electronics

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

Manufacturers pull together

✦

More about the new tubes

✦

Production of photocells

✦

Radio and the Aug. 31 eclipse

✦

Dynamic-speaker design

Highway in Holland lighted by new electronic vapor lamps. Efficiency, 3 to 6 times tungsten. *(Page 253)*

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The radio manufacturers

PULL TOGETHER

AS radio is now sold to the public,—in the form of finished sets,—the prosperity of the whole radio industry is dependent upon the success of the radio-set manufacturers. It was logical, therefore, that the set makers should take leadership of the Radio Manufacturers Association and direction of its contacts with the public, as occurred in the reorganization of the RMA voted by the directors last month.

The radio business had been rapidly developing into a "racket." If radio was to be saved and made the field of future possibility that it ought to be, it was becoming evident that individual desires to dominate must be subordinated to industry good, and that every manufacturer must adopt more of an attitude of "live and let live" not only to his competitors but also to his suppliers.

UNDER the new plans for the RMA, large opportunities for correcting industry evils and for promoting sales of radio products are made possible. The introduction of new models and new tube combinations can be discussed constructively. Production figures can be studied. Industry promotion plans can be carried out, cooperating with the broadcasters. Campaigns to revive interest in radio, can be developed with the aid of distributors and dealers, and having the united backing of all the principal set-manufacturing interests.

The steam railroads, the automobile manufacturers, and others have already worked out their association affairs along lines similar to those now proposed for radio, and which the membership of the RMA will be asked to ratify on August 23d.

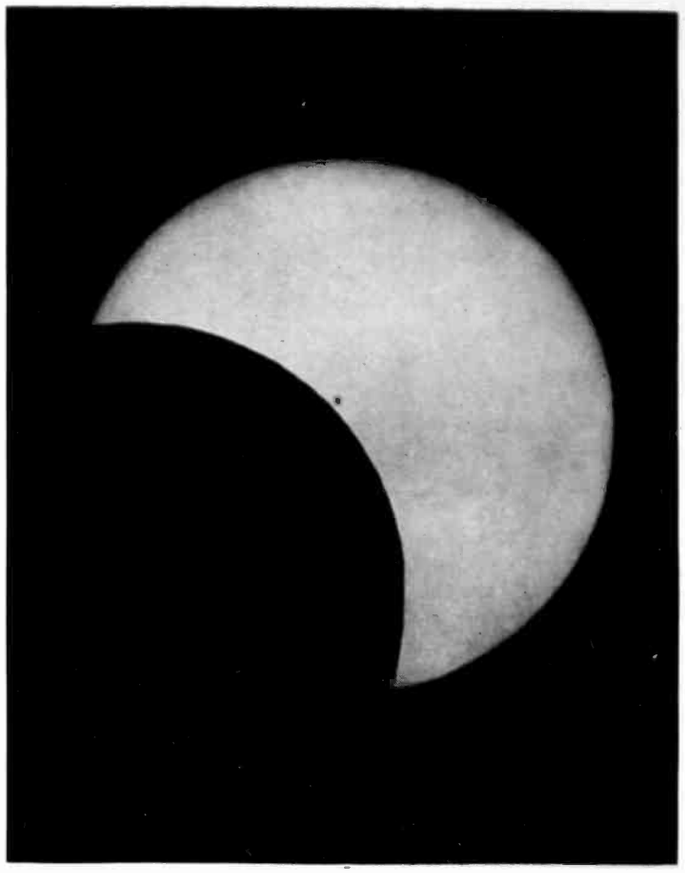
THE new RMA plan puts the executives of the set-producing companies in executive control of the association and its policies and relations with the public. Radio now has a united industry and a united purpose.

The result should be a marked improvement in trade practices, better safeguarding of the interests of the radio industry, and the development of greater total industry volume, in which all radio manufacturers and all radio men will share.

Radio during solar eclipses

Atmospheric disturbances, intensity of signals, delayed echoes, and goniometry

By DR. ARTHUR E. KENNELLY
Professor Emeritus of Electrical Engineering, Harvard University



OBSERVATIONS have been made during various recent solar eclipses, to ascertain whether effects upon radio transmission were concurrently produced. Professor Nagaoka, in Japan, suggested that such a correlation might exist. In Europe, several astronomical expeditions have conducted radio observations. In America, elaborate programs have been followed, under the auspices of the Bureau of Standards, to ascertain whether the passage of the moon's shadow over the earth was accompanied by noticeable effects on radio transmission.

In nearly every case, radio effects have been noticed in association with each solar eclipse subjected to examination; although the effects have sometimes been meager. It cannot be said that our knowledge thus gained of eclipse radio phenomena is extensive or nearly complete.

There is probably much to be learned from future eclipses; but in general, what has been thus far brought to light has been in support of the view that a solar eclipse is a partial and temporary injection of night conditions into the program of the day. Sunlight is temporarily withdrawn from a certain area of the earth and upper atmosphere covered by the moon's shadow. There is over this region a suspension of the ionizing action of sunlight on the upper air, thus tending to bring about a partial return to nocturnal conditions. The ionized layers in the upper air may be assumed to rise in a band which corresponds approximately with the path of the eclipse shadow.

On the occasion of the total solar eclipse of May 9, 1929, an extensive series of radio observations was conducted by radio specialists accompanying an astronomical expedition to the Island of Pulo Condore in the China Seas, off the coast of Cochin China, and not far far from the equator, in Lat. 8.40 N. and Long. 106° 36′ E. This little island, only a few square miles in area, happened to be in the belt of totality for this eclipse. Under the auspices of the French Bureau des Longitudes, radio observations were made at Pulo Condore, before, during and after the eclipse. The time of mid-totality on the island was in the early afternoon, $13^{h.}\ 56^{m.}\ 05^{s.}$, by Saigon 105th Meridian time, May 9, 1929.

Observations were made on the following phenomena:
1. Intensity of signals from distant radio stations.
2. Atmospheric disturbances or "static" at Pulo Condore.
3. Delayed radio echo signals.
4. Radiogoniometry.

Records were also taken of the solar radiation and of the earth's magnetic field.

In all these observations, records were made not only on the day of the eclipse but also on preceding and subsequent days, for free comparison.

The following is a brief abstract of the results obtained, as recorded in a long report with numerous attached blueprints.

DR. KENNELLY, radio pioneer, and author of the "reflecting-layer" theory of radio propagation, to which his name is given in the Kennelly-Heaviside Layer, outlines the phenomena which may be watched for during the coming solar eclipse of August 31. This eclipse will be total throughout a wide band across New England, and will be the last total eclipse to visit the Eastern United States for a generation.

Several distant stations in Java, China and Japan, using wave lengths of between 20 and 30 meters, were followed at the Pulo Condore station for several days. In general, these signals reached a daily minimum near local noon. On the day of the eclipse, these signals nearly all disappeared over the period of totality. The report expresses the opinion that this failure of signals was attributable to the eclipse.

Atmospheric disturbances

An automatic recorder of static disturbance was installed at Pulo Condore, and connected to a special antenna near the beach. Records were kept of atmospheric disturbance over more than a week, including the day of eclipse. The normal type of daily record showed a period of minimum, or freedom from static, in the morning hours. On the afternoon of the eclipse, the record indicates a change in the shape of the curve with a distinct reduction in the strength of the disturbances. The center of the deviation appears to have taken place about twenty minutes later than the center of totality.

Delayed echoes

A 500-watt transmitter of sharply interrupted wave impulses was installed on board a vessel anchored in the bay, about three kilometers from the receiving station on the island. The emissions were on a wavelength of 25 meters. The signals were received by telephone, in duplicate receiving sets, by two independent observers. The impulses were emitted at intervals of thirty seconds from the anchored transmitting station and recorded by the receiving operator with the time of reception as indicated by chronometer in front of him. The tests were carried on for the greater part of three days; i.e., the day of eclipse and the day before and after. Very many retarded echoes were noted and recorded on all three days, especially on the day of eclipse. They ranged in delay from one to nearly thirty seconds in retardation. The phenomenon was persistent but irregular. Some signals were not followed apparently by any echoes; whereas others would be followed by plural echoes.

The report states that just before totality on the afternoon of the eclipse, the retarded echoes, which had been plentiful, disappeared entirely for approximately 200 seconds. The period of totality from astronomical records was 280 seconds; so that the retarded echoes reappeared during totality and then continued for the remainder of the afternoon. According to the record, the center of the echo silence preceded the center of totality by about 200 seconds.

Goniometry

The commercial radiostation of Mytho, in Cochin China, not far from Saigon, was selected as the point of emission of radio waves for taking radiocompass bearings during the period of the eclipse. Mytho is 175 km. from Pulo Condore, and operates on a wavelength of 600 meters. Bearings were taken of Mytho with a wooden frame antenna 120 cm. square, turning about a vertical axis and furnished with a pointer swinging over a horizontal angular scale graduated to 360 single degrees. The frame was set up in a wooden house, without metal appointments. Bearings of Mytho could be made to nearly one degree of apparent azimuth, using the mean positions of audibility extinction on each side of the zero.

On the eclipse day, bearings of Mytho were observed continuously from 10.40 to 16.20, local 105th Meridian time. As stated in the report, the readings taken over the periods before and after the eclipse showed but little variation in the bearing. Three minutes before totality, however, a marked perturbation showed itself, first in one direction and then in the opposite, amounting to several degrees. The disturbance lasted nearly half an hour and thus continued for more than twenty minutes after the completion of totality.

Summary of results

The report shows that effects attributable to the eclipse were observed at Pulo Condore in all four categories; i.e., in strength of short-wave signals received, in atmospherics, in retarded echoes and in goniometry. On the other hand, the elements of the earth's magnetic field did not indicate any noteworthy perturbations. It is probable that with the exception of the atmospherics, all of the radio disturbances were attributable to changes in the ionized layers of the upper atmosphere; although the phenomena of retarded echoes are not as yet explainable.

The writer is indebted to General Ferrié, President of the International Scientific Radio union (URSI), for the opportunity of studying this radio report, as made to the Bureau des Longitudes.

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"Double eclipse" phenomena August 31 *(See map, page 267)*

PROFESSOR E. V. APPLETON, King's College, London, suggests that there exist two distinct ionized layers. The upper layer or *F* region at about 230 km. altitude is produced by ultraviolet light, the lower or *E* layer at about 90 km. by electrons or atoms thrown by the sun with speed of 1,000 miles per sec. Professor Appleton calls attention to the opportunity of using the forthcoming eclipse to shed light into this question. In consequence of the motions of the moon and the earth, the stream of supposed particles will be interrupted more than an hour before the ultraviolet light is stopped. There would possibly be two radio eclipses, the particle eclipse affecting the *E* layer from which the ordinary broadcast waves are turned back and the much shorter optical eclipse affecting the *F* layer which is reached by 80 m. waves. The particle eclipse covers a belt east of the track of optical totality. Professor Appleton, who is now vice-president of the American Institute of Radio Engineers, will be glad if anyone who is able to make observations, even with modest apparatus, would communicate with him.

A solution of the superheterodyne tracking problem

By V. D. LANDON and E. A. SVEEN

Grigsby-Grunow Company
Chicago, Illinois

IN MOST superheterodyne receivers, the oscillator is operated at a frequency higher than that of the signal, and alignment is obtained by means of a fixed condenser in series with the oscillator tuned circuit. It is common practice to obtain the values of the series condenser and of the oscillator inductance by cut and try methods. Calculation is rendered difficult by the fact that even with the optimum values tracking is not perfect. Graphical methods have been used as well as calculations, but most designs are worked out by purely experimental methods.

The usual procedure is to make a preliminary estimate of the proper value of the oscillator inductance. The oscillator is then lined up with the carrier circuit at the high frequency end of the scale by means of a trimmer shunting the tuned circuit. Then the two circuits are lined up at the low frequency end of the scale by means of the series condenser.

After re-checking the high frequency alignment the circuits are then in line at two points in the frequency band, but will in general be found to be somewhat out of line in the middle of the band. If, with these adjustments the oscillator requires more capacity for alignment in the middle of the band, then a slightly larger value of inductance is chosen. The whole procedure is repeated aligning at a high and a low frequency, and then checking alignment in the middle of the band. Eventually perfect alignment is obtained at three points in the range, and reasonably good tracking results over the entire band. After each inductance value is tried, however, there is no way of knowing how much the inductance should be changed. Hence it is a tedious process.

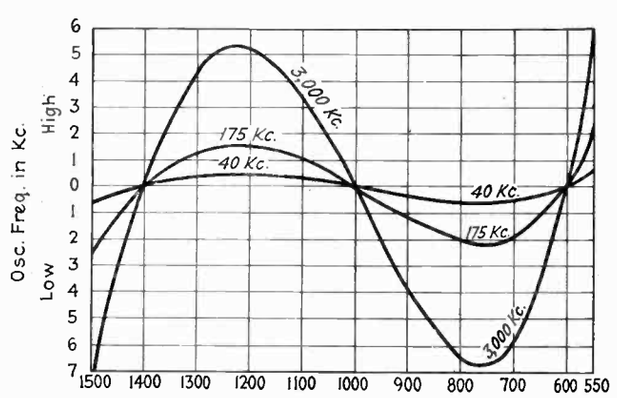


Fig. 1—Deviation from exact tracking at various intermediate frequencies

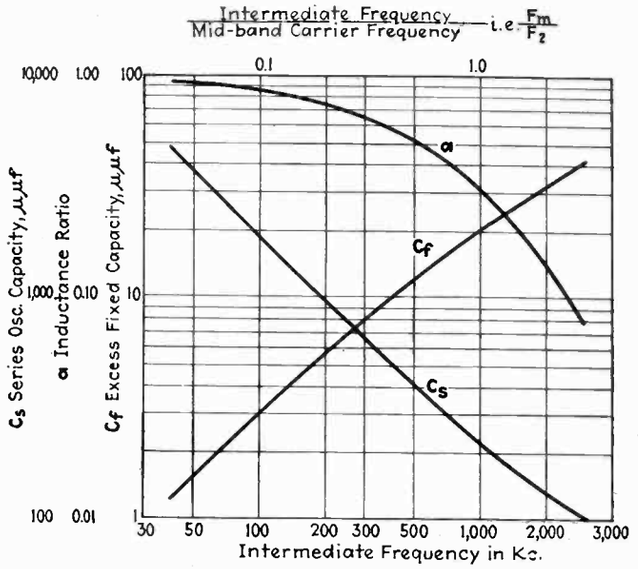


Fig. 2—Values of series and shunt capacity as function of intermediate frequency

A mathematical solution

The following shows how these values can be calculated without recourse to experiment. At best tracking is known to be imperfect. Therefore the mathematical method must follow the lead of the experimental and solve for those conditions which give perfect alignment at the three predetermined points in the frequency band.

The highest of these frequencies and the corresponding value of the carrier circuit capacity are designated by the subscript 1. Similarly the middle frequency is given the subscript 2 and the lowest frequency the subscript 3.

C_s is the capacity of the oscillator series padding condenser and C_f is that of the oscillator shunt lining condenser in excess of the value in the carrier circuit. (i.e. Mathematically the shunt lining condenser in the carrier circuit is considered as part of the tuning condenser.)

F_m is the frequency of the intermediate amplifier, and "a" is the ratio of the carrier circuit inductance divided into the oscillator inductance.

Since the expression $\left(\frac{F_1}{F_1 + F_m}\right)^2$ occurs quite frequently it has been abbreviated to the letter M_1. Similarly $M_2 = \left(\frac{F_2}{F_2 + F_m}\right)^2$ and $M_3 = \left(\frac{F_3}{F_3 + F_m}\right)^2$.

From inspection of the carrier circuit

$$F_1 = \frac{1}{2\pi\sqrt{L\,C_1}}$$

and from the oscillator circuit

$$F_1 + F_m = \frac{1}{2\pi \sqrt{aL\left(\frac{C_f + C_1 \quad C_s}{C_1 + C_s}\right)}}$$

$$\text{Then } M_1 = \left(\frac{F_1}{F_1 + F_m}\right)^2 = \frac{2\pi \sqrt{aL\left(C_f + \frac{C_1 \quad C_s}{C_1 + C_s}\right)}}{2\pi \sqrt{L C_1}} =$$

$$\frac{aC_f C_1 + aC_f C_s + aC_1 C_s}{C_1^2 + Cs \times C_1}$$

Which reduces to

$$M_1 C_1^2 + M_1 C_s C_1 - a C_f C_1 - a C_f C_s - a C_1 C_s = 0 \qquad (1)$$

Similarly for the second frequency

$$M_2 C_2^2 + M_2 C_s C_2 - a C_f C_2 - a C_f C_s - a C_2 C_s = 0 \qquad (2)$$

and for the third frequency

$$M_3 C_3^2 + M_3 C_s C_3 - a C_f C_3 - a C_f C_s - a C_3 C_s = 0 \qquad (3)$$

These comprise three simultaneous equations with three unknowns C_s, C_f and a.

The solution is obtained by eliminating two of the unknowns and solving for the third. A peculiar fact is that the final solution must be for C_s. If C_s and one of the others is eliminated the resulting equation is a cubic of quite formidable complexity. However, when a and C_f are eliminated a solution for C_s is not difficult.

