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telegraphy
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photo-electric cells
facsimile
amplifiers
phonographs
measurements
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therapeutics
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Price 35 Cents DECEMBER, 1930

electronics

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A McGRAW-HILL PUBLICATION

New York, December, 1930

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...he march of the electronic arts

...roducers to spend ...s in 1931

...expected to be one of the ...booms in picture production ...advent of sound pictures is ...for 1931, by leading executives ...industry. Adolph Zukor, of ...nt Publix Corporation has an-...that his studios would produce ...ately 55 or 60 feature pictures ...wood and 5 to 20 features in ...any's New York Studios under ...estimated at $25,000,000.

...r-Goldwyn-Mayer Studios are ...lans for approximately 50 fea-...ures and also additional foreign ...pictures.

...er Brothers, including First Na-...as announced plans for over ...re pictures making the largest ...on program undertaken by the ...

...d Artists and Universal Pictures ...ning the production of 20 fea-...ch necessitating a budget of ...000. Fox Film Corporation has ...am calling for upwards of 50 ... Radio Pictures has planned ...r more features, while Pathe, ...a and others are also planning ...hedules.

✦

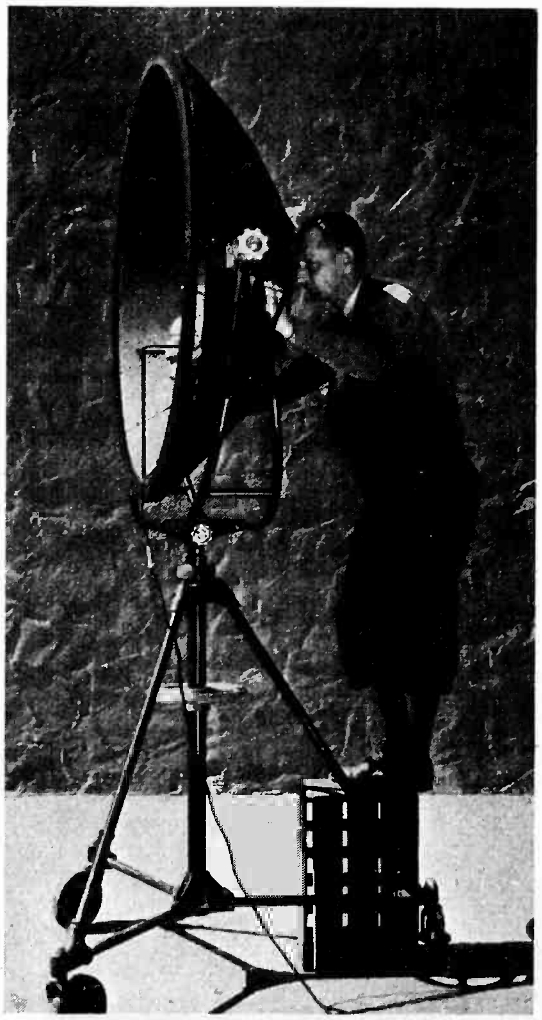
...radio quotas ...rn Commission

...ating an outcry in Congress ...the present division of radio ...sting facilities among the states, ...e members of the Federal Radio ...sion with the exception of Com-...er H. A. Lafount have advanced ...for meeting the state quota ...ons imposed by the Davis ...ation amendment.

...Davis amendment prescribes an equal division of wavelengths, power and hours of operation among the five zones into which the country is divided for radio administrative purposes and then a division among the states within those zones in proportion to their populations.

✦

BEAM MICROPHONE



Developed by RKO Studios, Hollywood, this parabolic reflector with microphone placed at the focus is used for long distance pick-up in recording sound pictures

U. S. Supreme Court holds film producers in trust

Ten of the largest motion picture producers in the country and 32 film-distributing boards handling 98 per cent of motion picture film output in this country, were held guilty of violating the Sherman anti-trust law in two decisions handed down November 24, by the United States Supreme Court.

The producers and distributors involved in the two cases before the Court included: Metro-Goldwyn-Mayer Distributing Corp.; Paramount-Famous-Lasky Corp.; Universal Film Exchanges, Inc.; United Artists' Corp.; F-O-B Pictures Corp.; Fox Film Corp.; Pathe Exchange, Inc.; Vitagraph, Inc.; Educational Film Exchanges, Inc., and First National Pictures, Inc.

Justice McReynolds, in referring to the standard exhibitors contract, stated: "Certainly it is unusual, and we think—directly tends to destroy the kind of competition to which the public has long looked for protection. Ten producers and distributors of films controlling 60 per cent of the business agreed to contract with exhibitors only according to a standard form and then combined through thirty-two local film boards of trade with other distributors, who with themselves control 98 per cent of the entire business.

"In order to establish violation of the Sherman Act it is not necessary to show that the challenged arrangement suppresses all competition between the parties or that the parties themselves are discontented with the arrangement. The interest of the public in the preservation of competition is the primary consideration. The prohibitions of the statute cannot be evaded by good motives."

Paramount startles industry with new 65 mm. equipment

Dr. N. M. LaPorte of the Paramount Publix Corporation, unveiled for the first time, to the New York Chapter of the Society of Motion Picture Engineers, on December 5, the new 65-mm. camera and projection equipment about which there has been so much secrecy for months. All of the equipment shown was developed and manufactured abroad. The projector is an Ernemann unit built in Germany and is of most unusual design. The projection head is a multiple type accommodating either 35 mm. or 65 mm. film. The aperture opening used for the wide-film shown is 23 x 41 mm. making a picture ratio of 1 to 1.78. The lenses for the projector and camera were designed by Carl Zeiss, Jena.

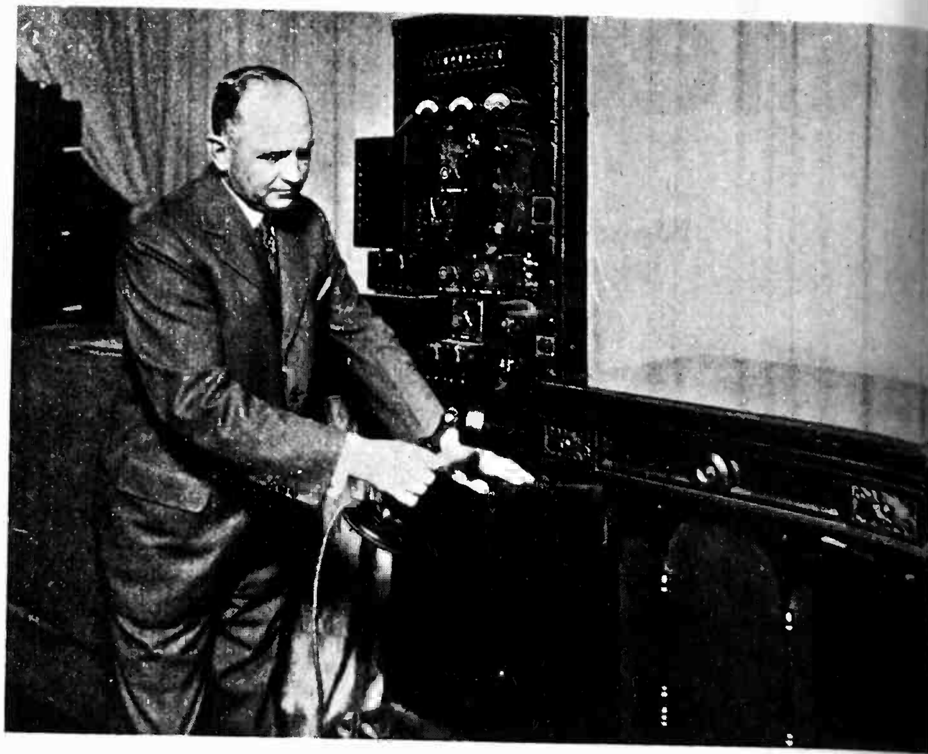
The new wide-film camera, which was built by DeBrie Etablissement, Paris, is also of unique design. It is built on a pedestal provided with an electric motor for propulsion; the camera unit can be steered about the set with a control lever similar to handling a motor car. The camera may be raised or lowered by motor power on the pedestal shaft. The camera is provided with a 230 degree shutter opening. Several reels made with this new wide film equipment were shown.

A new form of optical printer also built by DeBrie for Paramount and used in making reduction prints from 65 mm. to any width was exhibited.

Films showing Paramount's new color system were presented. These films were made by a three-color additive process and the definition and lighting values were most excellent indicating great progress in color photogr

Dr. LaPorte pointed out that a film equipment shown was adapta any standard width that migh agreed upon by the industry.

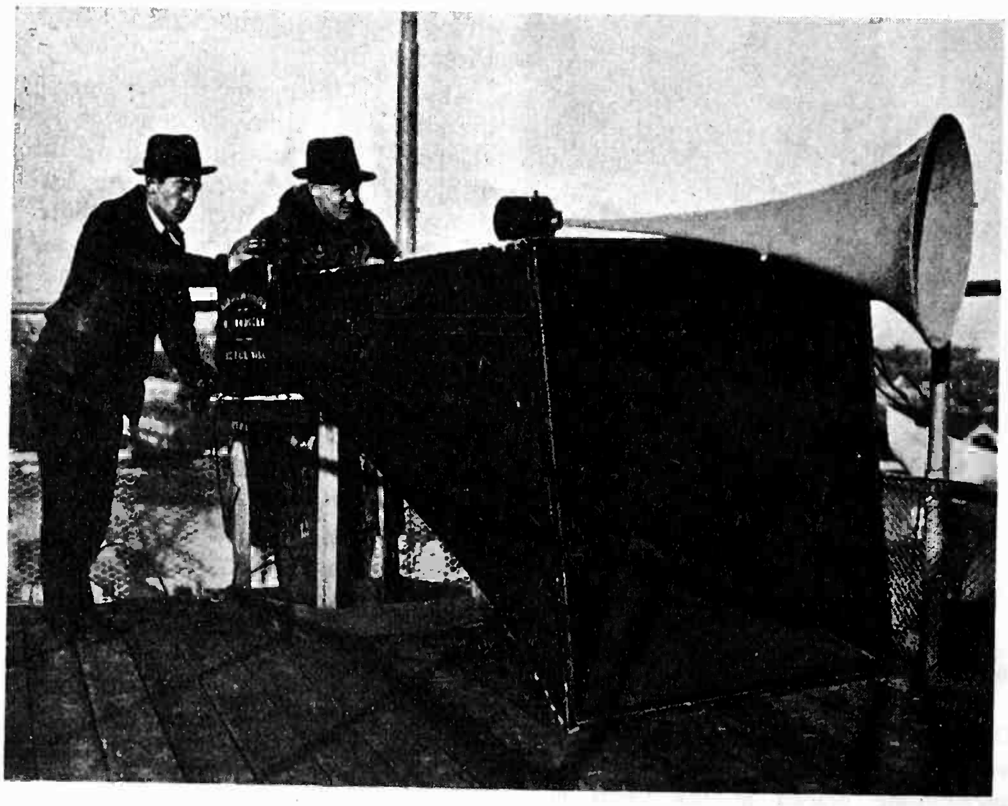
EAVESDROPPING OF NO VALUE HERE



Sergius P. Grace of the Bell Laboratories is shown demonstrating apparatus used for scrambling speech, making possible secret transatlantic radio telephone conversations

✦ ✦ ✦

TO CHEER HARVARD'S CRIMSON TEAM



This loud-speaker unit, said to be one of the largest in use, has been installed at the football stadium at Harvard, Cambridge, Mass. Announcements made from it can be heard with clarity over the entire field

✦ ✦ ✦

Amplifier business growin

A lusty growing infant of the family is the amplifier manufact branch. Amplifiers in theaters, toriums, public parks, ball rooms, way stations and similar places becoming so widely used that manufacturing of amplifiers is o the rapidly growing developmen radio. To meet the needs of am manufacturers the Radio Manufact Association has approved new se to be afforded to the amplifier g headed by A. C. Kleckner of Webster Electric Company, R Wisconsin, chairman. There has been approved a recommendatio Chairman Kleckner to form a s amplifier section of the Standards mittee of the RMA Engineering sion. The amplifier section will de standardized ratings for power a fiers and also cooperate with the tional Board of Fire Underwrite drawing up a satisfactory set of s ards covering amplifiers. Export in amplifiers and traffic, stati legislative and other interests of a fier manufacturers also will be spe developed by respective RMA mittees.

