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electronics

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

Film recording and reproducing

✦

A new voltage quadrupler

✦

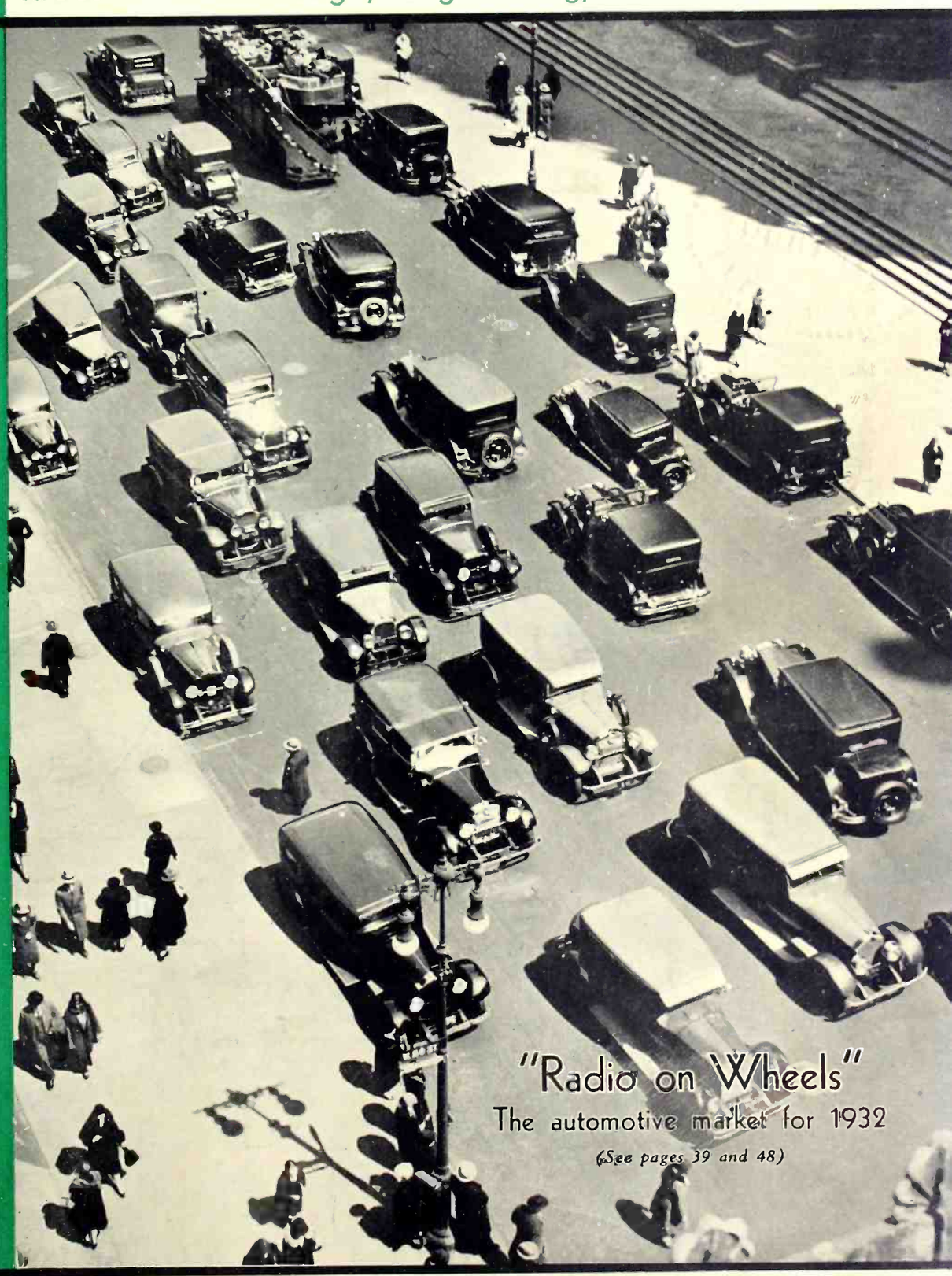
Electron tubes in medicine

✦

A chart of sound levels

✦

Loudspeaker efficiency



"Radio on Wheels"
The automotive market for 1932
(See pages 39 and 48)

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FEBRUARY 1932

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Maximum Peak Inverse Voltage 7500 Volts
Maximum Peak Plate Current 0.6 Amperes
Approximate Tube Voltage Drop 12 Volts
**Interchangeable with '66 types*

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Approximate Tube Voltage Drop 10 Volts
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ARCTURUS

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electronics

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New York, February, 1932

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Radio on wheels

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

WITH sixteen million of the homes of America already equipped with radio sets, it is logical that the radio industry next consider the nation's automobiles. For here is the next remaining "frontier" to be conquered for radio.

Some 23,000,000 passenger cars are now registered in the 48 states of the Union, and during 1932 at least 2,100,000 more cars will be sold. Looked at from any angle, here is a prodigious potential market for radio sales.

During 1931 sales of automobile radio sets probably reached 125,000. For 1932, the figure will undoubtedly double, totaling 250,000 auto radios. New firms have recently come into the field, and as the years go on, it is likely that the number of radio sets in cars will increase rapidly, just as home radio sets suddenly expanded back in 1922 and 1923.

NOR is radio the only use for electronic tubes brought in by the automobile. The new loads put on the storage battery (radio, cigar lighters, etc., with shorter charging periods due to free-wheeling) make auxiliary tube-chargers essential in many cases. And inverters, for supplying alternating current from the storage battery, comprise one of the most interesting developments of the past year. Perhaps a tube-oscillator auto horn will be the next craze in de luxe appointments, permitting rich musical chords and cheerful bugle melodies!

Meanwhile the automobile has created a traffic problem, which is solved by crossing signals, actuated by photocells, electrostatic trips, or delicately poised magnetic yokes, while the timing of the lights in proper sequence is accomplished by discharging condensers through tubes, without any moving or rotating parts, and with much greater facility of adjustment.

IN fact such signals in the future may show up on the driver's own dashboard. This could be easily accomplished by laying a high-frequency cable along the curb, which would actuate a detector tube and green signal light in the car while energized, changing the dashboard signal to red for "stop" when the high-frequency is cut off for cross-street traffic.

In some western cities, the neon-tube light has already been employed for warning flasher work, making it economical to operate these flashing roadway signals for long periods from batteries, without tearing up the street to install underground cables.

Apparently the electronic art is now just "finding itself" in the vast domain of automotive transportation. The next few years may see it go far among the varied branches of an industry that in normal years already collects four and a half billion dollars annually from the American public.

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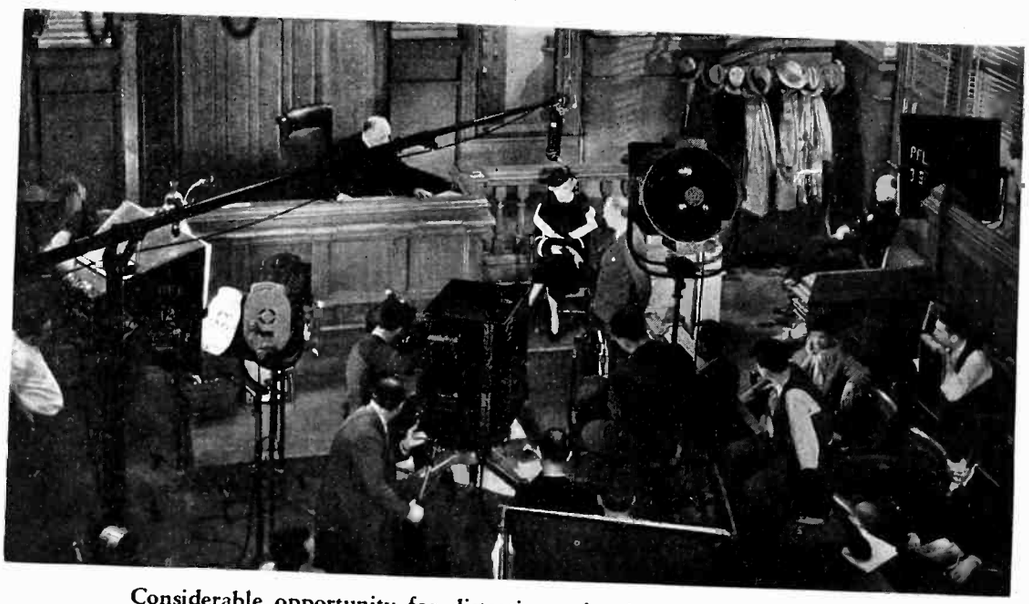
Frequency characteristics in

Film recording and reproducing

By GEORGE LEWIN
Recording Engineer,
Paramount Publix Corporation



Considerable opportunity for distortion exists in recording even under best technical conditions

THE ultimate purpose of any recording is to provide a means for preserving sound in some permanent form, so that at some other time and place it may be reproduced with all the characteristics of the original. To accomplish this purpose we depend on the accurate functioning of a series of different devices and processes, each of which may contribute some form of loss or distortion.

There are four general requirements which must be met if we are to secure faithful reproduction of sound. These are:—

1. Preservation of original wave form
2. Preservation of original volume range
3. Preservation of original frequency range
4. Suppression of extraneous noises

In this article we will concern ourselves only with frequency characteristics of film recording by the light valve method, and confine the discussion to the actual recording, processing, and reproduction of the film record, or, in other words, the portion enclosed by dotted lines in Fig. 1.

With present day microphones and amplifying equipment we can assume that a substantially flat frequency characteristic appears at the output of the recording amplifier. For present day requirements, and with the type of reproducing equipment in general use, we can further assume that 6,000 cycles represents the upper limit necessary for the overall reproducing characteristic.

Inherent losses

The first loss which takes place is that due to the finite thickness of the recording beam on the film. This loss is known as the "film transfer loss," and becomes increasingly great at the higher frequencies. This loss is somewhat analogous to trying to paint a series of parallel lines with a brush. The closer we try to paint the lines to each other, the more difficult it becomes to secure separation between the lines, until, when the spaces become equal to the thickness of the brush itself, the lines overlap completely and all definition is lost. It is possible to calculate theoretically what loss to expect at various frequencies for a given value of light valve spacing and objective lens reduction. Such a calculated curve is shown in Fig. 2. The upper curve gives the theoretical film transfer loss for a 1 mil light valve with a 2 to 1 reduction in the objective lens resulting in a $\frac{1}{2}$ mil image on the film. The lower curve shows for the sake of comparison, the loss for a 2 mil light valve.

In printing there should, theoretically, be no loss as long as good contact is maintained between negative and positive. Actually however, it is impossible to avoid some slippage, as well as partial loss of contact, with the result that a considerable, though variable, loss of high frequencies takes place during this process.

In reproducing the film through the medium of a scanning beam and photoelectric cell, another loss takes place at the high frequencies, due again to the finite thickness of the beam. This loss, which is usually described as the "scanning loss," can also be calculated theoretically, and is found to be smaller than the film transfer loss in recording. For a 1 mil image on the film it coincides very closely with the film transfer loss for a

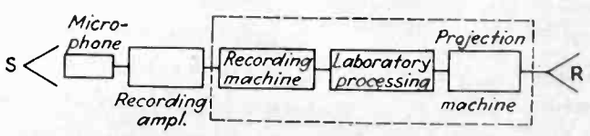


Fig. 1—Path followed by sound from source *S* to reproducer *R*

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½ mil image, and therefore corresponds to the upper curve in Fig. 2.

Following the conversion of the light modulations into electrical modulations in the photoelectric cell, still another loss takes place in coupling the output of the photoelectric cell to the first stage of the photoelectric cell amplifier. This is purely an electrical loss and, as in the case of all the other losses already mentioned, also becomes progressively greater as the frequency increases.

The light valve characteristic

The only compensating factor which is introduced in the entire system to partially offset the loss in high frequencies, is the rising characteristic of the light valve itself. The valve, being tuned to resonance at about 9,000 cycles, has a gradually rising response starting at about 3,000 cycles and rising to a sharp peak of about 24 db. at resonance after which it cuts off abruptly. A typical response curve of a light valve is shown in Fig. 3. While this characteristic is to a certain extent useful in offsetting high frequency losses, it is not without its drawbacks, chiefly among which is the fact that the general recording level must be kept sufficiently low to avoid clashing the ribbons at the higher frequencies. In any form of recording the ever present bugbear of surface noise prevents us from dropping the level too low, so that we must always seek a happy medium between surface noise, overload, and loss of high frequencies. It would be entirely possible to obtain a practically flat overall characteristic up to 6,000 cycles, by reducing the tuning point of the light valve so that its response at 6,000 cycles is just great enough to compensate for all the losses, but it would then be necessary to drop the recording level so low that the surface noise would become objectionable. It is apparent then that the only satisfactory way to secure a good frequency characteristic is to reduce all losses to a minimum, and come as close as possible to the theoretical loss curve for a given recording and reproducing setup.

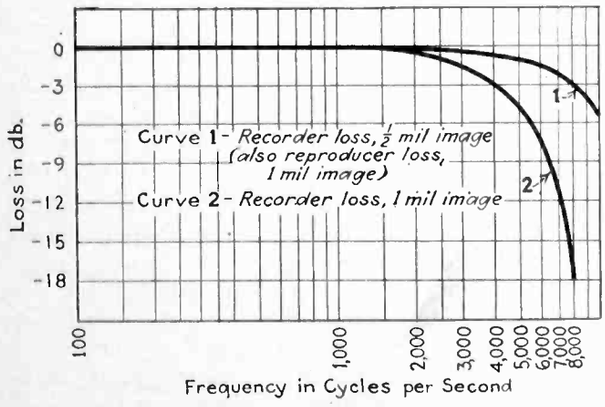

Fig. 2—Theoretical film transfer loss characteristics

Let us see just how much loss we should expect to get when we record with a ½ mil image on the film, and reproduce with a 1 mil image, which is the most common recording and reproducing set-up used at the present time. To determine the total loss we need simply to double the film transfer loss at each frequency, since the two losses are equal and are, of course, additive. To this we add the response characteristic of the light valve shown in Fig. 3 and the result is the upper curve shown in Fig. 4. From this curve it is apparent that if we had no losses other than the theoretical film transfer

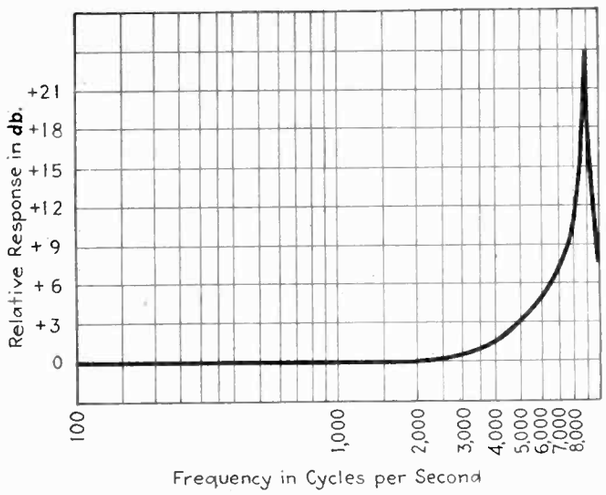

Fig. 3—Relative response characteristic of light valve tuned to 9,000 cycles

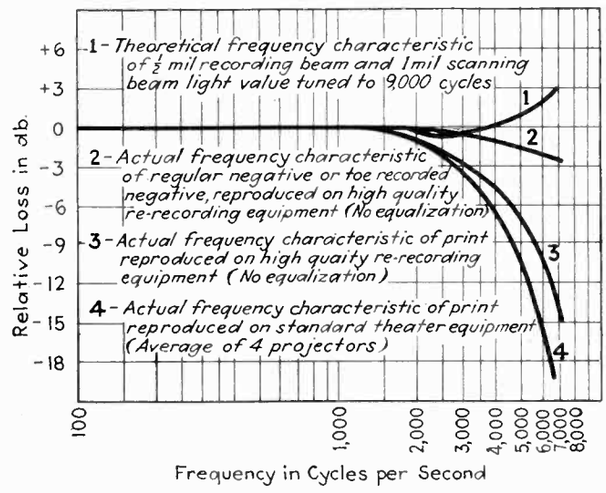

Fig. 4—Comparison of theoretical and actual losses in sound system

and scanning losses, that we would actually get a rising characteristic at the high frequencies due to the fact that the increase in light valve response over-compensates the losses. Unfortunately, however, we find by actual tests that we do not come anywhere near this ideal condition, and we will now discuss the actual results which are obtained with commercial recording and reproducing conditions.

Analysis of losses

To determine accurately the actual overall frequency characteristic, the frequency test film should be recorded at constant level and at approximately the same level as is used for actual recording. To do this, it is not practical to go above 7,000 cycles, as above this frequency the valve would overload due to its increased sensitivity. As a matter of fact, with the type of horn ordinarily used in most theaters today, frequencies above 6,000 cycles are of no commercial importance.

The lowest curve in Fig. 4 shows the average result of running a test film of the type just mentioned in four regular theater type projectors. The readings were made with a volume indicator at the output of the amplifiers. From this curve it is apparent that the actual response is considerably poorer than that shown by the theoretical upper curve, and that at 6,000 cycles, for example, there is a 17 db. loss to be accounted for.

This loss must be apportioned among four contribut-

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ing factors. First is the fact that the effective thicknesses of both the recording and the scanning images are considerably greater than the values assumed in determining the theoretical curve. While the geometric dimensions of the slits are actually 1 mil, considerable flare is encountered in the image on the film due not only to imperfections in the lens systems, but also to diffusion of the light when it strikes the film. The two curves in Fig. 2 show how the film transfer loss increases if the effective thickness of the recording image is increased from 1 mil to 2 mils.

The second factor not taken into account in the theoretical curve is the loss due to printing, which has already been mentioned.

A third factor is the resolving power of the film emulsion itself. It has been fairly well established, that this depends not only on the inherent graininess of the film, but is also affected by the developing processes. A discussion of this factor is outside the scope of this article, but it will be apparent that it is of importance as regards the frequency characteristic when we consider that at 6,000 cycles, there are about 330 striations per inch of sound track.

The fourth factor is the coupling loss, which has also been mentioned, and which will now be considered in greater detail. The circuit ordinarily used in coupling the output of the photoelectric cell to the first stage of the amplifier has a resistance R, of the order of 0.5 megohms which carries the photoelectric cell current. The fluctuations of current in the photoelectric cell, due to the modulations on the sound track, gives rise to corresponding fluctuations in potential across R, and these are transmitted to the grid of the tube by a coupling condenser. It is apparent that the higher we make the resistance of R, the greater will be the transfer of energy to the tube, all other factors remaining constant. However, there is a small, though measurable, capacity between the photoelectric cell lead, and the surrounding metal parts of the housing, which gives rise to a phantom capacity to ground which acts as a by-pass for R and reduces its effective impedance, thereby causing a loss of energy transfer which becomes increasingly serious as the frequency goes up. The higher the resistance of R, the more serious the high frequency loss becomes, hence we must compromise by using as low a resistance as possible, without cutting down the overall gain too far.

A 50 per cent decrease in resistance will decrease the general level by 6 db., but will have practically no effect at 6,000 cycles, so that the relative frequency characteristic is improved by about 6 db. at that frequency. Thus, when most theaters changed their coupling resistors from 2 megohms to 0.5 megohms, about two years ago, it was necessary to increase the fader setting by four steps, or 12 db., to maintain normal volume, but by doing so an increase of practically 12 db. in relative response at 6,000 cycles was obtained.

Separation of individual losses

It would no doubt be of interest to know approximately what proportion of the total loss is caused by each of the contributing factors, and for this purpose the two intermediate curves in Fig. 4 have been plotted.

Curve 3 shows the response obtained by running the test film through a high grade re-recording machine and a re-recording channel, instead of a regular theater projection outfit. In the re-recording machine the usual type of photoelectric cell coupling circuit is replaced by a special transformer coupling which has no measurable loss whatever at 6,000 cycles, and the scanning beam is 0.7 mils thick, in place of 1 mil. It will be noted that these refinements bring about an improvement of about 6 db. at 6,000 cycles. The transformer coupling device is not available for regular theater use.

Curve 2 shows the response obtained by running the negative of the test film, instead of the print, thus eliminating the printing loss, as well as any losses which may have been introduced during the processing of the print. The difference between curves 2 and 3 should not, however, be ascribed entirely to printing losses. It should be borne in mind that the negative is developed to a gamma of only 0.5, whereas the print has an overall projection gamma of close to unity. This means that any loss actually present in the negative would tend to be compressed, when measured with a volume indicator. Curve 2, however, does happen to be also the actual response curve of a toe recorded negative made under exactly the same conditions as the regular test film, except that the condensing lens was stopped down to approximately one-half the opening used for the regular negative. This results in a sharper image on the film, even though the slit itself is not reduced. The fact that a much lower intensity of light is used for the toe recording also tends to reduce the flare around the image. The effective projection gamma of a toe recorded negative being practically unity, it follows that the difference between curves 2 and 3 amounting to 8 db. at 6,000 cycles, is indicative of the improvement which may be expected to result from eliminating printing losses, and improving the optical system, of the recording machine. The difference between curves 1 and 2, equal to about 4 db. at 6,000 cycles is due chiefly to flare around the recording and scanning beams and to limitations in the resolving power of the film itself.

Variations of losses

It should be understood that the various losses given above represent merely an average set of results. The individual losses are subject to considerable variation depending on conditions. The printing loss seems to be the most uncertain of all, especially when the negative has become somewhat shrunk. Printing losses ranging from 3 to 12 db. have been encountered. Another source of variation appears to take place in the emulsion itself. Two tests made in immediate succession on the same recording machine, but on different rolls will often show discrepancies of 2 to 4 db. at 6,000 cycles.

In closing, the fact should be stressed that a good frequency characteristic is only one of four prime requisites for good recording, as pointed out at the beginning of this article. While the overall characteristics shown here are far from flat, actual experience has shown that very excellent sound quality can be obtained with them, provided the other requirements are satisfactorily fulfilled. Numerous methods are available whereby the frequency characteristic can be improved, but these usually carry other disadvantages with them, and must be applied with discretion.

The present set-up represents a careful compromise between all factors for the purpose of securing the best balance of these requirements. Changes in the set-up will be adopted only when they will not be detrimental to this balance. Possible improvements which are at present being investigated are a new type of film, and a new type of recording lamp, both of which allow further stopping down of the optical system without any effective loss of exposure.