Solving each of these equations for C_f

$$C_f = \frac{M_1 C_1^2 + M_1 C_1 C_s - a C_1 C_s}{a C_1 + a C_s} \qquad (4)$$

$$= \frac{M_2 C_2^2 + M_2 C_2 C_s - a C_2 C_s}{a C_2 + a C_s} \qquad (5)$$

$$= \frac{M_3 C_3^2 + M_3 C_3 C_s - a C_3 C_s}{a C_3 + a C_s} \qquad (6)$$

equating (4) and (5) and solving for a

$$a = \frac{(C_1 + C_s)(C_2 + C_s)(C_1 M_1 - C_2 M_2)}{C_s^2 (C_1 - C_2)} \qquad (7)$$

similarly from (5) and (6)

$$a = \frac{(C_2 + C_s)(C_3 + C_s)(C_2 M_2 - C_3 M_3)}{C_s^2 (C_2 - C_3)} \qquad (8)$$

equating (7) and (8) and solving for C_s

$$C_s = \frac{C_1^2 M_1 (C_3 - C_2) + C_2^2 M_2 (C_1 - C_3) + C_3^2 M_3 (C_2 - C_1)}{C_1 M_1 (C_2 - C_3) + C_2 M_2 (C_3 - C_1) \quad C_3 M_3 (C_1 - C_2)}$$

Substituting this value in equations 7 or 8 results in rather involved forms. Having solved for C_s it seems to be better to treat C_s as a known quantity and leave it in the equations for a and C_f Equations 7 and 8 are then solutions for a. Similarly equations 4, 5 and 6 become solutions for C_f when a and C_s are known. By substituting an appropriate set of data these equations yield values of C_s, a and C_f that agree well with these obtained by the experimental method.

Accuracy of tracking secured

It is interesting to see what degree of imperfection of tracking results from a set of values for a conventional receiver for the broadcast range.

Since the deviation is quite small and is obtained by subtracting two large numbers, it is necessary to use a high degree of accuracy in all calculations. In this paper all computations were made with seven-place log tables.

The following values are convenient and probably near the average:

F_m	= 175 kc.	C_1	= 61.7347 $\mu\mu f$
F_1	= 1400 kc.	C_2	= 121.000 $\mu\mu f$
F_2	= 1000 kc.	C_3	= 336.111 $\mu\mu f$
F_3	= 600 kc.		

The frequencies are arbitrary and the capacities calculated assuming 400$\mu\mu f$ at 550 kc.

Solving for the unknowns gives

C_s	=	1084.44 $\mu\mu f$
a	=	.770416
C_f	=	4.90399 $\mu\mu f$

Theoretically these values give perfect alignment at 1400, 1000, and 600 kc. At other frequencies the deviation is appreciable and may be solved for.

While the desired frequency of the oscillator is $\frac{1}{2\pi\sqrt{LC}} + F_m$, The actual frequency is

$$\frac{1}{2\pi\sqrt{aL\left[C_f + \frac{C_s \quad C_s}{C_s + C_s}\right]}}$$

The difference is the deviation from true alignment. This was calculated at eleven different frequencies. The results are tabulated below:

KC.	Cycles Deviation	KC.	Cycles deviation
550	+2048	1100	+1005
600	+2	1200	+1510
700	—1924	1300	1270
800	—2013	1400	— 9
900	—1159	1500	—2410
1000	— 1		

It should be noted that the theoretical deviation at 1400, 1000 and 600 kc. is zero. The values —9, —1, and +2 cycles obtained by calculation are a check on the accuracy of the method. This deviation curve is plotted in Fig. 1. The other two curves are obtained in a similar manner for intermediate frequencies of 40 and 3000 kc.

It is apparent that the points chosen for perfect alignment are about the ideal ones giving the smallest value of maximum deviation. It is realized that in a practical case these values cannot usefully be calculated to a very high degree of accuracy. Effects like the variation of effective oscillator tube input capacity with frequency, the effect of shield cans on inductance, etc., cause small errors which mean that a final adjustment is nearly always necessary by means of the experimental method.

Fig. 2 gives the values of C_s, a, and C_f for values of intermediate frequency between 40 and 3000 kc.

For frequency bands other than the broadcast range use the scale marked $\frac{F_m \times F_2}{1000}$. For values of maximum capacity other than 400$\mu\mu f$ (at the lowest used frequency) multiply all capacities by $\frac{C_{max}}{400}$. The value of a remains unchanged.

For greater accuracy than can be obtained from this figure the following tabulation is given:

F_m	C_s	a	C_f
40	4638.27	.938926	1.22449
110	1706.15	.845167	3.21078
175	1084.44	.770416	4.90399
265	727.625	.682466	7.04875
520	388.537	.501305	12.2054
1000	220.642	.309061	19.7324
1700	146.469	.175506	28.3115
3000	101.042	.0784013	41.3971

*This paper was read before the Radio Engineers Club of Chicago on January 7, 1932.

Technical data on new tubes

AS ANNOUNCED in June *Electronics* several new tubes have been developed for receiving sets and are now ready for use by set designers. These tubes include the double diode triode (the 55 and 85) and the new triple grid power amplifier tube as well as a new mercury vapor full wave rectifier. The latter tube differs from the 82 in its greater filament power consumption and hence greater emission and the greater output current available. The 55 (and 85 for 6.3 volt use) are the double tubes used as combined detector, amplifier and a.v.c. tube. The 89 with its three grids can be used as class A, class B or pentode output tube and like the 55 is extremely versatile.

Sylvania announces a heater-type pentode with a 25-volt heater requiring 0.3 amperes to be used in series with other 0.3 ampere tubes on d.c. lines. The increased voltage drop across the heater eliminates the necessity of employing series resistors to reduce the line voltage. The elimination of this series resistor permits the tubes to heat up more rapidly than otherwise.

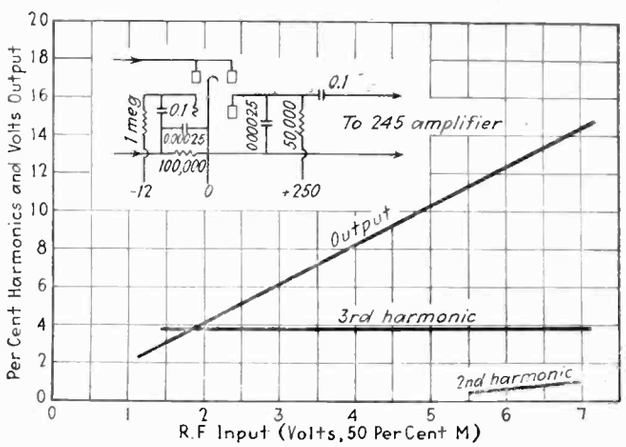
The big virtue of this 25-volt tube is its greater power output (approximately one watt) from the limited plate voltage available from d.c. lines without requiring several tubes in parallel. With 95 volts on the screen and plate and 15 volts grid bias and supplied with a peak grid voltage equal to the grid bias the tube will deliver 0.9 watt with minimum second harmonic distortion.

The 89 tube is a pentode in which connections are made to all three grids and are brought out to the base. Thus the grids may be so connected together or to cathode or to plate as to produce a triode for class A service with a low amplification factor, low plate resistance and a high mutual conductance; a triode with high amplification factor to be used as class B amplifier with zero grid bias, and finally a class A pentode power output tube of high signal efficiency.

From an interesting and valuable report on the use of the 55, 56, and 57 as detectors made by W. M. Merrill and W. M. Perkins of National Union laboratories the output characteristics of the 55 are taken. A crystal-controlled oscillator (950 kc.) modulated with 60 cycles and fed to the detectors under test by means of an attenuator and v.t. voltmeter furnished the desired signal. Conditions were sought which gave minimum distortion and fortunately were found to give at the same time nearly maximum sensitivity and reasonable output.

In the bulletin from which the curve was taken the characteristics of the 56 and 57 are discussed together with conditions of test. Only —12.0 volts grid bias was used on the triode grid in the 55 because the voltage at the plate due to the drop in the resistance was only 150 volts. This impaired the gain of the triode somewhat but the data shown give an idea of what may be expected from the tube.

Curves in the RCA Radiotron-Cunningham technical bulletin show that when driven by another 89 as a class A triode as much as 2.5 watts output power can be secured from two 89's with total harmonic output of the order of 2 per cent or less. With greater grid swing, and distortion of about 5 to 7 per cent, as much as 3 watts can be secured from the two tubes.



Voltage and harmonic output of 55 detector

An interesting feature of this tube is its 6.3 volt filament. The great advantage of this voltage as advanced in the RMA Vacuum Tube Committee meetings many months ago is the fact that it is adaptable for operation from either a.c. or storage batteries, or other source of direct current. Adoption of the Sylvania 6-volt line by Philco and the introduction of this new, and probably to-be-popular, 89 tube with its 6.3-volt heater will do much toward the ultimate standardization of a single-filament or heater voltage, an obvious economy.

CHARACTERISTIC DATA ON NEW TUBES

Type	Purpose	E_F Volts	I_F Amps.	E_P Volts	E_{sg} Volts	E_c Volts	I_p ma	I_{sg} ma	R_p	G_m	μ	R_o	P_o Watts	
43	Heater-type power pentode	25.0	0.3	95	95	—15	20	6	45,000	2,000	90	4,500	0.900	
55	Double-diode detector, avc tube	2.5	0.75	250	...	—20	8	..	7,500	1,100	8.3	20,000	0.200	
							Triode unit							
				10	...	....	0.5	..	.....	.....	.....	.....	.....	
				...			Diode unit		.....	.....	.....	.....	.....	
85	Double-diode detector, avc tube	6.3	0.3	Characteristics same as 55.										
				Class A, Grids Nos. 2 and 3 connected to plate										
89	Triple grid power amplifier	6.3	0.4	160	...	—20	17	..	3,000	1,570	4.7	7,000	0.300	
				Pentode; Grid No. 3 to cathode; No. 2 is screen, No. 3 is control grid										
				180	180	—18	20	3	82,500	1,635	135	8,000	1.5	
				Class B, Grid No. 3 to plate: Nos. 1 and 2 tied together										
				180	...	0	3; 75 peak		.....	.....	.....	2,350	3.5	(two tubes)

Type	Purpose	E_F Volts	I_F Amps.	Max. A.C. voltage per plate	Max. peak inverse voltage	Max. D.C. output current	Max. peak plate current	Tube voltage drop (approx.)
83	Heavy duty full-wave mercury vapor rectifier	5.0	3.0	500 rms	1,400	250 ma	800 ma	15 volts

Sodium-vapor lighting in Holland

Highway illumination with new gas-discharge units (see front cover)

A NEW gaseous-discharge lamp of extremely high luminous efficiency, has just been developed in the laboratories of the Philips Glowlamp-Works at Eindhoven, Holland, by Dr. Gilles Holst and his staff. In this lamp a low-voltage discharge takes place in a mixture of neon gas and sodium vapor, between an oxide cathode and one or more anodes. The lamps used in the highway lighting installation shown on the front cover of this issue of *Electronics* have a length of about 12 cm. and a diameter of 6 cm. and with an input of 100 watts give from 500 to 600 international candles. The total flux of light amounts to between 5,000 and 6,000 lumens. The surface light intensity is about 7 international candlepower per square centimeter.

In order to secure sufficient sodium vapor pressure the bulb must have a temperature between 200 and 300 degrees C. For this reason the lamp has been enclosed in a vacuum jacket tube or glass container.

The lamp resembles to some extent both the well-known gas-filled rectifier tubes and the sunlight lamp. In these devices there is provided a rare-gas filling and mercury vapor. In the new sodium lamp there is also provided a rare-gas filling and a small quantity of metallic sodium. Furthermore, the lamp employs an oxy-cathode and one or two anodes.

Starting the lamp

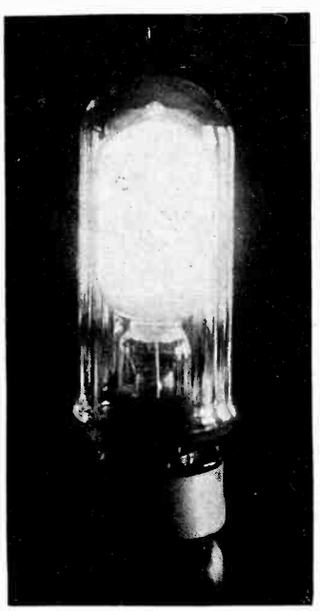
The operation of the lamp is as follows: When the cathode which is in the form of a filament is brought to incandescence and voltage is applied to the anodes, a so-called arc discharge is started. The color of this discharge is determined by the rare gas used. In view of the energy dissipated in the lamp, the bulb temperature rises. This causes the sodium to evaporate. Hereafter the light emission is mostly due to the sodium vapor; the color of the light therefore approaches that of the yellow sodium spectrum lines.

The arc potential is about 12 volts, and the anode current about 5 amp. This light is of a rather pleasant yellow-orange color and almost monochromatic. For this reason the light can only be used for very special purposes; the unusual large visual acuity which is secured by it when used for road or street lighting, however, is extraordinary. A remarkable contrast is observable by the very reason of its being monochromatic light.

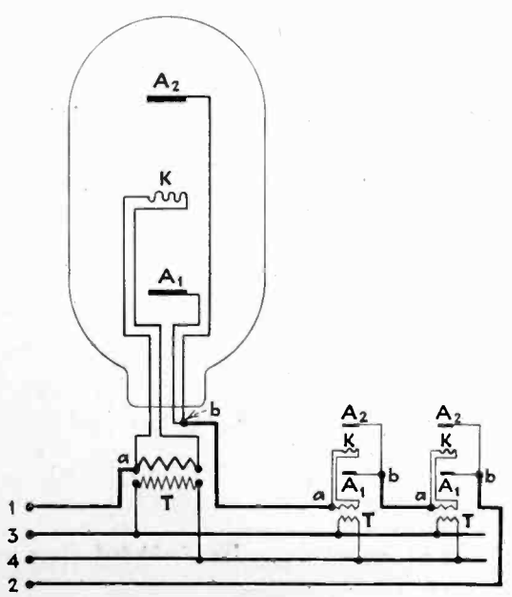
After a year of experimenting on lighting the streets within the laboratory grounds at Eindhoven, an experiment on a larger scale was made possible by the courtesy of the Stroomverkoop Company, Maastricht, Limburg, Holland. Its director, Professor Gelissen, offered to install the light on a length of 1,6 km. (one mile) on the main road between Maastricht and Nijmegen. (See cover photograph).

The lamps were placed at a height of 8 meters (26 feet) at a distance from light to light of about 25 meters (83 feet). The lamps themselves were placed in the reflectors in such a way that practically no direct light could strike the eye. Moreover the lamps cause very little glare, so that the eye is attracted rather to the road than to the light sources.

The installation was opened on July 1, 1932, with considerable festivity. A large number of officials interested in the experiment were present. So intense is the illumination along this roadway, that driving a car at 50 to 60 miles per hour without headlights, one feels perfectly safe.



Right — As the new lamp operates at a temperature of 500 deg. Fahr., it is necessary to enclose the gas-filled chamber in an outer vacuum envelope — literally, "a lamp in a Thermos bottle."



Below—Circuit diagram showing method of connecting lamps for highway lighting. Each lamp has a single cathode K, and two anodes, A A

An improved B eliminator

for automobile receivers

By W. W. GARSTANG
Consulting Engineer

IN THE design of B battery eliminators for portable storage battery receivers, efficiency and life are naturally the two important factors. A third factor which must be considered is the size and the adaptability of the unit for insertion into the radio receiver itself.

The third factor just mentioned makes it practically mandatory that an interrupter type converter be used, preferably of the vibrator construction. A converter designed along this line can be readily and cheaply manufactured in small size but in the past has been rather low in efficiency and short of life.

Inasmuch as the rectifier and the interrupter are the vital items in a B eliminator of this type, it is logical to look to each of these for an increase of efficiency and a lengthening of normal life. It is necessary to consider carefully the characteristics of a vibrator before attempting to analyze its life and efficiency.

The duty placed upon a vibrator and upon its contact points is of the most severe type. In the slowest types of vibrators 540 million makes and breaks are accomplished in a thousand hours which is considered minimum life. It can readily be seen that the greatest care and protection must be given this unit. An interrupter of the type used in B eliminators is in a class by itself as far as duty and requirements are concerned. They must be carefully engineered and minor points are of the utmost importance. In order to secure maximum life from the contact points amplitude must be obtained in the swing of the reed and it is distinctly desirable to secure a wiping action of the points. A special grade of tungsten has been found to be the most satisfactory point material. Before an interrupter may be adjusted for maximum efficiency it is necessary to ascertain the length of time it will operate at no load and the values of the no-load voltage and current.

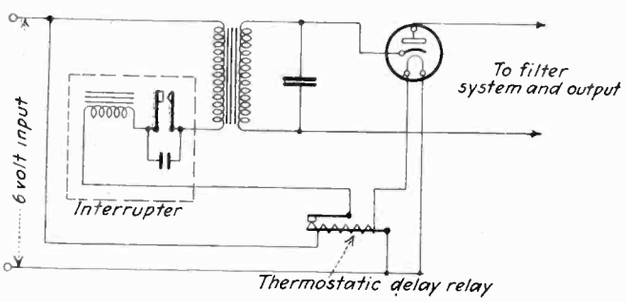


Fig. 1—Use of thermostatic relay to delay vibrator actuation

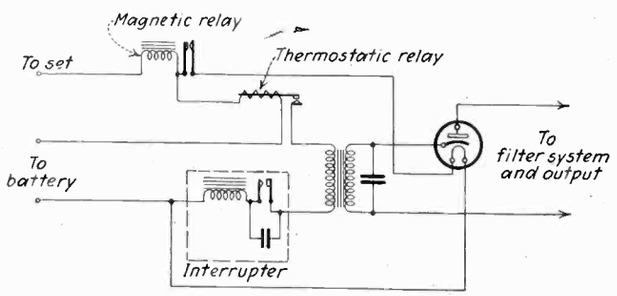


Fig. 2—Method of protecting mercury vapor rectifier

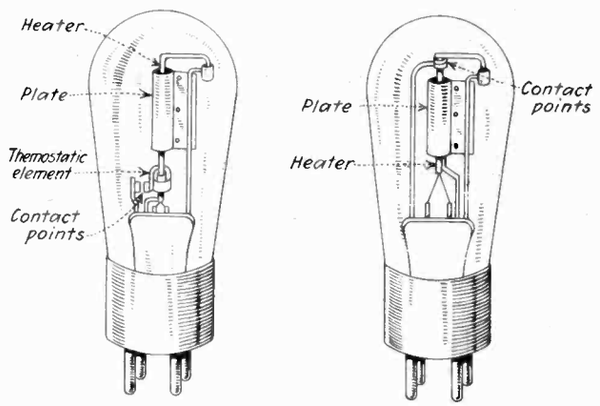


Fig. 3—Use of contacts within tube to close contacts after proper temperature has been attained

Various types of rectifier tubes have been used in eliminators. The gaseous type of tube with no filament has in the past been popular.

