# electronics

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

A platform for radio prosperity

✦

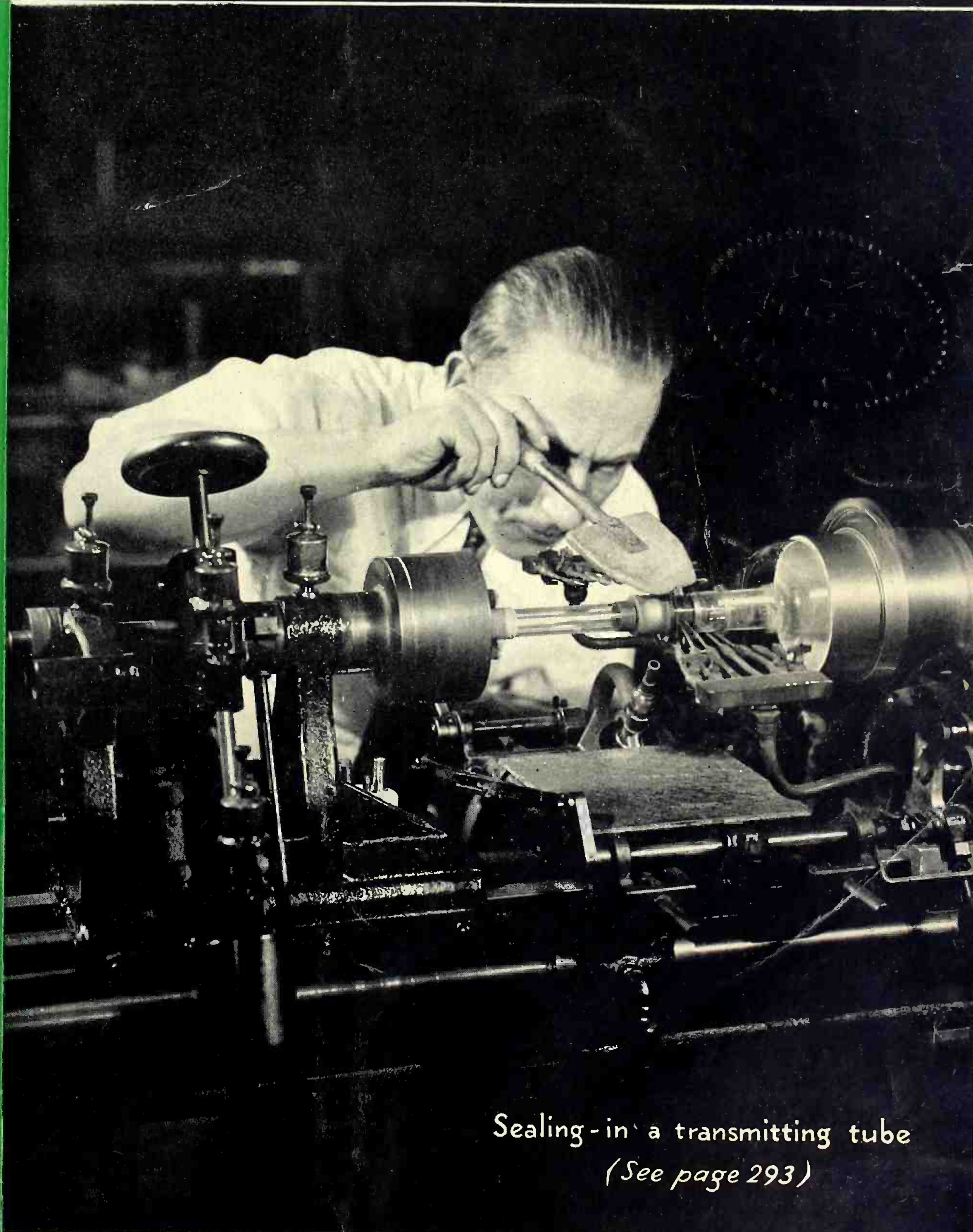
Madrid conference problems

✦

Electronic methods in commercial testing

✦

Tubes for short waves



Sealing-in a transmitting tube
(See page 293)

McGRAW-HILL PUBLISHING COMPANY, INC.

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SEPTEMBER 1932

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*Any* SET IS BETTER with BLUE ARCTURUS

# ARCTURUS

"The BLUE TUBE with the LIFE-LIKE TONE"

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# electronics

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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

## A platform for radio

# PROSPERITY

THE Radio Manufacturers Association has been reorganized. Leading set manufacturers now comprise the board of directors, and take control of the association's activities and policies. Fine enthusiasm and optimism is apparent among all concerned.

But internal reorganization of the R.M.A. is just the start.

The R.M.A.'s real usefulness to radio will come in what it undertakes for radio from now on.

Many opportunities confront the reborn association.

THERE is need to *rebuild popular interest* in radio. There is *want of cooperation with broadcasters.* A *"National Board of Strategy"* for radio could do much to aid manufacturers and broadcasters in reinforcing each other's efforts. *Standards of tone quality,* sensitivity and selectivity should be set up; conditions of *poor reception should be cleared* by a campaign of aid and education. The radio *sets in millions of homes need to be modernized.*

Meanwhile the spectre of overproduction and disastrous dumping should be laid forever; this can be done by *adequate statistics* of manufacturing and of stocks-on-hand. Factory costs need to be studied; freight rates to be clarified. Legislation is a recurrent vital problem; so are broadcasting situations growing out of federal regulation and international demands. New models and new tubes need to be controlled; destructive set advertising must be policed. And co-operative promotional efforts should now be pushed forward,—through newspapers, dealers' windows, and the air itself.

THE radio industry expects great things from the reorganized R.M.A. The recent internal shake-up accomplished, it is the fervent hope that the new directors will next speedily draft *"a platform for radio prosperity."* And speedily put it into execution.

# SHALL WE WIDEN THE

## International Radio Conference at Madrid now considering changes in assignments to services

AT THE Madrid International Radio Conference this month, the question of widening the broadcasting band to include more channels again comes up.

Already it is evident that there is a wide variety of opinion on this subject,—among broadcasters and set manufacturers, among transmission engineers and radio-receiver designers, and among American and European students of the problem.

Several different broadcasting proposals were to come before the Madrid meeting, when the international delegates convened September 3 to discuss the allocation of frequencies to various services.

The International Broadcasting Union, composed largely by European broadcasters, is recommending widening of the present band to include 540 kc., and also the authorizing of broadcasting on the long-wave bands from 150 to 285 kc., and from 370 to 460 kc. Furthermore it will urge that under conditions where marine services will not be interfered with, broadcasting shall also be permitted on the channels 540 to 460 kc. These recommendations would thus make a continuous broadcasting band from 370 to 1,500 kc. (114 10-kc. channels), in addition to some fourteen additional European channels in the long-wave broadcasting range.

### U. S. first favored short-wave extension

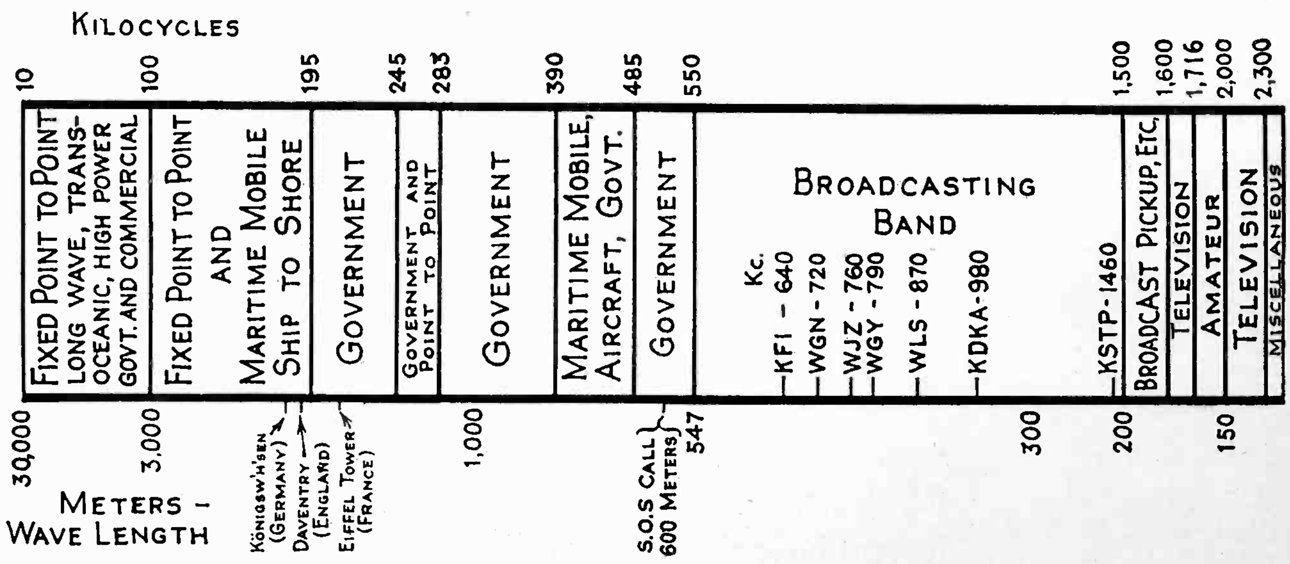
Advance proposals submitted by the United States in April, 1931, for consideration by the Madrid conference, apparently opposed extension of the broadcast band into the lower frequencies, but indicated that favorable consideration might be given to the high-frequency area, between 1,500 kc. and 1,715 kc. This would add some twenty channels to the short-wave end of the broadcasting dial. Since these advance recommendations were originally offered by the American group, however, the National Association of Broadcasters has been actively working to revise the official American position, so that extension into the high-frequency region will not be advocated by the United States delegates.

A strong group of opinion favors no change whatever in the broadcast band, pointing out that present number of channels is ample, if the number of stations is properly limited and the operation of stations is controlled through frequency adjustments with future possibility of widespread synchronizing. In support of this position it is urged that the present broadcast band has only just become crystallized and its supervision put on a sound basis. Political opinion, with an ear to the rights of the "peepul" would probably strongly oppose any change which would make largely obsolete the sets in 16,000,000 American homes.

On the other hand, manufacturing executives, looking for new developments which will stimulate new buying of radio sets, would welcome extension of the broadcast band, even though many of their engineers look with alarm upon the difficulties which would thereby be introduced into set design.

Broadcasters are divided. Those with good wavelength positions seem to feel that no change is needed, but there in a large group dissatisfied with present assignments, who think they "might get something better" if additional channels were made available. Still few broadcasters can be found who would be willing to move expensive transmitters "out onto a limb" in a section of the spectrum where there are yet no listeners' sets, in the hope of eventually attracting an audience.

And there the matter stands!




**Present broadcasting assignments and the classifications into which broadcasting might be extended**

# BROADCASTING BAND?

## Widely differing opinions of radio engineers, set makers, and broadcasters regarding extensions proposed

Advocates of the lower frequencies or longer wavelengths for broadcasting use, point out that fading and interference would be greatly reduced on these channels and that the service range of such long-wave stations would be limited only by the power used,—instead of by fading, which is now playing such havoc with reception at distances of 30 to 50 miles, after nightfall. The long-wave advocates insist that if broadcasting is to undergo periodic "mushing" and distortion over wide service areas, for a term of years at each sunspot minimum (as at present) it will be better to move broadcasting for rural service to the low-frequency channels, where the fading range is a matter of 300 miles or so, instead of 40 miles. With high-power stations (500 kw. to 1,500 kw.) on such channels, they estimate it would be possible to serve the whole continental United States with a dozen transmitters.

Opposed to this argument, is the objection that static is worse on the long waves in summertime, and would make such channels ineffective part of the year. Transmitter antennas would be more expensive, of course, and radio sets would be more complex. Band-pass tuners, now found in expensive sets, would be required in all receivers, and undoubtedly the average price of receiving sets would go sharply upwards.

### The "SOS" calling wave

Then there is the vital question of the 600-meter 500-kc. ship calling wave ("SOS") as a limitation to extending the broadcast channels beyond 550 or 540 kc. Broadcast interference could not be tolerated on this channel, so important to the safety of life at sea, and it is also unlikely that this channel can be moved for many years, even after agreement had been reached to do so, for many of the ships equipped to communicate on this wave, do not return to their home ports for years at a time. The "SOS" wave, with its buffer channels, therefore seems to offer a fixed barrier in the midst of the proposed broadcast extension. On the Great Lakes, it will be recalled, vessels now use the 750-meter wave as a calling and distress wave, but this shift was possible because there were only two nations concerned and agreement was made easy.

Extension of the broadcast band in the direction of the higher frequencies is not looked on with favor by the broadcasters, although some 1932 radio receivers reach to 1,750 kc. There is still a strongly intrenched "social sense" among broadcasters, that the longer the wavelength, the more aristocratic the assignment! Although some of the larger stations now operating in the 1,400's are getting good coverage, most station operators are firm adherents to the maxim "the better, the fewer" when it comes to kilocycles. The high-frequency waves also seem to give trouble in built-up city sections, in failing to cover regions of tall buildings.

Services that are now using the channels 1,500 to 1,750 kc., would also enter strong protest against being evicted from territory which they so recently inherited from the amateurs. The assignments now operating in this proposed broadcasting extension, according to the reallocation issued early this year by the Federal Radio Commission, are, in kilocycles:

| | | | |
|---|---|---|---|
| 1504-1512 | Guard band | 1572-1576 | State police |
| 1516-1520 | BC pick-up | 1580-1588 | Government |
| 1524-1528 | Motion-picture | 1592-1596 | Gen. experiment |
| 1532-1536 | Aviation | 1600-1700 | Television (also geophysical) |
| 1540-1544 | BC pick-up | 1704-1708 | Aviation |
| 1548-1552 | Television sound | 1712 | Police |
| 1556-1560 | Fire (marine) | 1716-1750 | Amateur |
| 1564-1568 | BC pick-up | | |

### Canada, Mexico and Cuba

The unsolved international situation on the North American continent is one compelling reason why some extension of the broadcast band may be necessary. By special agreement, the State Department has recently consented to a large increase in the number of channels to be used by Canada, and this will be at the expense of United States broadcasters. Mexico and Cuba are yet to be heard from, officially, but there seems every likelihood that these two republics to the south of us will soon demand some proportionate share of the broadcasting channels used on the continent. Of course, their regional stations can operate on channels shared with Canada, without interference. But the recent move to install 75-kw. transmitters along the Mexican border, if extended in Mexico and Cuba, whether by local or American capital, is bound to compress the existing stations in the present broadcast band, unless extension or synchronizing comes to the rescue. Already successful synchronization experiments have been in operation, and if this plan of operation can be extended to large numbers of stations on both sides of the borders, it should be possible to increase many times the present number of broadcasting transmitters.

* * *

The United States delegation to the Madrid Conference, is made up of Judge E. O. Sykes, chairman; Dr. C. B. Jolliffe, chief engineer of the Radio Commission, and Walter Lichtenstein, executive secretary of the First National Bank of Chicago.

Technical advisors to the American delegation are: Dr. Irvin Stewart, State Department; Lieut. Comdr. E. M. Webster, Coast Guard; Maj. Friedman and Lt. Wesley T. Guest, Army; Lieut. Comdr. J. R. Redman, Navy; Dr. J. H. Dellinger, Bureau of Standards; H. J. Walls, Airways Division, Department of Commerce, and Gerald C. Gross, Radio Commission.

The Radio Manufacturers Association will be represented at Madrid by Paul B. Klugh, general manager of Zenith Radio Corporation, and B. J. Grigsby, president of the Grigsby-Grunow Company, both of Chicago.

# New forms of short-wave tubes

By I. E. MOUROMTSEFF
G. R. KILGORE and H. V. NOBLE

*Westinghouse Research Laboratories*

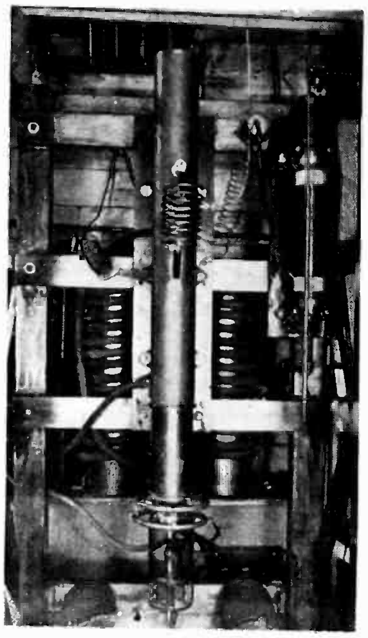
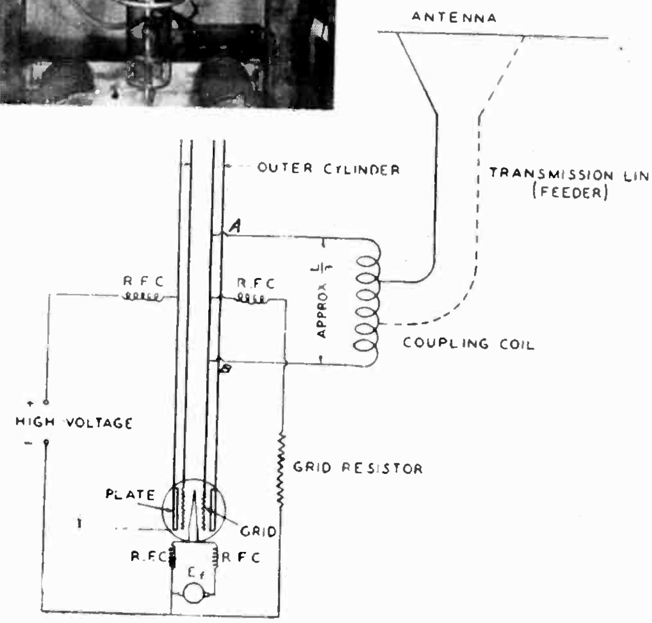


Fig. 1 — Standing wave oscillator for 3-meter work

Fig. 2—Method of feeding power from standing-wave oscillator to load




NUMEROUS practical applications of ultra-short waves were suggested during the last few years. This advanced a new problem in the high frequency engineering art: development of tubes and circuits for wavelengths below 8 meters. The fact is that the limitations inherent in the conventional power tubes and circuits make them refuse to oscillate at ultra-high frequencies, or they deliver too low a power and have a poor efficiency. The cause is clear. The natural way to increase the frequency of a conventional oscillator is to decrease the lumped capacity and inductance of the oscillating circuit.

Physical limits are defined by $C$ equal to the inter-electrode capacity of the tube, and by $L$ equal to the minimum inductance of the conductors connecting plate and grids outside as well as inside the tube. Therefore, tubes specially designed for ultra-short waves must have electrodes of comparatively small area, and a structure short in the axial direction. This results in limiting the power dissipation allowed for a tube; hence, the limitation in power output. The difficulty of securing large outputs from ultra-short wave tubes is further augmented by the comparatively low efficiency, which rapidly decreases as frequency increases, because of various losses in the tube and circuit. Thus, large tubes with a large inter-electrode capacity cannot be used for generating waves below 7 or 8 meters, while tubes with small capacity, due to their size, are limited in power output.

## A standing wave oscillator

However, one can find an interesting solution of the problem in such a way that the large inter-electrode capacity of a tube is no longer objectionable and has no influence on the frequency of oscillations generated by the tube. One must simply replace the conventional oscillating circuit, consisting of a lumped capacity and inductance, by a portion of a transmission line made of two concentric cylindrical conductors, having capacity and inductance uniformly distributed all over their length.* It is known that the oscillating energy of a generator fed into a transmission line of infinite length can readily be propagated along it, no matter what the frequency of oscillating energy is, from extremely high to extremely low values. In the case of a finite length of line with no terminating impedance across the far end, the electric waves are totally reflected from the latter, which gives rise to the phenomenon of standing waves along the conductor. Now, let us imagine that a tube is attached to a concentric transmission line so that the outer pipe forms an extension of the cylindrical anode, while the inner pipe is a continuation of the cylindrical grid. As soon as voltages are applied the tube starts oscillating at the natural frequency of the system, or at $\lambda = 2L$. Phase relations are such that the reflected waves, both on the outer and inner conductor arrive at the plate and grid in the proper phase to sustain oscillations, once they are started. By making the length of a transmission line equal to a half of the wavelength desired one can build a standing wave oscillator for very short waves, using large tubes, without worrying about their inter-electrode capacity. In this case the tube actually becomes a physical part of the transmission line, and the quantity $\sqrt{L/C}$, which is the characteristic impedance of the transmission line becomes of primary importance. $L$ and $C$ are here inductance and capacity per unit length of the transmission line. For an efficient propagation of energy back and forth in the transmission line, without unwarranted additional reflections, $L/C$ must be constant along the whole line, i.e., $L/C$ must be the same for the tube and for the rest of the line. In the particular case of concentric cylinders, $L/C$ depends only on the ratio of diameters of the inner and outer conductors, and for the tube, on the ratio of the grid and plate diameters.

Fig. 1 shows a picture of a standing wave oscillator for 3 meters. A similar transmitter was built also for 5 meters. It is almost 1 meter long; its plate-to-grid

*The original idea of this was first suggested by Mr. C. A. Boddie, formerly with Westinghouse Electric & Mfg. Co.

capacity amounts to 25 μμf. Particular features of the tube are: introduction of the filament and the grid from the opposite ends of the tube, and a highly symmetrical structure of the grid, having a re-entrant thimble support with a tubular outer connector, both of the same diameter as the grid itself. The copper anode is 3 in. in diameter; it is cooled by flowing water and can easily dissipate 25 or 30 kw. The water jacket 5 in. outside diameter fits tightly the outer cylindrical conductor of the oscillator, also 5 in. in diameter. The grid is connected to the inner pipe by means of a tapered conductor for avoiding sudden changes of the cross-section of the conductor. The ratio of diameters of the pipes and of the anode to the grid diameter is 2:1.