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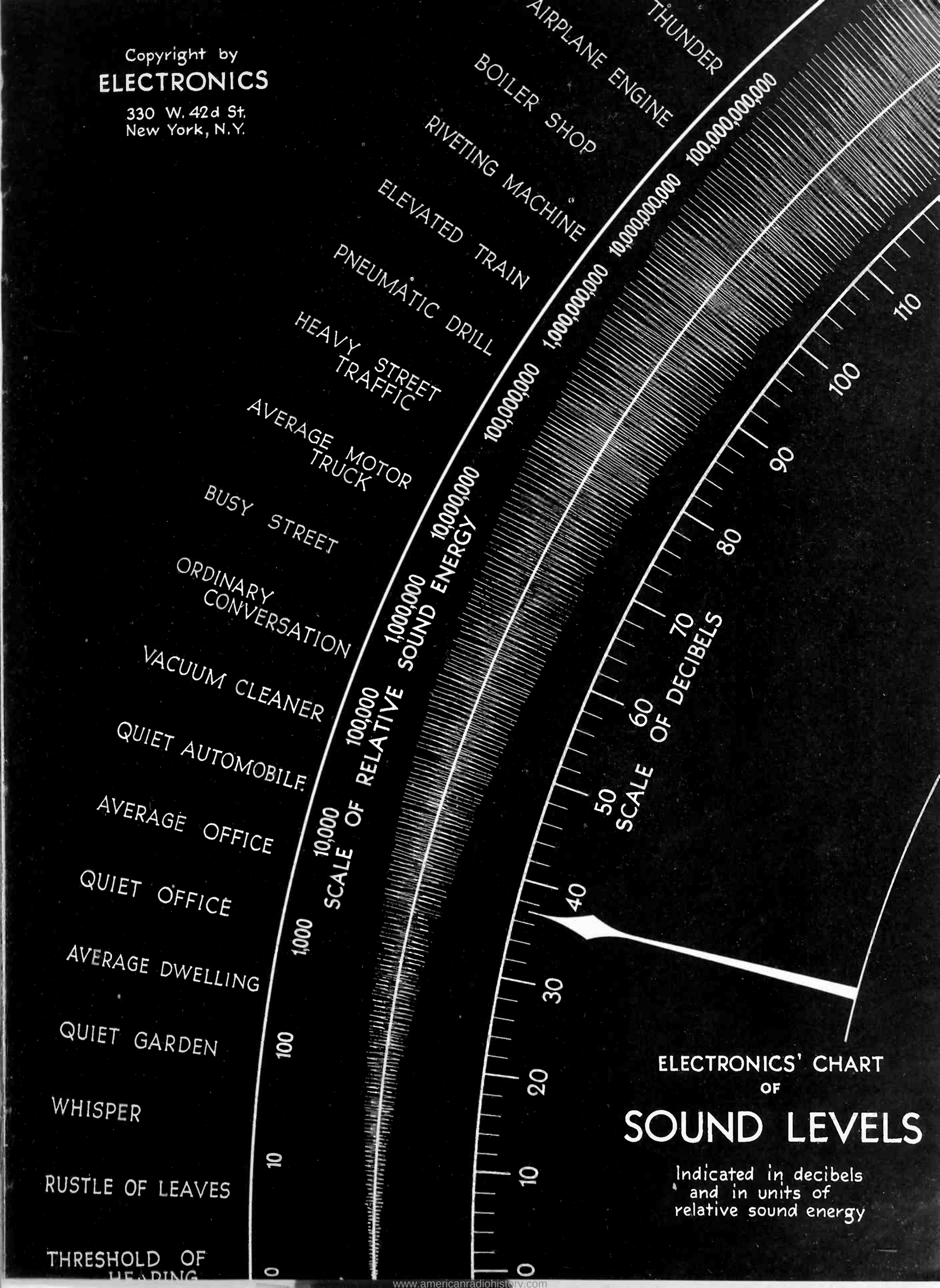

ELECTRONICS' CHART OF SOUND LEVELS

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Vacuum tube performance vs. manufacturing tolerances

By W. CHARTON, B.S., M.A.
Arcturus Radio Tube Company

IT HAS often been stated that the thermionic valve, or vacuum tube, is by its nature a laboratory device rather than a mass production article, and this explains much of the difficulties encountered by the manufacturer who tries to produce the largest quantity of the best product at minimum cost.

The vacuum tube, indeed, has a very ticklish personality, and it has to be treated just right to give its best. Not only must the design of the tube be correct and practical from the manufacturing standpoint, but the mechanical tolerances have to be kept to a strict minimum which is not always compatible with speed and economic production; otherwise the final characteristics of the tube lack too much in uniformity to be reliable and meet with the favor of the radio set manufacturer, or the consumer. Moreover the processing of the tube is of paramount importance to insure quality, long life and most efficient performance.

If the voltage on the filament of a tube is gradually raised from a low value to, say, twice its normal rating, the plate current increases at first more and more rapidly up to a certain point where its rate of increase drops rapidly, the plate current soon reaching an almost constant value. This means that after a certain filament temperature is reached, the space current nears saturation.

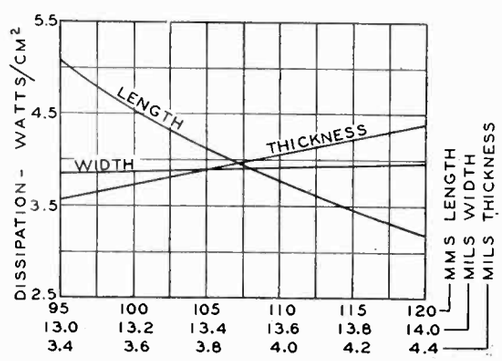

Fig. 1—Relation between filament dimensions and power dissipation in a triode

Now it is desirable that the plate current of the tube be as constant as possible, even if the filament voltage varies somewhat, as is liable to happen in ordinary use. Therefore the temperature of the filament should be high enough to give almost saturation, so that small changes in the temperature of the filament will not appreciably affect the plate current. On the other hand the higher the temperature the shorter the life. There is then an optimum point where the *regulation* of the filament is very good, and yet where the life is still reasonably long. This is ordinarily chosen as the operating point, and corresponds to a heat dissipation in the neighborhood of 4 to 5 watts per square centimeter of filament surface area, depending upon the construction and the kind of filament.

Since the tubes are designed to operate at a rated voltage it is evident that small changes in the dimensions of the filament will affect the wattage dissipation, hence the operating point, the regulation and the life.

Whereas the filaments are usually cut accurately enough, the burning length is affected by the allowance made for welding the ends to the tabs or the supports; the human element plays a part in this, and, as in many other instances, if the limits of tolerance are too narrow, the time required for the operation increases rapidly, thus increasing the cost. The width and thickness, or the diameter, of the filament wire depend upon the die used in the drawing of the wire, and as the die wears with use, a slow change in these dimensions takes place, which requires continual checking of the wire weight or size. Moreover as the filament is handled in various machines, for coating or cutting, it is liable to stretch and get thinner, especially when heated red in annealing or coating ovens.

In the mounted tube, tension springs also contribute to an additional stretching while the tube is being exhausted or aged at a temperature higher than the normal. Such troubles are particularly experienced with fine filaments as used in low-drain tubes (battery type), and allowance has to be made for such occurrences.

In every phase of manufacture the conditions are each liable to vary slightly, and it may be judged by this example that the total amount of uncontrollable variations may have a final effect greater than the desirable tolerance. Only the most attentive supervision and increasing inspection insure a final product worthy of praise.

Figure 1 shows the effect of variations in filament dimensions upon the power dissipation in one type of tube. It will be observed that a variation in length of one millimeter will affect the power dissipation by 2½ to 3 per cent; the effect of a change in thickness is even more striking since only one ten-thousandth of an inch makes 2 per cent difference, i.e., almost a tenth of a watt per cm^2.

Variations in geometry of the elements

In a triode with flat elements, like types '01-A, '26, '71-A, '45, etc., the amplification factor bears a direct relation to the distance between plate and grid, increasing as this distance increases, and vice versa. The transconductance and the plate current depend also upon this distance, and upon the effective area of the anode. In the case of cylindrical electrodes, like in types '99, '27

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and '37, a similar relation exists too, although more complex. The plate resistance, of course, decreases when the transconductance increases, if the amplification factor remains constant.

As these four characteristics are of great importance in the performance of a tube in a given circuit, it is necessary to keep them close to the rated values, and this is only possible through a uniform geometry of the tube.

The plates are generally punched in two halves, or punched and rolled into a cylindrical shape. This is usually done quite accurately, so that no trouble is experienced regarding the actual area of the anode. The diameter, though, is a more critical dimension, and is most liable to be subject to undue variations, if special care is not taken in design and in mounting.

For example, in a tube with a flat plate, the latter is ordinarily held by two fins welded to two supports, one at each side of the plate, which fit in a groove provided for that purpose. If the grooves and fins are not adequately shaped, the two halves do not fit as they should and the distance between the two half-plates is affected; the angles in the corners of the plates are subject to deformation and may cause a distortion of the flat portions.

Such a distortion is more often and more easily caused by the supports themselves. If they are not perfectly straight and well aligned or if they are just a little off their correct spacing, a strain is created in the plate when mounting, and as the tube is exhausted and bombarded with the plate red-hot, a permanent distortion is caused which may affect the plate diameter by as much as 15 mils!

In the Arcturus type 127, which has a cylindrical plate, one can easily see the circular ribs which prevent the distortion so frequent in tubes with circular elements.

The difficulty of misalignment is more difficult to overcome, for although all the parts of the tube may have the correct dimensions, their respective positions may not be maintained, especially after a certain amount of handling. Figure 2 illustrates the effect of plate eccentricity upon the characteristics of a plane element

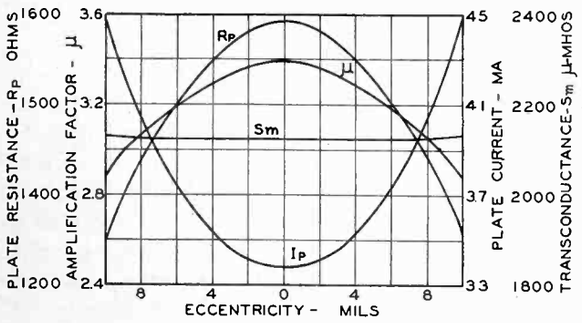

Fig. 2—Effect of plate eccentricity upon the characteristics of a triode

triode. They vary first only slightly for the first few mils of eccentricity, but soon change at an increasing rate. Similar curves can be drawn for grid or filament eccentricity, the only fundamental difference being that grid eccentricity decreases the transconductance, while filament eccentricity increases it without affecting the amplification factor.

Irregularity in grid structure

Because of its delicate structure the grid is the element most subject to irregularities, and only the utmost care can give the desired result.

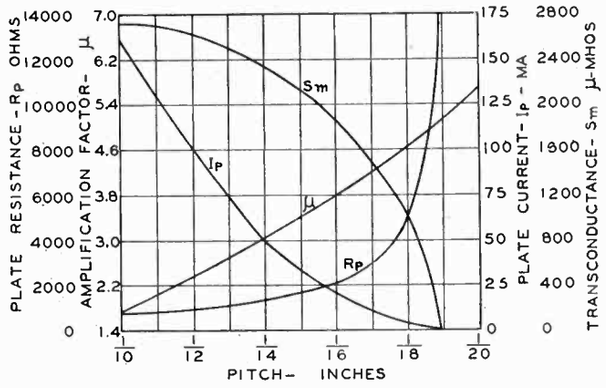

Fig. 3—Relation between the grid pitch of a triode and its characteristics

The grids are wound on an automatic machine subjecting the wire to a certain tension which tends to stretch the wire and reduce its diameter. When the turns of wound grids come off the winding mandrel, after swaging, the wire is no more under tension and the turns tend to spring back, thus affecting the diameters both across the supports and at right angles to them.

The supports themselves are subject to tension and are liable to stretch while the grid is wound, and while it is stretched under heat to straighten the supports; in this case the actual pitch of the grid tends to increase, thereby decreasing the amplification factor of the tube. If the supports are even only slightly under stress when mounted in the tube, the grid distorts permanently under the heat of the bombarder, the supports bow in or out and the diameter becomes irregular throughout the length of the grid. Each one of these disturbing factors has to be taken into consideration in the design and manufacturing specifications. For instance provision has to be made that difference in thermal expansion between insulating spacers and metal parts does not force these parts out of shape.

If successive grid turns are distorted in handling or as a result of the distortion of supports, some turns may crowd together while others spread too far apart, giving the tube a sort of variable-mu character, with very poor plate current cut-off. Such a tube would make a bad anode-bend detector.

Grid distortion affects essentially the amplification factor of the tube, and secondarily the other characteristics. As an example the relation between the grid pitch and the amplification factor and other characteristics of a type 145 triode is given in Fig. 3. Although these remarks refer to control grids, they can generally be extended to any type of grid, screen-grid, space-charge grid or cathode grid.

Other sources of trouble

Too large tolerances in the size of holes for grid supports may be the cause of noisy tubes, if they are not rigidly clamped or welded. An inaccurate mid-point on the filament of a pentode, where the cathode grid connection is welded, or an irregularly bent filament may be a cause for hum. Distortion or misalignment of parts, and too wide tolerances in the depth to which the welds, or supports, are sealed in the stem glass, or "press," may cause variations in internal capacitances sufficient to affect the tuning of a highly selective circuit or to cause a beat frequency, regeneration, etc., in a given receiver.

[*Please turn to page 74*]

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Aspects of standard-signal generator design

By JOHN D. CRAWFORD

General Radio Company

OFTEN the most difficult portion of a development job is deciding on the specifications and tolerances to which the finished product must conform. This is especially true of standard-signal generators. A discussion from the designer's viewpoint of some of the problems will serve to show the trend of development and help the user make tolerance specifications that are realizable in a commercial instrument.

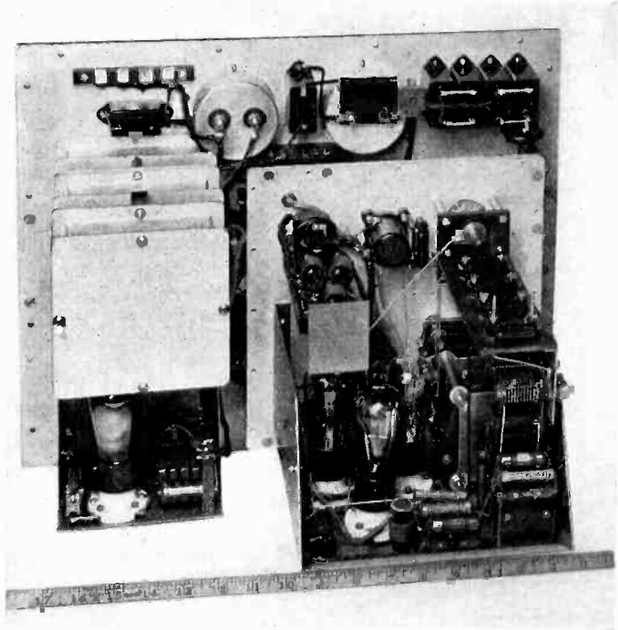
The requirements for standard-signal generators may be grouped under five headings. Each of these might be subdivided to include information which, with a statement of tolerances, would completely specify performance. Most of these possible subdivisions are mentioned or referred to in what follows.

The output-voltage system with leakage, referred to later, probably has received more attention from designers than all others combined, not because they are necessarily more important. Sometimes they are not. But the difficulties in eliminating stray admittances in radio-frequency attenuators, added to the ease with which discrepancies can be pointed out, have until recently forced intensive concentration on this phase.

The upper limit of output voltage is limited in a given mechanical structure by the amount of leakage that can be tolerated, since the larger the voltage, the more powerful the oscillator and the stronger the stray fields to be eliminated. High output levels are needed for studying the characteristics of power detectors and the behavior of receivers in abnormally strong fields.

The present lower limit of output voltage is less than a tenth of a microvolt, tube noises in calibration equipment being a limiting factor. Since tube noise also limits the sensitivity of broadcast receivers no hardship is caused by this factor. The lower this limit, moreover, the more careful must we be to keep spurious voltages out of the receiver. Hence shielding must be excellent.

Infinitely small increments of output voltage may be obtained by the use of a calibrated meter indicating input to an attenuator calibrated as a multiplier. Where a continuous gradation is not required, sufficiently small steps can be secured with cascade attenuators. With this system only one or perhaps two reference points on the input meter are marked. Some designers prefer this scheme on the ground that a rugged attenuator is less likely to change its calibration than a sensitive meter.



Interior of standard-signal generator with shield removed

The internal output resistance should remain essentially constant, over the lower ranges of output voltage especially. Failing this, it becomes difficult to allow for the resistance of the dummy antenna, since, by Thévenin's theorem the internal output resistance should be considered a part of the resistance allotted to the dummy antenna. The change of resistance with output voltage is the principal objection to the usual type of slide-wire attenuators for obtaining small voltage increments.

Absolute values of output voltage can be checked to within about 5 per cent, the probable error of the best known method for answering the question "What is a microvolt?" The method, used in the General Radio standardizing laboratory, uses a circuit of the heterodyne type with suitable precautions for the elimination of errors due to tube noise. The accuracy at present attained in standard-signal generators is in the neighborhood of 10 per cent and this accuracy can, if necessary, be held at frequencies as high as 10 megacycles. Better accuracies at still higher frequencies can be obtained

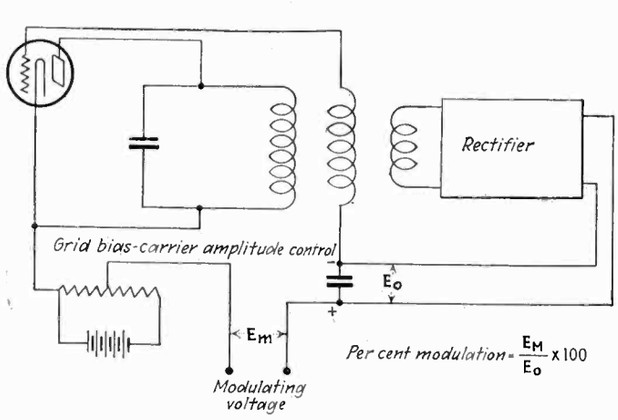


Diagram of Arguimbau method of obtaining constant output

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when sufficient interest from prospective users justifies the necessary development expense.

During the last year the answer has been found to many of the difficulties heretofore encountered with attenuators. Thick aluminium castings replace the usual copper and brass sheet, and every precaution is taken to minimize the area of current-carrying loops. The two-stage attenuator of a recent model, for instance, has a total attenuation of 130 db, a value that a few years ago would have been considered remarkable even at audio frequencies.

The problem of leakage

The amount of leakage that is tolerable depends upon so many factors external to the generator that it is often difficult to decide how far its elimination should be carried in a commercial model. The requirements are most rigorous with loop receivers in field-intensity measuring work. Electromagnetic and electrostatic shielding between the oscillator and the outside of the cabinet require tightly sealed coverings in which all external leads should be filtered and all meter holes should be protected by internal shields. The difficulties with such filtering plus the need for portability have in the past prompted several designs in which batteries are carried inside the shielded cabinet.

Radio-frequency oscillator design

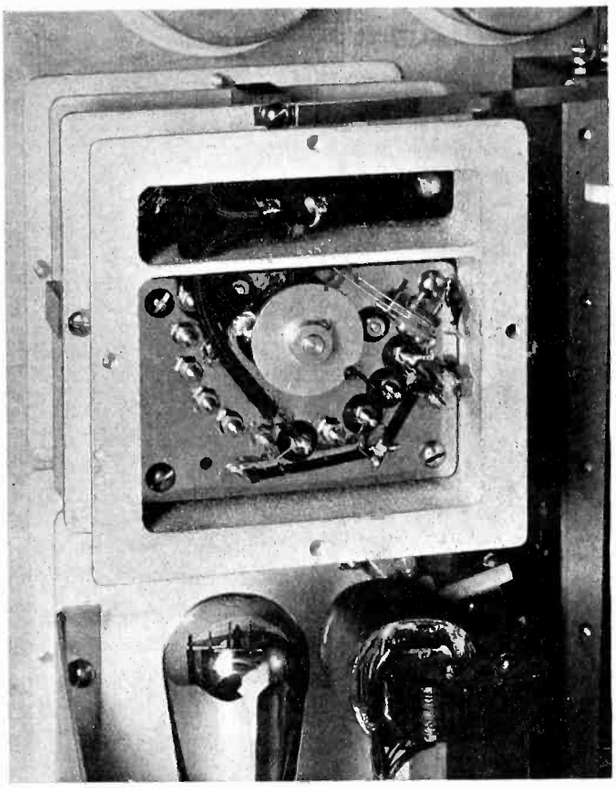
Since it is usually asked that a standard-signal generator cover as wide a frequency range as possible, the difficulties to be overcome in designing the oscillator are terrific if modulation quality comparable with the best broadcast transmitters is to be obtained. Consider the problem as one of designing a low-power broadcast transmitter to operate at any point in several bands, to have approximately constant output in spite of wide variation in L/C ratio, and to be stable enough to permit of known modulation. The use of a master oscillator and amplifier is banned because of the multiplicity of controls required. The attention that it has been possible to give to this requirement, since the major difficulties with the output voltage system can be considered overcome, is bringing out new circuits which hold out promise of bringing in results. Such a circuit is the one developed by L. B. Arguimbau* for use in a new standard-signal generator on which he was working.

This circuit, shown schematically in the accompanying figure, is unique in that a rectifier circuit coupled to the oscillator inductors automatically shifts the oscillator grid bias so that at all times the internal plate impedance of the tube matches the impedance of the circuit. In ordinary oscillators this condition is obtained by allowing the tube to operate over its curved as well as the desirable linear portions of its characteristic. Incidentally, grid current is eliminated.

Modulation depth and fidelity

The value of 30 per cent modulation used for the I.R.E. tests was typical of broadcast transmitter performance before the general use of master-oscillators with modulation applied to the radio-frequency amplifiers. When tests to determine actual performance are to be made, therefore, it is desirable that the percentage of modulation be increased to at least 75 per cent and higher. When this is done on simple oscillators, many strange effects appear, which are never found when

*Described at U.R.S.I. meeting, Washington, May, 1931.



A 10-megacycle attenuator multiplier protected by a heavy aluminum case

master oscillator circuits are properly operated. The most common of these is frequency modulation in which the frequency of the radio-frequency oscillator may be considered as varying over the audio-frequency cycle.

By suitable proportioning of the L/C ratio and of grid condensers and leaks some common circuits can be made to perform satisfactorily in this respect.

Another of these defects is the so-called inertia or "fly wheel effect" which has not been investigated thoroughly enough yet to yield quantitative data showing the amount of distortion in speech waves. It arises from the fact that an oscillating circuit has a definite reaction time and does not respond instantaneously to the modulating voltage. Square-topped waves, for instance, might look something like the signals in an inductive telegraph circuit. This effect appears in most ordinary circuits, but the new one mentioned above minimizes it.

It is difficult to secure a high percentage modulation when the ratio of the modulating to carrier frequency is large. Furthermore, the modulation characteristic of oscillators is often quite curved. These factors make it difficult to expect good quality from a speech- or music-modulated standard-signal generator. The standard-signal generator previously referred to has a better performance in this respect than earlier designs, yet it can reach 100 per cent modulation at 400 cycles but only 30 per cent modulation at 10,000 cycles when the lower carrier frequencies are used.

Ease of manipulation

Arranging the controls to make adjustments as easy as possible is probably the most promising field of improvement for standard-signal generators. Attention to this detail on the instrument previously referred to has met with such success that operating time is materially re-

[*Please turn to page 74*]

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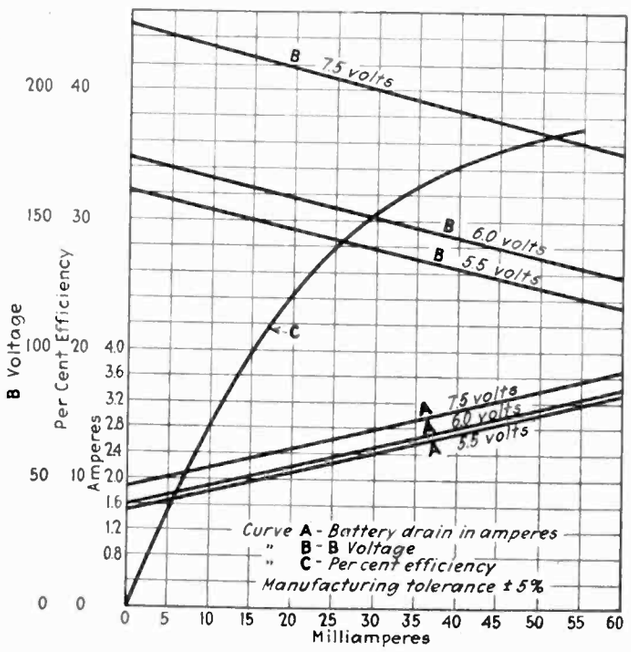
Survey of auto radio at national show

New York, Jan. 9-16

AN INSPECTION of the National Automobile Show in New York in January disclosed the fact that automobile salesmen knew less about automobile radio than did the unprecedented crowds which pressed into Grand Central Palace. Salesmen were vague or openly without knowledge when auto radio was discussed. A few sets were displayed, some B-eliminators or other accessories were for inspection.

The truth is that radio has made amazingly little impression on the automobile industry. To the average auto salesman, a radio is something he can cut price on and thereby give a prospective customer a good deal. Wherever radio finds itself, nowadays, it seems cursed with the cut price aroma.

About 60 per cent of the stock closed cars shown had antennas installed in the roof at no charge to the purchaser. About 35 per cent of all cars exhibited at the show will install radios at the factory if the customer wants it. Chrysler makes it a simple matter by having antennas already installed, and holes drilled in dash and holes in the floor for placement of the Philco battery box.