It is difficult to use a straight filament type tube due to the fact that a special filament winding must be placed on the transformer to avoid the interconnection of the primary and secondary of the transformer.

The heater type mercury vapor rectifier having much higher efficiency than either the gaseous or filament type tubes has been difficult to use due to the time required for the heater to reach its normal temperature. During this interval the interrupter operates at no load allowing exceedingly high a.c. voltage to be impressed between elements of the tube and allowing the inductive kickback to cause the points to spark brilliantly and burn.

This action is detrimental to not only the vibrator and rectifier tube but also to the transformer and buffer condenser, often causing the destruction of the tube and condenser and invariably shortening the life of the vibrator.

Since the tubes used in present auto radios are of the heater type, the use of a gaseous rectifier does not materially correct this action since high voltage is impressed across the filter system and buffer condenser, often causing their breakdown.

In order to obtain the efficiency desired, from a heater type mercury vapor rectifier and to eliminate the dis-

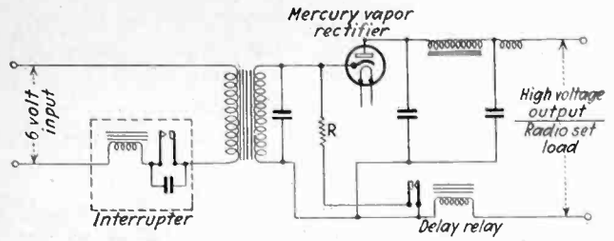


Fig. 4—The automatic load delay consisting of a small relay in series with radio set

advantages inherent in its use and the use of heater type tubes in the radio receiver and in order to prolong the life of all the integral parts of the eliminator, an "automatic load delay" circuit has been developed.

Three possible methods presented themselves to perform this function. The first was a thermostatic relay to delay the actuation of the vibrator until the heaters of the rectifier and radio tubes had reached their normal temperature. This method, as illustrated in Figs. 1 and 2, requires a rather complicated relay circuit, either in series with the radio set, or as a separate shunt element. In either case power is lost and the over-all efficiency is decreased.

The second method is the placing of two contacts within the rectifier tube itself which would be actuated by the heat from the heater and which would close after it had reached its normal temperature. The contacts can either be actuated by the expansion of the cathode insulator or by a piece of thermostatic metal placed adjacent to or around the heater (Fig. 3). Disadvantages present themselves immediately due to the fact that a cathode insulator which has a coefficient of expansion high enough to actuate contact points is exceedingly fragile and has a very short life. The manufacture of a tube having a piece of thermostatic metal close to the plate is quite difficult due to the fact that gas must be driven from the metal by flashing with an oscillator which immediately either injures or destroys the thermostat. Even if such constructions were possible it would mean the use of a special tube which would be undesirable.

The third method, using the "automatic load delay" circuit, has proven itself satisfactory in every respect. By placing a small relay in series with the radio set load the required action is obtained. In Fig. 4 it can be seen that the relay is closed until the radio tubes have heated and have begun to draw current and until the rectifier tube has heated and has begun to pass current. In the closed position a resistance is shunted across the secondary of the transformer. This resistance should be of a value slightly lower than the equivalent resistance of the radio set. The relay, adjusted to open at a current drain approximately two-thirds that of the radio set, disconnects the resistance from the transformer as soon as all tubes have reached normal operating temperature and as soon as normal current is being taken by the set.

This circuit automatically delays the impression of high voltage across the rectifier tube. If for any reason the eliminator is operated without an external load the circuit automatically places an internal load on the transformer thus protecting the filter system and buffer condenser against injury. Negligible power is lost in the circuit and the relay acts as an audio-frequency choke thus filling a dual duty.

Manufacture of caesium silver-oxide photocells

By W. H. NICKLESS

THE rapid advance in the industrial use of light sensitive devices has in a large measure been due to the development of the caesium silver-oxide photocell which is highly responsive to the radiations from the incandescent lamp. The general procedure used in the manufacture of the caesium silver-oxide type cell will be discussed in this article.

Of paramount importance to the successful manufacture of photocells is the exhaust system. A typical exhaust system is shown in Fig. 1. The impurities in the argon are removed by arcing between the tungsten electrode *T* and the sodium potassium electrode *SP*, for several hours.

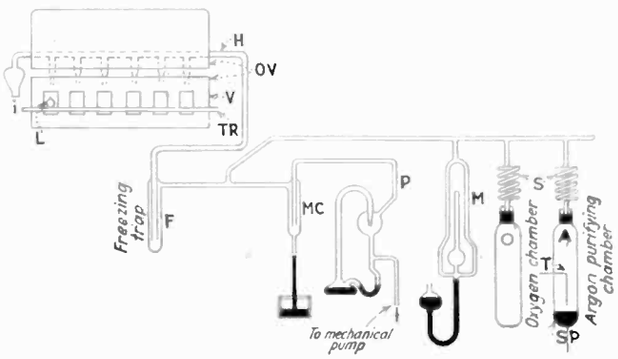


Fig. 1—Typical exhaust system for making caesium silver-oxide cells

Argon and oxygen are admitted to the exhaust system by means of porous plugs, which are secured by sealing wax to constrictions in the necks of each of the purifying chambers and the ends of the glass spirals *S*. The plugs are immersed in mercury to assure a vacuum-tight seal. It is only necessary to bring the plugs in contact with each other when it is desired to admit either gas into the system. *M* is a McLeod gauge to measure the argon and oxygen pressures. Liquid air is used as the freezing agent in preference to carbon dioxide snow. *MC* is a mercury cut-off. *P* is a mercury diffusion pump either air or water cooled backed by a mechanical pump. *I* is an ionization manometer for determining

the vacuum. H is the header usually made to accommodate six cells. OV is the oven for removing gas from glass and sensitizing the cells. The movable part V should be divided into as many compartments as the header has prongs so that the cells during the sensitizing process may be treated individually. Provision should also be made in each compartment of the oven to cut off the heat from any cell as it is desired without effecting the heat treatment of the other cells. The oven should also be provided with mica windows to admit the radiations from lamp L which rides on track TR.

Figure 2 shows two completed stems. C and C_1 are cathodes of pure silver semi-cylindrical in shape, 0.005 in. or 0.010 in. thick. The area of the cathode depends on the purpose for which the cell is intended. The pure silver cathodes have almost entirely displaced the silver-plated copper cathodes formerly used in this type cell. The distance between cathode C and anode An is not critical. In practice this distance is approximately 15 mm. P and P_1 are the mountings for the pellets from which the caesium is liberated. In P the pellet is secured between the helmet-shaped metal piece H, and the metal strip J. In P_1 the pellet is wrapped in the metal foil F, which is then clamped to the ends of the copper ring Cu. P has the advantage of lower labor and material costs.

Methods for producing caesium of high purity

Any number of combinations of a caesium compound and a reducing agent can be used to produce the caesium, caesium chromate, chromium oxide and aluminum metal, caesium chromate and silicon metal, caesium chloride and "Misch" metal have all been used with success.

The purity of the chemicals used cannot be too strongly stressed. The chemicals should be in the form of very fine powder and thoroughly mixed before being pressed into pellets. The amount of material used in the pellet is dependent on the cathode areas. The weight of the pellet varies from 20 milligrams in the smaller type to 50 milligrams for the larger type. Very small tolerances should be allowed in the weights of pellets chosen for a particular type of cell.

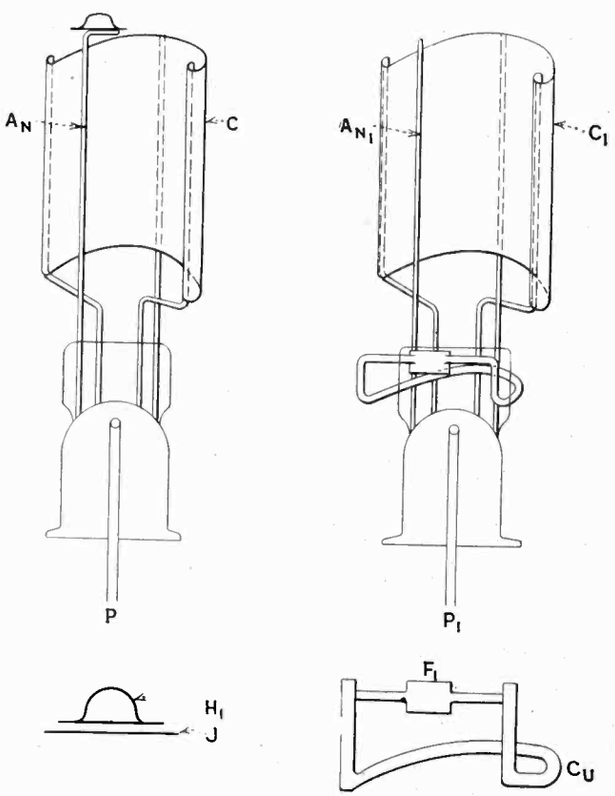


Fig. 2—Methods of mounting photocell elements

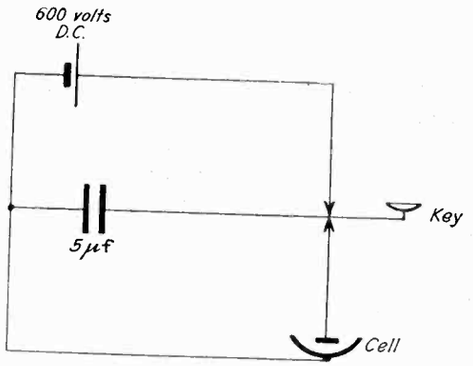


Fig. 3—Etching and oxidizing circuit used in phototube manufacture

The sealed-in cell after sealing to the header is baked to rid the glass of gases. The cathode is then etched by passing a discharge from cathode to anode in an atmosphere of oxygen. A d.c. potential of approximately 600 volts is required for this operation. The etching is sometimes accomplished by chemical means before the cathode is mounted to the stem. After etching, the cathode is oxidized by passing a discharge between cathode and anode in an atmosphere of oxygen. The correct depth of oxidation is determined by the color of the oxide, varying from emerald green in some types to a bluish white in others. As the cathode passes through its various stages of oxidation rapidly the time the potential is applied should be controlled by a telegraph key or timing switch. The circuit used for etching and oxidizing is shown in Fig. 3. The oxygen is then pumped out and the caesium liberated from the pellet by means of a high frequency induction furnace.

Baking the deposited caesium to sensitize cells

When the caesium has deposited on the walls of the bulb the oven is raised and the cells sensitized by baking in a temperature of approximately 250° Centigrade. The cathode is illuminated by light from lamp L (Fig. 1) and the increase in photo current with increase in temperature is noted on a sensitive microameter in series with the cathode and anode across a potential of 50 volts.

Some electrical leakage will be noted as the maximum temperature is reached but this disappears when the temperature is again lowered. When the sensitizing process is complete the oven is lowered and the cells are allowed to cool.

If a vacuum-type cell is desired, the cells are ready to be tipped off. If the cell is to be gas filled, argon at a pressure of 0.4 mm. of mercury is admitted to the exhaust system and the cells then tipped off. The cells are then ready to be based. A cement which does not require heat to set should be used to base the cells.

Dynamic speaker design—Part II

By A. R. BARFIELD

Chief Engineer,
Best Manufacturing Company

WITH given values of W_f, the weight of copper in the field coil, M, the mass of the diaphragm to be used, P_f, the power in the field coil, and the constants, it remains to determine the values of g and the product rt to make a maximum the force applied to the diaphragm at the base frequencies. A set of values was assigned to the constants and the maximum obtainable sensitivity determined for different values of W_f and for two values of field power and three values of clearance, c. Figure 1 shows six curves of the maximum obtainable F as a function of W_f for two values of field power, five and ten watts, and for three values of c, 0.056, 0.071, and 0.086 cm. These three values of clearance correspond to about .009, .012, and .015 inch respectively between the driving coil and the poles, about .004 inch being allowed for the thickness of the form on which the driving coil is wound.

The curves of Fig. 1 are of great value to the design engineer. It is seen that the sensitivity is by no means proportional to the amount of copper in the field coil for field coils of weights above about one pound.

The curves show the effects of two of the other factors also. These factors are the field power and the clearance c. It is seen that the maximum obtainable sensitivity is not proportional to the square root of the field power as is the sensitivity of a given model of a loudspeaker up to the point of saturation of some part of the magnetic circuit. This is because the diameter of the stem must increase in order to conduct the additional flux produced by an increase of the excitation developed by the field coil. An increase in the diameter of the stem decreases the ratio of the outside to the inside diameter of the field coil.

The factor c is one of the important design constants.

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THE first part of this article on the design of dynamic loudspeakers was given in the June issue of *Electronics*. This is the concluding part.

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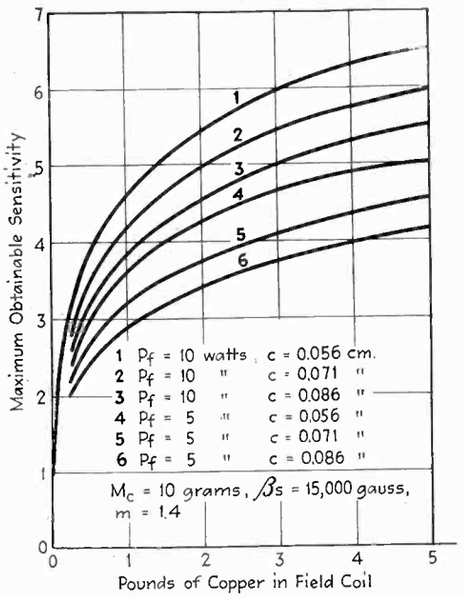

Fig. 1—Relation of sensitivity to amount of copper in field

The curves of Fig. 6 show that a slight change in c has an effect as great as a change of several pounds in the field copper in some cases. If, F_g and all of the other factors except g and c are held constant, F_d will be a maximum when g is equal to $2 \times C$ (see equation I). Then the substitution of this value of g in the equation reveals that F_d is inversely proportional to the square root of c. This case, however, is an extreme condition because F_g is generally a function of g.

It is obvious that the proper proportioning of several factors such as c so that a saving of field copper results in each case will bring about a decided total saving in field copper. This means that success in competitive loudspeaker design depends on the proper proportioning of the various factors. The weight of copper in the field coil is the most expensive and one of the least important items in the design for weights of field coil above about two pounds.

Inductance to resistance ratio

Another factor which must be considered in the design is the ratio of the inductance of the field coil to the resistance. As the field of the loudspeakers is generally used as a smoothing reactor in the filter circuit of a radio set, the inductance of the field coil is an important consideration. Calculations of the relation between the ratio of the inductance to the resistance and the weight of material in the field coil show that the nature of the relation is somewhat the same as the relation between the maximum obtainable sensitivity and the weight of material in the field coil. This means, then, that the loudspeakers having small field coils have a decided advantage in this respect also.

For large loudspeakers with heavy diaphragms, large amounts of field power, and heavy field coils, values of g the product rt and c are not at all critical. Figure 2 shows how the force applied to the diaphragm varies with the product rt, g being in each case of the proper value to make the force applied to the diaphragm the maximum obtainable with the given value of rt. The corresponding value of M_c as determined by rt and the optimum

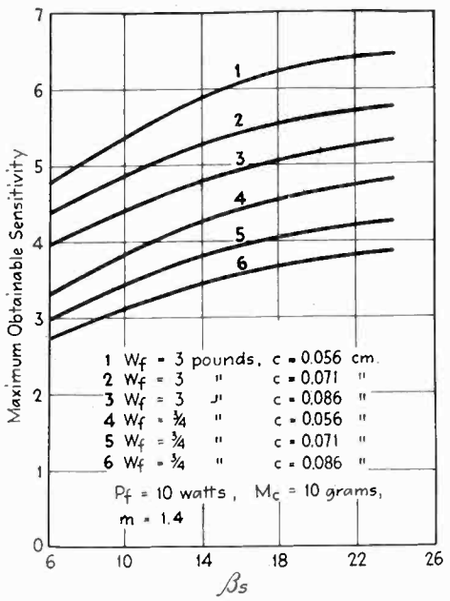

Fig. 3—Relation of sensitivity to saturation value of stem material

value of g as shown. It happened in this particular case that the weight of driving coil was the same for both the curves. This is not generally the case, however. M_c for maximum obtainable sensitivity generally increases with c. It is seen that a change of about three to one in the amount of copper in the driving coil produces a change of only about fifteen per cent in the sensitivity. This curve was calculated for a diaphragm with ten grams total effective mass and a field coil weighing three-quarters of a pound with ten watts field power. With diaphragms and field coils of smaller weight and with less field power, the values of g and rt are more critical. However, the allowable variation in M_c will still be great enough to make it possible to adapt the driving coil and diaphragm to each other.

As r and t appear together as a product in all of the equations, the product has been treated as a single variable. This product multiplied by 2π gives the area of the flux path at the gap. rt and m then determine the amount of flux passing through the magnetic circuit and, consequently, the area of the iron path and the amount of iron required. In general, the cost of the material in the iron part of the magnetic circuit is small as compared to the cost of the copper in the field coil. So the amount of iron is not important except in unusual cases.