The filament consists of 3 half-pin loops and, for a proper heating, requires 150 amperes and 15 volts. The plate voltage and the grid bias are supplied through the middle points of the respective conductors which are at zero r.f. potentials and, therefore, there is no urging necessity in placing r.f. chokes into d.c. leads. A self-biasing arrangement can be used alone or together with a d.c. generator.

The oscillator just described produces vigorous oscillations and radiates but little energy because of the enclosed arrangement of the transmission line. A load circuit can be located at any distance from the oscillator and coupled to it by a single or double-wire transmission line. The latter can be energized by attaching it directly to the outer or to the inner pipe. Or, instead of connecting directly, one can couple the feeder line to a coil, or else a small tank circuit placed across the central portion of the oscillator. Such an arrangement is more flexible, as by changing taps on the coil, one can better match the feeder impedance to the optimum dynamic characteristic of the tube.

Fig. 3 gives the experimental curves of the output and efficiency for a 5-meter and a 3-meter oscillator. An output up to 15 kw. can be secured, and this figure must not be considered as an ultimate limit.

By using two tubes in a push-pull arrangement, the output can be doubled.

## Other forms of short-wave oscillators

By making use of the oscillatory motion of electrons, one can generate oscillations of very high frequencies, which are in this case governed by the "flying time" of electrons between the filament and the anode. Actually,

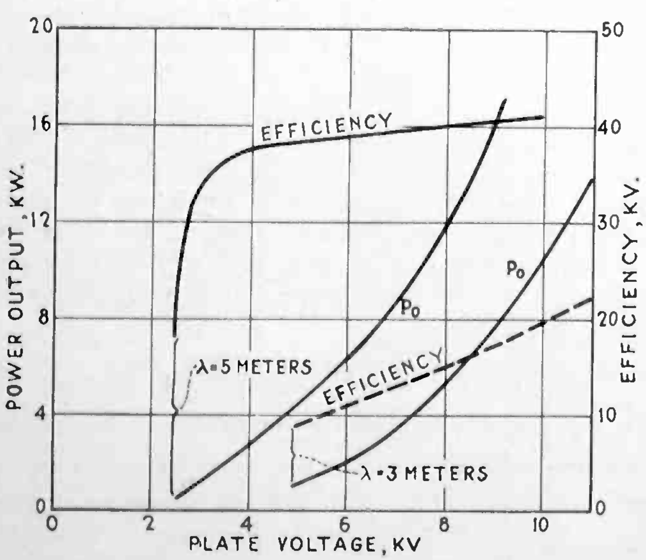



Fig. 3—Output characteristics of three- and five-meter oscillators

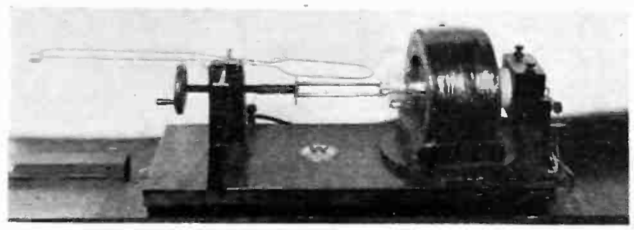


Fig. 4—Magneto-static oscillator for waves of the order of 50 cm.

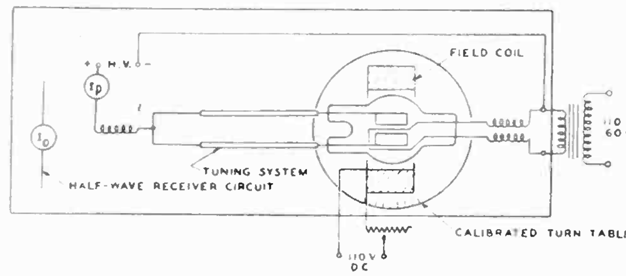



Fig. 5—Circuit used with magneto-static oscillator

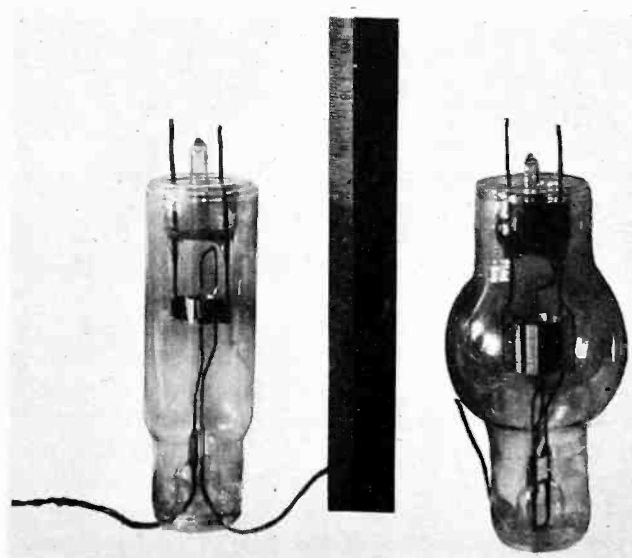


Fig. 6—Two types of tubes with split anodes for very short waves

such a method allows the generation of waves less than 1 meter long. The well-known Barkhausen generator is a representative of such oscillators. Employing two standard UX-852 tubes in a push-pull arrangement, it was possible to produce 67 cm. waves with about 5 watts output.[1]

A magneto-static oscillator is another example of an electronic generator which will now be discussed. A general view of the magneto-static oscillator is shown in Fig. 4, the circuit in Fig. 5 and two tubes used in connection with it in Fig. 6. The anode of a magneto-static oscillator is usually split into two or more sectors, each supported by a straight tungsten rod, the rods being parallel to each other and sealed through the glass envelope. The anode of the larger tube is 2.5 cm. in diameter and 2.5 cm. long; of the smaller tube, 1.25 cm. in diameter and 1.25 cm. long. The anode supports are extended outside the tube by a pair of parallel leads, adjustable in length, and having their far ends shorted by a heavy cross piece. The high voltage is supplied to both halves of the anode at the midpoint of the

[1]A paper by Dr. H. Kozanowski of this Laboratory presented before the April 1932 I.R.E. Convention.

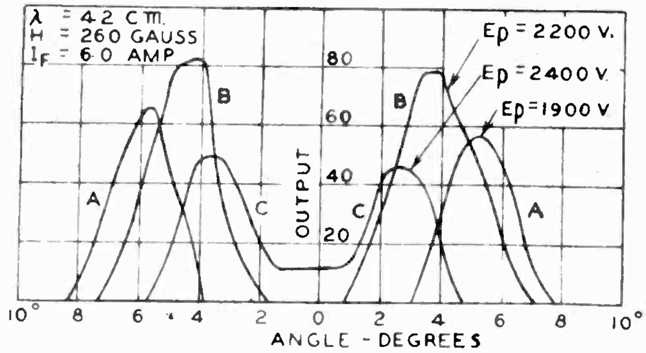



**Fig. 7—Relation between output and angle between tube and magnetic field**

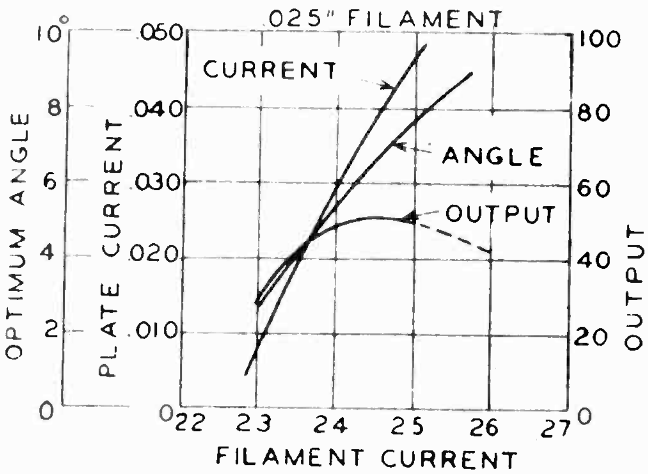



**Fig. 8—Characteristics of magneto-static oscillator**

shorting cross piece. A single-strand tungsten filament, 0.025 cm. or 0.043 cm. thick, is located exactly in the axis of the anode. The tube is placed inside a magnet coil so that the angle between the tube axis and the direction of the magnetic field can be varied within approximately $\alpha = 15°$.

The physical principle underlying the performance of a magneto-static tube is similar to that of a magnetron.[2] However, self-control of oscillations, instead of control by the h.f. component of the magnetic coil, is effected by the oscillating voltage between the two halves of the anode (one may say that each half alternately plays the rôle of grid with respect to the other half). Moreover, the frequency of oscillations is determined not by the characteristics of the oscillating circuit, but by the motion of electrons on their flight in curved paths from the filament to the anode. The rôle of the longitudinal slots is that of creating a strong electrostatic field at the edges of the anode sectors. This electrostatic field gives an impulse to the electrons which have already reached the vicinity of a slot in their tangential flight, which accelerates the electrons toward the plate and compels some of them to land on a sector with lower h.f. potential, thus increasing the output. Calculations[3] and experimental investigations[4] show that for a magneto-static tube there is a definite relation between the duration of a cycle, $T$, and the "flying time" of an electron to be given by $T = at_o$, where $a$ is a constant approximately equal to 2. The dimensions of the output circuit have no influence on the frequency of oscillation, but the output is strongly affected by it. For an optimum condition the length of the whole system, including the anode, must be adjusted to approximately $\lambda/2$, where $\lambda$ is the generated wavelength.

In 1928, Professor Yagi[5] and later Okabe[6] noticed that from a magnetron, adjusted to that critical condition, at which the magnetic field and the plate voltage are such that most of the electrons just miss the plate, weak oscillations of an extremely high frequency can be observed. The intensity of oscillations can be increased by splitting the anode into two sectors. Further investigations in the Westinghouse laboratories have shown that the intensity can be enormously increased, if the tube is located so as to make a small angle with the magnetic field. The optimum angle usually from 2° to 10° exists on either side of the "zero position"; the latter corresponds to the tube axis being exactly parallel to the magnetic field. Its value depends on almost all of the factors governing the oscillations; i.e., plate diameter, position and width of slots, plate voltage, filament emission and filament diameter (the last two factors influence the space charge in the vicinity of the filament). Fig. 7 shows the tube output as function of the angle for three different voltages. Fig. 8 gives the variation of the optimum angle as a function of the filament current. However, the density of the magnetic field, if varied alone, has no influence on the value of $\alpha_o$. The effect of the angle must be considered as emphasizing the influence of the slots. Indeed, the transverse component of the magnetic field causes a drift of electrons in the axial direction of the tube. Thus, the electrons move during a longer time in the strong electrostatic field at the slots, which evidently compels a greater number of electrons to fall on the proper half of the anode. It is possible that, in addition to the above explanation, the angle also governs the "end effect" of the anode as a whole.[7]

A typical set of operating conditions for the tube with 25 cm. anode and 0.25 mm. filament is as follows:

| | | |
|---|---|---|
| Magnetic field | 250 | gauss |
| Plate voltage | 2,200 | volts |
| Plate current | 0.050 | ampere |
| Filament current | 5.8 | amperes |
| Filament voltage | 2.2 | volts |

With these conditions a wavelength of 42 cm. is produced with about 10 watts total output, from which 7 watts can easily be utilized in a load resistance, or in a radiating antenna coupled to the oscillating circuit by a transmission line. By changing the plate voltage, and readjusting the circuit, the wavelength can be varied from 35 to 55 cm. with a certain decrease of the maximum output obtainable with the 42-cm. wave which is the optimum wavelength.

For different bands of frequencies, the tubes must have different anode dimensions. Thus, with a 1.25 cm. anode, the best conditions are at a wavelength of about 22 cm. By further reduction of the anode dimensions, one can produce still shorter waves, 12 or 10 cm., with a reduced output. The main difficulty in building an oscillator for such short waves lies in supplying a sufficiently strong magnetic field.[8]

[2]L. W. Chubb, Patent No. 1,565,416 Feb. 1921. A. W. Hull, Phys. Rev. 18, 1921. A.I.E.E., Sept. 1921. F. W. Elder, I.R.E., April 1925.

[3]A paper by Dr. W. Dehlinger of this Laboratory, presented before *Am. Phys. Soc.* in Feb. 1932.

[4]A paper by G. R. Kilgore of this Laboratory, presented before the April 1932 Convention of the I.R.E. [5]H. Yagi, I.R.E., June 1928. [6]H. Okabe, I.R.E., April 1929; K. Okabe, I.R.E. October, 1930.

[7]H. E. Holman, Physikalische, Vol. 8, 1931.

[8]Okabe, I.R.E., April, 1929.

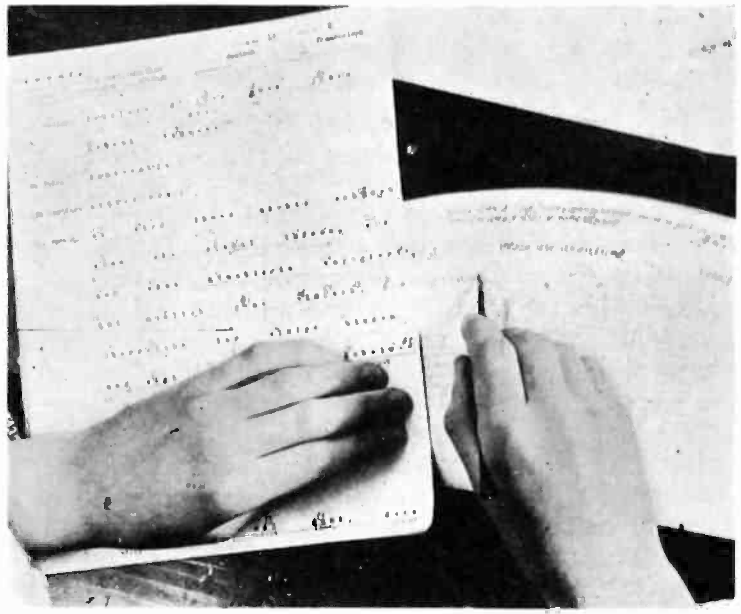
**This article is taken from papers delivered before the International Electrical Congress, Paris, July 4 to 12, 1932.

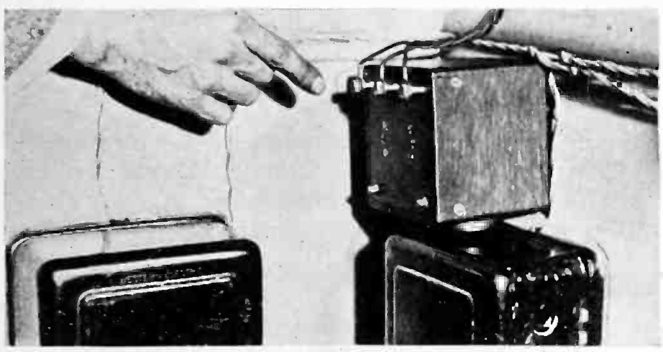
Some novelties in

# Sound recording

At left, the recording element of new "automatic secretary" developed by Loftin-White Laboratories, New York City, for recording telephone conversations without electrical connections. The pick-up coil is shown below. Placed near ordinary bell-box, it utilizes leakage flux from open-core repeating-coil in box, giving both sides of conversation. Similar disk recorders are employed in new "talking night letters"

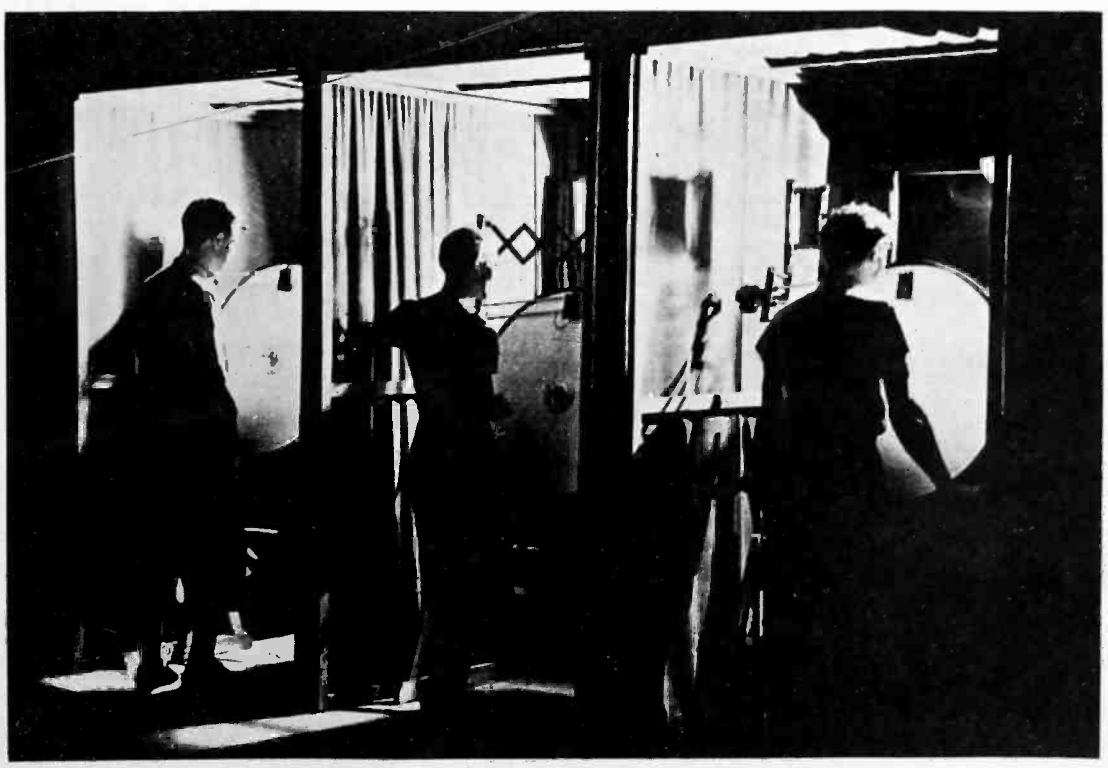
Disc-recording mechanism



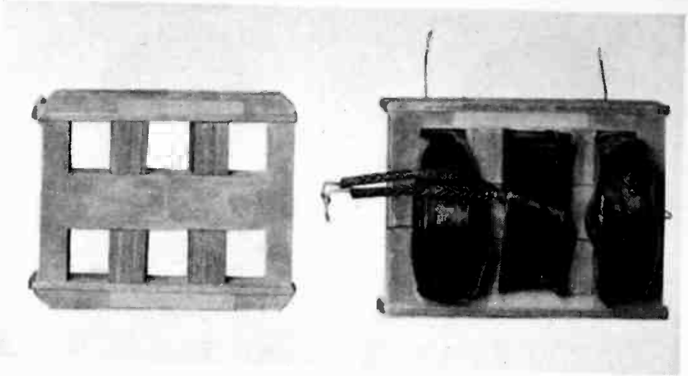


Pick-up coil alongside bell-box

The method of recording a foreign-language dialogue onto an existing film, is shown at right in these pictures of "dubbing" booths of the Jofa Studios. The foreign words must be carefully chosen and arranged to correspond to lip-movements and timing in film. The new words are then laid out on rotating disks, from which the three actors read with exact timing, in synchronism with the film "action"



# Transformers for gaseous discharge tubes



Assembly of balanced high voltage sign transformer showing core with magnetic shunts

By RUSSELL F. TRIMBLE

*Chief Engineer,*
*Beacon Neon Corporation*

THE recently coined appellation "electronic engineer" seems to be singularly apt and expressive of those whose activities are directed toward the development and application of apparatus employing the energy of controlled electronic phenomena. Under such a definition it would appear reasonable to include those engineers who are studying and developing the art of gaseous discharge tubes. The problems confronting those working on the development of vacuum tubes and those working on the development of gaseous tubes are, in the main, very similar. Both are confronted with problems of metallic disintegration under electronic bombardment; both have to give considerable time and thought to matters of glass technique and the production of high vacua; the purification of gases is important to each, while the phenomena arising from such secondary causes as ionization potential, threshold potential, saturation current, negative resistance, internal capacity, and many more, are mutually met with.

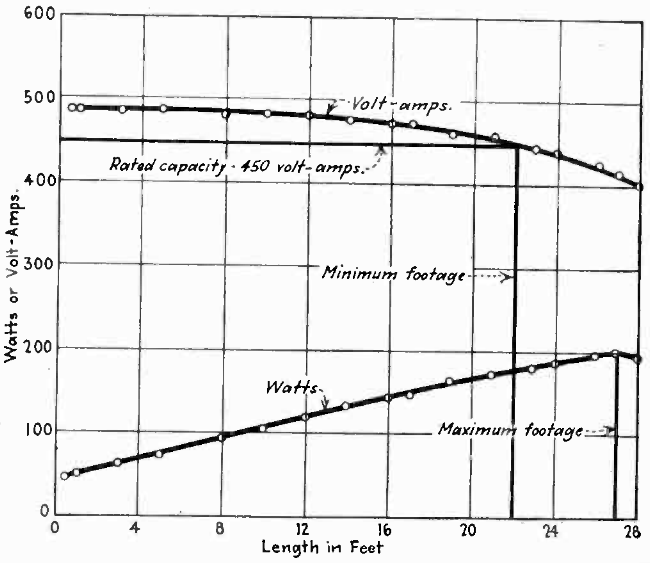



**Fig. 1—Gaseous tube load: 7 mm. diameter; gas used, neon; electrodes, nickel cylinders $1\frac{1}{4}$ in. by $\frac{1}{2}$ in. by 0.008 in. wall**

There are, likewise, many divergent problems peculiar to each line of endeavor. One striking difference being that the vacuum tube is in general a low potential device, while the gaseous discharge tube is in general a high potential device—and herein lies much of the grief of the neon sign manufacturer.

