electronics

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

Amplifier patents and licenses

✦

Two-speaker radio sets

✦

Voltage regulators

✦

Superheterodyne trimmer problems

✦

Piezo-electric loudspeakers

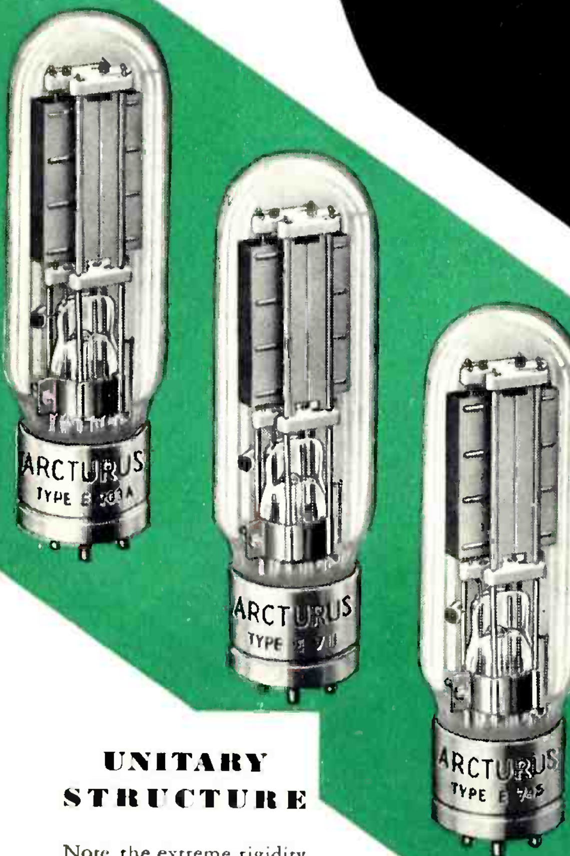
McGRAW-HILL PUBLISHING COMPANY, INC.

Price 35 Cents

MAY 1932

www.americanradiohistory.com

'Unitary Structure' in TRANSMITTING TUBES



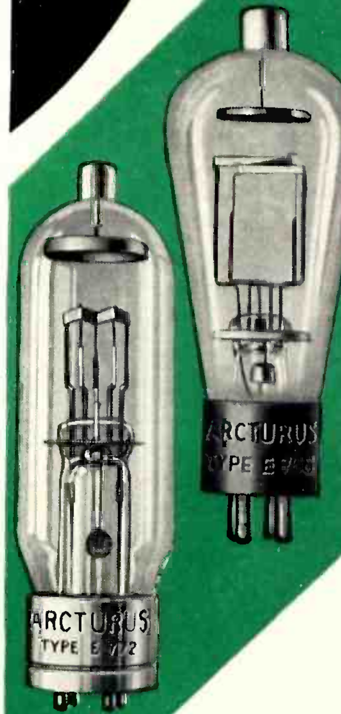
assures matched tubes . . . enduring uniformity . . . long-lived performance

Seldom have new products offered such a decided improvement over existing devices. The uniformity, performance and unique construction of Arcturus transmitting tubes establish a new basis for considering operation cost per hour.

The exclusive "*unitary structure*" principle employed in these tubes—the same as used in the well-known Arcturus *Blue* receiving tubes—assures unvarying uniformity even under most rigorous conditions. "Unitary structure" also insures matched tubes, so necessary for critical operation. These tubes are interchangeable with other makes whose last two digits are similar.

Write for technical data bulletins on the Arcturus Types E703-A, E711, E711-E, E745 (50-watt tubes) and E766 and E772 (mercury vapor rectifiers).

Arcturus Radio Tube Co., Newark, N. J.



UNITARY STRUCTURE

Note the extreme rigidity of these tubes. The Unitary Structure principle of interlocking the elements maintains the precise interrelation of parts through interdependence. Each rugged element is securely clamped at the top and bottom and the complete assembly is a sturdy unit—insuring constant uniformity.

ARCTURUS

Quality Tubes for Transmitting, Receiving and Industrial Uses

Electronics, May, 1932. Vol. 4, No. 5. Published monthly. McGraw-Hill Publishing Company, Inc., 330 West 42d Street, New York, N. Y. $3.00 per year, 25 cents a copy. Foreign Postage, $4, U. S. Currency or 20 shillings. Canada (including Canadian duty), $3.50. Entered as second-class matter April 4, 1930, at the Post Office at New York, N. Y., under the Act of March 3, 1789.

www.americanradiohistory.com

electronics

McGRAW-HILL PUBLISHING COMPANY, INC.

New York, May, 1932

O. H. CALDWELL
Editor
KEITH HENNEY
Associate Editor

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

▼

STOP SKIMPING!

...or..... Let the public know

SKIMPING, whittling, chiseling — these have been by-words of an increasing part of the radio industry for months. This cheapening process has gone so far that serviceability of the product is endangered, and the good name of radio imperilled.

Electronics has no quarrel with intelligent lowering of price through sound engineering and improved design—when the cheapening is not done at the expense of quality or service. But while lower price ranges often open up wider markets, it is not axiomatic that greater profits result.

▼

CONTINUED emphasis, in advertising, of low priced radio sets makes it easy for unscrupulous manufacturers to reap parasitic profits. The public should be taught to buy its receivers for fidelity of tone or for other technical or artistic reasons—not because one particular set is half-a-dollar cheaper than another.

In some quarters of radio, cheapening has already been carried far beyond the minimum standards of serviceability. Manufacturing is conducted without profit; parts are being supplied at bankrupt prices. As a result, sets break down after a few weeks or months of service; parts have to be replaced. Ownership of a cheap radio set thus becomes a nuisance instead of a pleasure.

▼

IF PRESENT conditions of skimping go any further it is time for those who have the good of radio really at heart, *to go before the public—on the air and in the press*—and let radio buyers really know the dangers of buying skimped sets—sets that are good for only a limited time of poor service.

www.americanradiohistory.com

LICENSES UNDER THE

How licenses are divided by "fields" determining the license groups involved

UNDOUBTEDLY the broadest application of the electronic tube and its most important and far-reaching electrical function, is its ability to amplify —to convert faint impulses into powerful ones—to multiply delicate electrical quantities into electrical forces of great magnitude.

These uses—present and prospective—cover a wide range of human activities, and as the opportunities for industrial control are better understood, the scope of electronic amplification will be still further broadened.

A great deal of misunderstanding has resulted among those persons who would like to make use of electronic amplification—misunderstanding particularly as to the patents covering the subject, how these patents are held, and how to proceed to obtain a license to utilize these inventions. In these paragraphs an effort has been made to clarify this extremely complex situation, to the end of giving a better understanding to inventors and manufacturers interested in devices involving electronic amplification in one form or other.

Twenty amplifier patents

The patents covering amplification by electronic devices are some twenty in number. The majority of these are detail patents, but the following three are important.

I. Langmuir, Resistance amplification,	No. 1,297,188
W. C. White, "Center tap,"	No. 1,195,632
I. Langmuir, Photo-cell coupling	No. 1,273,627

These patents are held and administered under the basic patent agreement between the American Telephone and Telegraph Company and the General Electric Company, which latter in turn has included its associated companies, the Radio Corporation of America and subsidiaries, in the privileges growing out of the agreement.

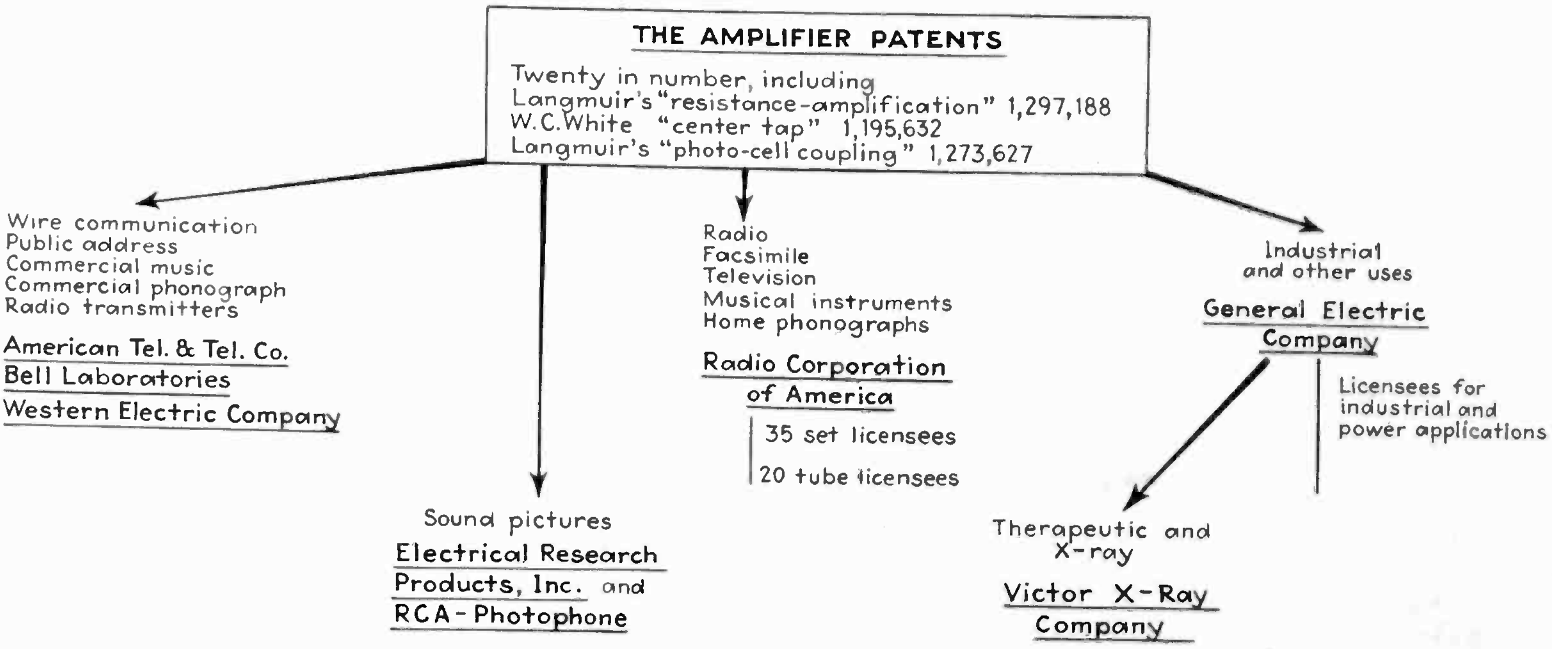
While in each case the original owner of any particular patent is the final authorizing agent for licensing, the conditions under which the patent can be licensed are primarily determined by the field or fields in which the amplification principle is to be used. Thus it is out of the question to apply merely for "a license to build amplifiers." The specific field in which the amplifier is to be used determines the availability of license, the negotiating authority, etc.

Wire uses controlled by A. T. & T.

All matters relating to wire communication, public-address systems, distribution of commercial music, and commercial uses of phonographs, are designated under the agreement as falling within the field of the American Telephone & Telegraph Company and its subsidiaries, the Western Electric Company and the Bell Telephone Laboratories. Any application for a license to use amplifiers in a public-address system, for example, must thus be taken up with the A. T. & T. group, to which the other parties to the patent agreement have already assigned full authority for licensing.

By the same token, amplifiers for use in radio applications, both transmitting and receiving, facsimile for home use, television by radio, musical instruments, home phonographs, etc., all fall within the authority of the Radio Corporation of America, which has been delegated with full power to issue licenses in the fields referred to. As is already well known, the Radio Corporation has accordingly issued licenses under these patents to some 35 radio-set manufacturers, and some 20 radio tube makers. Substantially the same number of ungranted applications are now known to be on file awaiting action by the patent owners.

Amplifiers for use in the sound picture field introduced a special problem since sound-picture apparatus had been developed by subsidiaries of both the high contracting parties. Accordingly jurisdiction over the sound-picture application patents was granted jointly to the RCA-Photophone Company, and the Electrical Research



www.americanradiohistory.com

AMPLIFIER PATENTS

Increasingly liberal policy seen among members of the controlling group

Products, Inc. Authority to grant further licenses for amplifier use in the sound-picture field is therefore in the hands of these two companies.

In the industrial and general field the General Electric Company retained all rights to grant licenses to use amplifiers for general technical applications, but has apparently determined on a very liberal policy of extending license rights to qualified concerns which apply for them.

Already it is known that in addition to patent exchanges with the Westinghouse Company industrial licenses have been granted to the Cutler Hammer Company, to Leeds & Northrup, to the General Radio Company, and to others.

General Electric attitude liberal

Members of the General Electric Company staff have indicated that every encouragement will be given to concerns desiring to manufacture industrial devices under the amplifier patents. Initial fees imposed will be only nominal and may not exceed $500 to $1,000 for limited applications. Royalty rates will run parallel to those in the radio field, where fees of 7½ per cent to 5 per cent have been charged.

But the principal impression to be gained is that the licensing department of the General Electric Company is disposed to work with friendly encouragement for those who desire to enter the industrial amplifier field, providing such concerns are qualified by technical skill and financial resources to conduct a successful business.

Meanwhile it should be pointed out that on the other hand the General Electric Company proposes to grant no further licenses for the manufacture of electronic tubes for industrial purposes. While representatives of the company expressed themselves very definitely concerning the present policy to keep the business in the company's own hands, it was stated that future developments might dictate a broad licensing plan with respect to industrial tubes also. Meanwhile, however, it is apparent that the policy will be to grant only licenses to make amplifier apparatus while retaining the tube business for itself, so far as possible. Thus the industrial apparatus licenses will act as feeders to build up the volume of tube business, which it is felt can be most economically handled in a centralized manufacturing operation.

Special and future fields

The same principle of "licensing by function" is also applied to the therapeutic and X-ray field. Amplifier licenses for use in such applications as radio knives, fever machines, cardiagraphs and other therapeutic devices fall with the control of the Victor X-ray Company.

Future developments of amplifier uses will undoubtedly also see the principle of "function" extended to other companies. For example, let us suppose that in the future the electronic amplifier became a necessary part of the heat control of a domestic electric range. In that event, licensing authority would be imposed in the Edison G. E. Appliance Company. Applications of other electric range makers for license rights under the amplifier patents applied to electric cooking would then be received and considered by that company.

"A liberal licensing policy" is the expression freely used in the offices of both the Radio Corporation and the Bell interests, in describing the prevailing attitude toward additional licenses. As already known, of course, the RCA group has licensed a large number of set makers and tube manufacturers, authorizing these to enter into competition with its own subsidiaries, RCA-Victor, and RCA-Radiotron.

During the last few weeks it is learned that the Radio Corporation has granted a number of additional licenses for sets and tubes. The Corporation is also known to be favorably disposed to the granting of further licenses in cases where the parties are responsible .

A document of great complexity

Policies respecting licensing seem less definitely formulated in the American Telephone & Telegraph organization and its subsidiaries. "Each case must be studied and investigated on its own merits" said one representative of the company. "The person seeking an amplifier license must show in what field he proposes to do business, and what particular patents are involved. These patents must then be traced back to their individual

[Please turn to page 182]

▼

Why one can't apply for just "an amplifier license." **Some applicants have asked merely for "a license to build amplifiers." This is not enough. The applicant must necessarily explain in what field the amplifiers he intends building are to be used.**

The group controlling the amplifier patents has assigned license control to its individual member companies most concerned. These individual companies can negotiate license rights in their own fields but are of course without authority in other fields.

▲

www.americanradiohistory.com

Improved fidelity of two-speaker radio receivers

By HUGH S. KNOWLES

Chief Engineer,
Jensen Radio Manufacturing Company

THE idea is prevalent that the use of two speakers in a radio receiver is largely for the betterment of the frequency response. This advantage, however, is not all. A better overload characteristic, improved transient response, and increased energy efficiency all are secured.

The average published fidelity curve of present day radio sets indicates the usual inexpensive receiver is down at least 8 db. at 60 cycles, and 25 db. or more at 5,000 cycles and about 40 db. at 8,000 cycles. Even when "siamese" i.f. and compensated a.f. circuits are used the listener usually adjusts the "tone control" so that this high frequency loss occurs. This leaves little incentive to build or use a speaker flat up to 8,000 cycles or so.

This is hard to reconcile with our intuitive feeling and the published results of recent work[1] which indicate

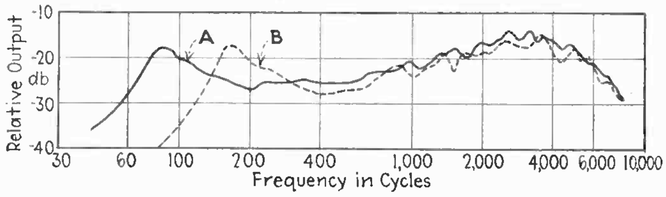


Fig. 1—Response of two speakers, large (A) and small (B)

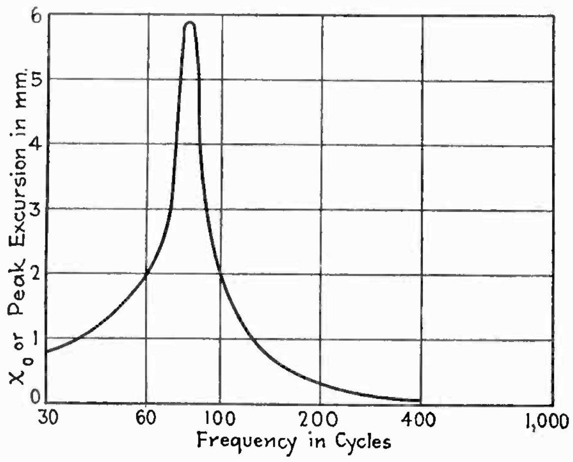


Fig. 2—Attempted excursion of the cone near resonance for one watt input

that the listener should prefer the entire frequency range to any curtailment of it. A practical compromise appears to be 80 to 8,000 cycles providing the listener gets faithful reproduction of the original—not merely an overall steady state curve which shows a linear modulated carrier at set input to sound pressure from speaker output curve. This is the direction toward which to work providing we consider the transient distortion as well.

Economic pressure has squeezed the cabinet until it is frequently less than half its former size with resultant loss in low frequency response. Use of rather poor transformers when a '27 detector drives the following grids positive to get two watts or so of extra noise is another prevalent place where low frequencies disappear. Use of single-circuit highly selective, often regenerative i.f. stages, more quickly aligned in production and in the field explains where most of the high frequencies go.

This cabinet, down at 80 cycles say 5 db. in comparison with a large baffle and the set down 6 db. at 80 and 35 or 40 at 8,000 cycles are brought to the speaker manufacturer with the stipulation that he provide a speaker having "good" lows and highs. The middle register presumably takes care of itself. There is a further

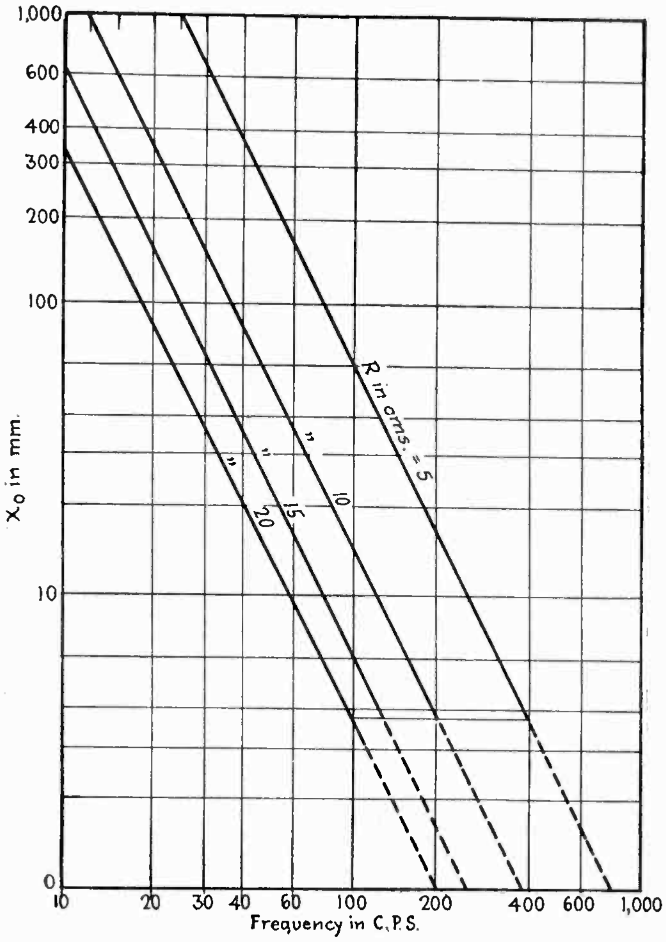


Fig. 3—Cone excursion as a function of frequency and cone radius for one watt sound output

stipulation that as little field excitation as possible be required, that it act as a good choke in the filter circuit, have no hum of its own or enough of the proper phase to reduce that of the set (often of variable amplitude and phase) to a negligible value. But worst of all *its virtue is to depend largely on its apparent sensitivity and bass response, not on its fidelity.*

The answer to the set with humped back fidelity has

[1]Audible frequency ranges of music, speech and noise. W. E. Snow, *Journal Acoustical Society of America*, July, '31.

www.americanradiohistory.com

been the speaker with a "sway back" characteristic. Two "good" examples are shown in Fig. 1. Curve A is a steady state curve of a medium size speaker measured on the speaker axis in a large baffle. Curve B is of a small size speaker measured on the speaker axis in a large baffle. These show that under steady state conditions the overall antenna input to pressure output curve on the speaker axes could be made reasonably flat from say 80 or 150 to 3,000 cycles providing the cabinet was not too small and the chassis fidelity too poor.