The value of r must be at least great enough to conduct the useful flux to the gap. It is general practice to make r equal to or less than r_o since r can be varied to conform to the requirements of the diaphragm. If it is too small, the frequency-response characteristics of the diaphragm shows marked non-uniformity at sharply defined bands of high frequencies.

The value of t in the product rt is important only in that the effective value of c depends on it, in practical cases. In other words, a driving coil with a great axial length is more difficult to keep centered between the poles than one with small axial length.

The magnetization curve of the stem material gives the necessary data with which to select the proper stem material from the standpoint of magnetic design. If the permeability is high and the saturation flux density is low, the stem will have little loss of mmf. in the iron, but will require the radius to be large, thereby reducing the mmf. developed by the coil. The characteristics of the material are generally good enough that the machinability and cost are the items of greatest concern. Figure 3 shows how the sensitivity varies with the flux density in the stem. The graphs can be interpreted as the variation of sensitivity with the material used for the stem, β_s being taken as the flux density just below the knee of the saturation curve of the material.

Characteristics of the stem material

Most good grades of machine steel saturate at thirteen to fifteen thousand gauss. The graph, Curve 2, shows that an increase from fifteen thousand to twenty thousand gauss in the stem results in an increase in sensitivity of only five percent. It is obvious that it would not be worth the extra cost to try to obtain a material which will pass more than fifteen thousand gauss without serious loss in mmf.

The parts of the iron circuit other than the stem may be made of any grade of ordinary steel. It is assumed that this part of the path will be made with considerably greater cross section area than the stem.

The leakage factor m affects the sensitivity by reducing the excitation developed by the field coil. As was shown before, the factor m does not represent the true condition as the leakage reluctance and the mmf. determine the amount of leakage flux. The factor m then, is less for designs having large values of t than for designs having small values of t. However, the change in F caused by a variation in m with a variation in t is small enough that m can be assumed constant for a given size of design. The effect of m is not one of the major considerations in most good designs. It has the same effect as the saturation value of the stem material except in the opposite direction. A change in β_s from ten thousand to fifteen thousand gauss gives an increase in sensitivity of ten per cent. This variation in β_s has the same effect as a variation of one and a half to one in m. In some certain very small loudspeaker designs, m is equal to about one and three eighths. The sensitivity, then, is only about eight per cent less than it would be if there were no leakage at all.

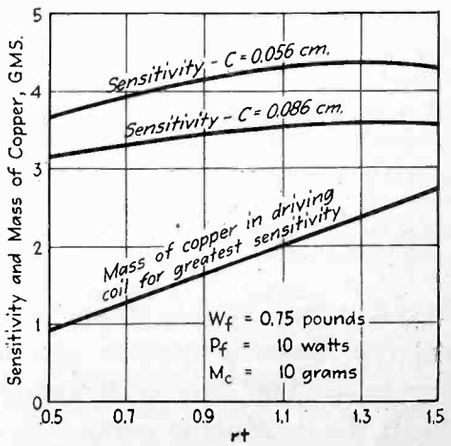

Fig. 2—Relation of maximum obtainable sensitivity and corresponding mass of coil to rt

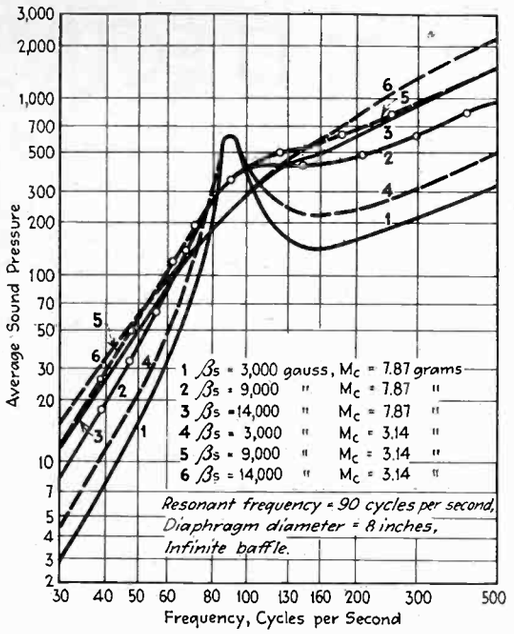

Fig. 4—Low frequency response under various conditions

The effect of the winding factor k_f is not seen very easily from the equations. In practical cases, however, it has been found that badly wound coils have as much as 12 per cent less turns for a given resistance and weight than properly wound coils. The winding factor is generally good for a tightly wound coil. It is a function of wire size, the small quantity d, the insulation thickness, etc.

The resistivity of copper in the equations is, of course, dependent on the temperature at which the coil operates. In most cases, the coil operates at a temperature of about 40 to 50 degrees Centigrade. The resistivity is about 15 to 20 per cent higher than it is for a temperature of zero degrees.

Low frequency response

It was stated earlier that the response at certain frequencies below the base frequencies was almost inversely proportional to the flux density about the driving coil. At these frequencies, the motion is limited, not by the mechanical forces, but by the back voltage that the coil generates by its motion. This condition is analogous to that of a d.c. motor separately excited and running with very light load. The speed is almost inversely proportional to the flux linking the armature. In the case of the loudspeaker, the diaphragm supports are made to have a stiffness which will resonate with the mass of the diaphragm and the reactance of the air at some frequency between zero and about 150 cycles. At resonance, the only mechanical load on the diaphragm is the air resistance which is very small for small diaphragms at low frequencies. The back voltage is almost equal to the applied voltage. It exhibits itself as an electrical impedance. The impedance of the driving coil at resonant frequency is generally from one and a half to 25 times the d.c. resistance, depending on the size of the diaphragm, the baffle around the diaphragm, the mass of the driving coil, the flux density in the gap, and the frequency of resonance. In most practical cases, the motion of the diaphragm for a rather wide band of frequencies just each side of the resonant frequency is limited for the greater part by the excitation.

It is easily shown that the ratio of the impedance of the driving coil to the d.c. resistance is

$$n = \beta_g^2 V_c / \varphi Z_m \qquad (20)$$

where β_g is the flux density in the gap,
V_c is the volume of copper in the driving coil,
φ is the resistivity of the driving coil material. and
Z_m is the mechanical impedance.

Z_m and n are complex numbers expect at resonance where they are resistances.

If equation (1) is squared, and $2\pi rt(g - c)k_c$ is replaced by V_c,

$$F_d^2 = \frac{\beta_g^2 V_c}{\varphi} P \qquad (21)$$

Thus it is seen that the impedance of the driving coil at low frequencies is proportional to the square of the force developed. The sensitivity is a function of the force developed by the driving coil. But as the force applied to the diaphragm is not exactly equal to the force developed by the driving coil, it is possible to effect a slight increase in low frequency response by making the volume of conductor in the driving coil as small as possible. The volume of conductor in the driving coil is to be kept within the allowable limits, of course.

As in the case of an electrical circuit, the impedance of the tuned mechanical circuit at frequencies near resonance is a function of the product of the effective mass of the diaphragm and the stiffness of the supports. This corresponds to the ratio of inductance to capacity in a tuned eelctrical circuit. With a given frequency of resonance, the product of mass and stiffness should be made as small as possible. The frequency of resonance is determined by the ratio of stiffness to mass. The mass then must be reduced as much as possible. However, the acoustic reactance is an appreciable part of the total effective mass of the diaphragm for very light weight diaphragms. Therefore, the actual mass of the diaphragm need not be carried below a certain amount.

The graphs of Fig. 4 are plotted for diaphragms having simple resonance. In certain practical cases, loudskpeaker diaphragms are made to have multiple resonances, similar to those of a transmission line. The result of the multiple resonances is a more uniform low frequency response.

The graphs of Fig. 4 are calculated for three values of flux density and two values of diaphragm mass. The frequency of resonance is the same for all six curves. It is seen that the heavier diaphragms have sharper resonance than the lighter diaphragms. It is seen also that the low frequency response is decidedly less with the higher values of flux density in the gap. The low frequency response, as was stated before, is almost inversely proportional to sensitivity at resonance. To obtain good low frequency response with high sensitivity, it is necessary to use large diaphragms. The radiation resistance at low frequencies varies as the fourth power of the diameter of the diaphragm. The proper combination of the three factors, flux density, diaphragm diameter, and a mechanical circuit having multiple resonances, will result in satisfactorily uniform frequency-response characteristic at the low frequencies. The amount of copper in the driving coil is another factor to be considered as seen by equation (21). The graphs of Fig. 4 are plotted to logarithmic scale. Differences would be more apparent on linear scales.

The writer wishes to take this opportunity to thank Mr. R. E. Hantzsch for his constructive criticism of the writing.

HIGH LIGHTS ON ELECTRONIC

Irradiating seeds speeds up flowering of plants

By Guy Bartlett

Still seedlings, upwards of a month in age, but already in flower—such has been the experience of two grapefruit plants in the electric hothouse atop the roof of the General Electric research laboratory at Schenectady. Under normal conditions grapefruit plants are at least five years old, and more usually ten, and at least a few feet high before they flower; but these plants are less than 2 inches high, have had their heads above ground only a matter of days, and are still wearing their "baby" leaves. Their flowers are dwarfed, but otherwise normal in appearance.

The early flowers are the result of X-ray treatment of the seeds, in the belief of C. N. Moore and C. P. Haskins, who are studying the effect of X-rays on plant life. One seed, exposed to 200,000-volt, 30-milliampere X-radiation for two minutes, produced a plant with normal leaf and flower coloration but with leaves somewhat elongate and diminutive and with a deficient root system. The other seed, subjected to the rays for eight minutes, produced a plant lacking in chlorophyll or green coloring matter (which effect frequently is encountered in citrus seedlings), but with the stamens of the flower of the proper golden color.

The seeds were part of a quantity supplied to the laboratory by the College of Agriculture of the Univeristy of California, from stock ordinarily yielding most uniform plants. On March 8 they were rayed, after having been soaked in distilled water and dried; and on March 16 they were planted in seed flats within the electrically-heated roof garden. Snow and winter were still in evidence, but within the structure the temperature was uniformly warm. On April 14 the plants began to sprout. Before the end of May the two flowers were in evidence, and on June 6 were in full bloom.

Whether the tiny plants would have had full-size, or even dwarfed, fruit will never be known. The experiments called for the removal of the pollen for use in additional experiments.

"It is hardly thought, however," said Mr. Haskins, "that the flowers could have matured into fruit. And neither should it be concluded that early flowering plants can be produced regularly by X-ray treatment. Other rayed seeds produced such abnormalities as twisted stems, double leaves, and blotches of white; and still others produced apparently normal seedlings. So far it has been a matter of chance as to how the chromosomes and genes—those tiny but controlling factors of heredity—might be affected by the x-ray treatment of the seeds. Promising leads of many kinds have been obtained in the work that is being done with seeds, bulbs and plants of many species, but it is too early to make definite statements regarding the results obtained.

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New method for distance finding

A new process for determining the distance of a vessel from a source of radio and sound, is being operated experimentally at the Columbia River Light Station in Oregon. According to announcement by the Superintendent of Lighthouses, when both signals are being operated for fog or low visibility the radiobeacon will transmit one long dash of 3 seconds during each transmission period of 60 seconds. The end of the long 3-second dash of the radiobeacon will be coincident with the termination of the third blast of a triple blast of the sound-in-air fog signal. The triple blast consists of three 1-second blasts at 1 second intervals and is sounded once every 3 minutes during fog or low visibility in place of the regular characteristic single blast. Otherwise the regular sound signal and radiobeacon characteristics will remain unchanged. The number of seconds elapsing between the termination of the 3-second radiobeacon dash and the termination of the triple blast of the sound-in-air fog signal, divided by 5, will give the approximate distance in nautical miles from the lightship.

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THE KIDNAPPER CAUGHT

During a broadcast over the NBC Red Network, use of a photo-cell to detect kidnappers was illustrated by this actual demonstration. As burglar approached child's crib, "electric eye" on crib turned on flashlights and took this picture

Equestrian-operated traffic signals

Senator Borah's rides on horseback in Rock Creek Park, Washington, now have a rival for popular interest in the new photo-cell traffic signals which safeguard the bridle-path at a point where it crosses a main automobile-traffic highway.

Employing a photoelectric cell, as a means of detecting approaching horsemen, a green light shows fixedly to the auto highway and a red light shows to the intersecting bridle path. At the approach of a horseman the signal changes so that the horses pass through the intersection fully guarded without having had to halt for a moment.

Two little invisible beams of light cross the bridle path. When a horse and rider pass through the beams, a shadow is cast on the "electric eyes" and an electrical impulse is sent to the control box. Immediately the lights change. The two beams that play across the path are operative only by horses going toward the intersection. When horses pass the other way through the rays, no notice is taken of them· thus not operating the signal needlessly. The signal "knows," too, when there are a number of riders, and automatically holds the red light against traffic until the last rider is clear of the intersection.

✦

Snare-drum and cymbals higher-pitched than piccolo

One reason why music heard over the radio or from a phonograph seldom sounds as "natural" as when heard directly from the orchestra, was disclosed by Leopold Stokowski, famous conductor of the Philadelphia Orchestra, in a talk before the Society of Motion Picture Engineers, in New York City. Experiments which he has carried out with acoustic and radio experts have shown that the range of pitch necessary for the different instruments of an orchestra is greater than has been believed. Some of the needed higher pitches are not transmitted by ordinary radio apparatus or recorded on phonograph records. Hence the music sounds weak and imperfect.

The pitch of the note written on the music is not the only one which the average instrument emits. Together with this "fundamental," tones also contain certain higher-pitched sounds or "harmonics." It is these which give the different characters, for example, to the same note played on a violin and on a cornet. The piccolo, which plays the highest-pitched fundamental tones used in the orchestra, was found in the recent

experiments to be unexpectedly low in its necessary range of higher harmonics. Its highest written note vibrates about 4,600 times a second, and harmonics vibrating only 6,000 times a second were found to be sufficient for a natural tone. Violins and trumpets, on the other hand, cannot be reproduced correctly with less than 8,000 vibrations a second, although neither of these instruments ordinarily plays written notes as high as those of the piccolo. Some other instruments, including the cymbals, the snare drum, the oboe and the piano, sound unnatural unless the listener can hear tones up to 13,000 vibrations a second.

✦

Neon-filled lamps for series operation

CHRISTMAS TREES are illuminated usually by strings of eight 15-volt lamps burning in series. The failure of one extinguishes the entire string and it is necessary to try each successive lamp in the string until the burned-out lamp is located. Neon-filled lamps have now been developed which operate in the usual manner until one fails. This impresses the full tine voltage across that particular lamp and causes it to glow with the characteristic neon red. As the current producing the glow is not sufficient to light the remaining lamps, the burned-out lamp is identified readily.

The same method can be applied in any series circuit, such as 110-volt lamps burning on a 600-volt trolley line.

✦

Tubes control Purdue's 3,500-lb. steam boilers

THE HIGHEST BOILER PRESSURES in the world, those in the new series steam generators developed by Professors A. A. Potter, H. L. Solberg, and G. A. Hawkins of Purdue University, Lafayette, Ind., are made possible by means of the sensitive control achieved by three-element gaseous tubes. Steam is generated at 3,500 lb. per sq.in., with a temperature of 830 deg. Fahr.

In the control system installed on the Purdue steam generator, two thyratrons are connected to a reversing pilot motor in such a way that one tube will operate the motor in one direction while the other tube will run it in the reverse direction. The motors controlling the oil throttle valve and the boiler-feed-pump rheostat are plugged when the system is in balance; that is, each motor is supplied with current from two thyratrons at the same time, with the result that it receives an alternating current which is limited by a choke-coil. If the boiler pressure or temperature should change, one tube is cut out, thereby causing the motor to operate at full speed until it reaches the desired position when the tube is cut in again and the motor stops instantly under the plugging influence of the alternating current. As a result, changes in fuel and water can be made at full speed without danger of overtravel. In the case of the air control, a variable inductance in the thyratron circuit causes the motor operating the dampers to rotate at high speed when the system is considerably out of balance but reduces the speed as the desired position is approached, thus causing the system to come into balance slowly without overtravel or hunting. In the neutral position, both tubes are cut out.

The basic idea underlying the automatic control of fuel and water on the Purdue series steam generator is that of regulating the supply of both water and fuel in proportion to the output of the unit. The output depends upon the position of the throttle valve in the steam line. In a commercial installation, this throttle valve would be on the prime mover.

Operating experience

Considering the fact that this installation is the first of its kind to be placed in service, surprisingly little trouble was encountered when starting or during operation.

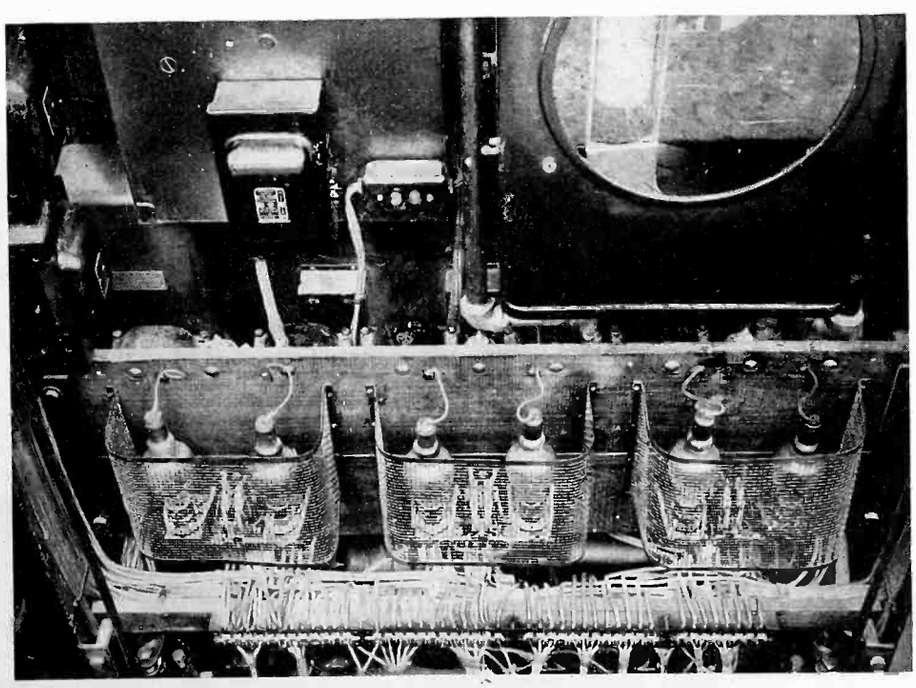
Outside of preliminary adjustments which could not be allowed for in the original design, the system has functioned well from the start. Only one tube burned out after several months of testing. However, difficulties due to tube failure can be eliminated by checking the tube voltage drop by an alternating-current rectifying-type voltmeter. This voltage drop will be found to increase rapidly just before the tube reaches the end of its life. When tests indicate that it is nearing the end of its useful life, a tube can then be replaced in a few seconds. The usual difficulties with burned contact points have been avoided in this installation by placing these contacts in the tubes' grid circuits where the current to be handled is very small.