It is not our purpose to recall the history of the art. The reader is already familiar with the Geissler Tube which was the father of the art and the Moore Tube which was the first successful commercial application of gaseous tube illumination. And surely we are all familiar with the more recent application of the rare gases—neon, helium, etc.—to the Moore system of letter bending and used so extensively in advertising signs.

### The transformer problem

One of the most troublesome problems encountered in the neon sign field is that of assigning the proper transformer to each circuit. The number of circuits in each sign is dependent upon the amount of glass tubing used. A large sign will have 10 or more circuits, i.e., 10 or more separate groups of various lengths of glass tubing each requiring a separate transformer. These transformers are all fed in parallel on the low-tension side while their output, or high-tension side, is fed directly to a group of tubes which are connected in series across the high tension. Neon transformers have been more or less standardized, by the various manufacturers, as to their output voltages—which range from $1\frac{1}{2}$ to 15 kilovolts—and output currents which are limited to 15, 25 and 50 milliamperes in operation. The illustration shows a typical neon sign transformer core with the magnetic shunts which cause the device to act as a constant current transformer. On the assembly of coils on core, note that the high-tension winding is evenly divided into two coils and assembled on either side of the primary coil. The center point of the high-tension winding is grounded to the case, which in turn is grounded to the metallic sign, thus reducing the electrical stress on all insulators used.

To properly assign a transformer to a given tube circuit one must not only know the operating characteristics of the transformer (which are supposedly given on the name plate of the transformer) but also the operating characteristics of the tubing to be lighted. Here we meet with so many variables that it is quite out of the question for the manufacturer of the transformer to instruct the sign builder as to how many feet of tubing may be efficiently operated on the various standard sizes of transformers. These tube variables are: (a) the size and type of electrodes used, (b) the kind of gas (or gases) used, (c) the pressure of gas in the tube, and (d) the inside diameter of the glass tube. These multiplied out give us about 150 tube variables and this, together with about 24 different standard sizes of transformers, results in a total of 3,600 combinations. For each of which one should plot a curve similar to Fig. 1 to be fully equipped to meet any possible conditions which might arise. Probably no one has undertaken this task, to date, but after having plotted upward of 300 such curves the author has found many unexpected and interesting peculiarities of both tubes and transformers.

### Effects illustrated from practical experience

As an illustration let us consider the four curves, which represent graphically the operating characteristics of two identically rated transformers, of different manufacturers, operating on two different types of gaseous tubes. These transformers are each rated as follows: Primary, 110 volts—60 cycles— 450 volt-amperes full load. Secondary, 15,000 volts—30 milliamperes short circuit—25 milliamperes operating current. Note, throughout the tests the primary voltage was kept constant at 110.

In Figs. 1 and 2 the same tubing was used to obtain the data. This tubing was 7 millimeter outside diameter, filled with neon gas to a pressure equivalent to 15 millimeters of mercury, using cylindrical nickel electrodes $\frac{1}{2}$ in. diameter by $1\frac{1}{4}$ in. long.

It will be observed that in the case of transformer of Fig. 1 the efficient operating range lies between 22 ft. and 27 ft. If this transformer is loaded with *less* than 22 ft. of tubing, its volt-ampere curve rises above its rated capacity of 450 volt-amperes. It may be objected here that if the transformer is well designed it should be able to stand a 10 per cent overload, and indeed it will for short periods, but, the sign manufacturer has no control over the operating conditions of a sign and so it would be a grave mistake to install a sign with a transformer overloaded. Many signs operate 24 hours a day and some signs have been in continuous operation for more than 24,000 hours.

As a matter of fact, the transformer of Fig. 1 was later put on a life test with a load of 16 ft. of this same tubing, showing a load of 473 volt-amperes (5 per cent overload) and at the end of 306 hours most of the compound had melted out of the case. The necessity of keeping well within bounds if trouble and service calls are to be avoided is apparent.

### Importance of testing before installation

The point of overload due to *too little* footage of tubing has been stressed as this is an error made very frequently where the completed signs are installed without the benefit of electrical testing with meters—as is the common custom in the large majority of sign shops.

Referring to Fig. 1, the maximum footage is seen to be 27 ft.—which is determined by the location of the knee of the curve showing the load in watts. Beyond this knee the transformer falls off in efficiency very rapidly and at 28 ft. the curve ends, indicating that at this footage the light begins to flicker. If this transformer were sent out operating on $27\frac{1}{2}$ ft. of tubing it would give satisfactory results, *provided* the line voltage never dropped below 110. This, of course, cannot be assumed, and therefore it is the usual practice to limit

[*Please turn to page 289*]

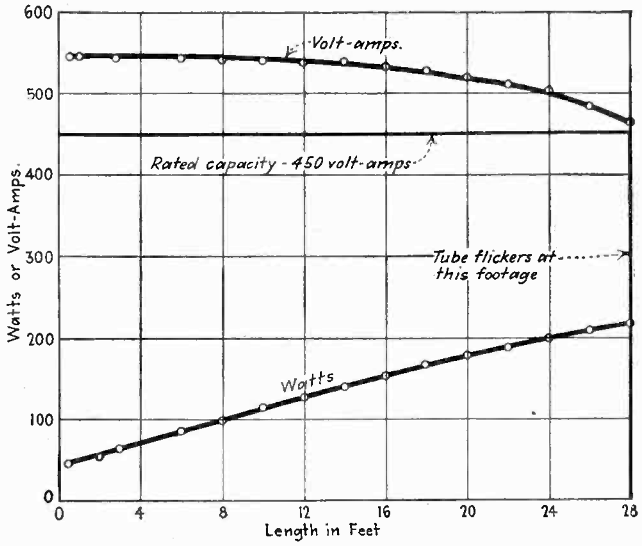



**Fig. 2—Transformer from another manufacturer used with same tube as Fig. 1**

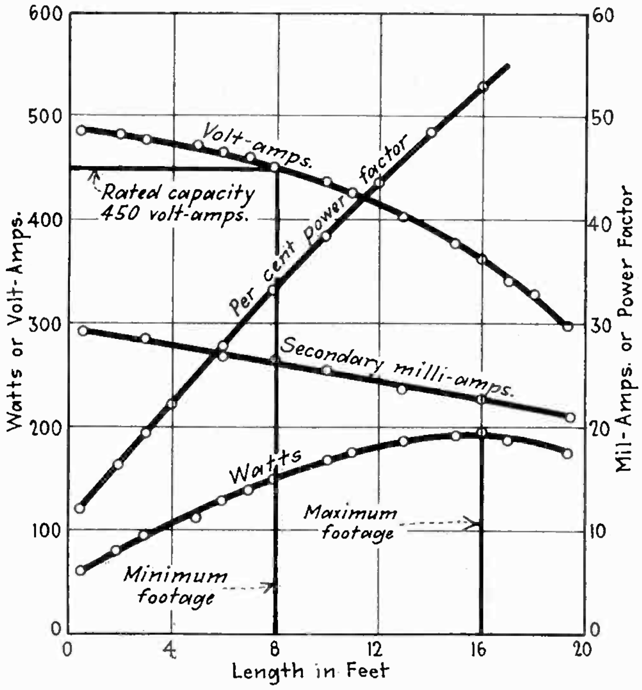



**Fig. 3—Transformer of Fig. 1 with helium tube 12 mm. in diameter, electrodes same as Fig. 1**

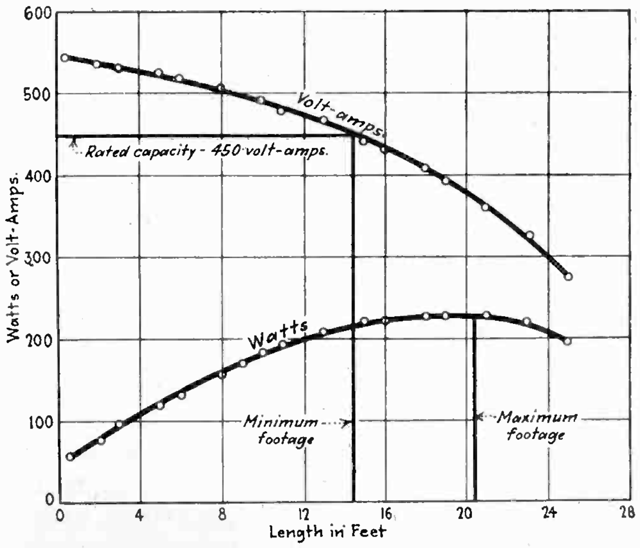



**Fig. 4—Transformer of Fig. 2 with gaseous tube of Fig. 3**

# Electronic devices in a testing laboratory

By DR. CLAYTON H. SHARP

*Vice-President, Electrical Testing Laboratories New York City*

ELECTRONIC devices have found a wide and varied field of usefulness in connection with the work which a testing laboratory is called upon to do. Not only have these devices enabled many of the operations of testing to be carried on with greater ease and with higher precision than was possible with the methods not employing them, but tests and experiments have become possible which were out of reach of possibility by the older methods.

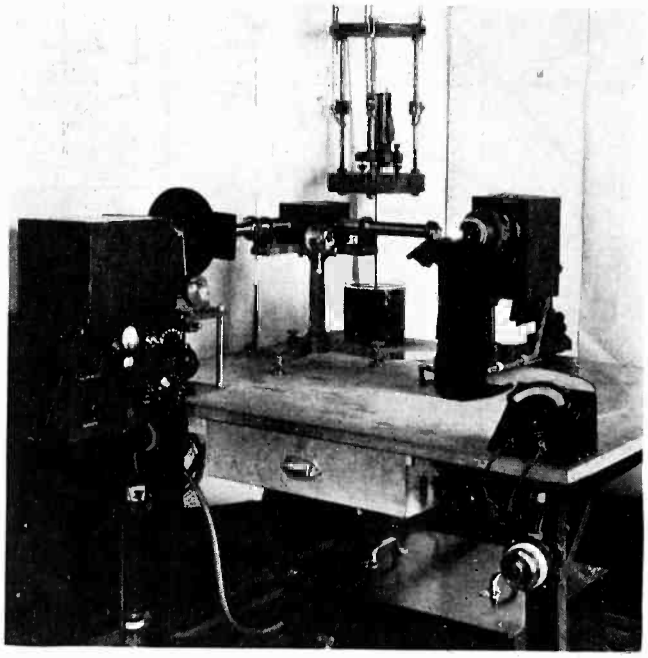


**Fig. 1—Spectrophotometer with photoelectric cell**

Through amplification the range of electrical measurements has been widely extended; through high-frequency oscillators a field previously unoccupied has been opened up; through photo-sensitive devices the methods of measurement have been improved and phenomena not previously directly observable have been brought within the range of experimental determination. In other words, a very powerful instrument has been placed in the hands of the workers in a testing laboratory and these workers, because of their experimental skill, are in a position to perceive and to realize the possibilities of its application. A partial listing of the applications actually made of electronic devices in a testing laboratory will serve to illustrate what is meant.

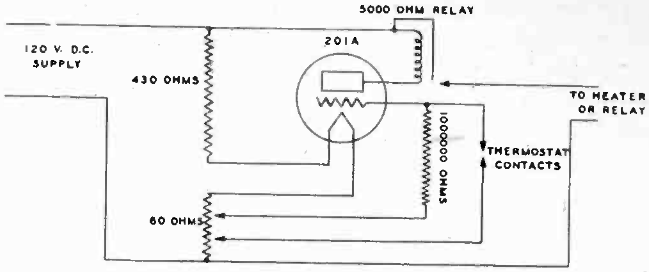



**Fig. 2—Temperature control bimetallic strip and amplifying tube**

First of all may be noted the use of the vacuum tube as a converter of electric current in the generation of oscillations of either the low frequency or the high frequency range as required for measurements of capacity, inductance, a.c. resistance and power factor in connection with the measurement of testing of condensers, audio and radio frequency transformers, reproducers, material, etc.

Extra high-frequency oscillators (1,000 to 2,000 kc.) are used to excite the gases in incandescent lamp bulbs. The lamp to be excited is held in the hand and brought close to the ungrounded terminal of the oscillator. A luminous discharge is then produced in the bulb of the lamp. The color of the discharge is an indicator of the composition of the gas and the appearance of the discharge streamers is indicative of the gas pressure.

## Amplifiers as aids to photometry

Amplifiers are of great utility in detecting small currents and making them observable either with a telephone or vibration galvanometer or otherwise. Very important applications are made in the field of photometry where the photoelectric cell combined with an amplifying train has very largely superseded the old kind of visual photometry with a resultant increase in speed and accuracy of work. In this connection the caesium coated photoelectric cell is most commonly employed since it has a spectral-response curve which is not so far removed as that of the human eye but that the interposition of suitable filters enables lights of somewhat differing color to be compared with each other.

In one method (See Fig. 2, p. 244, *Electronics*, August, 1930) the light of the lamp to be measured passes through a color-correcting filter to the photoelectric cell. The cathode of this cell is connected to the grid of an amplifying tube which, with another tube and two resistors, forms a bridge. The bias of the grids of both tubes is adjustable. In operation the bridge is adjusted to zero deflection of the galvanometer with the photoelectric cell dark. This adjustment is made with the adjusting bias on the right-hand tube, while the slider of the potential divider on the measuring bias is at the extreme right-hand position, which corresponds to zero on a scale. A standardized lamp is used for the purpose of establishing the calibration of the scale on the potential divider. That is, with the slider set at the point on the scale corresponding to the standard value of the lamp the current through the potentiometer is altered until the galvanometer again rests on zero. These two adjustments having been made, the light of an

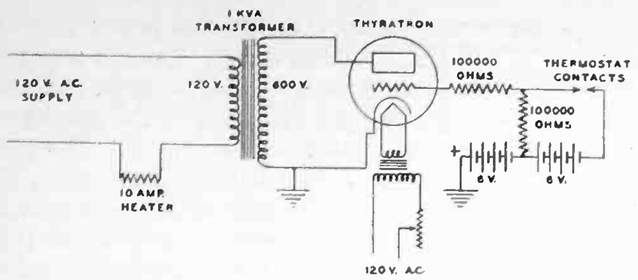



Fig. 3—Temperature control Thyratron and toluol thermostat

unknown lamp may be balanced by shifting the slider and reading its position on the scale. The accuracy of the result depends upon the linear response of the photoelectric cell to the light falling on it, but is unaffected by any critical adjustments of the measuring bridge.

In another system (See Fig. 3, p. 244, August, 1930) the photoelectric cell is made to take the place of the eye in the ordinary photometer, that is, to balance the light from a lamp being tested against the light from a comparison lamp which moves along a scale calibrated to read in photometric units. In ordinary photometry this is done by having two juxtaposed fields which are balanced in brightness by the eye. With the photoelectric arrangement this balancing is done by successive exposures of one lamp and the other to the photoelectric cell. A glass disk, one-half of which is silvered, is placed at 45 degrees to the beam of the test lamp and of the comparison lamp and is rotated by a motor. This results in allowing the light from the two lamps to pass in succession to the photoelectric cell. This is connected to an amplifying train, in the output circuit of which a transformer is connected. The secondary of the transformer has a tap at the midpoint of its windings. The end connections of the transformer go to a contactor which is driven by a cam on the shaft of the rotating mirror and which connects in alternation first one lead and then the other into the circuit closed through a galvanometer to the middle tap of the transformer. If one light is stronger than the other the galvanometer is deflected in one direction and if the other light is stronger the galvanometer deflects in the other direction. Hence, when by moving the comparison lamp a point is found such that the galvanometer stays on zero, the two lights are balanced and the photometric setting has been obtained.

The arrangement described above is used also in connection with the matching of color of incandescent lamps for the purpose of determining their color temperature. Instead of the glass disk half silvered, a disk made up of halves of red and blue celluloid is used. If these colors are properly selected and a proper photoelectric cell is selected to go with them, the responses will balance each other when light of a certain hue or color temperature is passed through the rotating disks.

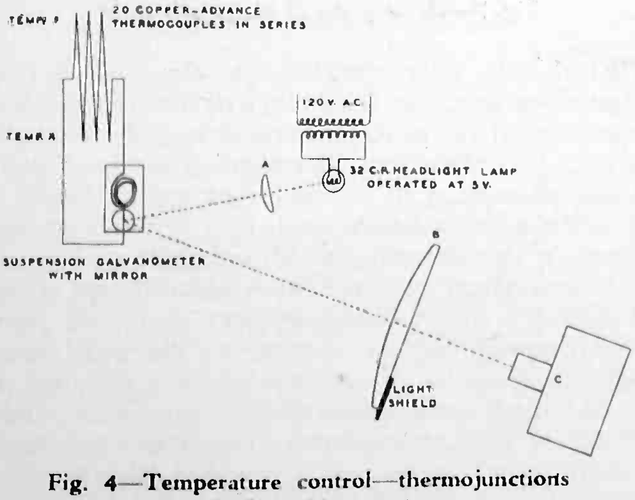



Fig. 4—Temperature control—thermojunctions and photoelectric relay

The color temperature of a lamp changes as the impressed voltage changes and with properly selected elements a voltage may be found at which the light of the lamp balances the apparatus. If another lamp is substituted for the first it will also balance at the same color temperature. If a balance is required at another color temperature this may be obtained by introducing a colored screen in the path of the beam. Thus if an amber colored screen is put in, the voltage of the lamp and its color temperature must be raised to obtain a balance. To cover the entire range of practical color temperatures in lamps an amber color wedge is provided. The operation is as follows: A test lamp, the color temperature of which is to be determined at a given voltage, is allowed to illuminate the apparatus and the wedge is displaced until the galvanometer registers zero. This lamp is then removed and a lamp standardized in terms of color temperature is put in its place and the voltage is determined at which the balance is once more obtained. From the calibration curve of the standardized lamp its temperature at that voltage is ascertained and this gives the color temperature of the test lamp. The apparatus is quite sensitive so that differences in color temperature of the order of one or two degrees may be detected. A difference of five degrees can be measured with satisfactory certainty. Considering that with a tungsten lamp a voltage difference of one volt corresponds roughly to ten degrees color temperature, it will be seen that the differences in hue which are detectable and measurable in this way are extremely small.

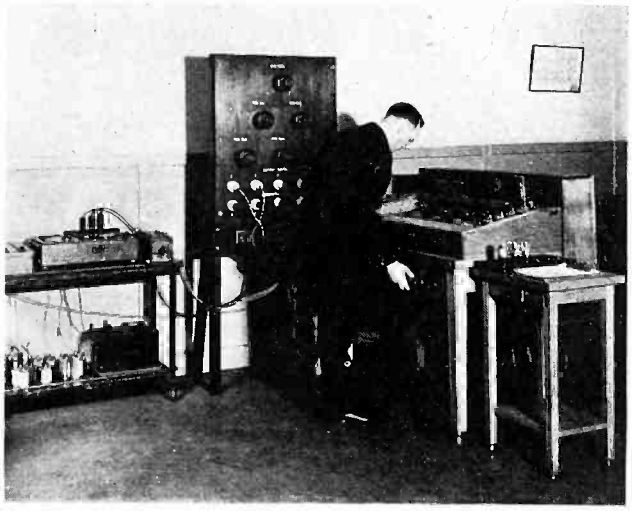


Fig. 5—Measurement of characteristics of radio tubes

In the domain of spectrophotometry and radiometry the photoelectric cell has an important field since by a substitution method the response given by an unknown source of radiation at a given wavelength may be compared with that of a known source, not only in the regions where the sensitivity of the eye is very low and consequently ocular comparison is difficult to make and also in regions where the eye is entirely insensitive. Similar photometric arrangements to the above are used also in spectrophotometry where, however, the conditions are frequently much more difficult because of the relatively feeble illumination with which work must be done. In this connection the FP-54 tubes, made by the General Electric Company, are of great value on account of their very high grid resistance which enables very feeble currents to be measured. A precision photoelectric spectrophotometer is illustrated in Fig. 1.

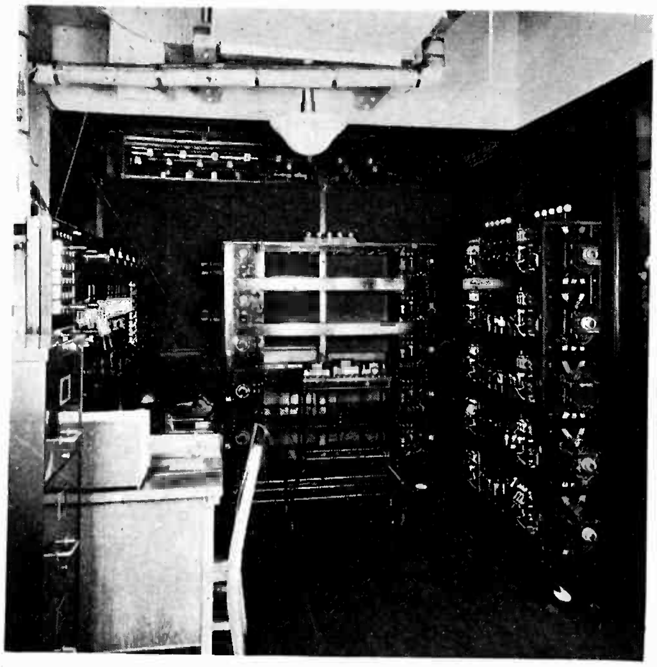


**Fig. 6—Life test of radio tubes**

The "erythermal" region of the ultraviolet spectrum is isolated approximately by filtering out the other parts of the spectrum or by using a uranium cell which is chiefly responsive to these wavelengths.