Under steady state conditions the excursion or displacement of the diaphragm is the thing that largely determines the harmonic distortion. Aside from this distortion we have an absolute limit set by the amount the moving system can be displaced without either an objectionable noise due to the system striking a stationary member or failure of one of the members.

The movement of the voice coil through the flux in the gap generates a counter emf. equal to $d\phi/dt$ as in the usual motor. If the resistance of the voice coil is measured while the moving system is blocked and then while moving there is an increase in the apparent resistance due to this generated motional or counter emf. From this "motional" resistance, as A. E. Kennelly first called it, and the constants of the voice coil and flux, we can determine the excursion of the cone at low frequencies. Such a curve for one watt input and the speaker of curve A Fig. 1 is shown in Fig. 2. The ratio of the motional resistance (R_m) due to motion, to the total resistance measured unblocked ($R + R_m$) is directly a measure of the energy efficiency of the device when the mechanical resistance is negligible.

This curve shows that the *attempted* excursion at and near resonance is large. Unfortunately in the type of design now almost universally used, the displacement of the cone is proportional to the voice coil current for only very small displacements. This arises from the emphasis placed on apparent sensitivity at moderate levels where the field structure cost must be limited.

A better appreciation of the excursion requirements of different size cones as a function of frequency can be obtained from Fig. 3. This gives the peak displacement for 1 watt output from the speaker. This is a large output, but is often reached for frequencies at or near resonance with speakers having high resonant efficiencies such as we are discussing. For the frequencies plotted 66 milliwatts is a very moderate output and for this the excursions should be divided by four. A cone with a 10 cm. radius, for example, must have 14 mm. excursion at 100 cycles to radiate one watt, or 35 mm. to radiate only 66 milliwatts. The usual speaker shows appreciable departure from linearity even for the latter value.

The curves are based on the following formulae which assumes the radiation for frequencies plotted is the same for both sides and that the back side radiation is effective in increasing the mean energy density level in the room. If radiation from one side only is considered increase X_o by 40 per cent.

$$W = V^2 R_r = \left(\frac{dx_o}{dt}\right)^2 R_r = \frac{2\pi^3 \sigma f^4 R^4 x_o^2}{1.4 \times 10^7 c}$$

from which $X_o = \dfrac{k\sqrt{w}}{f^2 R^2}$

where W = one watt = 10^7 ergs
X_o = peak displacement
R_r = resistive part air load
σ = air density
f = frequency
R = radius in cms
c = propagation velocity

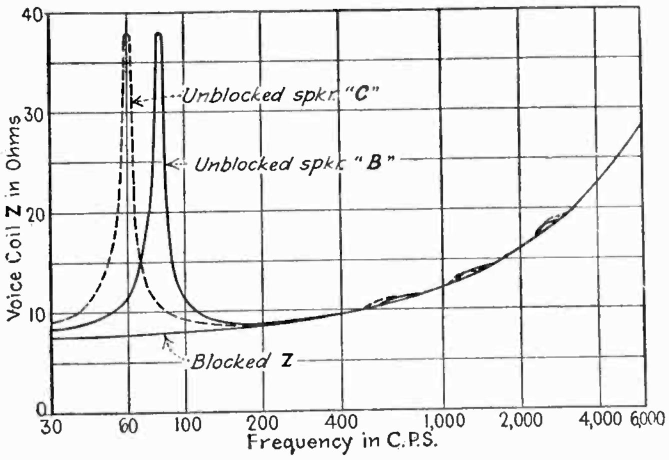


Fig. 4—Impedance curves of two speakers in the same baffle. Note the "selectivity" of the mechanical systems

The power radiated is obtained by multiplying the square of the diaphragm velocity by twice the resistive part of the air load given by Rayleigh[2] for a piston in an infinite wall working into an air load on one side. It is plotted only for frequencies for which the piston is nearly a point source. From this we see that if we double the diaphragm area we increase R four times.

We must also consider the mass reactance or inductive load due to the "accession to inertia" term of the air load. For frequencies for which the radius of the diaphragm R is small in comparison with the wavelength, i.e. for a point source this is

$$M_r = \sigma \pi R^2 \frac{8R}{3\pi} = \sigma A \frac{8R}{3\pi}$$

where σ = density of air A = diaphragm area and R = diaphragm radius. This is independent of frequency under these conditions and proportional to the diaphragm area. When we double the diaphragm area we therefore double the accession to inertia term or the reactance of the load. Since R is quadrupled and M doubled the power factor is improved 100 per cent.

Since the air load impedance is high, the velocity of the cone is reduced a negligible amount and the power radiated is therefore doubled.

Value of using two speakers

Two speakers mounted close together act as a single diaphragm having the same area for frequencies for which the wavelength is long in comparison with the average distance between elemental areas on the two cones. Under these conditions the added pressure on one diaphragm (which increases R_r) due to the other is nearly in phase with its displacement. The effect of using two identical speakers then is to increase both the energy and "absolute" efficiency by 100 per cent. Two speakers show an average improvement of 3 db. except near the resonant peaks of the two which may differ by about 20 cycles. Near these frequencies the diaphragms are slightly out of phase.

This improvement is equivalent to increasing the output of a pair of '45's from 4.5 to 9 watts. Actually the improvement is even more important because the speaker has more distortion than the tubes at low levels, hence there is less steady state distortion at room levels.

To get a given output from two speakers only half the former input is needed to the pair. This means only 25 per cent of the former input to a single speaker, so the system will give four times the output with no greater distortion.

[2]Theory of sound. Vol. II, p. 165.

The large rise in velocity at resonance in the latest types of speakers is due largely to the low mechanical resistance of the moving system. In these speakers, the rise in the unblocked voice coil impedance at resonance is very high as shown in Fig. 4. The selectivity is so high that if the two natural periods are staggered by even 20 or 30 cycles the impedance of one speaker is near its "blocked" value at the frequency for which the other is resonant.

When two "staggered" speakers are connected in parallel the one having the lower impedance takes most of the power thereby preventing distress to the one at resonance. In such a case the input power may be 7 or 8 times that for a single speaker. The exact amount depends on R_m and the load impedance—power output curve of the output tubes.

While we may not object to distortion of the low frequencies, this distortion unfortunately particularly affects other frequencies in the "piston" range. This effect is clearly shown in Fig. 5. Any heavy low frequency excursion therefore distorts all other frequencies in the middle register and even those at higher frequencies to some extent.

The frequency difference need not be great enough to create a valley in the response curve between the two natural periods (which differ in this case from their normal value due to the coupling between the two).

The use of a single large diaphragm is unsatisfactory because of the difficulty of controlling the higher modes of vibration. The mass per unit area must also be increased to give the desired stiffness and the increased mass reduces the steady state output and increases the transient distortion.

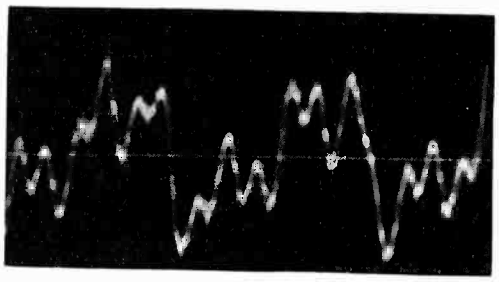


Fig. 5—Distortion of 60-cycle input and superimposed 400-cycle signal; 4-watt input

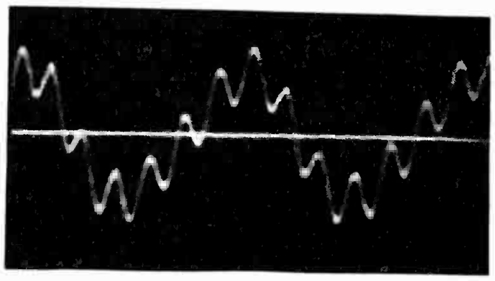


Fig. 6—Low value of 60 cycle and 400 cycle signal applied showing "reasonable" linearity

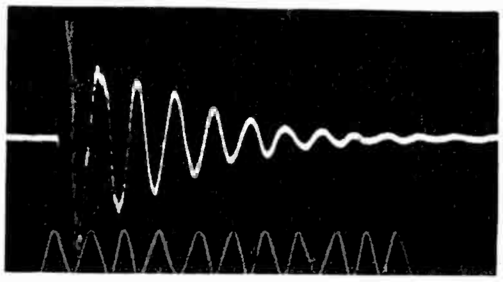


Fig. 7—Transient of loud speaker working out of push-pull '47's. Timing wave 60 cycles

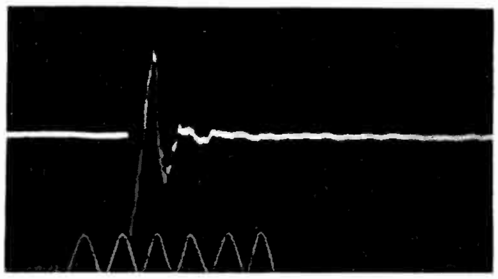


Fig. 8—Two speakers staggered 20 cycles working out of push-pull 245's. Timing wave 60 cycles

Practical realization of these improvements requires mounting the speakers on a horizontal line on the front of the cabinet. Where they are mounted on a false baffle several inches back from the front there is an objectionable cavity resonance effect. When the speakers are mounted at an angle so one reflection from the floor occurs there is quite naturally an absorption of highs on this reflection from the rug. The effective baffle length is also usually reduced.

Importance of transient response

Grill cloths should be even more open than usual since the low frequency output from a speaker travels not only through its own grill but through the adjacent one to increase the pressure on that diaphragm. Contrary to usual belief the grill cloth has its principal effect near the resonant frequency of the speaker where the velocities are large.

Unfortunately overall steady state curves tell only half the story. The fact that a speaker has a marked "sway backed" frequency characteristic always indicates that the transient distortion is bad. This cannot be predicted from a linear overall curve.

The transient resulting from an impulse is a damped sinusoid as shown in Fig. 7. The low frequency component is large and is that for a speaker of the type shown in curve *A* Fig. 1. The field excitation is a low value frequently used hence the "electro-magnetic" damping is low. The resistance reflected from the output tube circuit into the mechanical circuit is proportional to the flux density square and inversely proportional to the plate impedance. The damping therefore increases rapidly with increases in flux density.

By working out of triodes used as class *A* amplifiers and into another speaker in parallel the speaker may look back into a low impedance compared to its own value reflected (at resonance) at the input transformer. If the flux density is high under these conditions we get a transient such as shown in Fig. 8.

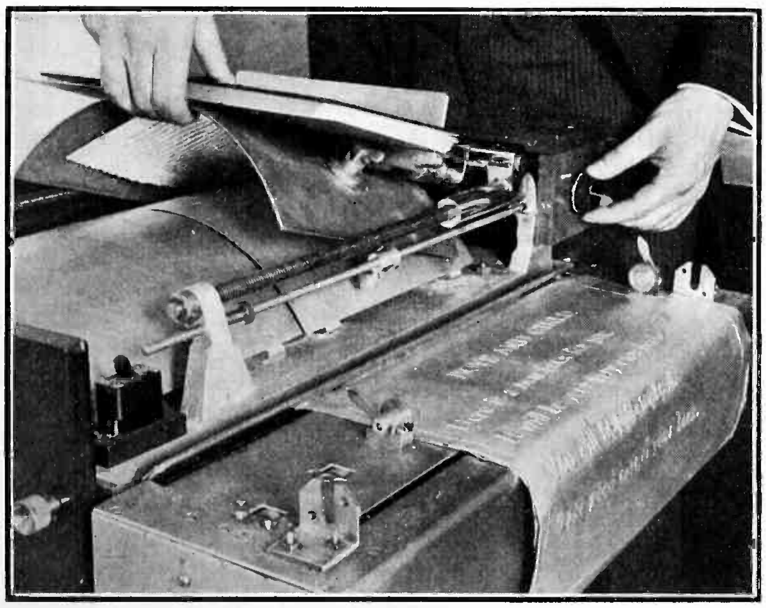
Because of the high and variable impedance the speaker looks back into in pentode and class *B* amplifiers the transient term is large unless special precautions are taken.

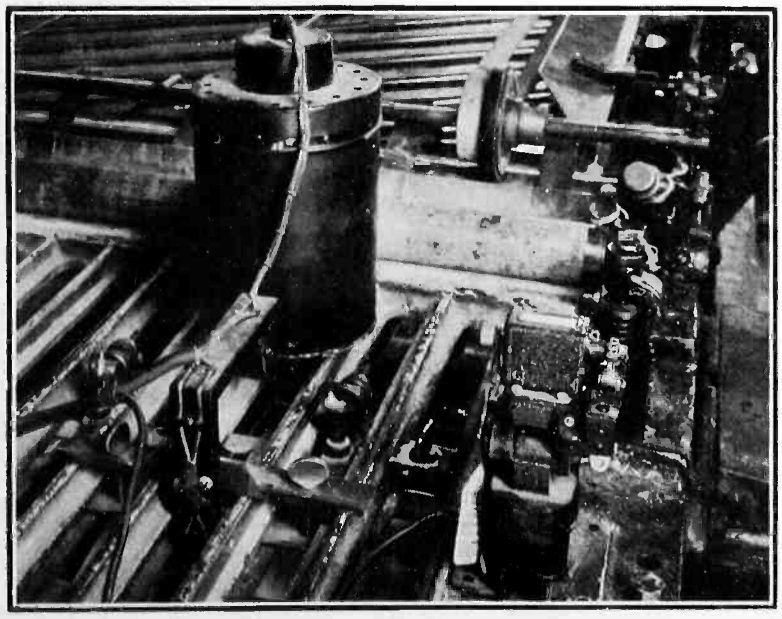
In Figs. 7 and 8 the first cycle or two show one or more very high frequency components. These correspond to the first three center moving modes and show why a lot of high frequency "hash" is obtained from "sway back" speakers. At these higher frequencies the speaker impedance is high (due to the inductive reactance of the voice coil) and pentodes therefore aggravate this condition by supplying more power into the high impedance load than triodes. Unfortunately these high frequency components are *inharmonically* related so the ear objects to them. This leads to the belief that this type of distortion, aggravated by the pentode and class *B* amplifiers and by the condenser mike characteristic has fostered the present public taste for "boom boom" reproduction.

With the use of two speakers properly staggered to reduce the steady state and transient distortion, and possibly an additional single small speaker to give the highs which can then be minimized as objectionable modes in the large diaphragms the present day fidelity can be appreciably improved. Multiple speaker units can be made with high absolute efficiencies at the low end and yet with a combined impedance which is uniform between ± 15 per cent from 30 to 8,000 cycles minimizing the transient distortion from working into a 4 or 5 to one impedance ratio load.

www.americanradiohistory.com

Some novel Electronic Recorders





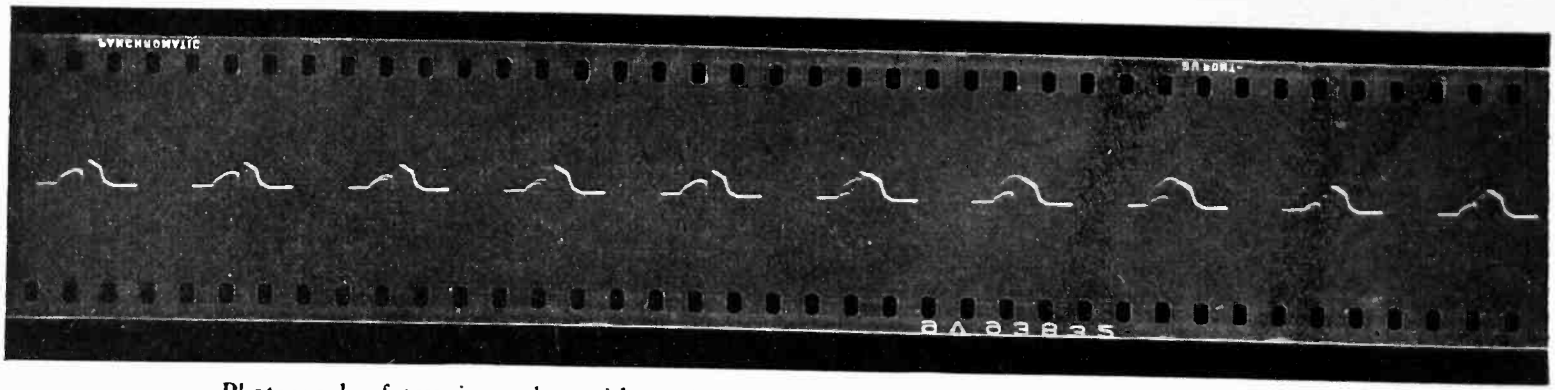
Top—The "bombs" on this Berlin conference table are microphones. Through amplifiers they record the proceedings by setting up local magnetization in steel wires miles in length

Left Center—To enable the blind to "read" any book, Robert E. Naumburg of Cambridge, Mass., has developed this scanner. Ordinary type lines in book at left are reproduced as enlarged embossings for finger reading

Right center—Newspaper halftones can be made in a few minutes without acids, in this electric-eye engraver, invented by Walter Howey, 235 E. 45th St., New York City

Left—An electric-eye counter on a folding machine in the McGraw-Hill bindery. This photo-cell keeps a record of sheets handled, obtainable in no other way

www.americanradiohistory.com



Photograph of transient taken with motion picture camera. Time of exposure, 1/20th second allowing of three traces of a 60-cycle wave

A new cathode-ray oscillograph tube

By G. F. METCALF

Vacuum Tube Engineering Dept., General Electric Company

THE development of the cathode-ray oscillograph from the original Braun tube to its present state is due to the contributions of many scientists and engineers. This paper covers one more step in this development in describing an improved high vacuum cathode-ray oscillograph tube with sensitive electrostatic control which operates at a d.c. potential of 1,000 to 10,000 volts.

Such a device is of increasing interest because accurate and rapid methods of studying the behavior of electric circuits are becoming more and more necessary as their complexity is being increased. The vibrating-mirror oscillograph is entirely inadequate in a large proportion of the applications because of its

1. Inability to respond accurately to frequencies greater than 100 cycles per second.
2. Large power required for indication.

The cathode-ray oscillograph overcomes both of these limitations but has the disadvantage of either the inability to photograph or insensitivity to low voltages. These two characteristics alone proved an insurmountable barrier to the wide commercial use of the early cathode-ray oscillographs. The low visibility or the complexity with the resultant high cost was also prohibitive.

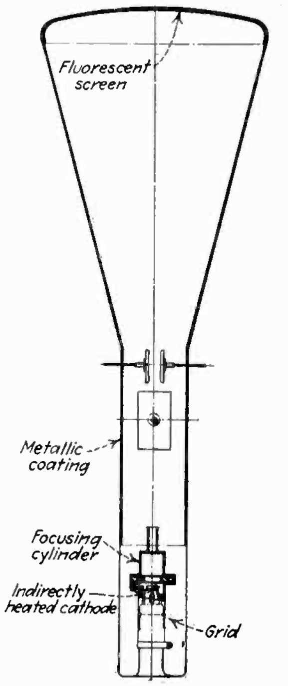
The new type FP-53 cathode-ray oscillograph tube completely overcomes the disadvantages of both the vibrating mirror type and the conventional cathode ray type. It allows visual observation by a large group in full daylight of steady state phenomena as high as 300 megacycles and photographic recording of single transients as high as 500,000 cycles per second. The voltage sensitivity is sufficient for use on 110 volt circuits. The life expectancy of the tube is approximately 1,000 hours.

Description of tube

The FP-53 is a hot cathode, high vacuum tube,[1] employing electrostatic focusing of the electron beam. The focusing of the beam is accomplished by adjusting the potential on the cylinder. This focusing method was shown by both Dr. V. K. Zworykin[2] and Prof. R. H. George[3]. The grid is used to cut off the beam for photographic work, to aid in focusing, and to protect the cathode from high fields. Two pairs of deflection plates are provided which allow the operation of the oscillograph from circuits of extremely high impedance. Electromagnetic deflection can also be used by the addition of a suitable current actuated coil near the deflection plates.

Auxiliary equipment

Although the voltages required for operation of the FP-53 are high, the power required is very small; this allows the construction of a very compact and convenient unit. The high voltage is supplied by a small 2200-volt transformer used in the voltage-doubling circuit. A resistance voltage divider is used to obtain voltage taps for both the cylinder and the grid voltages. The cathode heater is operated on a.-c. supplied by a small insulating transformer. It is often convenient to construct a separate sweep circuit which will produce a linear time axis. Such a circuit, giving a linear time axis for frequencies as high as 50,000 cycles per second, has been in use.



Drawing showing elements of the tube

When greater deflection sensitivity is needed, anode voltages as low as 1000 may be used. With this voltage a sensitivity of 23 volts per inch may be obtained. The decreased brilliancy of the trace at this voltage will be sufficient for observation in normal daylight, although the photographic activity will be reduced.

For photographic work a camera mounted on a tripod over the tube will be useful for single transients as high as 100,000 cycles per second. When the transients are of higher speed than the above, roll film can be used in contact with the end of the tube.

The manner in which the FP-53 will be used can be

www.americanradiohistory.com

divided into the following classes, the operating technique for each type of work being quite separate.