✦

Safeguarding drawbridge locks

TROUBLE HAS BEEN EXPERIENCED with railroad drawbridge locks coming loose and allowing the bridge to chatter or rock under the first cars, with the danger of derailing the rest of the train. It is now the practice to have through-bolts run through the hook to hold it positively in place.

To make sure that the hook and bolt are both in position, an electric-eye is now used on the South Norwalk (Conn.) drawbridge of the New York, New Haven and Hartford Railroad. When the bolt is in place, the photocell "sees" the parts as correctly positioned and sends a signal to the bridge operator without which he is not allowed to restore traffic across the bridge.



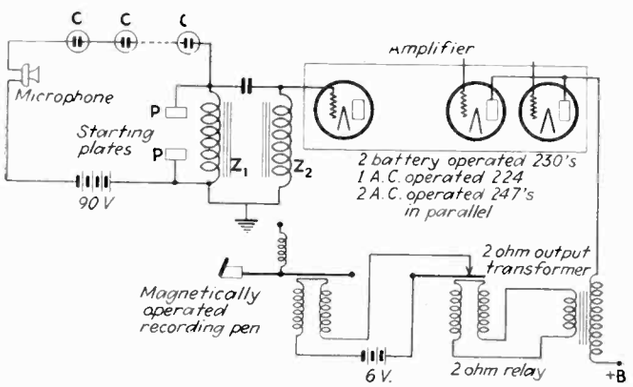
Three-element gaseous tubes on the rear of the automatic-control panel board are shown in the foreground. The two center tubes control the air supply while the sets on the right and left regulate the oil and water respectively

Electronic speed and acceleration recorder

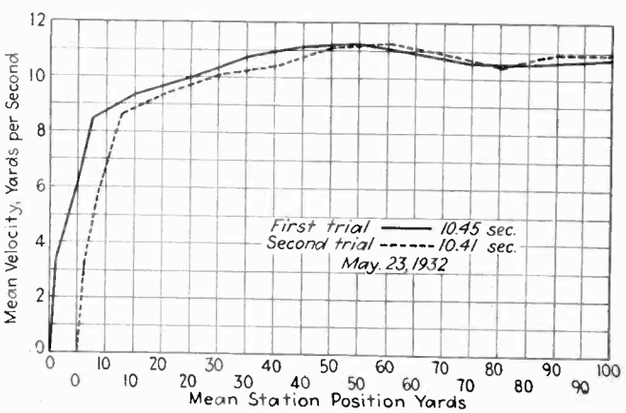
Gauntlet of 12 phototubes and their illuminators and starting plates

By H. M. PARTRIDGE, Ph. D.
New York University, N. Y.

ALTHOUGH the circuit described here was designed for timing foot races it lends itself to timing and recording many rapidly successive phenomena. In the laboratory it can be used for viscosity measurements or for recording occasional arrivals of radiation in an ionization chamber. It could be used for measuring velocities and accelerations of electric motors under varying input and load conditions for recording the velocity and acceleration of automobiles, airplanes, hydroplanes and the like with different loads and fuels, deceleration with braking and many other similar phenomena.



Schematic circuit of photoelectric recorder



Velocities of a runner from photoelectrically recorded data

With human reaction time varying from 0.1 to 0.3 second, it is obvious that where accuracy of 0.1 second is desired in timing races it is impossible to use manually operated devices except where a large number of timers permit a good average value to be obtained.

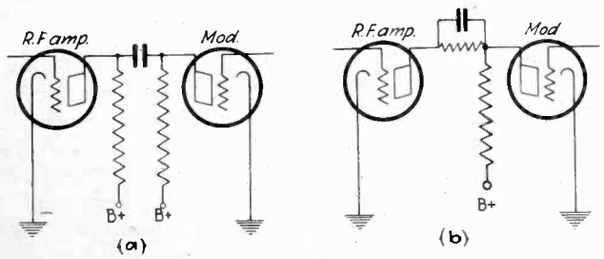
The present device differs from those mentioned above in that it is capable of directly recording in ink fourteen (probably more) successively occurring events to 0.001 second with an accuracy equaling that of the 60-cycle power frequency. (In New York, the frequency at any instant is 60.00 ± 0.03, a precision of one part in two thousand.) The device has been used by Mr. L. T. Rogers of the School of Education of New York University to record upwards of two hundred efforts of nearly as many students in the 100-yard dash in an attempt to correlate anthropometric characteristics with maximum speed.

In the circuit used M is a type HM Amplion microphone placed over the runner's head to pick up the gun. PP are the brass hand plates from which the runner starts 0.10 to 0.25 second later and C, C, C are twelve photocells of the Luxtron selenium type placed, each with its illuminator, at intervals along the track as shown in the accompanying photographs and data. Z_1 and Z_2 are coupling impedances consisting of audio transformer secondaries. As the runner intercepts successively the twelve light beams, as many impulses are transmitted to the grid of the first amplifier tube. The amplifier output operates a relay which in turn actuates a Taylor reservoir type recording pen which is traveling diametrically toward the center of a synchronously revolving disk. Sixteen-inch disks are used and one revolution is equivalent to 0.750 second. A 0.05-hp. induction motor drives the recording pen toward the center of the disk at such a rate that the normal distance between lines (when the pen receives no impulse from the amplifier) is 0.125 inch. Each impulse from the amplifier puts a sharply defined V in the otherwise smooth spiral. The time between successive impulses is measured by the angular rotation of the disk. It will be noted that each stimulus is subject to the same electrical and mechanical delays. It is also important to note that the timing mechanism is in operation at the beginning and at the finish of the race—thus eliminating any starting or stopping error.

Series modulation for Television transmitters

By BRADNER BROWN

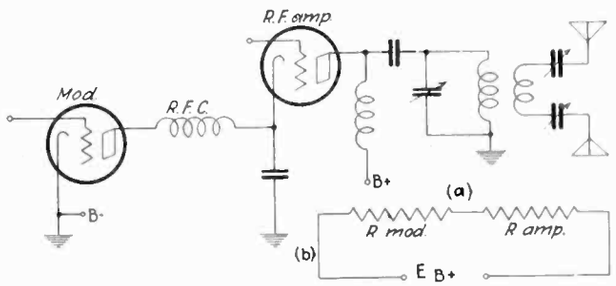
SERIES modulation was developed primarily for the television transmitter. The usual type of Heising or constant current modulation using plate reactors will not operate well when used to modulate the carrier with audio frequencies having values such as are reached in television practices. The impedance of the plate reactors used increases to a very high value when the audio modulating frequencies exceed 10,000 cycles per second, a very modest television frequency. Furthermore, the inherent capacities between the windings of even the best equipment available cause modulation to take place in a very uneven fashion over the range of frequencies necessary for good television transmission which extends from 100 to 40,000 cycles in the systems which we have today.



Two forms of Heising modulation circuit

An adaptation of the Heising system using two resistors and a coupling condenser has been used as is shown in Figure 1 at (*a*). Another version of the same idea is shown at (*b*). The losses in these systems make this type of modulation extremely expensive, from the standpoint of power lost and voltage to be supplied. Thus, if a 250-watt modulator tube using 1,000 volts on the plate is used to modulate a 75 watt r.f. amplifier, it will be necessary to use a resistance of at least 20,000 ohms for the coupling resistor. This will entail a loss of 3,000 volts at the rated plate current of 150 ma. and a loss of 450 watts in the resistor. Similar power losses occurring in the r.f. amplifier plate resistor make this type of modulation costly. Furthermore, it is necessary to supply the modulator with 4,000 volts, which means an added expense in filter condensers and rectifier units. To obtain 50 watts of modulated carrier, it is necessary to supply over 800 watts of plate power at an extremely high plate voltage.

The series modulator circuit does away with all of these difficulties and offers the really practical television modulation system. The connections for the series modulator are shown in Fig. 2, the equivalent circuit reduced to its simplest form being shown at (*b*) with all of the interelectrode capacities ignored. It can be seen that the modulator and r.f. amplifier are in series, the amplifier filament operating at the potential of the modulator plate. As the modulator plate resistance is changed by the grid voltage shift, the modulator will take more or less of the total plate voltage thus effecting modulation. It is apparent that the series modulator is a *voltage* and not a current modulator. As the grid voltage on the modulator is made more negative the plate voltage of the modulator will increase, thus lowering the



Series modulation circuit and its equivalent

plate voltage on the r.f. amplifier and therefore the power output. The percentage modulation to be expected can be calculated by setting up the conditions necessary for modulation in this system. This has been done, and with all in between steps eliminated is reproduced here:

R_m is the resistance of the modulator

R_a is the resistance of the amplifier (r.f)

The percentage modulation as the grid voltage of the modulator is changed from G_1 to G_2 is as follows:

$$\text{Per cent mod} = \frac{R_{a2}\ (R_{m1} + R_{a1})^2}{R_{a1}\ (R_{m2} + R_{a2})^2}$$

In most cases, the assumption can be made that the amplifier will offer a constant impedance with the results that $R_{a1} = R_{a2}$. In this case it is wise to make the resistance of the modulator as large as practical to obtain the greatest modulation. The ability of this type of modulator to handle a large range of frequencies depends on the fact that there are no choke coils or capacities to influence the response of the system. Furthermore, less voltage is necessary than with the resistance modulation schemes. In the example given before, it was necessary to supply 200 ma. at 4,000 volts. Owing to the better design of the series modulator, it is only necessary to supply 80 ma. at 2,000 volts as there is no power loss in coupling resistors. Fifty watts of modulated power can be secured with an input of only 160 watts as against 800 in the former case. It is also much easier to supply 2,000 volts as the tubes, condensers and chokes need not be as large as in the former case.

This system has been in operation in the transmitter of the First National Television Corp. of Kansas City and has proven quite satisfactory. Apparently, the system is much better adapted for use in low level modulation partially due to the fact that the power output of the modulated amplifier is materially reduced when operated at 700 volts which is the case in this installation. It is excellent, however, where a linear amplifier is to be used as the output stage. In the transmitter used, a 250 watt 204-A was used as the output r.f. amplifier.

+ + + ELECTRONIC NOTES

Cathode-ray frequency multiplier

AN INTERESTING METHOD of generating high frequencies using a cathode-ray tube was described in the April, 1932, issue of *Physics*, by Noel C. Jaminson, Northwestern University.

The electrons from the filament leave through a narrow slit, traverse the space between one pair of deflecting plates and arrive upon a plate made up of rectangular metal strips, neighboring strips being insulated from one another and alternate strips in electrical connection.

During one complete cycle of the deflecting plate field, the currents from the two parts of the plate will change at a frequency which is a multiple of the frequency applied to the deflecting plate. When the applied deflecting plate frequency was varied from 400 to 1,300 kc., strong indications of oscillatory current were obtained in a resonant circuit tuned to 2,580 kc., that is, tuned to two, four and six times the original frequency. It is hoped to produce oscillations in the range above 2,000 million cycles per second.

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Dielectric constant measurement

IN THE PROCEEDINGS OF THE ROYAL SOCIETY, May, 1932, J. W. Smith, University College, London, describes a resonance method of measuring dielectric constants. Numerous types of vacuum tube resonance methods for the measurement of dielectric constants have been described. The two-tube circuit here described has proved to be very useful for the measurement of the dielectric constants of dilute solutions. The oscillator enables the straight resonance circuit to be some distance removed from it; resonance in the pick-up circuit is detected by means of a low-resistance thermo-junction, introduced directly into the circuit. A quartz crystal connected between the grid and the anode of the first tube is used to control the frequency (1,227,282 ± 20 cycles per sec.).

A very much simpler circuit has been used for measuring the power factor of vulcanized rubber.

Studies in radio transmission

T. L. ECKERSLEY OF THE Marconi Company, in a paper read March 23, 1932, Institution of Electrical Engineers, London, gave the following data: The facsimile material used consists of a large number of records of short signals and up to four echoes taken from April to July, 1931, on stations at Kliph, South Africa (16.1 and 33.7 m.) and Drummondville, Quebec (35 sheets ruled with straight lines 0.01 in. thick and 1 in. apart, sent on 32 m.; and 24 sheets sent on 16 meters). The interpretation is based on the assumption that the time taken by a pulse along its curved path is equal to the time it would take to travel along the straight lines which are tangent to the rays leaving, or returning to, the ground and which would reach an effective height larger than the actual highest point. Multiple echoes correspond to rays which have been turned back several times. From the differences of the time of arrival, the ray angles, effective layer height and maximum electron density can be found, when the assumption is made that the first mark is made by a signal which leaves and arrives under glancing angles. The refractive index of the equivalent rays depends on the density of electrons in the Kennelly-Heaviside layers, and gives a critical largest possible angle above which the rays no longer return to ground. As a rule the maximum echo delay time measures the maximum ray angle, except for very long paths (South Africa), where the interpretation is uncertain, the high angle rays being greatly weakened.

Special attention was paid to the records taken on Montreal at intervals of 1½ hr., during the nights of May 10-11, 1931. These show a regular decrease of echo time as the night advances. Assuming that the initial signal takes 0.58 millisecond, the highest electron density in the path comes out to be 520,000 per cu.cm., the recombination coefficient 0.95×10^{-10}, the effective height 326 to 337 km. (F layer). The echo spreads on the South African path, which is twice as long, are not nearly double those of the Montreal route, probably because the high angle rays are absorbed and not recorded. It appears that the ionizing agency starts about sunrise and ceases about sunset (this point may be tested during the coming eclipse); it is probably ultra-violet light from the sun acting on atomic oxygen. The facsimile experiments give little information on the lower or E layer, the frequencies are so high that the waves penetrate this layer. Measurements over shorter distances (227 km.) give very much lower height for the F layer, but the tests were made on 60 and 120-meter waves during the daytime.

From October, 1930, to October, 1931, the strength of the horizontal magnetic component about 1.5 above ground of continuous carrier wave signals was measured on a number of short wave commercial stations scattered throughout the world. It was found that in general during a short period of two to three minutes the signal intensity varied as much as one to ten, it rose to a number of well defined peaks of more or less the same intensity, and the peaks were taken as the value for the period. It was found difficult to obtain reliable average values for monthly, night and day means. A large part of the variations is believed to be caused by magnetic disturbances. Eliminating disturbed routes, evidence was found that the index of the exponential over-all attenuation is proportional to the square of the wavelength, but that focussing effects and scattering by electron clouds must also play a part. Low angle rays are least attenuated (E layer) and long distance transmission is practically wholly effected by low angle rays. The results obtained for daylight transmission are in agreement with a mathematical theory developed by the author and valid in the wave-length range from 9 m. to 25 km.—*Paper read March 23, 1932, Institution of Electrical Engineers, London.*

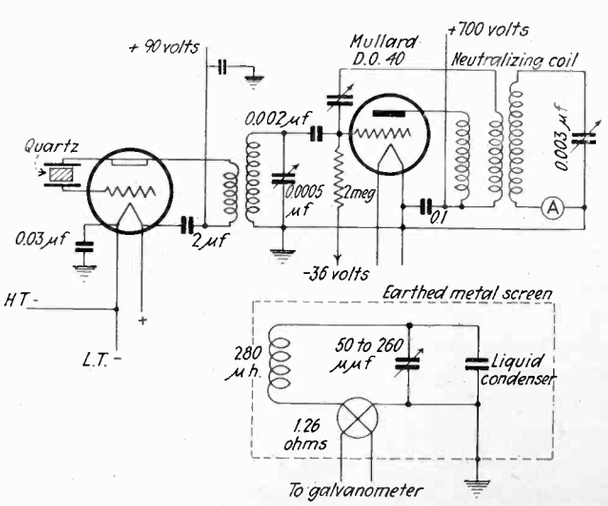

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Photo control for highway lighting

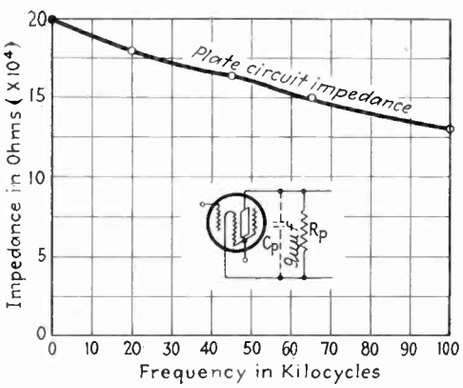
WHEN DARKNESS DESCENDS on U. S. Highway 40, outside of Kansas City, Mo., the photoelectric tube is on the job to turn on the new highway lighting system. This first known application of the photoelectric tube to highway lighting, is part of a new system designed by the General Electric Company and installed by the Missouri Public Service Company.