ɩess" will be keynote ɜ1 RMA trade show

ɩual convention and trade show Radio Manufacturers Associa- 931 will be held in some middle city and during the first or veek in June, under a decision November 18, at a meeting of A board of directors at the Cleveland. Business, without will be the keynote of the 1931 ; of the radio industry, which ɪrgest industry assemblage in ed States and which drew over ersons to Atlantic City.

ɩ of a meeting place for the eting was deferred temporarily MA directors. There is keen on for the 1931 trade show the cities of St. Louis, Pitts- Chicago and Detroit, and one our cities soon will be definitely The RMA Board plans to hold convention and trade show e roof and along simplified, al lines, with the least possible o exhibitors and trade visitors. ll be reduced railroad rates to ention city and no increases in otel rates.

ure exhibition of new and cur- aio merchandise in the 1931 e RMA board of directors ɩ new rule which will require tors to show their new or cur- ving sets and other radio lines. e will prevent recurrence of onditions in the last show. r new rule for the trade show nit exhibition, not in the show e demonstration rooms of ex- of associated radio products manufacturers in addition to sets, etc.

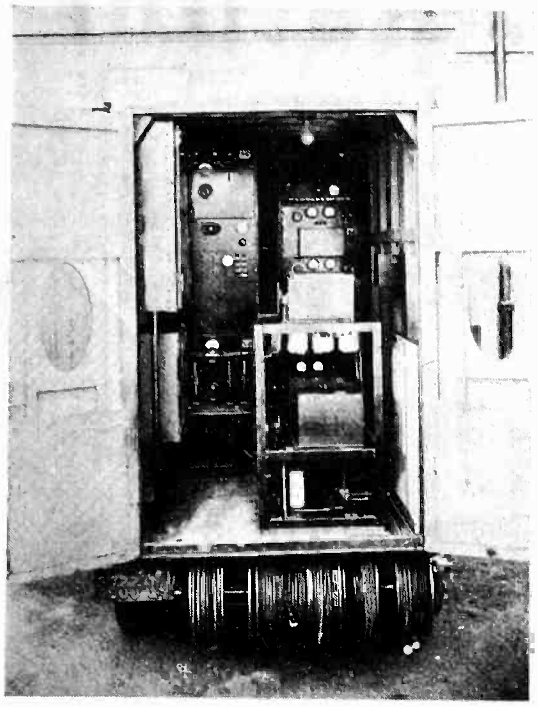
✦

d predicts early rity

F. Gifford, President of the Telephone and Telegraph king to members of the Essex in Salem, Mass., on Novem- aid: "As sure as I am stand- , this depression will soon we are about to enter a period erity, the like of which no has ever seen before; a new ig business working for the nt of its social obligations; and evelopment in industry to work problems of distributing what on the basis that we have a go around."

ifford stated it was inevitable iness through science would ward an industrial and social which would be gained by the n of the best and cheapest service consistent with financial

LABORATORY ON WHEELS



This motor truck is equipped with complete acoustical measuring equipment for making analysis of theaters and auditoriums. Designed by Warner Bros. Studio, Brooklyn, N. Y.

✦

Radio interference

A plan for cooperation between radio manufacturers to reduce the interference troubles of the radio public has been adopted by the Radio Manufacturers Association. The association's board of directors, meeting November 18, at Cleveland, approved the program presented by H. B. Richmond of the General Radio Company, Cambridge, Mass., chairman of the RMA engineering division, to enlist the cooperation of manufacturers on interference work. This will be carried on through a special interference section of the engineering division and later it is planned to enlarge the interference service for the owners of radio receiving sets by the establishment of a separate bureau in the RMA for such interference work, under the direction of competent engineers.

✦

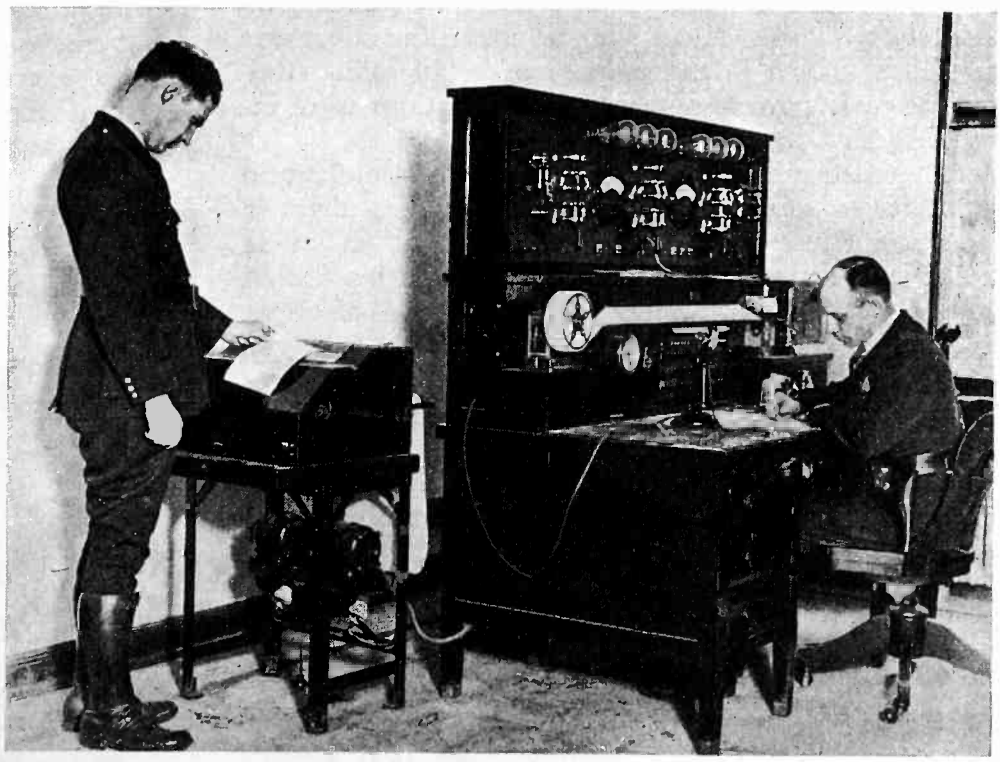
Short-wave channels made available to film industry

The Federal Radio Commission, on November 26, set aside three continental short-wave channels for the use of motion picture producers. Frequencies of 1552 and 1556 kilocycles, hitherto reserved for ship stations, have been made available for temporary use in connection with the production of motion pictures. Power on these frequencies is limited to 250 watts. A third channel, on 1554 kilocycles, was set aside for radio-telephone contact.

The purpose of these channels is to provide facilities for communication between parties "on location" with the main studios. This will provide the necessary means of communication to location parties in desert areas, shipboard, etc., where no other means of communication are available. Such facilities will speed up production of talkies and shorten the period of maintaining parties on location.

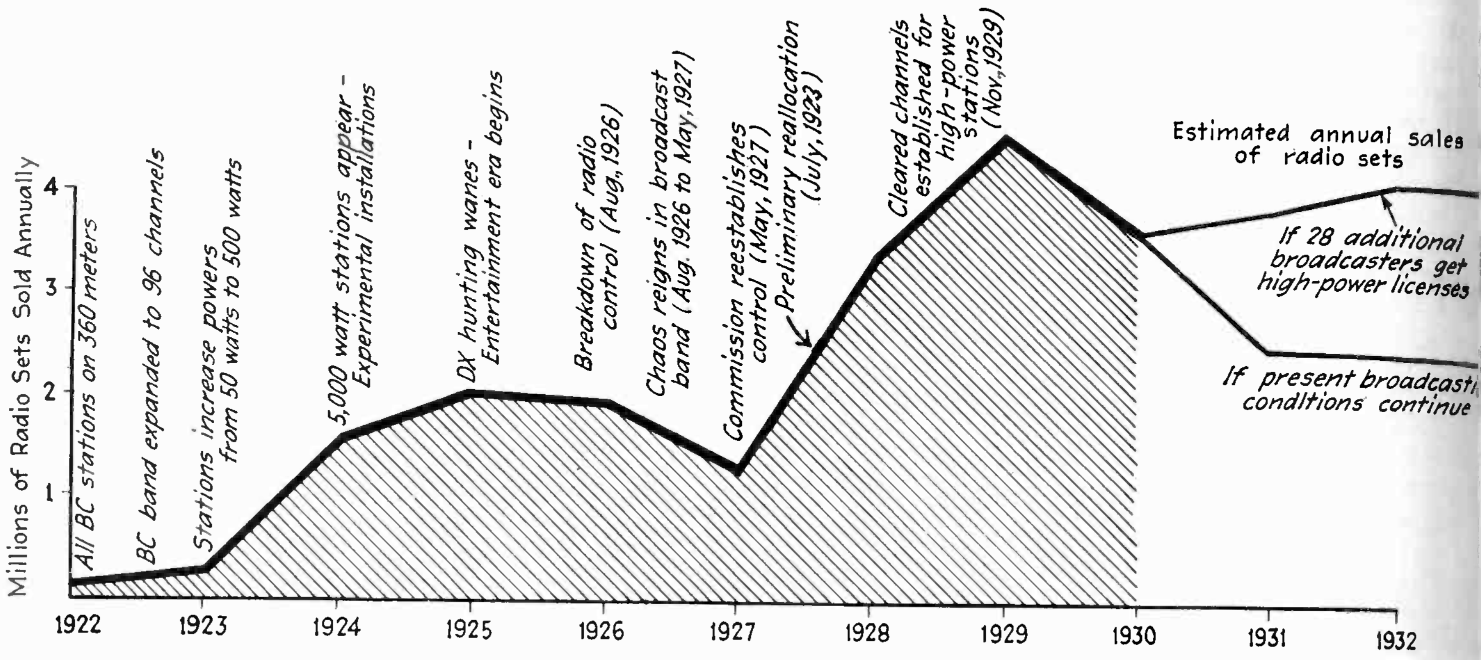
✦ ✦ ✦

CROOKS AND GANGSTERS BEWARE



View of teletype machine over which alarms are sent simultaneously to all precincts by the police department of Dearborn, Michigan. This equipment, with radio on police cars, will not make the criminal's lot any easier

Broadcast-station POWE



Annual sales of radio-receiving sets, 1922 to 1930, showing influence of broadcasting conditions on public's purchases

By O. H. CALDWELL

Editor Electronics, Former Federal Radio Commissioner

IN FEW other places in industry or business is there such a close relationship as exists between the quality of broadcasting service supplied to the public, and the public's response in the form of the purchase of radio sets. Radio-receiver sales in any territory depend upon the technical and program character of the broadcast service received, as can be shown by repeated examples when tracing the history of broadcasting to date.

In 1926, when the radio law broke down and radio broadcasting relapsed into a state of chaos, the effect was immediately shown in the collapse of retail radio sales. Again, as early powers of broadcasting stations were increased, radio sales mounted upwards.

Better broadcasting is thus an effective stimulant to radio-set sales. One cannot sell radios unless there is broadcasting; just as one cannot grow a garden unless there is sunshine. Obvious as this relationship would seem to be, there has yet been a surprising lack of attention given to the broadcasting situation by those whose business investments most depend upon it. Executives of radio manufacturing companies too often have felt or shown little interest in this vital service, which is the very life blood of their continued radio business activity.

Within the last two weeks, representatives of *Electronics* have interviewed radio leaders who have responsibility for producing and selling a large p[...] the country's radio sets.

These men all seem to expect a contraction in sales volume during 1931 and 1932. They say "saturation" is now so far advanced that we cannot have a 4-million-set year.