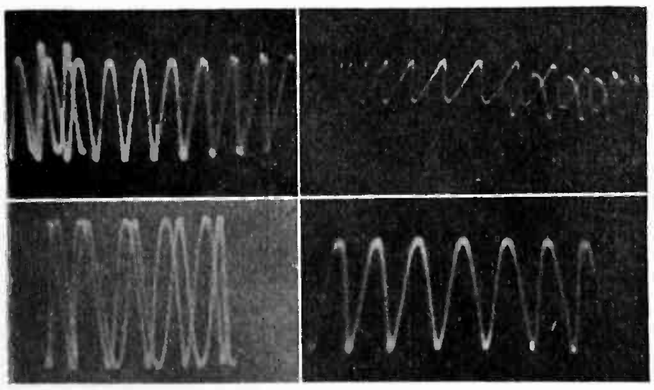
1. Visual observation of recurring phenomena.
2. Visual observation of transient phenomena.
3. Photography of recurring phenomena.
4. Photography of transients.

Consider first the visual observation of recurring phenomena. Due to the high brilliancy of the screen under any normal condition when repeating waves are observed, it is often found convenient to use very low anode voltages to obtain the maximum deflection for low voltage and low current studies. In many cases the beam may be allowed to deflect completely off the screen to give added amplification of detail to a particular portion of the wave. The time axis used may be either sinusoidal or linear, depending on the frequency of the phenomena. It is often convenient to observe the plot of the current vs. the voltage or the input vs. the output. In this case one serves as an axis for the other.

High image brilliance makes snapshots possible

Visual observation of single transients is possible due to the lag in fluorescence of the screen. Visual observation of transients may be carried to frequencies as high as several million cycles. The anode voltage for this use should be as high as allowed by sensitivity and tube characteristics. This is particularly useful in the preliminary study of circuits before photographic records are justified.

Photography of repeating waves follows the general principles outlined for visual observation and is usually used as a record only. Due to the high brilliancy, a snapshot may be taken to avoid any fogging by slight shifts of the waves on the screen. A motion picture camera may be used to advantage in the recording of waves which may contain transients.



Single transient photographs of waves of 600, 3,000, 25,000 and 100,000 cycle waves

Photography of single transients may be accomplished by either a camera or by direct contact between the film and the end of the tube. The first method may be used for phenomena with frequencies as high as 100,000 cycles per second. The writing speed in this case is 20 kilometers per second. The photograph shown was taken on Pancromatic film with a F-2 lens. The grid was used to turn the beam on at the start of the transient and to cut it off after a predetermined time. The ease with which transient phenomena may be photographed is an invaluable aid to the study of the operation of equipment under the most difficult conditions encountered in the field.

FP-53 CHARACTERISTICS AND RATINGS

Filament	
Voltage (maximum)	**2.5**
Current (amperes) (approx.)	**2.1**
Typical heating time (minutes) (approx.)	**1**
Anode or screen voltage	
Normal	**5,000**
Maximum	**10,000**
Focusing cylinder voltage (maximum)	**2,500**
Ratio anode voltage to focusing cylinder Voltage for focus (approx.)	**5**
Peak deflecting plate voltage (maximum)	**2,000**
Anode screen current at normal voltage (amperes) (approx.)	**0.00005**
Focusing cylinder current at normal Anode voltage (amperes) (approx.)	**0.00100**

Cut-off characteristic (to cut-off beam)

Anode voltage	Grid voltage
5000	—75 (approx.)

Deflecting plates sensitivity characteristic (volts per inch)

Anode voltage	D.c. voltage on deflecting plates
5000	200 (approx.) front pair
5000	115 (approx.) back pair

For photography of still higher speed phenomena, the film may be put in direct contact with the screen. This is particularly useful in the study of surges on transmission lines and allied apparatus when the wave fronts are not greater than 500,000 cycles per second. Writing speeds of more than 100 kilometers per second may be obtained. It must be recognized, of course, that an instrument of this type which operates at only 10,000 volts or less cannot give the quality of service obtained with the more elaborate Du Four oscillograph which operates at 60,000 volts, in the recording of transmisison line surges or like phenomena.

The major field of application of the FP-53 cathode-ray oscillograph tube may be divided into three classes:

1. Educational
2. Scientific
3. Industrial

The large screen and the high brilliancy of the trace makes possible the use of the FP-53 for classroom demonstration and group study. The screen may be viewed by an entire classroom under normal conditions of illumination. This is a great aid to the study of elementary and advanced alternating current theory.

The use of an instrument of this type in all fields of scientific research is practically unlimited, typical examples being the dynamic analysis of vacuum tube characteristics, recording of magnetic fields, testing of hysteresis characteristics at high frequency, and the study of circuit operation.

Applications in the industrial field are illustrated by the recording of transmission line surges, study of mercury arc rectifier performance, analysis of commutation of d-c. machines, testing of transformer iron, and measurement of power factor in high impedance circuits.

All changes of electrical quantities, either periodic or transient can be shown visually or photographed by means of a cathode ray tube like that described.

[1]Langmuir Patent No. 1,219,961—March 1917.
[2]Zworykin—*Radio Engr.*, Dec. 1929, p. 38.
[3]R. H. George—AIEE Journal, Vol. 48, July 1929, p. 534.

www.americanradiohistory.com

The padding condenser

Graphic solution of a single-dial super problem

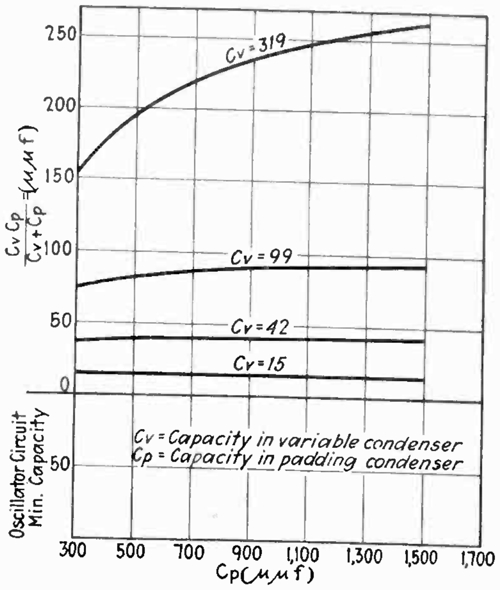


Fig. 2—Curves showing resultant of two capacities in series

By B. F. McNAMEE

Production Engineer
Colin B. Kennedy Corporation

THE tedious work involved in finding the correct values of padding condenser, minimum capacity and inductance of the oscillator circuit in a single dial superheterodyne receiver has prompted the working out of a graphic method which saves considerable time, and also lessens the chance of error.

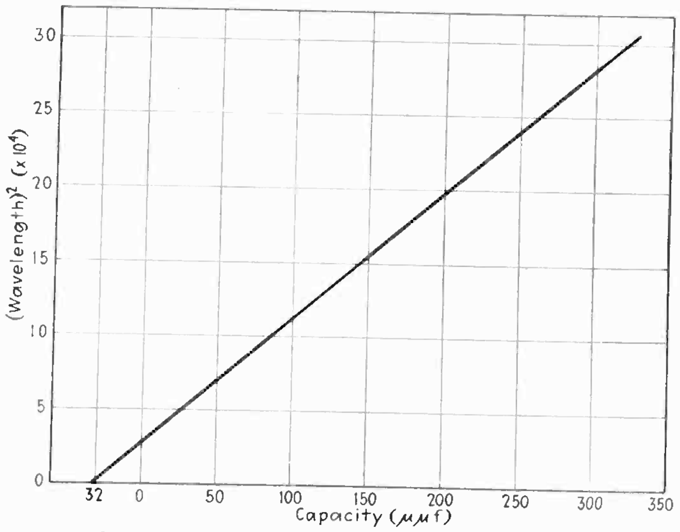


Fig. 1—Capacity curve for signal circuit

Three or four signal frequencies are selected, and the solution worked out for exact tracking of the oscillator circuit at these frequencies. The exact values of capacity in the variable condenser alone at these particular points must be known accurately before any further work can be done. Consequently one complete r.f. circuit must be set up on the chassis with all wiring and tubes in place. The variable-condenser dial should be calibrated in capacity before the coil is connected. Then with the r.f. circuit connected up a curve is made of capacity vs. wavelength squared. Readings taken at several points furnish an excellent check on this work, since any point incorrectly read will not fall in the straight line through the other points.

Figure 1 shows such a curve, made on the set which will be used throughout this article for illustration. The capacity values to the right of zero are those read off the dial of the calibrated tuning condenser. The distance from zero to the point where the curve intersects the capacity axis represents the total minimum capacity of the circuit except the minimum of the variable condenser. In this case the minimum is shown to be 32 μμf.

Incidentally, the true inductance in the r.f. coils may now be obtained from this curve, although it is not required for the problem at hand.

$$L = \frac{\lambda^2}{3.557\,C} = \frac{29.75 \times 10^4}{3.557\,(319 + 32)} = 240\ \mu h.$$

For all practical purposes four points on the dial are selected for the matching of the oscillator and r.f. circuits. The two ends of the dial, 550 and 1,500 kc. are chosen, with 900 and 1,200 kc. for the intermediate points. In the present case an intermediate frequency of 262 kc. is decided on, making the oscillator frequency at the four points mentioned 812, 1,162, 1,462, and 1,762 kc. The method to follow can of course be used for different intermediate frequencies and for different sets of points on the dial.

From the curve of Figure 1 we can find the capacity in the tuning condenser alone, at each of these four dial points. These capacities are shown in the following table:

Signal freq.	λ^2	Variable cap.	Osc. freq.
550 kc.	29.75x10⁴	319 μμf	812 kc.
900	11.10	99	1162
1200	6.25	42	1462
1500	4.00	15	1762

At each of these points the capacities in the oscillator circuit (not including the minimum capacity) will be less than the capacity shown in the above table by an amount depending on the size of the padding condenser. Assuming that the correct pad will fall between 300 and 1,500 μμf, the curves of Fig. 2 are drawn. These curves show the oscillator circuit capacities at each of the four points for any value of pad within the limits of the curves. For example, if a pad of 300 μμf were used these capacities would be 155, 74.5, 37, and 14.3 μμf, as can be seen by finding where each of these curves intersects the vertical line 300.

To each of these values must be added the unknown

www.americanradiohistory.com

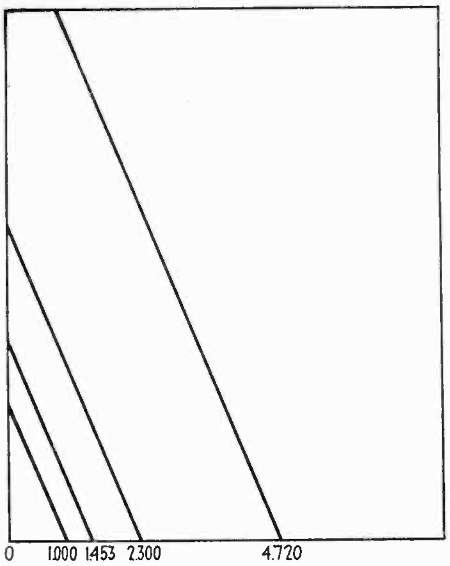


Fig. 3—Radio divider chart, to be drawn on transparent paper

minimum capacity of the circuit except the minimum of the tuning condenser itself. The latter is included in the calibration of the tuning condenser. This unknown minimum of the oscillator circuit will be added downwards from the zero capacity line in Fig. 2.

The next step is to calculate the required capacity ratios for the four oscillator frequencies. The ratios of these capacities to the capacity required at 1,762 kc. are as follows:

$$\left(\frac{1762}{1462}\right)^2 = 1.453; \quad \left(\frac{1762}{1162}\right)^2 = 2.300; \text{ and } \left(\frac{1762}{812}\right)^2 = 4.720$$

Figure 3 shows a ratio divider drawn on transparent material such as tracing paper. This chart should be about the same size as the graph sheet used for making the curves of Fig. 2. The lower line is laid off from the zero point in convenient units, such as inches, to correspond to the capacity ratios calculated above. From the last point on the right a straight line is drawn towards the upper left corner of the paper. Lines from the other points are drawn parallel to this one, so that any line drawn through the zero point and across these lines will be divided in the desired ratio. Obviously accuracy is very important in making this ratio divider.

Testing pad capacity values

Various pad values can now be tested by means of this ratio divider. Place the ratio divider over the graph sheet of Fig. 2 at such an angle that the zero point falls on the 500 line, the ratio line 1.000 cuts the 500 line at the intersection of the lowest curve and the ratio line 4.720 cuts the 500 line at the intersection of the highest curve. This can be done by rotating the ratio divider around its zero point, and at the same time moving the zero point up or down on the 500 line until the above condition is reached.

This value of pad is not correct, since the ratio lines 1.453 and 2.300 will intersect the 500 line below the intersections of the other capacity curves. If a 500 $\mu\mu f$ pad were used there would be about 5 $\mu\mu f$ too much capacity in the oscillator circuit at 900 kc. on the dial. Testing the ratio divider on the 900 line will show the ratio lines 1.453 and 2.300 crossing above the correct points. But on the 700 line all ratio lines cut at the intersections of the capacity curves. (See Fig. 5.) The zero point of the ratio divider falls 40 $\mu\mu f$ below the zero capacity line, denoting a total minimum of 40 $\mu\mu f$ (not including minimum of the variable condenser). The actual minimum of the circuit must be below this value, to allow for a few $\mu\mu f$ in a trimmer condenser for the purpose of adjusting this minimum value in practice.

The final calculation

The total capacity in the oscillator circuit, at each of the four frequencies in question, can be found by adding to each of the capacities found on the 700 pad line, the minimum capacity of 40 $\mu\mu f$. Since these capacities fit the ratio divider they will give a frequency curve for the oscillator circuit, when associated with the proper inductance, which must be correct at the four points chosen. The following table shows clearly the capacity conditions in the oscillator circuit.

Osc. freq.	Cap. ratio	Cap. in Variable cond.	Var. cond. and pad in series	Total Cap. Osc. circuit
1762 kc.	**1.000**	**15 $\mu\mu$f**	**14.7 $\mu\mu$f**	**54.7 $\mu\mu$f**
1462	**1.453**	**42**	**39.8**	**79.8**
1162	**2.300**	**99**	**86.7**	**126.7**
812	**4.720**	**319**	**219.0**	**259.0**

The inductance for the oscillator circuit may now be found as usual. For example take one of the oscillator frequencies and the total corresponding oscillator capacity:

$$L_{osc.} = \frac{2.53 \times 10^{10}}{f^2 C} = \frac{2.53 \times 10^{10}}{(812)^2 \times 259} = 148 \ \mu h.$$

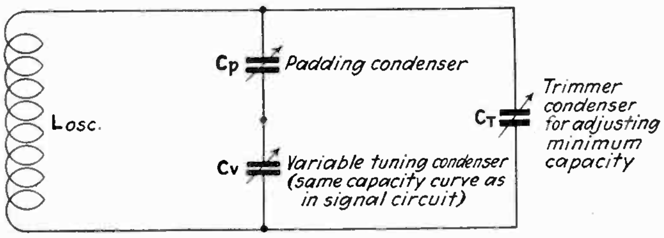


Fig. 4—Circuit of oscillator tuning circuit

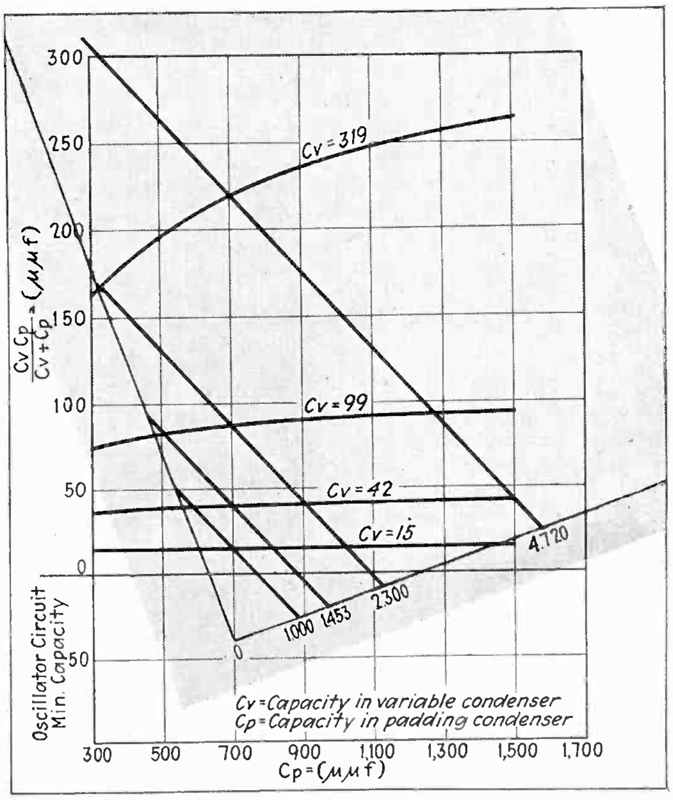


Fig. 5—Application of ratio divider chart to solution of problem

A heavy duty industrial amplifier tube

By C. B. UPP
Westinghouse Research Laboratories

THE use of vacuum tubes in the electrical industry is becoming so widespread and the applications so varied that a class of tubes quite different from those used in radio receivers is necessary. In numerous applications of control devices, such as automatic voltage control of generation, automatic frequency control, synchronization, illumination control, etc., as well as unlimited metering devices, a tube having an output response proportional to input signal is required. In addition to this characteristic which is inherent in the high vacuum tube, many applications are being found where a heavy plate current is necessary in conjunction with this linear response. For purposes such as these a tube with the rating and characteristics shown below was developed.

The RJ-563 is a three-electrode tube of the high vacuum type, employing an oxide-coated filament. This filament is of a very rugged nature and will give proper performance at rated voltage. The structure is rather long, giving a large plate area for heat dissipation purposes. The close clearances in this structure, together with the emission possibilities of the filament, are the contributing factors to the high mutual conductance obtained at the relatively low plate voltage of 250 volts.

Operating Conditions and Characteristics

	As d.c. amplifier	As a.c. amplifier
Filament voltage (volts)	2.5	2.5
Filament current (amperes)	3.0	3.0
Plate voltage (volts)	250.	350.
Grid voltage (volts)	-5	-50
D.C. Filament; grid return to negative filament.		
Amplification factor	4.0	4.0
Plate resistance (ohms)	800	1000
Mutual conductance (micromhos)	5000	4000
Plate current (amperes)	.20	.10
Load impedance (ohms)		2000
Maximum average current d.c. (amperes)		.24
Maximum crest current (amperes)		.35
Maximum plate voltage d.c. (volts)		600
Maximum crest voltage (volts)		600
Maximum plate dissipation—		
at 250 volts (watts) 60		
at 350 volts (watts) 45		
at 500 volts (watts) 10		
at 600 volts (watts) 2		

In most industrial applications this high mutual conductance, and in consequence the low impedance, is very necessary since a maximum current change in the output circuit per volt input makes the installation much simpler. While a very low impedance is obtained it has not been at a sacrifice of grid control, the voltage factor being

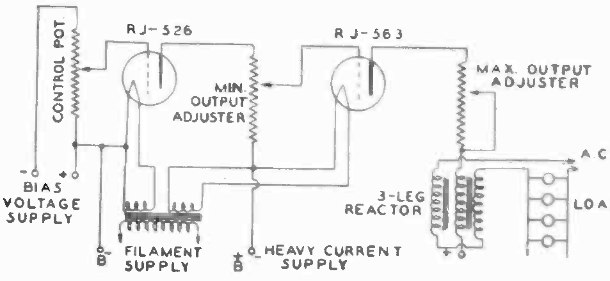


Fig. 1—D.C. amplifier for control of reactor load

held at four, which is unusually high for a low-voltage tube of this low impedance.