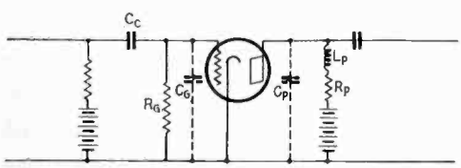
FROM THE LABORATORY + + +

A resistance-coupled amplifier for television

By C. Bradner Brown

Television has brought about the problem of designing amplifiers capable of operating over a wide band of frequencies having equal amplification characteristics. These frequencies range from 100 to 100,000 cycles per second in modern television amplifiers. A 100 line, 100 element system operating at 20 frames per second will produce such a range of frequencies as mentioned above. It is highly probable that even wider bands will have to be handled in the future in order to secure satisfactory results.





The resistance-capacity coupled amplifier has been accepted as standard for this type of work, owing mainly to its even amplification of all frequencies. The author's experience tended to show that certain losses occurred at the higher frequencies which had been heretofore unaccounted for. Hence, a detailed study was made to determine where the high frequency losses occurred, and what means could be taken to avoid or compensate for these losses. The tube capacities, inherent in the construction of the modern vacuum tube were apparently to blame for the largest portion of the high frequency loss.

A study of the effect of the various capacities showed that the grid to filament capacity changed the operation of the amplifier but slightly. When screen-grid tubes were used, the plate to grid capacity was eliminated, leaving only the plate to screen or so-called output capacity. Taking this into account, we find that the output impedance can be calculated as follows:

$$Z = \sqrt{X_c^2 + R^2}$$

where X_c is the reactance of the output capacity

R is the value of the coupling resistor

The reduction in plate coupling impedance is shown graphically below. As the plate output circuit impedance is decreased with the increasing frequency, the amplification is decreased. It is apparent that the main high frequency losses occur at this point. The circuit to compensate for this change in impedance is shown above. The coil L_p has such a value as to equalize the impedance at frequencies above 10,000 cycles.

An 8-stage amplifier was compensated with this system using 260 mh. chokes laterally wound to reduce distributed capacity. The rising characteristic past 80,000 cycles in such an amplifier was especially valuable owing to the failing characteristic of the response of neon lamps in this region.

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O. H. CALDWELL, *Editor*

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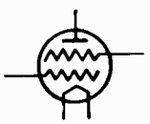


"Just around the corner"

EVERY plant, every shop, every place of business, is a challenge to the resourceful electronics man and radio engineer, to find ways to improve the routine processes that now go on. Most of mankind seems to lack ingenuity or the power of detachment which enables one to inspect familiar processes with the scrutinizing inquiry "How can I make this better? What entirely different method would give a better result?"

Nor have many practical production engineers and plant managers any conception of the ways in which the speeding electrons in vacuum tubes can help with their everyday tasks. To get electronic tubes put to use in these new roles is the responsibility of every reader of these lines. Especially does it open opportunities galore for every radio engineer with time on his hands, every electrical man who wants to keep abreast of the newest applications in his art.

"Just around the corner" from wherever you, restless reader, are now scanning these lines, there is an opening for electronic tubes to go to work. It waits only on your power to discern—and apply!

Shielding the antenna

BECAUSE the antenna is such a simple, elementary device, designers of receiving sets give all too little thought to this essential in the operation of their products. Yet the operation of the set can be no more satisfactory than is the installation of the antenna which supplies its original energy. Without good pick-up as the foundation, the excellence of the rest of the listener's installation is of little avail.

In Europe increasing attention is now being given to antenna methods, and in Germany, especially, the shielding of antenna leads has become of importance. In one German type the conductor is held clear of the sheathing by paper cords wrapped in loose spirals around it, so that the separation consists principally of air; in another this separation is of cotton-wool; in a third a rubber tube with external metallic sheathing has within it radial partitions to hold the conductor central. Another system uses a double antenna lead, coupled inductively to the antenna above and to the receiver below, thus reducing the need for very small capacities between lead and sheathing. These shielded leads have been strongly (perhaps too strongly) recommended by the power companies in Germany recently.

Radio and the communication balance sheet

SOME significant testimony concerning the radio experiences of the Bell telephone interests, was that given by Dr. Frank B. Jewett, president of the Bell Laboratories, and vice-president of the American Telephone and Telegraph Company, before a Mid-West court last month.

Dr. Jewett reported that research in radio to date has cost the Bell interests about $11,000,000. In addition $5,000,000 to $6,000,000 has been expended for the various radio circuits now in commercial use for telephone communication. Not a single one of these radio circuits comes anywhere near paying its costs, and the combined radio operations represent a loss of from $700,000 to $800,000 a year. Owing to the depression, recent trans-oceanic phone service demands have fallen far below expectations; the Buenos Aires link to New York sometimes carries only two phone calls per day.

This experience throws light on other radio operations from a balance-sheet standpoint. It also supports the view long held by Dr. Jewett and the telephone group that if a wire can be put up, wire service will perform more dependably and economically than space oscillations.

The coal industry wants to use electric eyes

THE coal industry is seeking ways to employ the electric eye, and is ready to utilize it on a large scale for cleaning coal, if a way can be found to apply it. Coal as mined contains from 4 to 20 per cent of slate, dirt and other foreign material. Heretofore the principal methods of mechanically separating out the refuse matter have been based on the differing densities of the coal and the slate and other impurities. But a great deal of hand picking has finally been necessary. Here is where it is believed the electric eye could prove of service.

Already experiments have been made by one of the large companies. The preliminary tests went along well enough, but the first practical attempt showed that wet slate coming from the mine had so nearly the same color as coal, that the photo-cell was unable to discriminate.

When the electric eye can be given a job in the coal fields, a large-scale industrial use is immediately assured.

Seeds, high-frequency, and evolution

EVIDENCE accumulates that irradiation of various kinds can exert profound effects and basic changes in the growth of living things, particularly beginning with the seeds or primary cells. Earlier pages of this and other issues of *Electronics* carry testimony to the effect that we are merely the creatures of the particular high-frequency ether bombardments which we (or our ancestors) underwent while in some nascent state of evolution.

Now comes, across the Atlantic, news of Mezzadroli's experiments in Bologna with two-meter waves on seeds, etc. Development is far more rapid, irradiated onions for example blooming ten days before non-irradiated control plants; the characteristics persist to a great degree in the next and subsequent generations; a special tendency obtains to produce variations and sports, and these are also usually hereditary. Little irradiation is needed: e.g. in the case of the onions above-mentioned exposure was for 30 minutes per day.

Electron shadows in "double eclipse" of August 31

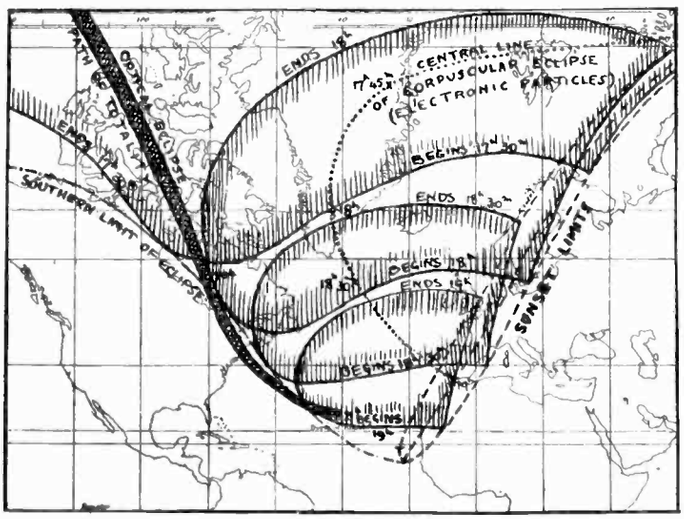
THE chart below shows the expected coverage of the electronic-shadow or "corpuscular eclipse" of the 31st of this month, accompanying the visible optical eclipse, as explained on page 249. This map is calculated on the assumption that the speed of the Sun's electronic or atomic particles through space is 1,000 miles per second.

The successive outlines of the electronic-particle shadow are shown at half-hour intervals, from 17:30 to 19:00 Greenwich mean time, by the series of sausage-shaped shaded areas. The central line of the electronic eclipse crosses the Atlantic from Greenland to northern Africa. At the left the narrow dark strip shows the path of totality of the visible optical eclipse.

The shadow cylinder thrown by the moon has a backward slope of one degree. During the four minutes required for the particles to traverse the distance between moon and earth, the lag of the shadow cylinder will be 4,300 miles. Since the moon is moving nearly parallel to the earth, but 35 miles per minute slower, the axis of the shadow cylinder will strike the earth 4300 ÷ 35 or 123 minutes before the axis of the optical shadow-cone touches the earth.

Radio transmission phenomena observed on the afternoon of August 31 will give interesting confirmation of these electron shadows and their effect on the radio reflecting layers. This information is important for a fuller practical understanding of the propagation of signals.

SUCCESSIVE ELECTRONIC SHADOWS, AUG. 31



The successive areas cut off from the sun's electronic bombardment by the moon's mass are shown by the series of sausage-shaped areas, taken at half-hour intervals. At the left is the path of totality for the optical eclipse (visible and ultra-violet waves)

REVIEW OF ELECTRONIC LITERATURE

HERE AND ABROAD

Radio direction-finding experiments with aurora

[DÜLL] A series of experiments is described in which bearings were taken every 30 seconds by night on Stockholm, wavelength 435 meters. The strength of signals was also recorded. Very rapid variations of bearing and strength occurred previous to the appearance of the aurora, together with practically constant earth magnetic field, but as soon as the aurora commenced the volume fell to a very low figure and the bearings became steady, the earth field showing rapid variations. This applies to the strong, wavering, green, S-form lights: the weaker, whitish or violet, filmy lights gave a very good and consistent volume and very steady bearings. At the point where the experiments took place Stockholm is practically inaudible by day.—*Funk, Berlin, June 10, 1932.*

✦

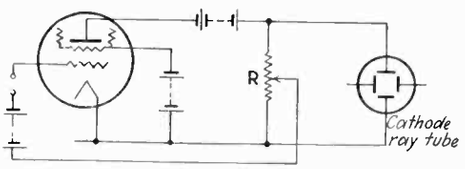
Distortion measurements

[HOFFMANN] Applies only to the a.f. portion, from microphone to transmitter. As sources of sinusoidal currents the heterodyne, light-siren, and condenser-siren are discussed. This last uses a motor to rotate a toothed wheel within but clearing the teeth of another, so that the teeth form small condensers as they come opposite one another, their shape being such that the variations of capacity follow a sinusoidal curve. The bridge for "Klirrfaktor" measurements is described, as also the Grutzmacher analysing instrument, with which the value of each separate (falsely added) overtone can be directly read. The principle is that of superimposing on the distorted voltage a sinusoidal voltage variable from say 30 to 10,000 periods, filtering out from the result any 20-cycle heterodyne voltage that may arise and measuring this. The measuring instrument thus shows a reading twice for each overtone present, once as the generator reaches a value 20 cycles below the overtone and again as it reaches 20 cycles above it—these can of course be recorded graphically and thus the entire band very rapidly explored. The analyser used by Siemens works on a similar principle. The fact however is emphasised that the "Klirrfaktor" really gives no true idea of the distortion as perceived by the ear, since in the case of music and speech it is not a sinusoidal voltage which has to be amplified, so that combination tones (sum and difference tones of fundamentals and overtones) occur and these are far less readily tolerated by the ear. For this reason a newer method uses as input two a.f. tones, differing by 50 periods for example: then at the output end a a filter passing 50 cycles is followed by the measuring or recording instrument so that in this case the strength of the difference-tones throughout the entire audible range is measured. To what extent such measurements give a truer indication of the distortion as perceived aurally is as yet doubtful.—*Funk, Berlin, May 20, 1932.*

✦

Linear time axis for broadcast frequencies

[G. VLBRICHT, Hanover Inst. of Technology] The usual methods of securing a linear time axis lead to a rather low upper frequency limit (see *Electronics*, December 1931, June 1932). By making use of the sudden appearance of the dynatron effect in screen grid tubes, the so-called tilting effect, the duration of the return trip of the cathode-ray beam may be reduced to less than one millionth sec.; and the wave-shape of



broadcast waves directly demonstrated. The upper limit is due to the rather large screen grid-to-plate capacity of commercial tubes.—*Hochfrequenztschnik and Elektroakustik, April/May, 1932.*

✦

Frequency analysis heterodyne envelope

[F. M. COLEBROOK, National Phys. Laboratory, Teddington] It is known that the superposition of two perfect sine waves gives a modulated wave whose amplitude varies periodically but not strictly as a sine wave at a frequency which is equal to the frequency difference between the two original waves. Theoretically the beat tone is therefore not strictly a pure wave. The maximum equivalent amplitude modulation is just under 70 per cent when the amplitude of the two sine waves is equal. The percentage of higher harmonics produced varies with the ratio of the amplitudes of the waves; the amplitude of the second harmonic is over 10 per cent of the fundamental when the ratio reaches unity. — *Wireless Engineer, April, 1932.*

The physics of the Braun tube

[von ARDENNE] Summary of the physical characteristics of these tubes, with large bibliography and useful photographs of incorrect and correct polarization and other similar adjustments. Curves of the plate-to-plate current and plate-to-plate resistance of the tubes for positive and negative values of plate-to-plate voltage are given, and discussed in terms of the simple theory. Some details of magnetic control are given, and mention made in this connection of the electronic compass. Photographs of disturbing effects apparently due to ionic oscillations are given (these digests June) and the phenomena discussed; also the possibilities of an increase of sharpness at very high frequencies by the use of such a gas as hydrogen in place of argon. Experiments with the fluorescent screen are described in detail, especially as regards the removal of weak responses (the fixing of a threshold value of response), the use of an electrically-conducting screen which can also be used an an auxiliary anode, the simultaneous use of such a screen to dissipate the heating caused at the fluorescent point. The phenomenon of secondary luminosity is discussed, with illustrative experiments, and its removal by the above-mentioned fixing of a threshold value.—*Funk, Berlin, April 24, 1932.*

✦

Dynatron type audio oscillator

[DON HALE, University of Nebraska] The 322 type tube will act as a dynatron if the screen carries a voltage of +112, the grid is grounded to the positive side of the filament and the plate is given less than 112 volts. It was possible to secure a frequency range from a few cycles per second up to the limits of the human ear by varying the filament current.—*Review of Scientific Instruments May, 1932.*

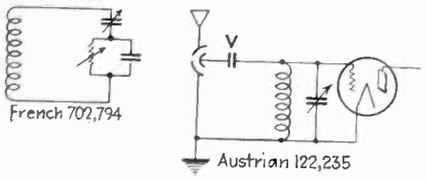
✦

Transmitting tubes for ultra-short waves

TELEFUNKEN HAS PUT on the market a special tube, capable of handling 5 watts on 3 meters and 20 watts on 15 meters, with a life of at least 1000 hours. An indirectly-heated oxide cathode is used.—*Funk, Berlin, May 27, 1932.*

Patents

[SCHR] French 702794 for control of selectivity by a variable resistance of about 100 ohms with a fixed condenser of about 1,000 $\mu\mu f$, in parallel as shown, in order to avoid changes in selectivity



with changes in the setting of the tuning condenser. Austrian 122235 for volume control by a differential condenser or similar device, V being a relatively small condenser to avoid changes in tuning when the volume control is changed. —*Funk, Berlin, June 10, 1932.*

✦

Interference prevention for street-cars

[HERMLE] Experiments have shown that maximum interference occurs when the contact between the trolley and the overhead wire is totally lost, rather than when arcing takes place. Small currents (e.g. the lighting current of a motorless car) cause more interference than large ones, and almost-invisible sparks more than large arcs. More rarely can the interference be traced to a loss of contact between the wheels and the rails. Propagation of the r.f. oscillations causing the interference is almost entirely along the overhead conductors. The use of a 2 to 4 μf. condenser at each pole, connected from the trolley wire to the rails, has proved effective, if costly; on the other hand the replacement of the trolley wheel by a single slider, an increase of pressure etc., have given no results. The best solution in general is the replacement of the trolley wheel by a double slider, gripping both sides of the overhead wire. Motor and switching contacts also cause interference, chiefly propagated along the overhead conductors. A new A.E.G. apparatus, comprising choke, condenser, and fuse has proved very satisfactory in preventing noise.—*Funk, Berlin, May 27, 1932.*

✦

Development of tubes

[URTEL] A brief historical sketch is followed by a summary of the present situation. The tendency towards increased "Gute" (product of μ and the mutual conductance) is discussed, but it is considered that further progress in this direction is unlikely. The state of the present market and its development since 1928 is shown diagrammatically. Battery tubes still show about 12 per cent and direct-current tubes about 20 per cent of the total sales. At least 130 types are on the German market. It is considered that this figure could be reduced to about 20, and some tendency in this direction is evident. Recent development has been towards higher mutual conductances (7 and 8 mA/V), but it has proved difficult to turn out such tubes in quantity within tolerances narrow enough to allow of their use in commercial receivers. Indirectly heated pentodes are considered of importance, in view of the better constants and freedom from hum attainable. The development of tubes suitable for both a.c. and d.c. (e.g. with 20 volts filament) is specially discussed.—*Funk, Berlin, May 13, 1932.*

✦

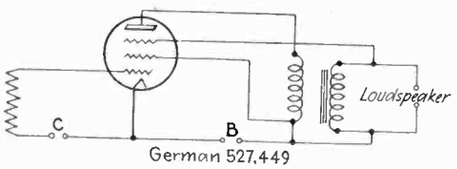
Improvements in cathode-ray tube construction

[VON ARDENNE] Photographs demonstrating the improved sharpness attained by new constructional methods; the avoidance of false records due apparently to ionic oscillation by the use of a grounded external shield; the increase of sharpness at very high frequencies (e.g. over a million cycles) by the use of a lighter gas in place of argon; etc.—*Funk Magazin, Berlin, April, 1932.*

✦

Radio patents

[SCHR.] German 527449 in which a second screen-grid replaces the special outer grid of the normal pentode, in the circuit shown in the diagram. By proper



transformer design the electric field between the two screen grids remains practically constant with varying anode current.—*Funk, Berlin, May 20, 1932.*

✦

High-frequency resistance of the human body

[N. N. MALOV AND S. N. RSHEVKIN, Moscow; J. PAETZOLD, Berlin, Siemens and Halske] Using a frequency of 400 kc. and large hand electrodes, the normal resistance for men is 535 $\mp$ 40 ohms, for women 655 ohms, for girls 980 and for boys 1,000 ohms. Some diseases cause an increase of up to 35 per cent.

