tube with the help of the static characteristic, together with experimental methods for the confirmation of the results.—*E.N.T., Berlin, September, 1931.*

✦

Radio-frequency A and B Supply

[Edelstein] Experimental work on this neglected field, giving the advantage that the receiver is completely separated from the mains. In the set described, one tube as oscillator supplies filament and anode voltages to a normal battery receiver, the filament current being controlled by a condenser and the (B and C) voltages by resistances in the usual way.—*Funk, Berlin, September 25, 1931.*

Braun tubes for television

[Zeitlin] Study of these tubes, especially from the point of view of difficulties arising in practical use; for example, the space-charge effect and the possibilities of removing it by the use of gas-filled tubes or by a polarizing resistance in the anode circuit; "wandering" of the actively emitting area of the cathode and its effects on the image, etc. The author considers however that in "two or three years" this tube will be generally used for television—*Funk, Berlin, September 18, 1931.*

✦

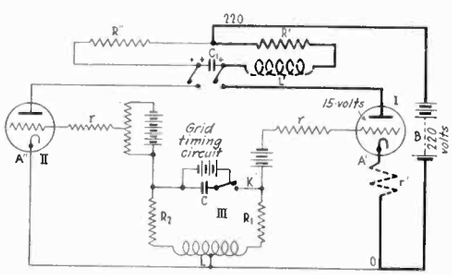
Detection, "linear" and power

[Tellegen] Study of plate and grid detection with special reference to the Philips receivers, the author being an engineer with this company.—*Radio Giornale, Milan, August, 1931.*

✦

Current impulses of rectangular wave-form

[A. J. Maddock] British Thomson-Houston Company. When using a parallel inverter circuit in which two Thyratrons are tied together by the capacitor C_1 (see *Electronics,* April, 1931), a single almost rectangular current of



considerable strength may be obtained by introducing sufficient resistance into the oscillating timing circuit so that the grid of the first Thyratron remains sufficiently negative and prevents the tube from restarting near the peak of the second oscillation of the timing circuit. For times greater than about 0.02 sec. ($L = 20$ henrys, $C = 8\,\mu f$) an oscillating neon tube is used in the timing circuit. The current is more nearly rectangular and the circuit more flexible in the cathode lead (output in R) than when the current in the anode resistance is used owing to the presence of the condenser C_v.—*Proceedings Physical Society London, July, 1931.*

Recorder of tube-characteristics

[Von Ardenne] An alternating voltage is applied to two of the plates of a Braun tube and simultaneously a variable portion of this (through a potentiometer) to the grid of the amplifier tube under test, the voltage drop across a resistance in the anode circuit being applied to the two other plates of the Braun tube. The characteristic curve is thus rapidly traced; the axes can be seen by short-circuiting one or the other pair of plates. In practice, difficulties arise because the resistance in the anode circuit must be kept low as compared with internal resistance of the tube under test, hence the voltage applied to the Braun tube is low. It can be amplified by the use of a second tube, but in this case phase shifts occur, and there is also a delay in changing from the recording of the axes to that of the characteristic, due to the time taken by condensers associated with the circuit to discharge. Full descriptions are given of the means taken to avoid these difficulties and of a practical apparatus for mains supply based on these principles.—*Funk Magazin, Berlin, October, 1931.*

✦

Purification of magnesium

[W. Kaufmann and P. Siedler] I. G. Farben Labor., Griesheim. Thanks to improved methods the purity of the technical product may reach 99.85 per cent. Distillation or sublimation may be used to purify it still further. Although the vapor-pressure is equal to 2 mm. of mercury at 650° C. it is necessary to distil it at much higher temperatures on account of the heat required to keep the metal liquid, and the danger exists then that the metal carries impurities with it. Sublimation can be carried out under commercial conditions between 500 and 650 deg. C. at pressures from 0.05 to 2 mm. Hg. The solid metal deposits in well formed metal crystals of 99.99 per cent purity. There remains a black powder consisting of iron, silicon, copper, manganese and aluminum. A second or third evaporation yields a material in which no impurities can be detected either chemically or spectroscopically. In the United States the price of magnesium has decreased during the past 15 years from $5 per lb. to 30 cents per lb. in carloads. (Ind. and Eng. Chemistry, October, 1931) so that it forms a cheap getter for vacuum tubes.—*Zeitschrift f. Elektrochemie, August-September, 1931.*

Telephone lines for radio programs

[K. HOEPFNER] German P. O. The thirty important German transmitters are connected by means of underground cable lines. In most cases the ordinary telephone cables could be used, because their core is provided with four well shielded wires intended originally for service communication. This line was provided with induction coils and audio amplifiers so as to transmit all the frequencies between 100 to 6,400 cycles equally well. Experiments have shown that losses above 5,000 cycles would be noticeable to even an average ear, and when new cables are laid provision is made to reproduce all the frequencies up to 8,000 cycles equally well, that is with less than 0.3 decibel difference.

Induction coils of 9.4 mh. are placed every $1\frac{1}{4}$ mile and amplifiers every 45 miles. The line is flat between 1,000 and 7,000 cycles, but falls off below 1,000 cycles, the difference between 50 cycles and 6,400 cycles amounting to 3 decibels. A two-stage amplifier with rejector circuit between the first and second tube equalizes the difference. Special Siemens and Halske tubes (OCk) are used, which produce less than 0.9 per cent linear distortion at 50 milliwatt output. The core is made of a special iron powder. Due to changes in resistance and leakage the higher frequencies might gain 3 decibels in summer, but compensation may be switched on in the amplifiers. The peak intensities of the sound are measured by means of a detector tube with grid and condenser preceded by a network which allows the tube to integrate peak values over about 20 milliseconds.

The presentation of the article before the Society of Electrical Engineers was accompanied by a demonstration in which music or speech was sent over a net of 400 miles back to the meeting place so that a comparison between the outgoing and the returning frequencies could be made. By means of filters, bands of 50, 100, 1,000 cycles, etc., could be passed. Suppression of frequencies below 100 cycles or above 8,000 cycles was difficult to observe in ordinary programs, and any future improvements will only be concerned with the range from 50 to 8,000 cycles.—*Elektrotechnische Zeitschrift, August, 1931.*

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New Russian Radio "Five-Year Plan"

[WIGGE] The former Five-year plan having proved unsatisfactory a complete reorganization has taken place. Up to now practically nothing had been done, divided responsibility having led to serious delays and shortage of tubes having proved a particularly serious obstacle. Further, the Radio Plan had to be extended since shortage of metals has made many of the proposed land-line extensions impossible and they will have to be replaced by radio communications. Very full details of the new plan are given, with map and statistics—the following are a few of the chief points only: Fifty short-wave senders (10 and 20 kw.) for the chief internal communications, one thousand similar transmitters but of one kw. only for the communications within provincial areas, a small increase in the total number of broadcast transmitters but a very large increase in the total power (63 for 60 stations but 2,620 kw. in lieu of the present 444), special attention to the development of set-less reception (i.e. where a central receiver distributes two programs by wire to subscribers who can choose between these two only) rather than reciver-reception, it being intended that 75 per cent of the total listeners shall have no receivers.—*Funk, Berlin, Oct. 8, 1931.*

✦

Bridge method for echo measurements

[HOLLMANN AND SCHULTER] (From the Heinrich Hertz Institute and the Darmstadt Technical High School). Description of a method in which the time of dying away of the echo is compared with the discharge time of a condenser. To avoid the need for the use of a galvanometer of very high resistance the two arms of the bridge feed this through two amplifier tubes and not directly. The effects of interference (standing waves, etc.) are better eliminated by a balanced arrangement of condensers and diodes (described) than by the use of a varied ("wobbled") tone. — *E.N.T., Berlin, September, 1931.*

Phonograph registration on film

[BRACHET] Description of the method of Huguenard, in which a film of the normal cinematograph type receives the sound-record by variations in its thickness (made by a heated stylus). The resultant record can be reproduced by a needle which is stated to cause no wear on the film; or by the variations of refraction of light passed through the film and actuating a photocell. Further, these latter variations being imperceptible by the eye, the record can be made on the unsensitized side of a cinematograph film, thus adding sound without reducing the width of the image.—*Science et la Vie, Paris, October, 1931.*

✦

Loudspeaker as speech recorder

[KETTERER] For scientific study it is desirable to translate speech-sounds from gramophone disks into a graphical form; mechanical methods have proved unsatisfactory and oscillographs too costly. A simple method is described, in which the recorder is a four-pole system as used in a normal electromagnetic loudspeaker, the membrane being replaced by a fine metal point ending in a straw and parchment style, and this recording on a blackened rotating cylinder. The record is played through a normal audio-frequency amplifier, but special filtering to remove all mains frequency is necessary. The possibilities and limitations of the system from a linguistic-phonetic point of view are fully dealt with and examples of the curves obtained are given.—*Funk, Berlin, August 14, 1931.*

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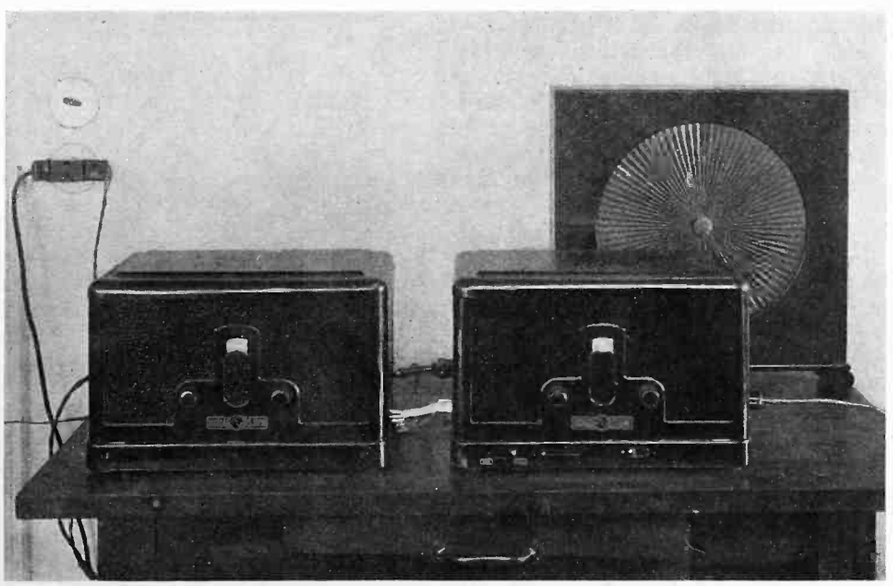


German radio receiver for the ultra-high frequencies described by Eduard Karplus at Rochester IRE meeting, November 10

The magnetic coil for focussing electrons

[E. Ruske and M. Knoll] Berlin W. Rogowski, Aachen Institute of Technology H. Dicks. When short coils are used for gathering the electrons emitted from a cold cathode of an oscillograph into a narrow beam, the electrons have to pass through a magnetic field the strength of which varies rapidly along their path. It is possible to show (H. Busch) that such a short coil acts exactly like a lens; placed at the distance a from the source of electrons, it gathers the electrons into a pencil which forms an image of the source at the distance b from the coil such that

$$\frac{1}{a}+\frac{1}{b}=\frac{1}{f}$$

where f is the focal length of the "magnetic lens." When a diaphragm is used before the cathode, the hole in the diaphragm of diameter D (0.4 mm.) may be considered as the source, provided that it is not much smaller than the image d, and in this case $d/D = b/2$. The focal length f depends upon the electron velocity or plate potential E and the field strength or the number of ampere-turns N of the coil radius r and for all practical purposes (E from 30,000 to 70,000 volts, current 0.05 to 1 milliamp, pressures below 5×10^{-3} mm. of mercury) $N^2 = 96{,}800\ E\ r/f$. A rectangular coil of sides l and m is equivalent to a circular coil of diameter $l + m$. By inclosing the focussing coil in an iron mantel leaving an inner air space one can decrease considerably the effective ampere windings of the coil.

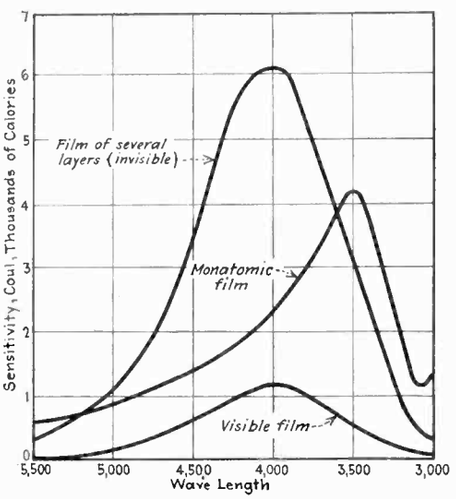
Rogowskis experiments

During the past four years Rogowski used an additional coil between cathode and diaphragm which makes the electrons pass through a very small spot in the diaphragm hole. When using this auxiliary coil alone the gain in intensity is such that a brilliant white spot is produced on the fluorescent screen of zinc sulphide, 2 cm. in diameter and as bright as a source of 50 candles (for 55,000 volts, 78 microamps. or 35 lumens per watt). With both coils and a photographic plate placed behind the screen in the tube, it is possible to record the separate oscillations of a wave of a few meters wavelength at a writing speed of one-third the velocity of light. Higher speeds are rendered impossible on account of the increase of mass of the electron when its speed increases. Outside photographs give a speed of 2,000 km., but it is hoped to reach 10,000 km.

Oscillograph tubes of glass are satisfactory when a cylindrical electrode is added either inside or outside the tube. —*Zeitschrift tech. Physik, August, 1931. Elektrotechnische Zeitschrift, October, 1931, Archiv f. Elektrotechnik, July, 1931.*

Sensitized potassium photocells

[R. Suhrmann] Dresden Institute of Technology. Extending an idea presented in an article published in *Electronics,* February, 1931, the author starts from the theory that the high selective emission of metals is due to a compound of the metal being formed when sensitizing it, this compound being deposited on a suitable conducting support and covered by a film of the same or another metal. The layer formed by the compound, potassium hydride for instance must be so thin as to remain conducting. The experiments show that when the surface of a pure potassium cell is treated with a substance which combines with potassium naphthalene, for instance, the high selective emission appears as soon as a new potassium film is made to deposit upon the layer formed by the compound. A substance which does not react with potassium, paraffin, for instance, or ordinary hydrogen, gives no selective sensitivity in contrast with oxygen, sulfur, selenium and tellurium.



Response of Suhrmann's photocells

Selective emission appears when a thin film of potassium is deposited on silver which has been slightly oxidized by passing a discharge through the cell as an apparently monatomic potassium layer is being deposited upon the silver oxide, the sensitivity shifts toward longer wavelengths and the maximum emission is enhanced. With a thicker potassium film the surface assumes a violet color, the sensitivity in the yellow decreases slightly, but the peak in the blue becomes still higher. When the potassium film becomes visible to the eye the entire emission drops to low values. A sensitive photocell consists therefore of three layers: a conducting support, a film of a metal compound and a film of pure metal. The peak sensitivity depends on the thickness of the compound, its height upon the thickness of the metal film.—*Zeitschrift für Elektrochemie, August, September, 1931.*

Photoelectric method of measuring yarn levelness

[G. R. Stanbury] Wool Industries Research Association. From the spinner's point of view one of the most important qualities of yarn is its levelness or evenness. Mechanical methods of control, however, are laborious; in one method, for instance, 1,000 weighings have to be made to obtain a good value for the coefficient of variation. By mounting a photocell under an illuminated slit over which the yarn was passing a varying photoelectric current can be produced corresponding to the amount of light cut out by the varying width of the yarn. Instead of using the yarn itself to block out the light it is more satisfactory to use an image of the yarn as this can be focussed accurately on the plane of the slit and is black no matter what color yarn is being tested. A beam of light illuminates a circular hole cut in a brass plate in front of which the yarn passes over two stainless steel guides. A magnified image of the yarn is formed on a slit of adjustable width. The light transmitted falls on a ground glass plate and is diffused over the active surface. A vacuum cell and a Lindemann electrometer were used.—*Journal of the Textile Institute, August, 1931.*

✦

British patents forecast American issues

Because patents in England are granted and descriptions are published considerably before their issuance in this country, a survey of abstracts published by the British Patent Office provides an excellent advance insight into the state of the art, and the probable advent of American patents.

In this issue of *Electronics* important British patents are digested—an amplification of the scope of the patent digest department which will become a regular feature.

✦

Corrections

The editors regret errors occurring in October *Electronics.* In Mr. Olken's article on the use of oscillating tubes in industrial control, the accuracy with which the electronic micrometer could measure thickness, and other measurements mentioned, was wrongly stated. A half-inch deflection on the ultra-micrometer results from a change in thickness of 0.0001 inch and not as printed 1/0.0001 inch which would, of course, be 10,000 inches!

In Mr. Sutherlin's article on measurement of grid-current the resistance used in the grid circuit, mentioned in the final paragraph should be 4,000 megohms, not 400 megohms as printed.