There are numerous applications for this tube, only a few typical cases being shown. It may be used as a d.c. amplifier or as an a.c. or non-distorting amplifier. In the first case the tube is used as a variable resistance, or producer of direct current through some external load, such as a reactor or field of a machine to be controlled. The amount of d.c. is dependent upon the grid potential and is practically linear in response, giving a uniform and steady voltage change in the circuit to be controlled. The optimum operating condition of the tube for this case is that of maximum plate current. The dynamic or

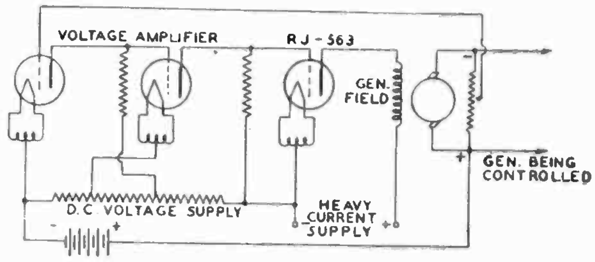


Fig. 2—D.C. amplifier for generator control

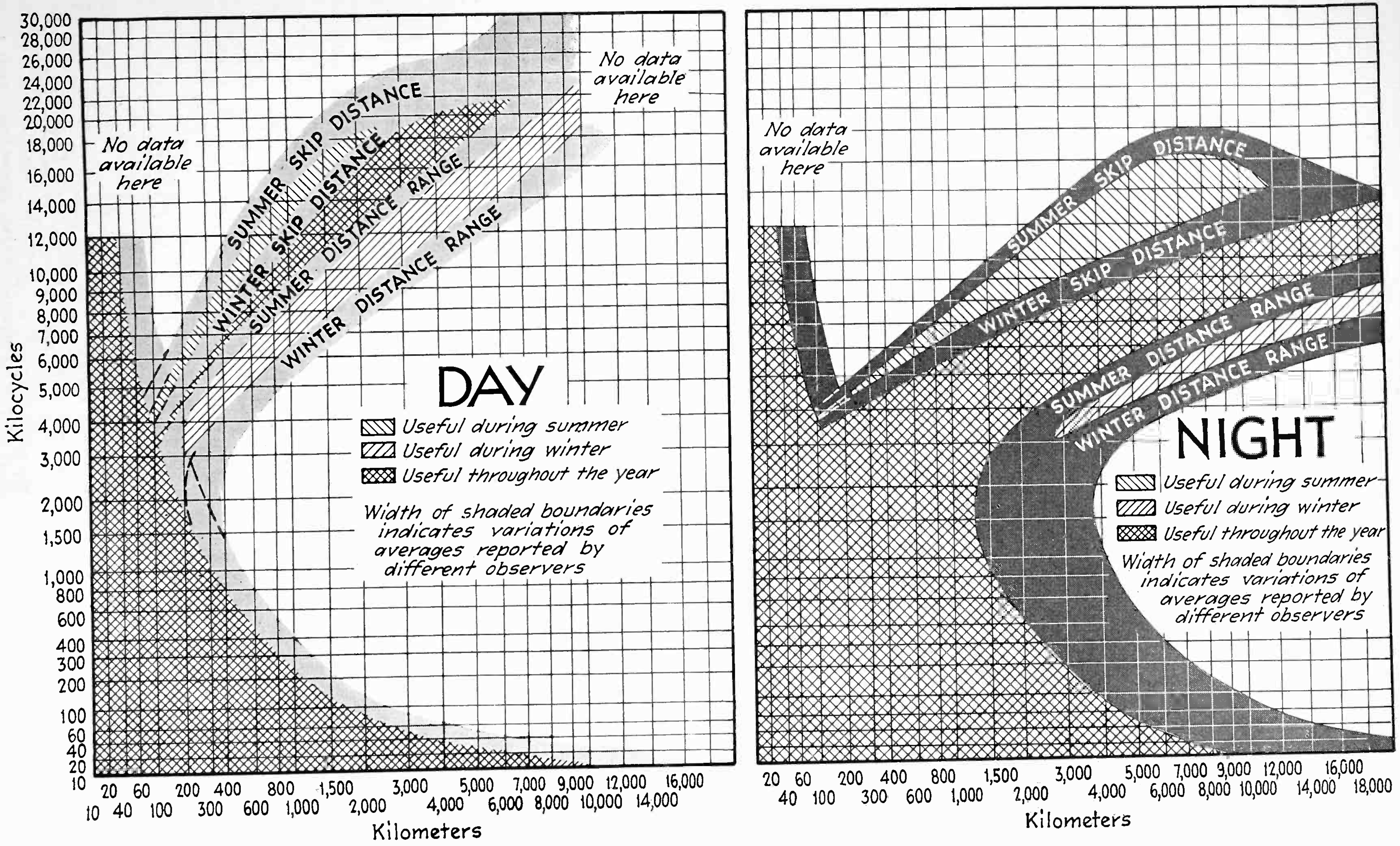
load characteristic in this case is for a decrease of plate current from this point by an increase of negative grid voltage; that is, the grid swing is in one direction *only* from the operating point.

In the second case, that of an a.c. or non-distorting amplifier, such as for oscillatory study, the optimum operating point is given so that a grid swing, both plus and minus, can be taken up to the amount of the fixed grid bias. With a properly chosen load impedance of twice the tube impedance, practically distortionless amplification is obtained.

The circuit diagram of Fig. 1 gives an idea of how the tube may be used to regulate a large a.c. load by a remotely controlled potentiometer. The d.c. plate current of the RJ-563 is used to saturate the center leg of a reactor in series with the load. Approximately $3\frac{1}{2}$ kw. can be controlled for each tube used. Larger power of course can be controlled by using several tubes in parallel.

In Fig. 2 is shown a method of automatic voltage control of a generator, or exciter controlling a larger generator. The regulation is brought about by small voltage changes being amplified and then applied to the grid of the RJ-563 in such a direction as to either increase or decrease the exciter or field current for correction.

www.americanradiohistory.com



DISTANCE RANGE OF RADIO WAVES

Day and Night Frequency Characteristics, compiled by the U. S. Bureau of Standards (Electronics, May 1932)

Automatic voltage regulation

By KASSON HOWE
Ward Leonard Electric Company

THE continuous fluctuation of line voltage must be considered in the design and operation of electrical devices, particularly those of electronic character. The accurate operation of photocells, of crystal controlled oscillators, of vacuum tube measurement circuits, and of innumerable other devices depends upon the voltages supplied to the various circuits remaining constant. By means of the Ward Leonard voltage regulator these voltages may be held to any desired regulation, even though the line voltage is continuously fluctuating through wide limits, and its frequency is varying through commercial limits.

Method of regulation

The voltage regulator is essentially a transformer in construction and performs all the functions of a transformer. It differs from a transformer in that control windings are used to give any degree of regulation required. This regulation may be made negative or to compensate for peculiarities of various loads. For the sake of simplicity we will analyze the simplest form of voltage regulator. This regulator is one designed for use with a fixed load of unity power factor.

Reference to Fig. 1 shows a shell type core differing somewhat from standard transformer practice. There is a window in the center leg, dividing this leg into three parts, which we will call A, B, and D. The primary circuit consists of three windings, around legs A, B, and D, respectively. The additive winding, the winding around the A leg, and the subtractive winding, the winding around the B leg, are connected in series across the line. The so-called primary, the winding around the D leg, is connected to the same side of the line as the additive winding and to a tap on the subtractive winding. These windings are so phased that the flux from the additive winding is practically in phase with the flux from the primary winding, and the flux from the subtractive winding is practically 180° out of phase with the flux from the primary winding. Also, for simplicity, we will assume leakage flux to be negligible.

As leg A is worked beyond the knee of the magnetization curve, a rise in line voltage cannot cause an appreciable increase in voltage across the additive winding. Therefore, practically all the increase in line voltage shows as an increase in voltage across the subtractive winding. This magnifies the tendency for flux to flow in opposition to the primary flux.

As the primary is in series with the greater portion of the subtractive winding the voltage across the primary does not increase in proportion to the increase in line voltage. Thus, the tendency for primary flux does not increase proportionately. Adding together algebraically these tendencies for flux to flow we find that the net flux linking the secondary, that is the flux in legs A and B, remains practically constant throughout a wide change in line voltage. Constant flux linkage means constant voltage induced.

The flux densities of the various parts of the center section of the core are as follows: A approximately one hundred to one hundred and ten thousand lines per square inch, B approximately fifty thousand lines, and D approximately seventy thousand lines. These figures are subject to variation depending on the input voltage range and the secondary regulation required.

If we carefully studied the part played by leakage we would find that it actually improved secondary regulation.

Types of regulators

By a similar analysis, although dealing with more variables, we could trace step by step the operation of the less fundamental forms of the regulator—the constant wattage type, the variable load type, and so on. Voltage regulators for use with variable loads are somewhat different in design from those for use with constant loads. This type has no additive winding and no secondary. The primary and subtractive windings are connected in series across the line. A capacitor is placed across the primary, and the load across the subtractive winding. This type is shown in Fig. 2. Similar modifications of design are made for other types of loads.

The degree of regulation may be controlled in various manners. In general, for a given core size and shape, regulation may be improved: first, by concentrating the secondary winding at the end away from the primary; second, by shifting the point at which the primary taps into the subtractive winding so as to increase the number of subtractive turns in series with the primary; and third, by reducing the number of additive turns. All of the above methods decrease the wattage output as the regulation is improved. Reducing the number of pri-

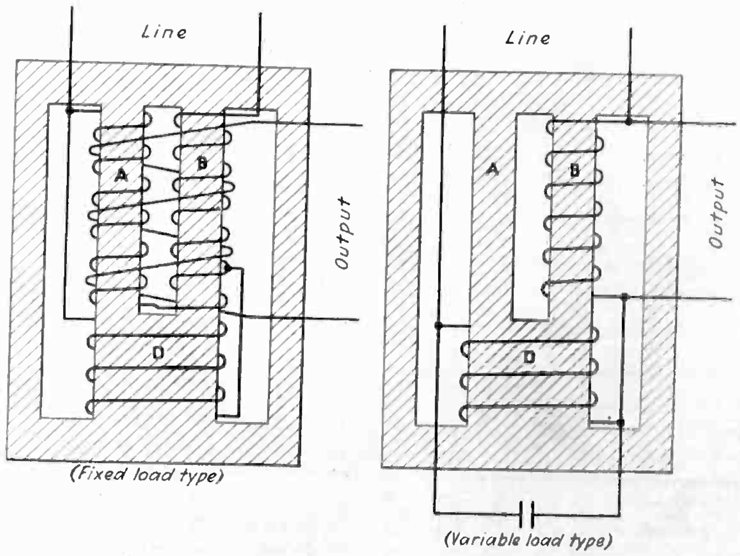


Fig. 1 Fig. 2

Two types of automatic voltage regulation transformers

www.americanradiohistory.com

mary turns improves regulation and increases the output as well.

The cost of the voltage regulator is comparable to the cost of an ordinary transformer designed for the same voltages and load. Closer regulation requires more material for a given output. Conversely, higher output may be obtained from the same amount of material if close regulation is not required. As the materials used in the voltage regulator are exactly the same as those used in an ordinary transformer the cost comparison is also one of weight and volume. A study of the curves in Fig. 3 will show the comparison.

The Ward Leonard voltage regulator has provided voltage regulation which has proven of considerable value in sound applications where voltage variation results in distorted sound reproduction, and in X-ray photography where constant lamp wattage is essential to prevent uneven exposure of the negative and uncertainty in the diagnosis.

Manufacturers of fine instruments for precision measurements and recording have adopted them because of the smooth and quick response. In the more recent developments of photo-cell applications, where the accuracy of operation is dependent upon the constancy of so many factors, and where constant lamp wattage plays so important a part, the regulator has played its part.

These manufacturers, through their engineers, are eliminating the variable of voltage fluctuation, meeting closer requirements and extending the market for their products at a cost increase that is almost negligible or offset by other savings due to voltage regulation.

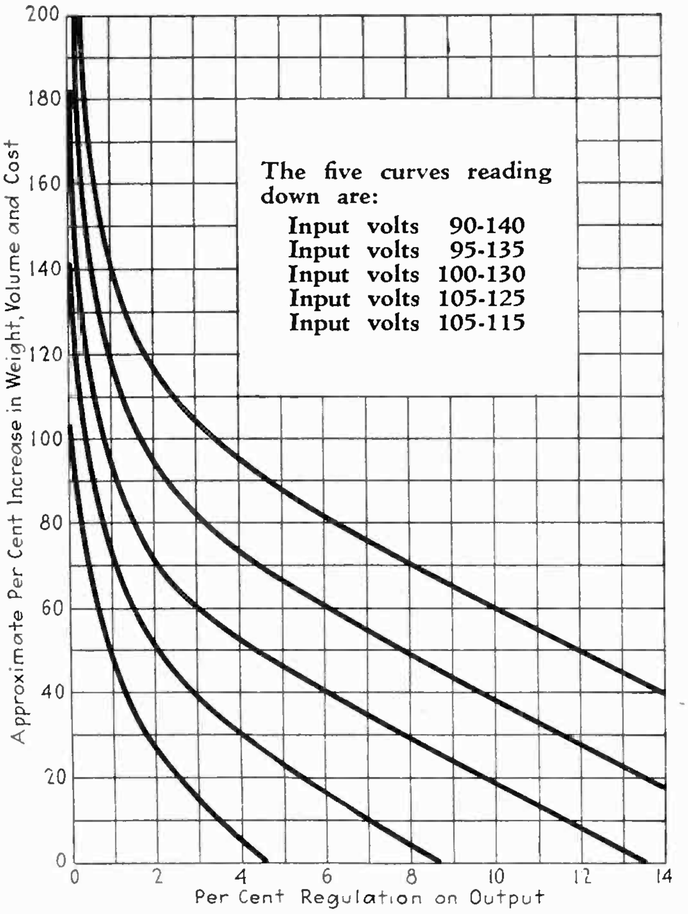


Fig. 3

Relation between cost and regulation desired

▼ ▼ ▼

NEW BOOKS ON ELECTRONIC SUBJECTS

Communication engineering

By W. L. Everitt, McGraw-Hill Book Company, New York, N. Y., 657 pages. Price, $5.

THE PAST DECADE has seen a change, for the better, in the manner in which text books are written. This reviewer noted it first in a book by Andrade dealing with the structure of the atom. There the author speaks of throwing a piano down a flight of stairs and of the resulting heterogenous radiation of tone. Another example is the excellent book on radio frequency measurements by Moullin.

There are other good examples of the attempt to lighten the text book and to make it readable. Now comes Communication Engineering by Professor W. L. Everitt of Ohio State University. It is a text which deals with the fundamentals of the art, rather than the design and building of equipment—and in that respect its title seems not a very good description—and it is readable. This is in spite of the fact that such subjects as Complex Quantities, The Infinite Line, Coupled Circuits, or Impedance Matching offer little chance of more than keeping the student pleasantly and happily somnolent.

The book is divided into broad divisions: Classification of Impedance Elements, Networks using Linear Bilateral Impedances, Networks using Unilateral Impedances, Networks using Non-linear Impedances, Negative Resistance Effects, Coupling between Mechanical and Electrical Circuits, Coupling between Electrical Circuits and Free Space, and Electrical Measurements.

Such practical subjects as Class B amplifiers, inductive interference, vacuum tube detectors and others are well handled. Problems are included at the end of the chapters. The text, although paralleling other books in many ways, merits attention from anyone wanting the fundamentals of the use of electrical energy as a carrier for intelligence.

✦

Rambling through science

By A. L. Le Leeuw. Cloth 5⅝ in. by 8⅝ in. 320 pages. Numerous diagrams. Publication date: April 4, 1932. Price: $2.50.

THERE ARE MANY readers (even of *Electronics!*) who openly or secretly find themselves completely at sea when they read of the discoveries of modern science. Most of them would be very glad to know what it is all about—witness the large number who have courted headaches and inferiority complexes in reading the more or less obtruse "popular scientific" books of the past few years. The chief appeal of "Rambling Through Science" lies in its accuracy, its simplicity, the author's agreeable narrative style and the wide scope of his subjects. It is not a lazy person's book, but it comes as near to being physical science without tears as any bit of writing can, and yet remain authentic.

The author is a native of Holland and was educated at the University of Leyden from which he received the degree of Master of Science. He has lived in America for many years, and is well known as a mechanical engineer and consultant. His writings in the past have consisted of technical books and articles which have appeared in such leading papers as the *American Machinist, Industrial Management, Railway Age,* etc. The present book has grown in part out of his long continued interest in modern science. It was written largely at the insistence of friends and members of his family to whom for many years he has been in the habit of talking informally and informatively upon scientific problems.

www.americanradiohistory.com

Piezo-electric loudspeakers and microphones

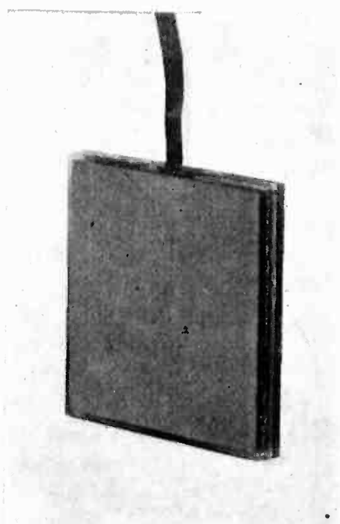
By ALFRED L. WILLIAMS

President, Brush Development Company, Cleveland, Ohio

THE following is a brief summary of progress since the IRE Meeting, Chicago, 1931, in the commercial application of piezo-electric loudspeakers and microphones.

Piezo-electricity relates to the appearance of an electrical potential on faces of certain crystals, or sections of crystals, when subjected to various stresses. As Rochelle salt crystals exhibit this effect to a much greater extent than any other known substance it was the natural one to be selected for further research and development; but advance was slow until the efforts of the Brush Laboratories Company under the direction of Dr. C. B. Sawyer, assured experimenters of an ample supply of perfect homogeneous crystals, and until this same group had developed means for handling and machining them. Progress was further accelerated by the conception of the principle of the bimorph, or opposed sections to multiply the piezo-electric effect and avoid saturation.[1]

Crystal microphone properly mounted



Motor crystal element foiled, showing inner electrode

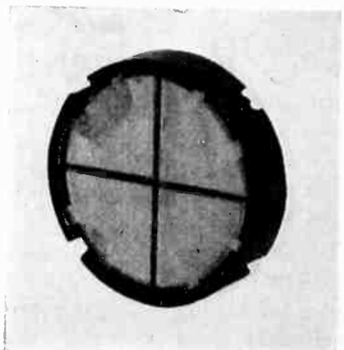
A great deal of time and research has been devoted to standardizing the crystal units used in the construction of loud speakers, pickups, and microphones.

The bimorph or opposed action types have been adapted and used for loudspeakers, phonograph pick-ups and microphones, due to the large amplification of motion obtained, and the elimination, within practical limits, of saturation and temperature effects. Simplified production methods have been developed for the manufacture on a commercial scale of these units, eliminating most of the tedious manual processes originally used, making available to manufacturers a uniform product for the above purposes.

Many sizes of bimorph crystal units, both bending and torque types, are made. Of the larger sizes, the most useful general purpose unit known as Type T24 is $2\frac{1}{2}$ in. square and $\frac{1}{4}$ in. thick, i.e., it is made up of two $\frac{1}{8}$-in. plates. This crystal has a capacity of about 0.03 μf. Bronze contact strips are provided to the inner and outer electrodes. When mounted in Brush Development Company Type R speakers, it is held firmly by clamping at three corners between the bed plate and the steel cover. The fourth or free corner is fitted with a metal cap from which an extension communicates to an amplifying tone arm which actuates the conventional cone. The tone arm ratio depends on the size and weight of the cone being used, but is approximately $2\frac{1}{2}$ to 1. The motion of the end of this arm depends on the voltage applied to the crystal and is about 0.007 in. per 100 volts a.c. One loudspeaker type is a very light compact speaker suitable for all general purposes; outside diameter $9\frac{1}{2}$ in., depth over all $3\frac{3}{4}$ in., total weight just over 2 lb., as compared to that of a typical dynamic with the same size cone $5\frac{1}{2}$ lb.

This speaker is a voltage-operated device, and the power consumption is very low; as many as ten crystal loudspeakers may be operated at the same volume as one electro-dynamic or magnetic speaker at a given power input, making this type of speaker invaluable for multi-speaker installations in schools, theaters, hotels, etc.

For purpose of transformer design, it has become customary to look upon this speaker as having a negative impedance of about 25,000 ohms at 1,000 cycles, but in the case of Type 47 pentode tubes, it operates satisfactorily directly across an output choke. Due to its high sensitivity, astonishing volume is obtainable across a pair of 230's in push-pull, and for battery operated sets a speaker of this new type should be ideal when operated by a pair of these tubes in a Class B amplifier.