The conclusion is drawn that for heart, liver and brain the wave-lengths producing the most marked effects lie near 12m., for muscle and blood, 2m., for the spinal chord slightly below 1m. —*Hochfrequenztechnik and Elektroakustik March; Zeitschrift techn. Physik, May, 1932.*

300 kilowatt tube

[SCHW.] Some details and a photograph of the new Telefunken tube, filament heating 30 kw. (1,800 amperes at 17 volts), indirect, plate volts 120,000; mutual conductance 0.3 A/V, plate current about 150 amperes. These tubes are now on the market.—*Funk, Berlin, June 3, 1932.*

✦

Light sensitive cells in the service of man

[F. H. CONSTABLE] The radiovisor cell with a selenium layer about 1/1000 cm. thick is described. The sensitivity of photoelectric vacuum tubes for radiation from a gas-filled tungsten lamp (2650°K) is 0.17 ma. per lumen for cesium, 0.44 for rubidium, 0.50 for sodium, 0.8 for potassium on copper oxide, with a spectral response curve similar to that of the eye, 1.0 for potassium, 1.25 for cesium on silver oxide. One of the commercial photovoltaic cells, known as Rayfoto, consists of a cathode made of a semi-cylindrical plate of copper uniformly coated with cuprous oxide, an anode made of a strip of lead in a dilute solution of lead nitrate. Eight charts show the great variation in the intensity of the illumination of the sky near sunset, the interesting point being that there is little seasonal variation in the minimum brightness (13 to 15 lux in England) against an average maximum during the day of 2,500 in winter and 36,000 in summer. This permits automatic lighting at dusk.—*Journal R. Society of Arts, May, 1932.*

✦

A month of radio

[*Germany*] The Rhineland local Union of Booksellers has been forced to ask the Langenberg sender to advise them in advance of the books to be discussed by radio so that a stock can be prepared to meet the great demand that invariably follows. *Italy*, viz. Negotiations are in progress to permit of the cardinals resident outside Italy being equipped with radio telegraph stations capable of communicating with Rome. *Norway.* As a result of the strike against the payment of license fees in the Northern province, where reception of Norwegian stations has been very bad, the Telegraph authorities have decided to erect one new high-power and five smaller transmitters to serve this area. *Sweden.* The Government has protested to Russia against the political propaganda transmitted in Swedish from the high-power station near the frontier. *Spain.* Radio Barcelona allows the parents of persons travelling by sea to send them greetings by microphone, twice a week from midnight to 12:30 a.m.—*Radio B.F.f.A., Stuttgart, June, 1932.*

Part played by Russia in television

[B. L. Rosing; P. Shmakov] A review dealing mainly with patents issued in Russia. Cathode-ray television has had the preference from the start. For focussing the beam a long coil surrounding nearly the entire tube is used in place of the short "magnetic lenses" and the deflecting plates also extend almost the whole length of the tube. The deflection obtained is 0.1 mm. per volt, and the size of the spot on the screen 0.1 mm. in diameter.

The report by the second author presents a different picture. For the purposes of television broadcasts a provisional standard about the same as in Germany, has been adopted in the U.S.S.R.: 30 bands, 12.5 pictures per sec. Since October 1931 television broadcast tests with 1,200 elements have been conducted regularly from the Moscow Radio-Technical Center (379 m.) and the Experimental Transmitter (720 m.) "Reports of good visibility have been received from Tomsk" (2,300 miles away). In addition television broadcasts will be commenced this year from Leningrad, Idessa and Novosibirsk. —*Revue générale de l'Electricite, April 1932. Journal Television Society, March/May, 1932.*

✦

Distortion in screen-grid tubes

[R. O. Carter] Res. Lab. General El. Co. Wembley. The selectivity of the tuned coupling circuit prevents all components of the anode current except those at or near the resonance frequency from being amplified, and the voltage applied to the grid of the next value will be practically a single wave of the same frequency as the input. But when the amplitude of the input is sufficient to sweep on to a part of the plate current-grid voltage curve with a considerably steeper slope, the relation between input and output voltage ceases to be linear. It is desirable to determine this stage by experiment for an unmodulated wave; the same curve can be used for predicting the performance for waves modulated 20 or 30 per cent, etc. This departure causes an increase in the depth of modulation which rise must not be allowed to become larger than about 20 per cent.—*Wireless Engineer, March, 1932.*

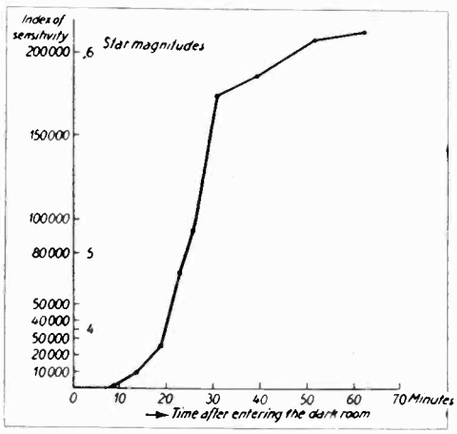
✦

Tubes for ultra-short waves

[H. Collenbush, University of Erlangen] The influence of the dimensions of the electrodes was studied to find the best method of producing extremely short waves. The radiation was measured by means of a tantalum silicon detector in conjunction with a millivoltmeter. The length of the cylindrical anode varied from 1.5 to 2 cm., its radius from 0.5 to 1.1 cm., the radius of the molybdenum or tungsten grid from 0.1 to 0.5 cm. and the tungsten filament had a radius of 0.01 cm. In the larger part of the tests the cylindrical plate was completely insulated. In several of the tubes the ends of the grid spiral were bridged by a short piece of metal wire; the closed circuit thus formed gave only the fundamental, and in one case, when a magnetic field was applied, the next harmonic. It was possible to obtain waves of 4.7 cm. length (about two inch.) A second system often formed along the lead-in wires; it was particularly strong when the frequency corresponded to that determined by the plate-grid capacity.—*Annalen d. Physik, April-May, 1932.*

✦

How eye adjusts itself to darkness



The time taken by the human eye to adapt its sensitivity to see faint objects in a dark room, or to detect star magnitudes, is shown by this chart complied by the Zeiss organization, in Germany.

✦

Laboratory skip distance effects

[L. Bergmann and W. Doerfel, Breslau University] Despite the fact that the existence of the ionized layers has been firmly established, the larger number of theories of wave-propagation are still based on the case of the isolated dipole. Weyrich's theory is an exception, and to test it, a short wave-sender for 33.1 cm. waves, from a Barkhausen circuit, grid + 380-volt, plate zero, filament 2.1 A, emission 25 ma, was placed between two metal surfaces of 16 sq.yd. area held 55 or 72 cm. apart. When the field was measured beyond 80 cm. from the sender, marked lows and highs appeared in the horizontal as well as in the vertical component of the field at different distances. The critical distances are not in a simple ratio, but can be accurately computed from Weyrich's theory of a dipole between reflecting planes.—*Annalen der Physik, April-May, 1932.*

Calibration of cadmium phototubes

[Fr. Levi, Meteor Observatory, Davos] Cadmium cells containing argon used in different places of the world for measuring the sun's ultraviolet radiation are calibrated at Davos with reference to a master cell which has been in service for 15 years. The cells respond to wave-lengths shorter than 3,200 A (3.2×10^{-5} cm.), the region where ozone absorbs radiation, but no two cells show the same sensitivity. A special glass screen renders the readings more comparable.—*Meteorolog. Zeitschr., April, 1932.*

✦

The latest

[H. G.] Experiments are being made near Berlin with a group of seven antennas in circular form designed to prevent fading by suppressing the space wave. It is stated that the new Berlin local high-power sender is to have an antenna of this type. A new anti-interference device due to Gloor of Zürich has been tested by the editor and gave satisfactory results, allowing of reception in the same room as ultra-violet machines and other interference-causing apparatus when without the device no reception was possible. Details are not yet available for patent reasons.—*Radio B.F.f.A., Stuttgart, June, 1932.*

✦

Radio interference and the law

[Michel Adam] In France no laws against disturbers of radio reception exist. But a review of ten decisions or sentences pronounced by the civil courts of Arras, Douai, Rouen, Amiens, etc., shows that the rights of the listener are fully recognized in practice. How necessary it is to pay attention to man-made static is shown by the fact that in Germany alone 68,000 complaints were received in 1930 and the evil remedied at least in part; in 1931 the number amounted to 125,000.—*Revue générale de l'Electricite, May, 1932,*

✦

Glow-lamp oscillators

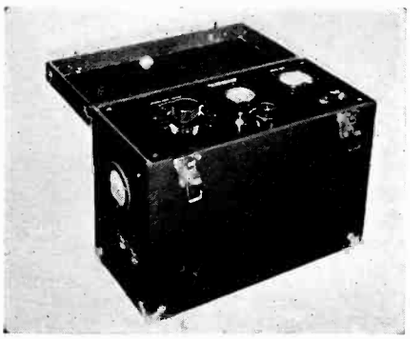
[von Hartel] Valuable series of studies of the relationships of lighting and extinction voltages to the distance apart of the electrodes, to the gas pressure for argon, air, hydrogen, etc. A point of particular interest is the effect on the lighting voltage of the rapidity of the cycle, the extinction voltage being practically unaffected. Some experiments as regards the effect of the form of the electrodes are also described.—*Funk Magazin, Berlin, April, 1932.*

+ NEW PRODUCTS

THE MANUFACTURERS OFFER

Noise meter

E. E. FREE LABORATORIES, 175 Fifth Ave., New York City, have developed their Type-123 noise meter to meet the need for a rugged, cheap, easily portable and highly flexible instrument for the accurate measurement of noise or other sound, entirely independent of the human ear. The instrument is self-contained, is independent of outside



electric supply, and can be operated by anyone as easily as a voltmeter or a thermometer.

The instrument consists of a dynamic microphone, a three-stage amplifier, an electric meter and the necessary dry batteries, contained in a leather-covered case 17 in. by 13 in. by 8 in., resembling a small suitcase. The carrying weight, complete, is 33 lb.

One reading of noise intensity, including all adjustments of the instrument, can be made in less than one minute. Repeated readings in one location require less than 10 seconds each.—*Electronics, August, 1932.*

✦

New resinous fabricating material

THE CONTINENTAL-DIAMOND FIBRE COMPANY, Newark, Del., has added to its series of other materials a new laminated resinous material under the name of Dilecto Uf. Like some of its predecessors, it is combined with either paper or fabric, molded between plates under heat and pressure, and is converted into a hardened infusible product, susceptible to any desired coloration.

Tests conducted on ⅛-in. specimens gave the following results: Specific gravity—1.45 to 1.49, tensile strength lb. per sq.in.—8,500 to 9,322, flexural strength lb. per sq.in.—16,800 to 24,082, hardness (Brinell)—32.5 to 39, weather absorption, ⅛ in. thickness, 24 hrs.—1 to 2 per cent, dielectric strength, volts per mil,—482 to 600, dielectric constant, 500 kilocycles—6.5 to 7.45, power factor, 500 kilocycles—2.88 to 3.69, loss factor, 18.7 to 27.5.—*Electronics, August, 1932.*

✦

Paraffin wax

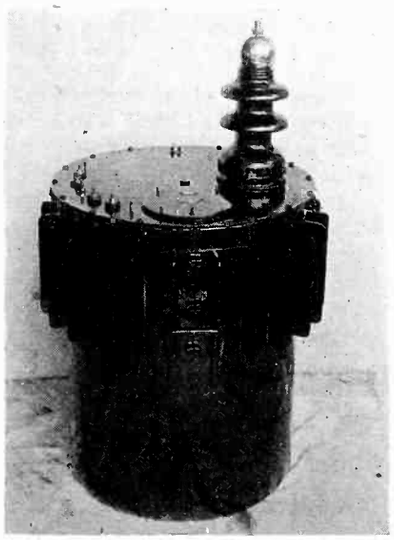
A SPECIALLY TREATED PARAFFIN WAX known as Paraflux has been developed by the Glyco Products Company, Inc., Bush Terminal Building No. 5, Brooklyn, N. Y.

It is of interest because it has greater firmness, adhesion, flexibility, water-resistance and oil solubility. Its melting point is 127 degrees F., and it is free from color impurities and sour odors. It is used in water-proofing insulations, etc. Its price is about the same as ordinary paraffin wax.—*Electronics, August, 1932.*

✦

High-voltage d.c. supply

THE WAITE & BARTLETT X-RAY MFG. CO., INC., 1063 Jackson Ave., Long Island City, N. Y., is now presenting an unusually designed high-voltage d.c. supply source. Both transformer and tube rectifier are housed in an oil-filled steel



tank which results in an unusually neat design, eliminating the exposure of all high-tension wiring except the one "hot" terminal shown above the insulation bushing.

Any variation of d.c. high-voltage supply can be had including pulsating, interrupted, sinusoidal or a definite frequency modulated supply. Suggested applications include: Cottrell precipitation, high-voltage test, special radio transmitters, X-ray and special industrial purpose. — *Electronics, August, 1932.*

B battery for theaters

THE BOND ELECTRIC CORPORATION, Jersey City, N. J., has developed a special "Stedyvolt" B battery for theater sound equipment, which embodies the following features:

1. Initial voltage is never over 94 volts. This lengthens the life of the sensitive coating of the photoelectric cell, removes one cause of primary output distortion and insures against all spilling over.

2. Each cell group is tested with a special Weston test meter accurate to 1/500th of a volt before being assembled into the battery nest.

3. The battery has four terminals, —, 45, 75, 90 volts so that this series of plate readings for checking vacuum tube plate characteristics can be obtained, 15, 30, 45, 75, 90 volts. This will assist greatly in checking the operating characteristics of tubes.

4. Special internal insulation and cushioning materials are used in constructing this battery so that the cells and internal connections cannot become noisy during the life of the battery.

5. A special new terminal clip with soldering thumb piece makes installation a quick job and prevents damage to wax and internal joints.—*Electronics, August, 1932.*

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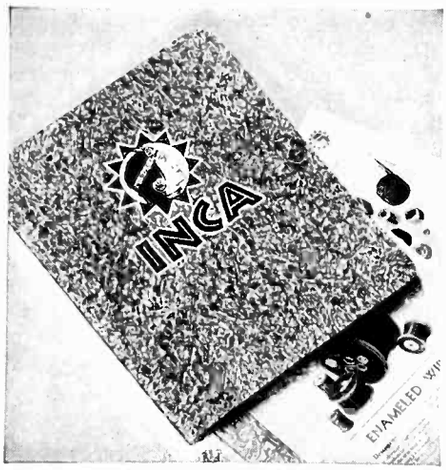
Experimental photo-cell kit

OFFERED COMPLETE FOR $10 by Herman A. DeVry, Inc., 55 East Wacker Drive, Chicago, the DeVry photo-cell kit includes metal base ready for assembly, photo-electric cell, relay, pentode tube for amplification, a potentiometer for fine adjustments for light, and necessary resistances, wire, sockets, etc. Included with the kit is a book of instructions for assembly, showing by diagrams the necessary steps to build six different devices.—*Electronics, August, 1932.*

Copper wire and coils

A SERIES OF NEW and very complete data sheets on copper wire and coils has just been issued by the Inca Manufacturing Division of the Phelps-Dodge Copper Products Corporation, Fort Wayne, Ind., and will be sent upon application to any recognized engineer.



They are conveniently arranged in loose-leaf binders so that subsequent pages can be added as issued.

These bulletins are among the most complete and authoritative published up to this time on these subjects, and will be welcomed by every designing engineer.

The book is of proper size for standard vertical filing and is attractively and durably bound. — *Electronics, August, 1932.*

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Binding post

IN KEEPING WITH THE requirements of present day conditions, a new low-cost binding post has been announced by the Cinch Manufacturing Company, 2335 West Van Buren St., Chicago, Ill. Two types are provided. One is a machine-screw type. The other is provided with knurled head screws. They come with $1\frac{11}{16}$ in. standard mounting centers. Lugs are sturdily mounted in $\frac{1}{8}$ in. thick bakelite. Both lugs and screws are Cinch-solder coated to resist corrosion and oxidization. Any size wire is accommodated and a quick, dependable contact is assured. — *Electronics, August, 1932.*

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Reset timing relay

THE ZENITH ELECTRIC COMPANY, INC., manufacturers of automatic control equipment, 537 South Dearborn St., Chicago, has developed its Type TZE automatic reset timing relay, for operation on alternating current, 110-220 volts, 25 to 60 cycles. The time periods are adjustable from 15 seconds to one hour.

A small contactor operates the main contact, and an adjustable-speed induction disk motor. Contactor is controlled by momentary-contact pilot circuit. When the contactor coil is energized it closes main contacts, and engages a pawl and cam to a pinion gear driven by the motor. Induction motor is started when contactor closes.

The minimum time of 15 seconds is obtained by operating motor at high speed, and disengaging cam, on rocker arm, from pinion gear. Time periods up to $3\frac{1}{2}$ minutes are obtained by changing speed of motor.