✦ NEW PRODUCTS

THE MANUFACTURERS OFFER

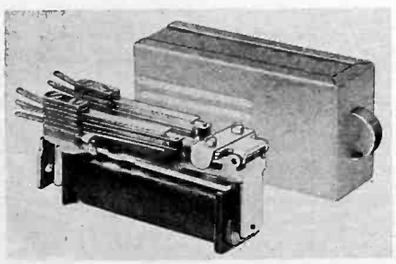
Light beam control relay

THE RELAY DEVELOPED by the Allen-Bradley Company, 1311 S. First St., Milwaukee, Wis., is applicable to the following devices: Counting relays, limit switches, alignment controls, sorting devices, automatic smoke detectors, position indication devices, traffic signal relays, and many others. The unit consists of a photoelectric tube which is connected to the amplifier tubes and relay through a flexible connecting cord. By adjusting a condenser, the relay can be made to operate at various values of light intensity. No appreciable power is consumed when the relay contacts are open. The capacity of the contacts is 10 amperes at 110 volts, a.c. non-inductive load. This relay is also available with all the parts, including the photoelectric tube, enclosed in a waterproof cast-iron case with window for out-door operation. — *Electronics, November, 1931.*

✦

Alternating current relay

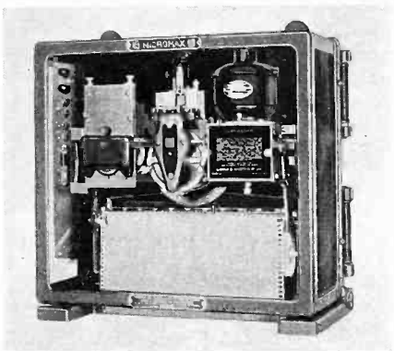
A QUICK-ACTING RELAY which provides firm, non-chattering contact when operated on alternating current is one of the recent achievements of Automatic Electric, Inc., 1033 W. Van Buren St., Chicago, Ill. This relay is of unusually large capacity, and makes possible, for the first time with a.c. relays, the use of complex multi-spring assemblies of make, break, and make-before-break contacts. The contact springs may be mounted in one or two groups, each consisting of six springs or less. Con-



tact points can be supplied, when specified, to handle currents of up to approximately one-half ampere a.c. or d.c., at 50 volts. Operating current may be of any voltage from a few volts up, and of any frequency from 16 to 66 cycles, or more. An aluminum-finished slip-on cover may be supplied to protect the working parts of the relay. This cover is only 3¾ in. by 2 in. by 1¼ in. in size, and encloses the entire relay. —*Electronics, November, 1931.*

Improved potentiometer pyrometer

THE IMPROVED L and N potentiometer pyrometer, "Micromax," is announced by the Leeds & Northrup Company, 4901 Stenton Ave., Philadelphia, Pa. Manufacturers claim a new high level of accuracy, reliability and automatic operation in the "Micromax," and also, that the instrument requires no manual adjustments or attention. The instrument circuit is standardized auto-



matically, every 45 minutes or less, giving a closer adjustment than is obtained manually. A new catalog No. 87, describing the instrument in detail, has been issued and will be sent upon request by writing the company direct.— *Electronics, November, 1931.*

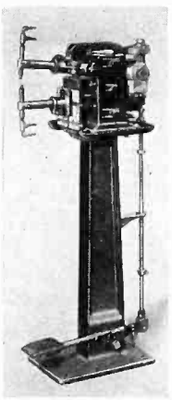
✦

New synthetic resin

A NEW HEAT-REACTIVE molding compound is now being produced commercially in the plant of Toledo Synthetic Products, Inc., Toledo, Ohio. This urea-base compound, called "Plaskon," was evolved at the Mellon Institute under a series of Industrial Fellowships sustained by the Toledo Scale Company. Copies of the report may be obtained by interested persons upon direct request to the Institute. "Plaskon" molding compound is said to be easily preformed, and it is pointed out that this property, in conjunction with the high speed of cure, makes possible rapid low-cost mass fabrication by the molder. Fabricated "Plaskon" is claimed to be unexcelled in color possibilities, combining bright colors with a hard, lustrous surface. Its base shade is one of neutral translucency, permitting pigmenting to give all colors of any intensity, either opaque or translucent. Infinite variations in mottled or striated effects are possible.—*Electronics, November, 1931.*

Speed spot welding machines

THE EISLER ELECTRIC CORPORATION, 740 South 13th St., Newark, N. J., announces the expansion of its line of speed spot welders. The range now covers ½ to 35 kva. with machines of the following capacities: ½, 1, 3, 5, 10, 20 and 35 kva., capable of handling from

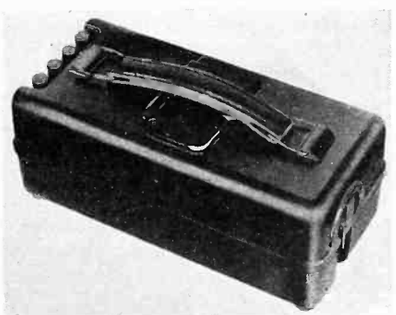


.0005 in. to ⅝ in. combined thickness of steel. The principal advantages claimed are: Speed in production, uniform welds, positive and smooth in action, simplicity of construction, few working parts, rugged and compact, wide range of heating steps and low maintenance cost. — *Electronics, November, 1931.*

✦

Molded case construction

THE USE OF A BAKELITE molded case has permitted the Paragon megohmer generator to be of heavier construction without increasing the total weight of the unit. High dielectric and mechanical strength were additional factors which influenced the choice of this molded material for the megohmer case.



The case is made up in two sections. For further information, write the Bakelite Corporation, 247 Park Ave., New York City. — *Electronics, November, 1931.*

Remote control switch

THE INDUSTRIAL CONTROLLER DIVISION of the Square D Company, 710 S. Third St., Milwaukee, Wis., announces Class 2510 W5, a compact and rugged manual starter. The three-pole starter is de-

signed to control across-the-line single and polyphase motors of 2 hp. or less. It is suitable for general applications where remote control and low voltage protection are not essential. Push-button operation, low price and compactness are the outstanding features of the manual starter. Overload protection is provided by time limit thermal relays which are front re-set and require no replacement of parts after operation. Tripping of either relay opens all three lines. The starter is arranged for wall or pedestal mounting. Approximate dimensions of the starter are: width, 4½ in., height, 7¼ in. and depth, 3¾ in.—*Electronics, November, 1931.*

✦

Tube development to improve auto radio

A NEW RADIO TUBE to overcome the limited power of present-day automobile radio sets is now in the experimental stage at the laboratories of the Arcturus Radio Tube Company, Newark, N. J. The manufacturers claim that this new tube with the increased volume which it makes possible, will overcome the usual noises encountered when driving with the windows open, not to mention body squeaks and the rumble of driving over rough roads.—*Electronics, November, 1931.*

✦

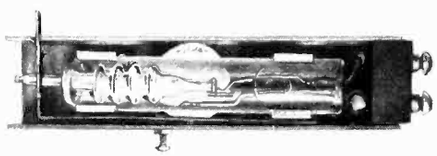
Distortion-factor meter

MOST OF THE METHODS of measuring harmonic distortion that have been employed either have been laborious, or have involved elaborate equipment. The type 536-A distortion-factor meter, a product of the General Radio Company, Cambridge A, Mass., has been developed to enable distortion measurements to be made accurately and rapidly. This instrument has a further important advantage over earlier apparatus in that its input impedance is very high. It may therefore be connected almost anywhere without causing appreciable disturbance of the circuit under test. In order that these ends might be achieved, two important simplifications of the problem have been made. Only a single fundamental frequency is employed, and only the total harmonic distortion is measured.—*Electronics, November, 1931.*

✦

Vacuum contact mounting

TO FACILITATE THE application of the Burgess vacuum contact to relays and other actuating mechanisms, a conveniently mounted unit has been developed by the Burgess Battery Company, 202 E. 44th St., New York City. The unit consists of a C-shaped metal casing to protect the glass vacuum contact held in a pair of clips, a connecting link for coupling the actuating mechanism to the extension stem of the vacuum contact, and a pair of screw binding posts. This vacuum contact mounting is especially applicable to the standard type telephone relay. It may also be applied to any mechanical, manual or thermostatic form of actuation. An actuating force of 6 to 10 ounces, with a movement of but .02 in., is sufficient to operate the



vacuum contact which in turn controls up to 6 amperes continuously or 8 amperes intermittently, at potentials up to 220 volts. The vacuum contact has innumerable possibilities in controlling power circuits by means of the most delicate actuating force.—*Electronics, November, 1931.*

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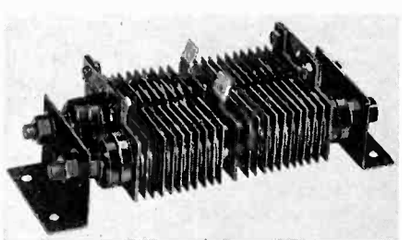
High voltage rectifier

WHAT IS CLAIMED to be the largest continuous rating of dry, metallic rectifier for a given space is illustrated. This is one of a new line of high-voltage rectifiers announced by the B-L Electric Manufacturing Company, 19th and



Washington Ave., St. Louis, Mo. It occupies a space of only 7¼ in. by 2¾ in. by 2¼ in., and may be given a continuous output rating of 75 watts. It will operate directly from the 115-volt a.c. line.—*Electronics, November, 1931.*

Portable cathode ray tube

A RECENT PRODUCT OF the General Electric research laboratories, Schenectady, N. Y., is a small cathode ray tube which may be carried complete with all of its equipment. Although operating at 70,000 volts, it uses only 110-volt power supply, a small semi-fluid immersed transformer producing the necessary high voltage. The tube itself is only 12 in. long, with a bulb 3¼ in. in diameter. The window through which the cathode rays escape into the air is of aluminum foil. The tube is mounted on a transformer case, measuring 8 in. high, 6 in. wide and 10 in. long. The design of the tube is such that most effective use can be made of the cathode rays. The rays, which can be seen in subdued light as a pale bluish haze surrounding the window of the tube, are quickly absorbed and stopped by the air. With the new tube it is possible to place the object being rayed within a small fraction of an inch from the window.—*Electronics, November, 1931.*

✦

Impedance matching transformers

FERRANTI, INC., 130 West 42nd St., New York City, has developed a special impedance matching transformer, along with its standard audio and output units, which gives a particularly flat curve from 30 to 8,000 cycles. This is accomplished by a special type of construction used which reduces the leakage reactance and self and mutual capacities to a minimum. In this construction the primary and secondary coils of the transformer are interleaved and each individual section is wound by hand. These special impedance matching transformers are particularly suited for broadcast stations, sound studios, tube and communication engineers and many other special uses. Literature will be sent on request.—*Electronics, November, 1931.*

✦

New bulletins available

Fansteel Products Company, Inc., North Chicago, Ill., announces publication of a bulletin entitled, "Metallurgy and Design of Contact Points." In this bulletin attention is called especially to the tables and diagrams in the back of the book showing standard forms of contact points and fixtures available. The booklet is offered gratis to electrical engineers and executives.

The Carter Radio Company, 407 S. Aberdeen St., Chicago, Ill., announces publication of its 1932 bulletin on radio components. This bulletin gives a complete listing of the many radio components manufactured by this company.

The Riverside Metal Company, Riverside, N. J., announces publication of two new bulletins, one on nickel silver and the other on phosphor bronze. These bulletins clearly define the metals manufactured by this company.

National Company, Inc., 61 Sherman St., Malden, Mass., announces publication of a new bulletin in which the more active items of its radio line are listed.

Copies of these bulletins may be obtained by writing the respective companies direct.

Electro-deposited sheet copper

INDUSTRIAL DEVELOPMENT CORPORATION, 50 Congress St., Boston, Mass., announces a new electro-deposited sheet copper which it is producing at its Bridgeport, Conn., plant. This metal is produced in coils 60 in. wide, in any length desired and in gauges down to 0.002 in. Being the product of an electrolytic cell, its chemical purity is high. Its physical properties it is claimed are equal, or superior, to those of rolled copper. The metal is uniform in gauge, being practically without variation across the width of the sheet and calling for a maximum tolerance of plus or minus 0.00025 in. through the length of a sheet 0.005 in. thick. In appearance, the copper is very similar to a polished rolled sheet on one side and the other side has the characteristic salmon pink color of pure electrolytic copper.—*Electronics, November, 1931.*

✦

Light-sensitive cell unit

STRUTHERS DUNN, INC., 148 N. Juniper St., Philadelphia, Pa., has announced the "Dunco" light sensitive cell unit which is housed in a case 6 in. by 5 in. by 3 in. overall, having an aluminum finish. It operates on standard voltage, 110 volts, 60 cycles, although special sets, both a.c. and d.c. can be built to order if voltages other than this are required. The "Dunco" uses a standard 112-A tube. As in the case with any light-sensitive cell unit, the new "Dunco" unit will operate at practically any distance, being limited only by the distance that light can be thrown. Either reflected or diffused light will operate the unit, which is adjusted at the factory for operation requiring a 10-watt lamp being placed one foot away. This test is without the use of any reflecting lens. The unit, however, can be adjusted for more sensitive operation. List price $30, less tube.—*Electronics, November, 1931.*

✦

Table model home "talkie"

MANUFACTURE OF A moderately priced table model home talking picture machine is announced by the Talkiola Corporation, 1600 Broadway, New York City. As in previous "Talkiola" models, a 16-mm. film is used, and the synchronized electric phonograph will play any records up to the standard 16-inch disks. The projector, which employs a 250-watt lamp, is noiseless in operation and incorporates a number of new improvements over the older models. The device is powered by a small a.c. motor. By means of suitable gears, two turntable speeds are available—33⅓ r.p.m. and 78 r.p.m.—*Electronics, November, 1931.*

✦

Slide wire rheostat

A NEW SLIDE WIRE RHEOSTAT, the "Jagabi," with porcelain tube 10 in. long and 2½ in. diameter has been added to the line of 8-in., 16-in., and 20-in. size rheostats manufactured by the James G. Biddle Company, 1211 Arch St., Philadelphia, Pa. It has relatively high resistance for its length, being wound on tubes 2½ in. in diameter, the same as the 20-in. rheostats. Details of construction of the new 10-in. "Jagabi" rheostat are identically the same as in the other sizes—which consist of resistance wire or strip wound on glaze porcelain tubes.—*Electronics, November, 1931.*

Molded compound

RADIO ENGINEERS WILL be interested in the new grade of phenolite laminated bakelite which has recently been developed by the National Vulcanized Fibre Company, Wilmington, Del., which is known as XP 209. The power factor of this grade at 1,400 kc. is 2.67 per cent and represents a distinct advantage in this respect without sacrifice of dielectric strength or mechanical properties. It may be punched, sheared or manipulated in the same manner as other grades of phenolite. Manufacturers are offering to those who are interested samples for examination.—*Electronics, November, 1931.*

✦

New friction tape

ESPECIALLY DESIGNED FOR electricians, but applicable to all other uses of ordinary type is the new friction tape developed by the B. F. Goodrich Rubber Company, Akron, Ohio. This tape is similar to inner-tube patching material, and practically vulcanizes in place after being applied, making a solid covering for wire. It is listed by insurance underwriters, and is approved for electrical use as taking the place of both insulating material and cloth tape. It has been designed so that it can be rolled lengthwise around an electric wire rather than wrapped and overlapped. It is especially applicable to wiring where it is difficult to wrap the wire. It is made in ¾ in. and 1½ in. widths, and packed in rolls. Manufacturers claim it will insulate 8,000 to 10,000 volts, is moistureproof, and will not dry out and uncoil.—*Electronics, November, 1931.*

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NEWS OF THE ELECTRON INDUSTRIES

James D. Jordan has been appointed chief engineer of the commercial division of the Ken-Rad Corporation. Mr. Jordan is well known in engineering circles and was formerly identified with the Ken-Rad Corporation when that company was founded. He was formerly in charge of the tube division of the Grigsby-Grunow Company.

Morton D. Joyce has been elected to the offices of secretary and treasurer of the Dubilier Condenser Corporation, according to its president, William Dubilier. For several years past, Mr. Joyce has been a director of the corporation, and prior to that time, he was engaged in the radio jobbing business on the West Coast.

Dubilier Condenser Corporation announces the appointment of Rock International Electric Corporation, 18 Laight St., New York City, as export managers in all foreign countries for Dubilier condenser products. Representing other leading radio companies, the newly appointed Dubilier export managers are in position to serve overseas buyers and users of condensers for radio, electrical and industrial purposes.

The Deforest Radio Company and the Jenkins Television Corporation of Passaic, N. J., announce the resignation of Charles G. Munn as president of both companies, and his election as chairman of the executive committee of both companies. Leslie S. Gordon, who has been identified with banking and manufacturing activities in Chicago, succeeds Mr. Munn as president of the Deforest and Jenkins companies. The personnel of both organizations remains the same.

Arcturus Radio Tube Company, Newark, New Jersey, announces that it is now completing the development of large power tubes for broadcasting and industrial uses in line with its expansion in other fields of the electronic art.

American Electro Metal Corporation, Lewiston, Maine, has reported a greater volume of sales for each month of 1931 over the corresponding months of 1930.

Jefferson Electric Company has purchased a 19-acre tract in Bellwood, a western suburb of Chicago, on which it will erect at once a $550,000 manufacturing plant which will house in one building its two Chicago plants now at 15th and Laflin Sts. and at Congress and Green Sts., and will care for its entire business with the exception of its Canadian subsidiary in Toronto. The company now employs approximately 1,800 and the new plant will have facilities for 3,000 workers.

Ralph Leavenworth has been appointed general advertising manager of the Westinghouse Electric and Manufacturing Company, according to an announcement made today by J. S. Tritle, vice-president and general manager. He will have charge of all advertising and publicity activities of the company, including the advertising division of the merchandising department, now centered in Mansfield, Ohio.

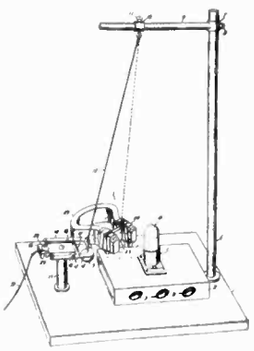
U. S. PATENTS

IN THE FIELD OF ELECTRONICS

A list of patents (Oct. 20) granted by the United States Patent Office, chosen by the editors of *Electronics* for their interest to workers in the fields of the radio, visio, audio and industrial applications of the vacuum tube

Radio Circuits and Apparatus

Tube testing apparatus. A device for determining the amount of microphonic movement between the electrodes of a radio tube. A. B. Rockwood and W. R. Ferris, assigned to G. E. Co. No. 1,825,548.



Insulation testing system. Method of using a vacuum tube for testing the presence of low insulation or high leakage in the conductors of a line. L. W. Brehman, assigned to A. T. & T. Co. No. 1,824,802.

Radio signalling system. An audible program modulates an intermediate frequency signal, one side-band of which is used to modulate a radio frequency signal. DeLoss K. Martin, assigned to A. T. & T. Co. No. 1,824,827.

Space-wired radio system. A method of transferring an oscillating tube from a radio antenna working at a relatively high frequency, to a power system working at a relatively low frequency. C. A. Boddie, assigned to Westinghouse E. & M. Co. No. 1,825,303.

Electrical filter. An interference eliminator for connection between radio receiving apparatus, and the source of power supply, comprising a series-connected choke coil for suppressing low frequency disturbances, a series-connected high frequency choke coil, and condensers connected in circuit with the high frequency choke, form an oscillatory circuit for preventing the passing of radio frequency disturbances. H. W. Houck, assigned to Dubilier Condenser Corp. No. 1,824,819.

Neutralizing system. A method of connecting the output of a tube to a filter system and of changing the phase of oscillation passing through the filter to cancel out oscillations in the main receiving circuit. W .M. Bruce, Springfield, Ohio. No. 1,824,803.

Aircraft course finder. Use of rectifiers actuating a pair of resonant mechanical members to utilize radio-transmitter course signals. H. W. Kline, G. E. Co. No. 1,827,590.

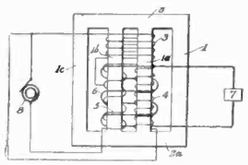
Remote control circuit. Motor-method of remotely controlling and monitoring a number of radio receivers. A. M. Trogner, Wired Radio, Inc. No. 1,826,845.