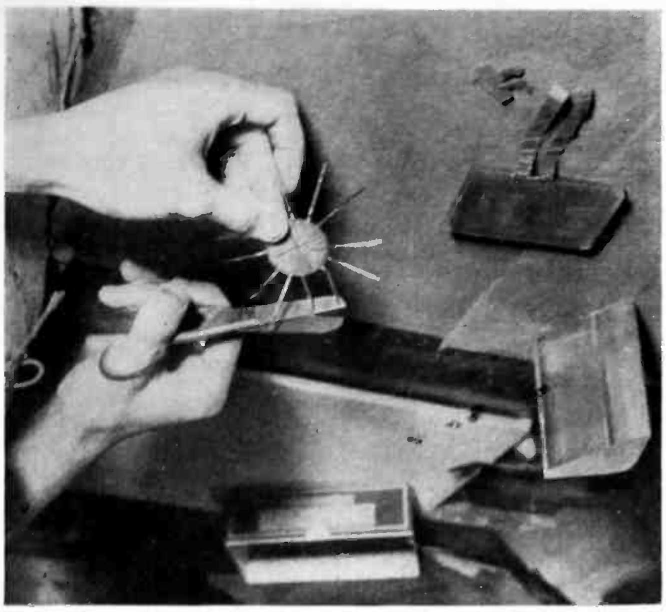


Microphone crystal assembly mounted in bakelite ring. The four individual crystals are clearly seen

Crystal speakers may also be used with advantage in dual speaker installations in parallel with a dynamic to increase the acoustical range, improve the power factor, and help to keep the load impedence constant at all frequencies. Improvement in load at various frequencies was obtained in a typical theater equipment by

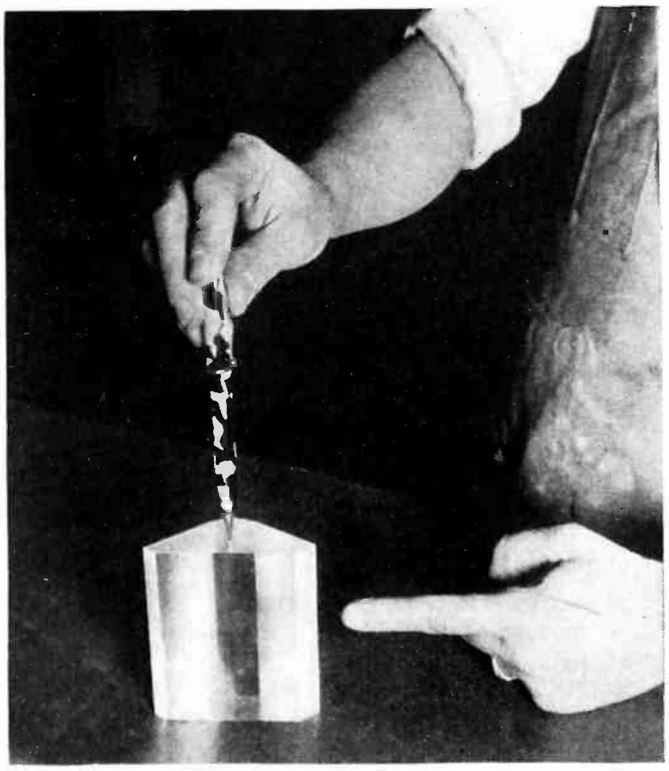
[1]Sawyer, C. B., *Proc. IRE*, 1931

www.americanradiohistory.com



Method of building up microphone crystal unit

Section of Rochelle salt crystal grown in the Brush laboratories

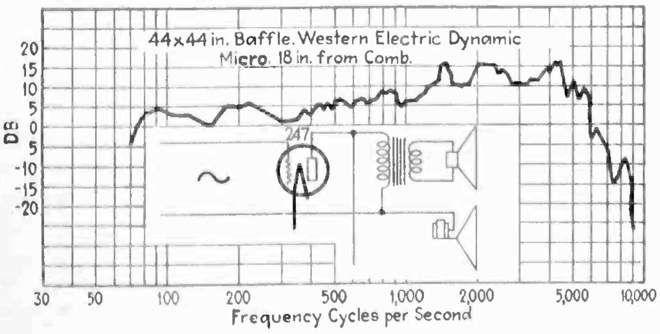


adding two crystal speakers. One speaker was a standard Type R95; the other specially damped with a stiff cone. Sound pressure curves were not taken, but aurally the reproduction was excellent on the oscillator up to 10,000 cycles, while the efficiency was improved.

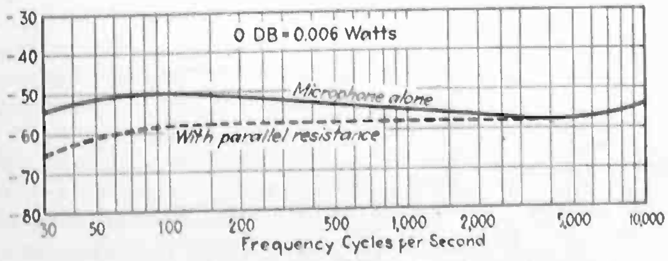
Before starting to discuss a new instrument, it might be helpful to consider first the ideal specifications for such a device, especially if the new instrument employs a completely different principle from those in common use, for it is not its similarity to existing types, but its closeness to the ideal that is important.

The ideal microphone might be summarized as a direct-converter of mechanical into electrical energy, whose voltage output is directly proportional to applied alternating pressure, irrespective of frequency; and with high enough output to operate standard commercial amplifiers. Add to this extreme compactness, portability, ruggedness, the ability to use long leads, and an absence of mechanical parts, metal diaphragms, etc.

Piezo-electric microphones may be designed using a separate diaphragm, pressure on which is transmitted to the crystal unit; or the crystal itself may be directly subjected to the sound pressure. In this case the piezo-electric unit becomes the diaphragm, allowing great variation in design.



Characteristic of dynamic plus crystal loud speakers in 4-foot baffle



Frequency characteristic of Brush microphone taken from secondary 500-ohm line transformer

The crystal microphone requires no current supply, or polarizing voltage, cannot be overloaded, is silent (no carbon hiss) and may be situated a long distance from its amplifier.

The voltage generated by this new microphone is proportional to pressure on the crystal, and not on the velocity of a conductor in a magnetic field, as in a magnetic or dynamic microphone. In fact, to go to an extreme, a direct pressure may be applied to a crystal microphone which will then generate a proportionate voltage which will remain until the pressure is removed, or until the electrical charge leaks away.

The crystal used in the Type Q202 Microphone consists of a bimorph disk, 2 in. in diameter, foiled in four sections, and ground to about 0.020 in. thick. This disk is firmly mounted in a machined Bakelite housing, the 12 electrodes connected in series parallel. The back is then sealed with insulating composition except for a vent for equalizing atmospheric pressure provided by the clearance around a bronze plunger held in place by a set screw. This unit is mounted in a brass case $3\frac{1}{8}$ in. by $1\frac{1}{8}$ in., finished in black and chromium. The total weight is $1\frac{1}{2}$ lb.

For special purposes it is possible to construct crystal microphones with outputs even as high as a good two-button carbon microphone. As such crystal microphones are unaffected by extraneous vibration, due to lack of loose or lightly suspended parts, this type lends itself admirably to special designs, such as pocket microphones for public speakers, and talking picture recording.

This article is too limited to cover piezo-electric phonograph pickups, relays, oscillographs, etc., which have already been developed and the other innumerable possible applications of this principle yet to be worked out.

www.americanradiohistory.com

+ + ELECTRONIC NOTES

Sensitive electric eye counts light quanta

An electric eye so sensitive that it can detect the ultraviolet rays from a lighted match at a distance of 30 feet has been developed by Gordon L. Locher of the Rice Institute, Houston, Texas.

This ultraviolet light detector, which will find many scientific uses, actually counts the individual electrons liberated by effect of light on the surface of a photoelectric metal. It is similar to the cosmic ray counters that have been demonstrated to several scientific audiences throughout the country. Like them it is hitched up to an amplifier and loud-speaker so that the liberation of each electron can be heard as a click.

With this arrangement a candle at a distance of three or four feet produces a steady roar in the speaker.

Preliminary tests of the so-called "mitogenetic" rays made with this apparatus are reported by *Science Service*, of Washington, D. C. These very faint ultraviolet rays, believed to be given out by rapidly dividing cells, for instance in growing root tips and in yeast cultures, were not detected by the new quantum counter though the apparatus was arranged for highest sensitivity.

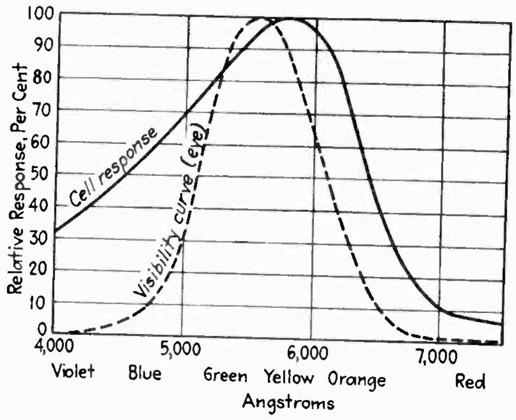
The apparatus may be called a "quantum counter" since the setting free of each electron requires exactly one quantum or energy-atom of the incoming light. In the usual photoelectric cell it requires very many quanta of light to produce a measurable effect on the instrument.

✦

Characteristics of the Photronic cell

The action of light in releasing electrons in the photoelectric cell is a process not clearly understood. In the Weston Photronic cell for example the action seems to be pure electronic and all tests conducted to date show no change either physical or chemical. A thin metal disk forms the positive terminal. On it is a film of light-sensitive material. A metal collector ring in contact with the surface acts as the negative terminal. The data given herewith in curve form are from a valuable brochure of data on this interesting cell, signed by W. N. Goodwin, Jr., chief engineer, Weston Electrical Instruments Co.

The current output is linear for values of external resistance which are small (of the order of 10 per cent or less) in comparison to the cell resistance. It will be noted that the resistance of the cell is a function of both



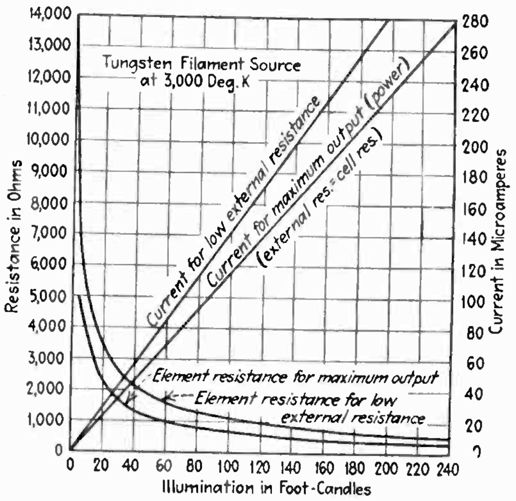
Spectral response of Weston Photronic cell

the current output and the intensity of illumination. The curves designated "for maximum output," which are also linear were derived by adjusting the external resistance for all values of current and illumination, to be equal to the cell resistance for the same conditions, which is the condition for maximum power output.

Cells will produce on the average about 1.4 microamperes per foot-candle of illumination uniformly distributed over the sensitive surface, when connected to a relatively low external resistance. The area of the sensitive surface is about 1.7 sq.in. so that the output of the average cell is about 120 microamperes per lumen.

The spectral response curve represents average relative current output for equal energy rates at various parts of the spectrum. The cells tested were without windows so as to obtain the ultra-violet and infra-red response in addition to the visible.

The standard eye sensitivity curve is given for comparison. It will be noted that the cell has a single peak in the yellow at about 5,800 Angstroms, whereas the eye is most sensitive at 5,550 Angstroms, and also that it is more sensitive than the human eye in the blue and red regions, and the response extends well into the ultra-violet and infra-red. It is known that the cell is responsive to ultra-violet below 2,750 Angstroms, but the region has not yet been explored sufficiently to be accurately known. Cells for use in the ultra-violet region can be provided with quartz windows.



Current output and resistance—Photronic cell

✦

Isolantite characteristics

The following data showing power factor of Isolantite are of especial interest to broadcast engineers because of the frequencies at which the measurements were made.

Relative humidity—45% to 50%

Frequency...	246 kc.	612 kc.	885 kc.	1,375 kc.
Power factor	0.183%	0.180%	0.180%	0.185%

Relative humidity — 65% to 70%

Frequency...	242 kc.	490 kc.	895 kc.	1,380 kc.
Power factor	0.197%	0.193%	0.212%	0.194%

After immersing in distilled water 24 hours

Frequency..........	335 kc.	885 kc.	1,360 kc.
Power factor........	0.184%	0.194%	0.192%

Resistivity*

Average volume resistivity (ohms per cm.)	Average surface resistivity (ohms per cm.²)
2.3×10^{14}	4.18×10^{16}

*Note — Determinations made with Compton quadrant electrometer.

✦

Iron as magnetic material

Thanks to research work it has been possible to increase the maximum permeability P of iron thirty-fold in the past thirty years, and to reduce the hysteresis loss (in ergs per cu.cm. and cycle) to 6 per cent of its former value, an enormous saving. O. Auwers (*Naturwissenschaften*, April, 1932) gives the following table:

	P	Loss
1900 Swedish iron..........	2,600	2,700
1912 Iron with 4 per cent silicon..................	11,600	....
1914 Vacuum fused electrolytic....................	19,000	810
1915 Vacuum fused electrolytic (0.15 per cent Si)	50,000	290
1928 Vacuum fused electrolytic....................	61,000	300
1930 Hydrogen treated pure iron Permalloy..........	180,000	200
1923 Permalloy 78 per cent nickel..................	87,000	180
1925 Hypernik 50 per cent nickel..................	70,000	200

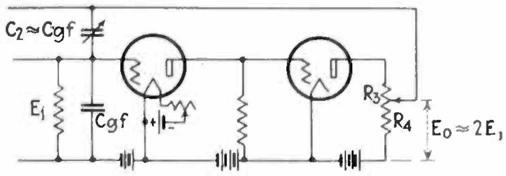
New points of view were introduced when it was discovered that a single crystal of iron would have no hysteresis loss, but would stand no mechanical treatment. Ferromagnetism is now considered to be a problem of crystal structure and internal mechanical tensions. The easily saturated permalloy is used for audio transformers, perminvar on account of its constant permeability, for the first trans-Atlantic telephone cable.

www.americanradiohistory.com

FROM THE LABORATORY + +

Low noise vacuum tubes

In order to allow voltages of less than 10 micro-volts to be amplified without noise over the frequency band below 100 cycles per sec. it is necessary to remove any insulating material from



the neighborhood of the path of the electrons, deposits on grid wires, for instance, to reduce the number of positive ions emitted and to have as high a vacuum as possible.

The capacity of the input circuit of the vacuum tube limits the charge sensitivity to the order of 10^{-15} to 10^{-16} coulombs per mm., so that with a current of 10^{-17} amps. it takes 10 sec. to 2 min. to produce a readable deflection. When the capacity is neutralized a two-stage amplifier containing one FP54 pliotron reaches a sensitivity of one electron per scale division.

In the Physical Review, February-March, 1932, G. F. Metcalf and T. M. Dickinson of the General Electric Company speak of the amplification of very low voltages.

✦

Properties of molded Plaskon

Some years ago there was established at Mellon Institute of Industrial Research at Pittsburgh a fellowship on nitrogenous resins. The first commercial product of this fellowship was offered to the molding industry recently under the name of Plaskon. It is an urea-formaldehyde compound produced by Toledo Synthetic Products, Inc., Toledo, Ohio. Because the material has properties which have uses in the electronics industry, the characteristics are given below.

Specific gravity—1.48.

Modulus of rupture—10,000 to 14,000 lbs./sq.in.

Tensile strength—4,000 to 6,000 lbs./sq.in.

Compressive strength—25,000 to 30,000 lbs./sq.in.

Impact strength (Sharpe)—0.7 to 1.2 ft. lbs.

Dielectric constant (25° C.)—5 to 6.

Dielectric strength (puncture)—300 to 400 volts per mil.

Water absorption (20° C.; ⅛ in. section)—0.07 to 0.66 per cent in 24 hrs.

Resistance to solvents—Unaffected by alcohol, acetone, oil or other common solvents.

Resistance to acids—Moderately resistant to cold dilute acids. Not resistant to hot or concentrated acids.

Resistance to alkalies—Quite resistant to cold dilute alkalies. Also resists hot, very dilute alkalies, such as soap, borax, cleaners, etc.

Hardness (Mohr scale)—3.0 to 3.5.

Hardness (scleroscope)—80 to 95.

Workability — Plaskon can be machined, bored, resurfaced, and polished.

✦

Physiological and biological effects of high frequency

The following bibliography is not complete, of course, but gives important articles on the subject of the effects of high frequency currents on biological and physiological tissue.

McKinley, John G. Jr. and McKinley, G. Murray.
High frequency equipment for biological experimentation.
in
Science. 71:508-510. (No. 1846). May 16, 1930.

Headlee, T. J.
Killing insects with radio waves. 1929
in
New Jersey Agriculture. v.11 No. 12:10

Christie, Ronald V. and Loomis, Alfred L.
Relation of frequency to the physiological effects of ultra-high frequency currents.
Journal of Experimental Medicine. v.49:303-321. No. 2 Feb. 1, 1929

Schereschewsky, J. W.
The action of currents of very high frequency upon tissue cells.
abstracted in
Berichte Vber die Wissenschaftliche Biologie. v.11:14-15. No. ½. July 10, 1929.

Szymanowski, W. T., and Hicks, R. A.
The biologic action of ulta-high frequency currents.
Journal of Infectious Diseases. 50(1): 1-25. January, 1932.

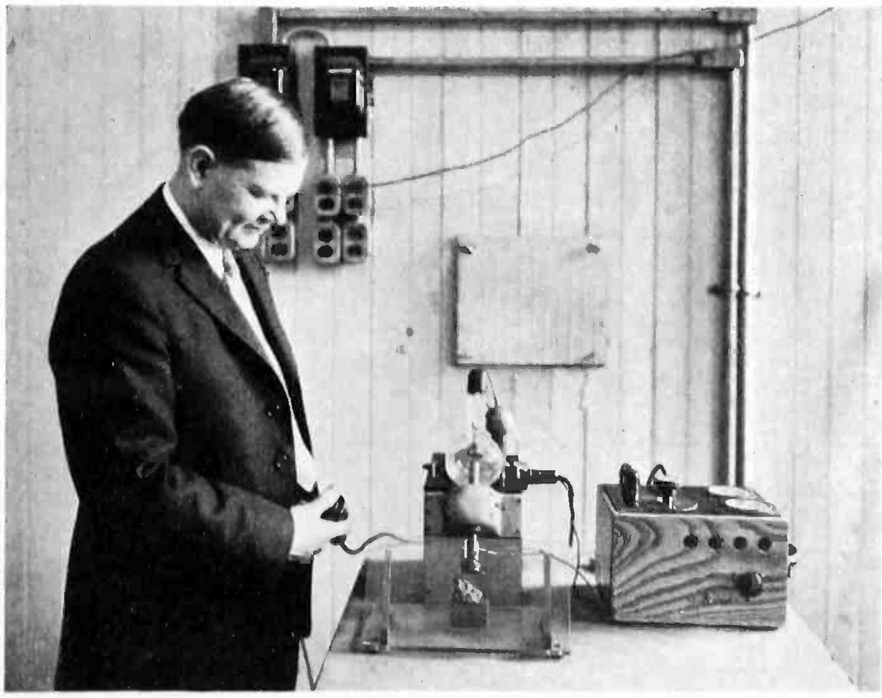
✦

Correlation between radio and passage of storms

The variation in received field intensity of long radio waves has been compared at the Bureau of Standards with variation of temperature, pressure and rain fall, during the passing of general storms at Washington, according to acting director S. J. Briggs. The results show that in general there is a definite falling off in signal intensity in front of the advancing area of low pressure. This is followed by an increased intensity which persists from one to two days after the storm center passes. This indicates some real relationship between received signal strength of long waves and weather, over that part of the path traversed by the wave shortly before reaching the receiving station.

✦ ✦ ✦

HIGH-SPEED ELECTRONS PUT TO WORK



George Hotaling of the General Electric Research Laboratories using a small sealed-off cathode ray tube on a mineral

www.americanradiohistory.com

Photocell control of temperature

for filament coating ovens

By W. P. KOECHEL

Ken-Rad Corporation

THE purpose of this article is to describe an economical means of automatically controlling the temperature of filament coating ovens. The fundamental principle can, of course, be applied to any type of electric oven.

In a vacuum tube plant in which the method was applied, it was necessary to have an accurate method of automatically controlling the temperature of four coating ovens. The temperature must be kept within very close limits. Each oven must be individually and constantly under automatic control. Furthermore any required temperature must be attained by setting the control and then maintained without additional attention.

The fundamental principle can be explained by referring to Fig. 1. The oven has installed on it, in permanent form, a suitable thermocouple junction. The output of this junction is fed into a variable range millivolt meter mounted with a suitable light source focused on the mid portion of its scale. In a light proof compartment, behind the meter, is mounted a photocell. In the center of the scale of the meter, there is a round aperture, and a corresponding hole in the bakelite case of the meter, so lined up that the rays of the focused light source travel through the apertures, and impinge on the photocell.

The hole in the scale is in such a position that when the indicating needle of the meter reads in the exact center of the scale, this aperture will be covered by the meter indicator. When thus covered by the indicator, no light rays reach the photocell.

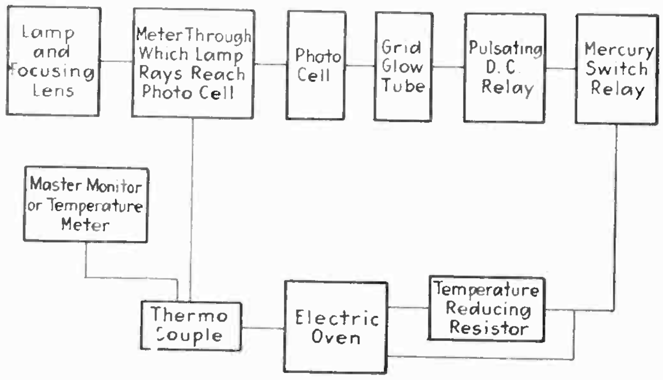


Fig. 1—Block diagram of the temperature control system

The photocell is connected to a grid-glow tube and associated relay system in such a way, that the ultimate relay connects and disconnects the line voltage to the oven under control.

The sequence of operation is such that, when the temperature of the oven is below any selected standard value, the meter indicator is on the lower half of the scale. Under these conditions, the rays of the light source reach the photocell and act so as to operate the relays and connect the power line to the oven. This condition exists until such a time as the temperature of the oven rises to the point equivalent to that required to give a meter indication in the center of the scale. Under such condition, the aperture of the meter is covered by the indicator. This acts so as to cut off the light from the photocell, and, in turn, to actuate the relay system so as to cut the power supply off from the oven. With the oven power turned off, the temperature decreases until the indicator of the temperature meter uncovers the hole in the center of the scale. This again permits light to reach the photocell and the above cycle is repeated continuously.