Performance characteristics of typical B eliminator (Auto-B-Power, Janette)

Philco seems to be making the best headway in this field. On a Plymouth car dash was a sticker announcing that it had been designed to operate with a Philco receiver. Nearly all cars either at the factory or through a local distributor are prepared to install Philco sets (some salesmen openly preferred Philco).

B-battery elimination

Long strides are being taken by those working on B-battery eliminators. Several were exhibited at the auto show. One by Mallory is an interrupter type which uses a half-wave rectifier made by Raytheon for rectification of the resultant interrupted d.c. current taken from the battery. The Bosch "Magmotor," a permanent magnet dynamotor continues to attract attention from the radio industry. Because of the permanent magnets the device takes little from the storage battery. It lists for $25 and at 180 volts has sufficient output to operate a highly sensitive receiver.

According to bulletins, the Elkon device takes up less space than the four B-batteries required by the usual receiver, lists at $24.50, delivers 30 milliamperes at 180 volts and takes about 2 amperes from the car battery. This figures out to be about 45 per cent efficient. The Pines-Winterfront Transverter uses a rotary transformer system with a brute force filter to iron out pulsations. It draws "less than 3 amperes" and delivers 30 milliamperes at 180 volts. It lists at $30.

Because of the wave form turned out by these various battery substitutes there seems to be considerable confusion as to how the efficiency should be rated or how the battery drain should be measured. One device claiming to take "very little from the battery" measured about 8 amperes on a hot wire meter.

At the auto show were several receivers designed for auto installation, some for batteries, some for eliminators and some had models for either d.c. or a.c. operation. Motormaster (reputed to have some deal with Auburn) has an all-electric model at $114.50 which includes a "breaker system for producing a.c. current." Motorola (Galvin) has a tuned r.f. all-electric set at $97, superheterodynes at higher prices. Battery models are about $20 lower than the all-electric sets. The Motorola eliminator is reported to have come from the Lear Development Company, makers of all kinds of electronic devices.

RCA Victor uses class B amplification—as they do in the farm set built around the Eveready Air-Cell battery, which rules out B-eliminators because of regulation difficulties. The service bulletin on this receiver gives rather complete instruction for installing the receiver in many of the well known makes and models of cars. The questions of where and how to install the set are answered at some length.

A new remote control unit designed by the Radio Vision Research Laboratory of the Federal Telegraph Company is available for both home receivers and auto sets. The latter model lists at $10, has 10 feet of control cord and places the tuning and volume control of the receiver on the steering column. The receiver can be placed anywhere within the length of cable furnished.

Electric Specialty (Esco) has available a dynamotor which is operated by the car battery and delivers 30 milliamperes at 180 volts. The list is $18 ($20 for ball-bearing unit) and a filter is under development to completely iron out any remaining pulsations.

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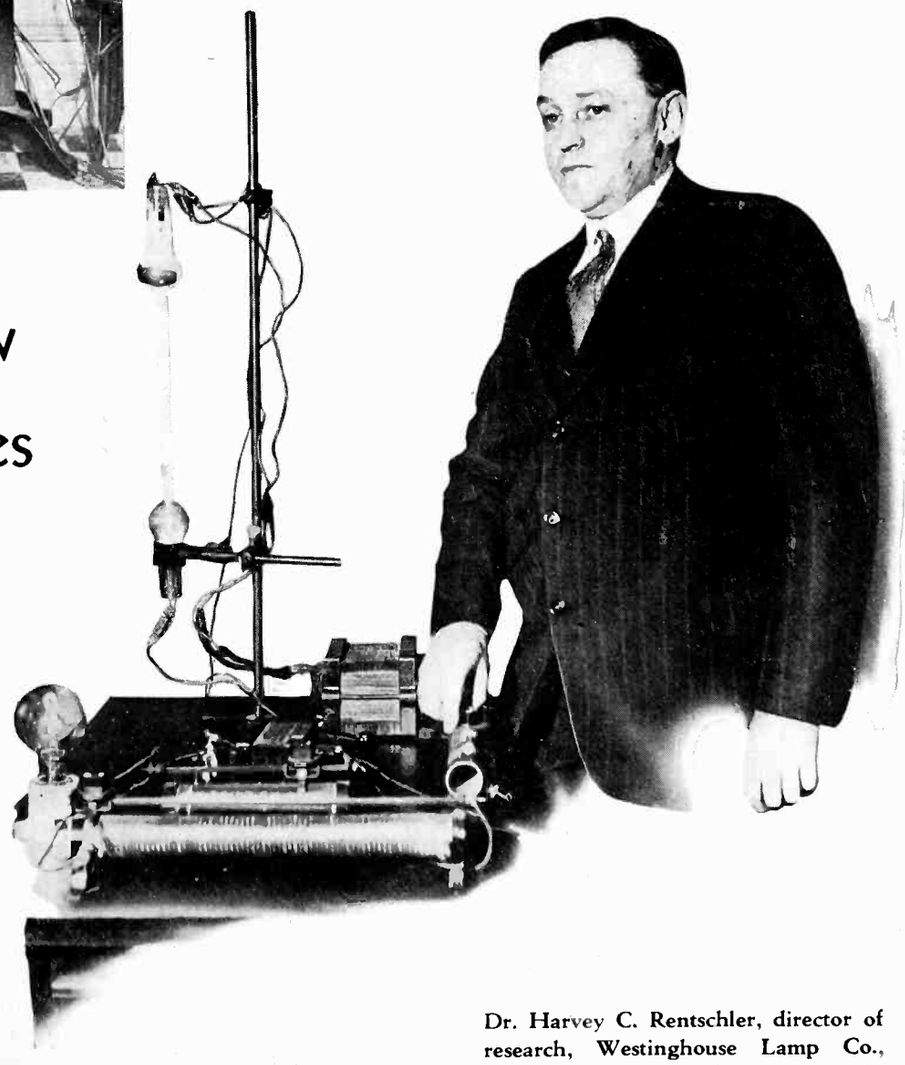
Professor Theremin now opens doors, starts machinery, with a wave of his hand. Door shown will follow his body at 2-inches distance. If he stops, it stops. Only the plate shown is sensitive; wire leading to it is inert and can be handled bare without effect

Electrons in new industrial miracles



In Childs' newest, finest restaurant, opposite Waldorf-Astoria, New York, photocells (in railing) control four kitchen doors, opening them swiftly, noiselessly, as waitresses approach

Dr. Harvey C. Rentschler, director of research, Westinghouse Lamp Co., demonstrates new sodium-vapor tube lamp which is three times as efficient as neon tube. Formerly sodium-vapor tubes quickly blackened and became useless; invention of new glass by Dr. Pirani, Berlin, avoids discoloring

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A new voltage quadrupler

By WILLIAM W. GARSTANG
P. R. Mallory Company

IN THE theory of electric circuits there is what is known as the voltage doubler system for the increasing in voltage and rectifying of alternating current. It is possible, of course, to raise a.c. voltages by the use of a transformer and in certain cases by the use of a thermionic vacuum tube, but the voltage doubler is practically the only known method whereby a.c. voltage may be increased without the use of a transformer or a thermionic tube and still be of efficiency suitable for commercial application.

In the mind of every engineer there has been, at one time or another, the idea to charge condensers in parallel and discharge them in series thus securing twice the charging voltage. It is on this principle that the voltage doubler operates. If we consider the fundamental circuit (Fig. 1), we can see that it consists of two condensers and two rectifiers. If we follow the course of the impressed a.c. potential through the circuit and take it a half cycle at a time it is clearly shown how the condensers charge and discharge.

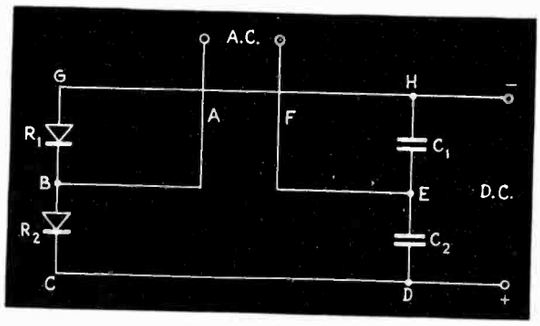

Fig. 1—Fundamental voltage doubler circuit

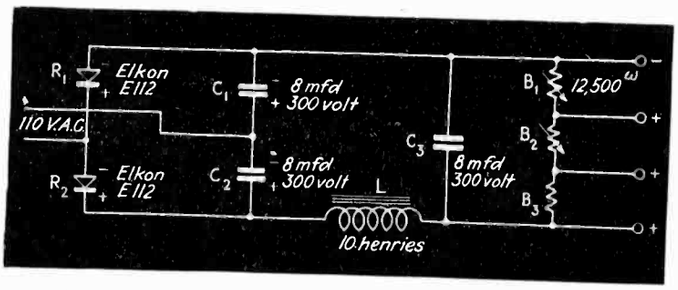

Fig. 2—Circuit constants of a modern commercial voltage-doubler

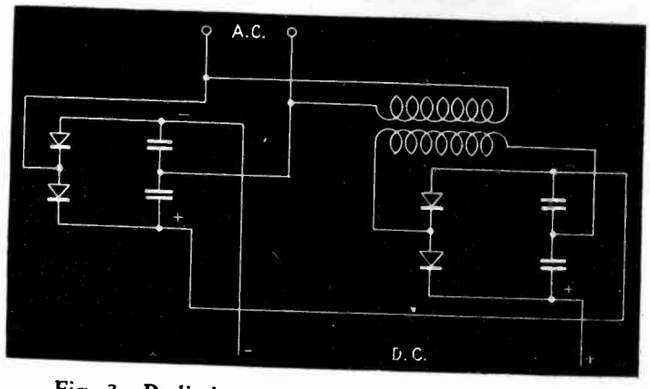

Fig. 3—Preliminary attempt to double the output voltage

As the a.c. is positive it enters at A passes through the rectifier, R_2, to C and D and charges condenser C_2 passing out and back into the line through E and F. The negative half of the cycle enters at F and follows the course $EHGB$ and flowing out through A charges condenser C during its transition.

Under ideal conditions, that is, conditions of no load, perfect rectifier efficiency, and zero circuit resistance, the theoretical action would be realized and the value of the d.c. would be two times the peak value of the impressed a.c. Under load, however, there is a continual drain on the condensers even while charging, consequently the maximum value of the d.c. is never attained, the actual value depending upon the capacity of the condensers, the efficiency of the rectifiers and the magnitude of the load. Inasmuch as the condensers are not charged at the same instant but are charged one on each half of the cycle the output pulsations are twice the frequency of the impressed a.c.

A modern voltage-doubler

For many years it was thought that since a.c. was applied to the circuit and even at the junction of two condensers that it was necessary to use condensers capable of withstanding high voltages. A.c. condensers of this type in the capacities required by the circuit were bulky and out of the question for use on account of cost. With the introduction of the liquid type of electrolytic condenser the circuit was again considered but it was found that although the a.c. was less than the polarizing d.c. across the condensers the power factor of this type of condenser was entirely too great to permit its use even with an a.c. component as low as 30 per cent of the polarizing voltage. It was not until the advent of the truly dry type of electrolytic condenser that the circuit became of commercial use. This type of condenser with its low power factor, less than 5 per cent, would easily take care of the high a.c. component.

By the use of rectifier piles of the dry disk type and by the use of condensers of the dry electrolytic construction a unit of surprising compactness and efficiency can be made.

One manufacturer has recently introduced a power supply using the voltage doubler principle. It was designed primarily as a "B" battery eliminator but can be used in any application where comparatively high d.c. voltages are required and where a source of a.c. is available. The manufacturer realizes that "B" eliminators and battery radios are obsolete in our modern day radio, however, he believes, after a careful survey, that there is still a demand for this type of a unit. The fact that it contains no liquids, no rectifier tube,

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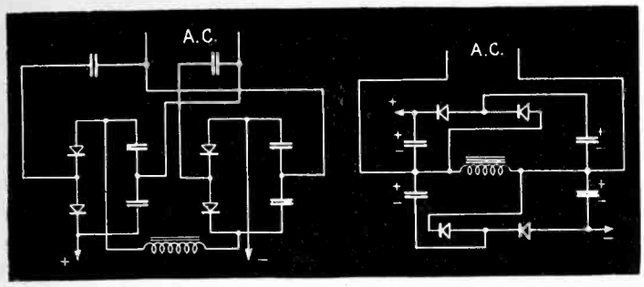

Fig. 4—Two circuits evolved in the development of a voltage-quadrupler

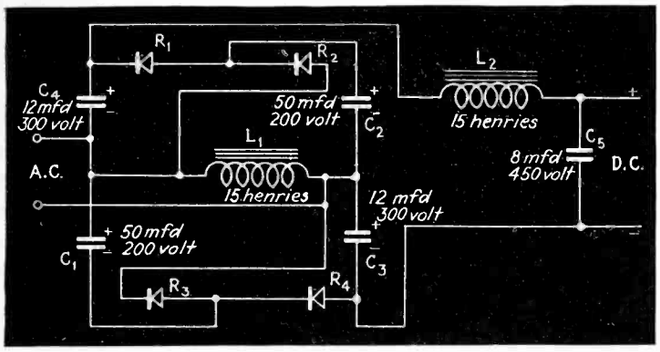

Fig. 5—Constants of the commercial voltage-quadrupler

no moving parts, no transformer, and above all operates on a.c. lines of any frequency, makes it an article of outstanding merits of many uses to the service man and the experimenter. The circuit for the completed power unit can be seen in Fig. 2.

It is interesting to note that the condensers in the voltage doubler circuit act in a duo capacity when used with a connecting filter system. They not only are integral units of the doubler system but also act as the first condenser in the filter system. The voltage divider is arranged so that various voltages may be secured. The unit will output approximately 220 volts when connected to a load drawing 30 milliamperes.

The author, while doing research work to develop the voltage doubler to its present commercial usefulness, was not satisfied in obtaining twice the impressed a.c. voltage so endeavored to place two voltage doublers in series in order to quadruple the impressed voltage. Whenever this was attempted it was found that no matter how the two circuits were connected they were invariably in parallel. This was due to the fact that a common source of a.c. was used for each circuit and the inter-coupling always resulted in a parallel connection.

The doubler "doubled"

On observation it was found that there were several ways of overcoming this difficulty. A transformer with a 1:1 ratio could be used to isolate one circuit and give an effective two sources of a.c. supply (Fig. 3). The use of a transformer, however, was not desirable as it would increase the bulk, the unit cost, and would prohibit the use of the unit on a.c. lines of any frequency.

The second method of attaining this same end was to insert a high-capacity paper condenser in each line leading to the rectifiers; this would isolate both circuits from the common a.c. source and thus do away with the inter-coupling. It was found that this would not entirely answer the purpose as there was still a large amount of a.c. flowing between the two voltage doubler circuits so a choke was inserted between the two circuits in the d.c. leads (Fig. 4).

This provided a working circuit that would, under fairly light loads, supply a d.c. voltage in excess of four times the r.m.s. value of the applied a.c. voltage. It had one disadvantage, however, in that six condensers were necessary, two of which were high capacity a.c. condensers.

On checking over the circuit and reading the a.c. and the d.c. voltage across each condenser it was discovered that two condensers were seemingly only floating in the circuit having neither a.c. nor d.c. voltage across them and that all of the condensers had a higher d.c. voltage than a.c. across them. The two were immediately cut out and all condensers were changed to electrolytic d.c. condensers of the dry type. The circuit was redrawn and the final voltage quadrupler circuit was evolved (Fig. 4).

This unit has many applications and has been used as a tubeless power pack. As in the case of the voltage doubler its efficiency depends upon the capacity of the condensers used. Only condensers of power factor less than 5 per cent are suitable inasmuch as the a.c. component in the condensers has a magnitude of approximately 70 per cent of the polarizing d.c. As in the case of the voltage doubler circuit it is a necessity to use a choke fed filter system on the output of the voltage quadrupler. The final power unit has an output voltage of approximately 440 volts when connected to a load drawing 50 milliamperes.

Devices of this type which can not only double the voltage obtainable from an a.c. line but multiply it by a factor of four may find considerable use where a high d.c. voltage is desired from an a.c. source. At present, transformers and rectifiers are necessary; the equipment may be not only large but heavy and have limited life due to the rectifier tube losing emission. On low frequency circuits the possibilities of the voltage doubler and voltage quadrupler seem fairly unlimited. The future will no doubt see important applications of the devices and circuits described above.

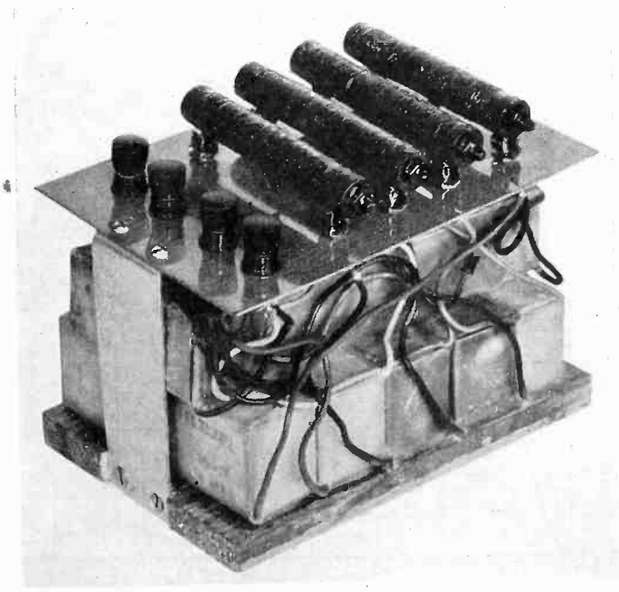

Fig. 6—Assembly of resistances, chokes, condensers, and rectifiers

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Calculation of loudspeaker efficiency

By IRVING WOLFF, Ph.D.
Engineering Dept., Research Div.
RCA Victor Company

AT FIRST sight it might seem most useful to define loudspeaker efficiency in the same manner as the efficiency of other generators is defined; viz., in terms of the ratio of the power delivered to the power which is supplied to it. Due to the conditions under which a loudspeaker is used, however, another definition of efficiency, which has been called the *"absolute efficiency,"* has been found of more value.

In practice, a loudspeaker is supplied from either a vacuum tube or a transformer attached to a vacuum tube. The impedance of this vacuum tube or the effective impedance of the transformer when placed in the circuit is very nearly a pure resistance independent of the frequency. If the loudspeaker motor has a large reactive component of impedance, or if its impedance varies greatly as the frequency is changed, it will be impossible to supply electrical power to the loudspeaker which is equal to that which could be delivered to a resistance having the same resistance as the supply source (the condition for maximum power transfer from a supply source to an external unit). Even though the loudspeaker might, therefore, have a high efficiency in the usual sense, under the conditions of use, it would not be possible to deliver a large amount of power to it and it would, therefore, from a practical standpoint, not be an efficient loudspeaker.

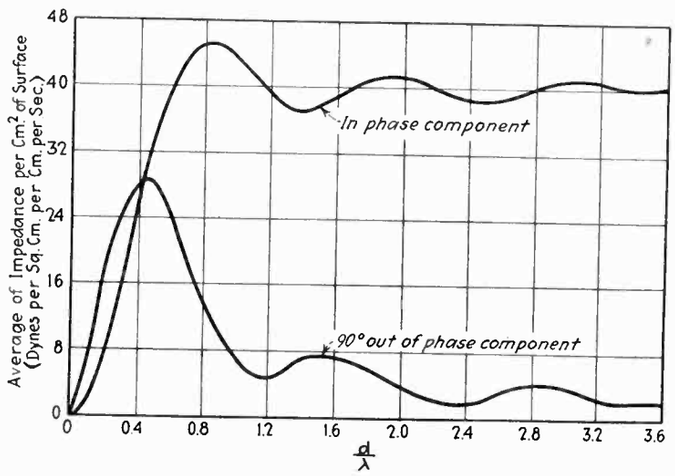

Fig. 1—Load on a vibrating circular diaphragm set in an infinite baffle

The general definition which the Institute of Radio Engineers has given for the absolute efficiency of electro-acoustic apparatus when applied to loudspeakers can be interpreted as follows:

The absolute efficiency of a loudspeaker for a given speaker not of the relay type is given by the following formula:

$$Eff = \frac{\frac{4 z_r}{|z^2|} \left| M^2 \right| R_s}{\left| \frac{M^2}{z} + Z + R_s^2 \right|} \qquad (1)$$

where z_r is the mechanical resistance due to acoustic radiation, z is the total mechanical impedance including reactance due to air reaction, and masses and stiffness in the drive system; also resistance due to radiation and any other energy losses, M is the vector force factor; i.e., complex quotient of force developed in the mechanical system per unit velocity in the mechanical system, Z is the impedance of the electrical system excluding the impedance due to the motion of the mechanical system which is included in the $\frac{M^2}{z}$ term, R_s is the electrical impedance of the supply source, and the bars indicate absolute values. When using the formula in the form in which it stands all mechanical quantities must be expressed in c.g.s. absolute units, and electrical quantities in absolute electromagnetic units when the force action is electromagnetic and in absolute electrostatic units when the force action is electrostatic.

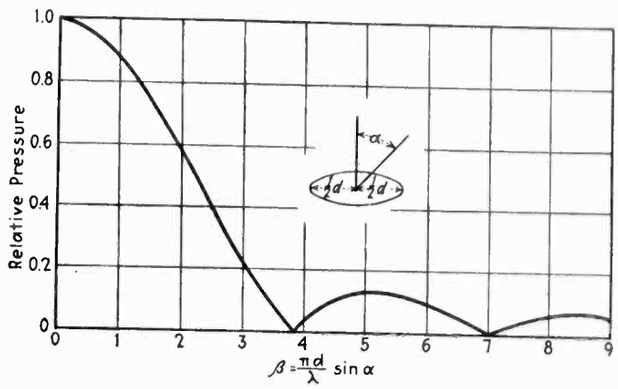

Fig. 2—Directional radiation characteristics of vibrating disc in infinite baffle

In the next succeeding paragraphs an illustration showing how formula 1 can be used to calculate the efficiency of a loudspeaker is given.

To simplify the illustration, a dynamic cone loudspeaker will be chosen having the following characteristics:

8 in. diameter paper cone, with ½ in. suspension. Mass of cone plus coil 14.7 grams. The mechanical systems, due to the stiffness of the suspension and the centering means is resonant at 100 cycles. The diameter of the air gap is 4 centimeters. Number of turns in the coil is 120. Flux in the gap is 9,000 gauss. The transformer feeding the loudspeaker reflects the tube impedance into the secondary as 11 ohms.

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To simplify the calculation, the assumption can be made that the radiation from the front and rear are equal and the same as that from a vibrating disk in an infinite baffle.

Referring to equation 1 we must first calculate the mathematical impedance due to radiation (z_r) and the total impedance (z). (z_r) is obtained directly from curve 1 by multiplying the values given on that curve by the area of the disk. The diameter of the disk plus the vibrating part of the suspension is approximately 22 centimeters, giving an area of 380 square centimeters. The values of (z_r) for a series of frequencies are shown in columns 3 and values of $\frac{d}{\lambda}$ corresponding to each frequency, where d is the diameter of the disk and λ is the wavelength of sound at that frequency, are shown in column (2) of the table. The total mechanical reactance is made up of a mass component due to the mass of the cone plus drive coil, a stiffness component due to the stiffness of suspension and centering device, and an additional mass component due to reaction of the air, the value of which is obtained by referring to curve and multiplying by the area of the disk. The values of the latter at a series of frequencies are shown in column (4), while the component due to the mass of the cone itself, which is equal to ω times the mass, is shown in column (5).

Since the system is resonant at 100 cycles the total mass component must be equal to the total stiffness component at that frequency and the stiffness component therefore equals 13.4×10^3 mechanical ohms at 100 cycles, and has values inversely proportional to the frequency, as shown in column (6) for the other frequencies. The total reactive component of the mechanical impedance, which is obtained by subtracting the total stiffness component from the total mass component, is shown in column (7). It will be noted that any frictional or heat losses in the vibrating system have not been included as they are negligibly small compared to the other quantities. Columns (3) and (7) determine the total vector mechanical impedance.

We next require the force factor M which is equal to the product of the length of conductor in the gap times the magnetic field strength. In the case of the loudspeaker under discussion, this is equal to $\pi \times 4 \times 120 \times 9{,}000$ and is the same at all frequencies. Its value is shown in column (8).