Antenna system. Several antennas placed in radii of a sphere. Georg von Arco, GDT, Berlin. No. 1,827,054.

Power Supply, Amplifiers, Etc.

Power supply. Source of power and load are connected as conjugate arms across an a.c. bridge. G. B. Crouse, Conner Crouse Corp. No. 1,826,743.

Voltage control. Method of controlling or keeping constant within small limits the voltage output of a transformer. H. K. Kouyoumjian, Ward Leonard. No. 1,826,890.



Piezo-electric oscillator. Crystals of opposite temperature coefficients connected in series to compensate temperature effects. R. A. Heising, B.T.L. No. 1,827,196.

High frequency wattmeter. Thermocouple method of measuring high frequency power. D. E. Richardson, H. G. Fischer Co., Chicago. No. 1,827,333.

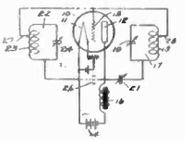
Bridge circuit amplifier. Two tubes in push-pull connected to avoid inter-electrode capacity trouble. W. J. Polydoroff, Johnson Laboratories, Chicago. No. 1,827,332.

Frequency changer. Tetrode with beat frequency generated in one of the two grid circuits and coupled to input. H. Andrews, Radio Patents Corp., New York. No. 1,828,094.

Carrier suppression. Use of piezo crystal to suppress carrier in modulated carrier system. E. I. Green, A. T. & T. Co. No. 1,827,843.

Protective device. Method of preventing abnormal voltage rise on filter condensers when loud speaker field coil, also acting as filter choke is disconnected. Wm. E. Brindley, Westinghouse E. and M. Co. No. 1,827,779.

Generator. Grid and cathode connected to points of different potential on one reactive circuit and grid and anode similarly connected to another reactive circuit. F. A. Kolster and G. G. Kruesi, Federal Tel. Co. No. 1,828,706.



Sound picture volume control. Impressed on the film are volume control records which operate through a phototube, etc. J. R. Balsley, assigned to Fox Film Corp. No. 1,827,735.

Geometric volume control. Varying the coupling between primary and secondary of several interstage transformers to affect gain geometrically. Lester L. Jones, Oradell, N. J. No. 1,826,550.

Tone control. Switch in grid circuit of tube when open causes condenser to act as tone control and when closed causes condenser to tune the r.f. part of the circuit. D. Hepburn and M. L. Thompson, assigned to DeForest Crosley, Toronto.

Light Sensitive Cells, Applications

Photoelectric cell. Two electrodes separated by an insulator whose thickness is not greater than several times the mean free path of ions in the insulating medium, means to liberate electrons by light and sufficient voltage put on cell to ionise the ions by the electrons. Abraham Joffe, Industrial Research Co., Cambridge, Mass. No. 1,827,016.

Patent Suits

1,128,292, E. H. Colpitts, Electric wave amplifier; 1,231,764, F. Lowenstein, Telephone relay; 1,426,754, R. C. Mathes, Circuits for electron discharge devices; 1,432,022, R. A. Heising, Circuit connections of electron discharge apparatus; 1,448,550, H. D. Arnold, Thermionic amplifier circuit; 1,504,537, same, Power limiting amplifying device; 1,483,273, D. G. Blattner, Circuit for heating the filaments of audions; 1,493,595, same, Applifying with vacuum tubes, D. C., W. D. N. Y., Doc. 7, Western Electric Co., Inc., et al. v. S. Wallerstein. Dismissed as to 1,231,764 and 1,483,273, decree for plaintiffs July 31, 1931.

1,266,988, Pridham and Jensen Amplifying receiver; 1,448,270, 1,579,392, same, Electro-dynamic receiver, D. C., N. D. Calif. (San Francisco), Doc. E 2166, The Magnavox Co. v. Thompson & Holmes, Ltd. Claims 8 and 9 of 1,266,988, claims 4, 8, 9 and 10 of 1,448,279, and claim 4 of 1,579,392 held valid and infringed Aug. 10, 1931.

1,268,988, Pridham and Jensen, Amplifying receiver, 1,448,279, 1,579,392, same, Electro-dynamic receiver, D. C., S. D. Calif. (Los Angeles), Doc. E R-73-M, The Magnavox Co. v. Grigsby-Grunow Co. Consent decree holding claims 8 and 9 of 1,266,988, claims 4, 8, 9 and 10 of 1,448,279 and claim 4 of 1,579,392 valid and infringed Aug. 31, 1931.

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Lovers of horseflesh will tell you that pedigree promotes performance. The prestige of the past insures the successes of the future. The experience and knowledge gained in the manufacture of more than twenty million CENTRALAB units gives a thoroughbred rating to a product that is now an integral part of many of the country's outstanding radio receivers. Experimenters, amateurs and set manufacturers everywhere pin their faith to CENTRALAB Volume Controls.

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BRITISH PATENTS

IN THE FIELD OF ELECTRONICS

Patents recently issued by the British Patent Office and described briefly in the Advance Sheets, Groups 38 and 40 relating to thermionic valves, wireless, television, musical instruments, signals and alarms, and chosen by the editors of *Electronics* as of interest to the industry.

Television

Multiple view television system. A method of dividing up the picture so that the view may be seen by several observers. ERPI. No. 340,612.

Synchronizing system. Use of a tuned relay for synchronizing. Telehor, Berlin. No. 345,610.

Multiple scanning system. Transmitter comprising several scanning devices, each arranged to transmit a different picture. Thomson-Houston Company. No. 345,595.

Synchronizing method. A phonic motor is energized by a component of the signalling current corresponding to the frequency. J. L. Baird, London. No. 346,834.

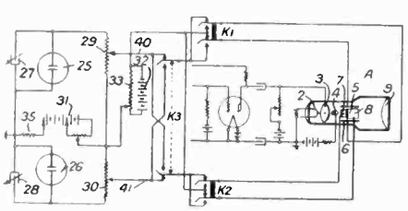
Reflector scanning disc. Reflector scanning disc using studs of highly polished plane surfaces. J. A. Fleming, Devon. No. 348,139.

Capacity compensation. A method of compensating the capacity of the photo-electric cell so that the output amplifier is not overloaded with unmodulated oscillation. Westinghouse E. & M. Co. No. 349,636.

Colored television. A method of exploring the image by a disk equipped with colored film. G. M. Bowtell, England. No. 340,833.

Condenser discharge system. A method of televising by using a condenser arranged in a tuned circuit, and containing the photo-electric plate on which the image is projected. Elektro-Physical Ges., Munich. No. 340,964.

Neon tube oscillator system. A scanning cathode-ray beam in which the potential controlling the scanning action has a wave form and frequency determined by neon oscillators or by the periodical discharge of condensers. Associated Tel. & Tel. Co., Chicago. No. 341,049.



Television system. Pictures reproduced three times by applying the signals to each of three lamps in delayed succession through phase distortion devices. Thomson-Houston Co. No. 341,353.

Television system. After signals corresponding to all the elemental areas of an object have been transmitted, only changes in illumination of a position are subsequently transmitted. Thomson-Houston Co. No. 341,811.

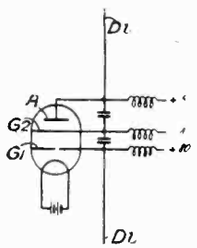
Retard apparatus. A system of receiving a picture on a film twice while the film is moved to the next picture. Kolster-Brandes. No. 344,091.

Selective system. A method of scanning by light in the short-wave range of the spectrum, generated by high density gas discharge means, and the filter cutting out all light above 5,000 angstroms. The object is "made up" so that the results obtained are the same as would be produced by white light. Telefunken. No. 344,736.

Detection, Amplification, Etc.

Hum eliminator. A method of connecting the cathode of an indirectly-heated tube to the heater by means of a potentiometer across the filament-heating transformer. Arcturus Radio Tube Co No. 340,396.

High frequency generator. Tetrode having an electrode at a high positive potential between filament and an electrode at low negative potential. A. Esau, Jena, Germany. No. 345,543.



Regenerative detector. A detector for frequency modulated signals. Marconi Co., assignee of C. W. Hansell, Port Jefferson, N. Y. No. 341,296.

Pentode amplifier. A method of compensating the unequal amplification of high frequencies. Philips, Holland. No. 341,403.

Hum eliminator. A push-pull amplifier deriving its supply through a tapped resistance. International General Electric Co. No. 341,472.

Frequency modulated wave reception. A method of indicating, measuring or detecting frequency modulated signals. Marconi Company, assignee of C. W. Hansell, Port Jefferson, N. Y. No. 341,732.

Constant frequency oscillator. Method of maintaining frequency of an oscillator independent of keying or other variations in plate and filament potentials. R. Gunn, Washington, D. C. No. 346,325.

Grid circuit detector. A method of eliminating anode detection in a grid circuit detector. Philips, Holland. No. 347,018.

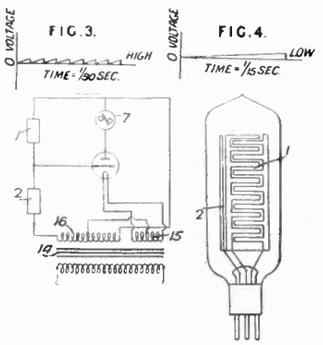
Audio amplifier. Transformer coupled inter-stage coupling, with a network arranged so that a high step-up transformer can be used without loss of high frequency amplification, and having a sharp cut-off beyond the desired frequency band. Philips, Holland. No. 347,085.

Modulation indicator. A method of indicating the percentage modulation by rectifying the wave and comparing the a.c. with the d.c. component. Thomson-Houston Company. No. 347,991.

Constant output generator. High frequency generator delivering a constant output over a wide frequency range. In the anode circuit of one tube is a series tuned circuit, tuned to the working frequency and in series with a resistance having the same value as the loss resistance of the tuned circuit at resonance. Ericsson, Stockholm. No. 348,941.

Light Sensitive Apparatus

Light-sensitive cell. A unit for use in balanced circuits, with operating resistance and a compensating resistance formed under identical conditions. Radiovisor, Ltd. No. 346,260.



Light sensitive cell structure. A special form of photoelectric or selenium cell for separating materials of different colors. T. E. Abbott, and H. H. Burn, Calcutta, India. No. 340,977.

Magnesium cells. A process of manufacturing a magnesium photo-electric cell. Raytheon Production Corp. No. 341,398.

Resistance variation cell. A cell using silver sulphide or selenide or molybdenum sulphide, etc., in which variations in light cause a variation in resistance. Arcturus Radio Tube Co. No. 341,527.

Light- and heat-sensitive cell. Two different materials, for example, lead sulphide and silver in point contact. M. Grutzmacher, Berlin. No. 345,317.

Alkali cell. Manufacturing patent. General Electric Co. No. 345,375.

Cell for colored films. A method of compensating the diminution of sound producing radiations caused by the density of the tinted film in colored movies. Kodak, Ltd. No. 345,524.

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Methods used in electrical prospecting

[*Continued from page 184*]

into the ground at equal distances from each other in a direct line with the energizing cable. The first position would normally correspond to the points *AAA* on the line *KK* of Fig. 2. The ratio of ground potential between the electrodes is then obtained in the manner outlined above, and the three electrodes are moved to correspond with position *BBB* in the figure. This procedure is thus repeated to cover points *CCC* and *DDD*, and as many more points as the survey permits. The energizing cable and buzzer are then moved over to the side (position 2) and the same work gone through. This procedure is continued until the whole territory has been surveyed.

If no deposit is present to distort or disturb the current paths through the earth, a curve of the potential ratios will appear as a set of parallel straight lines, the potential ratio between any two adjacent electrode positions being equal to unity. When a deposit whose conductivity is higher than the surrounding earth is approached, the potential ratio will change to a maximum and then to a minimum as the area is surveyed. A group of such lines is shown in Fig. 2, *a, b, c*. In the case of a deposit of higher resistance than the surrounding earth, the potential will swing through a minimum first and then through a maximum. With the apparatus mentioned above, potential ratios from point 0.05 to 98 are readily and accurately determined. The depth limit of the method mentioned above is approximately twice the distance between the two outside electrodes.

The electromagnetic ratio method

In cases where the field is covered with ice or snow, and direct and dependable contact with the ground is impossible, a method known as the "electromagnetic" ratio is used. An insulated cable is laid out in the form of a square as shown in Fig. 4. The size of the square is governed by the limits of the field to be surveyed, and may be anywhere from 200 ft. to 8,000 ft. on each side. The buzzer is placed in one side of the square. The pick-up system consists of two loops spaced a distance of from 30 ft. to 100 ft. apart connected by cables to the instrument used in the preceeding method. The loop nearest the side of the square is tilted through different angles until the phase of the signal picked up by both loops is the same. Balancing for magnetic field potential ratios is carried out in the same manner as in the preceding method. The electrical circuit of the two loops and the balancing instrument is shown fundamentally in Fig. 5. It can be seen from the figure that the theory of both the potential ratio and the electromagnetic systems is essentially the same. In Fig. 6 is shown the shape of the lines plotted from ratios determined by this method.

Electromagnetic compensation method

It is often desired to have a survey made in order to determine the position and depth of the different strata below the surface of the earth. By using the method to be outlined below, enough information and data are obtained to draw a cross-section of the earth beneath the areas surveyed. It is used mainly for structional investigations and is little used for other methods because of the amount of computation necessary. A buzzer or oscillator cable is stretched as shown in Fig. 7, and a coil is inductively coupled to the line. The coupling coil can be moved along the whole cable. Coupled to the coil is a phase balancing unit, a pick-up loop and an amplifier, arranged as shown in Fig. 5. Using this method the field strength of the magnetic lines of each point prospected will be given in terms of micro-gauss per ampere and the phase displacement. The phase balancer is a clever instrument and should find application in many other electrical fields. Figure 8a represents a fundamental diagram of the phase balancer. L_1 and L_2 are variable mutual inductances, and R_1 is a variable resistor. With R_1 set at zero the circuit becomes that of Fig. 8b. The phase change between input and output will be similar to that of any circuit coupled with a transformer. With R_1 set at some large value the circuit becomes as shown in Fig. 8c, which is merely that of an inductance in the line. Any value of R between these two extremes of resistance will result in a change in phase angle in the output. The absolute limit of phase shift possible with this arrangement is dependent upon the amount of unavoidable resistance in the circuit.

In the above discussion only the bare outline of the methods used by one group of prospectors are given.

Thanks are due to Mr. Zuschlag of the Swedish-American Prospecting Company, for his valuable help in assembling this material.

Glow-lamp noiseless recording

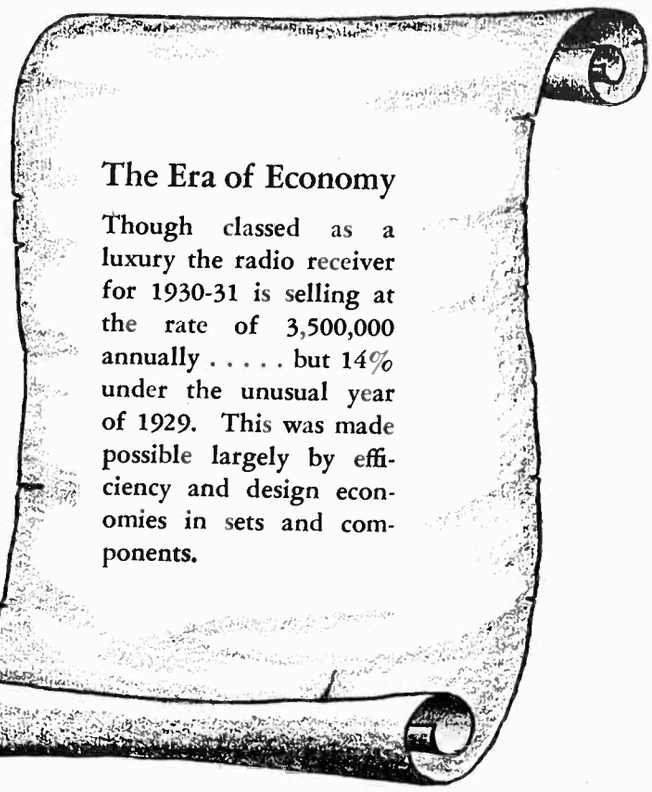
[*Continued from page 179*]

transmission, noise reduction is not linear with decrease of transmission, curving off at a point approximately 65 per cent. As this value falls in the fog region it is of little importance. The amount of noise reduction is based on the ratio between maximum signal unmodulated track and minimum signal unmodulated track. In the case of toe recording, normally this is the ratio of 40 per cent X′ to 20 per cent X″, or theoretically 6 db. reduction. In the case of the straight line print, it will be the ratio of 20 per cent X″ to 5 per cent X‴, or approximately 12 db. It will be found in practice, however, that the actual observed reduction is not quite as great. While the modulation value of toe recording is inherently higher, the net reduction of surface noise and signal-to-noise ratio is greater when using straight line methods.

It is the contention of the author that the reduction of surface noise is not the advantage to be gained by biasing methods, but rather it is the increase in range between signal and noise. At the present time the average auditorium background noise, which consists of audience movement, ventilation, etc., is approximately —15 db. Any reduction of film surface noise below this value will be wasted, it should, however, be applied to the other end of the volume spectrum.

In the average theater, having a capacity of approxi- 2,000 seats, +20 db. level into the horns is sufficient to create the illusion of a large orchestra, and +30 db. is sufficient to create a natural illusion of gunfire. It is, therefore, desirable that the maximum range of 45 db. between surface noise and peak signal be attained. This is greater than is at the present time attainable with the existing systems. It is believed, however, that with the adoption of methods producing sound tracks similar to the ideal, as represented in Fig. 1, that ranges of 60 db. on the film will be possible.

The Review *of* Progress

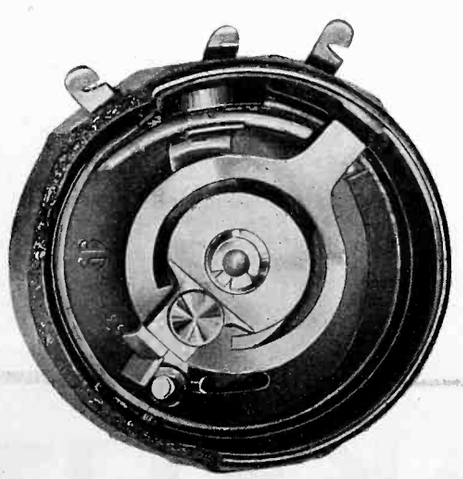


CLAROSTAT

***EVERY** step in electronic development has been anticipated by Clarostat engineers in their art of control design . . . They now offer a 60% saving in the "C"-bias limiting resistor.*

This year engineering problems in set design were largely matters of lowering cost. Many methods of cost reduction were attempted . . . . . some were seriously menacing factors of safety.