Longer time periods are obtained by allowing cam to engage. When entire cam is engaged and motor is operating at slow speed, time period will be approximately one hour. — *Electronics, August, 1932.*

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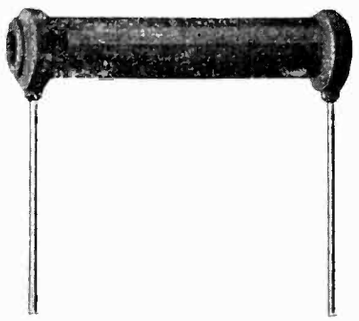
Power wire-wound resistors

A NEW LINE OF power wire-wound resistors has been introduced by the International Resistance Company, 2006 Chestnut Street, Philadelphia, Pa. These resistors are now made in 3-watt and 5-watt sizes and within the next few months will be available in units up to 100 watts, in steps of 10, 15, 25, 50 and 75 watt sizes.



The 3-watt resistor is made in ranges up to 5,000 ohms and the 5-watt resistor is made in ranges up to 15,000 ohms. These units were designed to meet the demand for a smaller resistor capable of dissipating high wattage. The 3-watt resistor is about the same size as the $\frac{1}{2}$-watt metallized resistor and the 5-watt resistor is about the same size as the 1-watt metallized resistor.—*Electronics, August, 1932.*

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Volume control with "click-on" switch

THE YAXLEY MANUFACTURING COMPANY, Indianapolis, Ind., has designed a wire-wound volume control with inclosed switch of the "click-on" type which is especially simple and efficient in very sensitive circuits. It is compact and operates quietly both electrically and mechanically. The Mallory-Elkon group of metallurgists now associated with the Yaxley Company assisted in achieving the design of this instrument. Two sizes are available, with or without switch, in any desired taper. Diameters are $1\frac{1}{2}$ in. and $1\frac{7}{8}$ in. Depth $\frac{3}{4}$ in.—*Electronics, August, 1932.*

Direct-current power supply

IN EVERY LABORATORY the need frequently arises for a variable source of d.c. voltage which is readily controllable. The G-M No. 2508 power supply has been developed by G-M Laboratories, 1731 Belmont Ave., Chicago, to fill this need covering such features as variable voltage; ample current capacity; micro-adjustment; extra heavy-duty potentiometer; line switch and fuse; large filter chokes and condensers; extremely low ripple voltage and substantial and attractive case.

The output of an '80 type full-wave rectifier tube is filtered and connected across the winding of the G-M Type "L" high resistance wire wound potentiometer, from which any voltage from 0 to 270 volts may be obtained in minute steps.—*Electronics, August, 1932.*

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Speaker diaphragm

THE MASLAND MANUFACTURING CORPORATION, Amber and Willard Sts., Philadelphia, Pa., emphasizes a number of features in its new diaphragm assembly. These include the maximum flexibility of the "Leth-R-flex" ring of specially processed material; the adaptability of the cone-paper to give individual characteristics; the rigidity of the assembly, from apex to edge, with specially stiffened apexes, if desired; the lightness of the assemblies, which are engineered for a maximum of lightness with maximum of bulk; and the high quality of material and workmanship involved, giving specially designed acoustical properties. — *Electronics, August, 1932.*

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All-wave switch

THE OAK MANUFACTURING COMPANY, 308 W. Washington St., Chicago, Ill., is now in production on an all-wave switch especially designed, because of the surface-cutting contact used, to give perfect, noiseless switching even at the highest frequencies.

The dimensions are $1\frac{3}{4}$ in. by $2\frac{5}{16}$ in. and the switch can be mounted below a 2 in. chassis using a single $\frac{3}{8}$ in. mounting hole. Length depends upon the number of switching sections required. The mechanical construction is sturdy and embodies steel end-plates, $\frac{1}{4}$ in. steel shaft, heavy brass side supports, brass bearings and silver-plated phosphor bronze contact clips.

The contacts are silver-plated and bite into the surface of the contact rotor, removing all foreign particles from the path of the current and maintaining a contact resistance below 1/1000 ohm. Since disturbances in a switching circuit are due to high contact resistance, noises due to switching are eliminated.—*Electronics, August, 1932.*

U. S. PATENTS
IN THE FIELD OF ELECTRONICS

Electronic Applications

Electrical production of images. In an illuminating screen comprising an arc path, means for obtaining a magnetic field in which the path is located, and a means for initiating an arc in the path, said path having stationary electrodes directing said arc along adjacent paths. A. M. Nicolson, assigned to Communication Patents, Inc. No. 1,863,278.

Magnetometer. Although not electronic, this patent appears of interest to engineers and others in the electronic field. It is for a magnetometer comprising a permeable member having high permeability so that a substantial amount of magnetism is induced therein by a magnetic field of about the strength of the earth's field, and means for conducting current past the face of this member, whereby a dynamic effect is obtained between the current and the magnetism. Frank Rieber, assigned to G. E. Co. No. 1,863,415.

Furnace control. A method of using a thermo-couple and a galvanometer to control the fuel supply to a burner. T. R. Harrison, assigned to Brown Instrument Co. No. 1,863,373.

Surgeons' instrument. A method for dissecting tissue, comprising means for discharging a series of sparks into the patient. The circuit includes the spark, an inductance and several capacities, arranged to provide various degrees of damping. J. G. H. Liebel, assigned to Liebel-Flarsheim Co. No. 1,863,118.

Time of day announcing system. A number of patents assigned to the Bell Laboratories on methods of announcing the time of day. No. 1,863,137 to C. W. Keckler and A. E. Hague; No. 1,863,139 to R. F. Massonneau; No. 1,863,141 to Wm. B. Bruce, and No. 1,862,519 to H. G. W. Brown.

Amplification, Detection, Etc.

Frequency changer. Two oscillating circuits, one carrying a local frequency and the other the frequency to be transformed, introduced into the grid circuit. A third oscillating circuit introduced into the plate circuit carries the transformed frequency. Lucien Cretien, Paris, France. No. 1,863,564.

Negative resistance circuit. A method of feeding energy back into a circuit by a hybrid-coil circuit. M. M. Dolmage, Washington, D. C. No. 1,863,566.

Current limiting system. The grid leak of an amplifier tube consists of the primary of a transformer and in the secondary circuit of this transformer is an element which becomes highly conductive to electricity when a pre-determined voltage is impressed thereon. This pre-determined voltage is secured by rectifying a portion of the input energy of the set, thereby virtually short-circuiting signal voltages above a pre-determined value. O. T. Francis, Quantico, Va. No. 1,863,568.

Oscillator. A method of avoiding high frequency connection of the output circuit coil with the filament of the tube in a Hartley oscillator. Wilhelm Kummerer, assigned to G.D.T. No. 1,863,798.

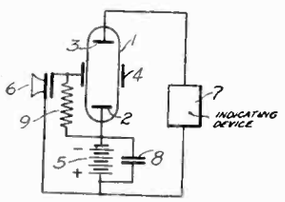
Current limiting system. A method of impressing across the input of an amplifier an out-of-phase voltage when the output of the amplifier increases beyond a certain desired point. Nathaniel Bishop, Bridgeport, Conn. No. 1,863,895.

Distribution system. A circuit involving two mercury vapor tubes. A. H. Mittag, assigned to G. E. Co. No. 1,864,364.

Oscillation generator. Two Piezo electric devices mechanically coupled together and non-reactive means for coupling one of the devices with the input and the other with the output. A. M. Nicolson, assigned to Wired Radio. No. 1,864,368. Also No. 1,863,372 to J. R. Harrison, assigned to Wired Radio, on a similar circuit using a Pentode tube.

Piezo electric transformer. A crystal motor element acting as a transformer connecting the output of one tube to the input of the next. A. M. Nicolson, assigned to Wired Radio, Inc. No. 1,863,345.

Pick-up amplifier. In an envelope is a photo-sensitive cathode and an anode, positioned within, in such a manner as to produce an elongated electronic stream, an electrostatic control electrode is on the outside of the envelope and the control electrode and cathode are relatively movable. A condenser microphone is attached to the control electrode and cathode. August Hund, assigned to Wired Radio, Inc. No. 1,863,052.



Voltage regulator. A battery of highly constant voltage and a battery of substantially equal voltage, which is variable, one pole of which is connected to the similar pole of the other battery, a condenser and means for periodically connecting the condenser in series with the remaining poles of the batteries. W. H. Holden, assigned to A. T. & T. Co. No. 1,862,595.

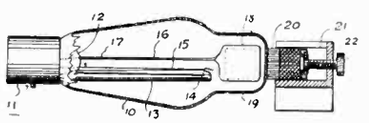
Method of electrical measurements. Two photo-cells and a corresponding amplifier tube, arranged in push-pull. F. A. Pearson, Great Barrington, Mass. No. 1,864,092.

Recording apparatus. A cathode-ray tube method for making photographic records of electrical variations. H. J. McCreary, assigned to G. E. Co. No. 1,864,363.

Ground exploration system. A method for determining the existence and depth below the ground, and nature of strata, differing in electric properties from the surface, consisting in determining the natural wavelengths and the damping resistance of an overground high frequency oscillation circuit. Heinrich Loewy, Vienna, Austria. No. 1,864,024.

Recording method. A method of recording sound by means of a voltaic arc, operating between oxide-coated electrodes in a gas. Heinrich Koenemann, Munster, Germany. No. 1,863,560.

Instrument for detecting vibration. A seismograph, comprising a thermionic vacuum tube with one element serving as a pendulum, movable in only one plane and external means for damping a relative movement of the tube and the pendulum. O. S. Petty, San Antonio, Texas. No. 1,864,214.



Shortwave - longwave circuits. Interstage coupling device for a receiver adapted to operate over a high-frequency band and over a low-frequency band. W. A. MacDonald, assigned to Hazeltine. No. 1,857,055.

Automatic volume control. A resistor between the cathode of the detector and the negative terminal of the common source of plate supply, and a connection from the screen grid of one of the r.f. amplifiers to a point along this resistor whereby an increase or decrease in the amplitude of a signal, gives rise to a decrease or increase in the sensitivity of the amplifier. M. D. Sateren, assigned to Westinghouse. No. 1,856,116.

Electrical filter. A filter current for storing up energy and compressing variations in the output of a two-way rectifier system. G. B. Crouse, assigned to Conner-Crouse Corp. No. 1,856,182.

Synchronizing arrangement. A method of using a fork and vacuum tube for synchronizing purposes. August Karolus, assigned to RCA. No. 1,856,076.

Terminating network. A network for two-way signalling system, to be used in a d.c. telephone cable system. C. N. Nebel, assigned to B.T.L., Inc. No. 1,856,654.

Frequency measuring circuit. The wave to be measured is supplied to a resistance and a tuned circuit and means are provided for obtaining and comparing voltages corresponding to the sum and difference of a voltage equal to the voltage across the resistance element and the voltage dependent in value upon the current to the reactance element. J. W. Horton, assigned to W. E. Co. No. 1,856,707.

High frequency amplifier. A coupling arrangement for a compensated high frequency amplifier. Eduard Karplus, Berlin, Germany. No. 1,856,709.

Transmission of color pictures. Illuminating a color picture by several

different colors and interrupting the light for each record at a different rate and converting the varying intensities into impulses of a frequency corresponding to the color. Rudolph Schmook, assigned to Siemans & Halske. No. 1,854,315.

Photocell amplifier circuit. Two amplifiers with photocell circuit as interstage coupling. H. J. McCreary, Associated Electric Laboratories. No. 1,855,863.

Wheatstone bridge filter. One arm of a bridge is the cathode-plate path of a tube, the other arms are capacities and a resistance. The output is taken across a capacity and resistance path. H. A. Wheeler, Hazeltine. No. 1,855,619.

R. F. Transformer. Balanced transformer for radio receiver. R. H. Hamman, Grigsby-Grunow. No. 1,855,517.

Radio signaling. A coil-antennae system, method for adjusting the wave conductors to a quarter wavelength. Louis Cohen, Washington, D. C. No. 1,854,448.

Modulation system. A system of modulating in the grid circuit of a tube. Werner Buschbeck, assigned to Telefunken. No. 1,859,024.

Transmission system. A method of suppressing undesirable oscillations through inter-electrode capacity. B. B. Minnium, assigned to Stewart-Warner Corp. No. 1,859,103.

Multiplex system. Several sending circuits with a common master oscillator, with different frequency multiplying means between the oscillator and the sending circuit. V. E. Trouant, assigned to Westinghouse E. & M. Co. No. 1,861,462.

Radio receiver system. A method for distributing signalling energy over a 3-wire power distribution network. C. W. Hough, assigned to Wired Radio, Inc. No. 1,861,183.

Automobile power supply system. A generator and means for controlling it for supplying power for an automobile radio. Chas. E. Chesney, Overland Park, Kansas. No. 1,861,262.

Discharge device. A gaseous triode and means for controlling the electric field between the electrodes, comprising a screen enclosing the major portion of the discharge between anode and cathode. Stephen P. Sashoff, assigned to Westinghouse E. & M. Co. No. 1,861,453.

Manufacturing Processes

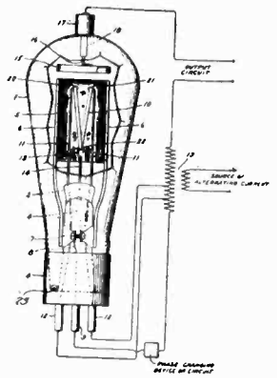
Manufacture of selenium. A method of manufacturing stable selenium sulphide, comprising treating a solution of hydrogen sulphide in excess with selenious acids. Claim No. 1 reads "stable, chemically active selenium disulphide." B. W. Nordlander, assigned to G. E. Co. No. 1,860,154.

Vacuum Tubes, Etc.

Gaseous conductance devices. Patents No. 1,863,702 and No. 1,864,378, to C. G. Smith, assigned to Raytheon, Inc.

A method of terminating tube life. A cathode coated with thermionically active material, a carbon-free electrode cooperating with this cathode, and an electro-positive substance within the device, capable of activating the cathode, whereby the emission does not decrease appreciably over a long period and then decreases rapidly. M. J. Kelly, assigned to W. E. Co. No. 1,863,342.

Grid controlled rectifier. A 3-element tube, including a V-shaped filament, an electrostatically controlled member and an anode, and an ionizing medium in the envelope, at a pressure sufficient to support an arc-like discharge at the impressed voltages, the negative terminal of the filament being positioned near the cathode and the control members at the apex of the V-shaped member. A. W. Hull, assigned to G. E. Co. No. 1,863,407.



Radio Circuits

Radio transmitter protective circuit. A circuit in which opening the doors of shielded cages housing transmitter circuits, automatically opens generator circuits and protects the operator. L. A. Gebhard, assigned to Wired Radio, Inc. No. 1,862,928.

Input circuit. Several tuned input circuits with means whereby at least one of them may be used alternately as a receiver or a rejector circuit. T. H. Kinman, assigned to G. E. Co. No. 1,863,409.

Transmitter filament supply. Secondary winding of filament transformer and means comprising a magnetic leakage path to maintain the induced voltage substantially constant. L. A. Gebhard, assigned to Wired Radio, Inc. No. 1,863,477.

Method of reducing fading. A combination of a vertical antenna and a horizontal doublet, and means of alternately connecting the power amplifier to these antennae. L. C. Young, assigned to Wired Radio. No. 1,863,518.

Two-way radio signalling system. A heterodyne system for simultaneously operating a transmitter and receiver. L. L. Smith and C. H. Moore, Glasgow, Ky. No. 1,864,498.

Multiplex system. Tubes using two grids, one for oscillation and the other for modulation. W. Brueckel, assigned to G. E. Co. No. 1,863,829.

Fading elimination. A method of receiving signal oscillations by a diversity system. H. O. Peterson, RCA. No. 1,863,695.

Combination radio and electric phonograph receiver. Individual volume controls for the radio and phonograph portions, change-over switches, etc. R. L. Maurer, assigned to Grigsby-Grunow Co. No. 1,863,909.

Transmitting system. A means for preventing impedance variations in the antenna circuit from affecting the frequency of oscillations, comprising an additional screening electrode interposed between the anode and control electrode of both amplifier and oscillator tubes, and means for maintaining this electrode at a positive potential with respect to the cathodes. I. F. Byrnes, assigned to G. E. Co. No. 1,857,137.

Multiplex system. A method of connecting several receivers to a common antenna by means of proper impedances. Louis Cohen, Washington, D. C. No. 1,857,359.

Signal level raiser. Simultaneously increasing field strength of several channels and properly feeding signals to radio receiver in proper phase. Bowden Washington and Wilson Aull. No. 1,856,009.

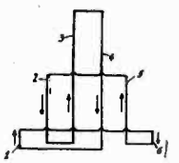
Bias circuit. Resistance bias system in which the grid potential bears a definite relation to the total potential developed across resistor system. E. Zepler, Telefunken. No. 1,855,375.

Keying circuit. Method of shorting part of screen-grid biasing resistance to affect keying a transmitter. R. M Blair, Crosley Radio. No. 1,855,509

Grid suppressor. A method of using an iron core inductance in series with the grid and the tuned circuit for suppressing oscillation. Wilson Aull, Jr., Astoria, N. Y. No. 1,851,078.

Compensating system. A compensating network connected with the antenna network in the input of a radio receiver. A method of rendering the antenna network less effective as the compensating network is rendered more effective, while maintaining, unchanged, the frequency characteristic over the tuning range. Virgil M. Graham, assigned to Stromberg-Carlson Tel. Mfg. Co. No. 1,851,387.

Directional antenna. A directional antenna system for use in wireless signalling, comprising (n + 1) groups of antenna, where n = 2 or more, the sum in effective heighth in successive antenna groups being proportional to the numbers of the series shown on cut. Leon Bouthillon, Paris, France. No. 1,863,741.



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Electron discharge device. Control electrode comprising a coiled vitreous member coated with alkali metal, one end of the coiled member being designed to receive light, to thereby control the current flow between cathode and anode. Albert W. Hull, assigned to G. E. Co. No. 1,851,706.