### Electronic temperature control

A vacuum tube relay used in conjunction with a bi-metallic thermostat for controlling the temperature of small oil and air baths for the calibration of resistance thermometers is shown in Fig. 2. The use of the vacuum tube reduces the current handled by the thermostat contacts to such a point that only the slightest movement is necessary to operate the control. A potential divider arrangement makes it possible to eliminate all batteries and operate direct from the 120-volt laboratory d.c. supply. This arrangement with a suitable high resistance relay will serve to control temperature to better than 0.1 degree C.

Where a finer degree of control must be maintained or heavier currents broken, the Thyratron can be used to advantage. The diagram, Fig. 3, shows a way of using a 2.5-amp., 1,000-volt Thyratron to control a 10-amp., 120-volt a.c. circuit.

This arrangement used in connection with a toluol thermostat has satisfactorily controlled the air temperature in a large test box to within 0.01 deg. C. It has the very decided advantage of having no mechanical parts to wear or stick and has operated continuously for over a month at a time without measurable deviation from the set temperature. The method has been successfully used in the close control of baths for accurate resistance measurements of materials having relatively high temperature coefficients.

To maintain two points exactly at the same temperature a very satisfactory automatic control makes use of a light sensitive relay as shown in Fig. 4. A group of 20 copper-advance thermocouples connected in series have their opposing junctions at the two points in question, *F* and *X* and the circuit is closed through a reflecting galvanometer. When the two points are at the same temperature the beam of light reflected by the galvanometer mirror falls on the photoelectric cell at *C*. The point *X* tends to be cooler than *F* and if this temperature difference exceeds a certain small amount the galvanometer beam is deflected from the photoelectric cell which then, acting through a 112-A tube operates a relay which throws into circuit a heating element at *X* and restores the condition of temperature equality. This arrangement has been used in preventing heat drain along the connecting leads used in thermal measurements on electrical apparatus.

### Life test on electron tubes

Not only do the electronic devices furnish most valuable auxiliaries in carrying out tests of other things but they themselves are an important subject for the operation of a testing laboratory. Sending and receiving tubes represent a manufactured product of wide range of characteristics and present at times certain deviations from nominal standards and qualities which can be inquired into by systematic tests. The apparatus and methods used in determining the characteristics of vacuum tubes are of a rather diversified and specialized character and suitable apparatus assemblies are required if tests of this sort are to be made with speed as well as reliability. Life tests of tubes are manifestly much more complicated than life tests of incandescent lamps, for instance, because of the requirements of the provision of not only filament or heater current but also of plate and grid voltages. Hence, the supply of current for these various purposes must be provided and this is best done by small steadily running motor generator sets. In order to cover even the most ordinary sizes and types of tubes a considerable number of such sets is required. The importance of uniform, high quality radio tubes to the millions of users is so great that the complexities and expense involved in a systematic examination of the commercial product do not excuse overlooking them.

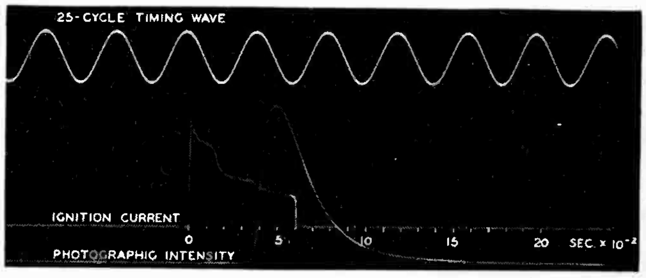



**Fig. 7—Oscillogram of photoflash lamp**

Photoelectric cells constitute a class of electrical devices covering a very wide range of differences both as to construction and as to photometric and electrical characteristics. A laboratory investigation of these characteristics is essential to an intelligent application of the cells to the wide variety of fields in which they are used. Among the measurements which are made on such cells are: The intensity-response curve with different voltages and different circuit characteristics; saturation points; spectral-response curves reduced to the equal energy spectrum; quickness of response; fatigue (if any), etc. To make these measurements with a satisfactory degree of accuracy requires apparatus of a variety and character such as only a very well equipped laboratory possesses and taxes the skill of the best of scientists.

# Pitch control for an electronic musical instrument

By T. R. BUNTING

*Technical Staff,*
*RCA Institutes, Inc.*

A MAJOR problem in the design of a musical instrument concerns the placement of a player's hands to secure a desired pitch sequence or melody. This will be taken up with respect to the beat-frequency class of instruments played by inductance variation, as contrasted with the RCA Theremin and the Martenot, which are played by capacity variation. Figure 1a shows the fundamental circuit. The oscillators are indicated, for simplicity, only by their tank circuits. Pliodynatron oscillators have proven particularly stable. The variable inductance in series in the tank circuit of one oscillator shows the method of controlling pitch. Pick-up coils $X$ and Y are each coupled to one of the oscillator tank circuits and, in series, form the input circuit to a grid-biased detector. When $L_v$ is maximum, a vernier condenser on one oscillator is adjusted to produce zero beat. Then as $L_v$ is decreased the frequency of the variable oscillator is increased, producing an audio signal of increasing pitch until the upper limit is reached when $L_v$ is at its minimum attainable value. It is assumed that the magnetic or electrostatic coupling between oscillators is so low that there is a negligible locking-in effect; the detector grid bias must be higher than the sum of the applied peak r.f. voltages, otherwise there will be a tendency to lock in when the grid goes positive.

The detector output voltage is passed through an amplifier, distortionless or not as desired for timbre, to a loudspeaker in which distortion may also be introduced if wanted.

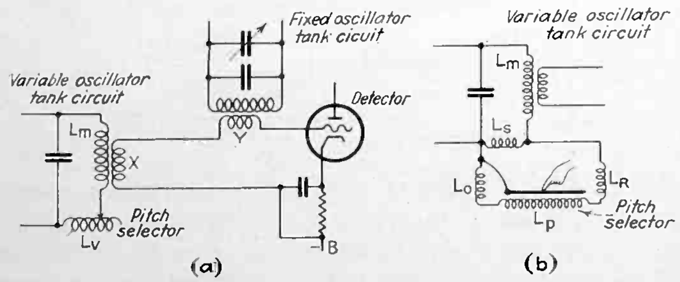



**Fig. 1.—Methods of obtaining pitch variation in beat-frequency type of musical instrument**

Except for the difference between black and white keys, a piano keyboard shows a good pitch placement in that a given pitch interval is the same linear distance on the pitch selector (keyboard) regardless of the actual frequencies produced by the terminal notes of the interval. Consider as a first criterion that the ideal pitch placement along a straight pitch control rod would be these equally-spaced octaves, resulting in the law that the logarithm (to the base 2) of the ratio of the pitch frequencies should vary directly with the linear distance moved by the selecting means, usually a finger of the hand.

In a beat-frequency system this pitch placement can be secured, in a single series inductance, only when the inductance of that coil varies irregularly with length in some fashion, either by a variation in diameter or in space between turns. Manufacturing problems in working with a varying turn-spacing or rod diameter led to the consideration of an approximate solution by circuit design permitting the use of a long inductance coil of uniform diameter and equal spacing of turns.

This rod might be of two types:

a. Closely wound by hand and the insulation scraped from the top. This has been used by several workers in the field, including Prof. Leon Theremin.

b. Wound in screw threads along a thin tube of laminated insulation or a staff of kiln-dried wood. A desirable wire is a bare copper, silver-plated, as used in wrapping certain heavy musical instrument strings. (The size numbers used in that industry are appreciably different from the gauges used in the electrical field.)

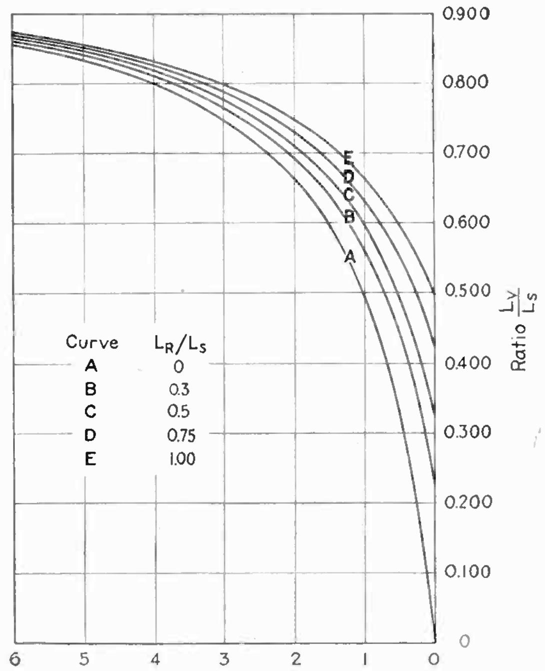



**Fig. 2—Inductance variation curves for determining pitch distribution**

Possible forms of pitch contactor are as follows:

a. Metal finger attached to an insulating handle held in the fist.

b. Wire screen formed into a semi-cylinder straddling the coil, and having a similar area of highly flexible insulating cloth closely covering the screen.

c. Keyboard of the practice piano type, each key provided with a springy wire contactor which moves to the rod when the key is depressed; all contactors connected together, taking the place of the overhead screen contactor in (b) above.

Returning to Fig. 1a, and considering the effect of changing the total inductance of the variable oscillator circuit by any small amount $L_v$ we find:

$$\frac{N + (F_2 - F_1)}{N} = \sqrt{\frac{Lm + Lv}{Lm}} \qquad (1)$$

whence

$$(F_2 - F_1) + \frac{(F_2 - F_1)^2}{2\,N} = \frac{Lv\;\;N}{2\,Lm} \qquad (2)$$

where: $F_2$ = maximum pitch with $L_v$ out of circuit
$F_1$ = minimum pitch with $L_v$ in circuit
$N$ = frequency of variable oscillator when $F_1$ is produced
$L_m$ = inductance of main tank coil

The pitch range $(F_2 - F_1)$ of a desirable instrument would be perhaps less than 2000 cycles and $N$ can well be around 100,000 cycles, whence it appears that the second term of equation (2) can be neglected compared to the first term. Then with $L_m$ and $N$ fixed, it appears that:

$$(F_2 - F_1) \text{ varies as } L_v \qquad (3)$$

After many trials of various inductance arrangements the author devised an inductance network to take the place of the single variable inductance of Fig. 1a. The network lends itself to easy calculation and is shown in Fig. 1b. Note that the only purpose of $L_o$ is to reduce the variable oscillator to the same frequency as the fixed oscillator (zero beat when the pitch selector is not in use), and its calculation will not be covered.

A control coil from $\frac{3}{4}$ to $1\frac{1}{2}$ inches in diameter and from 20 to 30 inches long has been generally used. It is assumed, with sufficient accuracy, that the inductance of any portion is proportional to its length.

If $L_s$ and $L_r$ are kept fixed, $L_p$ becomes the pitch control rod inductance and the following values of $L_v/L_s$ are noted:

$$\frac{L_{vx}}{L_s} = \frac{L_p + L_r}{L_p + L_r + L_s} \qquad (4)$$

$$\frac{L_{vc}}{L_s} = \frac{L_p + 2\,L_r}{L_p + 2\,L_r + 2\,L_s} \qquad (5)$$

$$\frac{L_{vn}}{L_s} = \frac{L_r}{L_R + L_s} \qquad (6)$$

where: $L_{vx}$ = maximum value of $L_v$ with contactor at left end of control
$L_{vc}$ = intermediate value of $L_v$ with contactor at center of control
$L_{vn}$ = minimum value of $L_v$ with contactor at right end of control

In Fig. 2 are graphed the values of $L_v/L_s$ for values of $L_p/L_s$ ranging from 2.5 to 6.0, and for values of $L_r/L_s$ from 0 to 1.0; such inductance variation curves enable us to determine the distribution of pitch frequencies along the pitch control rod because of the approximate proportionality of $L_v$ and $(F_2 - F_1)$.

Let $F_c$ = pitch produced by contactor at exact center of rod
$F_x$ = pitch produced at any other point along the rod
$L_v$ = net inductance of control network which produces $F_x$

$$\text{Then } \frac{L_{vc} - L_v}{F_x - F_c} \text{ is a constant} \qquad (7)$$

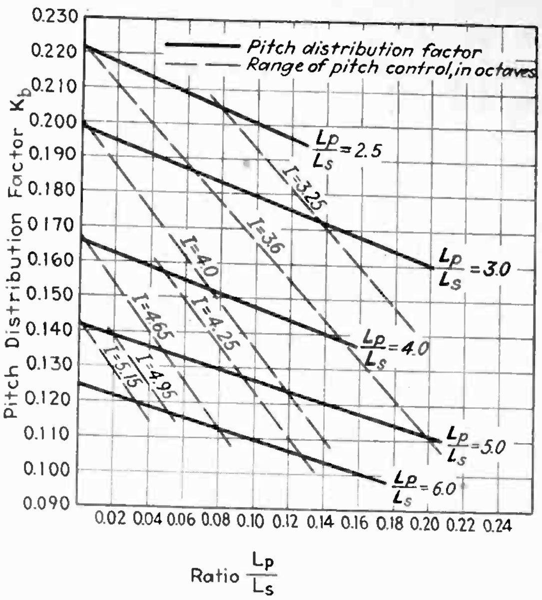



**Fig. 3—Pitch distribution factor with intervals balanced about central point of pitch rod**

Multiplying this by $F_c/L_s$ we get a formula for what we may term the "pitch distribution factor" which is:

$$K = \frac{L_{vc} - L_v}{L_s}\;\frac{F_c}{F_x - F_c} \qquad (8)$$

If $L_v$ is greater than $L_{vc}$, then $F_x$ will be less than $F_c$, and the two negatives from equation (8) will still leave $K$ as a positive value.

The interval in octaves between $F_x$ and $F_c$ is the logarithm (to the base 2) of the ratio $F_x/F_c$, which may be rewritten:

$$I_c = 3.32 \log_{10} F_x/F_c \qquad (9)$$

in which $I_c$ is the interval, considering it as positive when $F_x$ is greater than $F_c$. Combining equation (8) and (9) we get:

$$I_c = 3.32 \log_{10} \frac{L_{vc}/L_s - L_v/L_s + K}{K} \qquad (10)$$

In this equation, when $L_v$ is greater than $L_{vc}$, the ratio shown will be less than unity and the logarithm will have a negative value, merely indicating that the interval is "down" from the reference pitch level $F_c$.

This enables us to determine the pitch distribution factor $K_b$ which will give us a balanced number of octaves above and below the center of the rod. Remembering that $I_c$ to the right is positive and to the left negative in sign, and using the values $L_{vx}$ and $L_{vn}$ when the pitch control is at the left and right ends respectively we get for the maximum interval to the right:

$$I_c = 3.32 \log_{10} \frac{L_{vc}/L_s - L_{vn}/L_s + K_b}{K_b} = -\,3.32 \log_{10} \frac{L_{vc}/L_s - L_{vx}/L_s + K_b}{K_b} \qquad (11)$$

whence for balanced octaves,

$$K_b = \frac{(L_{vx}/L_s - L_{vc}/L_s)\,(L_{vc}/L_s - L_{vn}/L_s)}{2\,L_{vc}/L_s - (L_{vx}/L_s + L_{vn}/L_s)} \qquad (12)$$

In Fig. 3 are graphed, for the balanced octave arrangement, the values of the pitch distribution factor $K_b$ for various relations of $L_p$, $L_r$ and $L_s$. It is to be noted that the abscissa is not $L_r/L_s$ but $L_r/L_p$; the change from previous practice was made because use of the latter brings the results out to something pleasing to an engineer—straight lines. This figure also shows just how many octaves $I_t$ will be covered by the entire rod. This was secured merely by doubling $I_c$.

Perhaps this can be better understood by observing Fig. 4, in which the ideal pitch placement for an interval of 4 octaves is shown as a straight line. The actual pitch placement with the network devised by the author is shown for balanced octave arrangements by the several dotted curves crossing it, which may have more or less than 4 octaves, as desired by a designer. This process takes time, but the method after all is simple. It shows

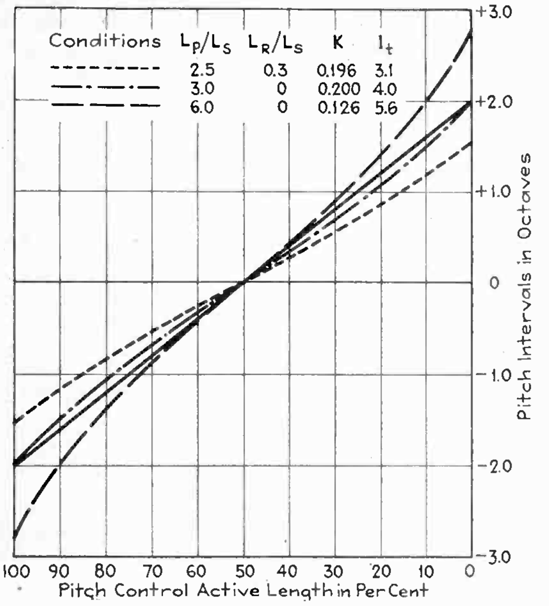



**Fig. 4—Pitch distribution—octaves balanced about rod center**

that, for the balanced octave arrangement, the pitch distribution will be such that identical small fractions of an octave to the left and right of center will be at practically the same distance from the center of the rod.

Just what is the usefulness of the data? We had at the beginning an approximation for equation (2) which can be combined with equation (8) defining the pitch distribution factor, to produce the useful formula:

$$N = \frac{2 L_m F_c}{K L_s} \qquad (13)$$

This enables us to predict the oscillator frequency which will give us a known musical range which is balanced as to intervals above and below a selected central pitch. The accuracy of the method depends on the oscillator frequency and the musical range desired. With a central pitch of 440 cycles and an oscillator frequency of about 50 kc. the value of $N$ will have to be increased about 5 per cent above that indicated by equation (13). If the oscillator frequency is of some value which makes the pitch distribution factor disagree appreciably with Fig. 3, the pitch distribution will not be balanced for the central pitch used in equation (13). It may, however, be made to balance by adjusting the vernier condenser to provide some other central pitch.

The calculations have been carried out with an accuracy which obviously is not justified by certain irregularities, among them being the change in inductance of some small section at the right end of the control rod when the pitch contactor is pressed to the rod at that point, shorting several turns perhaps.

The principles set forth are not limited to a balanced octave arrangement. The author has calculated, graphed and tried the relations for an odd pitch distribution such as three octaves to left of center and two octaves to right of center, and vice versa. It is considered that the balanced octave design is best, because it works out to provide a gradually decreasing linear distance along the control for a given musical interval as the hand is moved to either left or right of center. In other words, the distance between notes is somewhat greater in the central region of the pitch control rod where we may assume the notes will be played most often.

This investigation was begun when the author was assisting Mr. Charles J. Young in musical instrument development for the RCA Victor Company, and an indebtedness is acknowledged to him for his engineering leadership in this comparatively unexplored branch of electronics.

▼ ▼ ▼

# Transformers for gaseous discharge tubes

[*Continued from page 283*]

the maximum footage of tubing to a point 5 or 10 per cent below the knee of the curve.

Figure 2 shows the operating characteristics of a transformer with identical rating but from another manufacturer. The same tubing is used and the same results *should* be expected, but we see that this transformer cannot be trusted to operate any length of 7-millimeter neon tubing. At a load of 28 ft. we have reached the flicker point, while the volt-ampere curve still remains above the 450-volt-ampere rating. Obviously the two transformers cannot be identical, in spite of their labels, and what is here pointed out is that things are not always what they seem.

Figure 3 shows the first transformer operating on a different type of tubing. Here the tube contains helium and is of a larger diameter—12 millimeters. Helium is used to produce a peach-colored light, usually (and erroneously) referred to as a "white" light. The transformer will efficiently operate this tubing between the lengths of 8 and 16 ft., by the same reasoning as used in Fig. 1 as shown on page 282.

In Fig. 4 the second transformer is shown to operate this same tubing between 14 ft. 5 in. and 20 ft. 5 in. By observing these two curves we are lead to the conclusion that either the first transformer developing less than its rated 15 kilovolts, or the second is developing more, for, other conditions being constant the footage would be a function of the potential. As a matter of fact the operating potential of these two transformers was determined under a load of 400 volt-amperes and it was found that the first developed 12,021 volts while the second developed 12,242 volts.

As a matter of information two other important curves have been added to Fig. 3, one showing the variation in the power factor by percentage. It will be noticed that over the useful range this transformer has a power factor from 33 per cent to 52.8 per cent. The other curve shows the variation in the output current, in milliamperes. Other conditions being constant the secondary current controls the brilliancy of the tube.

# HIGH LIGHTS ON ELECTRONIC

## Razor blades tested by photocells

ADVERTISEMENTS RUNNING IN metropolitan papers call attention to the use of photo-cells for testing the sharpness of the new Gillette safety-razor blades. The ads read: "Padlocked! The photo-electric sharpness-tester—a secret new Gillette device kept under lock and key—proves conclusively that the Gillette Blue Super-blade is the keenest blade we have ever produced."

Inquiry to the research department of the company, by the editors of *Electronics*, confirmed the statement that the new method is guarded with the utmost secrecy. Theodore L. Smith of the Research Department writes: "This company has devoted a considerable amount of time and money to the development of this device, and for the time being, at any rate, it is the policy of the company to withhold information regarding it."