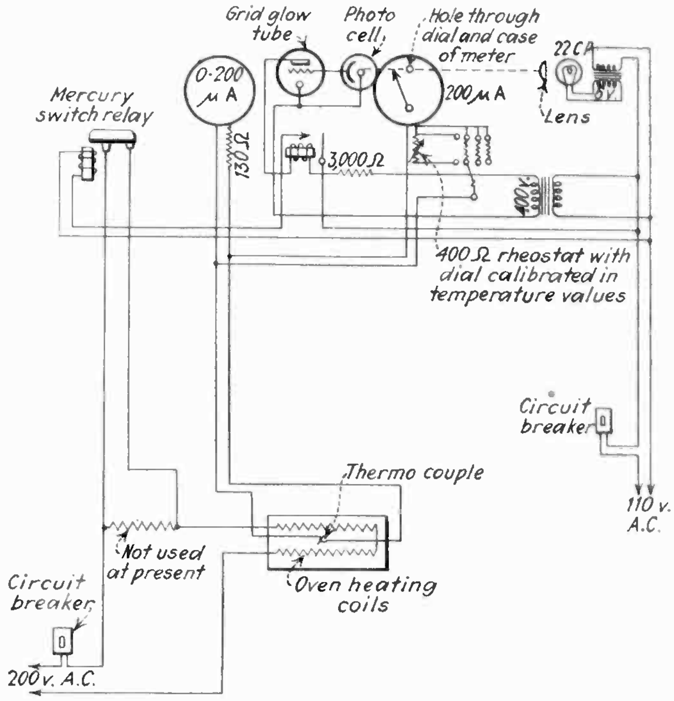


Fig. 2—Circuit diagram of control apparatus

A calibrated variable resistor, in series with the temperature meter, permits setting this meter so that it will read at the exact center of the scale for any required temperature setting. The dial controlling this variable resistor can, therefore, be calibrated directly in temperature values. When the dial of the variable resistor is set for any given temperature setting, it means that the temperature meter (millivolt meter) will indicate at the exact center of the scale when the oven reaches that temperature and, therefore, cover the aperture.

The reason for selecting the center of the scale is on account of the mechanical construction of the Weston Model 301 meter. At points other than the center of the scale, various internal portions of the mechanism prevent a "through" hole being drilled. It should also be noted that a stop is necessary to prevent the meter indicator from going beyond the point where the indicator covers the scale aperture. Otherwise, the indicator might

[*Please turn to page 182*]

www.americanradiohistory.com

Weak signal demodulation

by a strong carrier

BY PROF. E. V. APPLETON, F. R. S.
King's College, London

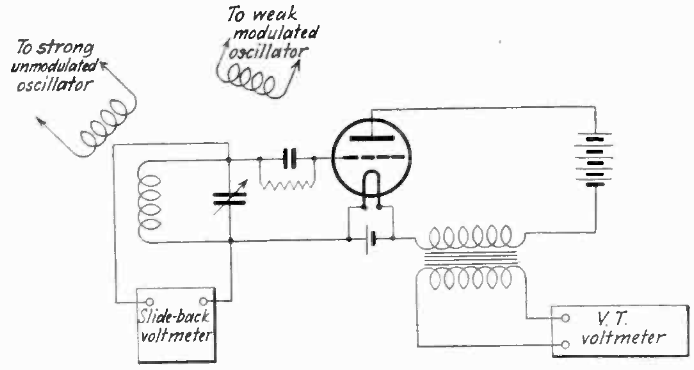


Fig. 2—Circuit for experimental investigation

IN connection with attempts to attain high selectivity in broadcast receivers, no proposals have created a more lively discussion than those of Dr. J. Robinson, the inventor of the Stenode radiostat receiver. Dr. Robinson proposes that we should use receiving circuits of the highest attainable selectivity and because such highly-selective circuits tend to produce a progressive falling-off in acoustic signal amplitude, as the modulation frequency is increased, Dr. Robinson proposes to correct this type of frequency-distortion in the audio amplifier.

My object here is not to discuss the performance of such highly-selective receivers in detail, but to confine myself to an examination of one of their properties which I regard as especially important.

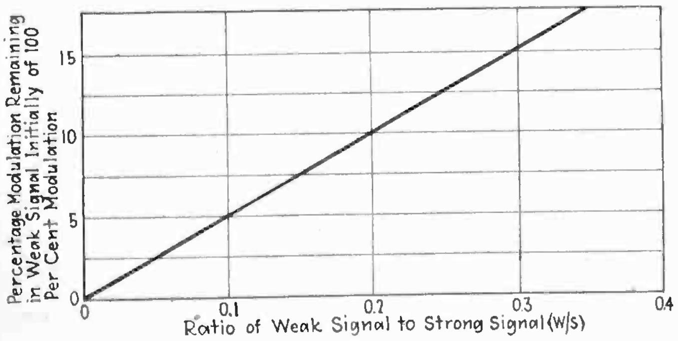


Fig. 1—Effect of the demodulation phenomenon

When a highly-selective receiver is tuned in to a given station the result is usually that the carrier of the wanted signal is very much enhanced relative to that of an unwanted station of neighboring frequency. Now if the signals from both stations are simultaneously rectified there is a curious interaction between them, the chief result of which may be described as an apparent demodulation of the weak unwanted signal by the strong wanted one. This subject was studied by Beatty[1] and Butterworth[2] two or three years ago. Beatty's theory indicated that, with a linear rectifier, the modulation of the unwanted signal is completely suppressed as soon as the carrier-wave intensity of the wanted signal is so enhanced by tuning as to be greater than that of the unwanted signal. Butterworth's theory, on the other hand, indicated that the demodulation depended in a somewhat complicated manner on the ratio of the carrier wave intensities of the two signals.

Prompted by the disagreement between the results of Beatty and Butterworth, Mr. D. Booharivwalla and I have examined the problem afresh, at the same time seeking to check our theory by experiment.

[1]*Experimental Wireless*, 5, No. 57, p. 300, June 1928.
[2]*Experimental Wireless*, 6, No. 74, p. 619, Nov. 1929.

Analysis of the demodulation

Let us consider the simultaneous reception of a strong signal and a weak one. Let the strong signal be expressed as $S \cos \omega_1 t$ and the weak one by $W \cos \omega_2 t$. The total signal V is therefore given by

$$V = S \cos \omega_1 t + W \cos \omega_2 t \quad \ldots (1)$$

$$= S \cos \omega_1 t + W \cos (\omega_1 + p)\, t \quad \ldots (2)$$

where $p = (\omega_2 - \omega_1)$ and is assumed to be a supersonic angular frequency. Now (2) is easily shown to be

$$V = -\sqrt{S^2 + W^2 + 2SW \cos pt}\ \cos (\omega_1 t + \Theta) \quad \ldots (3)$$

where

$$\Theta = \tan^{-1} \frac{W \sin p\, t}{S + W \cos p\, t}$$

Now, if we assume that the signal voltage V is applied to the terminals of a linear rectifier, we can say that the mean signal current i is proportional to the amplitude of V. We therefore have

$$i = a\sqrt{S^2 + W^2 + 2\, S\, W \cos pt} \quad \ldots (4)$$

Since, however, a telephone does not respond to the supersonic angular frequency p we have to find the mean value of the expression under the radical. In doing this it is a great advantage to remember that S^2 is large compared with W^2. Retaining only important terms we find

$$i = a\left(\sqrt{S^2 + W^2} - \tfrac{1}{4}\, \frac{S^2 W^2}{(S^2 + W^2)^{\frac{3}{2}}}\right) \quad \ldots (5)$$

This expression indicates how the received signal depend on S and on W. Let us now suppose that our weak signal is modulated, that is to be changed in amplitude from W to $W \pm \Delta W$. We know that, if the strong signal were not present, we should have this change registered as a change of mean signal current $\pm a\Delta W$. But by differentiating (5) with respect to W, and remembering that S^2 is large compared with W^2 we find that, in the presence of S, the change of mean signal current is now only $\frac{a}{2}\left(\frac{W}{S}\right) \Delta W$. We therefore obtain

[*Please turn to page 182*]

www.americanradiohistory.com

electronics

McGraw-Hill Publishing Company, Inc.
330 West 42d Street
New York City

O. H. CALDWELL, *Editor*

Volume IV — MAY, 1932 — Number 5

Radio signal ranges

IN THIS issue of *Electronics* will be found in chart form data on the day and night ranges and skip distances of all electrical waves useful for communication. These data taken from the Bureau of Standards Letter Circular 317 are the results of the long experience of many agencies. It is even yet impossible to set up exact formulas or charts which can be used to determine distance range over any path accurately, yet the data are useful.

The graphs assume about 5 kilowatts radiated power in a non-directional antenna, 10 μv/m up to 2,000 kc., decreasing to about 1 μv/m at 20,000 kc. These intensities are not sufficient for good program service on broadcast frequencies.

For example the maximum range of 1000-kc. signals, is about 300 kilometers by day and 1500 kilometers by night (180 and 900 miles, approximately). On 5000 kc. (60 meters) however, the picture has changed radically. By day the range is 60 kilometers at times increased to 800 kilometers with an uncertain region in which the ground wave does not arrive and the sky-wave is not returned to earth. By night a 5000 kc.-signal may be heard up to 9000 kilometers.

The Rockefeller "Electronic Center"

AS THE steelwork for Rockefeller Center (Radio City) goes up, and the first buildings in the group approach completion, the significance of this development from an electronic standpoint becomes evident.

Of course the whole $250,000,000 enterprise is actually founded on so frail a thing as the electron tube, for these massive structures are being built to house radio broadcasting and television studios, electronic musical devices, and sound-picture studios and theaters.

And now it is apparent that the great buildings in themselves will carry out on an unparalleled scale the installation of electronic apparatus. In the theaters and auditoriums, the largest installations of tube-controlled illumination ever made will employ circuits numbering three or four times those of any auditorium or opera house so far. Electron tubes will also control the outside flood lighting, and the color effects on the fountains. Tubes will speed the elevators, and photocells will guard the elevator doors. Public-address and communication circuits will be employed for many new uses. All in all, Rockefeller Center will be the latest embodiment of electronic ingenuity, built against a background of a quarter billion dollars!

Radios with two loudspeakers

LOUDSPEAKERS used by radio set manufacturers are largely a pragmatic by-product of economic pressure which calls for sets as little bad as possible at reduced cost. The speaker, therefore, is badly in need of improvement, particularly in two directions, improved overload characteristic and in transient behavior. Quest for high apparent efficiency has been responsible for the shortcomings of the present generation of loudspeaker but can share the blame with the complacence with which set engineers view steady-state characteristics of a speaker's performance.

Discussion of "hang-overs" and masking and other poorly defined terms can be obviated by a serious study by means of oscillographs or other tools. It will become apparent that measuring the output as a steady input is applied may not tell the entire story.

Research indicates that distinct advantages accrue when two speakers with slightly different resonant points are properly placed in a baffle. These advantages are a betterment of the overload characteristic and less tendency for hang-overs to occur. The future may see radio with two speakers, increased power output and still other technical advances toward the goal of "perfect quality."

www.americanradiohistory.com

Factory-installed filters on electrical devices

IF space radio broadcasting is to have its fullest development, more attention and thought must be given to the elimination of electrical interference by all parties concerned.

The most magnificent program, the most costly radio hour, can be utterly ruined by a heating pad or spark-coil or commutator motor in the vicinity of the listener.

Certainly the time must come when all electrical appliances, switches, motors, etc. are, by filters and condensers, made interference-free. And with that happy day, it will be a real selling point in favor of the device that can be marked "Will Not Interfere with Radio Reception."

A million school rooms in the U.S.

THROUGH Dr. Levering Tyson, executive secretary of the National Advisory Council on Radio in Education, Commissioner Cooper of the United States Office of Education at Washington, furnishes *Electronics* with some interesting figures on the number of school rooms or class rooms in the United States.

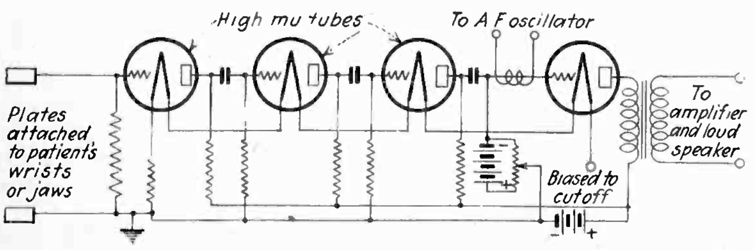
Including only public, elementary and secondary schools, the number of class rooms or teaching positions for 1932 is put at 842,601. This does not include private and parochial schools, nor college class rooms. Including these, Dr. Tyson thinks, would probably bring the total close to a million class rooms.

Of course not all of these rooms are electric-lighted. But of the 29,000,000 dwellings in the United States, 20,500,000 are electric lighted, or 70 per cent. If the same ratio be approached for school rooms, the opportunity for photo-cell control of lighting to protect students' eyes, would seem a very large field indeed.

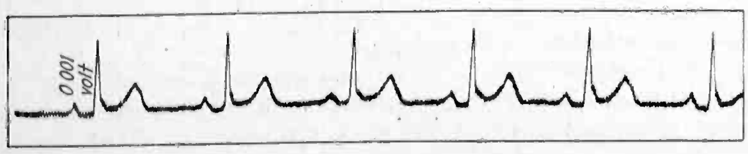
Patents and restraint of trade

APPARENTLY the sentiment of those appearing before the recent House committee hearings is almost unanimous against the bill which has been advocated during recent years by Senator Dill of Washington. That bill proposed that an infringer of a patent could make complete and adequate defense against the owner of the patent if he could show that the owner was guilty of illegal monopoly or restraint of trade. Those appearing argue vigorously, and with apparent good effect on the committee, that patent rights and liability for monopoly of unfair restrain of trade are two separate things. Such joining of the two separate matters would result in an intolerable complication in both classes of cases.

BROADCASTING THE ELECTRICITY GENERATED IN HUMAN MUSCLES



Whenever a muscle is moved, it gives off a slight flow of electricity, of one to three thousandths of a volt. With the circuit shown, these electrical flashes from the heart and jaw muscles were broadcast over NBC networks March 28 and April 30, to demonstrate the multiplying power of the electronic amplifier, during Electronics' editors' campaign to "Rejuvenate Radio Reception." A characteristic heart voltage curve appears below



www.americanradiohistory.com

The march of the electronic arts

Radio Trade Show at Chicago May 23-27

ANOTHER SUCCESSFUL RADIO INDUSTRY conclave and Trade Show at Chicago during "radio week," beginning May 23, is now assured, since nearly 100 exhibitors, including practically all prominent radio manufacturers, have secured space in the RMA Trade Show at the Stevens Hotel for the annual industry exhibit, restricted to the trade.

In addition to radio products there will be exhibits of refrigerators and other electrical items.

Following is the program for the week:

Monday, May 23:
- Arrival and registrations of jobbers and dealers, etc.
- Meeting RMA board of directors, 11:30 a.m.
- RMA committee meetings.
- Trade Show opens 1 p.m.; closes 10 p.m.

Tuesday, May 24:
- Open meeting of radio industry, 10:30 a.m.
- Welcome by Mayor Cermak of Chicago and addresses by prominent speakers on important industry problems.
- Trade Show hours—1 p.m. to 10:00 p.m.
- RMA committee meetings.
- Meetings of various industry organizations and associations.
- Meeting Institute of Radio Service Men, 2:30 p.m.

Wednesday, May 25:
- RMA membership meeting, 10:00 a.m.
- Meetings RMA committees in afternoon.
- Trade Show hours—1 p.m. to 10 p.m.

Thursday, May 26:
- Trade Show opens 10 a.m. to 10 p.m., closing.
- RMA committee meetings.

Friday, May 27:
- RMA board of directors meeting, 10:30 a.m.

✦

Motion-picture engineers at Washington

THE SPRING CONVENTION OF the Society of Motion Picture Engineers was held at the Wardman Park Hotel, Washington, D. C., May 9 to 12, with Dr. Alfred N. Goldsmith presiding. W. C. Kunzmann was chairman of the general convention committee, and O. M. Glunt chairman of the papers committee.

Papers of special interest to *Electronics* readers were scheduled as follows:

"The Lapel Microphone and Its Applications to Public Address and Announcing Systems," by W. C. Jones and D. T. Bell, Bell Telephone Laboratories, New York, N. Y.

"A 16-Mm. Sound-on-Film Projector," by H. C. Holden, RCA-Victor Company, Camden, N. J.

"A 16-Mm. Sound Picture Projector," by H. Pfannenstiehl and R. A. Miller, Bell Telephone Laboratories, New York, N. Y.

"Extension of the Frequency Range of Film Recording and Reproduction," by G. L. Dimmick and H. Belar, RCA-Victor Company, Camden, N. J.

"Wave Form Analysis in Variable Density Recording," by O. Sandvik and V. C. Hall, Eastman Kodak Company, Rochester, N. Y.

"The Weston Model 603 Illumination Meter," by R. T. Pierce, Weston Electrical Instrument Company, Newark, N. J.

"Theater Noise Problems," by S. K. Wolf and J. E. Tweeddale, Electrical Research Products, New York, N. Y.

"Tools That the Service Man Uses," by J. A. Mauran, RCA-Victor Company, Camden, N. J.

✦

Soviet Russia's 250-kw. broadcast station

ON MAY 1, in the presence of M. Stalin, the new Leningrad transmitter was scheduled to be inaugurated with a power of 250 kw. The wavelength will be 351 meters, i.e., that used by the existing Leningrad transmitter of 1.2 kw. and the range of the station is expected to include London and Stuttgart.

✦

ZINC VAPOR LAMP

Dr. Harvey C. Rentschler, director of research, Westinghouse Lamp Company, experimenting with the new highly efficient hot-cathode positive-column zinc arc, produced by passing current through a mixture of argon gas and zinc vapor

Acoustical Society at New York City

THE ACOUSTICAL SOCIETY OF AMERICA met at the Bell Telephone Laboratories, New York City, May 2 and 3. A feature of the Monday evening program was the stimulating addresses by Dr. Leopold Stokowski on "New Horizons in Music."

Dr. Stokowski hinted of some experiments in open presentation now being carried on in which the voices of the best artists will accompany the visual appearance of attractive personalities more suited to the rôles of the opera being rendered. The speaker commented on the new possibilities of tone quality, timbre, volume, range, duration and delicacy of control possible with electronic musical instruments. He also reported the increased emotional stimulus resulting from raising the volume level of his orchestra six or seven times normal, by electronic amplification.

Other papers of special electronic interest in the program were:

"An Efficient Miniature Condenser Microphone System," by H. C. Harrison and P. B. Flanders, Bell Telephone Laboratories.

"A New Analogy Between Mechanical and Electrical Systems," by F. A. Firestone, University of Michigan.

"The Variation of Hearing Acuity with Age," by J. B. Kelly and H. C. Montgomery, Bell Telephone Laboratories.

"Loudness, Its Definition, Measurement and Calculation," by H. Fletcher, Bell Telephone Laboratories.

"Recent Fundamental Advances in Mechanical Sound Records on Wax Disks Using Vertical Cut Demonstration," by H. A. Frederick, Bell Telephone Laboratories.

"Acoustic Pickup for Philadelphia Orchestra Broadcast," by J. P. Maxfield, Electrical Research Products, Inc.

"Automatic Reverberation Meter for Sound Absorption," by V. L. Chrisler and W. F. Snyder, Bureau of Standards

"Acoustics of Broadcasting and Recording Studies," by G. T. Stanton and F. C. Schmid, Electrical Research Products, Inc.

"Control of Broadcasting Pickup from Studios," by C. G. Jones and J. P. Maxfield, Electrical Research Products, Inc.

"Position Finding by Underwater Sound Signals," by B. R. Hubbard, Submarine Signal Company.

"A Method of Measuring Acoustic Impedance," by P. B. Flanders, Bell Telephone Laboratories.

"Automatic Logarithmic Recorder for Frequency Response Measurements," by Stuart Ballantine, Boonton Research Corporation.

"Acoustic Measuring Instruments," by R. L. Hanson, Bell Telephone Laboratories.

www.americanradiohistory.com

RCA gross twenty millions; net $503,224 for quarter

The Radio Corporation of America, David Sarnoff, president, reports for the first quarter of 1932 a net income of $503,224 after depreciation, charges, taxes and amortization of patents, compared with $1,566,519 in the first quarter of 1931.

Gross income from operations was $20,322,408, against $24,562,683 in the first quarter of 1931, and total income was $20,585,223, against $24,-843,372. Cost of sales, general operating, development, selling and administrative expenses was $18,334,904, against $20,821,011. Surplus on March 31, 1932, was $11,487,994, against $11,-327,789 at the end of 1931, no dividends having been paid on Class B preferred shares for the period.

The retiring directors were re-elected unanimously by 12,166,766 shares represented at the meeting. Record books of the corporation showed that General Electric Company owned 5,188,755 common and 27,080 Class A preferred shares, and Westinghouse Electric and Manufacturing 2,842,950 common and 50,000 Class A preferred shares, representing 31.9 per cent and 19.5 per cent of the voting strength, respectively.

✦

Congressmen send phonograph speeches for home broadcasts

"Ladies and Gentlemen of the radio audience, you will now be addressed by your Representative in Congress, who will discuss the issues of the day in the National Capital!"

Constituents in districts from Portland, Me., to Portland, Ore., are hearing this announcement and hitching up their chairs to get closer to their congressman. They think he is on the other end of the ether unless they listen closely to a following announcement and find their representative is talking to them via a phonograph record.

Nearly a dozen members of the House are using the transcription method to get their voices before the home folks, according to Carl Butman, formerly secretary of the Federal Radio Commission, who now has a recording studio in the National Press Building, at Washington. They send their records to broadcasting stations in their districts, most of which are willing to run them without charge.