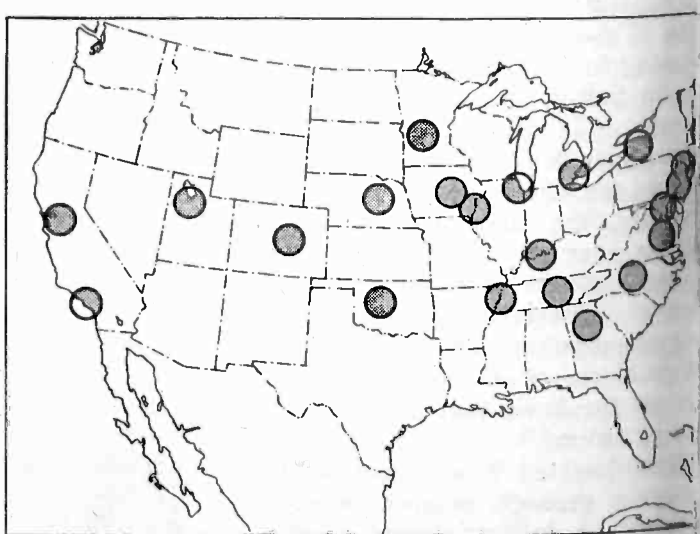
But is this the inexorable picture facing us?

Let us look at the real facts of the situation [...] the broader angles of the radio art.

In those parts of the United States where good [...]casting service (that is, high signal strength) is being had, it is true that saturation of receiving [...] now approaching a fair degree of intensity,—for the radio sets sold during recent years have been [...] into these regions.

But there are still vast populated regions o[...] country where broadcasting is pitifully poor,—whe[...] extent of the broadcasting receivable is a *single program,* available only *during night hours* in [...]

We must open up new territories for receiver selling, if 1931 and 1932 volumes are to repeat past levels. Higher powers for existing stations will do it.



Present "fair-quality" service areas of the 28 broad[...]casting stations (chiefly 5 kw.) which are now askin[...] the Radio Commission for 50 kw. licenses

nd 1931 radio-set SALES

Such broadcasting service of course cannot pro-
lio sales.

per cent of the nation's population live seventy-es or more from broadcasting stations furnishing nt regular satisfactory programs. In these served territories, where only one or two s are received, each spoiled by static, few radio-urally, are yet in use. But these populated areas eat opportunities for future radio-set sales, as demonstrated each time an increase in power granted to the broadcaster serving such a

lution of the radio industry's problem, therefore, existing broadcasting stations to increase their to reach these now sterile sections. At this 28 leading independent broadcasters from all the country are in Washington applying to in-heir powers to 50 kw., being willing to spend each to improve their service ranges—the very at all the listeners, the farmers, and the radio turers and dealers most want them to do.

the Radio Commission, operating against the s of all engineering opinion, holds back against cessary and inevitable action,—on account of pressure from its Senate masters (who do not prehend high power as an improved service to and farm population).

Independent broadcasters in majority

dy many radio manufacturers and other industry re on record as favoring high-power. For their -preservation, however, the present emergency that they go emphatically further, entering the igorously in the interest of the whole radio r. This matter of high power is not a question the so-called "radio trust" stations. The 28 sters applying are chiefly *independent,* far-seeing pirited concerns,—newspapers, educational in-s, department stores, business houses, etc., from of the country, independent of any radio-trust ip or control whatever.

HIGHER POWERS FOR STATIONS ON CLEARED CHANNELS WILL—

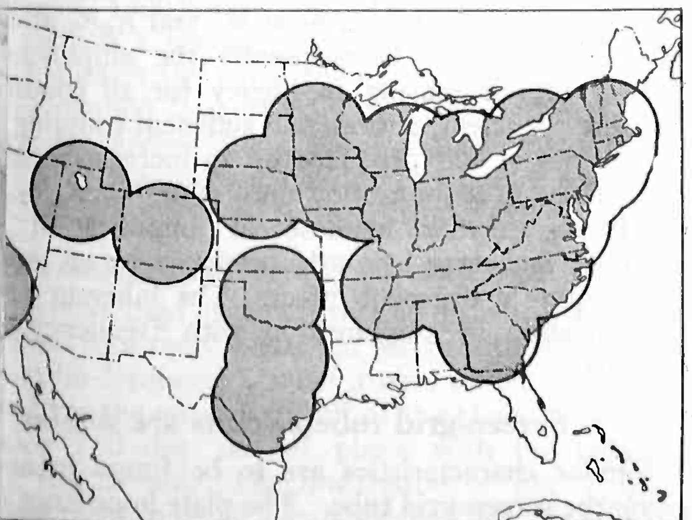
- **Bring clear, strong signals to millions now poorly served**
- **Open up vast new territories for receiver sales**
- **Improve summer reception everywhere, ironing out summer slump and extending production-period of radio factories**
- **Usher in $100,000,000 of waiting receiver sales**
- **Open up $10,000,000 business in broadcasting apparatus**
- **Restore employment to 100,000 radio workers**

The moral influence of the radio industry and trade, exerted through its representatives in Congress will speed Commission action on high power immeasurably by interpreting the situation to the Senators in its true terms of high power as a service to the rural population.

The direct effect would be to put good clear strong broadcasting into all the now unsaturated territories, and so immediately to stimulate sales of receiving, as has been repeatedly demonstrated locally where broadcast stations have increased their powers.

With radio manufacturing volume next year otherwise facing saturation, prompt action in getting high-power broadcasting is the one remaining fundamental factor which can restore radio sales to their past happy situation of 3 and 4-million-set years.

Thus upon the prompt action of the Radio Commission in granting high-power licenses, there now await $10,000,000 in broadcast station sales; $100,000,000 in receiving set sales; the future prosperity of the radio industry, and the employment of a hundred thousand radio workers.



"Fair-quality" service areas of the 50-kw. broadcast stations of U. S. as they would appear if applications now before Commission were granted

Broadcasting stations applying for 50 kw.

WHAM	Rochester, N. Y.	Stromberg Carlson Telephone Mfg. Co.
WOR	Newark, N. J.	Bamberger's Department Store
WBZ	Springfield, Mass.	Westinghouse Elec. & Mfg. Co.
WBAL	Baltimore, Md.	Consolidated Gas & Elec. Co.
WHAS	Louisville, Ky.	Courier Journal
WCAU	Philadelphia, Pa.	Universal Broadcasting Co.
WWJ	Detroit, Mich.	Detroit Evening News
WRVA	Richmond, Va.	Larus Bros. & Co.
WJR	Detroit, Mich.	The Goodwill Station, Inc.
WBT	Charlotte, N. C.	Queen City Broadcasting Co.
WSM	Nashville, Tenn.	National Life Insurance Co.
WSB	Atlanta, Ga.	Atlanta Journal
KVOO	Tulsa, Okla.	Southwestern Sales Corp.
WREC	Nashville, Tenn.	WREC, Inc.
WMC	Memphis, Tenn.	Commercial Appeal
KFAB	Lincoln, Nebr.	Buick Auto Company
WCCO	Minneapolis, Minn.	Washburn-Crosby Mills
WTMJ	Milwaukee, Wis.	Milwaukee Journal
WCN	Chicago, Ill.	Chicago Tribune
WMAQ	Chicago, Ill.	Chicago Daily News
WCFL	Chicago, Ill.	American Federation of Labor
WBBM	Chicago, Ill.	Atlass Brothers
WHO	Des Moines, Iowa	Bankers Life Ins. Co.
WOC	Davenport, Iowa	Palmer School of Chiropractic
KGO	San Francisco, Cal.	General Electric Company
KOA	Denver, Colo.	General Electric Company
KSL	Salt Lake City, Utah	Mormon Church
KPO	San Francisco, Calif.	San Francisco Chronicle
KHJ	Los Angeles, Calif.	Don Lee, Automobiles

Analysis of uniform r.f. amplification

By EDWIN A. UEHLING

AMONG the principal aims of all research in the field of radio-frequency is the development of an amplifier capable of high sensitivity and selectivity; and capable, moreover, of maintaining these characteristics with a high degree of uniformity over the entire broadcast range. Inasmuch as this is a range of three to one in frequency, and of nine to one in the variable parameter of the amplifier, this aim toward which development has proceeded will constitute no mean accomplishment when achieved. Progress has been so persistent during the years of the history of radio engi-

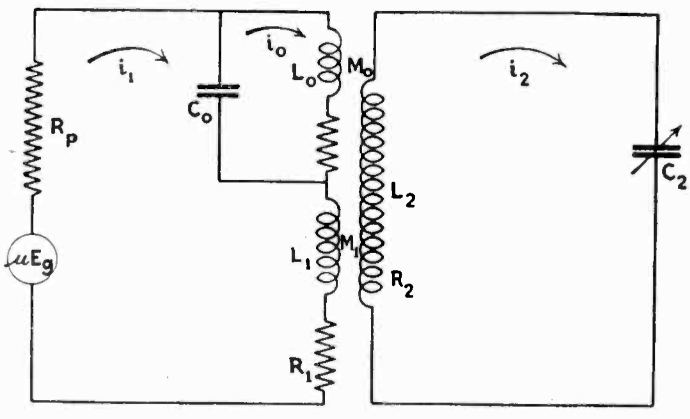


Fig. 1—Circuit suggested for effecting uniformity of amplification

neering that one might say the goal in question has been very nearly reached.

Uniformity of selectivity and uniformity of sensitivity are separate problems and are usually treated as such, though, of course, they are related in many particulars, and a complete treatment of one cannot be carried out without due consideration of the other. Nevertheless, it is our purpose at this time to consider exclusively the problem of uniform amplification. The methods to be described have been used frequently, and may find a more or less universal application in the future. However, an adequate description of the theory of uniform amplification is lacking, and in view of the importance of the subject, such a description may considerable value to many engaged in certain of research.

Non-uniformity is inherent

We will ascertain the nature of non-uniform amplification before discussing the means of cont it. The current in the tuned circuit of a transf coupled stage of radio-frequency amplification is by the equation

$$I_2 = \frac{\mu E_g \omega M}{\omega^2 M^2 + R_p R_2}$$

where μ is the amplification factor of the tube, the impressed signal voltage on the grid of the pre tube, ωM is the mutual impedance, R_p is the plate resistance of the tube, and R_2 is the tuned circuit ance. As the frequency is varied all factors i equation except ω and R_2 are constant. Rewritin equation to give the amplification directly, we hav

$$\text{Amplification} = \frac{\mu M L \omega^2}{\omega^2 M^2 + R_p R_2}.$$

The extent to which the amplification will vary change in frequency will depend on the value c term R_pR_2 as compared with ω^2M^2, and on the an of variation in R_2 with frequency. But in orc realize the maximum possible amplification at any frequency ω^2M^2 should be equal to R_pR_2 at thi quency. In general this condition is difficult to because of practical considerations. One permits h to feel fortunate if he can make the term ω^2M^2 eq or nearly equal to the term R_pR_2 at the highes quency of the broadcast range. Having establishe condition he has given to the amplifier the h possible amplification at all frequencies attainable the circumstances for which the amplifier is des The characteristic, however, will be anything but pendent of the frequency. If optimum condition be established at only one frequency, the amplifi frequency curve must necessarily reflect this con

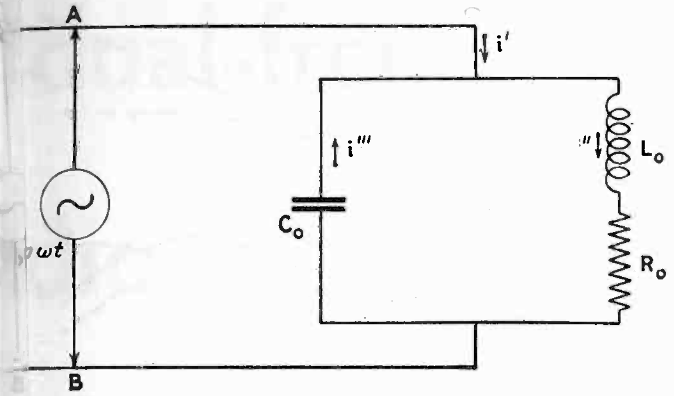
A first derivative of the equation with respect may be taken, considering R_2 in this equation as c the variables. If R_2 is considered to vary directly frequency, the derivative of the equation will be form

$$\frac{K'}{(\omega M^2 + K'')^2}$$

where K' and K'' are positive constants. The derivative is therefore positive for all frequencies r less of the relative values of ω^2M^2 and R_pR_2 at an ticular frequency. Consequently the amplificati creases with increasing frequency for all conditi coupling: deficient, critical, and sufficient coupling. an increase in ωM produced by an increase in M an increase in amplification until $\omega^2M^2 = R_pR_2$, which no further increase in amplification c obtained, an increase in ωM produced by an incr ω has quite a different effect. The inherent nat the variation in amplification with frequency is obvious.