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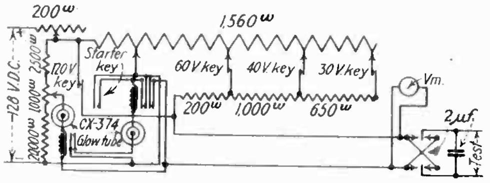
## Glow tube checks over and under voltages

THE TESTING REQUIREMENTS for coin relays used in coin collectors manufactured by the Gray Telephone Pay Station Company necessitate a close check of the testing voltages. With the design of a semi-automatic tester it was considered necessary to have a positive check of the voltages in addition to the operators' observations. Suitable voltmeter relays were not available and did not appear to meet the requirements so two CX-374 "glow tubes" were employed in conjunction with standard telephone relays.

The characteristic of the glow tube which makes it useful as an overvoltage check is the sharply defined voltage at which the tube strikes or ionizes sufficiently to pass a finite current. A relay in series with the tube will operate as soon as the tube strikes. On the other hand the undervoltage check glow tube does not operate directly with a drop in voltage, but serves to choke back the current sufficiently to release the relay.




A test was run on a glow tube and a curve was plotted showing the current vs. voltage relation. It was found that a drop in voltage from 86.1 to 85.9 volts caused a reduction in current from 16 to 10 milliamperes. Thus a .23 per cent reduction in voltage caused a 37.5 per cent reduction in current. An ordinary telephone relay was adjusted to release at 15 milliamperes and connected in series with the glow tube.

The overvoltage check is made with a glow tube in series with a relay connected from one side of the line to a bleeder resistor. The bleeder resistor connection is set at a potential just below the striking voltage of the tube. Any increase in line voltage causes the tube to strike and the operation of the associated relay stops the test.

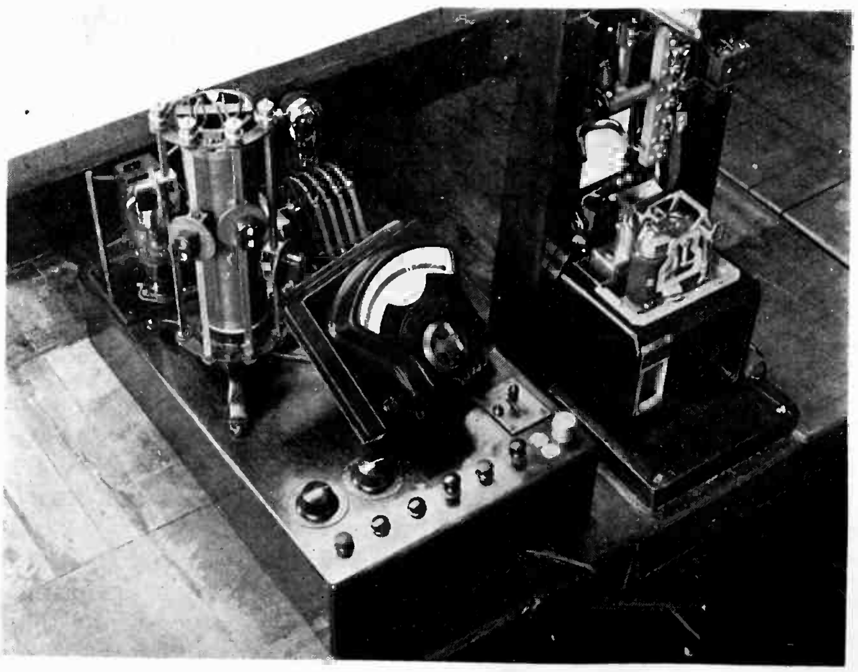
The undervoltage check is made with a glow tube in series with a locking relay which has a pair of contacts cut into the test line. The relay is operated by the momentary contact pair of the start key and holds as long as the voltage does not drop. The slider on the variable resistor is set at a point just above the release voltage with the 60-volt key depressed. This setting is made with the key depressed so as to give the highest normal drain through the test circuit and, therefore, the lowest normal voltage across the tube circuit. In case of subnormal voltage the tube and relay act to cut the line and this circuit breaker action in the case of short circuits has effected a considerable saving in fuse replacements and time.

The setting and operation of the test set is as follows: The start key is pulled forward to operate the locking relay and tube and then it is pushed backward to the manual position. The coin trigger is tripped, operating the line switch of the coin relay, and the 120-volt key is depressed. The 200-ohm variable resistor is used to set the voltage at 120.25 volts. The key is then released and the test line is cut by the line switch which is opened by the coin relay when it restores. The bleeder resistor connection of the overvoltage glow tube is slowly brought up until the tube strikes. The relay associated with it is operated and opens the locking relay circuit which in turn opens the overvoltage tube circuit. A little more resistance is cut into the line with the 200-ohm line resistor and the start key is again pulled. The sliders for the various voltages are set at their proper values with the coin relay in the circuit. The 60-volt key is depressed and the voltage across the under-voltage tube circuit is reduced by operating the under-voltage slider. The 60-volt slider is used in conjunction with it to maintain 60 volts across the test circuit. When the point is reached where the locking relay releases, the slider is withdrawn slightly and the start key operated.

To check the setting the 60-volt key is depressed and the 200-ohm line resistor is varied until the locking relay releases. A drop of less than .2 volt will cause the relay to release if the setting is right.

When the glow tube setting has been accomplished it need not be changed unless the glow tube relay releases and stops the test.

A circuit employing a glow tube in series with a relay has a number of possible applications, especially where inexpensive equipment is desired. As connected in the test set described it serves as an overload circuit breaker, as a coil resistance check, as an undervoltage check and as an overvoltage check.



**Apparatus for testing coin relays in telephone pay stations using glow tube**

# DEVICES IN INDUSTRY + +

## X-ray fluoroscope gives stereoscopic image

An improved fluoroscope which projects a reversed, three-dimensional image has been developed at the California Institute of Technology. It is expected to facilitate internal examination of human bodies and other objects. The illusion of a substance is so perfect that a physician can make internal measurements with calipers, as exactly as if the subject lay dissected before him.

Two tubes cast two shadows on the screen at slightly different places. The tubes are set the same distance apart as human eyes, their beams intersect each other and cross in the patient's body before reaching the screen. A shadow of the same size, shape and depth as the person, transparent, showing bones and internal organs, is formed.

The most promising medical use at present is for setting broken bones—seeing them in three dimensions. Other uses are more exact location of bullets and other foreign bodies, looking at internal organs and bronchial tubes, and measuring dimensions of internal cavities.

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## Smoke rings bell, lights sign, records time

The smokestack of the B. Altman store, Fifth Avenue, New York City, is in the midst of some overhanging apartment buildings, and it is desirable that no smoke offend the occupants. Accordingly a photoelectric relay unit has been put on guard, and if even a slight puff of smoke goes up the chimney, bells are rung in the two firerooms, a sign reading in big red letters *"Smoke"* lights in front of the desk of Chief Engineer Cummings, and the time and duration of the smoke is recorded on a curve-drawing galvanometer. From this last, at the end of the day, the graph-ribbon can be withdrawn and studied at leisure, showing just *when* smoke occurred, *how often*, and *how long* it lasted.

To install the American Photoelectric Corporation relay unit used, two six-inch holes were cut at opposite sides of the base of the stack, whose walls are a foot thick at this point. Opposite the holes, at points a foot outside the wall, the automobile headlamp light-source and the photocell are mounted, across from each other. This arrangement puts the lenses of these units well outside the smoke area, so that they cannot be fouled, since there is always a draft of fresh clean air entering the stack around the two light elements.

## High-frequency heating in industry

While high-frequency heating has long been largely used in radio-tube manufacture for the "bombardment" of inaccessible parts in the sealed glass tubes, there are many possible applications in general industry where such heating has not yet been tried.

For quickly heating small parts that are to be lacquered, high-frequency heating offers possibilities.

For heating parts to be drop-forged, high-frequency methods make it possible to deliver heat quickly, safely, accurately and without fumes or discoloration of the surface of the part heated.

High-frequency killing of bugs in wheat has recently been investigated in connection with the vast stores of wheat acquired by the Federal authorities. It was found that after long storage this wheat was getting "buggy," and electrical people were appealed to. Tests made with high-frequency, on the wheat showed that the bugs in the wheat when given doses of high-frequency, quickly turned up their toes and died. But the difficulty came in killing the eggs of the future generation of bugs. The high-frequency killed off all living creatures but with the passage of time, a fresh crop of insect inhabitants arrived, hatched out of the eggs, which defied all attempts at high-frequency sterilization. So the matter of "debugging" the wheat, though considered highly successful, was dropped until some way can be found to reach the germs in the eggs.

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## Airplane field lights turned on by photronic cell

Bowie Field, one of the intermediate landing fields which are located every ten miles along the airplane route from New York to Washington, now has all its lights automatically controlled by a Weston photronic cell, so as to be switched on at dusk. This field is located 30 miles from Washington.

The photo-electric control turns on the 1,000-watt 1,000,000-cp. beacon light, starts the electric motor which drives its 36-inch reflector, switches on the two 500-watt code signaling lamps which transmit the field's designation continuously in Morse characters, and also turns on the fifty small marker lights which enclose the field.

The operation of this entire equipment is automatically started at twilight and stopped at dawn. No human supervision is given to the apparatus, the only check on its operation being the attention given by a nearby farmer who looks out of his kitchen window a couple of times each evening to see whether the lights are on. So far, after nine months' operation, the automatic control has never failed.

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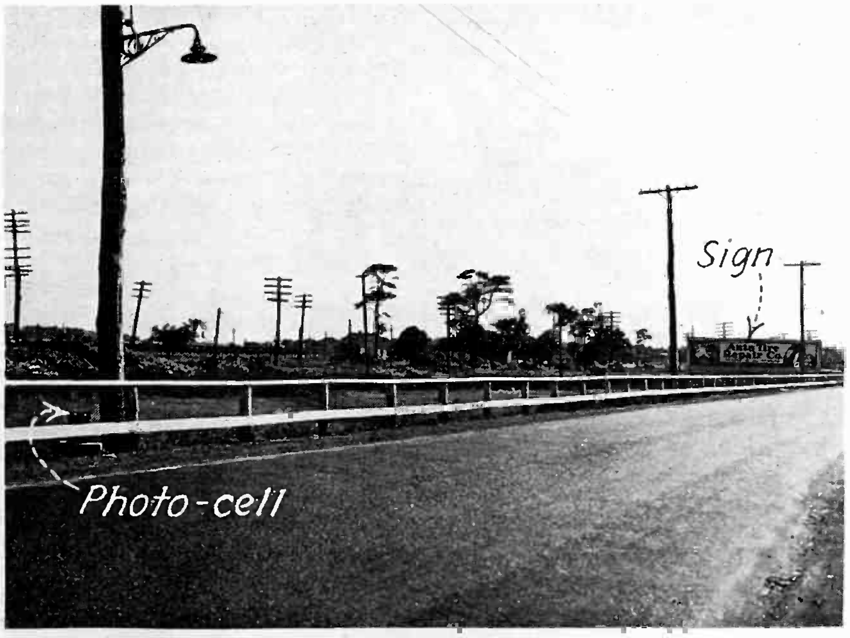
## CAR HEADLIGHTS TURN ON SIGN



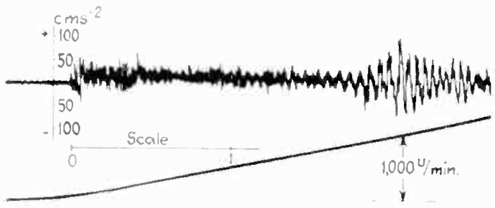

**This electric sign on a road near New Haven, Conn., is flashed on whenever a car's headlights approach after dark. The experimental photocell mounting, made by the Eastern Engineering Company of that city, also turns off the sign under prolonged illumination such as daylight**

## Piezo electric methods of measuring mechanical forces

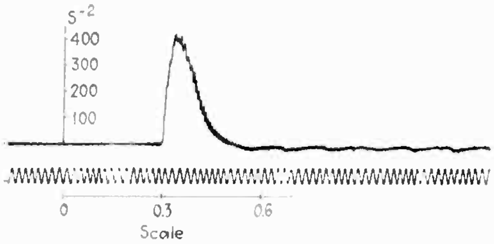
BY DR. I. J. SAXL

WHAT APPEARS TO OPEN a vast new field for the application of the electronic art and science has been worked out by the Doctors Kluge and Linckh, of the physikalisch-technische Reichs-Anstalt in Berlin, Germany.* This is the use of piezo electric crystals for measuring pressures.

The quartz pressure chamber used by Kluge and Linckh consists of two quartzcrystals (q) built in a chamber which protects them against the influence of gases, moisture, etc., by a membrane (m). Two crystals instead of a single one are used as to increase the electromotive power produced at the terminals and to compensate irregularities in the current production (e.g., the influence of the temperature). The power is applied upon the crystals over a ball bearing (b) which secures a uniform distribution of the power over the entire area of the crystal.



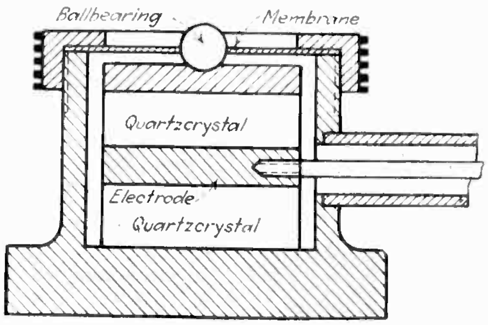

**Piezo-electric vibrometer. Vibrations of a foundation on which an a.c. motor has been started**




**Measurement of the starting acceleration of a d.c. motor**

In later constructions a greater number of crystals has been used. This increases the sensitivity of the apparatus, and if the crystals are placed parallel so that only a part of the mechanical stress is working on each single crystal the direct measurement of several thousand pounds is possible. Ordinarily the limit of fracture for each crystal is around 1,000 atmospheres. Several crystals, naturally, if placed parallel, are able to carry a heavier load.

The electrical charges are taken from the metallic part (e) between the crystals and carried through an electrode insulated by amber against the chamber which acts as the second electrode.




**Piezo-electric pressure chamber**

The piezo-electric current is brought to an amplifier tube which delivers about one-half milliampere for each pound of pressure applied to the quartzchamber. The smallest measurable forces are about 0.02 pounds. The relation between the pressure applied to the chamber and the electrical charge is almost linear. The electric current which has been amplified in the tube voltmeter is fed into an oscillograph or for relatively lower frequencies a galvanometer is used similar to the electrocardiograph used for the recording of the heart beat. For higher frequencies a cathode ray oscillograph is used.

By applying the forces to a membrane and measuring the elastic resistance of said membrane it is possible to measure with the piezo-electric method displacements as low as about one three-thousandths of an inch.

As all observations on machines can be reduced to the pondero-motoric effect of parts of them and all ponderomotoric effects within very broad technical limitations can be approached with piezo-electric measurements, this method seems to be most valuable for the investigation and for the development in all fields of the mechanical industries.

*J. Kluge u. H. E. Linckh: Piezoelektrische Messung mechanischer Groessen. Zeitschrift fuer Forschung auf dem Gebiete des Ingenieurwesens, II, 1931, 5, pp. 153-164.
Kluge u. Linckh: Piezoelektrischer Indikator fuer schnell laufende Verbrennungsmotoren. Zeitscher. d. Ver. Deutscher Ingenieure, Bd. 74, 1930, p. 887.

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## A million volt X-ray tube

THE NEW MILLION-VOLT X-ray tube of the California Institute of Technology is now being operated regularly at a potential up to 1,200,000 volts. The research staff, headed by Dr. Charles C. Lauritsen, has made measurements of the intensity of the radiation produced and the limit of the length of short-wave radiation has been determined by means of a crystal spectrograph. The tube is to be used especially for biological work. It is essentially a large and much modified edition of the conventional X-ray tube used in medical radiology.

## Measurement of gas pressure

BY H. C. RENTSCHLER

IN RESPONSE TO AN INQUIRY from a reader of *Electronics* as to the practicability of using the corona effect to measure gas pressure, Dr. Rentschler replied as follows:

"I do not see just how corona effect could be used for measuring rare gas pressure with any degree of accuracy.

"When we fill a tube or bulb with rare gas we get some indication of about what pressure we have by applying a high frequency spark coil to the outside of the glass bulb or tube. This gives a mere indication, however, in as much as the character of the discharge is somewhat affected by the purity of the gas in the bulb or tube.

"Another way in which a rough indication might be obtained would be to make a so-called negative glow lamp filled with the gas under consideration. If the pressure is fairly high the glow at the negative terminal will be confined very close to the negative electrode. In other words the luminous glow has an appearance of being rather thin although it may be fairly bright. If the pressure is lower the negative glow spreads out around the cathode to a somewhat greater distance depending upon the pressure. The thickness of this glow then might be used as an indication of the pressure but again it would afford no accurate way of measuring the pressure.

"The idea would be rather nicely illustrated by taking a fairly long tube with an electrode at each end containing an inert gas and gradually pumping down the gas. After reaching a certain pressure the Faraday dark space begins to appear at the cathode. As the pressure is diminished still further, this dark place moves towards the anode and a glow develops around the cathode. As the pressure is still further decreased the cathode dark space begins to appear and spread out while this negative glow between the dark space and the Faraday dark space moves up to the tube further and further towards the anode and finally when the pressure becomes very low the cathode dark space fills practically the entire bulb. This in reality is the principle involved in what I described above as giving an indication in the negative glow lamp of the pressure. That is, the distance that the glow spreads away from the cathode would be a rough indication of the pressure in the tube.

"This chasing down of the Faraday dark space and the negative or cathode dark space is fully described in J. J. Thompson's book on Conduction of Electricity Through Gases."

# FROM THE LABORATORY + + +

## Improved form of electrocardiograph

S. H. Caldwell, C. B. Oler and J. Peters, writing in the *Review of Scientific Instruments*, June, 1932, describes a system for measuring heart voltages. As the heart periodically contracts and relaxes, a variable electromotive force appears between points on the surface of the body, arms and legs, for instance; it consists of a fundamental (1 to 2 cycles) and strong harmonics. These fluctuations can be recorded most conveniently by means of a resistance-coupled amplifier with large blocking condensers and grid resistors and an input resistance of 250,000 ohms. For getting a regular zero line, only wire wound resistors could be depended upon. The output is fed into a standard three-element oscillograph.

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## Standardized 16 mm. sound on film

To clarify the 16 mm. sound-on-film situation, the RCA Victor Company, Bell & Howell, and the International Projector Company, leading manufacturers of sound reproducing equipment, and the Eastman Kodak Company, the largest producer of sixteen millimeter film, have individually decided to maintain the present standard size 16 mm. film in the production of sound-on-film motion pictures by eliminating one of the two rows of sprocket holes and by utilizing the space thus acquired for the sound track.

In maintaining this standard and by the elimination of one row of sprocket perforations, the dimensions of the picture on the film remain the same as on the present 16 mm. silent film. Present stocks of silent film can be run on sound projectors for the new film. The center line of the sound track is located centrally in the space between the picture and the edge of the film, the space thus available permits a sound track .065 inches in width and suitable margins on each side of the sound track.

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## Sealing-in high-power tubes

The cover photograph on this issue of *Electronics* was used through the courtesy of the *Bell Laboratories Record*. It was taken in the tube shop of the laboratories during the process of sealing-in a transmitting tube recently designed. In a future issue of *Electronics* C. E. Mendenhall will describe several new tubes and their manufacture.

## Circuit for determining heating time of vacuum tubes

By W. P. Koechel

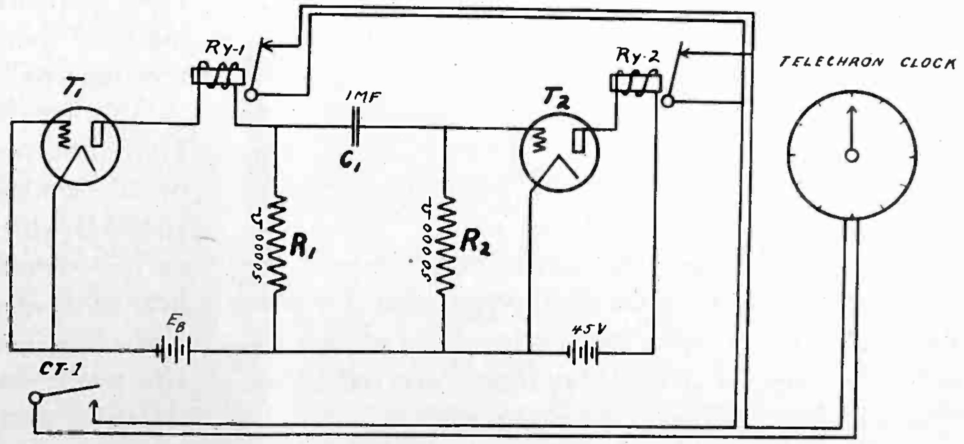
In the design and manufacture of vacuum tubes it is often of vital importance to know the exact length of time it takes the heater or filament to come to its normal operating temperature. The usual method of determining this is to utilize a stop watch and note the elapsed time between inserting the tube in the socket and the time required for the plate current to reach a predetermined value. However, this predetermined value of plate current varies for different types of tubes and does not always give the true heating time. In addition to this, it is not practical to try and "catch" the maximum plate current reading as this requires extremely close observation of the movement of the plate current meter indicator needle.

The circuit shown permits quick and accurate determination of heating time regardless of type of tube or exact value of plate current. The elapsed heating time is registered and recorded by a telecron clock. Insertion of the tube in the socket starts the telecron clock. As soon as the cathode or filament of the tube has reached its maximum temperature the telecron clock stops running. The elapsed travel time of the second hand of the telecron clock represents the exact heating time of the tube. The minute hand of the clock is used as a zero indicator in order to have a means of knowing the starting time when the tube was inserted.