The method costs less than a trip from Washington, and much less than the leasing of a local broadcasting chain, for in the latter case, even if the time on the air is donated, there are considerable charges for the telephone lines to carry the message from Washington to the broadcasting point.

Representative Horr (R., Wash.) now makes ten records a week and sends one to each of ten stations in his state. Another user of the method is Representative Boehne (D., Ind). Another regular broadcaster is Charlie Farrington, secretary to Representative Hugh Ike Shott (R., W. Va.). Farrington used to work on Shott's newspaper, the Bluefield Telegraph, and he does his stuff in the manner of a newspaper columnist, telling all the latest news and views of Washington.

✦

STUDIES COSMIC RAYS

Dr. Arthur H. Compton, professor of Physics at the University of Chicago and winner of the Nobel prize, is on a trip to mountain tops in Panama, Peru, New Zealand, Australia, Hawaii and Alaska, where he will measure the intensity of cosmic rays with this special micro-electrometer

✦

Test 20-lb. portable 5-meter transmitter

A 20-pound portable radio set operating on about 5 meters (56,000 kilocycles), was tested by Director W. D. Terrell of the Radio Division, Department of Commerce, during April.

One set was placed on Mr. W. E. Downey's desk on the sixth floor of the National Press building. This set was operated by Mr. Terrell.

Mr. Downey then took another set down the elevator to the street and voice communication was continued. As Mr. Downey walked up 14th St., N. W., Mr. Terrell, then transmitting, forgot that Mr. Downey wanted a turn at transmitting, and in order to get Mr. Terrell to quit talking, Mr. Downey went into a drug store and telephoned to his chief. Then the conversation was continued, one minute talking and one minute listening.

Radio manufacturers protest tax to Senate

Unfair discrimination against radio by the proposed 5 per cent special sales tax of the House Revenue Bill, was stressed by leading radio manufacturers April 18 at a hearing before the Senate Finance Committee, accorded the Radio Manufacturers Association. Reduction at least to 3 per cent on the same basis as the proposed automobile tax, was urged, and the senators were told that a general sales tax, or a general manufacturers' tax, exempting food, clothing, medicine, etc., would be distinctly preferable and more fair than the proposed discriminatory tax of the House bill.

The radio industry hearing before the Senate Committee was in general charge of Hon. Frank D. Scott, Washington legislative counsel of the R.M.A. It followed a conference in Washington last week of a large number of leading receiving set and tube manufacturers of the R.M.A. The radio industry hearing was represented by a committee including Messrs. Frank D. Scott, James M. Skinner, president of the Philadelphia Storage Battery Company, and Paul B. Klugh of the Zenith Radio Corporation.

✦

Points in British patent procedure

The first requirement for a patent in Great Britain is that the subject matter must be of benefit to the trade; it must be something for manufacture, i.e., a machine, an article, or a process. It cannot be an abstract idea. The next test is that of "novelty." The inventor does not get a patent unless the public is to get something new. Another test is that of "utility." A device which is useless or impracticable is not patentable. The test of ingenuity is apparently not strictly imposed in England, as it is in Germany for example. On the other hand a minor improvement which would naturally occur to anyone skilled in the art is not judged worthy of a patent.

In England, the validity of a patent is not guaranteed but cases of argument are left to the Chancery Division of the High Court of Justice for final decision. The offering of a device for sale before the patent is applied for ruins chances of issuance. If a provisional application is made the complete specification must be filed within nine months. After description is accepted by the Patent Office the public has two months in which to oppose issuance, after which the patent is issued and remains in force for 16 years.

The Government fees amount to about £5.

REVIEW OF ELECTRONIC LITERATURE

HERE AND ABROAD

Thermostat for crystal control

[UNSIGNED] Study of the heating produced by the oscillating crystal itself and hence of means to conduct this away from the crystal chamber. The method (as used at Aix, Cologne, Münster) consists essentially of enclosing the crystal in a copper cylinder with the ends closed by felt pads separated by metal disks, and with a heater-coil surrounding it, this being controlled by a thermometer within the cylinder. Externally the cylinder has large cooling vanes and is enclosed within a second thermostatic chamber together with the complete radio-frequency stage controlled by the crystal. Variations did not exceed ±0.002 degree C.—*Radio Amateur, Vienna, April, 1932.*

✦

Screen-grid detector

[STURM] Especially as regards resistance coupling following the detector tube and the avoidance of parallel plate-cathode capacity (reaction, by-pass condenser). Several new circuits are developed from this point of view.—*Funk, Berlin, April 1, 1932.*

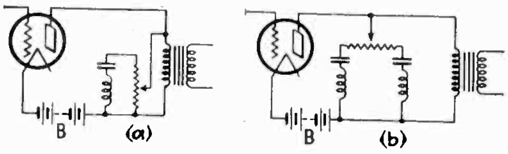
✦

Reflectors and transmission lines for ultra-short waves

[DARBORD] A complete study of the combination of spherical and parabolic mirrors as used in the Calais-Dover 18 cm. telephony (March, 1931), with calculations of the gains possible by the use of such mirrors and of the fields produced. Improvements have been subsequently made, especially as regards the separation of the tube from the doublet in order that the former may be placed under cover, the doublet remaining in the focus of the mirror, the transmission line thus involved can also serve to adapt the resistance of the tube, etc., to the radiation-resistance of the doublet, as in the case of normal short-wave operation. The arrangement now adopted is to place the doublet at the focus of a spherical mirror which reflects the rays to the much larger parabolic mirror, but to take the transmission lines, in the form of two concentric conductors, from the doublet out through the center of this latter mirror to the tube and associated circuits situated behind it. A new type of wavemeter for these frequencies is also described.—*L'Onde Electrique, Paris, February (published March 25), 1932.*

Patents

[SCHR] French 699749 and 700069, for tone-control and volume-control using the circuits shown, (a) being claimed to give pure volume-control without



change of tone-quality and (b) a tone-control if one arm has a high and the other a lower audio-frequency resonance. —*Funk, Berlin, April 1, 1932.*

✦

Passage of r.f. currents through discharge tubes

[L. ROHDE] Jena University. Whereas fairly high d.c. voltages are required for rendering and keeping a discharge tube conducting, much lower starting and operating potentials are sufficient for rapidly oscillating a.c., above 1,000 k.c. These potentials decrease with increasing frequency until 70,000 k.c. is reached, where they become nearly constant. The results for a tube 24 mm. in diameter with electrodes 19 mm. apart are given in the table (the wave-length used being 4.32 metres).

Gas	Starting	Operating voltage	Pressure mm. Hg.
Helium	95	16	0.35
Neon	82	10.5	0.5
Argon	80	8.5	0.05
Nitrogen	144	12.5	0.015

Partial rectification takes place and therefore appreciable distortion occurs. —*Annalen der Physik, February-March, 1932.*

✦

New "Radio Paris" transmitter

[STAUT] Very full description of this station. Some points of interest are: the underground cable to the studio in the city is "pupinised" to give frequency-true transmission of all frequencies between 30 and 10,000 cycles, with a cut-off at 17.000 cycles. The frequency of the transmitter is quartz-stabilized. The antenna is composed of a series of horizontal conductors forming five equilateral triangles one within the other and in the same horizontal plane at a height of some 200 meters, the largest having a side of 163 meters; and of a vertical conductor from the center of these to the station itself.—*L'Onde Electrique, Paris, January (published March 4), 1932.*

Stable potential of an insulated electrode

[BEAUVAIS] It has been found that an insulated electrode (plate or grid) within a triode may retain permanently a potential above zero if the other electrode is at a high potential and if the insulated one is momentarily placed at such a potential. Two possible explanations are given, based on secondary emission and on residual gas ionization respectively: the author tends to favor the second of these.—*L'Onde Electrique, Paris, February (published March 25), 1932.*

✦

Ganging superheterodynes

[A. L. M. SOWERBY] The perfect solution would be to have for the oscillator circuit a tuning condenser of special law by means of which a fixed frequency difference would be maintained. It is cheaper to have all tuning condensers alike, but to add a fixed condenser C_2 in series to the oscillator condenser and a second condenser C_3 in parallel to both. The minimum value c of the tuning condenser, C', the value in an arbitrarily chosen position, C the maximum and the parallel stray capacities C_o are known quantities as are also the corresponding $L_1 C_1$ products l, m, n of the signal frequency circuits and the L_2C products r, s, t of the oscillating circuit (that is L_2c, L_2C' and L_2C). It is necessary to give C_2 and C_3 values which produce the desired frequency difference at the three points. This leads to the equations for C_o, L_1, L_2, C_2, C_3.

$$C_2 = \frac{C'(gc+C) - cC(1+g)}{c+gC - C'(1+g)} \quad \text{where } g = \frac{s-r}{t-s}$$

$$C_3 = \frac{r}{L_2} - \frac{C_2c}{C_2+C} \qquad C' = \frac{M}{L_1} - Co$$

$$Co = \frac{lC - nc}{n-l}$$

$$L_1 = \frac{n-l}{C-c}$$

$$L_2 = \frac{(C_2+C)(C_2+c)(t-s)}{C_2 2(C-c)}$$

The deviations outside the three chosen points may be calculated and a few examples are discussed. The effect of quite large discrepancies in c is often of no consequence.—*The Wireless Engineer, February, 1932.*

www.americanradiohistory.com

Volume and tone control

[Reppisch] Exceptionally complete mathematical and practical treatment of this subject, both as regards the commercial apparatus on the German market and the necessary constants for home construction, with full tables of values. Automatic volume regulation is also fully dealt with.—*Funk Fachschriftenreihe 10, Berlin, 1932.*

✦

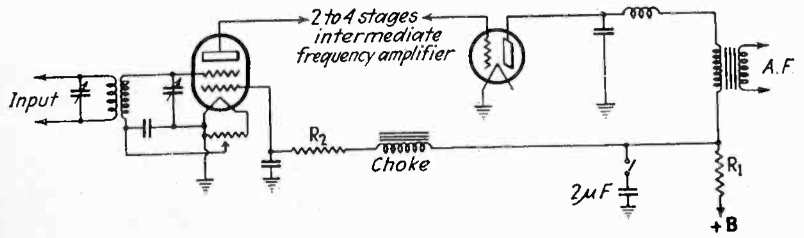
Electronic ultra-micrometers

[H. Olken] A brief discussion and simple diagrams are presented of Dowling's ultra-micrometer (variable condenser in oscillating tube circuit with grid leak and condenser), the resonance micrometer (effect of variation in capacity on resonance current, see *Electronics* Vol. 3 p. 144), the heterodyne circuits (effect of varying capacity upon audible beats) and the straight line circuit (movable contactor between two fixed condenser plates voltage differences measured by vacuum tube bridge). Motions of the order of a single wavelength of light, one millionth of an inch, can be measured.—*Instruments, February, 1932.*

✦

Double-grid tubes as fading compensators

[Laporte] Two new methods of using space-charge-grid tubes are suggested. In the first the variation of voltage across R_1 affects the grid bias, R_2 serving to reduce this to a normally suitable value and the choke to keep audio-frequency currents from the grid. The 2-μf. condenser when switched in so lengthens the time-constant of the grid circuit as to render the fading correction virtually inoperative. In the second method an additional tube is used, immediately following the first intermediate-frequency amplifier, and functioning as the resistance coupling this tube to the one succeeding its outer grid is negatively polarized, the inner one receiving its bias in a similar way to that of the diagram, but from a tube connected as grid rectifier instead of plate so that as the signals increase the drop in R_1 is less and the internal resistance of the tube thus decreases.—*Funk, Berlin, April 1, 1932.*



Circuit used by Laporte for using space-charge grid tube to compensate fading

Photoelectric tubes with large cathode area

[R. Fleischer[1]] Dresden Institute of Technology. A photoelectric cell giving one quarter ma. without any applied potential, when placed in the sunshine coming through a closed window, is constructed by silvering the inner walls of a well-evacuated Dewar flask, 28 cm. high and 10 cm. in diameter, and depositing cesium upon this surface (1,200 sq.cm.). A metal screen placed midway between the walls acts as the positive electrode. The current obtained without any applied potential is nearly 70 per cent of the saturation current obtained with about 2 volts. The photoelectrons produce a potential difference of 1.25 volts between anode and cathode placed 1.5 cm. apart.—*Zeitschr. techn. Physik, February, 1932.*

[1]The author known to readers of Electronics by an article on photo-cells has recently written a valuable review: Die licht elektrische Zelle, Dresden, 1932, by R. Fleischer and H. Teichmann.

✦

Weak oscillation of a tube

[Biasi Giovanni] Mathematical study of the way in which a small decrease in circuit resistance may start oscillations when near the limiting value, and of the conditions determining whether the entry into oscillations shall be gradual or sudden.—*L'Onde Electrique, Paris, February (published March 25), 1932.*

✦

Bridge measurements of small capacities

[Zickner] Full theoretical and constructional details of the modifications to normal practice, with diagrams and photographs.—*Funk, Berlin, March 11, 1932.*

✦

Radio patents

[Unsigned] Removal of line hum. Austrian 126301 in which a fixed condenser of suitable value connected from the grid to one side (to be ascertained experimentally) of the loudspeaker tube is claimed to remove the last traces of this hum.—*Funk Magazin, Berlin, April, 1932.*

Baird Television, Ltd.

Acccording to the "Electrician" Jan. 1, 1932, page 24, total expenditures of the Baird Television, Ltd., for year ending June 30, 1931, were £70,658. The general development account stands at £197,222. Cash on hand is £11,215 and assets include £64,000 nominal of 4½ per cent treasury bonds. Stocks amounted to £6,333.

✦

Music from tube circuits

[O. Vierling] H. Hertz Institute, Berlin. Diagrams are presented showing the main methods used for generating musical frequencies with the aid of vacuum tube circuits developed by Mager (beats obtained on rotating a condenser, or a.f. generator with condenser variable in steps), Theremin (variation by body capacity, thus permitting an unexcelled combination of rythmical play and sound, but lacking sharp intervals), Martenot (a.f. generator, rotation of condenser converted into straight line motion), Helberger and Lertes (a.f. generator, change in magnetic saturation by means of resistance in anode circuit), Trautwein (non-sinusoidal oscillations in discharge and vacuum tubes, time relay circuit) etc. As regeneration is playing a part, the devices are not strictly reproducible and they require considerable skill.

Although to some extent musical devices are mere accidental contraptions, several of them have been brought to great perfection in the course of time so that it is advisable to use these mechanical vibrations and to amplify selected portions, as Miessner and Ranger have done in America (see *Electronics*, March, 1932) and Nerst and Vierling in Europe. The main difference is that a mechanical system is more stable, and that a string, for instance, can vibrate in an almost infinite number of manners, a few coupled circuits only in a small number of ways.—*Elektrotechn. Zeitschr., February, 1932.*

✦

Chokes with iron core and air gap

[R. Guertler] Telefunken Laboratory. The value of the inductance for a.c. is modified when d.c. flows at the same time through the coil, and it is possible to show that for a given value of d.c. there is a definite width of the air-gap making the inductance a maximum. Formulas and graphs are discussed and presented, arranged so that the number of turns per unit length may be read off when the inductance per unit volume and the d.c. which the coil must carry have been chosen. Additional tables contain corrections for the stray-field, a point not seldom overlooked.—*Hochfrequenztechnik, February, 1932.*

www.americanradiohistory.com

+ NEW PRODUCTS

THE MANUFACTURERS OFFER

Multi-range general purpose meter

THE ENGINEERING DEPARTMENT of the Shallcross Manufacturing Company, Collingdale, Pa., has designed a general purpose meter circuit employing Super Akra-ohm wire wound resistors and a Weston Model 301 Universal (d.c. and a.c.) meter. The voltage scales are 1,000 ohms per volt and the current scales work on a five-volt drop.

Voltage ranges of 5, 10, 50, 250, 500 and 1,000 and current ranges of 1, 5, 25, 100 and 500 milliamperes are obtainable. By a method of cautionary deflection, a fuse and safety key it is practically impossible to ruin the meter by not properly setting the switch when changing to voltage from current.

The meter is supplied completely assembled with the purchaser's name on the panel at $50 or a kit of resistors and other parts is available.—*Electronics, May, 1932.*

✦

Superheterodyne "Pro"

THE HAMMARLUND MANUFACTURING COMPANY, 424 West 33d St., New York City, announces its new Comet "Pro," an a.c. operated eight-tube superheterodyne using interchangeable coils wound on Isolantite forms. The normal tuning range with three sets of coils is from 15 to 125 meters (20,000 to 2,400 kc.) and the tuning system employed provides "band spread" characteristics at any desired frequency within that range. With two additional sets of coils the range can be extended to 550 kc.

A 227 is used as an output tube to provide clean and humless headphone signals. Where great loudspeaker volume is required, the use of an external power amplifier is recommended. Such an amplifier unit, housed in a cabinet to match the receiver, will shortly be available. The price of the receiver is $159.20, including chassis, cabinet and tubes.—*Electronics, May, 1932.*

✦

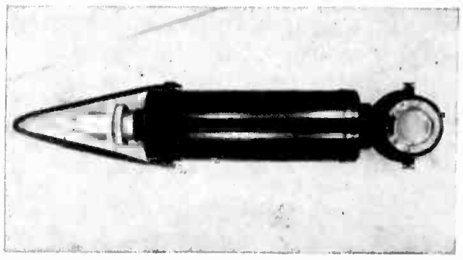
Oil-filled unit capacitors

REVERTING TO THE HANDY and economical unit form whereby any desired combination may be assembled for given capacity or kva. requirement, the Dubilier Condenser Corporation, 4377 Bronx Boulevard, New York City, has introduced a line of a.c. oil-impregnated, oil-filled capacitors available up to 660 volts. Each capacitor comprises a semi-compressed section permitting free circulation of oil to all parts for maximum dielectric strength, placed in an oil-filled container that is fully sealed against leakage. The Dubilier design of welded steel clamping members is designed to insure uniform yet moderate dielectric compression for the section, and to eliminate all of the usual difficulties and condenser failures experienced with compressed designs in a.c. circuit operation. In practice, the units may be employed singly or in groups, placed on shelves or mounted on any equipment, or placed in large steel cans.—*Electronics, May, 1932.*

✦

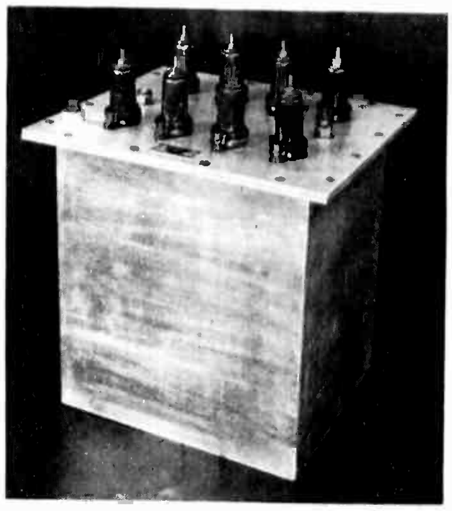
Bullet type microphone

THE CARRIER MICROPHONE COMPANY, 525 South Commercial St., Inglewood, Calif., has announced its Model No. 94 bullet-type microphone, primarily for suspended use. It is provided with bail for suspension purposes. The case is made of aluminum alloy and finished in black. It is provided with standard plug connectors and 20 feet of shielded cable. It is normally built with No. 30 tubes, although No. 64 tubes can be furnished on order. Transmitter head is equipped with barometric adjustment. Frequency response 30 to 8,000 cycles. It is built with either single or 2-stage amplifier. —*Electronics, May, 1932.*



Audio transformer

THE AMERICAN TRANSFORMER COMPANY, Newark, N. J., has developed the oil-filled audio transformer pictured which has been designed for operation at a level of + 50 db. — 600 watts. This unit is an output modulation transformer for feeding into a Class A amplifier utilizing four tubes connected in parallel push-pull. It has a primary impedance of 4,000 ohms, a secondary impedance of 5,200 ohms, and is insulated for operating potentials up to 15,000 volts. Forty pounds of special high-permeability alloy were used in its core structure and it was mounted in a welded aluminum tank with leads brought out through the cover in porcelain bushings. Tests made in "Amer-Tran's" laboratory indicate that the frequency-response characteristics of this transformer are flat from 30 cycles to 6,000 cycles and that the drop at 10,000 cycles is less than 2 db.—*Electronics, May, 1932.*



✦

Automobile speaker

VICTORY SPEAKERS, INC., 7131 East 14th St., Oakland, Calif., has developed a new speaker with outside diameter of 8 in. and depth of only 3⅝ in., which will mount in Fords on top of steering column. Field, 6 to 8 volts. The case is of heavy metal, non-resonant, with finish in antique bronze, or may be had in plain black and has been designed to meet the rough usage in autos.

The installation is simple. A standard 4 or 5-prong socket is incorporated in speaker housing. All that is necessary for connecting speaker to set, is the insertion of the standard type of speaker plug into the socket. No soldering is necessary.—*Electronics, May, 1932.*

www.americanradiohistory.com

Tourmaline crystals for high frequency control

TOURMALINE MAKES POSSIBLE crystal control at frequencies which is not obtainable with quartz. Considerable experimental work has been done on the commercial production of tourmaline blanks by Premier Crystal Laboratories, Inc., 74 Cortlandt St., New York City.