The "C"-bias limiting resistance was subjected to various forms of design economy. In some cases it was attached like an appendix to one of the volume control terminals. In most cases these efforts resulted in lack of mechanical and electrical protection and a high percentage of assembly troubles.



Clarostat engineers, backed by a decade of control and resistor experience are now offering a simple solution. The "C"-bias limiting resistor is made an integral part of the volume control resistance winding. The contact arm is accurately stopped when it reaches the bias winding, resulting in an exact fixed value of desired "C"-bias permanently set at the Clarostat factory. Thus the "C"-bias limiting resistance is protected within the volume control housing, resulting in a simpler trouble-proof design. More important, a 60% saving is effected in the cost of the "C"-bias limiting resistance, with actual increase in mechanical and electrical factors of safety.

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

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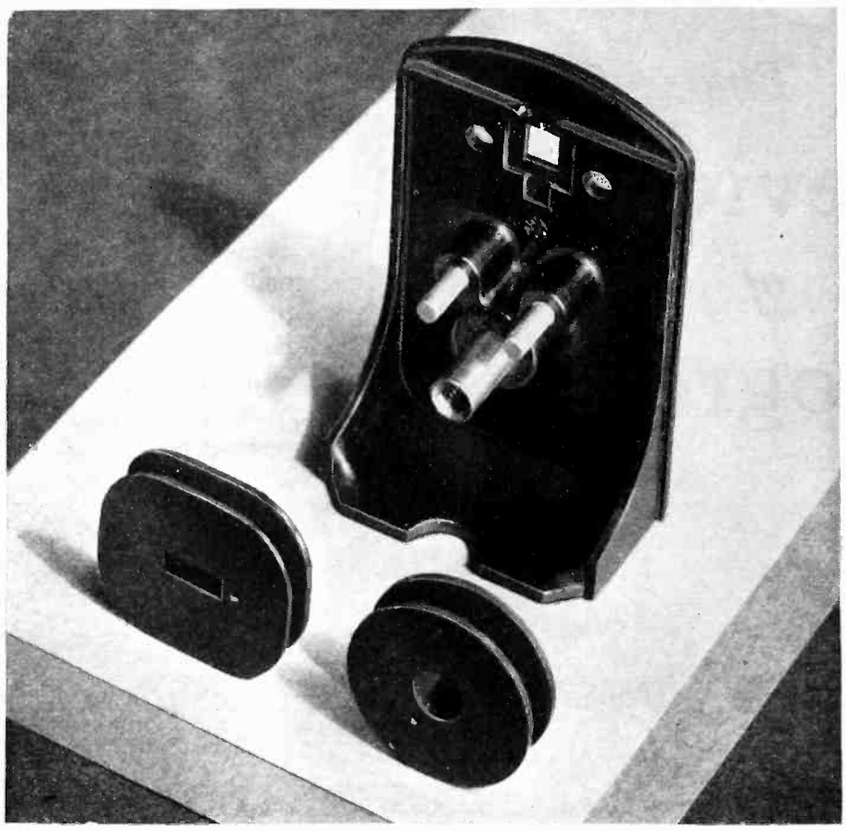

Bakelite Molded back plate and spools used in electric pick-up, made by Webster Electric Co., Racine, Wisc.

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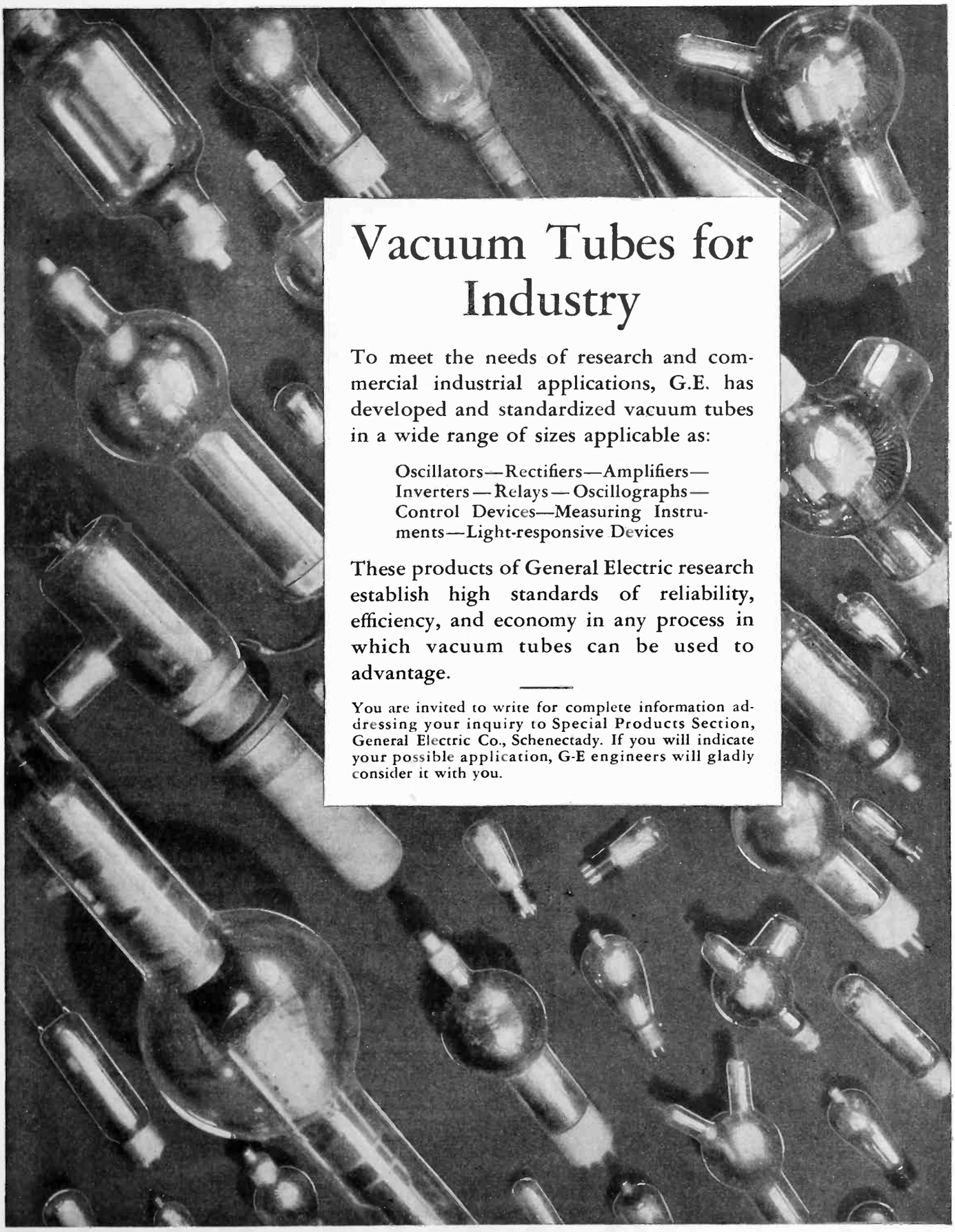

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840-19

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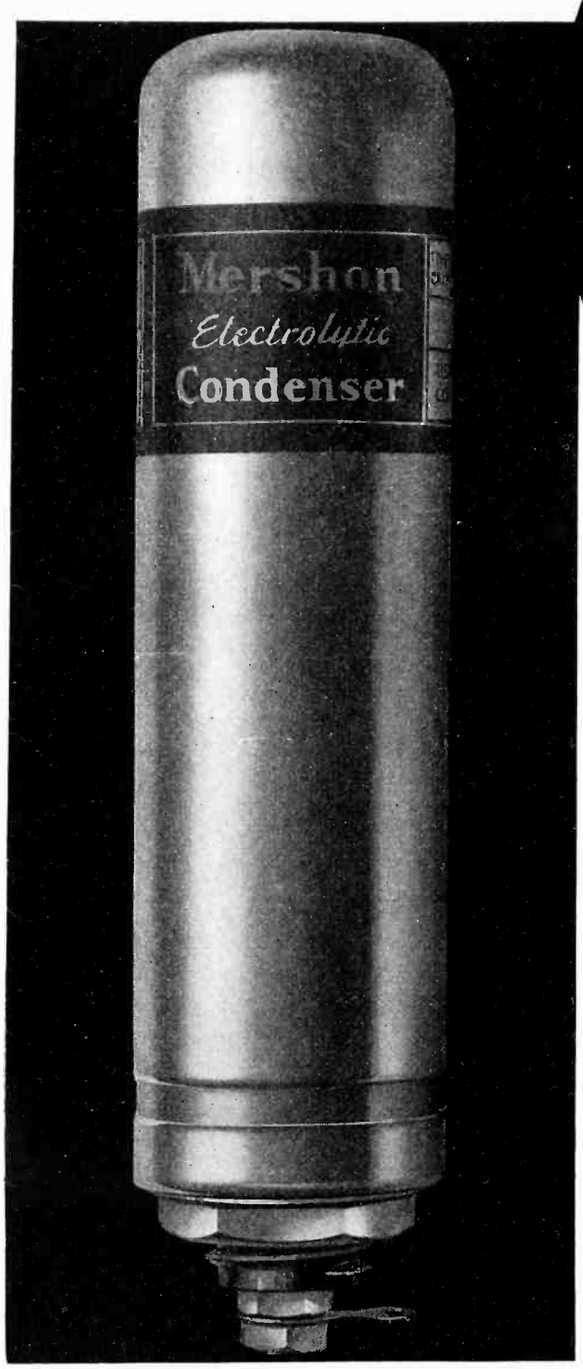

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1,419,564
1,604,122
1,697,954
1,782,387
Other patents pending.
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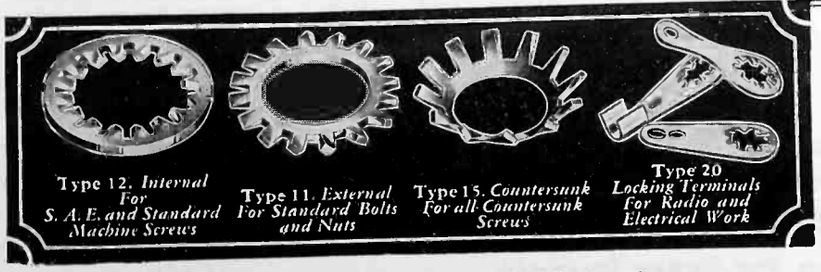

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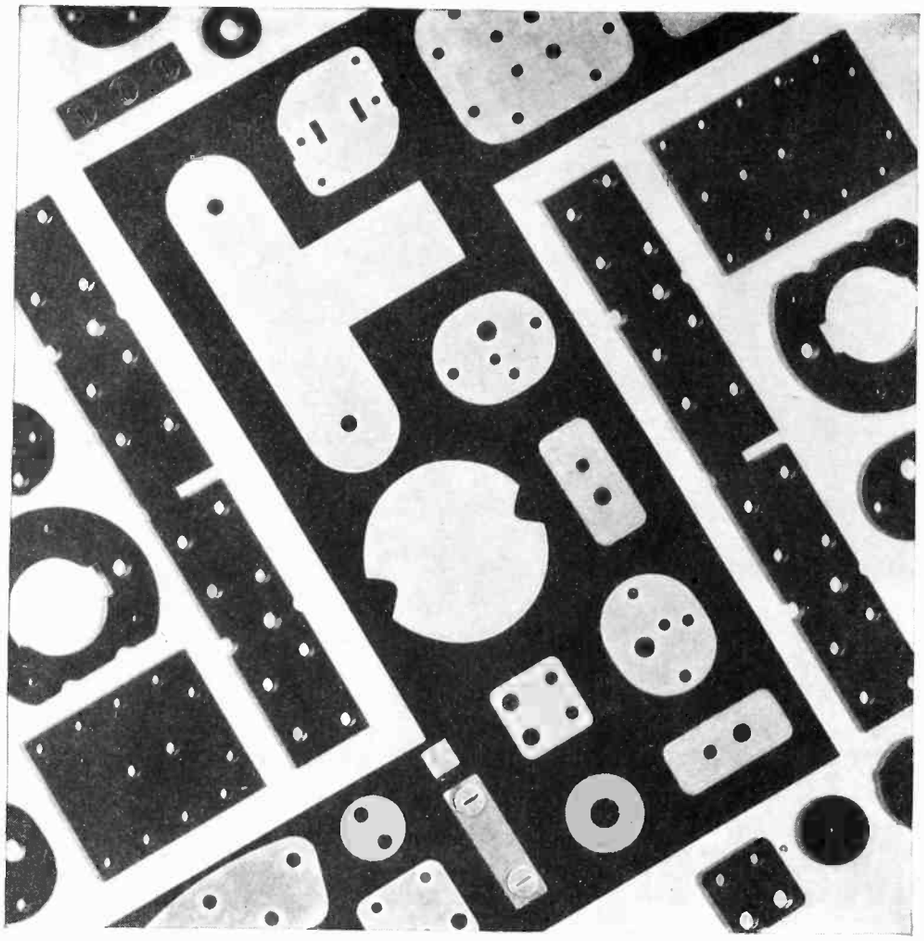

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Smooth, clean cut edges characterize parts that are made of Lamicoid laminated Bakelite punching stock. Holes of any shape can be stamped close to the edges without the slightest danger of developing cracks. The most complicated designs are rapidly and economically formed because this Lamicoid stock possesses, to an unexcelled degree, the necessary resiliency.

This quality is under perfect control. It can be and is being duplicated daily in large quantities. In fact, so outstanding is the uniformity of Lamicoid punching stock that a rapidly increasing number of manufacturers will accept no substitute.

Lamicoid is made in a great variety of finishes and in any required thickness. Our engineers will gladly cooperate with you in determining the best type of Lamicoid for your needs. You incur no obligation by availing yourself of this service.

"An Electrical Insulation for Every Purpose." *Lamicoid* laminated Bakelite sheets, tubes and rods. *Micanite* and *Super-Micanite* built-up mica in sheets, tape, tube and rod form. *Mica* varnished cloth and paper — varnished cambric tubing, etc. Write for Catalog No. 87 to 200 Varick St., New York, or 520 So. Dearborn St., Chicago.

Sales Offices and Stocks at Cleveland, Pittsburgh, Cincinnati, San Francisco, Seattle, Birmingham, Los Angeles, U. S. A., Montreal, Toronto, Canada. *Factories at* Schenectady, N. Y., and London England.

MICA INSULATOR COMPANY

Electrical Insulations

A Type For Every Purpose

You Will Find These Important Plus Values Behind Radio Tubes

Made By

Hygrade Sylvania Corporation

1. *Production Facilities*

The facilities of Hygrade Sylvania permit the economies of mass production (70,000 tubes a day) without any lowering of quality standards. Efficiency in inventory control assures every purchaser of new fresh tubes.

2. *Financial Strength*

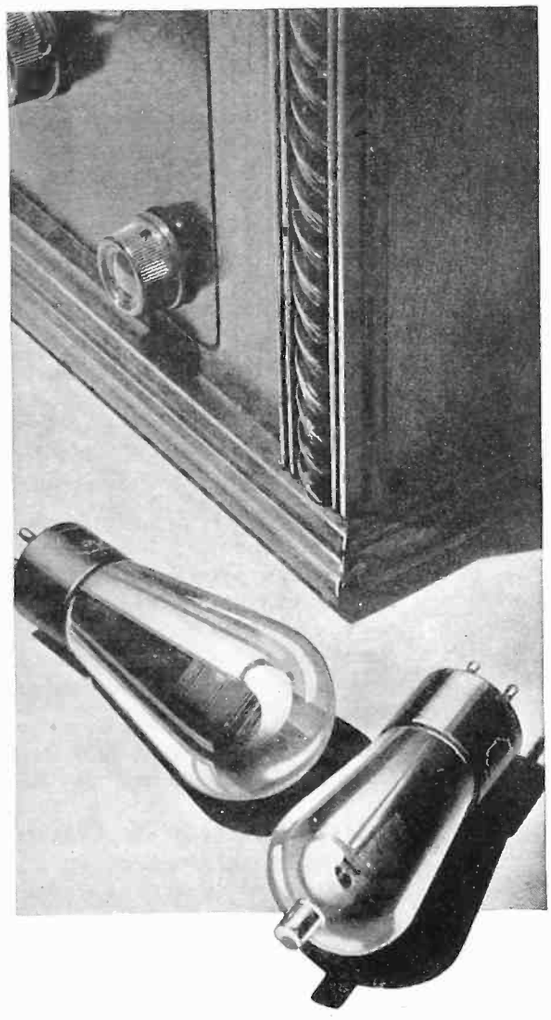
One of the outstanding successes in the tube industry, Hygrade Sylvania offers the assurance of financial strength. There is no danger that economic pressure will effect any let-down in quality or falling off in prestige. This manufacturer is in the business to stay.

3. *Engineering Skill*

The success and growth of Hygrade Sylvania have been attended by the development of a large, highly competent engineering staff, abreast of the latest developments and able to handle the growing demands of the set manufacturer.

4. *Experience*

Hygrade Sylvania has an enviable background of experience, drawn from years of close co-operation with some of the country's most exacting and successful set manufacturers.



NO OTHER RADIO TUBE MANUFACTURER IS GEARED SO WELL TO THE REQUIREMENTS OF THE RECEIVING SET MANUFACTURER

HYGRADE SYLVANIA CORPORATION

HYGRADE LAMP DIVISION
SALEM, MASS.