The underlying principle of this circuit is as follows. A one stage amplifier is so connected that it will be acted upon *only by a change in plate current* of the tube under test. When there is no further change in filament temperature (and consequently no further change in plate current) the amplifier is no longer acted upon and then operates indirectly to shut off the telecron clock.

Detailed circuit operation follows: Contacts $CT$, are closed by physical contact due to insertion of the tube in the socket. As there is no plate current flowing when the tube is first inserted, relay $RY_1$ will be in an inoperative position. Therefore, its contacts will be closed. These contacts being in series with the contacts $CT_1$, the circuit is completed to the telecron clock. Relay $RY_2$ is meanwhile in an operative position due to plate current through it of tube $T_2$ (as at this time there is zero bias on the grid of this tube, it will have its maximum plate current flow). However, as soon as plate current starts to flow in $T_1$ there will be a voltage developed across $R_1$ and this in turn will permit charging current to flow through condenser $C_1$ and resistance $R_2$. This charging current acts as a negative bias on the grid of tube $T_2$ and soon becomes sufficient to cut down the plate current of tube $T_2$ and release the armature of relay $RY_2$. After a certain interval the plate current of the tube under test increases sufficiently to operate relay $RY_1$. However, as the contacts of this relay and that of $RY_2$ are in parallel, the circuit to the telecron clock will still be complete, for the contacts of relay $RY_2$ will remain closed until plate current again flows in tube $T_2$. This plate current flow (through $T_2$) will not take place until current flow through $C_1$ and $R_2$ has entirely subsided which condition will be obtained when the filament temperature of tube $T_1$ reaches its maximum value. When the temperature (and conseqently $I_p$) has its maximum value, current flow ceases through $C_1$ and $R_1$, thus allowing the grid of tube $T_2$ to again assume zero bias potential. This permits relay $RY_2$ to operate and the contacts of this relay to open the circuit to the telecron clock.

This circuit has been in operation for some time and has proved very valuable as it permits of an easy and accurate means for determining total heating time of any type of tube




**Vacuum-tube method of determining accurately the heating time of filaments**

# electronics

McGraw-Hill Publishing Company, Inc.
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O. H. CALDWELL, *Editor*

Volume V — SEPTEMBER, 1932 — Number 3


## Three hundred electron tubes

COMMUNICATION and industrial engineers in the United States are blessed with a vast array of electron tubes from which to choose the one which has the exact characteristics to perform a desired function. Over three hundred different types of tubes have been listed by *Electronics* editors and complete characteristics on them will be found in the October issue. This tube chart, the first of its kind published in this country, will list the tubes by type number and function, and will give not only the complete electrical characteristics but the physical dimensions as well.

The data gathered in this ambitious undertaking should be valuable to the engineer of the communication company or the industrialist as well, containing as it does all known types of all the major manufacturers.

## Radio's "lost decade"

THE death of Professor Reginald Aubrey Fessenden who long stood alone in his comprehension and support of the "continuous-wave" theory of radio, has led his former associate, John V. L. Hogan, the consulting engineer, to point out factors which were responsible for the slow progress made in that early period of radio's development,—a period pointedly referred to as "radio's lost decade."

"Like the early investigators other than Fessenden, both Hertz and Marconi were in the 'whiplash' school," declares Mr. Hogan. Both "concluded it was essential to use a spark discharge in order to snap off the waves from radiating antenna wires. Thus Fessenden's radical view that radio waves might better be transmitted by the flame-like or continuously 'glowing' process, later sustained as novel by Judge Julius Mayer, was all the more a striking departure from the trodden path.

"But the decade lost to the progress of radio was due less to the conflict of views as to the whiplash effects than to the lack of refined and commercially adequate generators of high-frequency continuous waves." If in the years following 1906, concludes Mr. Hogan, the mechanism and potentialities of the audion vacuum tube detector had been better understood, the art would perhaps not have had to wait for the high-frequency oscillating-tube circuits of 1912 and 1913.

## Two lessons from European broadcast studios

THE new studios of WCAU, in Philadelphia, have been designed to feature novel acoustical characteristics. This is the first attempt made in this country to construct or to broadcast from what is known as a "live-and-dead-end" studio. From one-half to two-thirds of each room, depending on the size of the studio, will be lined with sound absorbing material to form a "dead-end" where the microphones will be placed to receive the program which will be in progress at the opposite, or "live end" of the room. The "live end" walls will be constructed with a hard material that will reflect the sound waves to the receiving or "dead end."

Another innovation not before used in the United States will be the zigzagging of the walls of the two larger studios. These studios are constructed with "V" shaped walls which will break up the sounds as they strike the sides and will deflect them at various angles and so prevent the reverberations of the notes from striking the opposite walls,—a practice widely followed across the Atlantic, and likely to be regularly adopted here where construction permits.

## Needed—An "all-sided" photocell

THERE seems to be commercial need for a photo-electric cell which can receive light impulses not only from one direction but *from all sides,* and thus greatly increase the incident light energy collected by its reflector. When an ordinary photo-cell is mounted like an automobile lamp in a regular headlight reflector, only a small part of the concentrated light can be utilized.

But if the light-sensitive surface were in the form of an exposed cylinder, onto which the light rays could pour from all directions, while the necessary anodes were placed nearby so as to obstruct a minimum of light, the sensitiveness and output of the cell would be increased.

## Delayed television

REPORTS from the Berlin radio exposition indicate that motion-picture film apparatus for television transmission has now reduced the interval between exposure and projection to twenty seconds. Thus, using motion-picture film as the necessary "relay" to get the amount of light needed with present systems, the transmitted picture need be only twenty seconds behind the action in reality. This is progress.

But this is not the only limit imposed on commercial television by present available apparatus. The most advanced sets so far produced are undoubtedly working at the very limits of physical capacity. One set requires thirty tubes, and some of these have to be immersed in a blast of air to keep them working. The cathode-ray tube is running at such an intensity of electron emission that it presents a real danger whether some slight misadjustment may not flood the spectators with X-rays. Television sets that cost nearly a thousand dollars, and $100 for a single tube replacement, are still far from being subjects for mass merchandising.

Men who are closest to television still have high hopes that our dreams will all come true, in 1935 or thereabouts. The fact that these indefatigable workers continue to have faith in present methods, is evidence that the future of television may not, after all, depend on the discovery of some brand new principle yet unknown to the art, as so many observers fear.

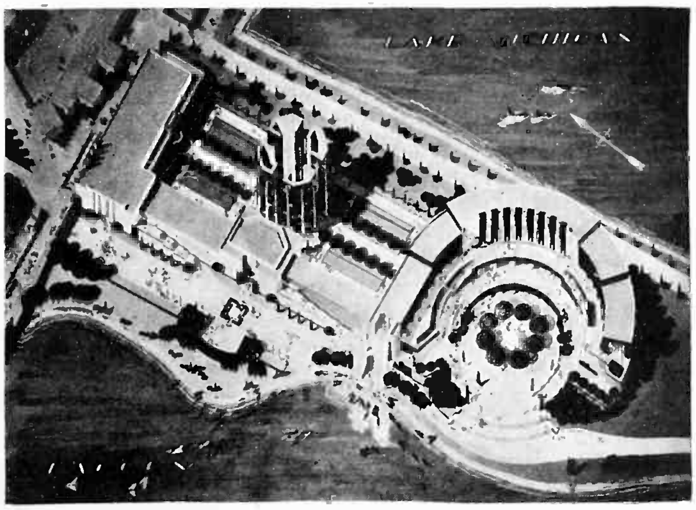
## A changing art driven by many influences

THE only thing permanent is change,—and any radio allocation, however perfect it may appear, considered for some given day or year, is not to be taken as a fixed or permanent solution of the problem, in an art advancing as rapidly as is radio, or subject to such a wide variety of influences, human, political, scientific, and even cosmic.

Such diverse factors as television, sun-spots, new radio circuits, wired wireless, broadcast advertising, electronic-tube progress, Mexican relations, educational wavelengths, labor demands, phase synchronizing, crystal control, etc., may each at some time effect important influence on the general requirements of the radio spectrum and be the cause of logical changes in the present or any existing set-up,—however excellent in the recent past.

It is important therefore that the Federal administrative authority keep an open mind regarding the changes which must from year to year, be made in the radio spectrum and in radio allocations,—while protecting existing operations for the widest human service of radio.

### THE HOME OF RADIO AND ELECTRONICS AT CHICAGO WORLD'S FAIR



The great radio and electrical building of the Chicago Century of Progress Exposition, to open in June, 1933, is now approaching completion. This building, of unique architecture, in red, yellow, gold and silver, is the design of Raymond Hood, architect also for Radio City, the Tribune Tower, Chicago, and the McGraw-Hill Building, New York. Exhibits by the telephone and radio interests will occupy the building above. Other experimental demonstrations of electron tubes will be shown in Science Hall

## *Single battery tube voltmeter*

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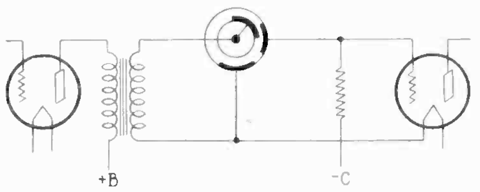


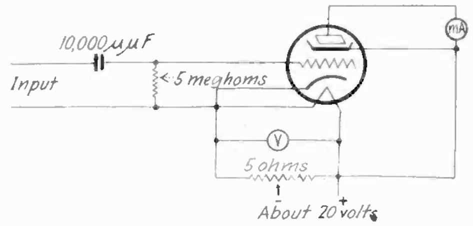


voltage shown is of the order of 3 ma. so that a highly sensitive instrument is not necessary in the plate circuit. It is desirable to add a shunt of about 2,000 μμf to the milliammeter if radio-frequency voltages are to be measured.—*Funk, Berlin, August 5, 1932.*

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## *Resonance indicator for quartz*

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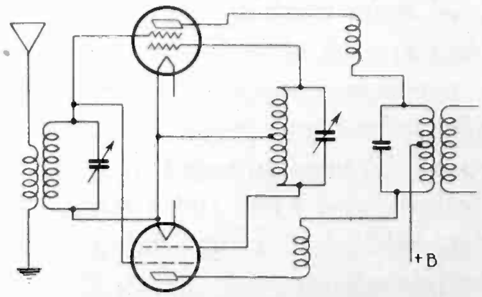


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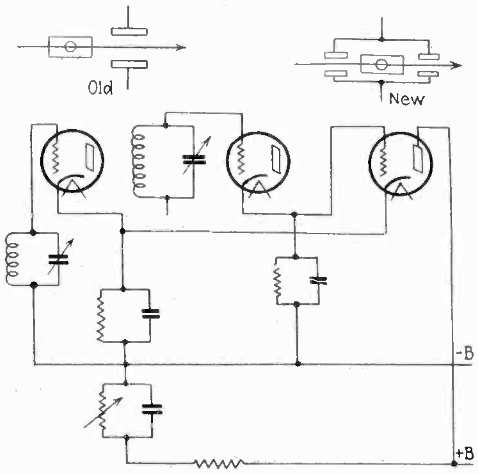


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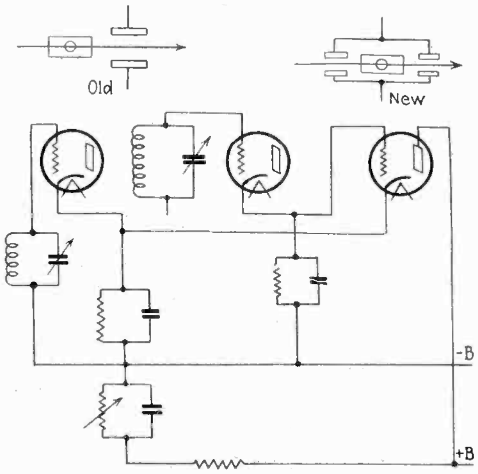


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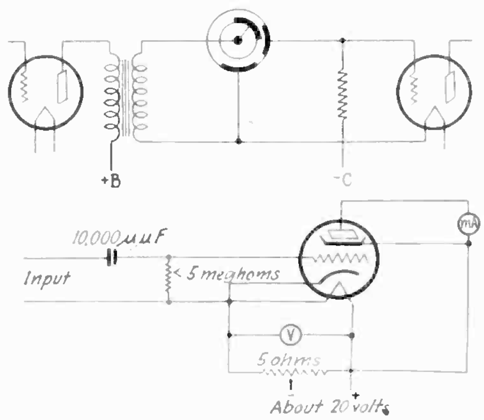


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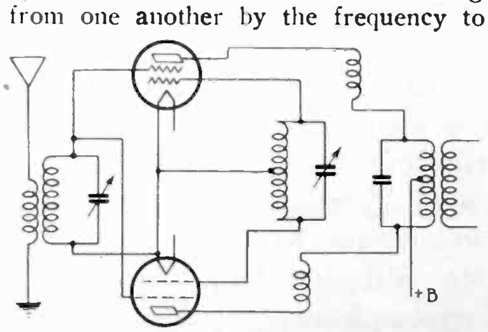


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✦

## *Capacitive output coupling*

[L. G. A. Sims] When an output choke $L$ is used as a coupling device between output tubes and loudspeaker (represented by a straight resistance load $R$), the coupling condenser $C$ may if suitably chosen, increase the output at low audio frequencies. When a 3 db. loss is allowed at the lowest frequency $f$, the relation holds that $\omega L = RR_i/(R + R_i)$, where $R$ is chosen equal to $2R_i$, twice the internal resistance of the tube for triodes and equal to $0.2R_i$ for pentodes. For pentodes the best value of the coupling capacity is much smaller than the 2 $\mu f$ usually employed; with a pentode of $R_i = 60{,}000$ ohms a 0.26 $\mu f$ condenser leads to an almost complete compensation.—*Wireless Engineer, June, 1932.*

✦

## *New French broadcasting service*

Parliament having voted the necessary funds, the broadcasting service will be reorganized so as to comprise 10 main zones (Lille, Rennes, Paris, Strabourg, Limoges, Lyons, Bordeaux, Toulouse, Marseille, Nice), and the Alpine district around Grenoble. Each zone will possess at least one transmitter covering a range of about 100 miles, the power depending on wave-length assigned, geographical and geological conditions, and sufficient to give good reception throughout the zone when using a three tube set. The senders will be built at a distance of at least ten miles from the next urban center and connected with the studios by means of underground wires giving perfect transmission between 25 and 12,000 cycles. All the stations will finally be connected by cables loaded every 915 m. by 0.22 mh. coils so as to allow faithful transmission of programs up to 10,000 cycles.—*Revere Générale de l'Electricité, July, 1932.*

✦

## *Home recording*

[Kluth.] Elementary but exceptionally complete and practical booklet, chiefly dealing with the materials available in Germany. Weidmann (publishers of "Funk,") Berlin, 1932: 1 mark 50.

✦

## *Exchange of programs with U. S.*

[Nestel.] Popular but very full article, with diagrams and photographs.—*Funk, Berlin, July 15, 1932.*

✦

## *New tube characteristic for detector performance*

[P. K. Turner] The makers give $I_g/E_g$ curves in a few cases, but $I_a/E_a$ curves taken with varying amounts of 50-cycles input (0, 0.25, 0.5, 0.75 to 2 volt), to a grid rectifying circuit (0.25 meg. grid condenser reactance 1,500 ohms) are more desirable. The intersection of these curves with the load resistance line must give equally spaced points in the case of faithful reproduction. The curves show at once the useful voltage output for a known input and percentage modulation.—*Wireless Engineer, July, 1932.*

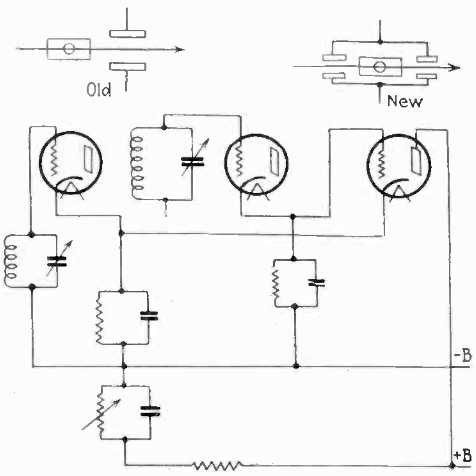
## *Demodulation of weak signals*

[F. M. Colebrook, E. V. Appleton] A letter points out that the result obtained with regard to the apparent demodulation of weak stations (carrier amplitude $w$, frequency $f$), by strong stations (amplitude $S$, frequency, $f_2$) namely that the response to $w$ is reduced to $w/2S$ (see *Electronics*, May, 1932) is only valid if the time constant of the grid circuit is sufficiently low to permit the mean grid potential to follow faithfully changes of the frequency $f_1 - f_2$. If the time constant is high, the mean signal current is that corresponding to the signal peak voltage $S + W$, and there is no "demodulation" effect.—*Wireless Engineer, July, 1932.*

✦

## *Cathode-ray tubes at high frequencies*

[Hollmann.] Although these tubes are relatively free from inertia, the velocity of the electrons sets a certain limit, especially with the modern low-voltage tubes. Research at the Heinrich Hertz Institute has led to the development of a new system of control plates which allows of the use of these tubes




also on the hundred million cycle frequencies (waves below one meter). The new form of tube has three pairs of control plates instead of two, the two outer pairs being connected in parallel. Photographs are given of oscillograms taken at these frequencies, and the phase distortion and loss of sensitivity associated with the normal type of tube are discussed mathematically. — *Funk-technische Monatshefte, Berlin, July, 1932.*

✦

## *Electroacoustic distortion and its prevention*

[Forstmann.] Very condensed article, dealing especially with certain less-studied forms and aspects of distortion, and with special reference to the mechanism of the ear itself and its effects on such distortions.—*Funk, Berlin, July 22, 1932.*

## *New definition of the television "point"*

[AISBERG.] Discussion of the present definition, leading to a suggestion to define the "point" as "The segment of a band scanned in a lapse of time equal to one-half period of the maximum modulation frequency available"; hence the optimum utilization of the frequency band available for the television transmission is such that the number of half periods available per unit of length in the direction of scanning shall be equal to the number of lines per unit of length in the transverse direction.—*La Television, Paris, July, 1932.*

✦

## *Radio business*

Details of the Dutch, Venezuelan, and Siamese markets. The first of these is dominated by Germany and Great Britain, the U. S. being practically unrepresented. In Venezuela very rapid development is reported, especialy as regards U. S., Dutch, Canadian, and British imports. The Siamese market is dominated by Germany, the U. S. and Great Britain coming second and third: as a practical point of especial importance it is mentioned that the a.c. supply, nominally of 110 volts, in reality varies between 80 and 130.—*Funk Magazin, Berlin, August, 1932.*

✦

## *Carrier interference eliminator*

[W. BAGGALLY] In contrast with sideband intereference which produces high pitched twittering noises the steady whistle produced by carrier interference can be reduced by means of a single band-pass circuit consisting essentially of two coils (L-M) and (1-M) wound so as to produce opposite voltages across a variable condenser and coil *M* which from the common end of the coils lead to ground. With three coils in the "primary," and four in the "secondary," each having 1,100 turns of No. 36, double silk covered wire, the primary and mutual conductance (L-M) being about 1 henry, a frequency range from 4,500 to 12,000 cycles is obtained when a 1,500 $\mu\mu f$ condenser is used. The band width R/6.28M is made equal to 1,500 cycles.—*Wireless Engineer, July, 1932.*

✦

## *Propagation along the earth of 1.6 m. waves*

[R. L. SMITH-ROSE and J. S. MCPETRIE] Measurement of the field intensity at different distances from the transmitter has been carried out for varous heights of the apparatus above the ground level. When both sender and receiver are close to the ground, the attenuation curve is similar to that given by longer waves. When the distance from the ground exceeds one wavelength, maxima and minima occur due to interference between waves directly transmitted and those which arrive after reflection from the earth's surface. The resistance offered by the ground is about 95 ohms per cc. at 190 Mc. or three times higher than for 60 Mc. waves.—*Proceed. Physical Society, July, 1932.*

✦

## *Another anti-fading device*

[CHRETIEN.] Using a variable-mu tube anode detection is employed. Among the advantages claimed are that no independent battery is necessary, that no variation of total anode current takes place (important in the case of mains-fed sets), that the regulating tube can be of the normal type, and that the margin of regulation is very great. In the case of grid detection the grid and cathode connections of the r-f tube must be interchanged, but the regulation is not so good.—*T.S.F. Moderne, Paris, July, 1932.*

✦

## *Electronic devices*

[A. W. HULL] Gen. El. Company. A general account of recent developments in red-sensitive phototubes, special amplifiers for small currents and voltages, and the thyratron, with charts giving the resistance of typical dry glass, the whole illustrated by applications the larger number of which have already been recorded in *Electronics.* The main function of these devices is to make possible the measurement of smaller things than could be measured before, and with less disturbance, by the measuring rod, of the thing measured.—*Physics, June, 1932.*

✦

## *Vertical sound records*

[H. A. FREDERICK] Bell Tel. Lab. Vertical records of sound cut on a wax disk extend the upper frequency cut-off nearly an octave, increase the playing time for a 12-in. record from about 4 min. to 15 min., give about 25 to 30 db. less noise and double the volume range. A much more faithful reproduction is secured.—*Journal Western Soc. of Engineers, June, 1932.*

✦

## *The Rotaphone*

[KEGEL.] Description of an instrument playing from celluloid discs, on which sounds are photographically recorded in spiral form, by means of a source of light above and a photo-cell below the disc.—*Funk Magazin, Berlin, August, 1932.*

## *Influence of magnetic fields on barrier-layer photocells*

[E. RUPP] German Gen. El. Research Lab. The photoelectric current obtained from cuprous oxide rearwall cells decreases in a magnetic field with the square of the strength of the field. The decrease is smaller at liquid air than at room temperature, and is most pronounced when the sensitive surface is parallel to the lines of force. In commercial cells inertia effects appear.

| Lines of force per sq.cm. | Relative decrease in current | Increase in resistance |
|---|---|---|
| 4,200 | 0.5 | 1.1 |
| 7,200 | 1.5 | 3.5 |
| 8,400 | 2.0 | 4.5 |

—*Zeitschr. f. Physik, July, 1932.*

✦

## *A new home "television"*

THE LATEST MODEL made by the British Baird Company has a screen 4 in. wide by 9 in. high. A mirror drum replaces the disk, and the neon lamp is replaced by a special form of Kerr cell so that brilliant images in black and white are obtained. The special Kerr cell does not require high voltages. The receiver measures when closed 18 in. by 8 in. by 13 in.—*Television, July, 1932.*

✦

# NEW BOOK

## First principles of television

*By A. Dinsdale. John Wiley & Sons, Inc. 237 pages. Price $3.50.*

A THOROUGH-GOING BOOK on television, treating in good style nearly all the known systems and devices used or invented for seeing at a distance. The basic facts of the science seems well handled throughout and the book is sufficiently up-to-date to deal to some length, with the recent work of U. A. Sanabria. The elements of optical systems, of light sensitive cells, of the various scanning schemes in considerable detail are all treated before the author plunges into a description of the various systems such as the Jenkins, Baird, the Bell system, and others.