The supply impedance must be expressed in electromagnetic absolute units and is equal to 11×10^9 abohms as shown in column (9). The electrical impedances of the system, as measured with the mechanical system clamped so that it cannot vibrate, and expressed in abohms are shown in columns (10) and (11); (10) giving the resistive component and (11) the reactive component. The efficiencies calculated by means of the formula and the values which have been given in the preceding columns of the table are shown in column (12). Care must be taken in using the formula to use absolute values and components in the proper place as indicated by the double bars.

Efficiencies at higher frequencies

The calculation of the efficiency has only been carried to 1,600 cycles as the simple assumptions which have been made no longer hold for frequencies above this value. The fact that the vibrating body is a cone rather than a disk affects the radiation at frequencies where the depth of the cone becomes comparable with the wavelength. The cone also fails to vibrate as if it were moving all in phase at the higher frequencies so that the assumption of a vibrating piston is no longer valid. The calculation of the efficiency where the more complicated phenomena takes place is beyond the scope of this simple example and reference can be made to an article by M. J. O. Strutt in the *Annalen der Physik*, Vol. II, page 129, 1931, for additional information. The effect of the use of a finite baffle has also been excluded as this calculation usually involves a consideration of the cabinet which is used to surround the loudspeaker and must be considered as a separate problem.

The response of the loudspeaker in any direction may also be obtained by means of the efficiency values which have just been calculated and the directional radiation curves shown in Fig. 2. The response of a loudspeaker as defined by the Institute of Radio Engineers is expressed in terms of the quantity $\frac{p/}{/v}{\sqrt{R}}$, where p is the resultant sound pressure in the medium expressed in bars, R is a resistance equal to that of the source to which the loud speaker is designed to be connected, expressed in ohms, and v is the voltage supplied to the loudspeaker in series with a resistance R. The calculation of the response as thus defined by means of the efficiency values and the directional curves is made in the following manner:

The absolute efficiency has been defined in the preceding paragraphs. The acoustic output of the loudspeaker expressed in ergs per second may be obtained by integrating the sound energy flux density

[*Please turn to page 76*]

CALCULATIONS FOR DYNAMIC SPEAKER

(1)	(2)	(3)	Reactive component of mechanical impedance (4)	(5)	(6)	(7)	(8)	Electrical impedance $X + jY$ (9)	(10)	(11)	(12)	(13)	(14)
Frequency	$\frac{d}{\lambda}$	Z_r	Air loading	Mass of cone	Stiffness of suspension	Total	M	Frequency	R_s Abohms	X Abohms	Y Abohms	Absolute efficiency Per Cent	$\int \phi^2 d$	Response directly in front $\frac{p_o}{v}{\sqrt{R}}$
50	.032	$.16 \times 10^8$	2.0×10^3	4.6×10^3	-26.8×10^3	-20.2×10^3	13.6×10^6	50	11×10^9	10.7×10^9	1.0×10^9	.6	12.5	$220 \times 1/r$
75	.049	$.35 \times 10^8$	3.0×10^3	7.0×10^3	-17.9×10^3	-7.9×10^3	13.6×10^6	75	11×10^9	10.7×10^9	1.5×10^9	4.7	12.5	$610 \times 1/r$
100	.065	$.62 \times 10^8$	4.1×10^3	9.3×10^3	-13.4×10^3	0	13.6×10^6	100	11×10^9	10.8×10^9	2.0×10^9	12.7	12.5	$1010 \times 1/r$
200	.13	2.5×10^8	8.2×10^3	18.5×10^3	-6.7×10^3	$20. \times 10^3$	13.6×10^6	200	11×10^9	11.0×10^9	3.6×10^9	9.9	12.3	$900 \times 1/r$
400	.26	9.5×10^8	16.4×10^3	37.0×10^3	-3.3×10^3	50.1×10^3	13.6×10^6	400	11×10^9	12.0×10^9	7.0×10^9	5.6	11.4	$700 \times 1/r$
800	.52	26.8×10^8	23.0×10^3	74.0×10^3	-1.6×10^3	95.4×10^3	13.6×10^6	800	11×10^9	13.9×10^9	12.6×10^9	2.9	7.8	$610 \times 1/r$
1600	1.04	32.6×10^8	4.6×10^3	148.0×10^3	$-.8 \times 10^3$	$152. \times 10^3$	13.6×10^6	1600	11×10^9	17.6×10^9	22.0×10^9	.9	2.5	$600 \times 1/r$

Note: r expressed in centimeters.

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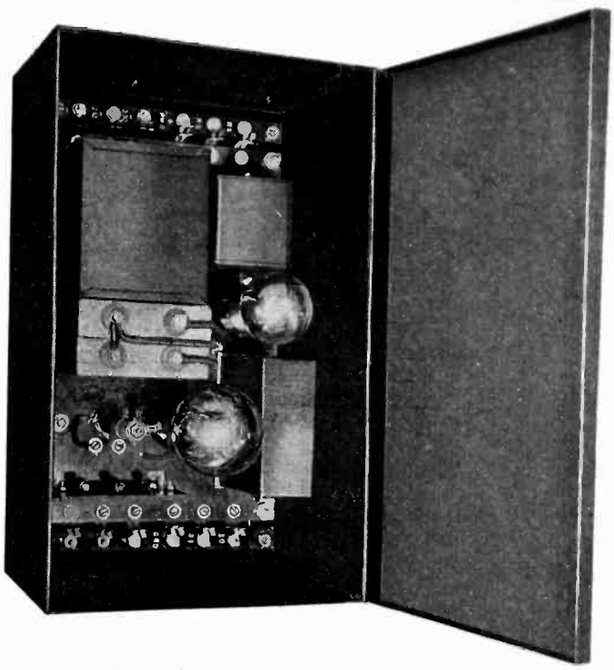
Photocell controlled elevator doors

By C. E. ELLIS
Engineer, Westinghouse Electric Elevator Company

DURING the past ten years in the elevator industry, power-operated automatic doors have come into increasing use in all types of building. They have taken the place of hand-operated doors and gates, both on landings and on the car proper. The modern tendency to enclose elevator cabs fully, using solid doors instead of collapsible gates, has made power operation almost a necessity, if the operator is to be spared undue fatigue, with consequent slow and inaccurate operation. The increasing use of the full automatic elevator, wherein the operator does nothing but register calls and stop the car, has also furthered the use of power doors.

Until six years ago pneumatic devices of various description were universally used as the motive force for the doors, but at that time the first all-electric door operator was placed on the market, using electricity not only as the controlling element but also as power, through an electric motor.

The tempo of present city life demands speed. Leading building engineers, encouraging this trend, are now writing specifications that call for door operation in one second. This rapid operation requires that the door in some cases reach a peak speed of 5 or 6 feet a second during its cycle, so that the energy stored in the door as momentum may exert a considerable crushing force upon collision with any obstacle. For instance, the force exerted on the head of a passenger, that part of the body most often injured, may reach the astonishing total of 2000 lbs. if caught directly between the doors. This hazardous condition until recently had made it necessary to operate doors at slower speeds, with a consequent waste of time that offset to some extent the advantages of the power door. But most serious of all, the increasing use of power doors has carried with it a rising toll of elevator-door accidents now totaling in money loss alone a considerable sum yearly.



Amplifier with full wave rectifier for "Safe-T-Ray" equipment

To protect the passenger and to permit safe higher speed operation, a photo-tube device known as the "Safe-T-Ray" was developed. This makes use of two parallel beams of light separated by a few feet, shining across the door opening, along and close to the path of door movement, it depends for its action on the response of a pair of photo-cells, one located at the terminus of each beam. As long as the beams are unobstructed, the light reaches the photo-cells, which respond in a manner to permit the doors to close. But, if the light fails to reach either photo-cell, a condition brought about by the obstructing presence of a passenger in the doorway, the response mechanism connected to the cells prevents the doors from starting to close, or if started, reverses their direction instantly. The advantages of this protection lie in its quickness and in the fact that no mechanical contact with the obstruction is necessary for instant operation.

The satisfactory solution of this problem involves the use of light sensitive apparatus under a number of interesting physical and electrical conditions.

In the limited space on the elevator car between the car doors and the wall of the elevator shaft, are mounted light-ray projectors aimed and focused, spot-light fashion, on the "electric eyes" opposite. Receiving the minute current from these cells, produced by their light-sensitivity, is the amplifier unit mounted on top of the elevator. From this amplifier are run wires through the trail cable from the car to the door control in the elevator penthouse. Since the entire safety assembly travels on the car the one unit serves to protect all doors.

OTHER SAFETY USES

MANY practical hints on the use of photocells in other safety applications, can be gained from this article on "electric-eye" elevator door-closing equipment.

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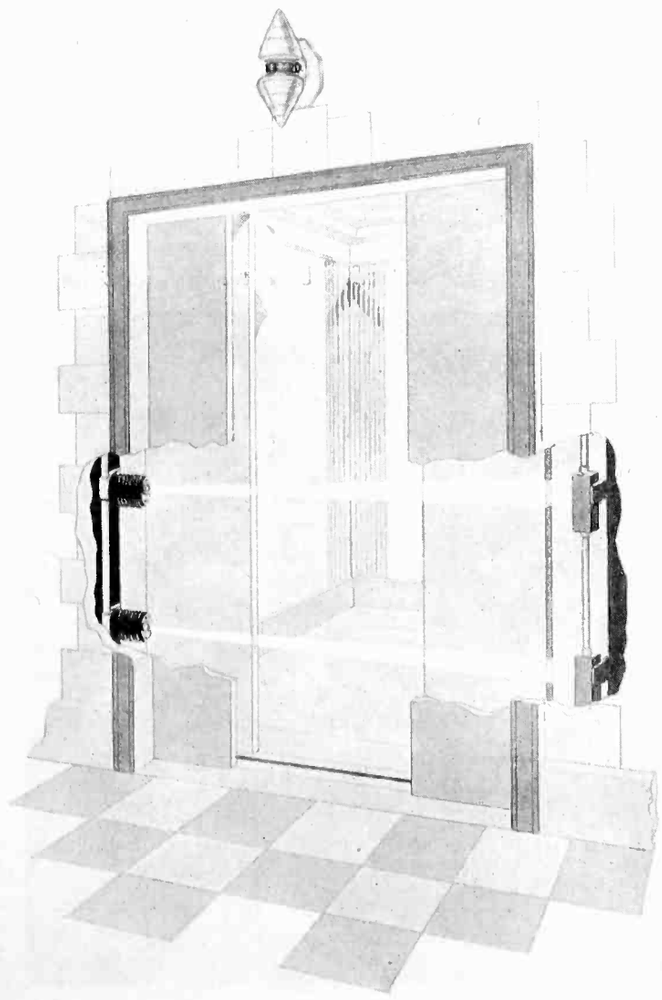
The space alongside the door path is but 2 inches so that the projectors must be shaped high and narrow to fit it. A small aluminum casting, ribbed with vertical cooling fins carries in one end a double convex two-inch simple lens at the focal point of which is set a 12-volt Mazda automobile bus lamp.

The entire assembly is mounted on a small base which permits very close adjustment of the direction of the beam through a small angle.

The beam averages about 5 feet in length so that a twist of one degree in the projector mounting would throw the beam off the cell by over an inch, hence heavy $2\frac{1}{2}$ inch structural steel angles are used as projector supports. On the opposite side of the door opening the beams strike the photo-cells, which are enclosed in dust-tight sheet metal boxes with small windows glazed with thin glass, through which the cells look out.

Since the amplifier cannot be located any closer than 8 or 10 feet from the photo-cells, an unusual condition in light sensitive work, but required by the construction of the elevator with its close clearances, it is mounted on the top of the car where it is most readily accessible. This makes the lead wire from the cells to the grid of the amplifier tube about 10 feet long and with a high capacity to ground. Were unrectified alternating current used as the power supply as is usual in most light relay setups, the capacity reactance of this lead would permit a charging current to flow therein considerably in excess of the current due to the photo-cells alone. Therefore included in the amplifier box which houses all the control equipment is a full-wave vacuum-tube rectifier supplying, through filters, nearly pure direct current for the control elements of the amplifier tube and photo-cell. The capacity of the long grid-lead, while still present, has no appreciable effect with direct-current energy beyond perhaps slowing the response by a few thousandths of a second.

The illuminated resistance of the vacuum type photo-cells is several megohms while the dark resistance rises to several hundred. For this reason, it is essential that strict attention be paid to the quality of the insulation of the high-voltage side of the photo-cell circuit. If the insulation resistance of the leads and socket which bridge the cells approaches the cell resistance when lighted, a false response by the amplifier will result. We have used high-tension rubber and cambric auto-ignition cables and high quality bakelite sockets to obviate this possibility.



Phantom view of "electric-eye" and light projector for "Safe-T-Ray" equipment

A safety device of this character must of course be completely reliable. Every precaution has been taken to the end that failure, if it occurs, will be on the side of safety. The circuit and current constants that will best work to this end have been chosen. This circuit is the light responsive circuit wherein a relay is held closed, permitting operation of the door while light is on the photocells. Thus, if a projector lamp fails, or the amplifier tube, rectifier tube, photocell or filter circuit fail, the relay contacts will open, preventing operation of the doors and any hazard through dependence on a Safe-T-Ray device that may be temporarily ineffective.

Life expectancies for continuous duty:

Projector lamp, Mazda No. 1142	270 days
Photo-electric cell, Type VB	1 year minimum
Amplifier tube, S593428	2 years
Rectifier tube, UX280	2 years

All elements of the device, particularly those that deteriorate with use, are operated at a conservative rating. Since the approximate life of metal-filament lamps varies about inversely as the cube of the voltage, we are able to get nine times rated life from the light source. The bus lamp used for the projector has a rated life of 300 hours at 12.5 volts, but by operating it at 86 per cent rated voltage, or 10.75 volts, we get a life of 2,700 hours. Likewise the amplifier and rectifier tube filaments are worked below voltage and plate current.

Regular inspections to check emission are recommended, in order to avoid shut-downs due to premature ageing of the electronic devices.

Because no direct impact by the doors is required to make the device operate, anything from a puff of smoke properly directed, to a hat box or a passenger will reverse the doors and prevent operation.

This characteristic impresses all who have seen the device, which, with modifications which accumulating operating experience may dictate, bids fair to become standard equipment in department stores and other buildings seriously interested in the welfare of their passengers.

It is expected that insurance companies will allow preferential rates on those elevators equipped with such safety control. And it may even be that this device, by its elimination of door hazard, will pave the way for the first large building equipped with operatorless elevators.

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The latest in high-intensity

X-rays and "fever machines"

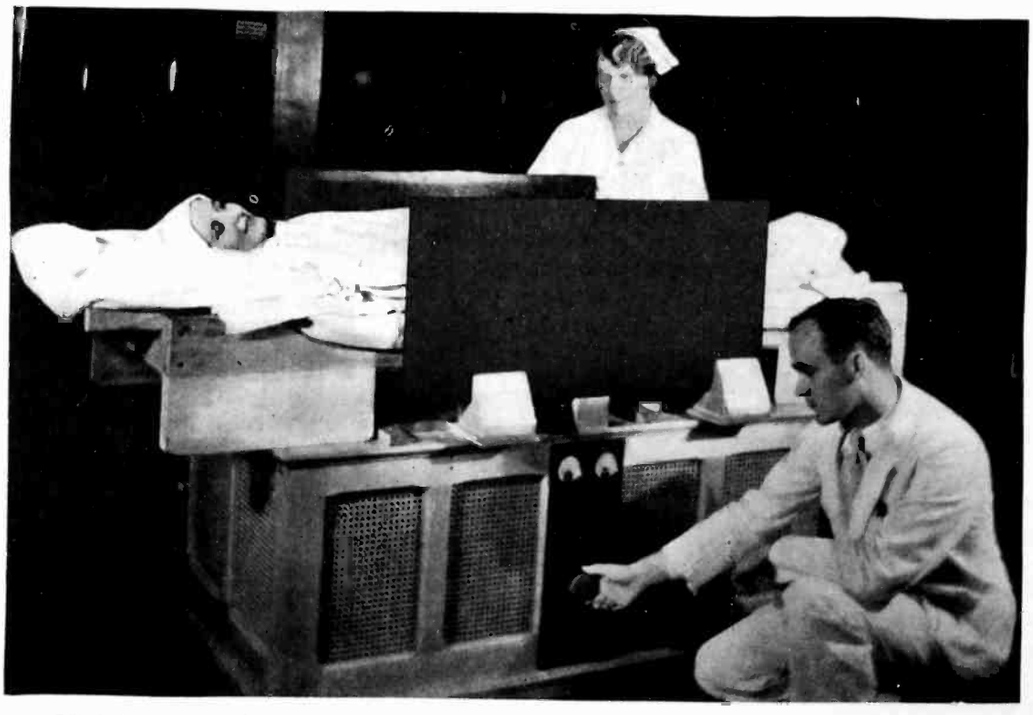
Some new roles of the electron tube as aid to the physician in healing

VACUUM tubes are the newest and most promising tools of the physician and surgeon. Already such tubes produce X-rays, ultra-violet light, infra-red rays, cathode streams, high-frequency surgical cutting currents, "radio fevers," etc. And to the specialist and research worker, they afford new delicacies of diagnosis and measurement of the body's functions.

Among the most interesting new developments of the electronic healing arts is the method of treatment by which cancer patients are being exposed to ordinary X-ray radiation (185,000 volts) continuously 24 hours a day for two weeks. Since the greatest difficulty is encountered in the treatment of tumors which are widely disseminated throughout the body, it was decided to treat patients of this type by irradiating the whole body continuously for a week or two.

An X-ray machine capable of continuous operation was installed last May in the Memorial Hospital, New York City, under the direction of Dr. G. Failla, physicist. The X-ray tube is so arranged that a large beam of X-rays falls on four beds in an adjoining room. The patients stay in this room and take an "X-ray bath" continuously for one or two weeks. During this time they have no sensation of the treatment and they hear no noise from the machine.

Not knowing just what dose of X-rays can be tolerated by the human body under these conditions, it has been necessary to start with a very low dose. This has been increased gradually and so far the most delicate tests have shown no bad systemic effects from the long-continued radiation.



High-frequency "fever machines" in use in the Fifth Avenue Hospital, New York City. At the top of the page is shown the new portable "radio therm," for local heating of knee-joints, limbs and arms

Realizing the importance of an artificial source of gamma rays, Dr. W. D. Coolidge, of Schenectady, N. Y., undertook to develop one. He set out to construct an X-ray tube and accessory apparatus capable of continuous operation at about one million volts, with sufficient power to produce a high intensity of radiation. These requirements are very exacting and increase the difficulties of the problem very greatly. High-voltage tubes which function for a fraction of a second at a time and emit little radiation, can be made rather easily. But the one which Dr. Coolidge set out to develop required several years of experimental work.

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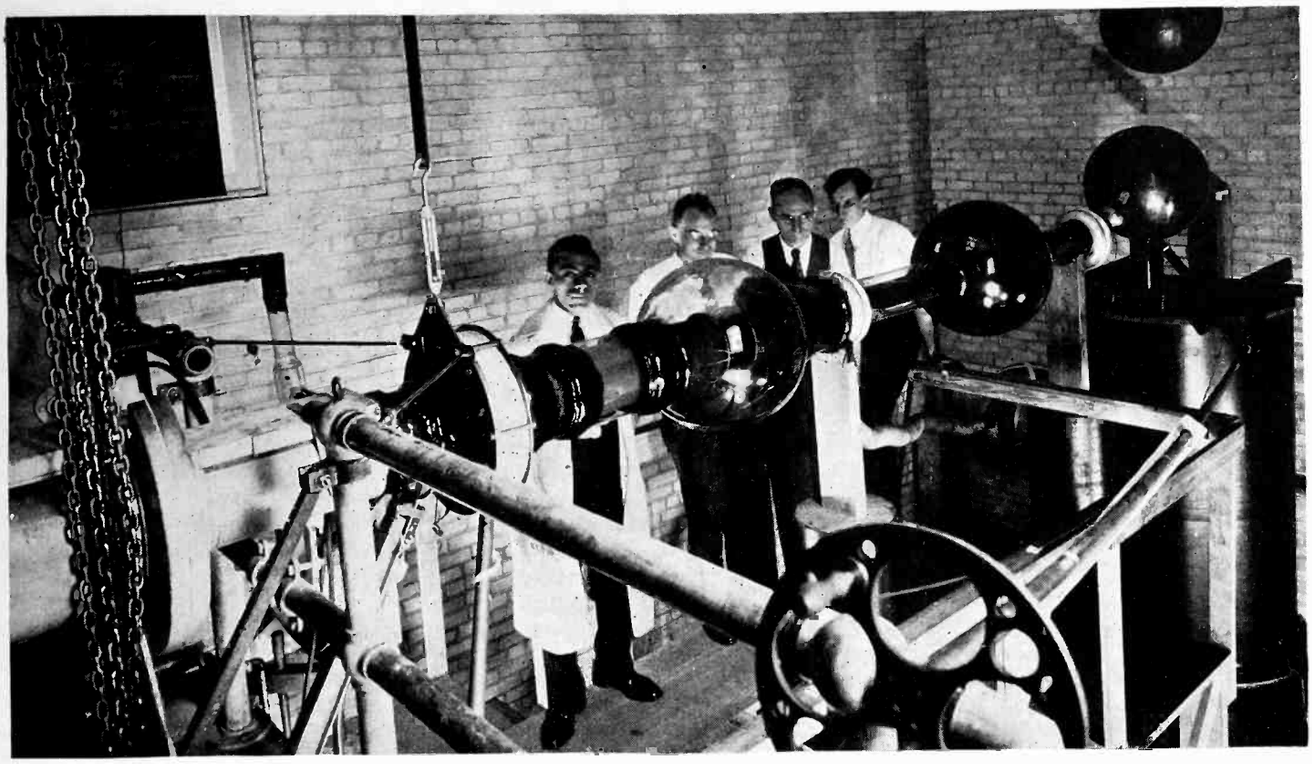
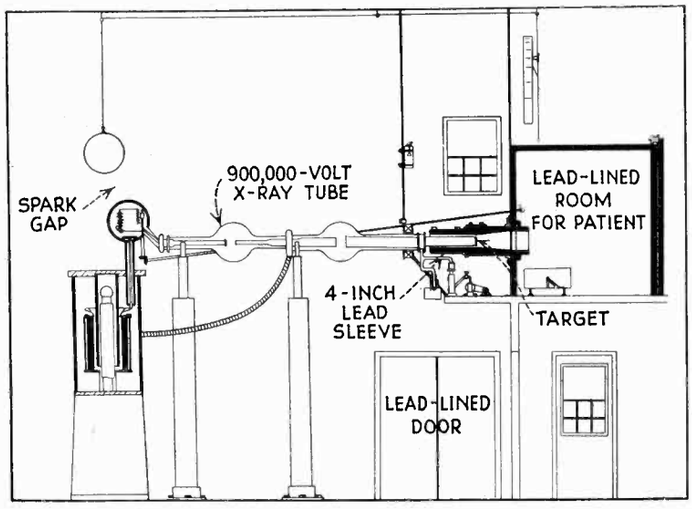


About a year ago Dr. Coolidge had obtained enough experience with a tube operating at 900,000 volts to warrant its use in a hospital. Through the General Electric X-ray Corporation the tube and accessory apparatus were loaned to the Memorial Hospital for clinical experimentation. But Dr. Coolidge did not think that he had reached the high voltage limit and he immediately began to work on tubes and generators for still higher voltages. The size of the 900,000-volt tube and the required protective measures necessitated the erection of a separate building adjoining the hospital. The installation was completed last July. Since then the hospital staff has been carrying out physical investigations to determine the characteristics of the tube and the emitted radiation at different voltages. The information thus obtained has permitted the staff to begin the treatment of patients only a month or so ago, with the proper basis for safe dosage.