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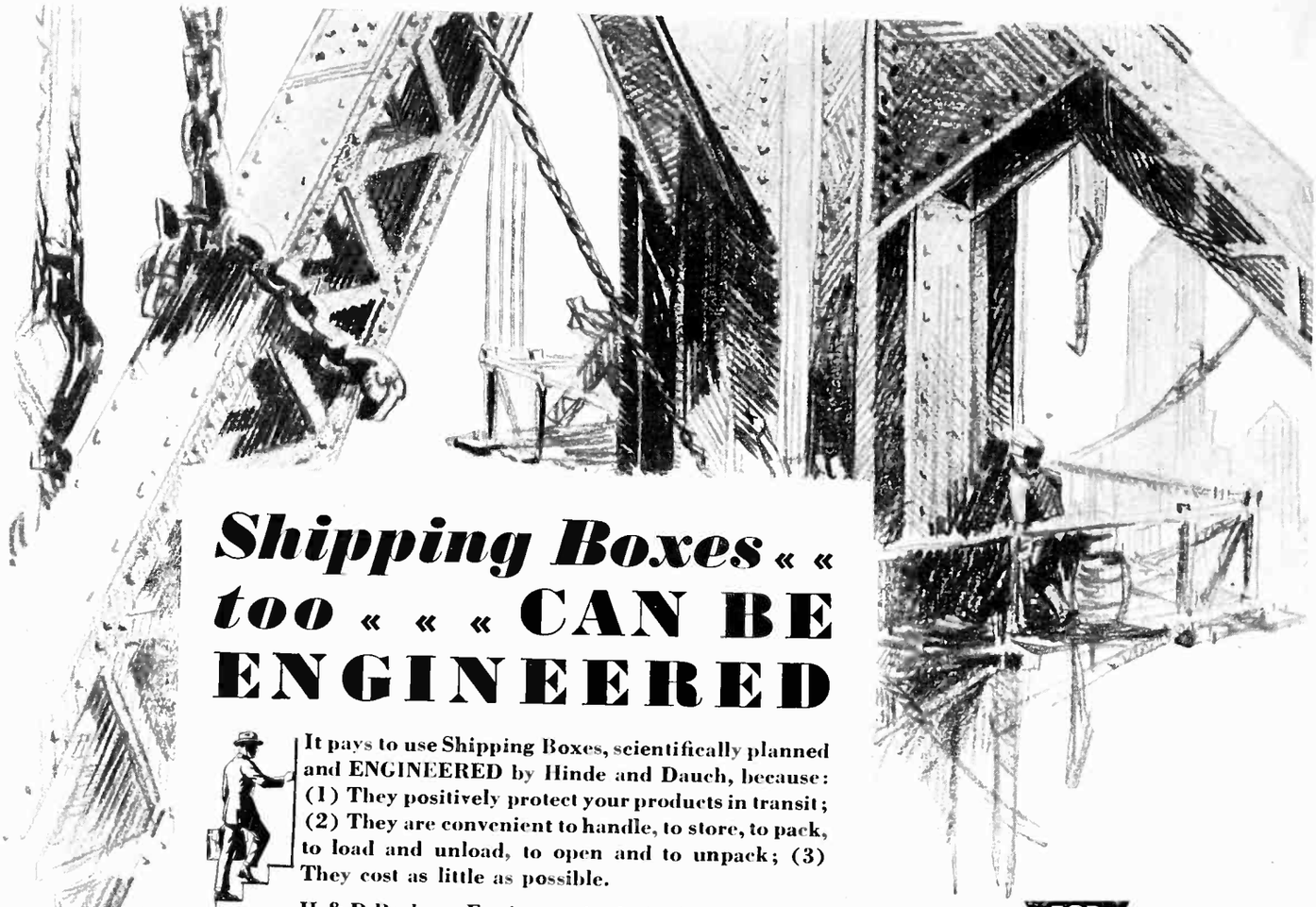
EMPORIUM, PA.



Shipping Boxes « « *too* « « « CAN BE ENGINEERED

It pays to use Shipping Boxes, scientifically planned and ENGINEERED by Hinde and Dauch, because: (1) They positively protect your products in transit; (2) They are convenient to handle, to store, to pack, to load and unload, to open and to unpack; (3) They cost as little as possible.

H & D Package Engineers, in designing a package, take into account such factors as speed in packing, speed and security in sealing, weight distribution, size of package, number of units per package, sales advantage to the user. Above everything else, SAFETY. H & D Engineered Shipping Boxes must give absolute protection to their contents and convey them safely to their destination.

ENGINEERED Shipping Boxes may be obtained, without extra cost, from The Hinde & Dauch Paper Co., Sandusky, Ohio. Send for your free copy of "Package Engineering."

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Western Address: Kansas City Fibre Box Co., Packer's Station, Kansas City, Kansas.
Canadian Address: Hinde & Dauch Paper Company of Canada, Ltd., King Street, Subway and Hanna Avenue, Toronto.

FOR SAFETY THIS MERCHANDISE IS PACKED IN AN H&D BOX

Your customers know that products shipped in Boxes bearing this mark are packed for SAFETY!

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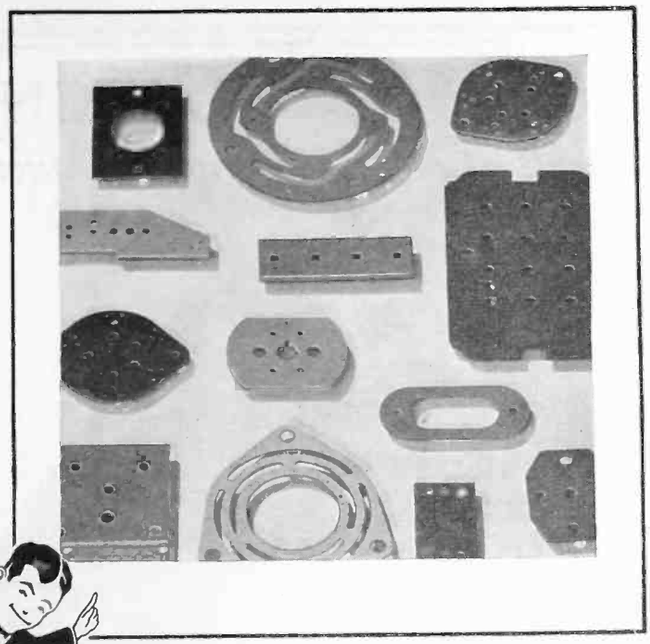


A few representative pieces of Textolite laminated prepared for application to radio receivers

MEET — the Radio-frequency Family of TEXTOLITE LAMINATED

EXHAUSTIVE tests show that in the radio-frequency grade of Textolite laminated the power-factor is so slightly changed by wet or dry conditions that humidity ceases to be a problem. This distinguishing quality, combined with characteristics of easy machinability and mechanical strength, accounts for the use of Textolite in leading radio receivers.

Ask the Textolite specialist at the G-E office in your vicinity, or representatives of the eastern or western fabricators, to outline the properties of this insulating material which make it desirable for application to the set you manufacture.

SHEETS RODS TUBES

General Fabricating Co.
37 East 18th Street
New York City

Electrical Insulation Corp.
308 W. Washington St.
Chicago, Ill.

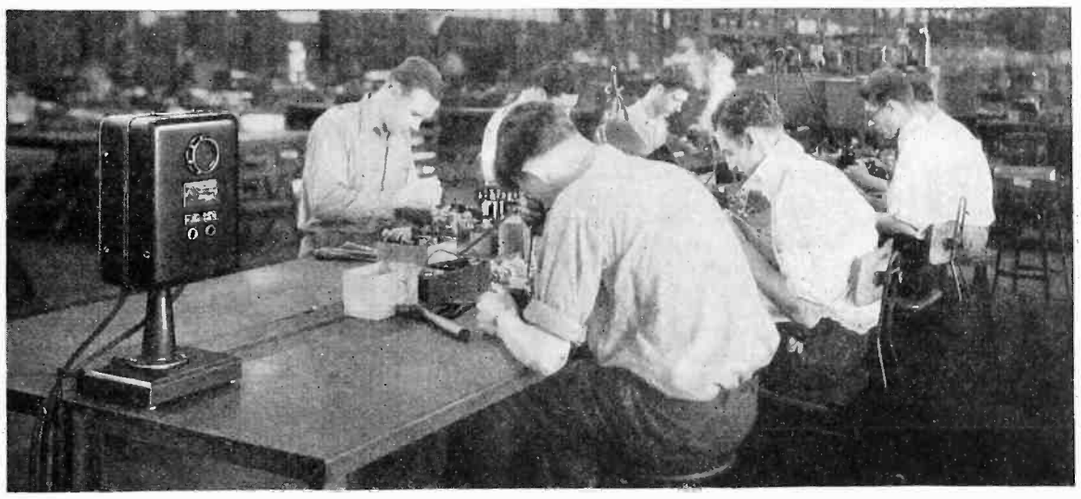
831-4

GENERAL ELECTRIC

SALES AND ENGINEERING SERVICE IN PRINCIPAL CITIES

Better Health—Increased Production—Better Products

Where G-E PHOTOELECTRIC EQUIPMENT protects workers' eyes



G-E indoor light-control unit installed on the production line in the Schenectady plant of General Electric

GENERAL ELECTRIC has built and applied a Type CR7505-D3 photoelectric unit to protect workers against eyestrain caused by insufficient illumination—whether in factory, office, or classroom. The function of this new equipment is simply explained. ● For example, natural illumination from outside the room falls below an adequate level. Before the workers are aware of the change, before eyestrain has begun a definite campaign against personal efficiency, the G-E photoelectric equipment has switched on the artificial lights. When natural illumination returns to normal intensity, the G-E photoelectric equipment again functions, this time to extinguish the artificial lights. ● Better seeing means lower production costs—reduced spoilage, better products, greater safety. Better seeing, resulting from precise, unquestioned control of artificial illumination, calls for G-E photoelectric control. Why not investigate this new key to profit? Your nearest G-E office will be glad to supply complete information.

In the schoolroom. G-E indoor light-control unit installed at rear (arrow)

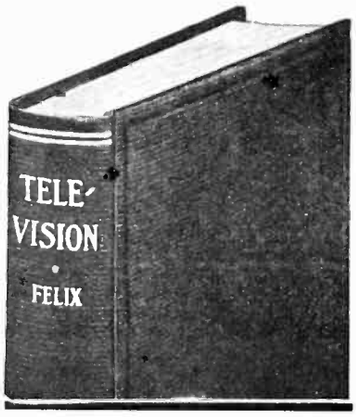
The G-E photoelectric unit for the supersensitive control of factory, office, and schoolroom illumination

301-91

GENERAL ELECTRIC

SALES AND ENGINEERING SERVICE IN PRINCIPAL CITIES

4 *recent* McGraw-Hill Books



***Brown*—Radio Frequency Electrical Measurements**

By HUGH A. BROWN, Assistant Professor of Electrical Engineering, University of Illinois.

386 pages, 6x9, illustrated, $4.00

This book outlines the fundamentals of the standard and also the recently developed radio frequency electrical measurements and explains the methods of procedure and the degree of precision obtainable. It is designed as a combined laboratory textbook and laboratory manual for students of radio communication and radio frequency electrical measurements, and also as a manual and treatise for practicing electrical and radio engineers. The book explains theory and principles; describes the necessary steps in the laboratory procedure of manipulation, and discusses the precision attainable, precautions, and general merits of the method.

***Felix*—Television—Its Methods and Uses**

By EDGAR H. FELIX, Broadcast Consultant; Member, Institute of Radio Engineers.

266 pages, 5½x8, illustrated, $2.50

This book explains the technical principles and processes involved in transmitting and receiving picture-signals. It describes the equipment and devices employed by various systems and evaluates each from the standpoint of general utility and effectiveness. And finally it points out the problems still unsolved and the likely direction of future development.

***Moyer and Wostrel*—Radio Handbook—Including Television and Sound Motion Pictures**

886 pages, 5½x8, 650 illustrations, flexible, $5.00

A comprehensive handbook of radio data, both theoretical and practical, and covering the whole radio field, from the fundamentals of electricity, magnetism and electron theory down to latest applications of radio apparatus and vacuum tubes in industry.

Recording Sound for Motion Pictures

Edited by LESTER COWAN, Manager Technical Bureau, Academy of Motion Picture Arts and Sciences, for the Academy of Motion Picture Arts and Sciences; in collaboration with a group of technical experts, with a preface by WILLIAM C. de MILLE.

404 pages, 6x9, 229 illustrations, $5.00

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MARKET GROWTH *in Three Dimensions*

1. Wider Use of Known Applications of Known Tubes.

Extensions of receiver market into Office, School, Hotel, Airplane Police System, Automobile, Club, Store, Restaurant, etc. Extension of sound amplifier principle into Home and School Talkies; wider use of Electric Phonograph; wider use of Public Address, etc.

2. New Applications of Known Tubes.

Extensions of known tubes into new uses, such as Ultra-short Waves, Light-sensitive Control, Machine Control, D.C. Power Transmission, Therapeutics, Airway Beacons and Compasses, Rectifiers and Inverters, Elevator and Train Control, etc.

3. New Tubes:

Grid Glow, Thyratrons, Mercury Vapor, Cathode Ray, Crater Lamps, Barkhausen Oscillators, Magnetrons, High Output Selenium Cells, Vacuum Switches and Breakers, Light Sources, Cold Cathode Tubes, Neon Illuminating Tubes, etc.

Few other industries offer the marketing possibilities to be found in the electronics field, *Electronics'* staff will be glad to provide technical and commercial market data on products applicable to this field.

ELECTRONICS ABC

A McGraw-Hill Publication

These Production vs. Sales Arguments

which we always hear when business fails to show improvement are amusing—but not very profitable —to the firm. Each side has its troubles and problems to overcome but the solution is seldom found in these man-to-man conferences. It takes new ideas, new thinking, new materials.

What National can do about it

IN THE radio, electrical and mechanical industries the demand for *greater value* is usually laid at the door of the designing department. From there must come the ways and means of reducing cost while maintaining quality. To this department National offers not only two of the most versatile materials known but a technical knowledge of these materials and their qualities which makes practical your original ideas for improvements and economies.

Tell us what you are after and we will get together with your men on the job in question. National's services for experimental work are gratis.

NATIONAL VULCANIZED FIBRE CO.
Wilmington, Delaware

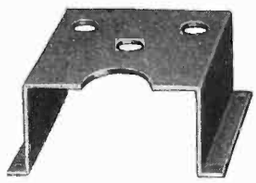
Parts stamped out of NVF Hard Vulcanized Fibre usually cost less than steel; about ¼ the cost of brass, and less than ½ the cost of aluminum.

Glad to quote on any stamped parts which might be made of fibre.

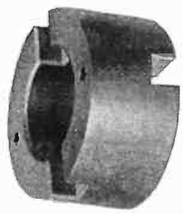
NATIONAL VULCANIZED FIBRE

"The material of a million uses" is continually replacing combinations of metal and insulation in a wide range of electrical and mechanical products.

It is inexpensive to buy and to fabricate. Made in sheets, rods, tubes and special shapes.



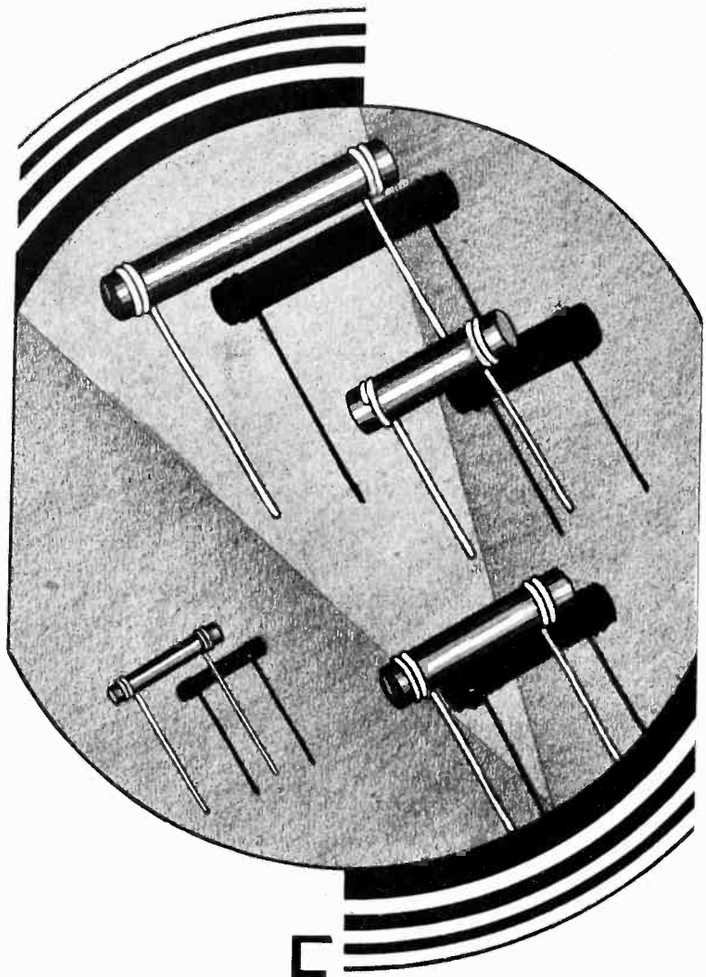
Molded laminated Phenolite channel stock designed to take the place of a complicated assembly of metal and hard rubber. This part was delivered to the manufacturer completely fabricated.



A coupling disc fabricated by National from a grade of Phenolite developed for the known requirements of this particular part—high tensile strength and resistance to wear; unaffected by oi's, acid and moisture; highly shock absorbing.

The electrical industry has found many instances where a very thin, tough and *flexible* fibre of high dielectric strength is an absolute necessity. It discovered too, that *Peerless Insulation* exactly meets their needs.

N V F



ERIE RESISTORS are the result of careful and painstaking manufacturing methods. Daily laboratory checks on the different steps in the manufacturing processes are made. Rigid triple inspection follows.

Users of resistors appreciate the significance of such careful manufacturing methods and many leading manufacturers specify ERIE RESISTORS with their 99.7% perfect record for all of their installations.

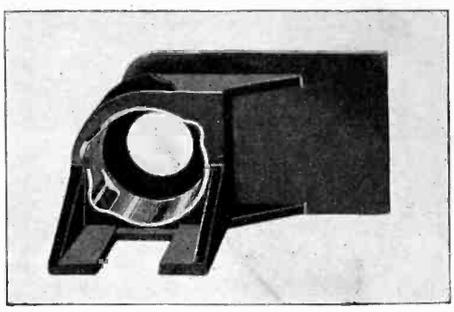
ERIE RESISTORS

Erie Resistor Corporation, Erie, Pa.

In the Center of the Radio Industry

Factories in Erie, Pa. and Toronto, Canada

IT HAD TO BE **PERFECT** TO PERFORM PROPERLY



Absolute accuracy was essential . . . the molded-in metal insert had to be perfectly placed . . . in every unit. There could be no deviation from perfection in this molded radio part . . . that's why its manufacture was entrusted to our skilled engineers. Accuracy is a tradition with us!