Later portions of the book deal with the state of the art in Germany, England and America. Zworykin's work, or as much of it as has filtered through the rigid company censorship, is described and Farnsworth's dissection tube and electron scanning system are detailed.

Many diagrams of apparatus and circuits as well as photographs are used as illustrations. There is no mathematics, and the text is descriptive rather than technical.

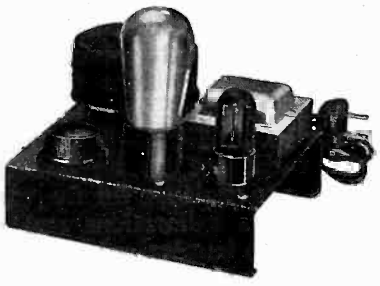
# + NEW PRODUCTS

## THE MANUFACTURERS OFFER

### Photo-switch

A NEW, LOW-COST photoelectric relay, the Foto-switch, is announced by the G-M Laboratories, Inc., 1735 Belmont Ave., Chicago, Ill. This unit embodies an electro-magnetic switch which is opened or closed by the interruption or variation in the illumination on the photoelectric cell. With the Foto-switch, any sort of electrical device, such as motors, electric signs, signals, or alarms, can be controlled through the medium of a light beam.

This new relay is designated as a junior model of the more expensive industrial photoelectric relays offered by



this company. The parts furnished include Visitron type B photoelectric cell, transformer, magnetic relay, wire-wound potentiometer tube, condensers, and terminal strip. Full accessories, such as lenses, light sources, light filters, special transformers, magnetic counters, power switches and mirrors are also available.

The Foto-switch is capable of handling many commercial applications which do not require the ruggedness demanded of industrial installations, such as door-openers, illumination control, burglar alarms, displays in store windows, signals for customers entering stores, counting people or products, control of electric sign illumination, etc.—*Electronics, September, 1932.*

+

### Standard signal generator

RCA VICTOR COMPANY, INC., Camden, N. J., announces a new standard signal generator, its type TMV-18-C. This instrument covers a frequency range of 90 to 10,000 kilocycles by means of six standard plug-in coils easily removable from the front of the panel.

The range can be extended down to 25 and up to 25,000 kilocycles by means of special coils. Voltages from $\frac{1}{4}$ microvolt to 2 volts are available at the output terminals of the instrument. A 400 cycle self-contained oscillator is capable of modulating the output up to 80 per cent as indicated by a percentage modulation meter on the panel. A new type of precision vernier dial using a planetary gear system gives 4,500 scale divisions for 270 degree rotation of the tuning condenser.

External modulation may be applied through an input transformer and controlled from the front of the panel. The output impedance of the attenuator is 0.7 ohm except for the higher multiplier settings.—*Electronics, September, 1932.*

+

### B power unit

THE MELROSE RADIO CORPORATION, 3224 Southport Ave., Chicago, has put on the market a B power unit, for supplying dependable B power to radio sets on automobiles, motor boats and airplanes. The device is compact, measuring $5\frac{3}{8}$ in. by $6\frac{1}{4}$ in. by $2\frac{5}{8}$ in., and weighs 6 lb. It is easily installed and can be placed in any position. The unit has no rotating parts, and does not need to be oiled or greased. No special tubes are required, standard licensed tube being used.—*Electronics, September, 1932.*

+

### Power amplifier combination

THE NEW MODEL 17 combination power amplifier unit, just announced by the Operadio Manufacturing Company of St. Charles, Illinois, embodies a design of extreme flexibility in application.

Nearly every sound application—including airport, sound truck, amusement park, and dance hall installations requiring up to 15 watts undistorted power output—may be filled by this unit. An additional output stage may be secured at small extra cost to provide 30 watts output.

The control panel of the amplifier has provision for microphone, radio, and phonograph inputs. Operating switches and volume controls for each input, an amplifier tone control, and all input connections are segregated on this separate unit that may be removed from the amplifier housing when remote control operation is desired.—*Electronics, September, 1932.*

### Photoelectric counter

A PHOTOELECTRIC COUNTER has been developed by the American Photoelectric Corporation, 215 Third Ave., New York City, to meet the demand for a counting device involving no contact, either electrical or mechanical, with the objects being counted. In use with a

suitable light source, this counter will record faithfully and accurately every interruption of light by passing objects.

The counter is small, light, and will operate from any 110-120 volt outlet, with less current drain than a 40-watt lamp. It is positive in action, and will count passing objects at any rate up to 360 per minute—six per second. The standard model has a four-digit (0.9,999) counter. It requires the minimum of maintenance.

Complete counter (d.c. or a.c.), minus photocell and amplifier tube, is priced at $29.50. Standard tested photocell costs $7.50, and amplifier tube $1.40.—*Electronics, September, 1932.*

+

### Glass-enclosed magnetic contactor

IN ITS NEW MAGNETROLE RELAY, the Hart Manufacturing Company of Hartford, Conn., employs a special glass tube inside of which there is a porcelain cup separating two concentric pools of mercury, each connected to a terminal in the base. A magnetic cylinder surrounds the porcelain cup and is so arranged that when moved under the action of the external solenoid winding, the mercury in the outer pool is displaced, completing the mercury-to-mercury contact. The action is thus entirely magnetic, the tube remaining stationary at all times. The unit is mounted on a bakelite base, and metal enclosing boxes can be supplied if desired. This Diamond H Magnetrole relay will close circuits up to 10 and 20 amp., using only 5 watts. As there is no exposed arc, the relay can be operated in the presence of inflammable or explosive gases.—*Electronics, September, 1932.*

## Condenser microphone

THE NEW CONDENSER MICROPHONE produced by the Remler Company, Ltd., 2101 Bryant St., San Francisco, Calif. is a.c. operated with power supply unit, has two stages of pre-amplification with an essentially flat response from 40 to 10,000 cycles per second. Other features include: New plug-in type transmitter head, only three wires and shield necessary for operation in public address, pressure-equalized diaphragm, moisture-proof head, complete plug-in assembly

of head amplifier and transmitter head, combination 200 and 50-ohm output, automatic bias, special high permeability core, output level approximately 10 decibels. Pie-amplifier housing only 2½ in. in diameter. Does not obstruct view of speaker. Transmitter head—diameter 3⅛ in. Depth 1⅜ in.—*Electronics, September, 1932.*

✦

## 60-watt amplifier

BELIEVING THAT THERE ARE many instances where power up to 60 watts is necessary, Victory Speakers, Inc., 7131 E. 14th St., Oakland, Calif., has developed its new Victory a.c. 60-watt amplifier. This unit fills the requirements for airports, large auditoriums, parks, playgrounds and schools. It uses six-46; four-45; one-56; one-57 and three-83 type tubes. It can be furnished also for mounting on a standard 19-in. rack. Mixers, volume-level indicators and selective output controls are built to order for use with this instrument. Its frequency characteristic is declared to be essentially flat between 30 and 8,000 cycles, and the gain is 120 decibels.—*Electronics, September, 1932.*

✦

## Photronic exposure meter

LIGHT INTENSITY MEASUREMENT has been placed on the same basis as the measurement of amperes or volts by the Weston Electrical Instrument Corporation, Newark, N. J., using its newly developed Photronic photoelectric cell. In this universal exposure meter for photographic use, brightness measurements are taken directly from the scale of an instrument easily read by the layman.

The exposure meter is scientifically designed to give accurate exposure information for both "stills" and "movies." It consists essentially of two parts, an electrical instrument operating from two Photronic cells located in the back of the meter and a simple, novel mechanical calculator for translating the brightness measurements into proper apertures and shutter timings for any plate or film speed.

No batteries are required and no adjustments are necessary. The meter is independent of climate conditions and intensity of light.—*Electronics, September, 1932.*

✦

## Airplane radio

A COMPLETE NEW LINE of radio telephone equipment for aircraft use is announced by the Western Electric Company. The new transmitter is arranged to transmit on any of three pre-arranged frequencies. Stability is maintained by an improved type of quartz crystal oscillator. Circuit changes and the improved types of tubes used do away with the necessity of neutralizing the transmitter. The coupling unit for the antenna is included as part of the transmitter unit, eliminating the separate tuning unit which was formerly employed and was installed at the base of the transmitting antenna.

The receiver employs an ultra-selective superheterodyne circuit, variable mu tubes with pentode output and has a wide range automatic gain control. It is designed for rapid frequency shift between two pre-arranged frequencies. —*Electronics, September, 1932.*

✦

## Interference locater

THE TOBE DEUTSCHMANN CORPORATION, Canton, Mass., offers a new signal-strength meter for locating sources of radio interference. The instrument is compact and weighs 28½ lb. It has a sensitivity range from 0.5 to 25,000 micro-volts per meter, and its selectivity and fidelity are comparable to those of a modern socket-operated receiver. The circuit comprises a four-stage tuned radio-frequency amplifier and two-stage resistance-coupled audio amplifier. A

two-meter collapsible steel rod serves as antenna. Both audible and visual signal indications are given. Calibration curves makes possible accurate measurement of signal level. The Deutschmann Engineering Bulletin No. 232 gives full details of the new signal-strength meter.—*Electronics, September, 1932.*

## Condenser microphone

THE GATES RADIO & SUPPLY COMPANY, of Quincy, Ill., offers its model G bullet-type condenser microphone for either table or suspension operation and for use in broadcasting, recording and public-address applications. This microphone has as its features absence of background noise, freedom from blasting, and a uniform response from 30 cycles to 8,000 cycles. It uses two No. UX-864 tubes in connection with a special condenser head sealed to prevent sudden humidity changes from seriously affecting the frequence response of the microphone or freezing of the diaphragm. Net price is $75.—*Electronics, September, 1932.*

✦

## Tuning dials

THE DEJUR-AMSCO CORPORATION, 95 Morton St., New York City, describes its various full-vision tuning dials in a new catalog just issued. These include the ninety-degree full-vision friction-drive dials with both travelling spotlight and stationary pilot light; 180-degree dials, in both direct-drive and friction-drive, and pilot-light holders. A large variety of artistic escutcheon designs is also available for the various dials. Various calibrations and scale colors can also be obtained upon application.—*Electronics, September, 1932.*

✦

## High-resistance values

D. T. SIEGEL, GENERAL MANAGER, Ohmite Manufacturing Company, 636 North Albany Ave., Chicago, announces that fifteen new high resistance values have been added to the 42 values which comprise the "Red Devil" line.

The new units are also of the wire-wound type in which the resistance wire is wound over a genuine porcelain tube and covered with Ohmite refractory cement. The values range from 30,000 ohms to 100,000 ohms in steps of 5,000 ohms, which added to the present values make it possible to obtain these resistors in values from 1 ohm to 100,000 ohms.—*Electronics, September, 1932.*

✦

## Seven-prong socket

THE CINCH MANUFACTURING CORPORATION, 2335 W. Van Buren St., Chicago, announces a new seven-prong socket for use with the new seven-prong radio tubes. The Cinch floating contacts provided are designed to eliminate all strain on the bakelite. Warping and loss of tension after tube is inerted is thus prevented. The soldering operation is also simplified. All holes generally used for riveting contacts to bakelite are eliminated—making the socket considerably stronger. — *Electronics, September, 1932.*

# U. S. PATENTS
## IN THE FIELD OF ELECTRONICS

### Amplification, Generation, Detection, Etc.

**Grid connection.** Grid return lead is connected through a bias battery to one terminal of a tertiary winding and then to the filament of a tube which is lighted by a.c. Across this tertiary winding is a resistance shunted by a condenser. The resistance is substantially equal to half the resistance of the cathode. P. G. Gardiner, assigned to G. E. Co., No. 1,871,409.

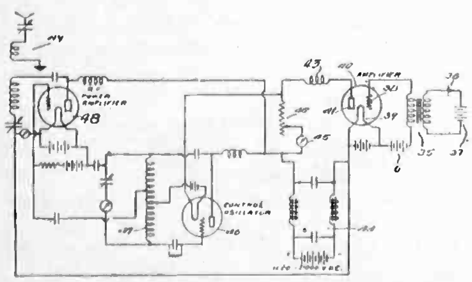
**Hum-reducing circuit.** Method of reducing the capacity between grid and cathode. E. A. Lederer, assigned to Westinghouse Lamp Co., No. 1,871,537.

**Oscillation system.** A circuit in which the grid and plate of an ordinary crystal controlled oscillator are interchanged. F. E. Terman, assigned to Wired Radio, Inc., No. 1,871,632.

**Transmission regulator system.** Combination of a pilot circuit the resistance of which changes with temperature and a rectifier to automatically control the d.c. potential applied to the screen-gird of a tube. R. C. Corderman, assigned to A. T. & T. Co., No. 1,871,959.

**Frequency changer.** A mechanical vibratory device having a marked tendency to vibrate at one period. Method for altering the frequency by adjusting the phase of a locally generated signal. L. J. Wolf assigned to Westinghouse E. & M. Co., No. 1,872,379.

**Suppressed-wave carrier system.** An amplifier-modulator system. H. A. Brown, assigned to University of Illinois, No. 1,872,398.



**Single side-band modulation.** Method of modulating a carrier frequency with suppression of the carrier wave with one of the side bands. F. Trautwein, Berlin, Germany, No. 1,868,339.

**Frequency responsive relay.** A readily ionizable medium surrounding an electrode and an electric crystal for ionizing the medium when a predetermined frequency is impressed upon two electrodes. A. M. Skellett and V. K. Zworykin, assigned to Westinghouse E. & M. Co., No. 1,869,829.

**Filtering circuit.** A selective network coupled to an antenna whereby transmission is suppressed at a frequency different by a substantially constant amount from the frequency of the tuned circuit. G. H. Stevenson, assigned to B. T. L., Inc., No. 1,869,870.

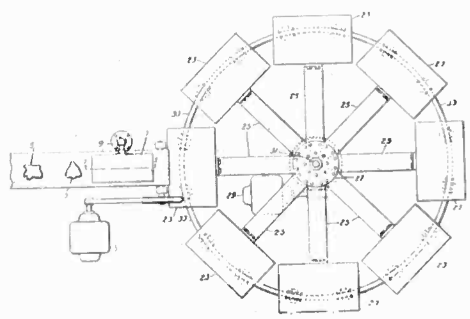
**Modulating arrangement.** Two patents granted to Rudolf Urtel and assigned to Telefunken for modulating, Nos. 1,868,033 and 1,868,034.

**Rectifying and stabilizing apparatus.** Method of controlling the output of rectifying tubes so that it is maintained constant independent of fluctuations in the energizing supply service and variation in load. W. S. Werner, assigned to Kelley-Koett Mfg. Co., No. 1,870,937.

**Interstage system.** A combined resistance and transformer coupling for connecting two tubes. Richard Feldtkeller, assigned to Siemens and Halske, Berlin. No. 1,869,914.

### Electronic Applications

**Photoelectric device for classifying laundry material.** R. F. Elberty, assigned to Westinghouse E. & M. Co., No. 1,872,258.



**Method for testing condensers.** A variable electric condenser is inserted in a tuned circuit which generates current of known frequency and higher harmonics. The settings of the unknown condenser corresponding to points of resonance for the various currents are noted. M. H. Bennett, assigned to Scovill Mfg. Co., No. 1,867,131.

**Voltage limiter.** Two patents, Nos. 1,869,464 to W. A. Knoop, and 1,869,466 to I. E. Cole, both assigned to B.T.L., Inc., using a pair of hot cathode gaseous discharge devices for voltage limiting purposes.

**Measuring device.** Four element vacuum tube is used to measure the product of two quantities. M. S. Mead, Jr., assigned to G. E. Co., No. 1,869,209.

**Apparatus for indicating speed.** Mechanism to be measured produces a pulsating current having a regular sine-wave characteristic which is compared to a locally generated frequency. L. H. Brown, assigned to W. E. Co., No. 1,871,404.

**Steering system.** A vacuum tube operated method of keeping an airplane or other vehicle on a straight course. T. R. Rhea, J. D. Tear, and C. F. Green, assigned to G. E. Co., No. 1,871,469.

**Control system.** A mechanism for performing a predetermined operation upon a material and a motor to operate it is controlled by vacuum tubes. H. R. Crago, assigned to G. E. Co., No. 1,871,499.

**Telemetering apparatus.** Method of producing a temperature difference proportional to some quantity of the transmission circuit. Thermal differences are transmitted by vacuum tube amplifiers. B. D. Bedford, No. 1,869,128, assigned to G. E. Co.

**Cable testing system.** A d.c. high voltage testing system having an a.c. system as a source of power. H. S. Hubbard, assigned to G. E. Co., No. 1,867,407.

**Self-focussing camera.** An automatic focussing means for cameras, including a light-sensitive cell. L. G. Simjian, New Haven, Conn., No. 1,866,581.

**Apparatus for maintaining synchronism.** A rotating segment connected to and controlling the output of a transmitter and a receiving vacuum tube amplifier, the tubes being selectively tuned to the respective frequencies generated in the transmitter. Samuel Ruben, New Rochelle, N. Y., No. 1,867,925.

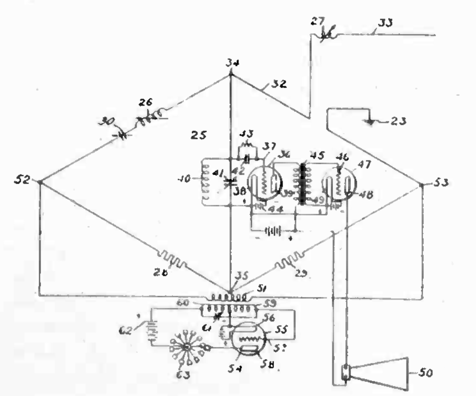
**Measuring reverberation time.** Time delay circuit, etc., closing a relay when currents have decayed to a predetermined level. F. L. Hopper, assigned to E. R. P. I. No. 1,868,105. Also No. 1,869,196, F. H. Hibbard to E. R. P. I.

**Power transfer system.** A method of transferring d.c. to a.c. power by means of triodes and a reactor. C. A. Sabbah, assigned to G. E. Co. No. 1,870,027.

**Testing device.** A method of determining the stress in a member under tension, consisting of vibrating the member in a constant magnetic field to generate an a.c. voltage. A. M. Curtis, assigned to B. T. L., No. 1,869,884.

**Advertising device.** Several devices, the operation of which can be visually observed, all being located in the field of view of a spectator and a sound responsive device operated by the spectator for controlling the operation of the advertising device. R. J. Wensley, assigned to Westinghouse E. & M. Co., No. 1,872,372.

**Protective system.** An alarm system in which a balanced network analogous to a Wheatstone bridge is used, the dielectric of a condenser of which comprises a stage to be protected. E. B. Mallory, assigned to Westinghouse E. & M. Co. No. 1,870,181. See also No. 1.872.560. J. V. Breisky and No. 1.871.787, S. L. Goldsborough, both to Westinghouse E. & M. Co.



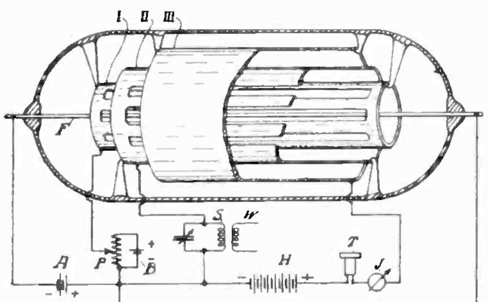
## Vacuum Tube Construction

**Tube support, etc.** A series of patents granted W. L. Krahl, Robert Harding and others and assigned to the Arcturus Radio Tube Co., Nos. 1,866,715, 1,868,600, 1,868,604, 1,869,560, 1,869,561, and 1,869,566 to 1,869,568 inclusive.

**A method of obtaining metallic coatings.** Gaseous compound of the alkali and alkaline earth metal is introduced into the tube and decomposed by electrolysis. H. J. Spanner and Ulrich Doering, Berlin, assigned to Electrons, Inc., No. 1,866,729.

**Method of cleaning up gases.** An ultra-high frequency current is passed through a grid lead to which is attached a vaporizable getter material. H. E. Clarry, assigned to Westinghouse Lamp Co., No. 1,869,544.