Screen-grid tube circuits are similar

Similar characteristics are to be found in am using the screen-grid tube. The plate impedance o tubes is so high that conditions seldom exist under it is possible to realize the optimum amplificatio acteristics. The square of the mutual impedance coupling between circuits is by means of a transf



ig. 2—Circuit used for solution of the problem of uniform amplification

ully but a small fraction of the product of the ircuit and plate resistances. For this reason a proximation to the amplification obtained is given product of the mutual conductance of the tube load resistance. If the coupling from one tube her is by means of a tuned impedance the load ace is given by $\frac{\omega^2 L^2}{R_2}$. The amplification is then ional to this term. Since R_2 seldom varies at er rate than the first power of the frequency frequencies, and at only a slightly higher rate at her frequencies, this term can be considered to pproximately as the first power of the frequency. ngly the amplification when screen-grid tubes are ries at even a greater rate than when other tubes d. The variation for a single stage may be almost one over the broadcast range, and for a two- hree-stage amplifier the value of the variation will square and the cube of this value respectively. e causes of variation in amplification, which are t in the amplifier, cannot be eliminated by any forward application of amplifier principles. re when an amplifier is to be used over a wide of frequencies something more than a simple r is required. Means, which are not a part of r design as such, must be employed which will ce a certain amount of uniformity in the amplifier ristic at various frequencies. It is these methods vill be discussed at this time.

ying the amplification equation we observe that bol denoting the mutual inductance of the ampli- pears in the numerator. A method of introducing nity in amplification suggests itself immediately. mutual inductance can be made to vary in some fashion a partial or complete compensation for ariables in the equation may be obtained. Obvi- his method is worthy of investigation. We will ter the investigation has been made that a partial ion of the method has been used many times in t, usually unknown to the research engineer.

Introducing uniformity of amplification

method used is characterized principally by the ction of a tuned circuit in series with the primary radio-frequency transformer which is coupled vely to the secondary coil of the transformer with ling 180 deg. out of phase with the principal g to this coil. The illustration of Fig. 1 shows angement in detail. It is evident that the effective g between primary and secondary is a function frequency. The rate and sign of the variation is obvious, and a solution of the circuit equations ssary. This solution will yield the design information required, and will increase considerably the ease with which the desired results may be obtained.

A study of Fig. 1 shows that the arrangement consists essentially of three circuits and three sets of mutual impedances. Using the notation of this figure we write down the circuit equations

$$\left[R_o + L_o\frac{d}{dt}\right] i_o + \left[R_o + R_1 + R_p + L_o\frac{d}{dt} + L_1\frac{d}{dt}\right] i_1 + \left[M_o\frac{d}{dt} - M_1\frac{d}{dt}\right] i_2 j\omega t = \mu E_g e$$

$$\left[R_o + L_o\frac{d}{dt} + \frac{1}{C_o}\int dt\right] i_o + \left[R_o + L_o\frac{d}{dt}\right] i_1 + M_o\frac{d}{dt} i_2 = 0$$

$$M_o\frac{d}{dt} i_o + \left[M_o\frac{d}{dt} - M_1\frac{d}{dt}\right] i_1 + \left[R_2 + L_2\frac{d}{dt} + \frac{1}{C_2}\int dt\right] i_2 = 0$$

The solution for i_2 due to E_g is not sufficiently simple to be used with facility, and accordingly another method of solving these equations will be used. The problem is unlike ordinary three-circuit problems in that not only does a mutual impedance exist between the first and second, and the second and the third circuits, but also between the first and third circuits.

We will obtain an approximate solution of these equations in the following manner. Assume an alternating e.m.f. $E_o \sin \omega t$ impressed between the points A and B of Fig. 2. A current i' will flow in the principal circuit having the value

$$i' = \frac{\frac{E_o \sin \omega t}{j\omega L_o + R_o}}{1 - \omega^2 L_o C_o + j\omega R_o C_o}$$

In the inductive branch of the parallel circuit there will be a current

$$i'' = \frac{E_o \sin \omega t}{j\omega L_o + R_o}$$

and in the capacity branch

$$i''' = j\omega C_o E_o \sin \omega t$$

We are interested in the ratio of i'' and i'

$$\frac{i''}{i'} = \frac{1}{1 - \omega^2 L_o C_o + j\omega R_o C_o}$$

This ratio is a function of the frequency, and as a consequence the tuned circuit $L_o C_o R_o$ located with reference to the principal circuits as shown in Fig. 1 may be considered simply as an arrangement for obtaining a variation of the current in a mutual impedance ωM_o according to a predetermined manner. But a current varying as a function of the frequency in a fixed circuit parameter can be replaced by a fixed current in a variable circuit parameter. Therefore in place of M_o we may consider a mutual inductance of the value

$$M' = \frac{M_o}{1 - \omega^2 L_o C_o + j\omega R_o C_o}$$

Since this mutual inductance is of the opposite sign to the inductance M_1 the total effective mutual inductance in the circuit connecting the currents i_1 and i_2 is

$$M = M_1 - M' = M_1 - \frac{M_o}{1 - \omega^2 L_o C_o + j\omega R_o C_o}$$

Now if the frequency at which the amplifier is used is always below the frequency for which

$$\omega^2 = \frac{1}{L_o C_o}$$

the value of M, the effective mutual inductance, will decrease with increasing frequency. The values of L_o and C_o can be so chosen that this condition for ω is fulfilled throughout the operating range. Also, the rate at which variation with frequency will take place will depend on the product of the values of L_o and C_o. A proper choice of M_1, M_o, and the product L_oC_o will give to M any desired value at any frequency in the broadcast range as well as the desired change in this value with change in frequency.

For a single effective mutual inductance M, the amplification has been found to be equal to

$$\text{Amplification} = \frac{\mu\omega^2 ML}{\omega^2 M^2 + R_pR_2}$$

In deriving this equation all impedances in the primary circuit with the exception of R_p have been neglected. Therefore we may use for the value of M in the amplification equation the effective value

$$M_1 - \frac{M_o}{1 - \omega^2 L_oC_o + j\omega R_oC_o}$$

only on the supposition that the impedance of the tuned circuit $L_oC_oR_o$ is small compared with R_p. This is not a serious limitation. In selecting values for L_o and C_o, it will in general be found advisable to place the resonant frequency of this combination of circuit elements well out of the broadcast range. Consequently the impedance is small compared with the value of the resistance R_p.

We are now ready to see how the equations for amplification and for effective mutual inductance may be used together. We have seen that the value of the amplification increases with increasing frequency. We may wish to know now the condition under which the amplification will decrease with decreasing M. The derivative with respect to M of the amplification equation is positive when

$$R_pR'_2/\omega_o > \omega M^2$$

and negative when

$$R_pR'_2/\omega_o < \omega M^2$$

where R_2 is considered to vary directly as the frequency, but has the value R'_2 at the lowest frequency $\frac{\omega_o}{2\pi}$ of the broadcast band. Therefore the amplification decreases with decreasing M throughout the broadcast band if at every frequency in this range

$$R_pR_2 > \omega^2 M^2$$

This condition is nearly always satisfied. In amplifiers using the screen grid tube this condition is not only satisfied, but the value of R_pR_2 is so large compared with ω^2M^2 that the amplification varies very nearly inversely as the coupling.

We are now ready to determine the approximate values of M_1 and M_o for an amplifier using the screen grid tubes. If in the tuned circuit in the series with the primary coil $\omega^2L_oC_o << 1$ for the highest frequency of the broadcast band, a simplification in the equation for the effective mutual inductance of the circuit may be introduced and the equation written as follows:

$$M = M_1 - \frac{M_o}{1 - \omega^2 L_oC_o}$$

We will now determine the values of M_1 and M_o to be used in a particular amplifier. Experience tells us the value of the ratio of the amplification at the highest broadcast frequency to that at the lowest frequency in a particular amplifier. Let this ratio be denoted by k. Now introducing the circuit modification of Fig. 1 we will require a change in the effective mutual inductance over this range of frequencies which expressed as a ratio may also be denoted by the symbol k. It should be remembered that this simple procedure is possible only

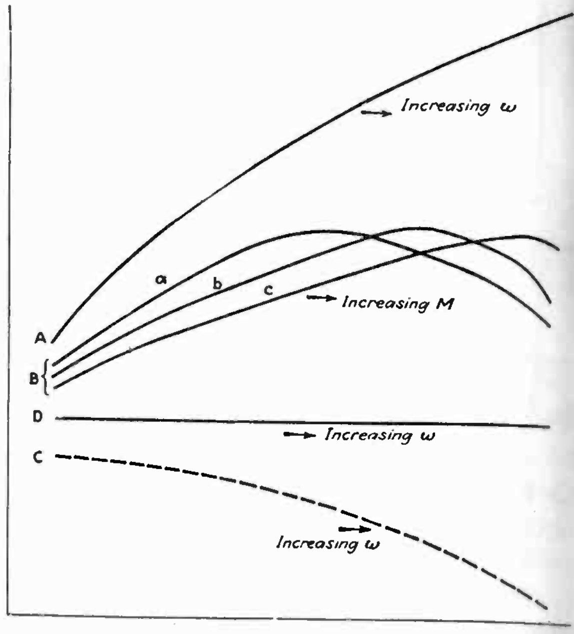


Fig. 3—Curve A—Variation in amplification with frequency

Curve B—Amplification as a function of M for values of R_pR_2 increasing in the order a, b, c
Curve C—Required variation in M needed to approximate ideal Curve D

in the case of the screen grid tube. For all other t the change required in M will differ considerably the value k. Since the ratio of the effective m inductances at the highest and lowest frequencies is to k, we have

$$\frac{M_1 - \dfrac{M_o}{1 - \omega_1^2 L_oC_o}}{M_1 - \dfrac{M_o}{1 - \omega_2^2 L_oC_o}} = k$$

where ω_2 corresponds to the highest frequency an to the lowest frequency. L_o and C_o are chosen o basis that $\omega^2_2L_oC_o < 1$. M_1 is chosen generally a largest possible mutual inductance obtainable. This tion then gives the required value of M_o.

When other than screen grid tubes are used the of M_o is selected with slightly greater difficulty. easiest method is perhaps one of selecting a se values; determining from this set a value of M a highest frequency and another value for the lowest quency; and then substituting these values of M in amplification equation, determining a value of the a fication at two different frequencies. In making substitution different values of R_2 must be used fo different frequencies. This process may be carrie until a set of values for M_1, M_o, C_o and L_o are f that give a constant value for the amplification.