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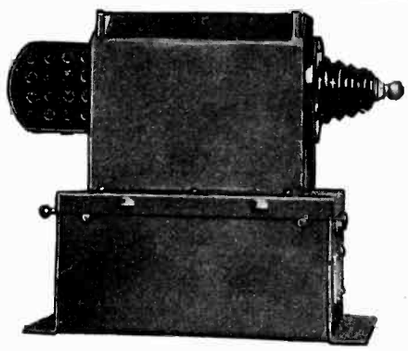


Model "E" Short Wave Oscillator

for

Gas Detection

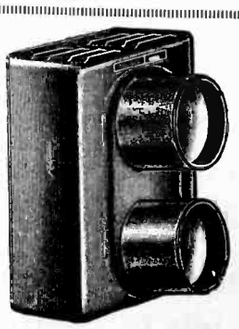
in

Vacuum Tubes

LEPEL HIGH FREQUENCY LABS., Inc.

39 W. 60th St., New York City

Manufacturers of Bombarding Equipment



Regular price $65.00 each. Net price to you—NOW—while they last, $48.75.

25% DISCOUNT

on G-M 1281

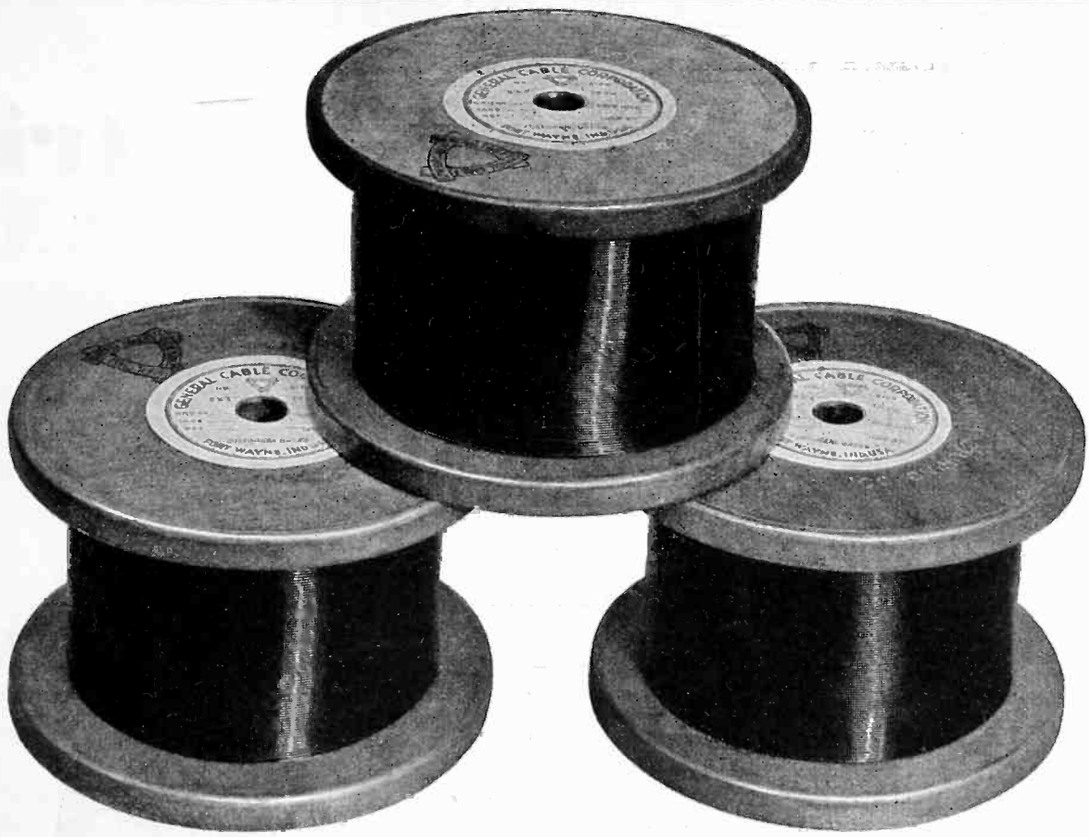
Photoelectric Relays . . . . .

Standard Photoelectric Relays for commercial, industrial, and educational use, complete with lamp, lenses, and Visitron type A photoelectric cell, set up and ready to operate. Slight changes in chassis and case design make it necessary to dispose of present stock of G-M 1281 Relays at a substantial sacrifice while they last. Order immediately as the supply is limited.

G-M LABORATORIES, Inc.

1735 Belmont Ave., CHICAGO, ILL.

MAGNET WIRE
of EVERY TYPE and SIZE

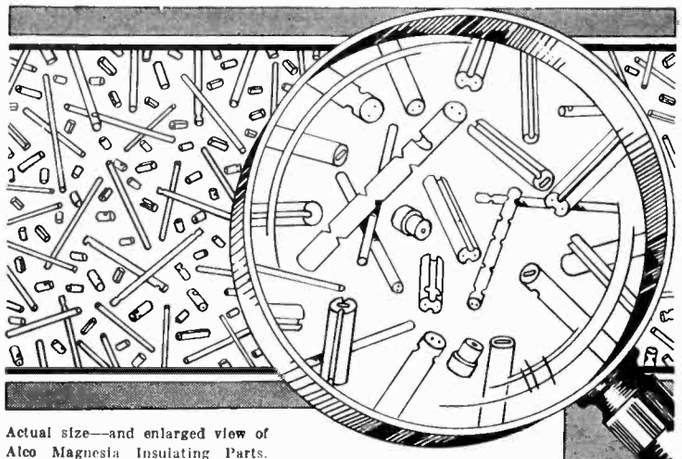


Specify General Cable Magnet Wire! Available in a wide variety of sizes . . . round, flat or square . . . with insulations of enamel, cotton, silk, paper or asbestos. Manufactured under rigid inspection, its uniform high quality will meet the strictest requirements.

COILS General Cable's coil facilities — engineering assistance, manufacturing experience and productive capacity — are at your service.

GENERAL CABLE CORPORATION

EXECUTIVE OFFICES: 420 LEXINGTON AVENUE, NEW YORK • CONSULT OUR NEAREST OFFICE



Actual size—and enlarged view of Alco Magnesia Insulating Parts.

MAGNESIA CERAMICS

For Tube Insulators

Only the purest of Magnesia should be considered.

Such insulators perfectly formed represent the highest achievements in tube insulation.

Our equipment is available for your particular designs.

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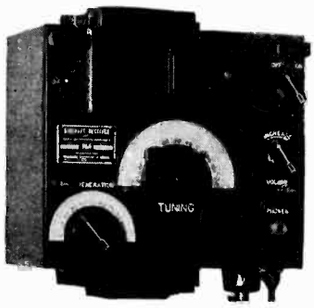
Inquiries Invited

AMERICAN
LAVA CORPORATION
CHATTANOOGA, TENNESSEE

S.S. WHITE RESISTORS



S. S. White Resistors, noted for their reliability, are used in all RCA Aircraft Radio Receivers, Type A. Their small size enables them to be used in compact receivers of this type without loss of quality or efficiency.

S. S. White Resistors are made in six different standard types and are being used extensively for special radio receivers, motion picture sound amplifiers, condenser microphone amplifiers, photo-electric cell amplifiers, traffic controls, geophysical instruments and many other special types of equipment requiring the very best resistors available.

Standard values are carried in stock and special values manufactured up to resistance of 10^{12} ohms.

Further information, descriptive circular, and quotation will be furnished on request.

The S. S. WHITE Dental Mfg. Co.
INDUSTRIAL DIVISION
152 West 42nd Street, New York, N. Y.

A New Circuit

The Engineering Department of the Shallcross Mfg. Company has designed a general purpose

Combination Multi-Range Voltmeter and Milliammeter, A.C. and D.C.

employing the new Weston A.C. and D.C. Type 301 Universal Meter and

SHALLCROSS
Super Akra-Ohm
Wire 

Wound
Resistors

The voltage range is from 5 to 1000 volts, 1000 ohms per volt and the current range is from 1 to 500 Milliamperes A.C. and D.C.

A complete diagram and full information on the construction of this circuit are contained in our Bulletin 150-D, which also contains very useful information on the application of Akra-Ohm Resistors to multi-range voltmeters, ohm meters, etc.

Our new Bulletin 150-K will be sent upon receipt of 4 cents in stamps.

ALWAYS Super AKRA-OHM ACCURATE
Shallcross Mfg. Company
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700 PARKER AVENUE
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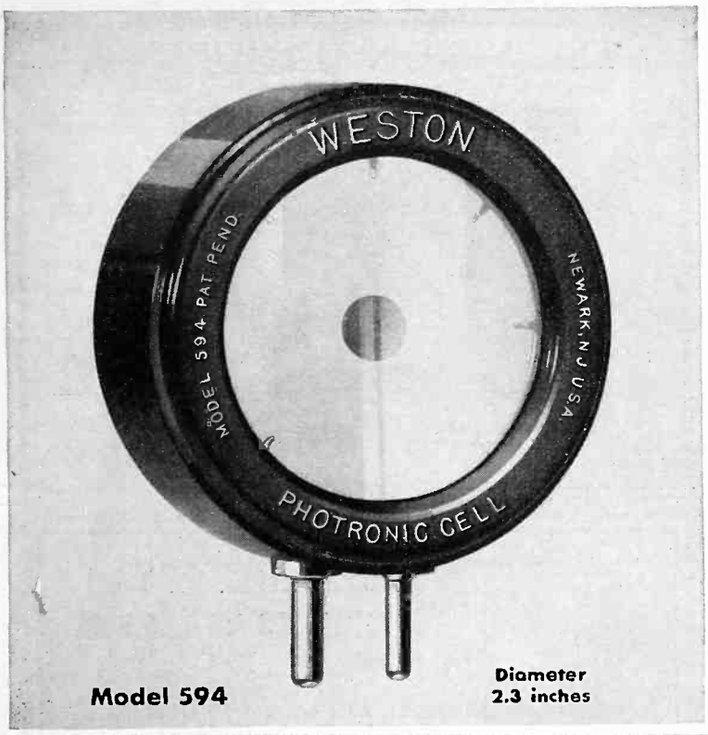
(NEAR PHILADELPHIA)
Accurate NON-INDUCTIVE WIRE WOUND RESISTORS



Model 594

Diameter
2.3 inches

Simplicity and Economy with the new

PHOTRONIC CELL

Now with the new Weston PHOTRONIC CELL, light sensitive cell applications are reduced to a new simplicity. Reliability increased . . . new fields opened . . . present developments advanced.

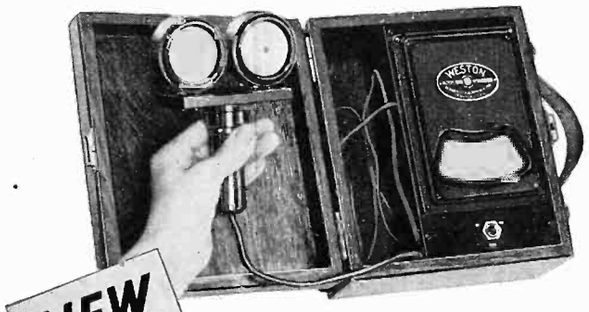
In construction and use, the PHOTRONIC CELL is different—utterly simple—and low in cost. It operates instruments or relays directly. It uses no batteries . . . no polarizing or exciting voltages . . . no amplifiers.

Highly sensitive. Its current output approx. 5 milliamperes in direct sunlight . . . approx. one microampere per foot-candle. No dark current. Response is instantaneous.

Life unlimited as far as known—in use or on shelf. No drifting . . . no readjustment of circuit . . . nothing to replace . . . not easily damaged. Constant characteristics.

Amazing in performance, revolutionizing in operation, the new Weston PHOTRONIC CELL advances light sensitive cell applications to a new degree of reliability, simplicity and economy.

Descriptive details on the new PHOTRONIC CELL, write for Circular YY



NEW

ILLUMINOMETER

(MODEL 603)

using the new PHOTRONIC CELLS

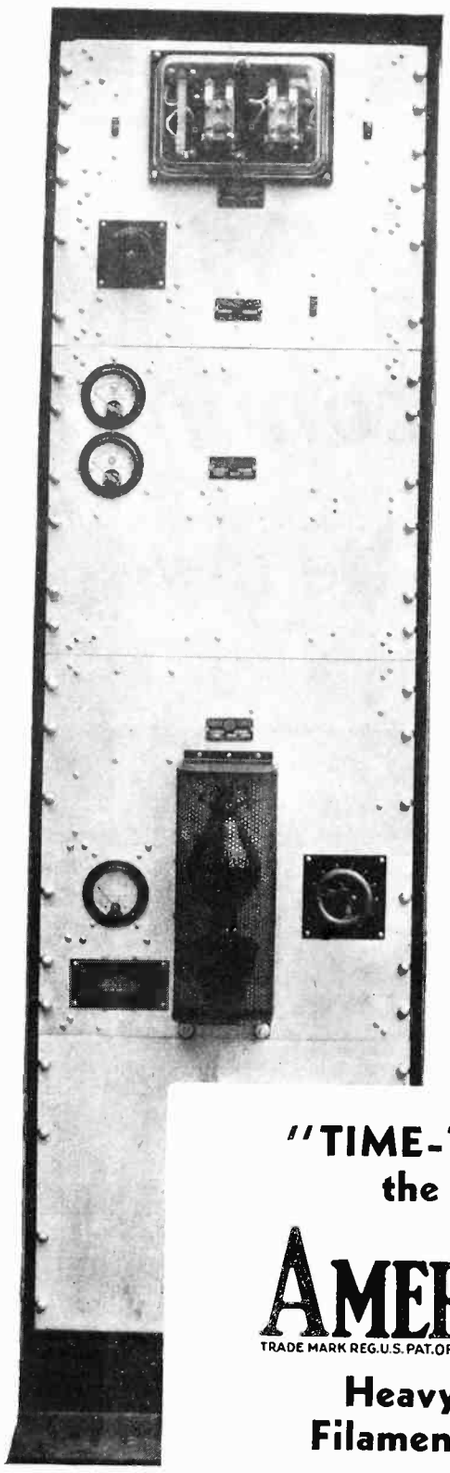
With the new Weston ILLUMINOMETER, one man can make an accurate, reliable illumination survey—just by noting the pointer indication—no adjustments, human error eliminated—high degree of accuracy. This means decided savings in time and labor.

Simple, rugged, compact, the Weston ILLUMINOMETER is a marked improvement—a striking example of how simplicity, accuracy and economy result from use of the new Weston PHOTRONIC CELL.

WESTON

ELECTRICAL INSTRUMENT CORPORATION

618 FRELINGHUYSEN AVENUE **NEWARK, N. J.**



AMERTRAN

A Standard AmerTran 10 Ampere, 12 volt filament supply system (illustrated at left) which includes a power supply, filter system, voltage control and control relay. Similar units are available for D.C. outputs of 3-15-30-60 or 100 amperes at 12 volts or special sizes can be made to your specifications.

"TIME-TESTED" the New

AMERTRAN

TRADE MARK REG. U.S. PAT. OFF.

Heavy Duty Filament Supply

After two years of laboratory experimental work and with many units already giving over a year's satisfactory service in actual installations, the American Transformer Company announces the new AmerTran Heavy Duty Filament Supply System.

These systems have been designed to replace batteries in amplifiers (including low level and high gain amplifiers) and other places where pure direct current is required. They are a worthy companion to the AmerTran Type P-77 plate supply announced last fall.

Write for Technical Data Sheet D1 describing in detail AmerTran 10 Ampere "A" Supply System.

American Transformer Company

Factory and Main Office—
178 EMMET STREET
Newark, N. J.

New York Office
Room 1963
HUDSON TERMINAL
50 Church Street

TELEVISION HANDBOOK

By **Paul A. Kober, AA (Harvard)**
Formerly Television Engineer for General Electric Co.
Chief Engineer Television Laboratories, Inc.
Director School of Television

Price $2.00 (Postpaid)

Announcing the first concise Handbook on *Television*. A technical guide which includes all available data, charts, curves, and material for design and operation of television transmitters and receivers — everything pertaining to the practical development of television.

NOTE: A looseleaf book, with 12 supplements, which will be sent periodically *without additional cost*. The latest exposition in the laboratory will be detailed by this means. The "Television Handbook" is invaluable to the engineer as well as to every experimenter and practical worker.

Ready December 1st. Mail your order direct.

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Interference Eliminators
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These outstanding products embody many decades of manufacturing and operating experience of Siemens & Halske and of Telefunken and command the enthusiastic approval of exacting engineers in the electronics industry the world over. Send for bulletin N.

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Manufacturers of materials and components used in the Radio, Sound and allied fields are assured of market growth based on *technical development* of new Electron Tube devices.

ELECTRONICS ABC

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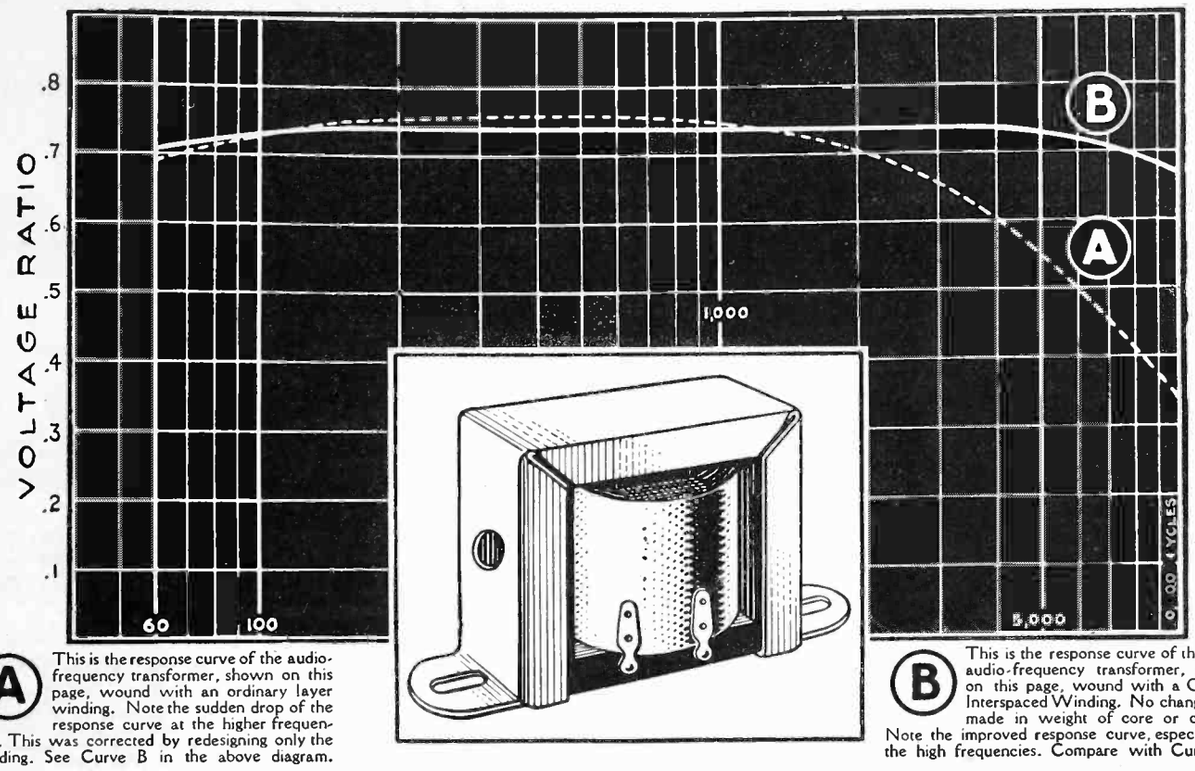
From Transformer Headquarters



A This is the response curve of the audio-frequency transformer, shown on this page, wound with an ordinary layer winding. Note the sudden drop of the response curve at the higher frequencies. This was corrected by redesigning only the winding. See Curve B in the above diagram.