X-rays confined by 3 inches of lead

"We have operated the tube up to 850,000 volts," Dr. Failla reports. "But for clinical work, we have decided to use it at 700,000 volts, with a current of 5 milliamperes. Under these conditions the tube can be operated continuously for several hours without any trouble. An idea of the power of the tube may be obtained by comparing it with the amount of radium which would emit the same radiation. At 700,000 volts and 5 milliamperes, the radiation emission is equivalent to that of 450 grams of radium. This amount of radium would cost more than 22 million dollars. The penetrating power of the radiation, however, is not so high as that of gamma rays, although it is much greater than that of 200,000 volt X-rays, which are ordinarily used for cancer therapy. We can measure 700,000-volt X-rays after they have traversed a lead plate one and one-half inch thick. Accordingly, to protect the hospital personnel from these rays, it was necessary to surround part of the tube with a lead sleeve more than three inches thick, and to erect a small room with lead walls, floor and ceiling, ranging in thickness from one to two inches.



The great 900,000-volt X-ray tube of the Memorial Hospital, New York City. In this tube the electrons are twice accelerated before they strike the target, producing X-rays of tremendous penetrative power

"This super X-ray tube will permit us to determine under comparable conditions whether better results are obtained by the use of high-voltage X-rays. At present no one can predict what the outcome of these experiments will be. As with all clinical work a long time will be required before the results can be properly evaluated. We are also carrying out several biological experiments using 200,000-volt X-rays, 700,000-volt X-rays, and gamma rays under comparable conditions, to determine the relative biological effectiveness of these radiations."

"Radio fever" machines here and abroad

A second most promising electronic curative agency is the new group of "artificial fever" machines, or high-frequency oscillators, being experimented with in both Europe and America. Quite aside from the important

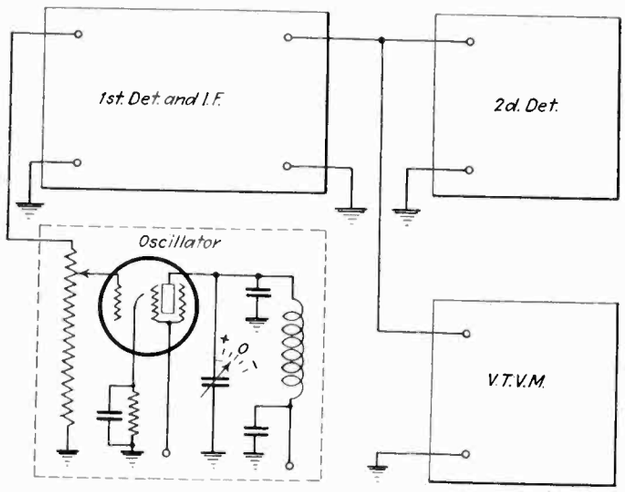
[*Please turn to page 76*]

+ + + ELECTRONIC NOTES

Visual tuning of band-pass amplifiers

By Rinaldo DeCola

The difficulty of tuning band-pass amplifiers so as to realize approximate flat-top response is well known. The usual practice of tuning intermediate frequency amplifiers in superheterodyne receivers by tuning for a peak is rarely very satisfactory. Tuning for maximum sensitivity in this manner almost always results in a lopsided band-pass response curve. An attempt by trial and error to juggle circuits to have approximate flat tops and fairly symmetrical sides is hardly possible in production where speed is a prime requisite. However, oscillographic methods are available of tuning such circuits by taking an actual picture of the response curve. Such a system is perhaps the best available, but is however hardly useable in most production systems where the system must be fairly fooproof and economical.



The system to be explained here is very simple and quite cheap. It consists merely of a variable frequency oscillator, which, when tuned, makes it possible to plot at least a mental image of the curve, as shown by a vacuum-tube voltmeter. The deflection of the vacuum-tube voltmeter is also an excellent method of determining approximately the gain of the i.f. amplifier.

Such a system is shown above. Because of its ease of coupling, simplicity and fair frequency stability the dynatron oscillator is used. By loosely coupling this oscillator to the input of the i.f. amplifier, a milliammeter inserted in the plate circuit of the second detector will, when the oscillator is tuned through the band-width of the i.f. circuits, trace a replica of the selectivity curve of the i.f. amplifier. By calibrating the variable condenser of the oscillator in frequency the band-width at the base and at the peak of the curve can be readily obtained. By imposing suitable restrictions upon the minimum deflection in the detector plate current and deflections at any point along the frequency curve, the instrument becomes quite adaptable to production. Any discrepancies therefore in the symmetry of the response curve can be readily seen by the operator and remedied by judicious retuning. Such a method is quite as satisfactory as other methods where even direct division of the curve is constantly before the operator.

By using a separate vacuum-tube voltmeter, instead of the second detector in this role, and biasing it below the cut-off point for plate current, the signal voltages imposed upon it must exceed a certain minimum value before a deflection can be obtained. Since the top and a small section of each side of a selectivity curve is a fair indication of the shape of the remainder of the curve, only this position need be tuned through. The operation of the voltmeter with such a high value of bias also prevents the input impedance of the voltmeter from seriously affecting the tuning of the circuit to which it is connected. A straight-line-capacity condenser in the oscillator can calibrate linearly in frequency without any material error, and obviates the necessity of using a straight-line frequency condenser, or resorting to non-linear frequency calibration of the dial.

✦

Laboratory study of the sounds of musical instruments

By means of electronic methods such as by producing beats varying from 30 to 10,000 or 15,000 cycles, complex sounds emitted by musical instruments can be much more completely analyzed than was possible with the former optical or mechanical methods. The study of grand pianos furnished by three modern makers to E. Meyer of the Henrich-Hertz Institute of Berlin shows that the strength and the manner of playing a single note influence the number and the distribution of the harmonic and the unharmonic components of the sound. The method is described in the *Zeitschrift für Technische Physik,* December, 1931. Pianos of the seventeenth century possess a very large number of overtones, up to forty; therefore the "tinny" sound. In practically every case the higher notes have fewer overtones than the lower notes when the strength is forte. The fading out of the overtones after the note has been struck may be gradual, or by fluctuations and is just as important as the composition of the sound. In the stringed instruments the fundamentals of all the lower notes are very weak or even absent, because the radiating surface is small, and this explains why a famous conductor has been led to amplify them with vacuum tubes. Among the wood instruments the bassoon is remarkable because all its notes show the presence of a group of frequencies near 500 cycles; a similar state of things occur when vowels are sung. The drums possess only a narrow range of low frequencies, reaching down to 30 cycles, castanets have a strong and almost continuous spectrum over more than 10,000 cycles and the triangle has strong components at 15,000 cycles per second.

✦

Oil adulteration detected by ultra-violet

Robert S. Bolan, chief engineer, Hygrade Sylvania Corporation, Salem, Mass., reports an interesting use of ultra-violet for detecting mixtures of oils.

Harold Smith of the Salem Oil and Grease Company on a recent trip to Germany found in one laboratory that mixtures of dilutions of vegetable oils can be detected by an experienced observer with ultra-violet light. The mixture gives a fluorescent result, where the pure oil gives very little fluorescence. Visible light should be reduced as much as possible for this test by means of a filter. Mr. Smith's company is working on a further development of this idea.

✦

Vacuum tubes in the Stratosphere

For its flight in the Arctic the Graf Zeppelin was equipped with small unmanned balloons which contained meteorological instruments and a small transmitter which at given intervals communicated the readings of the instruments to the airship. Special 1.6 volt A-batteries of the dry type were used, 1 in. in diameter, $\frac{1}{8}$ in. high and weighing four grammes. Forty of these elements put in series formed the B Battery. Four ascents were carried out during the flight, and despite the low pressure, $\frac{1}{10}$ atmospheric and the cold, minus forty deg. C., the transmitter gave good results.

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FROM THE LABORATORY + + +

Technical notes

SAE-RMA Committee

Problems of the automobile radio receiver will be solved if present plans for a joint committee of the RMA and the SAE go through. Questions uppermost in the minds of engineers of both professions are: 1. Mounting space requirements for the radio and batteries; 2. Ignition and shielding, and 3. Battery and charger capacity.

Citation tubes

Laboratory workers will be interested in a new line of tubes announced by CeCo. These tubes are specially engineered and tested and inspected to insure uniformity and long life. The tubes are of all the standard types, bear a uniform list price of $4 and are called "Citation" tubes.

A new patent deal

Representative William I. Sirovich, new Democratic chairman of the Patents Committee of the House of Representatives, is going to give the patent law a thorough renovating. The idea is to bring patent law up to date and to simplify the progress of a patent from filing to issuance. If he can eliminate the lawyer's red tape, he will be doing patentees a genuine favor, according to inventors who feel that so long as patent law is made by lawyers it will not be a short and sweet process.

Many suggestions have been made in many years. This is the most sweeping invitation to the industry ever made by any Patent Committee. It is an opportunity which the electronics art ought to use to the limit.

Panacea for detector trouble

A new detector tube and circuit which, although very simple, does away with much of the trouble existing in present detection methods, i.e. distortion, overload, etc., has been announced. This new scheme embodies an automatic volume control feature and reports from those who have witnessed demonstrations indicate that there is really something new under the radio sun. The scheme is sponsored by Norman Wunderlick, Arcturus has agreed to build the tubes and engineers in general are impatiently awaiting more technical information.

Distortion in the talkies

A method of measuring directly the distortion occurring in an audio amplifier system is described by W. N. Tuttle in the February issue of the *SMPE Journal*. The distortion factor which is employed is defined as the ratio of the effective value of the combined harmonic voltages to the voltage of the fundamental. A simple rapid method, having several advantages over systems previously used, is described, and measurements showing the performance of the apparatus used in applying the method to the testing of audio frequency amplifier systems are presented.

The system provides an attenuator paralleled by a tuned filter for suppressing the fundamental, and a switching arrangement for adjusting fundamental and harmonic voltage to the same value. The ratio of the two voltages is determined by the respective attenuations of the two parallel paths.

Canadian patent

An article on measurement of high resistance by Dr. Irving J. Saxl appeared in August, 1931, *Electronics*. M. Charles B. Limbrick of the Keyes Supply Company, Ltd., Ottawa, calls attention to a Canadian patent, No. 301,583 granted to him July 1930, on the "measurement of moisture content of grain."

Full vision dials for farm sets

Over 40,000 battery receivers for rural use were sold during 1931, engineered around the Eveready Air-cell battery. A user of one of these sets writes that receiver manufacturers would do well to avoid the "peep-hole" dials of the type which expose only a small part of the scale and which are very annoying to the user. The Air-Cell battery does not permit illumination of the dial by the usual dial light.

Push-push

Class B amplification is attracting more and more attention from receiving set designers. David Grimes of the RCA License Laboratory presented a paper on the subject at the Chicago Section of the IRE Jan. 15. A paper on push-push systems is in type for a near issue of *Electronics*. It is by C. E. Kilgour, Crosley Radio Company. Some measurements on the output of receivers, both as to power and distortion, using several types of amplification including Class B are described in an article by J. R. Nelson, of Raytheon Production Corp. It will appear in an early issue of *Electronics*.

Silver-Marshall scoops Chicago show

Called the "Q" receiver, Silver-Marshall's combined short-wave and broadcast receiver proved to be the sensation of the Chicago show. The receiver is standard size lowboy; there are no boxlike adjuncts to the broadcast set which show too visibly that short wave has been added usually as an afterthought. The secret of the small size is electrical switching from one wave-band to the other. Kendall Clough designed it. The factory is reported swamped with orders.

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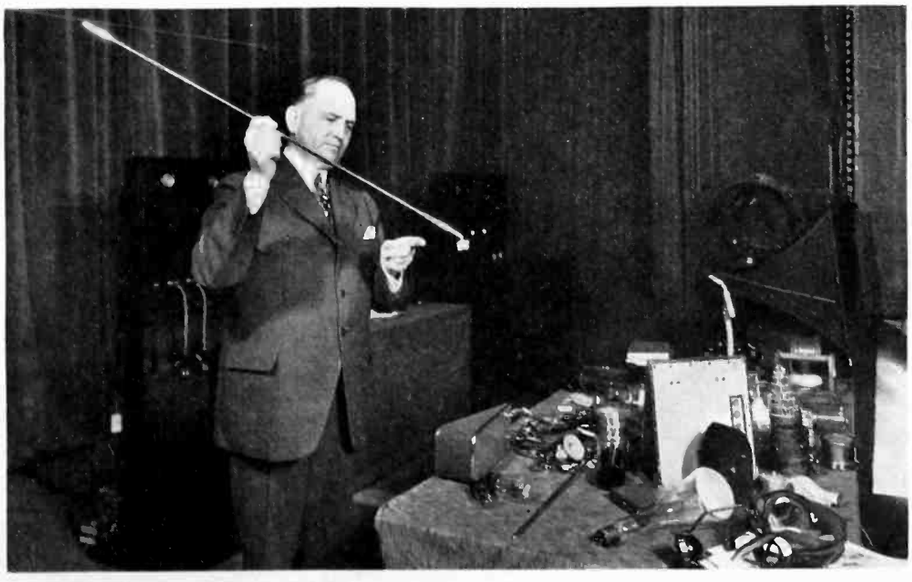
PERMALLOY ROD BECOMES MAGNET



Sergius P. Grace, of the Bell Telephone Laboratories, is holding a permalloy rod in a north-south direction. In this position, due to the earth's magnetic field, the rod becomes a magnet of sufficient power to hold up a block of steel which falls when the rod is moved from its position

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HIGH LIGHTS ON ELECTRONIC

Continuous weighing with light-sensitive "telepoise"

By E. J. White

Electrical means have long been employed in weighing materials in transit on conveyor or feeder scales, but it is only now that light-sensitive cells have been applied. Working on the simple idea of interrupting a light beam a varying number of times depending on the momentary weight passing over the scale section, and converting the light impulses into corresponding electrical impulses for the actuation of an electric counter, a marked step has been scored in the weighing art.

In essentials, the weighing of a continuous flow of material is relatively simple. It is necessary simply to combine the size of the stream with the speed at which it moves. The speed may be constant, but the size of the stream may range from zero pounds per foot of movement, to the full capacity of the conveyor. Consequently, any variation of load must be instantaneously noted at the controller so that true integration or totalling of weight may be obtained.

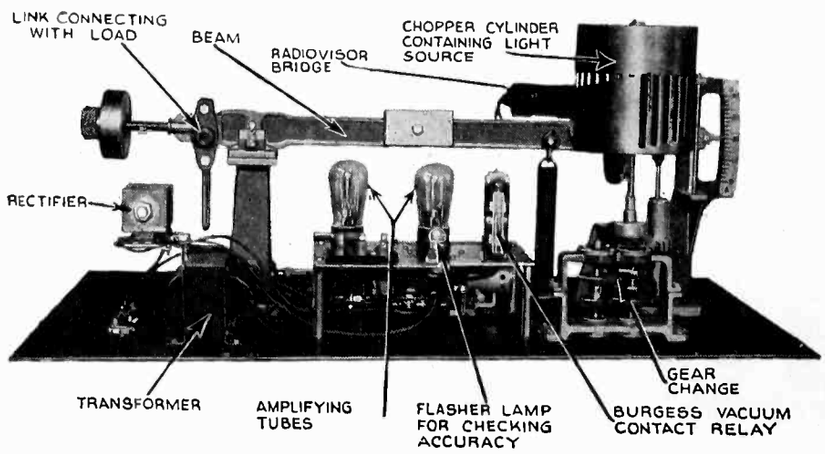
At the point the continuous stream of material is to be weighed, a short section of belt is mounted in such manner that its carrying weight is communicated to the weight equipment placed directly above. The varying weight of the load on the conveyor-belt section is transmitted directly to the end of the fulcrumed weighing beam, causing this beam to swing over the scale of the load indicator at the far or free end.

Close to the free end of the swinging beam is mounted a cross-arm carrying a Burgess selenium cell, together with a light source. These members are so mounted that one is outside while the other is inside a revolving light-chopper cylinder driven in step with the speed of the belt. The light-chopper cylinder derives its name from the fact that it carries 32 parallel longitudinal slots which interrupt the passage of the beam of light between light source and bridge. The slots, however, are of varying lengths. The first is equal in length to the distance traveled by the scale beam from zero to full load. Each succeeding slot is shortened an equal amount at the bottom, so that a line drawn from the bottom of slot 1 around the cylinder to the bottom of slot 32 would form a true helix, touching the bottom of all slots.

The bridge or cell is mounted in a housing provided with a window directly opposite the sensitive plate. The condensing lens of the light source is adjusted to concentrate the intense beam of light through the window and on to the light-sensitive plate. However, the wall of the rotating chopper cylinder comes between, allowing the light beam to pass only when a slot is in line. Each admission of light reaching the bridge sets up an electrical impulse, which impulse in turn drives the mechanism of the integrator that keeps tally, as well as the time chart recorder.

With no load on the belt, the free end of the beam is down, with the focused point of light just below the bottom of slot 1 on the chopper cylinder. Hence no impulses result since no light reaches the electric eye. However, as load is placed on the belt, the beam swings upward proportionately, bringing the focused point of light higher and higher on the chopper cylinder, so that more and more slots admit light to the photo-cell and cause a correspondingly greater number of impulses to actuate the electrical integrator. Thus the number of impulses is always proportional to the load, from zero to the capacity at which the scale is calibrated. At full load there are 32 contacts per revolution of the chopper cylinder. With 350 contacts per minute, an impulse is obtained for each foot of belt, which is representative of a certain weight or amount of material passing over the scale.

The "telepoise," as this continuous-weighing mechanism developed by John Chatillon & Sons is called is finding applications in mines, power plants, warehouses, factories and other places where bulky materials must be weighed while in motion.



The telepoise with its light-sensitive selenium bridge which indicates the number of interruptions by the "chopper" cylinder

✦

Chart surveying by electronic methods

The U. S. Coast and Geodetic Survey has adopted revolutionary changes in the method of making hydrographic surveys of water areas—the principal step in the processes of chart production.

The application of these innovations based on the velocity of sound in sea water permits a surveying vessel while traveling at full speed to gather a continuous profile of the bottom. Visibility of land or weather conditions are non-essentials. The rate of progress is multiplied and permits the definite completion of projects formerly expected to extend into the indefinite future.

The two principal operations in the survey of a water area combine the measurement of thousands of water depths and the determination of their positions on the earth's surface.

Depths are measured by accurately ascertaining the time for a sound at the ship's hull to travel to the bottom and reflect back. The location at which the depth is measured is learned in a similar manner. The sound of a bomb exploded in the water near the ship, radiating in the water in all directions, is picked up by microphones at two shore stations of known positions. The minute impulse is automatically magnified and radioed back to the ship. There its receipt is recorded by the same delicate instrument which previously recorded the time of the explosion.

The travel of the radio wave is practically instantaneous. Consequently, the elapsed times are those required for the sound to travel from the bomb to the respective microphones. The results obtained are two distances from the ship to two points at the shore, and in consequence the position of the vessel.

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DEVICES IN INDUSTRY + +

LISTS 521 TUBE USES

George Lewis, popular Arcturus Radio Tube vice-president (right), has compiled 521 industrial uses for electronic tubes, a typewritten list as tall as himself. Jack Gaertner, his associate, is helping count 'em

✦

Supersonic sterilization of milk

SUPERSONIC VIBRATIONS OF 300,000 cycles per second and higher are known to have the power to destroy red blood corpuscles. If a salt solution containing corpuscles is placed in contact with the vibrating oil the living matter will become dispersed, and the cloudy solution will become a clear red color.

In the Loomis Laboratory at Tuxedo Park, N. Y., filaments of living spirogyra have been torn to pieces and the cells ruptured by the vibrations. Small unicellular organisms such as paramecium are rendered immobile by a short treatment and killed by a longer exposure. Small fishes and frogs are killed by an exposure of one to two minutes. Mice are less sensitive, a twenty-minute exposure in one case failing to result in death, though the number of red corpuscles were reduced to 60 per cent of normal in that time.

It is this killing effect on small organisms which Professors Gaines and Chambers of Texas Christian University suggest might be used to protect delicate foods, such as milk. The present method of killing bacteria in milk, pasteurization, involves raising the temperature of the milk to 143 degrees Fahrenheit, holding it there for thirty minutes, then cooling it to a temperature of 60 degrees. Though this process in no way injures the milk for human consumption, it does bring about slight changes in chemical composition and alters the flavor to a certain degree.

In the process put forward by the Texas scientists the milk would be fed upward through an inverted funnel. A hollow tube, aimed at the funnel just below its large end, receives the high-frequency vibrations and conducts them to the funnel, in which they are concentrated. Dr. Gaines believes that such treatment will kill 90 per cent of all the bacteria without altering the composition or flavor of the milk. If practicable, such a device would probably cost less than conventional pasteurizing equipment and might do the work more quickly.

✦

"Radio Knife" for marking leather, cutting glass

BY A. P. MOORADIAN

REFERRING TO Dr. de Forest's early work with high-frequency cutting currents, I have just looked up his early patent on a "cautery" issued on Dec. 17, 1907, the patent number of which is 874,178. Dr. de Forest's apparatus of that time did not use tubes for generating the high-frequency current, since his patent shows that he used the singing arc for generating his high frequency.

A paragraph from his patent is as follows:

"My invention relates to devices for producing burning effects by means of high frequency electrical currents, and more particularly to cauteries employed in surgery and to instruments for burning leather, marking on glass, glass-cutting, etc."

Robot humidifier actuated by moisture on window pane

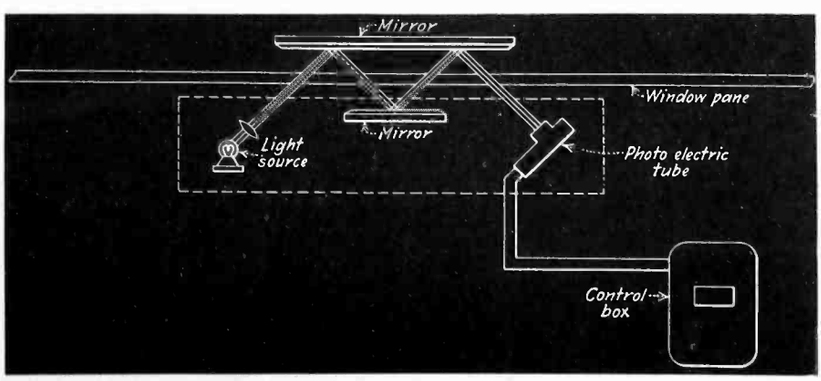
BY B. S. HAVENS

THE MOISTURE ON THE window pane considered undesirable by many house wives, is made the governing element in a new robot designed to keep the home properly humid especially during the dry winter months. This equipment, developed by the B. F. Sturtevant Company in collaboration with the General Electric Company, sets a photoelectric eye to watch the window pane to determine when the air contains the proper amount of moisture.

Healthy conditions indoors, particularly in winter, require a relatively high degree of moisture in the air. A good measure of the amount of moisture in the air is the moisture which accumulates on the window pane. By directing a beam of light through the window and on a photoelectric tube, a method of control is produced which turns off the humidifying equipment at the proper time. The moisture on the glass obstructs the light and the sensitive photoelectric eye passes an impulse to a pliotron tube which actuates a relay to stop the humidifier.

The photoelectric control is installed at a window preferably on the north side of the house where the sun's rays will not interfere. In actual installations the light does not shine directly on the photoelectric tube but is reflected by mirrors back and forth through the window two or three times to cover a larger area of the window and thus make the equipment more sensitive.

The relay governs the starting and stopping of the motor driving the humidifier. As soon as sufficient moisture collects upon the window pane to reduce the intensity of the light, the motor is stopped. When the moisture clears, the motor starts again.



Moisture on the window pane interferes with light beam's passage to electric eye, controlling humidifier

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electronics

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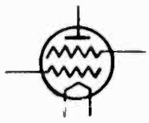

"American Plan" broadcasting goes under fire

WITH the introduction of the Senate resolution calling for an investigation of advertising in broadcasting, with the move to take 15 per cent of the wavelengths for "educational institutions," and with the filing of Senator Dill's bill to destroy clear channels, the forces which would tear down our present wonderful radio system begin to get in their work.

Lest radio engineers and the radio industry itself share in these general attacks on the broadcasters, who are the very foundation of commercial radio, *Electronics* feels that it is time for plain talk.

Where do the present attacks come from?

From certain newspaper interests which eye radio enviously as competition.

From "blocs" claiming places in the air to disseminate their own propaganda.

From politicians eager to fix their own political fortunes, by utilizing radio's popularity, and by getting closer control over stations back home through the 15-per cent grab of "educational" wavelengths.