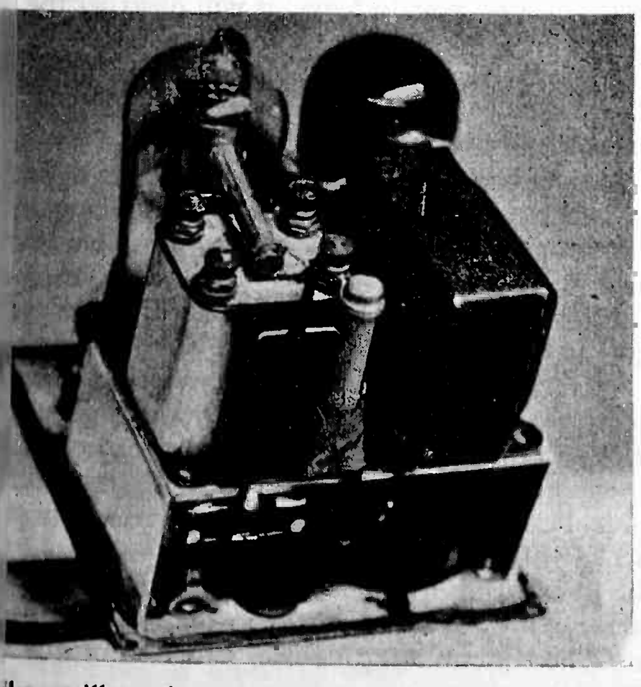
These equations will probably simplify to some e the work of designing radio-frequency amplifie uniform amplification characteristics. They are di applicable to amplifiers using the screen grid tube as a consequence they are especially valuable at this when the use of the screen grid tube is almost uni in radio-frequency amplifiers. Similar results m obtained directly in the laboratory by experiment, small amount of computation using these equation greatly facilitate the work. One might add, further that these equations and the methods by which the c of Fig. 1 has been solved give an interpretation c functioning of this circuit, which, if a more rig method of solution had been used, might have bee siderably more difficult, or practically impossible.

dual-frequency
dio source
general
oratory use

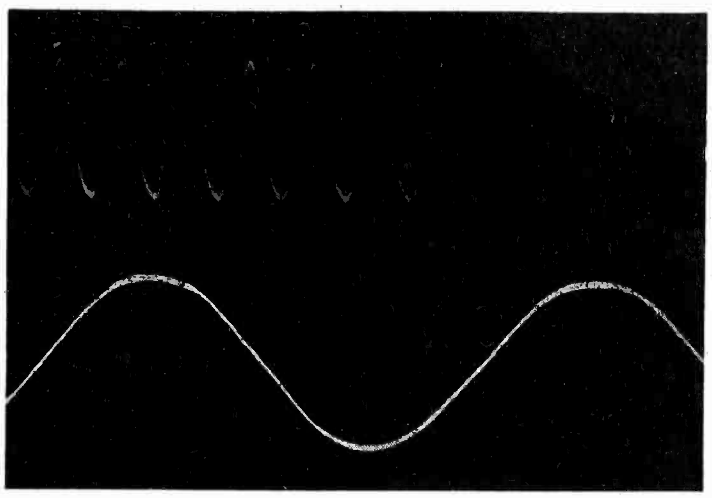
F. LAMPKIN

A continuously variable source of audio frequency esired, a beat-frequency oscillator is a most ble instrument. There are other times, however, y a single audio frequency is needed, and a beat- y oscillator is either too bulky or too expensive. ch times a dynatron oscillator of the sort de- below is adequate. It has been designed to be mpact; to give a wide range of output voltages; one frequency near the center of the musical nd another near the center of the voice range; arly independent of the nature of the load; and a sinusoidal wave form.

imes when a single-frequency audio source is



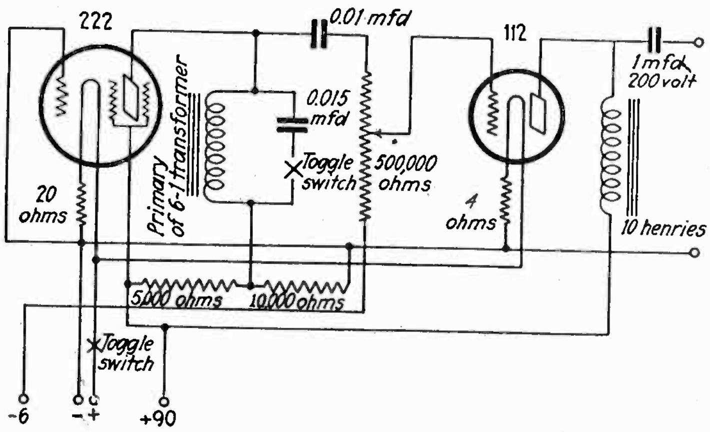
he oscillator is very compact; it is contained in a box five inches square



Comparison of the wave form with a 60-cycle timing wave of the 415-cycle output

of use include those when bridge measurements are necessary; when sensitivity and selectivity tests on radio receivers are made; when tone modulation is needed on radio transmitters; or when various transmission networks—amplifiers, filters, long lines—are to be studied.

The schematic circuit of the unit is drawn in the figure



Circuit diagram of audio oscillator of the dynatron type

The UX-222 screen is used as a dynatron oscillator because of the simplicity of the circuit, the ease of oscillation at audio frequency, and the purity of wave form. Two resistors are used to place the correct plate voltage on the UX-222, and thus eliminate one battery tap and connection. The oscillator feeds through a voltage-controlling potentiometer to the output tube. The latter is used to isolate the dynatron from the load. A choke and condenser filter keeps the d.c. from the output.

The operating voltages shown are for a 222 and a 112 tube. A 171-A may be used for the output tube if a higher voltage is desired, since there is ample input from the oscillator. The new 2-volt 230-series tubes would be excellent for enhancing portability of battery supply.

Using the constants and apparatus as above, the two frequencies are approximately 415 and 1060 cycles. The 1060-cycle note increases 4 per cent with filament voltage change of 4.5 to 5.5 volts; and decreases 20 per cent with a 90 to 112-volt plate-voltage change. With 90 volts plate the output voltage range on a 13,000-ohm load is from overload on the 112, or about 30 volts peak, down to around 15 millivolts. Lower output can be obtained by using a potentiometer on the output. Higher output calls for a 171-A-type tube. The wave form of the 415-cycle output is shown in figure, accompanied by a 60-cycle timing wave. The film was taken with 22.2 volts r.m.s. across the primary of a stepdown transformer working into the oscillograph vibrator.

Phototube voltage supervisor

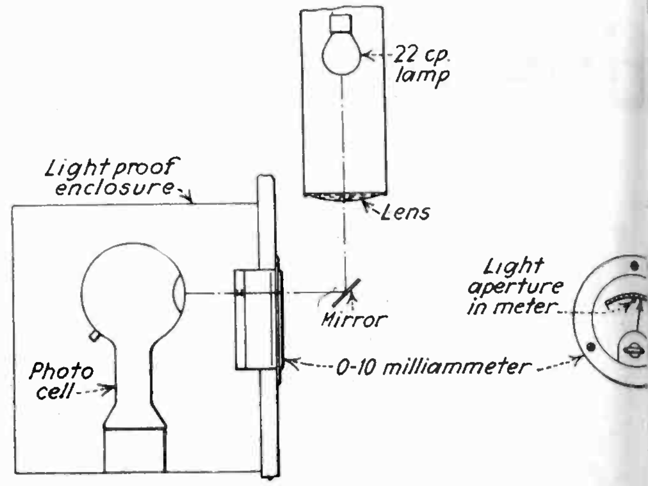
An aid to tube production

By W. P. KOECHEL*

EACH of the 40 test tables in the radio tube factory of the Ken-Rad Corporation, Owensboro, Ky., was until recently equipped with individual batteries, voltage controls, and voltmeters. Under these conditions, requiring constant attention and maintenance, it was extremely difficult to keep the test tables in such a condition that those tables testing similar apparatus would check each other consistently. To meet this problem, an automatic master voltage control has been developed which depends upon the simple action of a phototube. There are 17 different voltages in constant use for the grid, plate, and filament voltages of the tubes under test. These voltages now originate from a central bank of storage batteries, from which the desired voltages are tapped and carried to separate receptacles in the test tables.

The voltages are all adjusted and controlled from a central control panel, thus eliminating the voltmeters and

IN A tube manufacturing plant the problem of supplying correct and uniform voltages to the test positions is important. An ingenious solution is to apply a phototube to monitor these voltages and to give warning when abnormalities occur. The method can undoubtedly be applied to any production problem where movements of a current meter needle indicate a proper or improper condition.



Arrangement of phototube and meter

voltage controls on the individual test sets. In that the 17 independent voltage settings at the control panel may be properly supervised, an in automatic alarm system was devised whereby an alarm, both visual and audible, is given whenev voltage supply is higher or lower than its specified The accuracy of this scheme is such that an ind of one per cent above or below normal will g immediate alarm. This is accomplished as sh the accompanying illustrations by the use of a ph in conjunction with a master monitoring meter commutating device by which this monitoring m successively connected to each of the voltage being supervised.

The master monitoring meter is an 0-10 milliar arranged by means of proper series resistors to re actly 5 ma. whenever it is connected to any voltage for supervision providing that circuit is adjusted normal voltage. At exactly the 5 ma. point on th of this meter a small hole is drilled through the d another hole exactly in line with it is drilled in the the meter. Over the front of the meter, suspende bracket, is a tubular case containing a 22 candl lamp and a suitable lens for focusing the light r means of a mirror, on the aperture.

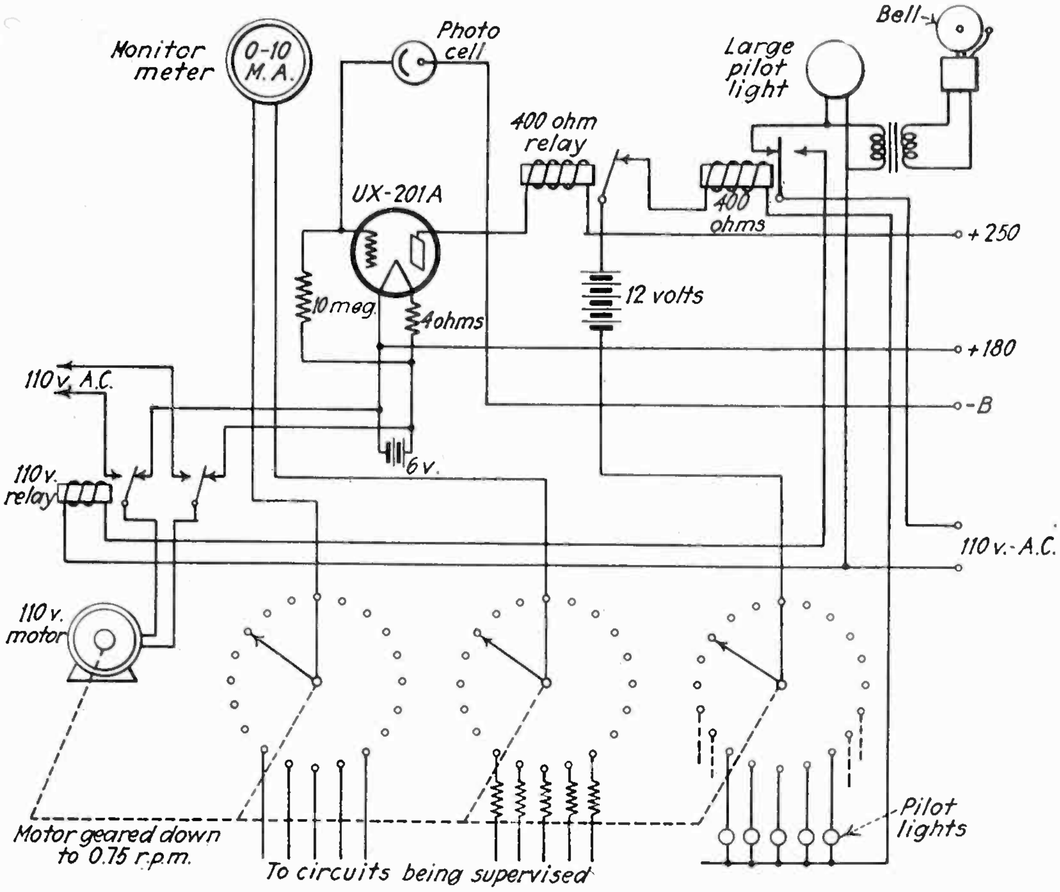
If the pointer of this master monitoring mete cates any value other than 5 ma., the focused ray the lamp will pass through the aperture on the scale and impinge on the phototube. However, pointer indicates exactly 5 ma., it will obstruct the of the ray of light and the phototube will be "darl

This phototube is connected to the input of a tube amplifier in such a manner that the action on the cell will increase the negative bias on the a tube and reduce the plate current to a negligible In the plate circuit of the amplifier tube is a rela is continuously energized as long as the phototul a "dark" condition. The operation of the ph causes this relay to drop to the non-operative co energizing a second relay which in turn operates pilot light and gong. This second relay also acts connect the motor driving the commutating devi addition, there are a number of small pilot lights, each voltage circuit being supervised. These sm lights indicate which particular circuit is indica abnormal voltage.