B This is the response curve of the same audio-frequency transformer, shown on this page, wound with a C.T.C. Interspaced Winding. No change was made in weight of core or copper. Note the improved response curve, especially at the high frequencies. Compare with Curve A.

What an Amazing Difference in these two Response Curves

All due to a special C.T.C. winding

The C.T.C. Research Laboratory is producing some remarkable results in improving audio-frequency transformers.

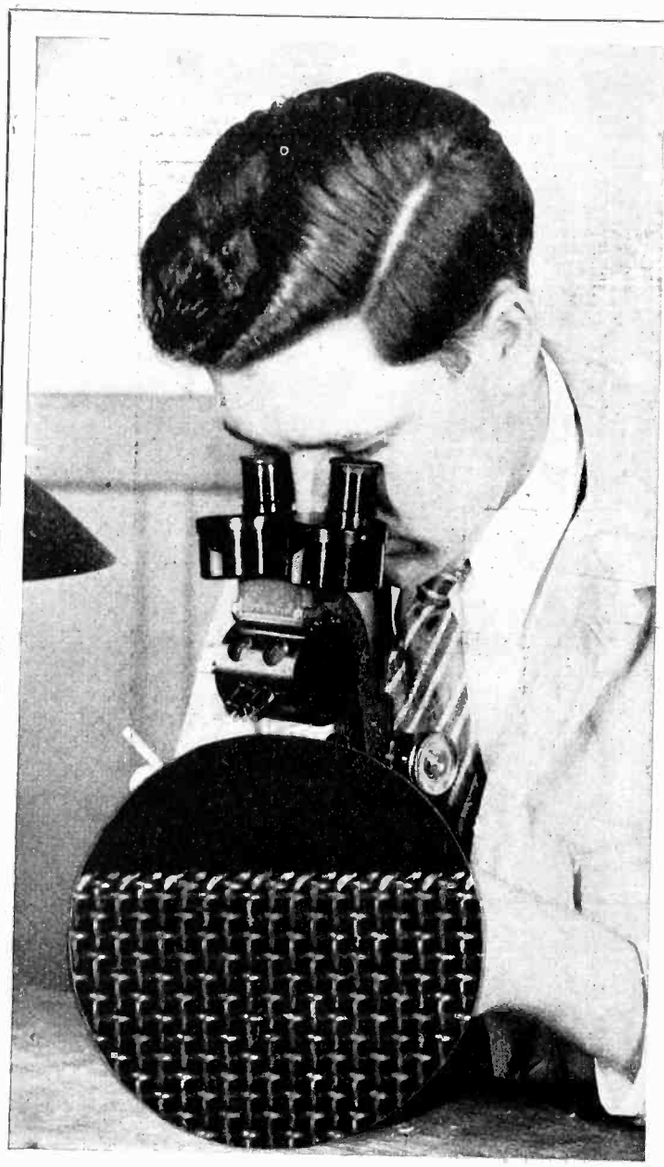
A notable example is illustrated above. Here was a transformer made of standard core material and wound to the usual specifications for use with a 30-type triode amplifier tube which was coupled to a 500 ohm line for either microphone or photoelectric cell operation. The response curve was not satisfactory. The C.T.C. laboratory staff produced a C.T.C. "Interspaced" winding which shifted the response curve from the drooping characteristic "A" to the flat characteristic "B", shown above. This was achieved without the slightest change in core material or in the amount of copper. With only a slight increase in the cost, an extraordinary improvement in performance was achieved by designing the special C.T.C. Interspaced Winding.

C.T.C. Engineers are ready to solve your transformer problems. Let them study your circuits and submit a transformer produced to C.T.C. specifications. Write today.

CTC

CHICAGO TRANSFORMERS

CHICAGO TRANSFORMER CORP., 2628 WASHINGTON BLVD., CHICAGO, U. S. A.



He is examining

"SEALEDGED" GRID SCREEN

REG. U.S. PAT. OFF (*Patented*)

Note the perfect weave, the smooth finish, and the edge that cannot unravel. "SEALEDGED" is the ideal wire cloth for pentode, variable-mu and other modern tubes. Only the purest nickel wire used: 99+% pure nickel.

Molybdenum screen is also available for special applications.

Newark Wire Cloth Co.

355-369 Verona Ave.

NEWARK NEW JERSEY

☐ Without obligating us in any way please send sample and further particulars concerning "SEALEDGED" Grid Screen.
☐ Please advise regarding molybdenum screen.
☐ Please send representative.

Name .....

Firm .....

Street .....

City ..... State .....

HOW DOES ? *THIS SOUND*

FOR A C

Rawson Electronic Microammeters

from FULL SCALE *for*
ONE MICROAMPERE

Also

Rawson Electronic Multimeter

Full Scale

Ranges from 30 microamperes to 1 ampere and 30 millivolts to 1000 volts.

•

These Meters Will Stand Heavy Overloads

•

RAWSON ELECTRICAL INSTRUMENT CO.

Incorporated 1918

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Branch Office:
91 Seventh Avenue
New York City

Mid-Western Representative:
EARL N. WEBBER
Daily News Bldg., Chicago, Ill.

Also Manufacturers of DC Multimeters, Microammeters, Milliammeters and Ammeters, Microvoltmeters, Millivoltmeters, and Voltmeters, Cable Testers, Timers, Earth Current Meters, Fluxmeters, Thermo Junctions, Electrostatic Voltmeters, Wattmeters, etc.

Write for bulletins.

ACME WIRE PRODUCTS

All ACME products are made to recognized commercial standards, including those of:

Nat'l Electric Mfrs. Assn.
Radio Manufacturers' Assn.
Amer. So. for Testing Materials.

Magnet Wire
(All Insulations)

Coils, Magnet Wire Wound

Varnished Insulations
(Cambric, paper, silk, tape)

Parvolt Condensers
(Filter and By-Pass)
also condensers for Power Factor Correction

Aerial Wire
(Stranded and Solid)

For over 25 Years, suppliers to the largest radio and electrical manufacturers.

THE ACME WIRE CO.

New Haven, Conn.

Cuts down SHRINKAGE LOSSES on hard-to-make tubes

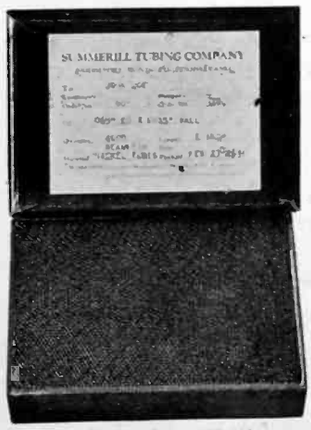
Tube manufacturers find there are big advantages in using Summerill Seamless Nickel Tubing to support and space elements in pentode, variable-mu and other new, hard-to-make tubes. That's why so many have standardized on these super-excellent tubes.

Mechanical accuracy, size uniformity and perfect condition on arrival combine to bring down percentage of rejects to new records in tube production . . . assure rapid assembly.

Chemical purity—vitally necessary for uniformity of operation, high emission and long tube life—is a recognized characteristic of Summerill Tubing.

Ample manufacturing facilities enable us to meet any demands . . . to ship promptly . . . 24-hour deliveries, when required.

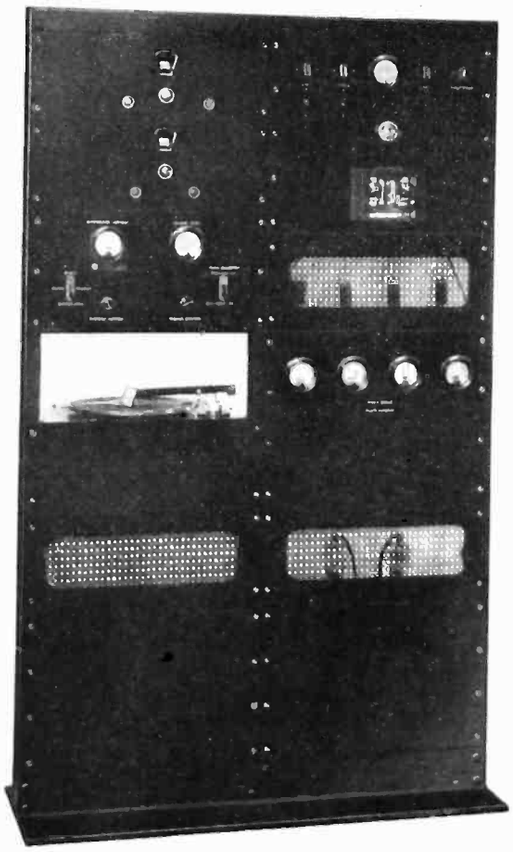
We ship on guaranteed schedules in amounts sufficient to keep your plant at capacity, yet without overstocking.



PROMPT DELIVERIES
anywhere—any time—any quantity

The scientific care used in making Summerill Seamless Nickel Tubing is carried through until it reaches you. It is packed in a sturdy box carefully made to insure the contents against all shocks in transport. It assures perfect condition of the tubing when it reaches you.

THE SUMMERILL TUBING CO.
Founded 1899
BRIDGEPORT (Philadelphia District) PENN.



Illustrating one model of Webster-Chicago custom-built rack and panel amplifier. Finished workmanship and engineering superiority is guaranteed.

Amplifiers by Webster-Chicago

The Webster-Chicago Company is now ready with its new and complete line of Sound Amplifying Devices—small amplifiers for home talkies, rack and panel units for all types of public address and centralized radio and sound picture work—special equipment for broadcasting stations. Custom-built amplifiers designed and manufactured to meet your particular requirements.

Webster-Chicago has established an international reputation in the sound-amplifying field. Our engineers will be glad to assist you in your amplifier problems. Inquiries from you will bring prompt response—let us send you our latest catalog and bulletins on Webster-Chicago sound-amplifying devices.

THE WEBSTER CO.

850 BLACKHAWK ST. CHICAGO

I. R. E. REMINDER...

Be sure to get the latest specifications on Gilby tube materials and resistance wires.

Gilby engineers are constantly developing new products—improving processes to meet requirements for new and better materials in the advancement of the electronic arts.

Our methods conform to most rigid specifications and help bring manufacturing shrinkage to a minimum.

GILBY PRODUCTS

Filament...Grid Materials...Plate Materials...Nickel Wire and Sheet...Nickel Mesh—plain and selvage. Carbonized Nickel and Mesh...Nickel Chrome Alloys... Nickel Copper Alloys...Manganin.

These materials in wire and sheet form, covered with cotton, silk and enamel.

GILBY WIRE CO.

WILBUR B. DRIVER, *President*

NEWARK, N. J.

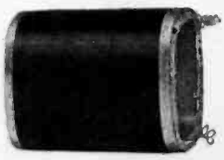
Coil Costs Reduced To New Low Levels

New developments in automatic coil winding machinery completely upset all previous coil manufacturing costs.

Two new "Universal" models are now available, for paper-filled coils, or for cross-wound radio coils. Both machines are fully adjustable for a wide range of work.

Glad to send you details—futhermore, to demonstrate how coil winding costs can be reduced remarkably by these new machines.

Coil wound on No. 84 Universal 4-Coil Winding Machine.



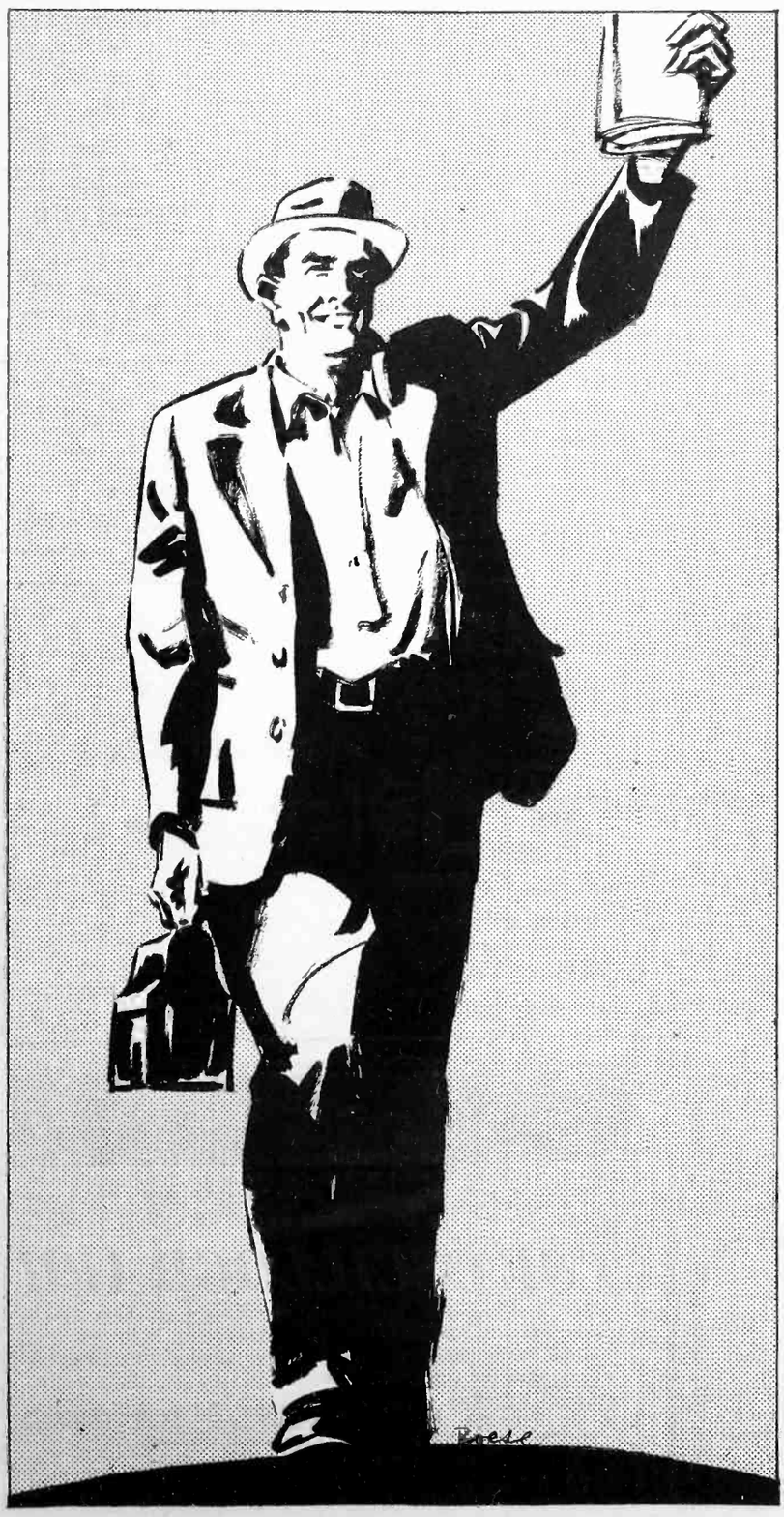
Power Amplifier Transformer Coil wound on No. 104 "Universal" Multi-Coil Winder.

LEESONA

UNIVERSAL WINDING COMPANY—BOSTON

Keep his head up

and we'll all come through!



You recognize this man. He lives in your own town, not far from you . . .

Though faced with unemployment, he is combating adversity with courage. He has retreated step by step, but fighting. He has spread his slender resources as far as they will go.

This winter he and his family will need your help.

There are many other heads of families much like him in the United States. This winter all of them will need the help of their more fortunate neighbors.

This is an emergency. It is temporary. But it exists. It must be met with the hopefulness and resource typical of American conduct in emergencies.

Be ready! Right now in every city, town and village, funds are being gathered for local needs—through the established welfare and relief agencies, the Community Chest, or special Emergency Unemployment Committees . . .

The usual few dollars which we regularly give will this year not be enough. Those of us whose earnings have not been cut off can and must double, triple, quadruple our contributions.

By doing so we shall be doing the best possible service to ourselves. All that America needs right now is courage. We have the resources. We have the man power. We have the opportunity for world leadership.

Let's set an example to all the world. Let's lay the foundation for better days that are sure to come.

The President's Organization on Unemployment Relief

Walter S. Gifford

WALTER S. GIFFORD, DIRECTOR
Committee on Mobilization of Relief Resources

Owen D. Young

OWEN D. YOUNG, CHAIRMAN

The President's Organization on Unemployment Relief is non-political and non-sectarian. Its purpose is to aid local welfare and relief agencies everywhere to provide for local needs. All facilities for the nation-wide program, including this advertisement, have been furnished to the Committee without cost.

PROFESSIONAL SERVICES

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

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Designers, developers, and manufacturers of accessories and essentials for recording, broadcasting and testing at sound frequencies.
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Cable Address: Jenkadair *Telephone:* Keystone 2130

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Phone: Montclair 2-2176

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159 Prospect St., Cambridge, Mass.

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ELECTRON RESEARCH LABORATORY
Vacuum tube and photocell applications. Radio and audio frequency measurements and design of all kinds.
HOWARD E. RHODES
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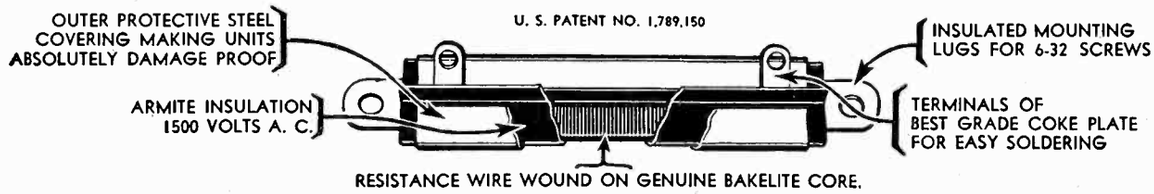
This Service Directory
is designed to give you the kind of services that will be of real value to your business.
Take advantage of it.