From small stations envious of the greater service and popularity of the successful broadcasters.

On the one hand we have the most marvelous entertainment and educational system that ever existed, a creation of the past five years. And arrayed against it are selfish interests who would destroy all that has been created, in order to benefit from the wreckage.

There is no question on which side lie the interests of radio engineers and the radio industry. Broadcasting is the radio industry's very lifeblood. And the present "American system" of *paying for programs through advertising* has brought to American broadcasting the greatest aggregation of talent in the world.

Every man who derives his livelihood from radio in any way owes it to himself, his family and his industry, to help strengthen the hands of the broadcasters at this critical time. The "American system" of broadcasting is entitled to a square deal. The American system brings *free* to the American public nightly "the greatest show on earth."

Let no rocks be thrown from inside radio's own camp. In the battle now starting, the interests of all radio men are bound up together.

SMPE standards for sound-picture film

THE past month has seen considerable activity in connection with the establishment of sound-film standards by committees of the Society of Motion Picture Engineers. The dimensions resulting from the addition of sound, several years ago, so limited the area of the film available for photography, that cameramen were forced to restrict the included action to the available area of the film.

The difficulty extended also into the theater; the distorted shape of the picture, departing considerably from the 3 by 4 height-to-width ratio desired, made it necessary for projectionists to mask the tops and bottoms of the pictures, in addition to correcting for "keystone" effect, so that often the images of the heads and feet of the actors did not reach the screen.

The original projector aperture dimensions were 0.600 by 0.800 inch. The action of the Standards Committee, in agreement with recommendations made recently by the Academy of Motion Picture Arts and Sciences, increased the width of the aperture from 0.800 to 0.825 inch. The Academy recommended that the height of 0.600 inch be retained, in order to preserve a pleasing shape of picture for theaters using large projection angles. The SMPE Standards Committee, however, agreed that so long as changes

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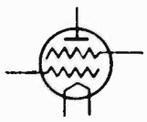
were to be made, they should be made to the full extent, and that the height of the aperture should be reduced from 0.600 to 0.590 inch, to obtain a picture of pleasing shape in theaters which employ projection angles as great as 27 degrees.

The SMPE Standards Committee is now beginning an intensive study of the design and manufacture of 16-mm. sound-on-film equipment, and is also looking into the various methods of processing film in the laboratories, with a view of determining what phases of processing are susceptible of standardization, particularly with reference to sensitometric control and the specification of light sources.



To bring patent-law abuses out into the open

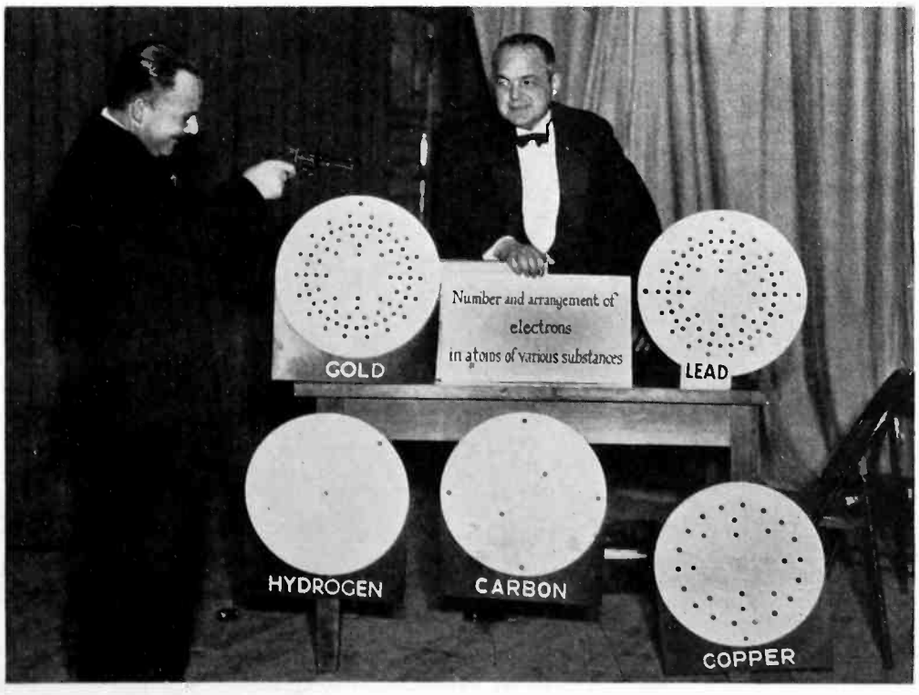
ALL during February the Patents Committee of the House of Representatives will hold hearings at Washington looking to fundamental revision of the patent laws. Chairman Sirovich has invited all persons interested to appear before the committee and give testimony.

In the conflict of self-interested opinion that has surrounded the patent law, its primary object, that of obtaining disclosure of inventions for the benefit of the public, is almost lost to sight. "Pat Pending" is sure to get a sound tongue-lashing when the hearings open. He has been employed to extend indefinitely the period of protection which the law allows inventors as a reward for revealing to the public their ideas for the advancement of art and industry.

The life of a patent from date of issue is 17 years but many applicants, after filing their claims, permit them to hang fire, thus obtaining a large measure of protection for a long period before patent is actually granted. In general, this practice would be suppressed by limiting protection accorded by a patent to 20 years from date that application is filed.

Amendments proposed by the American Patent Law Association and approved by the American Bar Association provide: that if an applicant fails to put his claims in condition for issuance of patent, or for appeal, within a time limit set by the Commissioner of Patents, they shall be regarded as abandoned and that the Commissioner of Patents may order an application pending three years to be placed in condition for allowance or appeal on 30 days' notice, and shall then take final action. This recommendation was adopted as an alternative to a proposal that patent applications pending three years be thrown open to the public.

TO ILLUSTRATE SMASHING OF ATOMS BY "CATHODE RAY" BULLETS



How a high speed cathode-ray stream may knock electrons out of atoms and smash the nucleus, was illustrated during an address before the Pelham (N. Y.) Men's Club by Orestes H. Caldwell, editor of *Electronics*. The 82-electron "lead atom" was revolved rapidly, and when fired at, by Clarence Law, New York Edison official, the atom was suddenly seen to change from lead color to a golden hue. Brought to a standstill, it was found to have lost three electrons

(Photo by New York Times)

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The march of the electronic arts

RMA leaders oppose radio tax at House hearing

RADIO INDUSTRY LEADERS appeared at Washington, Jan. 23, before the Ways and Means Committee of the House of Representatives in opposition to the proposed 5 per cent sales tax on radio and accessories, declaring that such a tax would cause increased prices to the public, reduce sales, increase unemployment and yet raise negligible additional taxes for the Government. The radio spokesmen were followed immediately before the House Committee by a large delegation of automobile industry leaders in a similar plea.

That radio is not a luxury but a great agency of communication and human development was strongly urged by the radio men. For over a year radio receiving sets and tubes have been generally sold to the public below cost, with great losses to all but a few manufacturers, it was stated. It was emphasized that the proposed special and discriminatory tax on radio could not be absorbed and must be passed on to the public.

Those testifying, included Hon. Frank D. Scott, RMA legislative counsel, Arthur T. Murray, Springfield, Mass., president of the United American Bosch Corporation; B. J. Grigsby, Chicago, president Grigsby-Grunow Company; William J. Barkley, Newark, N. J., president Deforest Radio Company, and A. M. Ferry, Washington, representing radio tube manufacturers. Major I. E. Lambert, Camdem, N. J., counsel for RCA Victor Company, and other industry representatives also were present at the hearing.

✦

Senate holds up settlement of RCA suit

ON MOTION OF Senator Blaine, the Senate, Jan. 22, passed a resolution which requests the Attorney General to report the status of "any negotiations or conferences which may have taken place between the representatives of the government and the said defendants," and asks him "not to compromise or settle" the suit, or permit the entry of a consent decree "until the Judiciary Committee of the Senate has received the information and advices requested herein, to the end that legislation may be initiated for the protection of the public's interests and the safeguarding of the radio industry, if necessary."

✦ ✦ ✦

TO MAKE BRITISH SET OWNERS PAY UP

The "broadcast van" now operating in London. With roof antenna, its original purpose was to locate unlicensed transmitters. But lately, it has been used chiefly to frighten radio-set owners into paying their license fees

IRE emergency employment broadcast survey

THE DIRECTORS OF THE Institute of Radio Engineers, at its meeting Jan. 6, appointed an emergency employment committee to provide for radio engineers who are in need. Capt. R. H. Marriott is chairman.

A plan has been devised to permit employing a number of engineers in the making of a radio broadcast survey at a wage which will keep them in food and shelter until they get something else. Such a survey will prove of value in the development of radio, which is the objective of the Institute. It can also be made of great value to the Federal Radio Commission, Congress, broadcast stations, radio advertisers, radio manufacturers, and the public.

✦

RMA engineering heads meet Feb. 9 and 10

RECEIVING-SET as well as tube problems are receiving the active attention of the RMA Engineering Division and its several sub-committees, under the direction of Dr. C. E. Brigham, chief of the division. A semi-annual conference of the Engineering Division committee chairmen will be held Feb. 10, at the Hotel New Yorker in New York. On the preceding day, Feb. 9, there will be a large joint meeting of the vacuum-tube and receiving-set committees.

✦

Radio engineers at Pittsburgh April 7-9

THE ANNUAL CONVENTION of the Institute of Radio Engineers will be held at the William Penn Hotel, Pittsburgh, Pa., April 7 to 9.

An exhibit of radio equipment and components will be held during the convention. Representations of *Electronics* will be found in Booth 19.

✦

Italy's reallocation—two 75 kw. stations

ITALY HAS DECIDED upon a reallocation of the five exclusive wave-lengths allotted it under the Prague wave division plan, one wave each to be given the high power stations at Rome, Milan, Florence, Trieste and Bari. The Milan station, now under construction, is to have power of 75 kw., the equivalent of that of the American-built "Radio Roma."

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Pan American Airways

RADIO COMMUNICATION ON THE international airlines of the United States was the subject of the paper delivered by H. C. Leuteritz, chief communication engineer of Pan American Airways, at the January meeting of the Radio Club of America.

Early in 1929 the P.A.A decided to establish its own communication department. Tests proved the effectiveness of 5,000 and 6,000 kilocycles for daylight operation. International regulations required the use of 500 kc. while over water—(P.A.A. has a long water hop)—and 333 kc. while over land. The apparatus had to be reliable for at least 250 hours.

The present radio communication system utilizes 59 ground stations and 102 airliners completely equipped. The entire service includes weather reports, squalls and thunderstorms, changes in visibility, changes in height and amount of clouds, changes in precipitation and changes in wind forces.

✦

Radio engineers elect Dr. Cady president

THE BOARD OF DIRECTORS of the Institute of Radio Engineers has announced the result of the recent election of officers for 1932. Dr. Walter G. Cady, professor of physics, Wesleyan University, Middletown, Conn., becomes the new president and Professor E. V. Appleton of Kings College, London, England, was elected vice-president. O. H. Caldwell, editor of *Radio Retailing* and *Electronics*, and E. L. Nelson, radio development engineer for the Bell Telephone Laboratories, were elected directors.

The work of Dr. Cady in the piezoelectric field has been of outstanding importance and in recognition the Institute presented to him in 1928 its Morris Liebmann Memorial Prize. Professor Appleton was also, the recipient of this prize which was presented to him in 1929.

✦

Rutgers arranges research employment for engineers

UNDER A PLAN adopted by P. H. Daggett, Dean of the College of Engineering, Rutgers University, to provide employment for engineers, authorization has been received for the appointment of six special research assistants for the Spring term in the College of Engineering of Rutgers University. These assistantships will carry a stipend of $150 and exemption from all tuition fees.

Four of these assistants will be used in part-time work on the following projects: 1. Study of the velocity of flow and sedimentation in tanks. 2. Study of New Jersey sands.

Motion Picture Engineers at Washington, May 9

N. D. GOLDEN, assistant chief of the motion picture bureau, Department of Commerce, has been appointed chairman of the local arrangements committee by W. C. Kunzmann, chairman of the convention committee preparing for the meeting of the Society of Motion Picture Engineers at Washington, D. C., May 9 to 12.

C. Francis Jenkins, Raymond Evans, C. N. Nichols, N. Glasser, C. J. North and N. C. Haefele have been appointed to serve on Mr. Golden's committee.

✦

Dr. Stokowski's orchestral theremin

DR. LEOPOLD STOKOWSKI, director of the Philadelphia Philharmonic Orchestra has been experimenting with electric-oscillator music for several years, using the deep sonorous tones of electrical vibrations to enrich the volume output of his musicians. As a further supplement to the usual instrumental music, Dr. Stokowski has recently added a special form of keyboard theremin, designed and constructed for him by Professor Leon Theremin, whose laboratory is now at 37 West 54th Street, New York City.

As shown in the illustration, this keyboard instrument combines in its construction the fingerboard channel, so that it may be either played as an organ or fingered as the strings of a bass viol are fingered. The keyboard reaches down almost to the lowest note on the piano. The instrument has an output of 100 electrical watts, and is ordinarily played through six 12-inch speakers. The instrument is sufficiently portable to be carried about with the orchestra in its travels, and during January was heard in New York and Washington, as well as Philadelphia.

✦

American Physical Society at Cambridge, Feb. 25-27

THE 176TH REGULAR MEETING of the American Physical Society will be held at Cambridge, Mass., Feb. 25, 26, and 27, as a joint meeting with the Optical Society of America. Tentative arrangements for the program include: Thursday afternoon, a symposium on "Properties of Matter," led by P. Debye, Thursday evening, an illustrated lecture by Henry Norris Russell on "Revealing the Universe through the Spectroscope." At Harvard on Friday, a symposium will be held on "Electronic Devices and their Applications to Research with Special Reference to Radiation Sensitive Devices," under the direction of Prof. E. L. Chaffee.

✦ ✦ ✦

NEW KEYBOARD THEREMIN USED BY STOKOWSKI

The special keyboard theremin, with fingerboard channel, being used in Philadelphia Orchestra recitals

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REVIEW OF ELECTRONICS LITERATURE

HERE AND ABROAD

Oxide-coated filament research

[J. A. BECKER and R. W. SEARS] Bell Telephone Lab. [A. L. REIMANN and L. R TRELOAR] G. E. Company, Wembley. Work at the Westinghouse Laboratory on the oxide-coated filament with Konel core (cobalt, nickel, iron and titanium) has shown that the same plate current may be obtained from oxide-coated Konel at 775 deg. C. and from coated platinum filaments at 995 deg. C. and that therefore the electrons are set free right at the core and pass into the vacuum through the porous oxide layer. The experiments at Wembley indicate that the electrical conductivity of the oxide (measured with a potential difference of 0.1 volt applied between two coated filaments twisted together), and the emission of electrons vary in the same way when the temperature is changed, and that the conductivity may account for the changes in the emission. The filaments were heated by means of a small tungsten furnace which surrounded them; the temperature was above 650 deg. C.

Becker and Sears, however, find that an active filament with a Konel core acts just like other active filaments, at least at 250 deg. C. When electrons are shot into the oxide layer, the activity increases first, but decreases when the treatment is continued. The original activity may be restored by glowing the filament at 770 deg. C. A little barium distilled onto the filament increases the activity, larger amounts reduce it. With pure tungsten the effect of barium is however, many thousand times more pronounced, probably because the interior of the oxide film is never entirely free of barium metal particles. The conclusion is that barium dispersed near the outer surface forms the source from which the electrons are drawn.—*Physical Review, December, 1931. Phil. Mag. and Journal of Science, December, 1931.*

✦

New Munich broadcast sender

[DASER] This station is at first to work with 75 kw. but can be increased to 150. Modulation 70 per cent maximum without distortion. The chief point of interest is the system of six vertical antennas which it is hoped will prevent fading.—*Funk Magazin, Berlin, January, 1932.*

Five picture channel television system

[C. O. BROWNE] The Gramophone Company. Five picture channels are used to accommodate a frequency band sufficient to produce an image composed of 15,000 elements. The received picture is projected on to a screen 24 by 16 in. and the scanning is at the rate of 12.5 times a second. The frequency band necessary for transmission is thus $12\frac{1}{2}$ by 15,000 by $\frac{1}{2}$ or 93,750 cycles. —*The Electrician, January, 1932.*

✦

Novelties in high-frequency measurements

[DR. G.] In a method developed by Pungs and Vogler the voltage to be measured is applied to the plates of a Kerr cell between two Nicol prisms, the amount of light thus caused to pass being compared with a fixed standard (by photocells, amplifiers and a galvanometer) and the potential itself measured by causing the same amount of light to be passed by the applied alternating voltage from a source of low frequency and of readily measurable potential.—*Funk, Berlin, January 1, 1932.*

✦

M. Thomas, a French engineer, has invented an apparatus which enables blind people to read ordinary books. The principle of the new invention is a photoelectric cell

Automatic registration of frequency curves

[VON ARDENNE] Description of a method using a Braun tube and photographic paper on a revolving drum, and applicable to all apparatus (e.g. complete receivers, loudspeakers, amplifiers, pick-ups). Particular advantages are the absence of inertia of the Braun tube and the linearity of its response. Only two of the controlling plates of the tube are used, the other pair being preferably grounded. It is desirable that the pair in use should be shunted by about $\frac{1}{10}$ megohm if the applied voltage available is sufficient to allow this. Examples of records are given.—*Funk, Berlin, December 25, 1931.*

✦

Properties of industrial photocells

[W. KLUGE] Research Lab. German General Elec. Company. The photocells which German G. E. manufactures are based on the American Bainbridge patent of 1928 for silver-oxide of potassium and potassium films deposited on the inside wall (see these Digests, August and November, 1931).

The films are transparent. The sensitivity increases gradually from the dark red to the highest value in the violet. In another type of cells caesium is used in the place of potassium. In order to study the constancy of the performance, a series of cells were left in diffuse daylight (0.2-ft. candles) for about a year with 60 volts applied so that a current of one microamp. was flowing all the time, except at night and during these tests. The sensitivity of gas-filled silver-oxygen potassium cells increases quite markedly during the first thirty days, but remains practically constant after this period. When used with sound pictures, the average current is about one-tenth microamp. — *Zeitschr. Tech. Physik, December, 1931.*

✦

Braun tubes

[UNSIGNED] These are now available at prices ranging from 30 cents to 50 cents, smaller types working with 220 to 4,000 volts, larger with 500 to 4,000 volts. They are useable up to 10,000 cycles. — *Advertisement in Funk Magazin, Berlin, November, 1931.*

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General meeting of the Heinrich Hertz Society

[Dr. G.] Leithäuser on the propagation of ultra-short waves in city areas. Measurements were chiefly made with a superregenerative receiver, on 8-10 meters. Practically no absorption takes place above the general building-level, absorption by buildings being on the other hand very high. The necessity for elevated receiving antennas is stressed. Experience has shown that these waves are not so free of interference as was hoped. In summary, these frequencies are certainly very suitable for city broadcasting, but considerably higher transmitter powers will be necessary than was at first thought. Schröter on the transmission of half-tone pictures by television, with special reference to the Telefunken method. Here the density of the image varies the current from a photocell in the usual way, this causing more or less deflection of an oscillograph mirror. A light ray is thus reflected onto a rotating drum provided with a multiplicity of series of holes of varying number per revolution. The ray is thus interrupted at a frequency depending on which series of holes it reaches, and thus on the density of the image, this being therefore translated into one of a series of modulation frequencies.—*Funk, Berlin, December, 1931.*

✦

Studies on oxide-coated filaments

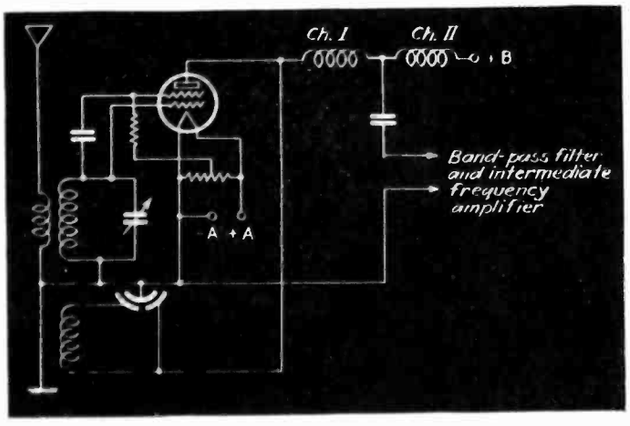
[W. Hinsch] Dresden Institute of Technology. At present the filaments are prepared by depositing barium upon an oxidized filament of nickel, or of platinum either by the azide process or the thermite method. A solution of azide is placed onto the plate of a screen-grid tube, decomposed by heat and the metal evaporated by inducing high frequency currents in the plate. Unless the filament is strongly heated during this latter process during which the plate is outgassed at the same time, the plate current is small. The filament has to be activated by passing excessive current through it. The higher the current the stronger the emission and the more distinct the saturation stage. A partly activated filament appears dull owing to microscopic bosses and pits. The bosses have metallic lustre, and remain unchanged in moist air. They consist of a barium platinum alloy with very little barium. The roughness of the surface leads to uneven distribution of the electric force near the surface and makes saturation difficult. Indeed with stronger activation the excess of barium mixes with the platinum or evaporates and the alloy spreads all over the surface as an even layer.

K. Becker *(Phys. Zeitschr., July, 1931)* in reviewing the whole question of the influence of metal films and gas films on the thermionic emission still thinks that as far as the quantity of atoms adsorbed, whether it be thorium, barium, rubidium, cesium, etc., is concerned, the best results are obtained if it corresponds to a surface layer one atom thick, either on the pure metal, or on the oxide.—*Zeitschr. Techn. Physik, November, 1931.*

✦

New short-wave superheterodyne circuit

[Horan] The circuit shown is usable from 10 to 100 meters, the tube is not a screen-grid but a double-grid tube, as used largely in France for frequency-changing in superheterodynes. Reaction control is by a differential condenser. The first choke must stop the



short wave but have little effect on the intermediate frequency (about 30 kc. was used). The second must on the other hand block this frequency—it can be replaced by a circuit tuned to it.—*L'Onde Electrique, Paris, October (published November 8), 1931.*

✦

Radio direction-finding and air lines

[Serre] Chiefly on organization problems as exemplified by the "Aeropostale" services (France-South America) rather than technical. Some points of interest are: For tropical transmitters it has proved preferable to use low tension a.c. with transformer and rectifier rather than the simpler high-tension dynamo. The only reception possible through tropical atmospherics has been with superheterodyne and loudspeaker, head-telephones proving too tiring. Direction finding is usually by the ground station. Special attention is given in this article to the night effect on bearings, and two systems of double loops are described which overcome this at the cost of considerable sensitivity.—*L'Onde Electrique, Paris, October (published November 5), 1931.*

Highly sensitive vacuum photocells

[M. L. Teves] Philips Research laboratories, Eindhoven, Holland. [A. R. Olpin] Bell Telephone Laboratories. The main tendency is to make photocells more sensitive to white light, that is to enhance the response in the red region. One of the methods is to allow a thin layer of salt (barium fluoride, sodium chloride, etc.) to take up metal atoms from cesium vapor. A still better result is obtained when a layer of cesium oxide is exposed to cold cesium vapor, the sensitivity to the light from an ordinary tungsten lamp (2410 deg. C.) increases to 12 μa. per lumen, or about one electron per 50 quanta of light. It is possible to go still higher by using thicker layers of oxide (100 to 1,000 molecules high), the maximum shifting from the orange red toward dark red and infra-red. In the laboratory 65 micro-amps. may be obtained at 40 to 50 volts plate potential; in the regular manufacturing process the cells are produced with 20 to 30 μa. per lumen, so that they are almost as sensitive as gas-filled cells. But they cannot be exposed to strong light without being injured; when dealing with 0.1 to 0.2 lumen the sensitivity decreases by 5 per cent in three hours.