The monitoring meter is connected in proper s to each circuit for about three seconds in every onds. The commutating device, mounted on the

*Engineer in charge of Test Department, the Ken-Rad tion, Owensboro, Ky.

ɪrol panel, consists of three r of 20 contacts each, e with three rotating arms shes. Two of these com- ɪs make the connections to uitoring meters, while the erates the alarm signals. cuit is so arranged that e phototube alarm feature , the motor stops at that nd causes the pilot light nding to the circuit in o stay lit until the trouble ted. In order to prevent or from coasting beyond er commutator point after ent is cut off, an electric cheme is utilized, in which .c. is applied to the motor ntant that the 110 volts a.c. ed. This acts as a very and silent brake, and the a which the motor decel- n readily be controlled by he applied d.c. voltage. accompanying diagram shows ratus connections.



ɪg this master control system, the voltage values t djusted manually at the control panel. As each rcuit is supervised once every 80 seconds, it is almost impossible for an abnormal voltage condition to persist. When the alarm is sounded, the faulty voltage is manually reset to its proper value.

▼ ▼ ▼

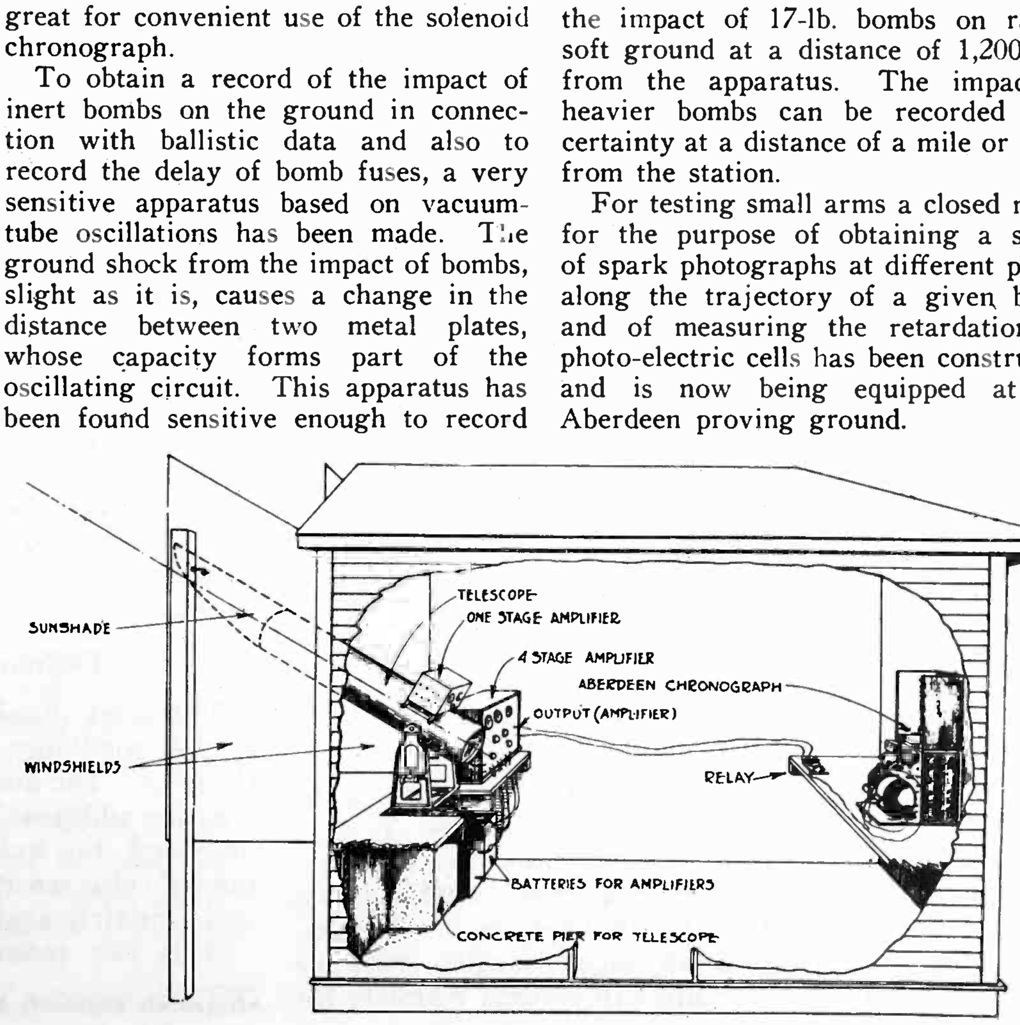
:LECTRONIC RECORDING OF HIGH-SPEED PROJECTILES

ɪications of the photo-electric he vacuum tube have been the testing of government quipment, in ways that may ivilian and industrial uses. to cell, in one instance, serves werful amplifier to obtain an record of the time of flight craft projectiles. The ampli- is apparatus is so arranged uses a spark to perforate a aper which is carried on the slow-motion Aberdeen chron- When the gun is fired, the n the muzzle flash causes the to jump, and the burst of tile at a remote point of the causes the second spark. This has functioned satisfactorily firing but with less certainty ytime, because of the great required.

oto-electric cell has also been the measurement of velocity iles. The apparatus is so con- hat when the projectile passes a reduction in the light which on the cell is recorded by an amplifier on an oscillograph instrument. This method of g velocities is especially suit- he measurement of the velocity guns at angles of elevation too great for convenient use of the solenoid chronograph.

To obtain a record of the impact of inert bombs on the ground in connection with ballistic data and also to record the delay of bomb fuses, a very sensitive apparatus based on vacuum-tube oscillations has been made. The ground shock from the impact of bombs, slight as it is, causes a change in the distance between two metal plates, whose capacity forms part of the oscillating circuit. This apparatus has been found sensitive enough to record the impact of 17-lb. bombs on rather soft ground at a distance of 1,200 feet from the apparatus. The impact of heavier bombs can be recorded with certainty at a distance of a mile or more from the station.

For testing small arms a closed range for the purpose of obtaining a series of spark photographs at different points along the trajectory of a given bullet and of measuring the retardation by photo-electric cells has been constructed and is now being equipped at the Aberdeen proving ground.



Acoustic and light characteristics of sound screens

By BARTON KREUZER*

DUE to the advent of sound motion pictures the choice of picture screens for theater use has become increasingly important. The factors governing the choice of a screen are several. They may be divided into two general classes, i.e., the merit of the screen judged by its technical performance, and its serviceability.

Under the latter class, such points must be considered as: the type, weight, and strength of the material, its inflammability, whether it collects dust easily and is difficult to clean, whether it will fade, crack or discolor and the amount of handling it will stand. The last point is of especial importance with beaded and mesh screens. All of the factors in this class may be tested both without a great deal of technical knowledge or equipment.

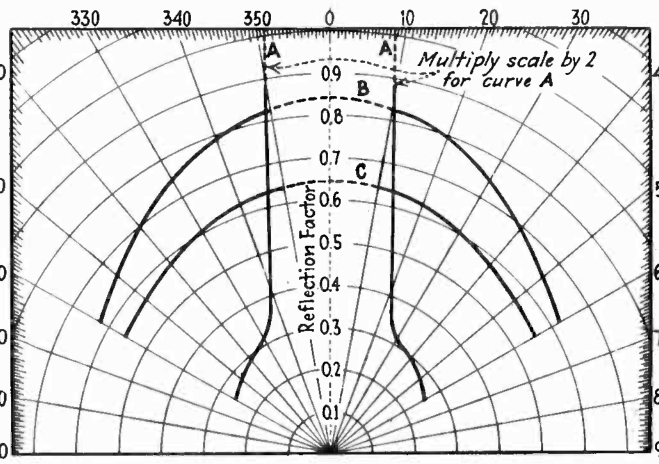


Fig. 1—Typical brightness curves for different screens. Note rapid "fadeout" of the beaded screen shown by curve A

The merit of a sound screen from a technical viewpoint is based on two characteristics. These are the "brightness" characteristic and the "acoustic transmission" characteristic of the screen. The "brightness" characteristic of a screen may be defined as the intensity of illumination of the screen plotted for various angles from the illuminating beam. There are two general methods for

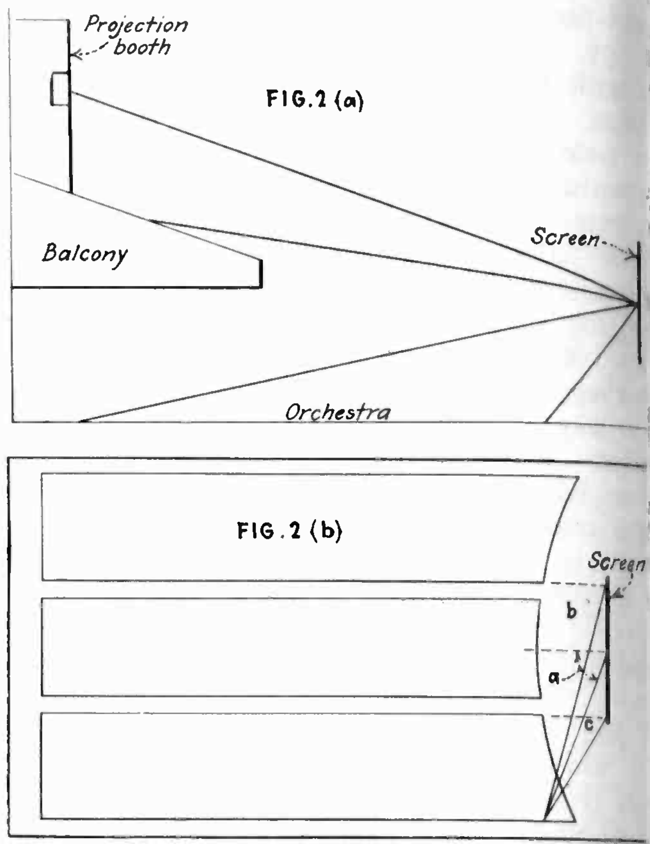


Fig. 2 (a), (b) Limiting projection and viewing angles in a theater. These angles determine the best screen from its light characteristics

obtaining the "brightness" curve for a screen. Th of these is by the use of some photometric comp instrument, such as an illuminometer, where the the observer is called upon to match two bright The second method is by the use of a photoelectr

Methods for obtaining light intensities

The photoelectric cell can be used in two way one method it can be used "statically" to measu brightness at various angles of a normally incider beam. With a large resistance in the circuit the c be adjusted for linearity over a fair range of inte and can be employed to vary the bias on a vacuu voltmeter.

In the second method if a rotating wheel cut to cause sinusoidal variations in the light inten placed in the path of the incident light beam, lower intensity source may be used, as a quite c tional audio frequency amplifier will amplify the electric cell output to the point where meter readi convenient. This is much more convenient thar the d.c. amplifier necessary with the same illumi for the "static" method. A greater linear intensity is also available with the dynamic method since may be polarized through a transformer eliminat appreciable change of anode potential with incide intensity.

Difficulties in using photo-cells

The chief disadvantage of the illuminometer is the possibility of error introduced by the observer. The disadvantages of the photoelectric are: the additional equipment, the greater light i necessary, the lack of uniformity of cell sensitiv the cell color sensitivity characteristic which may inate unfairly against certain screens.