WIRELESS EGERT ENGINEERING, INC.
179 Varick Street, New York City
Barclay 7-3583
Electrical Engineers
Apparatus involving the use of the electron tube *designed* and *constructed* to conform with your needs.

CANDOHMS
THE LEADING RADIO RESISTOR



May we submit Samples and Quotations?

MEMBER RMA

THE MUTER COMPANY
1255 So. Michigan Ave., Chicago Phone—Calumet 3700

YAXLEY
APPROVED RADIO PRODUCTS

Special facilities for the production of accessories for radio, audio, visio and industrial electronics.

Send for full information

YAXLEY MFG. CO.
Chicago—Illinois

Volume Controls
Switches
Program Selectors
Jacks
Phone Plugs
Terminals
Terminal Strips
Resistances
Radio Convenience Outlets

LEFT: Oscillogram of a 0-1 Milliammeter (D'Arsonval Type) under a short-circuit of 110 Volts, D.C. Note the oscillograph drum made almost a complete revolution before the instrument burned out. Time—.173 seconds. **RIGHT:** The 1/32 amp. Littelfuse under the same test. Blowing time—.001. seconds.

THE OSCILLOGRAPH

tells the story how Littelfuses protect under short circuit conditions. Made in 1/100, 1/32, 1/16, 1/8, 1/4, 3/8, 1/2, 1 and 2 amps. capacity. Also made in 1,000, 5,000 and 10,000 volt ranges for transmitters, etc.

RADIO FUSES: 1, 1½, 2 and 3 amps. Use ⅛ amp. Littelfuse in the B circuit on auto and battery sets. *Special mountings available.* *Send for your catalog or samples—today.*

LITTELFUSE LABORATORIES
1772 Wilson Ave. **Chicago, Ill.**

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Discount of 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

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An advertising inch is measured vertically on one column, 3 columns—30 inches—to a page.

Electronics

COPY FOR NEW ADVERTISEMENTS RECEIVED UNTIL 3 P. M. ON THE 24TH FOR THE ISSUE OUT THE 2ND OF THE FOLLOWING MONTH

POSITION WANTED

ENGINEER, acquainted with design and application of cathode ray tubes, desires connection with manufacturer contemplating entering that field. Full time or consulting basis; 15 years designing radio and electronics fields. PW-25, Electronics, 330 West 42nd St., New York.

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Wish to Purchase Electronics

Odd copies current or back issues as well as other Scientific Journals. We carry a fair stock of Scientific Journals of back issues. B. Login & Son Inc., 29 East 21st St., New York.

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

Of Electronics, published monthly at New York, N. Y., for October 1, 1931.

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

Before me, a Notary Public in and for the State and county aforesaid, personally appeared C. H. Thompson, who, having been duly sworn according to law, deposes and says that he is the Secretary of the McGraw-Hill Publishing Company, Inc., publishers of Electronics, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 411, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

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Publisher, McGraw-Hill Publishing Company, Inc., 10th & 36th St., N. Y. C.

Ave. & 36th St., N. Y. C. Editor, O. H. Caldwell, 10th Ave. & 36th St., N. Y. C. Managing Editor, None. Business Manager, Maurice Clements, 10th Ave.

2. That the owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding one per cent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a firm, company, or other unincorporated concern, its name and address, as well as those of each individual member, must be given.) McGraw-Hill Publishing Company, Inc., 10th Ave. & 36th St., N. Y. C. Stockholders of which are: James H. McGraw, 10th Ave. & 36th St., N. Y. C. James H. McGraw, Jr., 10th Ave. & 36th St., N. Y. C. James H. McGraw, James H. McGraw, Jr and Malcolm Muir, 10th Ave. & 36th St., N. Y. C., Trustees for: Harold W. McGraw, James H. McGraw, Jr., Donald C. McGraw, Curtis W. McGraw, Curtis W. McGraw, 370 Seventh Ave., N. Y. C. Donald C. McGraw, 10th Ave. & 36th St., N. Y. C. Harold W. McGraw, 285 Madison Avenue, N. Y. C. Anne Hugus Britton, 10th Ave. & 36th St., N. Y. C. Mason Britton, 10th Ave. & 36th St., N. Y. C. Edgar Kobak, 10th Ave. & 36th St., N. Y. C. Grace W. Mehren, 2440 Lakeview Ave., Chicago, Ill. J. Malcolm Muir & Guaranty Trust Co. of New York, Trustees for Lida Kelly Muir, 524 Fifth Ave., N. Y. C. F. S. Weatherby, 271 Clinton Road, Brookline, Mass. Midwood Corporation, Madison, N. J., Stockholders of which are: Edwin S. Wilsey, Madison, N. J. Elsa M. Wilsey, Madison, N. J.

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5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the six months preceding the date shown above is (This information is required from daily publications only.)

C. H. THOMPSON, Secretary.

McGRAW-HILL PUBLISHING COMPANY, INC.

Sworn to and subscribed before me this 28th day of September, 1931.

[SEAL] H. E. BEIRNE,

Notary Public N. Y. Co. Clk's No. 203, Reg. No. 3B102. Kings Co. Clk's No. 636, Reg. No. 3129.

(My Commission expires March 30, 1933)

electronics

M. E. HERRING, *Publishing Director*

M. CLEMENTS, *Sales Manager*

Contents for NOVEMBER, 1931

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CABLE ADDRESS:

Published monthly on the 15th. regular issue. Entered as second-the Post Office at New York, N. 1879. Printed in U. S. A.

Member A.B.P.

Index to Advertisers

Searchlight Section—*Classified Advertising*

C., 330 WEST 42d STREET, NEW YORK, N. Y.
Aldwych House, Aldwych 883 Mission St., SAN FRANCISCO

"MACHINIST, N. Y."

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

Member A.B.C.

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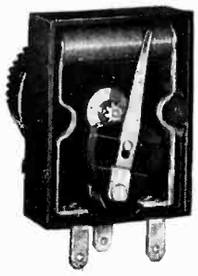
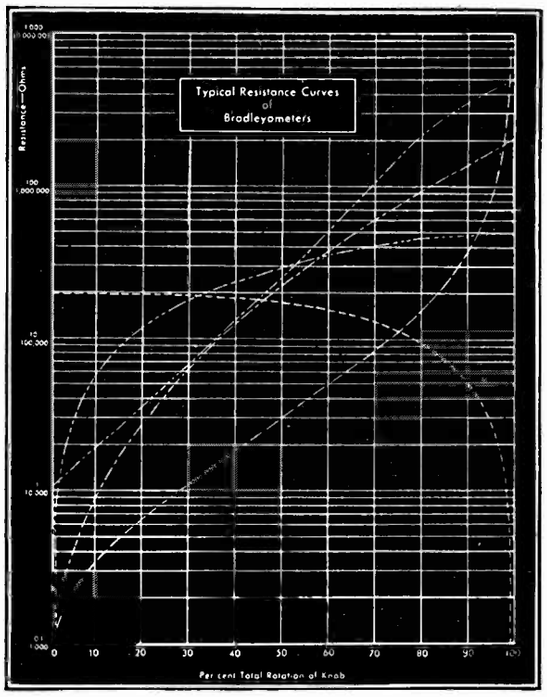
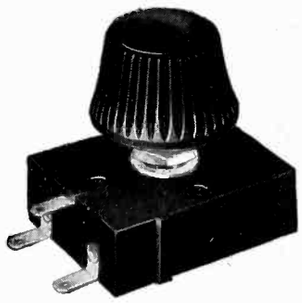


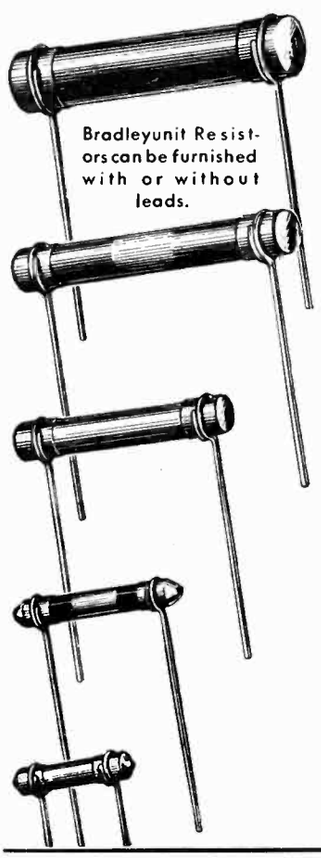
In the Bradleyometer approximately 50 solid resistance disks are interleaved between metal disks, forming a resistance column that will produce any form of resistance-rotation curve, as shown to the right.





The Bradleyometer is a "stepped" potentiometer for volume level control and tone control. Can be furnished with one to six units operated by one knob. Ideal for sound recording, telephone lines, etc.

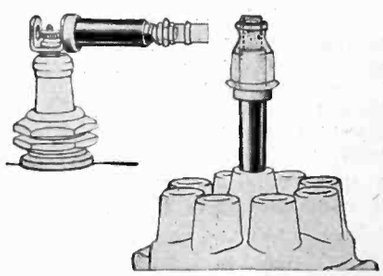
Every Radio Engineer
should have the latest data on these remarkable resistors



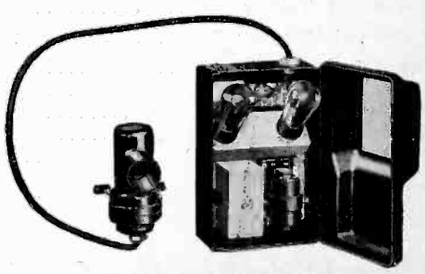
Bradleyunit Resistors can be furnished with or without leads.

Bradleyunit Resistors are made in five sizes, with or without leads. All Bradleyunits are color-coded to meet set manufacturers' specifications. These solid molded resistors are accurately calibrated and have great mechanical strength. They are used by the world's largest radio manufacturers for providing correct C-bias, plate voltage, screen grid voltage, and for use as grid leaks. Get an Allen-Bradley quotation on your next order.

Bradley Suppressors are special solid molded resistors which minimize the disturbing oscillations in the ignition circuit of cars equipped with radio resistors. They resist the destructive effects of heat, moisture, and age. They are the last word for motor car radio. Send for complete data.



Bradley Suppressors installed on spark plugs and distributor of radio-equipped car.



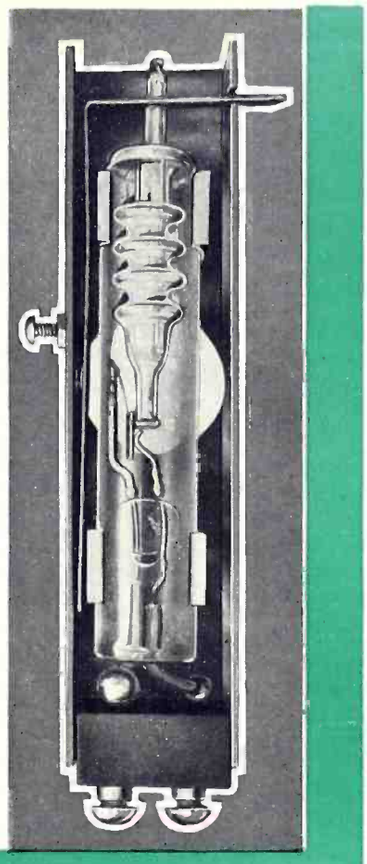
Allen-Bradley Bulletin 880 Photo-electric Relay used with Allen-Bradley Bulletin 875 Light Source. Can be furnished in water-tight enclosures for outdoor service. Send for Bulletins 875 and 880 today.

Allen-Bradley Co.

110 W. Greenfield Ave. Milwaukee, Wisconsin

ALLEN-BRADLEY RESISTORS
Produced by the makers of Allen-Bradley Control Apparatus

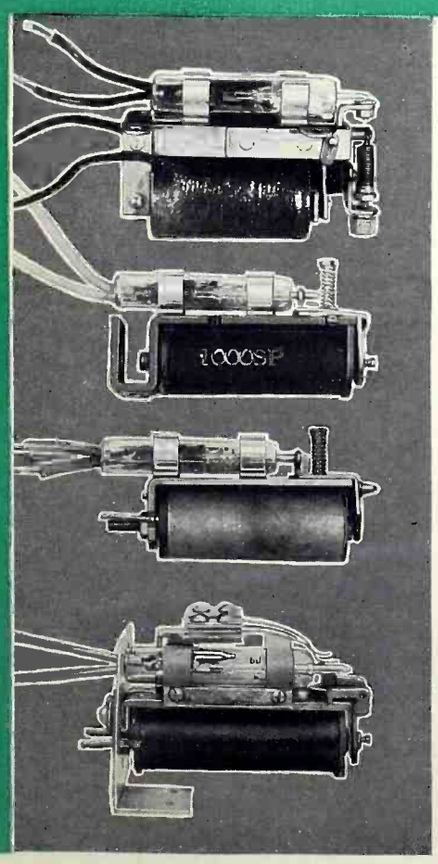
STANDARD RELAY + BURGESS VACUUM CONTACT = POWER RELAY



MULTIPLYING the usual power-handling capacity 700 times, the Burgess Vacuum Contact is applicable to most relays. Readily attached with fuse clips, straps, or in convenient mounting. Slightest armature movement actuates contact set for normally open or normally closed circuit.

Relay manufacturers are now equipping relays with Burgess Vacuum Contacts, as shown below. Operating on a few milli-amperes, these sensitive power relays feature clean makes and breaks even at high speeds, complete freedom from dust, dirt and moisture, flameproof operation, and long service life.

BURGESS VACUUM CONTACT MOUNTING



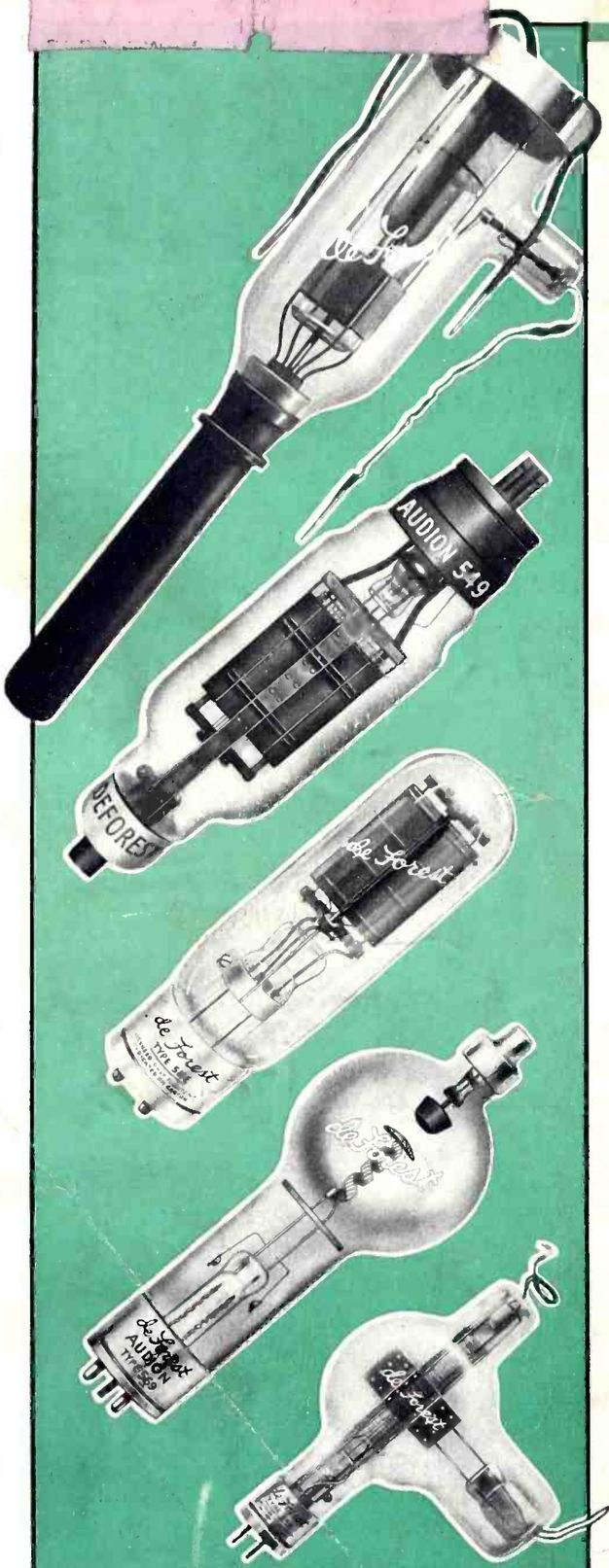
For utmost convenience, the vacuum contact is now available in a standard mounting as shown above. Heavy casing, nickel finished, protects glass mechanism. Link extends through slot and connects with actuating force. Adjustment screw regulates pressure applied on extension stem of vacuum contact. Mounted for normally open or normally closed circuit operation. Screw binding posts. This contact device requires but .02 inch, or from 6 to 10 ounces, to operate. Rated at 6 amperes continuously or 8 amperes intermittently at 220 volts. May be actuated manually, mechanically, electrically or thermostatically, controlling any circuit handling up to 1350 watts.

Write for data on the Burgess Vacuum Contact Mounting, as well as relays fitted with the Burgess Vacuum Contact. Our engineers are always ready to co-operate with you in the application of Vacuum Contact or the Burgess Radiovisor Bridge (light-sensitive cell) to any equipment or requirement.

BURGESS BATTERY COMPANY

202 East 44th Street, New York City

111 West Monroe Street, Chicago



An Audion for Every Need

SINCE 1906, when Lee De Forest gave the world its practical vacuum tube, De Forest engineers have engaged in unrelenting research and development.

A quarter century of pioneering continues. Original work in every phase of tube theory, tube design, tube production and tube application characterizes the products of the De Forest Radio Company.

There is a De Forest Audion of every standard and special type to meet every need. Each Audion is the De Forest version of a given type, incorporating obvious refinements and improvements. In addition, the De Forest engineers work out the most practical applications for their Audions, even to complete De Forest transmitters, amplifiers and allied equipment. Only in this manner can the heritage of true pioneering be justified and maintained.

After all, there's no substitute for 25 years' experience

Write for literature descriptive of De Forest receiving and transmitting audions, as well as De Forest transmitting equipment.

de Forest
(AUDIONS)
RECEIVING AND TRANSMITTING TUBES

DE FOREST RADIO COMPANY

PASSAIC, NEW JERSEY

Export Department
304 E. 45th Street
New York

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Chicago, Ill.