Work in the Bell Laboratories has shown that the mere introduction of small amounts of oxygen onto an alkali metal hydride surface enhances the photo sensitivity, but without changing the position of the maximum. Just as in the case of sound waves, the transmission of electrons will be greatest when the de Broglie waves associated with their motion are of such length that they form stationary waves between the layers. The wavelength of maximum sensitivity is then given by $330\ d^2$, where d is the distance between lavers. —*Zeitschr. Techn. Physik November, 1931. Physical Review.*

✦

Short-wave television experiments, U. S. to Europe

[Hewel] Description of the antenna, receiver, etc., with which the author was able to follow the Alexanderson experimental transmissions from 2XAW. The antenna used consisted of five vertical doublets spaced at one-fourth the wavelength and in the plane of the incoming signals. A mirror-wheel system was used. Details of the results are given.—*Funk, Berlin, January 8, 1932*

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Progress in airplane radio

[SCHW] Largely based on a lecture by Fassbender. Special details are given, with photographs, of the screening adopted for the ignition systems. The development of the very compact telegraph transmitters is described. Telephony has been abandoned. Experiments with short-waves, especially between Cadiz and Las Palmas are still in progress and have given good results. Navigational radio is exclusively by rotating loops, whether on the plane itself or from the ground. Ultra-short waves are used to direct the plane during its approach to the airdrome and while gliding down to this, a highly directional transmission being obtained by a series of oblique doublets at the ground station, and the plane carrying a small horizontal doublet only. The use of short-waves for the automatic transmission from meteorological instruments attached to small balloons is fully described, with photographs of the apparatus (total weight 1.4 kilograms) —*Funk, Berlin, December 11, 1931.*

✦

Growth and decay of vibrations in loudspeakers

[H. NEUMANN] Siemans Research Laboratory, Berlin. Strong magnetic fields increase not only the efficiency—the range of the 600-watt speaker with a 22,000 gauss field is over 12 miles—but also the quality of reproduction, because they produce strong damping and lower the natural period of vibration of the membrane, from 80 cycles, for instance, at 5,000 gauss to near zero at 22,000 gauss per sq.cm.—*Zeitschr. Tech. Physik, December, 1931.*

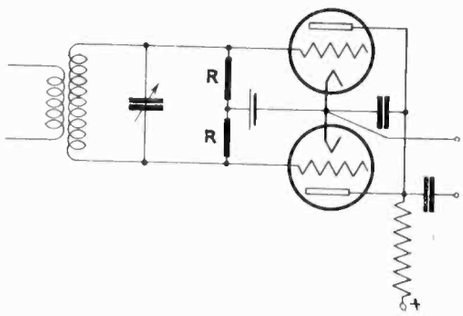
✦

Kerr cell in high frequency measurements

[L. PUNGS AND H. VOGLER] Brunswick Institute of Technology. In some work on the behavior of insulators the authors had to measure voltages of 500 to 4,000 volts at frequencies of 3,000 kc. and above. They applied the voltage to be measured to the condenser plate of a Kerr cell and measured the average amount of light transmitted by the cell; this depends only on the peak voltage, not upon the frequency, so that low frequency voltages may be used for calibrating the cell or for comparison. It seems certain that the Kerr-effect has no inertia up to frequencies of at least 30 megacycles (10 m.) and there is no heating provided that the nitrotoluol is carefully treated. The errors are smaller than 1 per cent, whereas commercial electrostatic voltmeters are only good up to 1,500 kc. and give errors amounting to 30 or 40 per cent at 12,000 kc. — *Elektrotechn. Zeitschr., August, 1931.*

Quality detectors

[W. GREENWOOD and S. T. PRESTON] Research Department, Brit. Br. Company. With respect to the output resistance R a rectifier with a given characteristic is equivalent to a generator giving E_o volts when the circuit is open and sending current through its internal resistance r in series with the load R. The output voltage E is therefore equal to E_oR divided by $R + r$. In order to get high values of E, it is desirable to have r small (steep characteristic); for power R must equal r. In order to prevent losses a by-pass condenser C for the r.f. is usually provided, parallel to the output resistance; the product of capacity in mf. by resistance in meg. should not exceed 1/100,000. A third point to be considered is that the rectifier circuit should not damp the high frequency input circuit (see also *Electronics*, July, 1931, March, 1931). In the case of the anode bend detector with negative grid the working point is on the lower part of the bend, where the resistance r is high. A high output resistance R must therefore be chosen, 100,000 ohms and C cannot be increased beyond 0.0001 mfd. Distortion will be serious for small input amplitudes, but the damping introduced in the r.f. circuit is very low. The grid-current detector has a sharp initial bend followed by a long steep range which cannot be made use of completely without getting anode bend detection. A high grid resistance, grid leak, is required, and as C cannot be less than 0.0001 mfd. the grid leak should not be higher than 100,000 ohms, and need not be with two volt or indirectly heated tubes. It is best to have the rectified current equal to ⅓ of the steady anode current. The only serious disadvantage is damping due to load thrown back from the anode circuit. A remedy is to use push-pull detection in which there will be no r.f. in the anode circuit, "as the applied voltages are equal and opposite" no r.f. feed back and only a small by-pass condenser is required for R. The blocking condenser can also be dispensed with. The grid leak may be increased.—*The Wireless Engineer, December, 1931.*



Push-pull detector, somewhat similar to circuit used in America

The dynatron oscillator

[F. M. COLEBROOK, National Physical Laboratory] When the screen-grid is more positive than the plate, the plate current versus plate voltage curve of any tube may show a negative slope over a fairly wide range, the control grid bias determining the steepness of the slope (*Electronics, May, 1931*). For reasons not completely understood the highest frequencies obtained when a tuned circuit is inserted in the plate circuit, is 15 megacycles. But when a variable condenser (0.0001 mfd. for broadcast frequencies, 5,000 mmfd. at audio frequencies) is placed between plate and control grid and the latter connected to the negative end of the filament through about one megohm, then the circuit will still oscillate at very high frequencies, up to 54 megacycles (5.5 meters). The oscillating condition is accompanied by a fall in screen-grid and anode current. A circuit oscillating at seven meters maintained oscillations for 48 hours without adjustments.—*Wireless Engineer, November, 1931.*

✦

Demountable 500,000-watt radio valve

[METROPOLITAN VICKERS ELECTRICAL COMPANY, Trafford Park] Investigations have been conducted for many years with the object of devising a valve in which the vacuum could be maintained by pumping (as in the case of mercury rectifiers) and the difficulty of sealing off the electrodes under vacuum avoided. Mercury vapor pumps can only be used in connection with liquid air for trapping the vapor, a costly and unwieldly process. During some work in another field oil distillates were found with a vapor pressure so low that at ordinary temperatures they can be placed inside a vacuum tube without impairing the vacuum. They can be boiled at low pressures without decomposition and can take the place of mercury, water cooling the pumps being sufficient. The vacuum tube is made of steel, porcelain and copper, it can be taken to pieces and reassembled in a few hours. It stands 10 feet high and is 14 in. in diameter. The plate is 26 in. long and weighs 3 cwt. The valve filament consists of nine sections, each controlled by one section of the grid. The total filament current is 500 amp., the filament emission 160 amp. or 300,000,000,000,000,000 electrons per sec. Some of the parts had to be produced with an accuracy of 1/100,000 in. The tube will operate the main transmitter at Rugby replacing a bank of 50 high-power tubes. Photographs of this new tube will be found on page 191 of November, 1931, *Electronics*. — *The Electrician, September, 1931.*

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✦ NEW PRODUCTS

THE MANUFACTURERS OFFER

Spot welders with reduction-gear heads

THE EISLER ELECTRIC CORPORATION of 740-772 South 13th St., Newark, N. J., has added a new series of motor drives to its line of speed spot welders. This new series is equipped with a variable-speed reduction gear head motor, enabling the operator to make from 30 to 100 welds per minute in graduated steps. A variable current regulator controls the heat of the weld while the pressure is adjusted by a pressure nut. The timing is automatic and is maintained uniform at all speeds. As with the other welders in this line, the series "M" ranges in six sizes, ½, 1, 3, 5, 10, 20 and 35 kva. and will weld from 0.0005 to ⅝ in. combined thickness. The principal advantages claimed are: Speed in production, uniform welds, positive and smooth action, simplicity of construction, few working parts, wide range of heating steps, and low maintenance cost.—*Electronics, February, 1932.*

✦

Small sound-head

THE GOODALL ELECTRIC MFG. COMPANY of Ogallala, Neb., is marketing a small new sound-head for Powers and other projectors which employs a new principle in sound-on-film construction.—that of using the lower take-up sprocket to film past the aperture plate at a constant even speed. This is accomplished by proper filtering of the drive, which is in turn connected by the usual train of gears to the lower take-up sprocket drive shaft.

The projector itself is driven by means of the conventional V-belt drive connected to the constant-speed motor. A 6-in. flywheel of sufficient weight to maintain constant momentum, is attached to the high-speed shaft of the projector by means of an extended shaft. The outer end of this extended shaft is supported by an auxiliary arm containing a double row of ball bearings. Consequently the weight of the flywheel is carried by the ball bearing and not by any bearing in the head.

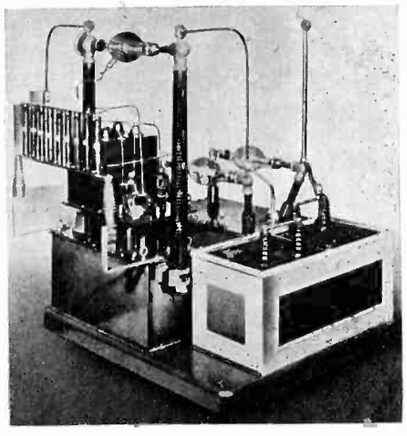
When this equipment is tested with constant-frequency film the frequency response is declared to be actually smoother and steadier than many of the larger common type sound heads, owing to the fact that the flywheel and drive is properly filtered by an inclosed sponge rubber filter, which allows for all unevenness in the gears of the head.

The small Goodall de luxe head is only 3 in. high and 5 in. long, and is small enough to fit under the condensers and shield of the lamp house, just back of the present head between the lamp house and the head itself. In this way perfect synchronization is secured, as the distance between the sound aperture and the light aperture can be varied at the discretion of the operator from 18 to 21 frames. A new feature of this equipment is the tubular "cell house" which also acts as the aperture plate. This head may be used with either the 6A or the 6B Powers, and gives very good results even though the heads may be badly worn.—*Electronics, February, 1932.*

✦

X-ray machine for 1/1,000-second pictures

A THREE-ELEMENT X-ray tube and machine which makes possible the taking of an X-ray snapshot in less than 1/1,000th of a second has been announced by the Westinghouse Electric & Manufacturing Company. It enables



physicians to see clearly, for positive diagnosis, the inside of a human body, up to this time blurred or hidden in X-rays by the motion of the patient's muscles.

An interesting feature of this new apparatus is that it can be operated from an ordinary house-lighting circuit and in appearance resembles a large size radio tube. The method of operation is similar to water collecting behind a dam. When the accumulated electricity behind the dam is sufficient the dam is opened, which sends the power suddenly through the tube and the fast picture is produced.—*Electronics, February, 1932.*

Short-wave superheterodyne coil assembly

THE BEST MANUFACTURING COMPANY, 1200 Grove St., Irvington, N. J., offers an assembly of short-wave coils and a low-capacity switch eliminating the inconvenience of plug-in coils. A turn of the switch enables the choice of the 10-20, 20-40, 40-80 or 80-200 meter coils. Coils may be readily wired into a short-wave converter circuit for use with t.r.f. or superheterodyne broadcast receiver. Circuit is so arranged that all power for the converter is furnished by the broadcast set. Complete wiring diagram and instructions for building short-wave converter are furnished with each assembly. Each assembly is equipped with knob and escutcheon plate marked with wave length. Overall dimensions of entire coil and switch assembly, 4⅜ in. wide by 4⅛ in. high by 6¼ in. long.—*Electronics, February, 1932.*

✦

Distortion-factor meter

THE MAXIMUM OUTPUT LEVEL of amplifiers as determined by the introduction of harmonics is now easily measured, as the result of the development by the General Radio Company, Cambridge, Mass., of a distortion-factor meter which reads total harmonic content of an impressed wave directly on a potentiometer dial. The method is entirely visual and may be used in a noisy locality. No calibration is required and the manipulation is simple.

The distortion-factor meter consists of a calibrated potentiometer and a filter. The filter is so designed as to cut off sharply above 400 cycles (the test frequency for which the instrument is designed) and has an absolutely flat characteristic from well below the second harmonic to above the 15th harmonic.

In operation the signal being examined is connected to the input and passed through the filter which entirely suppresses the fundamental. The total harmonic content remains and the deflection caused by it on a meter is observed. The filter is then switched out of circuit and a potentiometer adjusted until the output of the instrument for the fundamental is the same as that previously obtained on the harmonics. When equal deflection is obtained the total harmonic content of the wave is read from the potentiometer dial.—*Electronics, February, 1932.*

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Power-level indicator

THE JEWELL ELECTRICAL INSTRUMENT COMPANY, 1650 Walnut St., Chicago, has developed a new power-level indicator and voltmeter to enable power-level readings to be taken in audio-frequency systems of all kinds. Alternating-current voltages over a wide range may be measured directly, which gives the instrument an added usefulness. The movement itself is a Pattern 88 rectifier type voltmeter, calibrated to 1.5 volts full

scale and to a resistance of 4,000 ohms. The scale also carries indications in decibels, so that power level readings may be taken above or below the accepted value of zero level, 6 milliwatts in a 500 ohm load.

Five voltage ranges are supplied, these being 1.5, 6, 15, 60, and 150 volts, all with a constant impedance of 4,000 ohms. A change of 20 decibels in power corresponds to a change of 10 decibels in voltage for that change in power, and this is the same as multiplying the voltage by 10. Thus, the 15 volt step is 20 decibels up from the 1.5 volt point, the former being +12 decibels, and the latter, —8 decibels. Again, the 150 volt step is up 20 decibels from the 15 volt point. The 6 volt step is up 12 decibels from the 1.5 volt point, this corresponding to an increase of 6 decibels in voltage, which is (within a very small fraction of a per cent) equal to a multiplying factor of 4.—*Electronics, February, 1932.*

✦

Resistors 1 to 35,000 ohms

ACCORDING TO D. T. Siegel, general manager, Ohmite Manufacturing Company, 636 North Albany Avenue, Chicago, the line of 50-watt rheostats manufactured by this company and announced several months ago has been increased and now includes several new resistance values.

The Ohmite rheostat, which may also be used as a potentiometer, employs no organic materials in its construction. A porcelain base and horseshoe-shaped porcelain support the winding. The entire unit with the exception of the surface on which the contact-arm rides, is vitreous enameled. This construction is new to the rheostat field but has been used by this company for many years in the manufacture of vitreous enameled fixed resistors.

These rheostats are now made in a range of values from 1 ohm up to 35,000 ohms. And although these units are only 2¼ in. in diameter and less than 1¼ in. in depth they are conservatively rated at 50 watts. The 1-ohm unit has a current-carrying capacity of seven amperes without overloading. Twenty-five other values are carried in stock, the highest being 35,000 ohms, with a current-carrying capacity of 34 milliamperes.—*Electronics, February, 1932.*

✦

Caesium argon cells

THE TELEPHOTO & TELEVISION CORPORATION, 133-35 West 19th St., New York City, is specializing in caesium argon cells for both sound and commercial uses. It has just developed a new type of cell No. TC-2 in a globular bulb and will also manufacture a complete line of crater tubes for television reception and cathode-ray tubes for

television and commercial work. A new type of neon tube for commercial sign lighting operating on 110 volts is also announced. These tubes or lamps have a standard socket and will fit in the present receptacle and consume about 5 watts. Pamphlet No. 5, which describes in detail this company's complete line of cells is available upon request.—*Electronics, February, 1932.*

✦

Insulating shield against airplane interference

THE IGNITION SYSTEM of an airplane engine develops a slight electrical leakage, which interferes with radio reception, and transmission. To eliminate this interference, the Breeze Corporations, Inc., has developed a shield which is made of Bakelite molded material.—*Electronics, February, 1932.*

Vacuum-contact toggle switch

A DECIDEDLY NOVEL TYPE of switch, featuring sealed-in-vacuum contacts, is being introduced by the Burgess Battery Company, 202 East 44th St., New York City. This switch, based on the use of the Burgess vacuum contact actuated by

the usual toggle switch movement, is at once flameproof, free from dust and dirt, positive, low-resistance, quick-acting and corrosion-proof.

The Burgess vacuum contact switch is rated at 8 amperes intermittently or 6 amperes continuously, 220 volts. The makes and breaks are clean, free from dangerous arcs, and without corrosion. The contact resistance is extraordinarily low. This switch is especially applicable in places where there is a fire or explosive hazard, or again in precise laboratory practice. The list price is $12.—*Electronics, February, 1932.*

✦

Low-voltage electrolytic condensers

A LINE OF LOW-VOLTAGE electrolytic condensers is announced by the Dubilier Condenser Corporation, 4377 Bronx Boulevard, New York City. These compact, units are especially designed for audio by-pass applications, and in plate and grid filters of the resistance-capacity type where high capacity and low impedance are essential. They are available in a large variety of capacities and voltages, and in two different forms, namely: first, a small metal can of rectangular shape which can be conveniently mounted between tube sockets; second, a cartridge type container similar in size and appearance to carbon resistors and cartridge type paper condensers.

Dubilier low-voltage electrolytic condensers are available in three d.c. working voltages—125, 50 and 25. The 125-volt units are available in the 15 and 10 mfd. capacities, the 50-volt in the 8, 6 and 4 mfd. capacities, and the 25-

volt units in the 20, 10 and 8 mfd. capacities. The metal container type measures 23/32 in. by 2 1/16 in. by 1¼ in. The cartridge type measures 1 in. in diameter by 2¼ in. long for the 125-volt units, and ⅝ in. in diameter by 2¼ in. long for the lower voltage units.—*Electronics, February, 1932.*

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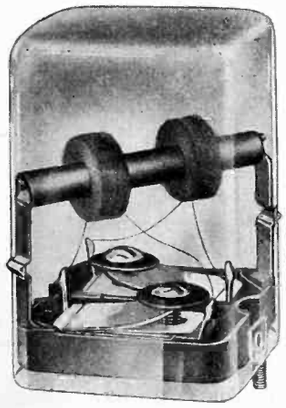
Condenser material

AQUARESIN (GLYCOL BORI-BORATE) a water-soluble non-drying resin, is now being produced by the Glyco Products Company, Inc., Bush Terminal Bldg., No. 5, Brooklyn, N. Y., in a modified form called Aquaresin M. It is completely soluble in water, ethyl alcohol, methanol, cellosolve, etc., but insoluble in hydrocarbons. It has aroused interest as a fire-proofing agent with other materials, it is a conductor of electricity and is being used in special types of condensers. Its chief use, however, is in compounds which must remain flexible and pliable and as binding agent between gelatin, glue and water soluble gums and pyroxylin, rubber-latex and varnish gums or resins.—*Electronics, February, 1932.*

✦

Intermediate frequency transformer

BECAUSE OF THE ANNOYANCE experienced in receiver sensitivity and selectivity, due to temperature changes, the Radio Coil and Wire Corporation, 847 W. Harrison St., Chicago, offers a new intermediate frequency transformer unit, which will stay peaked at 175 kilocycles with a steady, even gain, although subjected to extreme temperature and humidity changes. The unit is small in size and ruggedly constructed. It is easily mounted with positive ground to



chassis, and held by two spade bolts. The coils are carried on a low-loss coil form and are extremely efficient in selectivity and gain. Compactly assembled, the coils are mounted on a newly developed material known as Learite and enclosed in a satin finished can.—*Electronics, February, 1932.*

✦

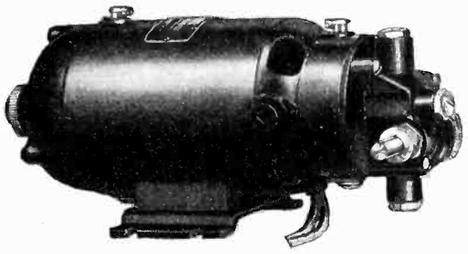
Universal tapped output transformer

AMONG THE NEW radio products announced by the Jefferson Electric Company, 1,500 South Laflin St., Chicago, Ill., is a tapped output transformer with features insuring flexibility which can be used for coupling any combination of tubes (Nos. 171,245 or the new 247 pentode either single or push-pull) to any dynamic or magnetic speaker with low, medium or high impedance voice coil. A patented bracket permits mounting in any position. The windings are thoroughly impregnated. Each transformer is supplied with complete instructions for installing, including impedance chart.—*Electronics, February, 1932.*

✦

Constant-speed universal motors with governors

A NEW LINE OF series-wound motors with improved electric governors is now offered by the Bodine Electric Company, 2264 W. Ohio Street, Chicago, Ill. This new governor has shown itself reliable on such applications as talking motion-picture equipment, electric pyrometer control drives, office appliances, traffic signal control, etc. Although most frequently applied to the series-wound mo-



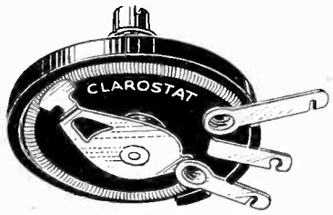
tor, this governor may also be used with the shaded-pole type motors.

Accuracy approaching clock time and rapid acceleration are features of these motors. They are available in two forms: Form R, adjustable while running, and Form S, adjustable at standstill only.—*Electronics, February, 1932.*

✦

Volume and tone controls

A NUMBER OF NEW TYPES of Clarostat controls and fittings are described and illustrated in Clarostat control handbook and catalog, just issued by the Clarostat Manufacturing Company, makers of electrical, radio and sound equipment, 285 North 6th St., Brooklyn, N. Y. The book contains much useful infor-



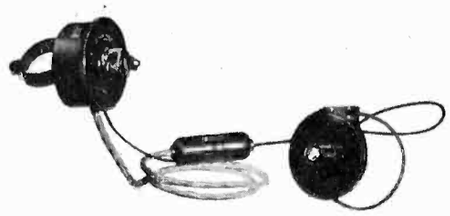
mation for the experimenter, engineer and production man, and is available without charge.

Included in the handbook are detailed specifications of attentuators, column controls, constance impedance controls, phonograph pickup faders, tone controls, line ballasts, line voltage regulators, rheostats, potentiometers, fixed resistors, etc.—*Electronics, February, 1932.*

Remote control for radio

A FLEXIBLE CABLE type of remote tuning and volume control unit for radios, automobile or home, has been developed by the Radio Vision Research Laboratory of the Federal Telegraph Company, 200 Mt. Pleasant Ave., Newark, N. J.

The unit consists of a control unit, condenser driving unit, flexible drive cable, multiple-wire cable, and electrical connecting plug. It provides positive, simple, manual control of the receiver through a $\frac{1}{8}$ in. flexible cable which is thoroughly weather-proof. The operat-



ing cable, firmly anchored to both units, and easily adjustable to any length, drives the tuning condenser of the radio receiver by means of a pulley attached to the condenser shaft, and enclosed in the snug-fitting housing of the condenser driving unit. One complete turn of the hand-grip tuning control covers the entire tuning range of the radio receiver. The unit is specially constructed to give precise, accurate tuning.

For automobile use the unit has a 3-ft. electrical conductor cable terminating in a polarity connecting plug, and 10 ft. of control cable. List price is $10. The home control unit is a table model with a 25-ft. cable which includes the control cable and electrical conductors. The list price is $12.50.—*Electronics, February, 1932.*

✦

Solder for aluminum

A NEW SOLDER called Alumaweld, is a development of the Allied Research Laboratories of Glendale, Calif., and is declared actually to break down structure of the aluminum metal being repaired and to fuse or weld with it to form a single, solid piece. Alumaweld is applied to any metal with an ordinary soldering iron or blow torch. It melts at an exceedingly low temperature, but once applied, requires a much higher temperature to melt again. The fact that it has a tensile strength of 12,000 lbs., which is over ten times that of ordinary solder, indicates its permanency. It is now being used extensively in radio work for the repair of aluminum cabinets, aluminum housings, and other metal parts. Alumaweld is quite ductile, machines easily, and will take a polish over which chromium plating or any other plating can be applied.—*Electronics, February, 1932.*

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U. S. PATENTS

IN THE FIELD OF ELECTRONICS

A list of patents (Feb. 2) 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

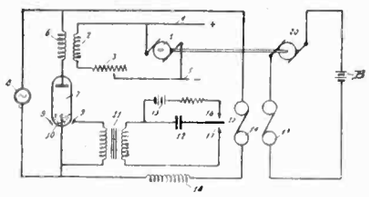
Manufacturing Processes

Electrical condenser. Conductive layers are coated with cellulose-ether solution, layers are exposed to atmosphere until partly solidified and then rolled into mass before coating becomes solid. Hans Bartel, Siemens & Halske. No. 1,842,648.