This last reason is important because in t

*Research engineer, RCA-Photophone, Inc.

the brightness of a screen is judged by the /e; the color sensitivity of which is a broad peak llow portion of the spectrum with less response ie-violet and red ends of the spectrum. Prac- of the present photoelectric cells, whether red merely possess a peak in the blue region, or n they are yellow sensitive do not match the sitivity of the eye. Because of this a screen either end of the spectrum may be unduly by accepting its rating from a photoelectric because the eye bases its judgment chiefly on v region in which only very slight absorption r.

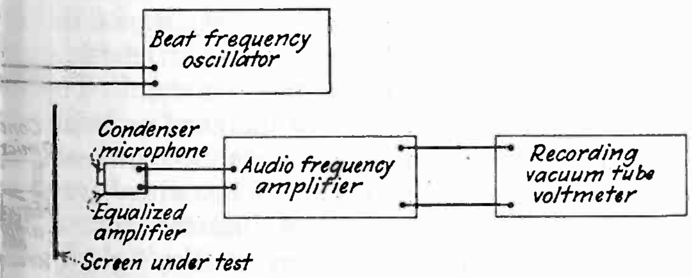
a visual (photometric) instrument method he eye may have difficulty matching intensities nt color characteristics, yet, a small amount erice will enable the observer to obtain accu- lts by adjusting the instrument to secure a of the line of demarcation between the sur- inated by the working standard and the image rface under test.

ither method the procedure is to cast a spot the screen, free from color or filament image, ent normally both horizontally and vertically. ents are then made of the brightness as close am as possible and progressively away from arc of a circle.

)btaining typical brightness curves

rves in Fig. 1 have been obtained with an eter in this manner and later checked with electric cell method. In some cases it may be to take characteristics with the light beam at agle than normal, but usually the results of such be predicted from the normal curves.

rves are plotted in polar form and are in terms



3—Set-up of sound measuring equipment for determining acoustic qualities of screens

ection factor." The use of a reflection factor provides a more intelligent understanding of n's properties and makes direct comparisons e reflection factor for a perfectly diffusing mat s unity. Where curves rise above unity the is not paradoxical for a spherical distribution considered and at certain angles these surfaces use light poorly and verge on direct totally surfaces. Conversion to a reflection factor accomplished by taking readings on a standard opal test plate whose reflection factor was

y observed curves for representative screens n in Fig. 1. No actual points are shown to an 10 deg. from the normal because of the difficulty encountered when the test equipment the light beam source.

A shows the characteristics of a typical beaded

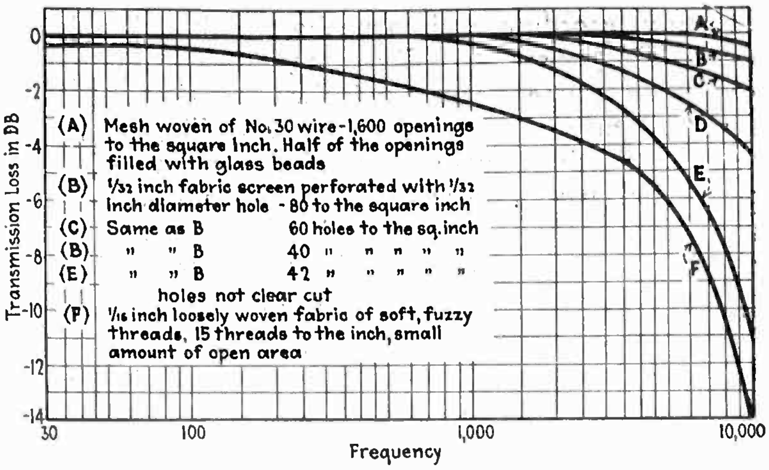


Fig. 4—Typical sound transmission curves showing losses in decibels for different types of screens

screen. Note the high value for the first few degrees and the rapid "fadeout" making it suitable for use only in a narrow theater where no patron will be at a very great angle from the normal. This type is preferred for a house with a large balcony since the point of maximum brightness always lies along the incident beam whether it be normal or inclined. With the light coming from a projection booth above the balcony this insures good screen illumination for the balcony seats. This type of reflection is due to the spherical globules used as "beads."

Curve *B* shows the characteristics of a reflecting type screen. Note its greater uniformity over large angles and its freedom from "fadeout." This makes it quite suitable for use in large, wide, theaters. With this type a maxima is observed along the incident beam with a slight, secondary maxima at the angle of reflection (an angle from the normal equal to the angle of incidence) due to a slight mirror effect.

The type of curve obtained from a diffusing screen does not differ appreciably from that of curve *B* except that when the light is not thrown on normally the slight maximum point occurs along the incident beam without any secondary maxima. It more closely approaches a perfect diffusing surface.

Curve *C* has been obtained from a special type of "beaded" screen. Here the "beads" are glass cylinders whose height is about equal to their diameter. These disks are embedded in the screen material and give a very uniform "brightness" characteristic although with reduced efficiency.

Figs. 2 (*a*) and (*b*) show the angles to be considered in choosing the right screen for a theater. In Fig. 2 (*a*) (vertical cross-section) the angles to be considered are obvious, but in Fig. 2 (*b*) (horizontal or plan view) the angle (*a*) not only of the furthest seat with the center of the screen must be considered, but also the angles (*b*) and (*c*) that opposite sides of the screen subtend at that seat. Care must be exercised not only to prevent distortion and "fadeout" due to the large possible difference between angles "*b*" and "*c*" but also to prevent fatigue to the eye due to great differences in the apparent intensity of illumination at these points.

Measuring acoustic characteristics of screens

The "sound transmission characteristic"[4] of a screen is the variation with frequency of the sound transmitted through the screen. To obtain these characteristics response curves were taken on standard theater loudspeakers with a beat frequency oscillator, using sound measuring recording equipment, both with and without a screen being present. By careful selection of an acoustically treated room and the use of many check curves, the effects of reverberation, standing waves, and "stray" reflections were successfully minimized. The screen when placed in front of the loudspeaker was put in exactly the same position as it would be in a theater installation. This meant that the screen was sufficiently removed from the speaker mouth to prevent any reaction upon the speaker which might alter its response and lead to incorrect measurements. It will be noted that the curves obtained in this manner were quite regular and smooth.

The schematic diagram of the sound measuring equipment is shown in Fig. 3. The beat frequency oscillator has a logarithmic variation of frequency from 30 to 10,000 cycles with uniform rotation of its dial. Its output is fed to the stage type loudspeaker, consisting of an electro-dynamic cone unit, and a directional baffle. In front of this is the screen under test. The sound pressure is converted by the condenser microphone into electrical energy and amplified in an associated amplifier which is equalized to correct for the frequency characteristic of the microphone. After further amplification the output is fed to a vacuum tube voltmeter. A drum carrying logarithmic frequency paper is geared to the beat frequency oscillator. As the frequency is varied this drum revolves and an ink trace is left by a pen connected by linkwork with a pointer pivoted over the output meter of the voltmeter. By means of a handle attached to this system the observer is able to make the pointer follow the variations of the meter and leave a trace on the drum proportional to the speaker response at any point over the frequency range.

The relatively linear vacuum tube voltmeter (any slight non-linearity is corrected in the mechanical system) is obtained by using a UX-864 with $E_p = 45$ volts, $E_g = -3.0$ volts, making the output meter insensitive

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ELECTRONIC MUSIC IN THE SPOTLIGHT

THE musicians in a symphony orchestra, the performers in a popular band, and the musical artist in the home, have suddenly found a strange and startling novelty—the electrical musical instrument. Into the realm of music, where for so many centuries instrumental progress has been largely along conventional and time-honored lines, the electron suddenly comes to the middle of the stage and waits for the spotlight of public interest which soon will blaze upon it.

—DR. A. N. GOLDSMITH

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by shunting it down and using a large input. Thi may even drive the grid positive. Linearity is ac for individual tubes by the variation of a serie resistor of from 5,000 to 20,000 ohms. With a former input this may not be necessary.

Types of sound screens available

Fig. 4 shows the sound transmission characte of several screens. These curves show the l decibels for different screens under test. In gener screens are 100 per cent efficient for the lower fr cies and then gradually fall off. This is compar the situation in an electrical transmission system a series element which reduces the current flow 30 per cent at 5,000 cycles may not cause any de below 500 or 1,000 cycles that can be measure conventional instruments.

Curve *A* in Fig. 4 shows the transmission for a with a "mesh" backing. This is ideal for soun poses but unfortunately it is one of the beaded s whose characteristic is of the type shown by cu Fig. 1. This naturally limits its use. Curve *B, C* show the characteristic of well-perforated scre satisfactory brightness qualities. These are very used screens.

Curve *E* shows the characteristic of a poorl forated screen. The holes in this screen were not cut."

Curve *F* shows the absorption in a woven scre to the use of soft "fuzzy" thread. Lint fro thread blocks the openings in the material and dissipation of the sound.

The electrical analogue of the usual sound scree be considered as an inductance of very slight resi placed in series with a transmission network. The of the inductance and resistance are a function dimensions of the holes in the screen and their d The values of inductance and resistance incre the holes become tube-like, i.e., as their length appr or becomes greater than their diameter. This n due, of course, to thick screen material or small ho The value of resistance may also be increased presence of poorly perforated holes with "frayed" or holes clogged with lint or dust to cause dissi The effect of the perforations on the light quali screens is approximately linear, i.e., with 10 per c the screen area occupied by perforations the ref factor at any angle is reduced to approximately cent of its value for an unperforated like surface

The effect on sound transmission is different, ho This same percentage of holes may transmit as m 80 per cent of the sound at 5,000 cycles.

Although a slightly lowered reflection factor overcome usually by greater light from the pro booth the perforations introduce an intangible effe the picture because of the "greying" of the scre face. This is due, very often, not only to th themselves but also to the view of the darker n forming their side walls, which the audience may sciously perceive.

It is obvious that good screens require the l technical skill in design. To be quite ideal a should have a high reflection factor reasonably c over large angles, be free from diffraction and s reflection, and transmit sound satisfactorily up to cycles, as well as be sufficiently rugged to wi theater use.

importance of

ase control in

ıchronizing

.W. HORN*

HRONIZATION of two or more broadcasting ons transmitting the same program involves the ion of two important problems, that of keeping ns on the same carrier frequency, and that of ng them at some constant phase difference with each other. While it has been recognized that r frequencies must be identical and must be d so, it is only recently that the importance of phase difference was discovered. This phase need not be zero, it can, as a matter of fact, be so long as it is unvarying, or at least varies at a rate.

umber of years, WBZ and WBZA have been ized," i.e., they have been on the same carrier and have transmitted the same program sim- y with each other without noticeable interfer- each other. Here, however, conditions were to be generally experienced. Ordinarily any perating on approximately or even exactly the quency created an area between the stations in nsiderable distortion was evidenced. This dis- as due to the fact that the ground waves of the ons at times opposed each other, thus giving t strength of signal which was very low; while times they might aid each other by being in us creating a stronger signal.

The WBZ installation

WBZ-WBZA area, however, there were special favorable conditions operating in the region he two transmitters, in which listeners would experience "mush" where neither station can and so nothing was lost so far as they were l. At the same time, neither station is able to its carrier over the barrier which exists.

ments have been conducted for a number of o determine the feasibility of synchronizing h-powered stations as WEAF, WGY, and On a number of occasions these stations were tied together transmitting the same program same technical conditions as exist at WBZ and i.e., frequency synchronization. Peculiar results were at once apparent which made it evident that maintenance of the same carrier frequency was not sufficient no matter how exactly it was performed.

For example, within the service area of WEAF bad interference was experienced from the other two stations when all were transmitting identical programs on the same carrier. It was evident that the carrier waves of the other stations were destroying the program emanating from the local station, WEAF.

When, however, the stations were maintained not only at the same frequency but in a fixed phase relation, several important and encouraging events transpired. No longer was the program coming to local listeners from WEAF disturbed; the mush area disappeared, and those listeners in this area experienced an increase in local field strength. Apparently when one of the stations was fading out, another, or both of the others might be fading in. It was certain that the average field strength was no worse and nearly always better—some of the fading hollows had been filled in.