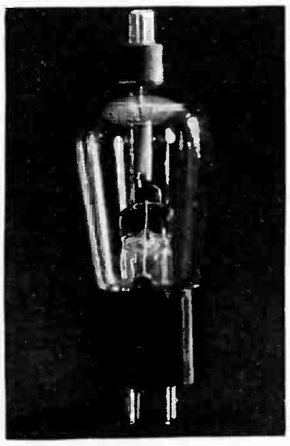
An important charactertisic of tourmaline crystal is the absence of side-tones, which are experienced with quartz on frequencies of 6 or 7 megacycles. A further advantage of importance is the higher thickness coefficient (146.25 against 112.5 for X-cut and 77 for Y-cut quartz crystals), thus making it possible to grind tourmaline crystals to very much higher frequencies than can be obtained when grinding quartz. All tourmaline crystals thus far developed are reported to have given steady output and proven to be extremely stable oscillators.

The Premier Laboratories can supply oscillating blanks and also finished crystals ranging in fundamental frequencies from $3\frac{1}{2}$ to 20 megacycles. Booklets on "Proper care of crystals" and "Instructions for grinding and finishing quartz blanks and crystals" are available and may be had by writing the company direct.—*Electronics, May, 1932.*

✦

Indirectly-heated cathode rectifier

THE THERMIONIC LABORATORIES, 10 Liberty Street, Kearney, N. J., have brought out a new rectifier tube of the indirectly-heated cathode type, known as the TL-1.



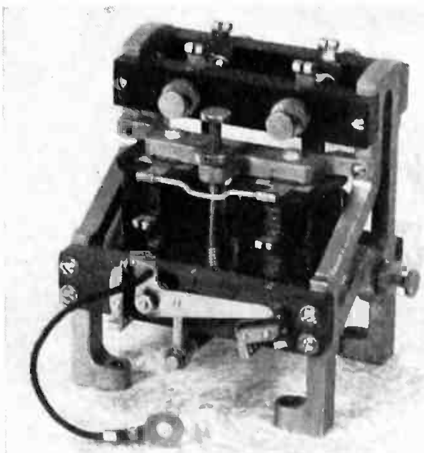
Characteristics of this new tube are as follows:

Fil. volts	2.5
Fil. current	5.0
Max. plate volts	500
Min. plate volts	24
Average plate voltage drop	10.5
Max. plate current	2.5 amps.
Guaranteed average life	3,000 hours

—*Electronics, May, 1932.*

High-hazard equipment

THE ALLEN D. CARDWELL MANUFACTURING COMPANY, 81 Prospect St., Brooklyn, N. Y., offers not only a line of variable condensers for transmitter and receiver communciation systems, but also, a line of high-hazard equipment. This service is typified by specifications which require audio transformers to withstand 48 hours of salt-water immersion followed by an immediate 5,000-volt a.c. peak voltage between winding and shell.



Break-in relay for U. S. Signal Corps transmitter, manufactured for the General Electric Company

Transformers and components meeting this and other rigid requirements, as well as a wide variety of special apparatus and components, have been supplied by this company whose products include high-hazard transmitters, receivers, wire repeater equipment, special components, etc., suitable for army, navy aircraft, and public-service wire and space systems.—*Electronics, May. 1932.*

✦

Tone control

THE NEW TYPE 3 TONE CONTROL and potentiometer made by H. H. Eby Manufacturing Company, 22d St. and Lehigh Ave., Philadelphia, has a maximum outside diameter of $1\frac{9}{16}$ in. and a depth of case of $\frac{42}{64}$ in.

The resistance element is a composition material coated upon specially prepared tough fibre and constructed so that the resistance will not change appreciably under wear or humid conditions. The enclosing case is of steel, cadmium plated to prevent rusting and to insure neat appearance. The bushing is of brass and the shaft of steel to prevent scoring and seizing.

The contact shoe is triangular and is made of nickel-silver to retard corrosive action. The design insures low hop-off resistance values due to the fact that in zero position the triangular shoe touches connection along the full length of the triangle.

A heavy bronze arm is used to provide a low resistance conducting path from center connection to contact shoe. This is made of best spring material to insure a continuously constant spring pressure on the resistance element.—*Electronics, May, 1932.*

Portable microphone boom

THE JENKINS & ADAIR portable microphone boom is designed to supply owners of newsreel and similar talking-picture recording equipment with an extremely light and portable boom for use in the field or studio. It is also useful in broadcasting studios, in orchestral broadcasts and public address work in general. The boom arm and saddle may be removed from the vertical mast, leaving a strong and rigid tripod which may be extended from 2 ft. up to 8 ft.

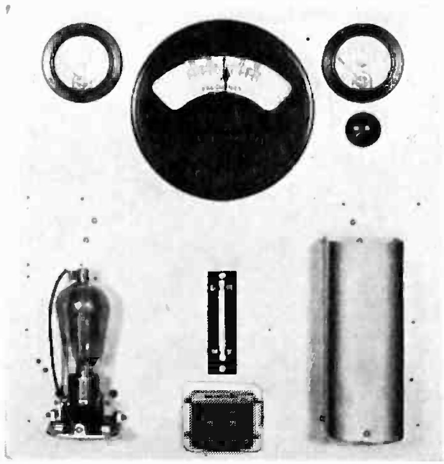
A feature of the boom is that no counter-weight has to be carried. The welded steel container becomes the counter-weight as soon as it is filled with water, sand, gravel or similar material which may be readily obtained under any conditions.

Jenkins & Adair, Inc., 3333 Belmont Ave., Chicago, are the makers.—*Electronics, May, 1932.*

✦

Precision monitoring

DOOLITTLE & FALKNOR, INC., 1306 West 74th St., Chicago, Ill., has developed this checking instrument of high order and accuracy. The temperature controlled chamber is maintained at a substantially constant value by means of a mercury column thermostat and a thyratron or grid-glow tube for heat control. The plate circuit of this tube is used to provide the heater current, thus eliminating all relays and mechanically operated contacts. There are no moving parts in the entire device except the mercury column thermostat.



The crystal supplied is ground to a frequency 500 cycles different from the frequency to be checked. Power from the standard frequency crystal is fed to a detector tube through two screen-grid "buffer" stages thus completely isolating the crystal standard from reaction from the transmitter.

Since this device employs a frequency meter of standard design, instead of depending on a combination of vacuum tube voltmeters and resonant circuits, the accuracy is dependent upon the standard crystal and the frequency meter only.—*Electronics, May, 1932.*

www.americanradiohistory.com

U. S. PATENTS

IN THE FIELD OF ELECTRONICS

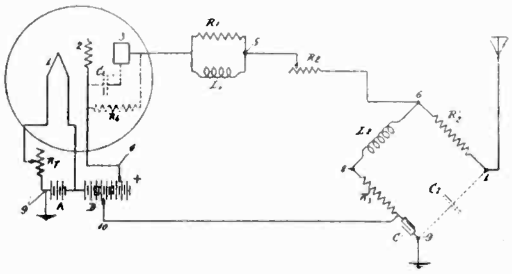
A list of patents (April 26) granted by the United States Patent Office, chosen by the editors of *Electronics* for their interest to workers in the fields of the radio, visio, audio and industrial applications of the vacuum tube

Amplification, Generation, Etc.

A method of detecting impulses. A circuit for transmitting electrical impulses in accordance with mechanical variations, comprising a normally balanced electrical circuit which is unbalanced by the variations. R. A. Fessenden, assigned to Submarine Signal Co. No. 1,854,025.

Separating desired from undesired electric current. A method of increasing the difference in current strength between desired and undesired current. E. G. Gage, assigned to RCA. No. 1,853,678.

Resistance tuned circuit. An electric circuit, responsive or self-oscillatory, comprising a serially connected inductance, capacity and variable resistance, each set at distances being approximately equal to the square root of the ratio of the inductance to the capacity. Sewald Cabot, Brookline, Mass. No. 1,853,604.



Filter system. A current supply and filter system with inductance coils in each circuit so coupled that the field generated therein by a.c. components is opposed. Benjamin Miessner, assigned to RCA. No. 1,853,217.

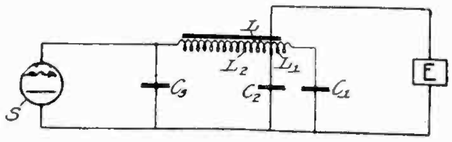
Regenerative amplifier. The input is tuned, and has coupled to it an inductance in series with a capacity and connected in shunt with the plate circuit for regenerative purposes. S. Y. White, assigned to RCA. No. 1,853,184.

Anti-regenerative circuit. Coupled to the tuned input of an amplifier is an inductance in series with a resistance and shunted across the grid filament path. S. Y. White, assigned to RCA. No. 1,853,106.

Wave transmission device. A helical spring having a length great enough to include several vibration wave lengths at the lowest frequency, a means for impressing mechanical vibration corresponding to each speed upon one end of this line, and means at the other end for converting the mechanical vibrations into oscillatory current. R. L. Wegel, assigned to B.T.L. No. 1,852,795.

Radio current supply circuit. A rectifier filter system and an acoustic device electrically connected to one of the output terminals and to the a.c. plug. W. H. Grimditch, assigned to Philco. No. 1,852,882.

Electrical filter system. A combination of series and shunt filter inductance with a mutual between them substantially greater than the shunt inductance and poled so that the resulting field is opposed. B. F. Meissner, assigned to RCA. No. 1,852,125.



Binaural transmission. Brand and Pierre Mertz, assigned to A. T. & T. Co. No. 1,854,247.

Control of oscillatory current. Use of an electro magnetic device for compensating for variations in strength of oscillatory current. Josef Hofmann, Merion, Pa. No. 1,854,259.

Tuning fork generator. Combination of a tuning fork and means for driving it comprising a coil of wire having an iron core which is midway between and parallel to the prongs of the fork. Andrew L. Matte, assigned to A. T. & T. Co. No. 1,854,267.

Perfection of electric systems. Vacuum tube amplifier and relay arranged to open a line when some fault occurs. Oliver C. Traver, asigned to G. E. Co. No. 1,854,965.

Measuring speed variation. Measuring the speed variation of a rotatable member, by producing electrical impulses whose frequency varies with the speed of the member. M. S. Mead, Jr., assigned to G. E. Co. No. 1,854,949.

Tube testing apparatus. W. M. Goodwin, Jr., assigned to Weston Electrical Instrument Corp. on circuits for testing vacuum tubes. No. 1,854,900 and No. 1,854,901.

Light beam modulating system. A method of transforming acoustic vibrations into light variations. H. Tischner and F. Klaiber, assigned to G. E. Co. No. 1,854,003.

Interference detector. A measuring system for determining the inductive interference effect that an interfering line produces in an electrostatically shielded conductor of a communication cable. J. Collard, assigned to W. E. Co. No. 1,852,769.

Hot wire measuring instrument. A measuring instrument with a hot wire and a system with several electrodes to influence the relative position of the electrodes by the hot wire. Siegmund Loewe, Berlin, Germany. No. 1,852,850.

Battery charging system. A tapering system for charging batteries. R. T. Cheeseman, assigned to G. E. Co. No. 1,852,799.

Frequency multiplier. An amplifier tube with tuned input and output circuit. Between the input tuned circuit and the grid is a condenser and a resistance across the grid cathode circuit of the tube. The values of condenser and resistance are so chosen that for substantially positive quarter of a cycle of input energy the grid of the tube is subjected to a negative biasing potential, and for the remaining three-quarters of the cycle, the charge on the grid leaks off to a negligible value. Wilhelm Runge, assigned to Telefunken. No. 1,851,408.

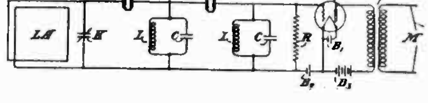
Modulating system. A method for producing photo-electric current of alternating character by subjecting the photocell to an external alternating magnetic field. Frank Gray, assigned to B.T.L. Re-issue No. 18,400.

Amplifier system. A method of selectively amplifying alternating current, comprising selectively impressing the current upon a triode, non-selectively transferring the tube output to a second tube, and selectively controlling the amplifying ability of the first tube independently of the step of selectively impressing the current upon the triode. E. H. Loftin and S. Y. White, assigned to RCA. No. 1,851,587.

Equallizing system. A method for equallizing the audio-amplification by means of an auxiliary stage of audio-frequency amplification, with circuit giving the system a dished-gain frequency characteristic, so that the entire system has a flat characteristic. R. S. Hayes, Ardmore, Pa. No. 1,851,905.

Harmonic generator. A Piezo electric governed oscillator, coupled to a second generator which produces in the output circuit additional frequencies evenly spaced between the different harmonics of the crystal generator. F. J. Moles, assigned to G. E. No. 1,851,721.

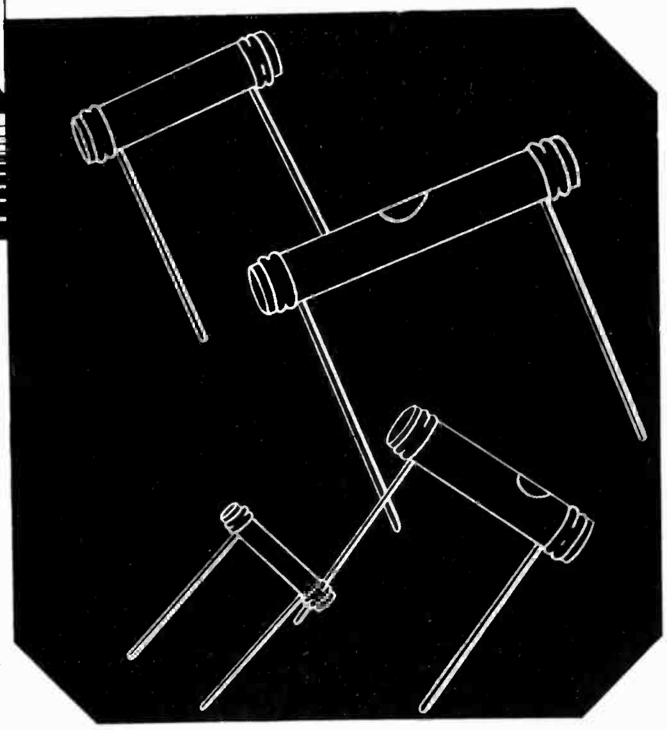
Wave filter. A combination of a means for receiving several bands of frequencies a Piezo electric wave filter, and network designed to freely transmit any desired band of frequencies while suppressing the frequencies within all other bands. C. H. Fetter, assigned to A. T. & T. Co. No. 1,851,091.



Tube checker. A device for indicating inter-element short-circuit in a triode by impressing different voltages on a meter to move the indicating element different distances upon short circuits between different pairs of tube elements. J. R. Barnhart, Lakewood. Ohio. No. 1,851,658.

www.americanradiohistory.com

Modern methods

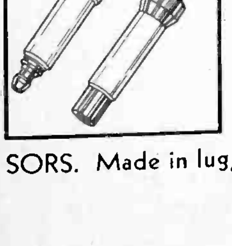


ERIE RESISTORS are made under modern conditions with modern methods.

They are in every way equal to every demand made upon them in modern production work of the manufacturers who use them.

Enjoying the enviable reputation for accuracy, ERIE RESISTORS are standard with manufacturers who are looking for excellent performance and minimum rejections.

May we send you samples and prices?



ERIE SUPPRESSORS

If you build an automobile radio set, ask for information on ERIE SUPPRESSORS. Made in lug, screw and distributor types.

ERIE RESISTORS

ERIE RESISTOR CORPORATION, ERIE, PA.
Factories in Erie, Pa., Toronto, Canada, and London, Eng.

Licenses under the amplifier patents

[*Continued from page 153*]

owners, for of course authority to license ultimately comes from the original patentee."

The amplifier patent situation it was further pointed out, is a tremendously complicated one, and sometimes study of an individual case may take months. But persons desiring licenses should make application, with the company in the corresponding field, and careful consideration will be given.

In complexity of provisions and details, next to the Treaty of Versailles or the detailed financial Reparation plans of European governments, probably comes the excessively complicated patent agreement under which the amplifier patents are administered. First formulated by the original contracting parties in 1920, and then largely revised in 1926, the text and interpretation of the elaborate agreement occupied hundreds of pages of the Federal Trade Commission's investigation into "The Radio Industry." This document, although now six years old, still stands as the clearest readily-available public statement of the complex agreement in its various manifold ramifications—although the full significance of much that was then written has since become clearer with the growth of understanding of the real possibilities of the electronic tube.

But out of the whole situation there develop at least two important conclusions to which the applicant for license privileges can well give careful consideration.

1. Licensing proceeds by fields, and the applicant for a license should determine in what field he desires to operate, and then communicate with the company or group having jurisdiction.

2. A liberal licensing policy is now in effect in several important groups, and this attitude is likely to be clarified into a clear-cut policy all along the line of amplifier applications.

✦ ✦ ✦

Photocell control of temperature

[*Continued from page 170*]

"overshoot" and uncover the aperture, which condition would act to turn on the voltage supply to the oven, and cause it to run up to its maximum temperature.

A second meter, directly connected across the oven thermocouple, is in the circuit at all times. This meter (a suitable range millivolt meter) is calibrated directly in temperature degree values and used as a means for direct monitoring of oven temperatures.

The sensitivity of this system is a function of the strength of the light source, sensitivity of the photocell and of the ratio of the scale aperture to the width of the pointer which covers it. With a focused light source of 21 c.p. and a photocell with sensitivity of 30 microamperes per lumen, and a $\frac{1}{16}$ in. aperture in a Model 301 meter, it is possible to maintain temperature values in the oven of within one-half of one per cent of the range being used.

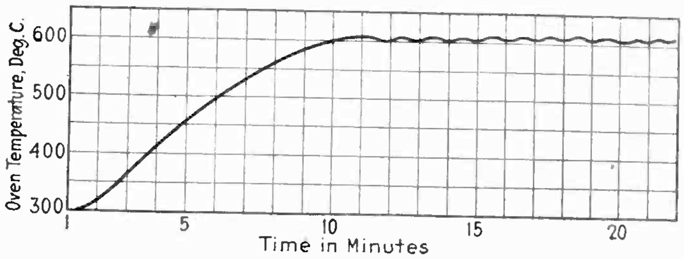


Fig. 3—Typical operation curve obtained with the apparatus

Each oven has an individual circuit similar to Fig. 2 and all apparatus pertaining to each oven is mounted on an individual panel. There are, thus, four panels for the four ovens with an additional fifth panel used for fusing and main switches.

✦ ✦ ✦

Weak signal demodulation

[*Continued from page 171*]

the very simple result that *with a linear rectifier the modulation of the weaker signal is reduced to 0.5 (W/S) of its normal value, W and S being the carrier wave amplitudes of the weak and strong signals respectively.* This result is exhibited graphically in Fig. 1.

To make an experimental check of this remarkable result, which illustrates how the detection process assists selectivity, tests were made using the linear rectifier advocated by H. L. Kirke[3] and also a cumulative grid rectifier. The circuit used in the latter case is illustrated in Fig. 2. The induced carrier wave amplitudes of the weak modulated signal and the strong unmodulated were measured by means of the "slide-back" method. The acoustic output of the weaker signal was measured by means of a tube-voltmeter. This voltmeter was read when the weaker signal was received alone and then when received in the presence of the strong signal. The results obtained were found to be in complete agreement with the theory given above.

These experiments therefore show that there is a great gain in using highly selective circuits, for, besides the action of the normal circuit selectivity, we have this very potent demodulation effect which tends to suppress to negligible magnitude the modulation of the weaker signal.

[3] *Wireless World*, 24, p. 32 (1929).

✦ ✦ ✦

Patent Suits

1,173,079, E. F. Alexanderson, Selective tuning system; 1,195,632, W. C. White, Circuit connections of electron discharge apparatus; 1,251,377, A. W. Hull, Method of and means for obtaining constant direct current potentials; 1,297,188, I. Langmuir, System for amplifying variable currents; 1,728,879, C. W. Rise, Amplifying system, D. C., S. D. Calif. (Los Angeles), Doc. E T-116-J, Radio Corp. of America et al. v. Platt Music Co. Consent decree holding patent valid and infringed Nov. 27, 1931.

1,231,764, F. Lowenstein, Telephone relay; 1,403,475, H. D. Arnold, Vacuum tube circuit; 465,332, same, Vacuum tube amplifier, D. C., S. D. Calif. (Los Angeles), Doc. E T-117-M, Radio Corp. of America et al. v. Platt Music Co. Patents held valid and infringed Nov. 27, 1931.

1,455,141, Lowell and Dunmore, Radio receiving apparatus, filed Jan. 23, 1932, S. C., D. of C., Doc. E 53937, A. S. Blatterman v. P. D. Lowell et al. Doc. E 53938, Wired Radio, Inc., et al. v. R. D. Duncan, Jr., v. P. D. Lowell et al.

1,466,777, L. Winkelmann, Radio active vacuum tube; 1,650,921, same, Vacuum tube; 1,651,308, same, Audio amplifier, D. C., S. D. N. Y., Doc. E 50/150, L. Winkelmann v. Royal-Eastern Electrical Supply Co. Dismissed on merits (notice Jan. 29, 1932).

Re. 16,870, T. H. Nakken, Means for transforming light impulses into electric current impulses, D. C. Del., Doc. E 882, Nakken Patents Corp. v. Westinghouse Electric Supply Co., Inc. Dismissed Dec. 8, 1931.

www.americanradiohistory.com