Preparation of emitting surfaces. A method of producing activated thoriated-tungsten cathodes, comprising heating the cathode below 2,000 deg. C. in hydrogen to remove carbon and tungsten carbide, and subsequently heating the filament in vacuo at about 2,850 deg. C. to decompose the thorium compound. M. N. Rich and E. A. Lederer, assigned to Westinghouse Lamp Co. No. 1,842,203.

Electronic Applications

Machine regulating system. A speed regulating system for electric motors using mercury vapor tubes. Hans Schuchmann, assigned to Siemens & Halske, No. 1,839,416.



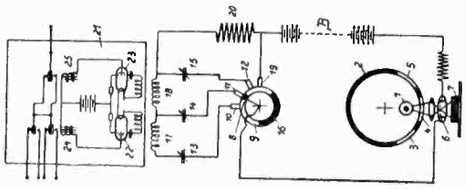
Grid glow tube control. In the anode circuit of the grid glow tube is a relay. Between control electrode and anode are photo-electric cells, and between cathode and control electrode is a series impedance. J. V. Breisky and E. O. Erickson, assigned to Westinghouse E. & M. Co. No. 1,839,864.

Electrical measuring instruments. A Wheatstone bridge for determining conductance, slide-wire scale, calibrated in units of conductance, means to compensate for cell constant and temperature. H. C. Parker, assigned to Leeds & Northrup. No. 1,840,635.

Radio surgical apparatus. As oscillating circuit for surgical cutting apparatus. N. H. Lowry, assigned to W. J. Cameron, Chicago. No. 1,841,968.

Seismograph. Condenser of tuned circuit is varied by mechanical vibrations and these changes of tuning are recorded. Sepp Horvath, Houston, Tex. No. 1,842,968.

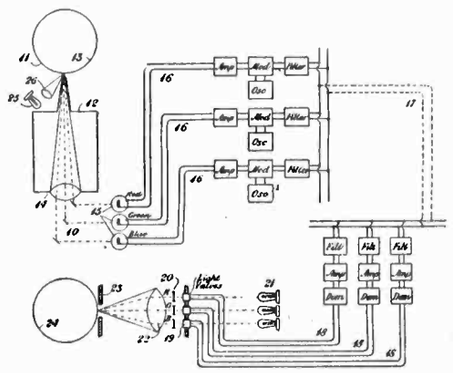
Determining and measuring light and color differences. Light-sensitive cell and vacuum tube amplifier method of measuring the light and color differences of a number of objects. H. H. Geffcken and H. R. Richter, Leipzig, Germany. No. 1,840,500.



Television and Facsimile

Television system. A pair of vibrating mirrors and means for vibrating these mirrors, with periods of vibration expressed by two large co-prime numbers, differing from each other by a small number, the mirrors jointly projecting a beam of light to produce a transmitted picture. Ludwik K. Silberstein, assigned to United Research Corp., No. 1,839,777; also No. 1,839,706 to the same patentee.

Colored television system. Light from successive points of the picture to be transmitted is filtered according to the color sensitivity of the eye, component rays of these colors are used to modulate respective carrier current, and are respectively demodulated at the receiver and are synthesized. A. Weaver and D. E. Branson, assigned to A. T. & T. Co. No. 1,839,361. Filed 1923.



Recording system. A method of projecting a recording fluid toward a record surface, in accordance with the received signals. R. H. Ranger, assigned to RCA. No. 1,841,452.

Scanning system. Two light-producing beams spaced apart a greater difference than the average distance between the eyes of an observer and optical means for bringing the light from the two sources, to two points spaced apart the average distance between the eyes of the observer. W. T. Lewis, Racine, Wis. No. 1,841,487.

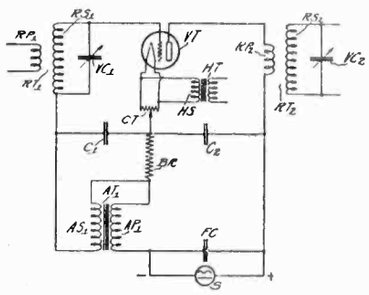
Radio Circuits

Direction indicator. A series of patents of various numbers around 1,842,343, to Warren S. Eaton, assigned to Eaton Radio Instrument Corp., Los Angeles, on methods or apparatus for indicating direction by radio waves.

Push-pull amplifier. A method of connecting the midpoint of the input coil to various points on a potentiometer across the filament supply sources for the two tubes. C. T. Jacobs, assigned to Thom. A. Edison, Inc. No. 1,835,781.

Input system. Tunable input system for r.f. amplifier. Voltage to be amplified is taken across a variable capacity. Across this capacity is a variable inductance in series with a fixed capacity the latter shunted by a resistance. The antenna-ground input is connected to this resistance through a variable tap. F. H. Drake and W. D. Loughlin, RCA. No. 1,843,018.

Hum elimination. Reduction of hum in amplifier due to fluctuating grid and plate voltages. B. F. Miessner, RCA. No. 1,842,977.



Cold cathode amplifier. Circuit which is described more fully under British patent granted to J. M. Schmierer, assigned to Radio Patents Corp. No. 1,838,871.

Hum Neutralizer. Method of eliminating effect of power transformer flux from affecting audio transformer. B. F. Miessner, RCA. No. 1,842,558.

Double modulation system. First modulation of received signal lowers the frequency to resonate with a circuit of high time constant. The second modulation restores the original frequency. H. R. de Bellescize, Paris France. No. 1,842,898.

Distance determination. Radiating and receiving from a concentrated field and from a distributed field and determining distance of transmitter by noting differences in reception. E. E. Gage Electrical Industries Mfg. Co. No. 1,828,531.

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BRITISH PATENTS

IN THE FIELD OF ELECTRONICS

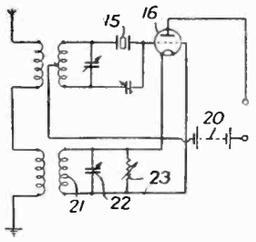
Because patents are issued in Great Britain some months before issuance in the United States, and because British patents reflect what is going on in Europe better than the American Patent Gazette, the editors of *Electronics* choose representative disclosures each month for this page.

Radio

Automatic gain control. A method of integrating the peak values of the signal as an automatic volume control. A. H. Reeves, Paris. Assigned to Standard Telephones & Cables. No. 356,210.

Frequency control. A method of insuring constancy of frequency for common wave broadcasting by means of a piezo-electric crystal. C. Lorenz, Berlin. No. 356,042.

Frequency modulation receiver. In a receiver for frequency modulated waves, interference is prevented by balancing the output from a receiving circuit which is uniformly responsive to a wide range of frequencies, against the output from a highly selective circuit. The latter uses a piezo-electric crystal. J. Robinson, London. No. 355,828.



Coupling system. A coupling system operating over two distinct frequency bands, the required band being selected by the short-circuiting of one out of two or more transformer secondaries. W. A. MacDonald, assigned to Hazeltine Corp. No. 353,447.

Distortion reduction. To reduce distortion due to the persistence of oscillations in a highly selective receiver, energy is sent back from the output of a tube to a coil which has the effect of deflecting the electronic or ionic stream within the tube. Sir Oliver Lodge and J. Robinson, London. No. 351,446.

Position finder. Aviator gets visual indication of his position relative to landing field. An electronic-radio method. J. H. Hammond, Gloucester, Mass. No. 356,969.

Detection, Amplification, Etc.

Grid bias detector. A grid bias applied to a plate circuit detector is varied in accordance with the impressed carrier wave whereby an increased output is obtainable before distortion due to grid current arises. J. C. Warner, assigned to British Thompson Houston Company. No. 356,130.

Energy transfer circuit. A transmission line supplying energy from a high frequency source matches the load to the surge impedance of the line by providing a reactance across the line adjacent to the load. D. S. Carter, assigned to Marconi. No. 356,085.

Frequency selective device. A sharply resonant tuning fork or piezo-electric crystal is used in a circuit for the elimination of side frequencies from the output of a frequency multiplier. A. Karolus, Leipzig, Germany. No. 355,754.

Tone control circuit. A method of volume control designed to preserve a correct balance of tone as received by the ear over a wide range of absolute sound intensities. Philips, Holland. No. 352,772.

Vacuum Tubes, Etc.

Magnetron. Magnetrically controlled generator. Described in Electronics, April, 1930. K. C. de Walt, British Thomson-Houston. No. 356,964.

Cathode ray tube. Tube with several sets of deflecting plates to concentrate beam of electrons and to intercept slow moving electrons. A. M. Opsahl, Associated Electrical Industries. No. 356,904.

Space-charge electrode. Outside the electron path from cathode to plate but close to the cathode is an additional electrode maintained positive to do away with space charge. H. F. Dalpayrat, Dubilier. No. 356,663.

Television

Kerr cell receiver. A system using a lens-type scanning disc, an arc at the source of light, and a Kerr cell. R. D. Kell, British Thomson-Houston. No. 356,093.

Television system. A method of modulating a beam of light in accordance with electric impulses, by passing it through a moving medium, the optical properties of which change in accordance with electrical impulses, e.g. its transparency. Sodium sulphate with an indicator of phenolphthalein is cited. G. B. Banks and Baird Television, London. No. 355,896.

Scanning system. Method of transmission of motion picture film in which frame lines are not scanned. T. A. Smith, Marconi. No. 356,880.

Television motion pictures. Cathode ray system of reception. V. K. Zworykin, Westinghouse E. & M. Co. No. 355,890.

FIG.1.

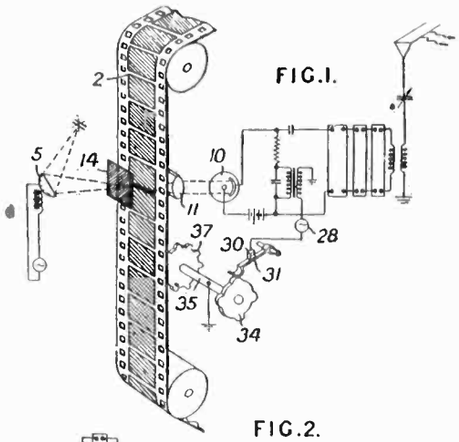
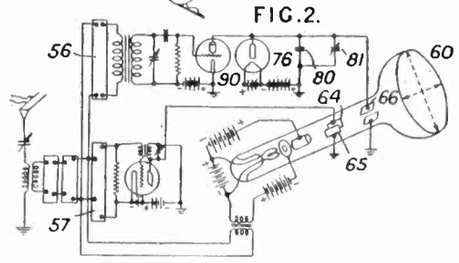


FIG.2.



Glow lamp screen. Linear glow lamps which light up successively under control of voltages applied through time-lag circuits. O. von Bronk, Berlin. No. 836,760.

Position finder. Television method of transmitting to an aviator his position in foggy weather, etc. The position of the plane is transmitting to the ground where it is placed on a map and this map is televised to the aviator. J. H. Hammond, No. 356,906.

Photoelectric Cell Construction

The photo-electric electrode contains an alkali metal deposited on an oxide of an alkali metal having a composition R_2O where R is the metal. A layer of silver is deposited on the envelope by volatilizing a strip of silver short-circuiting the leads of a ring-shaped anode; caesium is introduced in the envelope and deposits on the silver layer. Oxygen is then admitted to oxidize the caesium forming Cs_2O_4. A further quantity of caesium is admitted so as to reduce this oxide to Cs_2O, the reduction being assisted by heating at 200° C.; the caesium is partly absorbed in the oxide layer and excess is removed by a getter or pump. Alternatively Cs_2O may be placed on the anode and volatilized by heating at 250° C. Calcium fluoride may be placed on the layer of silver to improve the adherence of the oxide. A mixture of one part of caesium chromate and 2 parts of zirconium may be heated to 725° C. to produce caesium and caesium oxide which are deposited on the silver layer, excess caesium being deposited on the mixture. Philips. No. 356,395.

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Aspects of standard-signal generator design

[*Continued from page 47*]

duced without sacrificing anything in precision. The controls requiring the most attention are the output voltage control and calibration, the means for setting to the desired carrier frequency, the selectivity control, the percentage modulation control, and the adjustment for different values of modulation frequency.

The use of single-setting input meters for the attenuator and the use of logarithmic attenuators in cascade saves appreciable time, especially when decibel scales are available. There is much to recommend the decibel scale for adoption by the industry as a whole, at least one manufacturer (Colonial) having already done so. There is no agreement at present on whether 1 volt or 1 microvolt should be the standard zero level.

Experience shows that a simple means of locating the desired value of channel frequency, even if it be only a simple detent device, is worth while. The problem becomes complicated when several bands are covered with the same frequency control and scale.

The adjustment of the circuits for definite pre-assigned values as is done with one General Radio standard-signal generator, is a solution when the frequency control does not need to be continuous or cover a wide range.

Pre-assigned channels also aid in arranging a satisfactory method of measuring selectivity by permitting the use of a special straight-line frequency condenser to sweep over each channel. When the control must work over a band and be continuously variable the use of a vernier frequency scale or of a variable inductor is required. Both schemes are open to objections.

If the modulation system is in perfect working order, the measurement of modulation percentage can be made by several systems of direct-reading meters. These can be calibrated directly in percentage modulation. More elaborate checks are desirable if the modulation is not symmetrical, for unless both positive and negative peaks are measured erroneous results will be obtained. Probably the best method of avoiding this trouble is the use of a reliable oscillator circuit which can be modulated.

Modulation frequencies other than the customary 400 cycles can best be obtained from either a beat-frequency oscillator or from an oscillator of the step-by-step type where each step corresponds to a discrete frequency.

Vacuum tube performance vs. manufacturing tolerances

[*Continued from page 45*]

The variations and tolerances associated with the manufacture of vacuum tubes thus affect the characteristics in the manner roughly outlined. These in turn are reflected in the performance of the tube to various degrees depending upon the use of the tube and the type of circuit. The most important cases may be noted as follows:

Variations in amplification factor are most effective in a voltage amplifier, where the impedance of the load is large compared to that of the tube; this applies to most resistance coupled amplifiers, as used in many a.f. circuits.

The transconductance becomes important wherever the load is small compared to the internal plate resistance of the tube. This is especially true of screen-grid tubes in r.f. tuned amplifiers; the plate resistance of the tube may exceed 400,000 ohms while the load in the plate circuit is of the order of only 10 to 50,000 ohms at the most.

With an output tube (power amplifier) the load is of the order of $\frac{1}{4}$ (pentode) to twice (triode) the plate resistance. The gain factor (mu $\times$ transconductance) is what determines the power output for a given load. The amplification factor and the transconductance are then equally effective. These, though, often vary in opposite direction, thus leaving the gain factor practically constant. In this case the plate resistance varies rapidly, and since the maximum undistorted power output depends upon the proper matching of the load and tube impedance, variations in this latter will affect both the actual power output and the signal distortion.

The proper matching of impedance is also a requirement in oscillator circuits, where the load for maximum power output must be equal to the tube impedance. The amplification factor is of importance in an oscillator circuit insofar as the ratio of the a.c. plate voltage to the feed-back voltage in an ideal oscillator is equal to one-half of the amplification factor. A readjustment of the load and of the feed-back would then be necessary whenever an oscillator tube is replaced if the characteristics are not kept within practical limits.

Variations in normal plate current will in most receivers effect the "B" voltage distribution by causing insufficient or undue voltage drop in some parts of the circuit. Most important of all is the drop through the automatic biasing resistor which must be kept within strict limits; too high a bias causes a loss in sensitivity and too low a bias overloading; both may be the cause of bad distortion, without mentioning such effects as grid-blocking, regeneration, and noises of various sorts. The shield-grid or space charge grid currents of tetrodes and pentodes may also contribute to such undesirable effects.

Finally, the efficiency of a tube when used as a detector may be seriously impaired by a poor plate current cut-off, as caused by too short a grid or distorted grid turns. The amplification factor is also of importance inasmuch as the maximum efficiency of an anode bend rectifier has been shown to be μ/π under ideal conditions.[1]

Thus it will be realized that in order to produce a perfectly dependable article the radio tube manufacturer probably more than any other has to keep an increasing vigil on the smallest variations in any part of his product, and use all his ability both as a designer and as a factory engineer to conceive and create a product which will fulfill all the requirements for accuracy and reliability of characteristics together with simplicity and speed in manufacture, a genius's task indeed.

Thus it will not be surprising to hear that the Arcturus Radio Tube Company makes as many as 137 tests and checks on the various parts and on the finished tube to insure dependability, and to correct undue irregularity before it is too late. The intransigent conditions of accuracy and the exacting requirements of manufacturing cost and tolerances fight a royal battle, with the market as a prize; and the tube maker's precision deserves, indeed, all the fame of the proverbial watchmaker's precision.

[1] A. G. Warren, *Experimental Wireless and Wireless Engineer*, August, 1929.

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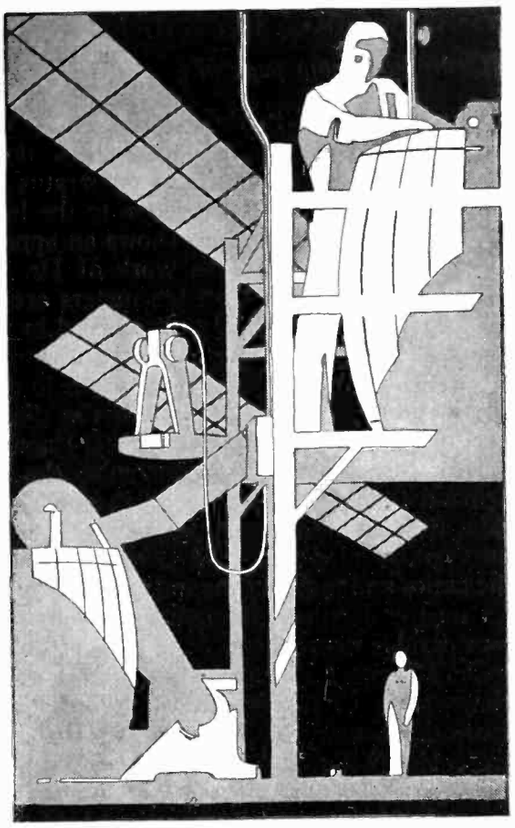
the Genesis of the Fixed Resistor!



ON PAGE ONE of the "Story of Centralab Fixed Resistors" the artist has shown the intricate mixing apparatus which grinds the ceramic material which goes into the manufacture of the Centralab Fixed Resistor. Send for this informative booklet, "A Baptism of Fire" which is free for the asking. It describes in detail how Centralab Fixed Resistors are made . . . and how they differ from the average resistor.

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Electronics

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X-rays and "fever machines"

[*Continued from page 57*]

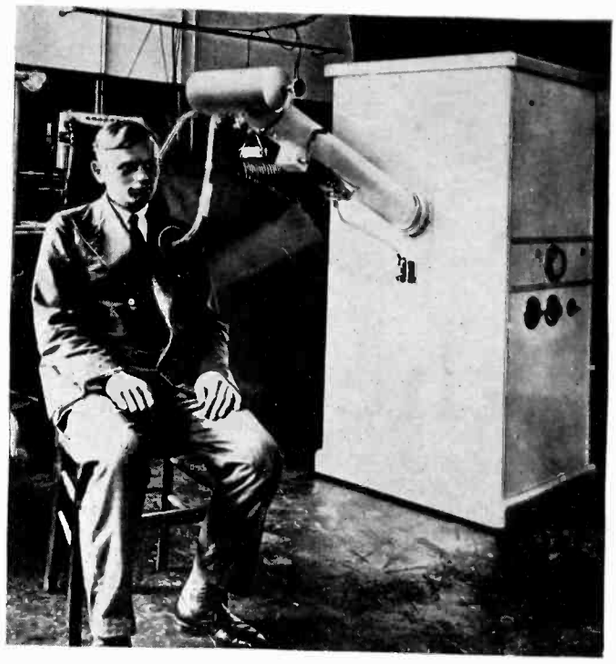
work being done in the United States itself, there has also been considerable development done recently in Germany and in France of apparatus for the direct application of ultra-short waves to the human patient.

One of our photographs shows an apparatus produced by Siemens, based on the work of Dr. Schliephake, in which waves of less than ten meters are produced by a tube oscillator of normal type and led by a non-radiating twin-wire feeder to the insulated aluminum electrodes.

In any case, all experimenters are in agreement as to the striking differences between the diathermic actions produced by the normal (600 meter) and the ultra-short waves respectively. For example, the normal waves demand that the electrodes be in good contact with the skin, the ultra-short waves act as well or better with an intervening air-layer; the normal waves act least on the bones and most on the muscles, the ultra-short waves act on the deep-seated organs and can be directed to a considerable degree, etc.

Dr. Charles F. Tenney, of the Fifth Avenue Hospital, New York City, recently described the use of that institution's new "radiotherm" or artificial-fever outfit, presented by Mr. Rex Cole of New York. The machine employs a transmitter outfit similar to that used in short-wave work, but instead of antenna leads, it is fitted with vertical condenser plates, on top of the cabinet.

By placing the patient on a stretcher between the plates, the short waves, passing from one plate to the other, traverse the body. It has been found that an exposure of an hour or more will produce a rise in body temperature from 98.6 to 104 and 105 degrees without harm to the patient, and without the chill which was the objectionable feature of other ways of producing fever.



The Siemens apparatus for applying ultra short waves to the human body, as manufactured in Germany, employing principles developed by Dr. Schliephake

Dr. Tenney demonstrated at New York in December a portable radiotherm, the first of its kind in use, which is much smaller than the original and can be readily moved from room to room in the hospital. This machine is capable of producing heat locally where the physician wishes to apply it, without raising the entire body temperature.

Calculation of loudspeaker efficiency

[*Continued from page 53*]

over a sphere with the loudspeaker as center. The energy flux density through any small area dS is equal to JdS, where J is the energy flux density through that area. Expressed in terms of solid angle, this is $Jr^2d\Omega$, where r is the radius of the sphere with the loudspeaker as center, and $d\Omega$ is the solid angle subtended by the area dS. The energy flux density may be expressed in terms of the pressure produced by the loudspeaker as follows: The product of the density of air by the velocity of sound in air is approximately equal to 40, and the energy flux density through the area dS is therefore equal to

$$\frac{p^2 r^2}{40} d\Omega$$

The total energy flux is obtained by integrating this over the surface of the sphere. If p_o equals the sound pressure directly in front of the loudspeaker, the sound pressure at any other point at the same distance from the loudspeaker is equal to $p_o\phi$, where ϕ is the relative pressure as shown on Fig. 2. The total sound energy flux is equal to

$$\frac{p_o^2 r^2}{40}\int \phi^2 d\Omega$$

the maximum power which can be drawn from the supply source is

$$\frac{v^2 \times 10^7}{4R} \text{ ergs per second.}$$

The efficiency is therefore

$$\frac{\frac{p_o^2 r^2}{40}\int \phi^2 d\Omega}{\frac{v^2}{4R} \times 10^7} = \frac{p_o^2}{\frac{v^2}{R}} \times 10^{-8} \times r^2 \int \phi^2 d\Omega$$

and

$$\frac{\frac{p_o}{v}}{\sqrt{R}} = \frac{10^4}{r}\sqrt{\frac{Efficiency}{\int \phi^2 d\Omega}}$$

An expression is thus given for the response directly in front of the loud speaker in terms of the efficiency and the integral of ϕ^2 taken over the whole sphere. The values of this integral, as determined from Fig. 1, integrating by quadrature, are given in column (13), and the values of the response directly in front of the loudspeaker, calculated by means of the last equation, are given in column (14). It will be noted that the response is more uniform as a function of frequency than the efficiency due to the fact that the radiation is encompassed in a smaller solid angle as the frequency is increased. The response in any other direction may be determined by reference to Fig. 2 and the values in column (14) of the table.

Note. This material is part of a chapter by Dr. Wolff for a handbook for radio engineers to be published by the McGraw-Hill Book Company.

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