**High frequency tubes.** A circuit and tube of interesting construction. George Seibt, assigned to RCA, No. 1,868,443.



## Radio Circuits

**Direction finder.** Method of generating a current the amplitude of which depends upon the deviation of the directional receiving apparatus from a straight line between the receiving and transmitting station. G. G. Kruesi, assigned to Bendix Aviation Corp., No. 1,868,945.

**Anti-radiation system.** Method of using a blocking tube between the antenna and a regenerative detector tube. L. A. Hazeltine, assigned to Hazeltine Corp., No. 1,689,894. Original application filed Feb. 27, 1925.

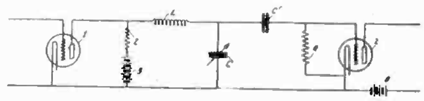
**Automatic volume control.** A relay method by which variations in signal intensity operate relay armatures and control the output amplitude. H. J. M. Regnauld, assigned to RCA, No. 1,867,139.

**Selective system.** A multiple path antenna and a pair of branch circuits and a rejector for unbalancing the circuits at a selected frequency. S. Y. White, assigned to RCA, No. 1,867,608.

**Amplifier tube control.** An arrangement for reducing current losses in the anode circuit of power amplifier tubes by a method of reducing the current flowing to zero in the absence of signal voltage in the grid circuit. W. V. B. Roberts, assigned to RCA, No. 1,872,347.

**Noise reduction circuit.** Method of coupling two antennas to a radio receiving set through series condensers and adjusting until an increase and decrease in the value of one condenser effects no increase in the noise. J. M. Miller, assigned to Atwater Kent Mfg. Co., No. 1,872,487.

**Interstage amplifier.** A coupling between tubes comprising a series of resonance circuits tuned to a definite low frequency. Paul Bories, Paris, France, No. 1,872,109.



**Interstage transformer.** Transformer for transferring r. f. current over a broad band of frequencies from the output of one amplifier to the input of the next. Primary and secondary windings coupled to each other are formed of high resistance wire and the L C ratio is such that the maximum voltage across the terminals of the secondary winding are not greater than twice the minimum voltage. H. J. Round, assigned to RCA No. 1,869,914.

**Radio alarm system.** A distress transmission receiving system comprising mechanical means response only to low a. f. signals. J. D. Durkee, Washington. D. C., No. 1,872,257.

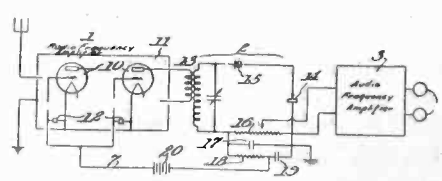
**Superheterodyne receiver.** Method of producing an intermediate difference frequency such that it can be produced by only one signal frequency within the desired range. W. V. B. Roberts assigned to RCA, No. 1,871,740.

**Constant beat frequency.** Method of maintaining a local circuit at a fixed frequency relation with the frequency of incoming signal regardless of signal and local frequency variation. A portion of the beat frequency energy is limited to remove amplitude variation, transforming the variation into potential variations which are amplified and impressed on the circuit for control purposes. George Rodwin, assigned to RCA, No. 1,871,741.

**Method of energizing filaments.** Vacuum tube filaments heated by a.c. by altering the wave form until it becomes rectangular. Alexander Nyman and G. V. Peck, assigned to Dubilier, No. 1,870,960.

**Control system.** Method of deenergizing all vacuum tubes in a transmitting system when the microphone control is deenergized. R. L. Davis, assigned to Westinghouse E. & M. Co., No. 1,870,795.

**Automatic volume control.** Method of suppressing fluctuations in an output circuit due to variations in incoming signal by means of a rectifier of incoming signal energy and by impressing upon the grid of this tube a direct current derived from the rectifier. The rectifier has an approximate relation between d.c. output and r.f. input above a critical input voltage. Stuart Ballantine, assigned to Boonton Research Corp., No. 1,869,331.



**Scanning system.** An optical system with means for reversing current impulses. Heinz Lux, assigned to Telefunken, No. 1,866,573.

**Electro-optical system.** A transmitter comprising an induction lamp, means for energizing the lamp with composite current including components of high and line carrier frequencies. Frank Gray, assigned to B.T.L., No. 1,869,194.

## Patent Suits

1,533,858, L. A. Hazeltine, Method and means for neutralizing capacity coupling in audions, C. C. A., 2d Cir., Doc.——, Hazeltine Corp. v. Radio Corp. of America. Decree affirmed (notice June 9, 1932).

1,710,073, 1,714,191, S. Ruben, Electrical condenser, filed June 3, 1932, D. C., S. D. N. Y., Doc. E 68/212, Ruben Condenser Co. et al. v. Condenser Corp. of America.

1,606,212, Dunmore & Lowell, Power amplifier, C. C. A., 3d Cir., Doc. 4656—4657—4658, U. S. of America v. Dubilier Condenser Corp. Decree affirmed May 24, 1932.

1,633,366, H. Fischer, Sound amplifier, D. C., S. D. N. Y., Doc. E 43/354, H. Fischer v. Utah Radio Products Co. Dismissed for lack of prosecution (notice June 22, 1932).

1,456,528, H. D. Arnold, Electric discharge device; 1,459,412, A. M. Nicholson, Thermionic translating device Re. 15,278, I. Langmuir, Electron discharge apparatus, D. C., S. D. N. Y., Doc. E 44/332, Radio Corp. of America et al. v. Tectron Radio Corp. Dismissed for lack of prosecution (notice June 22, 1932).

1,648,808, L. A. Hazeltine, Wave signaling system, D. C., S. D. N. Y., Doc. E 44/90, Hazeltine Corp. v. Stewart-Warner Speedometer Corp. Dismissed for lack of prosecution (notice June 22, 1932).

1,113,149, E. H. Armstrong, Wireless receiving system, D. C., S. D. N. Y., Doc. E 42/120, Westinghouse Electric & Mfg. Co. et al. v. Allen-Rogers, Inc. Dismissed for lack of prosecution (notice June 22, 1932).

1,271,527, M. C. Hopkins, Sound regenerating machine, D. C., S. D. N. Y., Doc. E 35/313, Lektophone Corp. v. A. Scaison et al. Dismissed for lack of prosecution (notice June 22, 1932). Doc. E 35/315, Lektophone Corp. v. Bear Tone Radio Corp. Decree as above.

1,455,141, Lowell & Dunmore, Radio receiving apapratus, D. C., S. D. N. Y., Doc. E 37/383, Dubilier Condenser & Radio Corp. v. Batteryless Radio Corp. Dismissed for lack of prosecution (notice June 22, 1932).

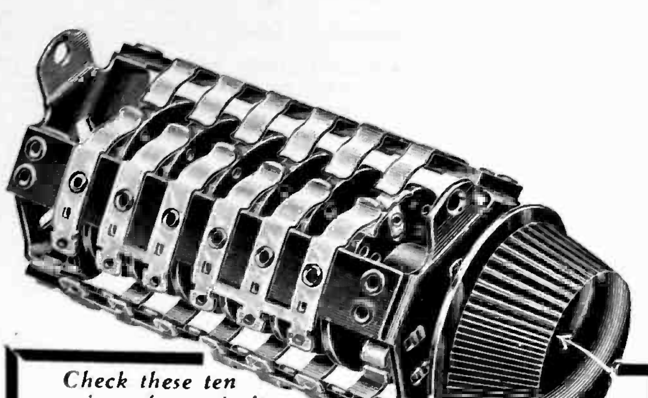
1,573,374, P. A. Chamberlain, Radio condenser, D. C., S. D. N. Y., Doc. E 40/24, Mohawk Corp. of Illinois et al. v. United Scientific Laboratories, Inc. Dismissed for lack of prosecution (notice June 22, 1932).

1,506,046, W. H. Bullock, Radio receiving system, D. C., S. D. N. Y., Doc. E 46/13, W. H. Bullock et al. v. Haynes-Griffin, Inc. Dismissed for lack of prosecution (notice June 22, 1932).

1,549,882, L. L. Jones, Condenser, D. C., S. D. N. Y., Doc. E 38/287, Amsco Products, Inc., v. General Instrument Corp. Dismissed for lack of prosecution (notice June 22, 1932).

# EBY

## *has a brand new Short Wave Switch*



*Check these ten points of superiority before designing any new circuit.*

1. **STURDY CONSTRUCTION** permits ganging of any number of units into a strong, compact assembly, insuring long switch life.
2. **COMPACTNESS** resulting in the switching of the most intricate circuits in the smallest possible space.
3. **FLEXIBILITY** which provides any variety of circuit arrangements and contact sequences desired.
4. **NEGLIGIBLE CAPACITANCE EFFECTS** between adjacent switch circuits and to ground.
5. **NO VARIABLE EFFECTS:** High frequency circuits compensated for the electrical characteristics of the switch remain satisfactorily adjusted for any position of the switch.
6. **EXCEPTIONALLY LOW CONTACT RESISTANCE** is obtained by the use of the highest grade, silver plated-phosphor bronze contact springs. Negligible contact resistance is present, even after twenty thousand oscillations of the switch. All circuits having common connections are linked by one piece contact spring construction. This eliminates all possibility of loose or high resistance contacts.
7. **COMMON GROUND CONNECTION** of shaft, end plates, and all electrically inactive metal parts.
8. **INSULATION** of the highest quality between all circuits and ground.
9. **SMOOTH ACTION AND POSITIVE ALIGNMENT** is obtained by the sturdy construction of the unit and gang assemblies, by the special design of the contact springs, the perfect, rigid alignment of all parts, **and the ball bearing snap action giving positive, decisive switch positions.**
10. **UNIVERSAL MOUNTING** with either single hole threaded bushing, or two hole screw or eyelet mounting is available.

Designed to meet the critical electrical and mechanical requirements of a multi-polar, multi-position switch for use in the radio frequency circuits of multi-waveband radio receivers—well adapted to any switching problem that requires the opening or closing of a number of circuits at once or in sequence.

The new Eby Switch provides greater flexibility by making it possible for you to open or close one or more circuits before opening or closing another circuit or series of circuits.

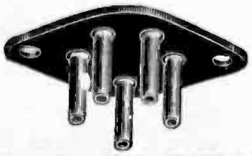
Ingenious, simple yet rigid construction prevents any possibility of shifting contact positions. You get a smooth, positive contact at all times.

Cut shows a six gang position switch. Can be supplied single, double, triple and so on up to ten or twelve gangs.

Samples are now available. Prices upon request.

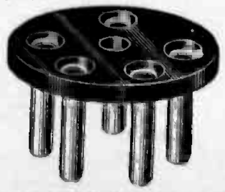
### MOULDED FEMALE CABLE CONNECTORS

Consist of a moulded cap and a socket assembly. The two fit together by means of a bayonet arrangement which permits quick and positive assembly and disassembly. Socket same as Type 8 illustrated on right with a special base plate to fit the moulded cap. Assembled unit matches Moulded Male Plug Cable Connector, illustrated below, the two providing an ideal method of making quick make and break multiple circuit connections between multi-wire cables.
These Eby units conform to Underwriter's standards of safety.



### LAMINATED PLUGS FOR CHASSIS MOUNTING

Where "hot" outside wires must be connected to the chassis wiring by means of a multiple circuit connector, it is important, to conform with the Underwriter's safety requirements, that the "hot" wires be connected to female socket terminals. In such cases, the chassis wiring or "cold" terminals of the receiver or similar equipment should be connected with male plug prongs.
Eby male plugs for chassis mounting are designed for this purpose and form a simple, inexpensive way of accomplishing the desired purpose. They are furnished regularly in Brown finish.



### LAMINATED MALE PLUGS

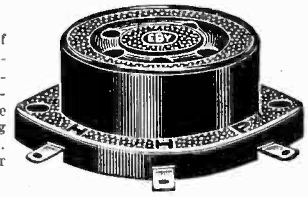
Offer one of the simplest and lowest cost methods of making multiple circuit connections when used with a standard socket as the female section of the connector.
Consist of laminated Bakelite discs with tube prongs inserted and fastened firmly in place in holes properly spaced to correspond with standard tube socket spacings.
These units are furnished regularly in Black Canvas Bakelite.

### TYPE 8

Designed for sub-panel mounting, where a large hole, approximately 1 7/16 in. to receive the body of the socket, is drilled or punched through the sub-panel. In mounting, socket is inserted into hole of sub-panel through bottom so that the mounting base remains beneath the sub-panel, with only the top projecting through.

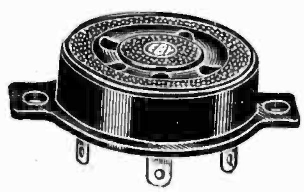
### TYPE 12

Eby "Universal" with entire shell and base moulded in one piece. Contact spring terminals arranged so that it can be mounted on metal or insulating panels with terminals projecting above panel for experimental or above board wiring or projection below the sub-panel for sub-panel wiring.

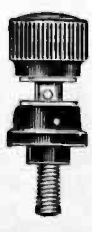


### TYPE 3

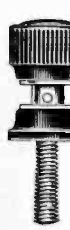
Bronze contact springs are of one-piece construction, punched and shaped to lend themselves to quick, low-cost assembly operations. Available in the following mounting centers—1½ in.—1 27/32 in. and 1 11/16 in.—the latter two in the same size plates.



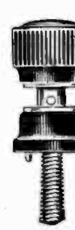
Eby moulded tube sockets are available in black Bakleite finish only. They are specially recommended, because of sturdy construction, for use in vacuum tube aging racks, life test racks, experimental set-ups, etc., where tubes are constantly withdrawn. Contact designations are moulded on top and bottom of base, close to terminals. Eby laminated sockets are designed to permit mass production at low prices, being stripped down to the absolute essentials of a fundamentally good socket.



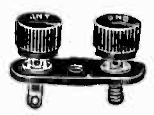
Junior P4



Junior



Junior P3



### TWIN POSTS

Eby Twin Post units form neat assemblies for making connections to any electrical device. On the Type No. 22-S Twin Units with non-removable tops, the markings "A" and "G" are made on the laminated strip next to the binding posts.

### BINDING POSTS

Eby Binding Posts with non-removable heads, which prevent the loss of tops or errors due to the shifting of knobs to the wrong terminal, have long been recognized as the standard of comparison in the Radio and Electrical Industry. They are examples of real engineering applied to the solution of the problem of effecting a positive contact between leads and terminals.

**THE H. H. EBY MANUFACTURING CO., INC., PHILADELPHIA, PA.**

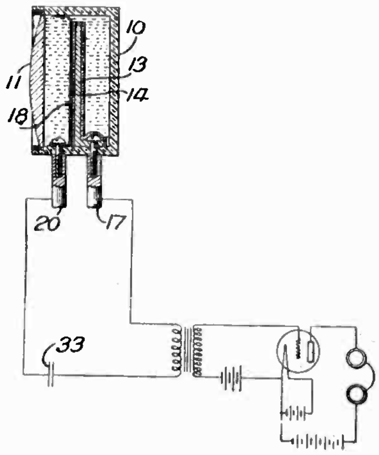
# BRITISH PATENTS

## IN THE FIELD OF ELECTRONICS

### Vacuum Tubes, Photocells, Etc.

**Thermionic cathodes.** A filament wire, to be used as a heater in the indirectly-heated cathode tube. An insulated coating, comprising an insulating metallic oxide in its molecular state, having a high melting point and a small percentage of another insulating material having a melting point lower than that of metallic oxide. Suitable oxides are those of aluminum, beryllium, magnesium, calcium, chromium and titanium. To obtain a layer of aluminum oxide in its molecular state upon a Tungsten filament, a series of successive coatings of a saturated solution of aluminum nitrate containing from 3 to 10 per cent by weight of silicon dioxide, are applied thereto, the wire being heated after each coating to break the aluminum nitrate up into aluminum oxide, nitric oxide and water, the last two being driven off as vapor. The silicon dioxide melts at a temperature below the filament temperature obtained during the exhausting of the vacuum tube, thereby causing the aluminum oxide to adhere closely to the wire. Preferably the aluminum nitrate solution is a saturated one, having a specific gravity of 1.4, at 27 deg. C. Metallic oxides which are good insulators and which have a melting point at or below a dull red heat, may be added to the aluminum nitrate solution, instead of silicon dioxide. Arcturus Radio Tube Co., Newark, N. J. No. 367,820.

**Light sensitive cell.** A light-sensitive cell comprises a casing 10, having a transparent window 11, filled with liquid and accommodating an openwork electrode 18 separated by a light sensitive layer 14 from an electrode 13. The electrodes are connected to external terminals 20, 17 and are preferably of copper. The light-sensitive material is preferably copper sulphide, selenide, telluride, or oxide, and may be formed by heating the copper electrode 13 to about 1,000 deg. C., to form cuprous oxide; it is then immersed in hydrochloric acid to clean and reduce the outer layer of cupric oxide to copper and some of the cuprous oxide, cleaned in nitric acid and the oxide surface etched with hydrofluoric acid or some other suitable reagents such as sulphuric acid or ammonium chloride and the back of the electrode is coated with an opaque insulating varnish. The gauze electrode 18 is coated with cupric sulphide, e.g., by heating to about 500 deg. C. in an atmosphere of sulphur, so that when the cell is in darkness the potential across the electrodes is reversed, cupric sulphide being electro-negative with respect to cuprous oxide. The liquid in the casing 10 preferably has a high inductive capacity and may be glycerine, ethyl glycol or alcohol and may be diluted with ½ per cent of an organic acid such as citric, butyric or oxalic acid to provide an electric leak and preserve the etched cuprous oxide surface. When the liquid is conducting, a condenser 33 in series with the cell prevents any direct current flowing through the cell. Arcturus Radio Tube Co., Newark, N. J. No. 368,388.




**Barium getters.** Commercially pure barium to be introduced into tubes to improve the vacuum or activate the thermionic cathode, is treated to distribute the remaining impurities evenly, so as to avoid the usual rapid attack by air, due to the distribution of the impurities in layers in the commercial metal. The metal, preferably of a purity of at least 98 per cent, is fused or heated to just below its melting point, for a considerable time in a current of rare gas, and is then rapidly cooled to below 400 deg. C. For example, the metal is heated in a steel receptacle which is quenched in water. The treatment may be carried out in small nickel or molybdenum receptacles and subsequently introduced into the discharge tube or in recesses in the electrodes. Alternatively, the metal is distilled in vacuo, or in rare gas in a chamber raised quickly above 1,150 deg. C. Metal so treated is not rapidly attacked in air, and slow attack at the surface may be avoided by a coating of paraffin oil, or other material vaporizing without decomposing when the tube is evacuated. The coated metal may be rolled or pressed into ribbons or filaments and again coated with paraffin oil, before applying to an electrode or to a separate support. The coated metal may also be ground to a paste and compressed into tablets or painted on an anode. International G. E. Co. No. 367,792.

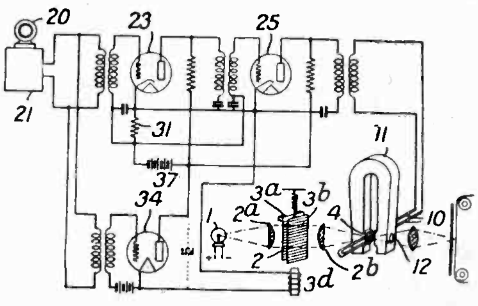
**Heater type tube circuit.** Disturbing voltages due to alternating or pulsating variations in currents in unipotential cathode tubes, are compensated by providing separate and independently adjustable means for grounding the electric center of the heater circuit, and for adjusting the compensating voltages applied to the grid. A. E. G., Berlin. No. 368,152.

**Discharge lamp.** The envelope of a magnesium vapor lamp consists at least partly of an alkali-proof boro-silicate glass, containing not more than 50 per cent of silica, a considerable proportion of boric acid, and the usual glass constituents, such as alkali, alkaline earths and aluminum oxide. For ultra-violet lamps, a thin layer, conveniently less than 0.3 cm. in thickness, is deposited on the inside of an envelope for transference of ultra-violet light; for example, of quartz or of the material known under the registered trade-mark "Uviol." G. E. Co. No. 368,209.

### Radio and Television Circuits

**Superheterodyne circuit.** A method of adjusting the local oscillator of a superheterodyne receiver to produce an intermediate frequency exactly equal to the middle frequency of the band for which the amplifier is designed, without interruption of signal traffic. Marconi Co. No. 368,286.

**Valve amplifying circuits.** In recording sound and like oscillations by a beam of light directed through a light valve 2 operated in accordance with the varying amplitude and a light valve 4 operated in accordance with the frequency, the valve 4 is influenced from a microphone 20 or the like through a valve circuit 21, 23, 25 and the light valve 2 is influenced by a shunt from the microphone circuit through a detector 34. In order that the large amplitudes in the oscillaitons supplied to the light valve 4 may be reduced with the object of influencing this valve at substantially maximum frequency modulation, the plate circuits of the valves 23, 25, 34 are fed from a common source 37 and after passing through the valves are returned through a common resistance 31 in the grid circuits of the valve 23, 35 whereby the gain of these valves is reduced at increased amplitudes. Electrical Research Products, New York. No. 367,912.




**Phonograph amplifier.** Means are provided for varying the gain of an amplifier in accordance with the intensity, to prevent overloading and to control the amplification in accordance with frequency. The system is adapted to pick up from a photocell or a pickup unit. Extraneous noises of high pitch, for example, a scratch, are suppressed at low intensity. J. H. Hammond, Gloucester, Mass. No. 366,937.

**Typesetting telegraphy.** A type composing machine operated electrically from a distance by means of oscillators. H. E. Van Thijn, and M. Kann, Amsterdam, Holland. No. 366,441.