Neutralized point of interference

At various places out in this area, usually characterized by "mush," the ground waves of two stations may create what might be termed a "neutralized point" if they meet head on and are 180 degrees out of phase. Theoretically, no field strength exists at this point but fortunately such a "neutralized point" is sharply defined, and of only a few meters extent. Therefore, any ordinary antenna will cover an area greater in extent, and thus will receive sufficient energy. Experience indicates that so long as the phase displacement of the synchronized carriers is constant or varies very slowly, the listener will be better off than if the stations were not synchronized. Depending upon location and distances, the listener will benefit by a better average field strength, because it is unlikely that all of the synchronized stations would fade out at the same moment—even in this contingency, reception would be in no way worse than if only a single station were transmitting the program on that particular frequency.

Thus far we have looked only at the technical problem and the results of experiments carried out with the cooperation of the National Broadcasting Company, the Radio Corporation of America, and the American Telephone and Telegraph Company. The difficulty of putting into practical operation any number of synchronized stations, whether to cover sections of the country or the whole country, is one that must be studied carefully in each individual case, for it involves many factors, including wave allocations and more particularly, highly important economic considerations.

▼

THIS statement by the engineer who for years has been studying and advocating "synchronizing," tells how the dream of all broadcasting engineers has at last been achieved.

▲

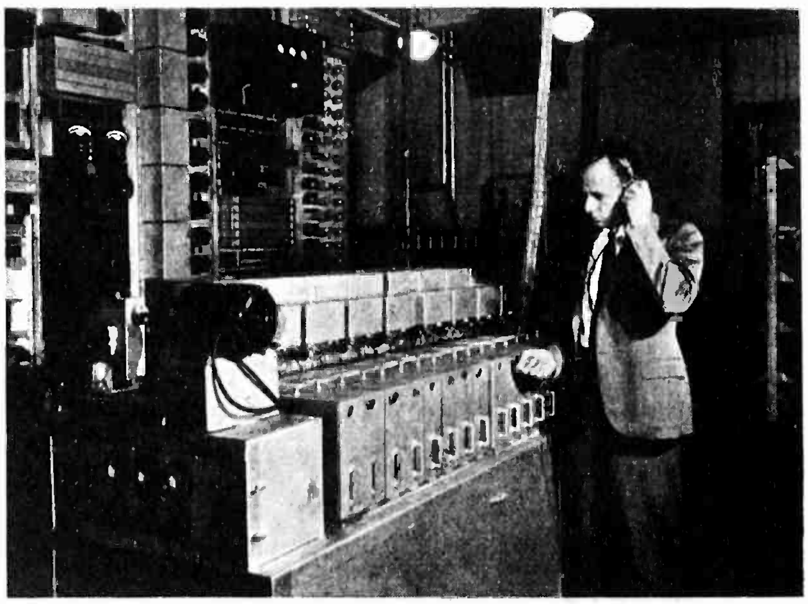
Engineer, National Broadcasting Company, Inc.

Voice number calls from dial phones

By PAUL B. FINDLEY*

FUNDAMENTAL research in the fields of electronics and thermionics has long been conducted by Bell Telephone Laboratories and has resulted in such devices as the telephone repeaters which make possible long-distance telephony. A recent and extremely interesting development in this field is the "call announcer," which transforms into speech the pulses produced when you dial a telephone number.

The necessity for apparatus of this nature is a result of the present transition period from manual to dial operation of telephones. If you were to dial the number of a telephone connected with a manual exchange, you would cause a series of pulses to pass over the wires to an operator in that exchange. These pulses, however, are absolutely unintelligible to the operator, and there must be present some means of translating them into a signal which she will understand and which will give her sufficient information to set up the desired connection.



The "call announcer" in use. Below the motor-driven sound-film units can be seen the associated amplifiers. At the left are operating meters and controls

When this problem first arose, it was solved use of "call-indicators" in which the pulses fr telephones caused certain numbers and letters to played before the operator. There were limits use of this apparatus, however, and it became ne to develop supplementary apparatus. Due to th of the Laboratories on sound-picture systems, th available considerable sound-picture apparatus, investigation was therefore made of the possib translating dial pulses into speech.

The result of this work was the call-announcer, as finally developed, consists of eight drums. these is a spare and the other seven carry on thei edges fourteen strips of film, on each of which corded one of the ten digits or one of the four ters, J, M, R, W. These drums are mounted on mon shaft and driven by a small motor. In f each film is a small lamp which is focussed on behind the film and within the drum is a photo cell of the type developed for sound pictures.

For any apparatus designed for use in the tel system, length of life is very important. Fort the shortness of the individual records used in t announcer makes it possible to clamp the short st film to the drums, thereby eliminating the fricti wear of the sprockets and gates, which is unav in showing sound pictures. Under the conditio with in the call-announcer, film need be replac more than once a year.

Long life of tube and film elements

The question of replacements also arose in con with the lamp and photoelectric cell, which, as a sound-picture projector, have a life of about 10C In a call-announcer, due to their continuous use elements would have to be replaced too frequen economical operation, and a departure from sound- operating technique has therefore been made for t pose of decreasing the necessary number of replac This departure consists in operating the lamp at lower illumination level, thus obtaining a longer ing life for lamp and cell. As a result, the aver of these elements in a call-announcer under norm ditions is about 200 days.

Due to the lower illumination level of the lam ever, the current from the lamp is of much lowe sity than in sound picture practice. For this re three-stage amplifier is associated with each of th teen systems, and is located immediately bene in front of the drums. On passing through these fiers, the current is raised about fifty decibels and fed into telephone repeaters which act as final amplifiers.

When a subscriber dials a number, the numbe corded on relays in the sending mechanism, w remains stored until the operator who is to comp call is free to do so. She then pushes a button relays in which the number is stored actuate othe and cut in the proper films in the correct sequ announce to the operator at the manual board the which has been dialed.

Development work on this machine has bee pleted and numerous tests have been made of formance. It is expected that a number of th be placed in service before the end of the year.

*Bell Telephone Laboratories, 463 West St., New York

plified method of

easuring

oadcast

rmonics

C. MILLER*

OADCASTING station to be as effective as pos-
ible must transmit into the ether as much power s possible on its fundamental carrier frequency little as possible on any of the harmonics of this cy. In considering this radiation of harmonics broadcast transmitter, cognizance must be taken relative strength. A five kilowatt transmitter duce a field strength of 100,000 microvolts per t a distance of from four to five miles over flat ucted terrain. If the harmonic percentage radiated er cent, a field strength of 200 microvolts per laid down for the harmonic at the same distance. y sections of the country, signals of this magni- the maximum available.

in an area of about three miles of such a station, g harmonic signal can be expected to harass n. At night these intensity ranges are greatly d, causing comparatively strong signals capable of producing cross-talk and heterodyne interference with distance stations whose signals are of comparable magnitude. Such interference is of course caused by harmonics of stations operating in the channels between 550 kilocycles and 750 kilocycles, and 1,100 and 1,500 kilocycles. However it is also well to consider the reduction of the second harmonic of the latter group. The third and succeeding harmonics of broadcast transmitters may, due to their successively weaker generation be neglected. Notwithstanding the high percentage of modulation usually obtained in present transmitters, the trend toward powers of the order of 50 and 100 kw. presents a serious problem in the adequate reduction of harmonics. Probably for powers of this magnitude a reduction of the second harmonic to 0.01 per cent is essential, but for the average transmitter a value of 0.05 per cent is sufficient. It is the purpose of this article to describe a simple method of measuring harmonic percentages in a transmitter or r.f. oscillator.

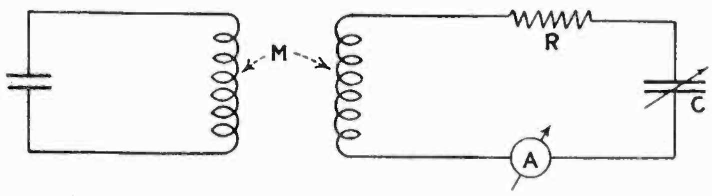


Fig. 1—Wavemeter circuit for harmonic measurement of broadcast stations

Determination of harmonic output

While the determination of harmonic percentages of broadcast transmitters is probably best effected by the use of field strength measurements at a distance from them, such equipment and facilities are not always available, so that the subject is likely in some instances to be neglected.

An ordinary selective wavemeter may be employed for the detection. A knowledge of its constants permits the calculation of the percentage of the harmonic current to that of the fundamental in the tank and antenna circuits of the transmitter or in the tuned plate circuit of an r.f. oscillator. A wavemeter coupled as shown in Fig. 1 to an r.f. generating circuit containing harmonics will reveal a current versus frequency characteristic as shown in Fig. 2. The current curve of gradual slope is that due to the fundamental, while the current humps are produced by the various harmonics, whose numbers are multiples of the fundamental frequency. The fundamental current in the wavemeter is with sufficient accuracy the mean of the two cut-off currents, while the harmonic current in the wavemeter is the difference between the maximum current at the harmonic, and the fundamental current. The numerical ratio obtained directly by these measurements is not the actual ratio of fundamental to harmonic existing in the primary, or generating circuit, but by taking into account the coupling and tuning conditions the ratio of primary or generating currents of harmonic and fundamental frequencies is equivalent to the ratio of secondary or wavemeter currents of fundamental and harmonic frequencies, and from this ratio the percentage of harmonic to fundamental may be readily determined.

Considering the case of inductively coupled circuits

lculation of Harmonic Percentage

POWER AMPLIFIER TANK

—Wavemeter Currents—									
Low-Freq. Cut-Off, ma.	High-Freq. Cut-Off, ma.	I' ma.	Max. Cur. ma.	I'n ma.	Rn Ohms	$n(n^2-1)$	ωL Ohms	$\frac{I_n}{I}$	Per Cent Harmonic $100\times\frac{I_n}{I}$
48	46	47	86	39	15.5	6.	629.	.0033	.33

ANTENNA CIRCUIT

—Wavemeter Currents—									
Low-Freq. Cut-Off, ma.	High-Freq. Cut-Off, ma.	I' ma.	Max. Cur. ma.	I'n ma.	Rn Ohms	$n(n^2-1)$	ωL Ohms	$\frac{I_n}{I}$	Per Cent Harmonic $100\times\frac{I_n}{I}$
74	72	73	103	30	15.5	6.	629.	.00168	.168

*Assistant engineer, Buffalo Broadcasting Corporation.

as in Fig. 1 it is found that when the secondary circuit resonates at the harmonic:

$$I' = \frac{I\omega M}{\left(\omega L - \frac{1}{\omega C}\right)} \quad (1)$$

and

$$I'_n = \frac{I_n \omega_n M}{R_n} \quad (2)$$

where I' and I'_n = secondary currents of fundamental and harmonic frequency respectively.
n = harmonic number.
M = mutual inductance between primary and secondary.
R_n = secondary or wavemeter resistance at harmonic n.

Taking the ratio of these expressions and solving for the primary current ratio:

$$\frac{I_n}{I} = \frac{I_n}{I'} \times \frac{\omega}{\omega_n} \times \frac{R_n}{\left(\omega L - \frac{1}{\omega C}\right)} \quad (3)$$

When the secondary is tuned to the harmonic, $\omega_n L = \frac{1}{\omega_n C}$. Remembering that $\omega_n = n\omega$, eq. (3) reduces to

$$\frac{I_n}{I} = -\frac{I'_n}{I'} \times \frac{R_n}{\omega L} \times \frac{1}{n(n^2 - 1)} \quad (4)$$

The measurements and calculations may readily be tabulated on a form similar to that given in the table. The figures given are actual measurements on a 1,000-watt transmitter operating on 550 kc. before steps were taken to reduce the harmonics. The measurements were taken in the power amplifier tank and in the antenna circuit.

It must not be forgotten that if the indicating meter

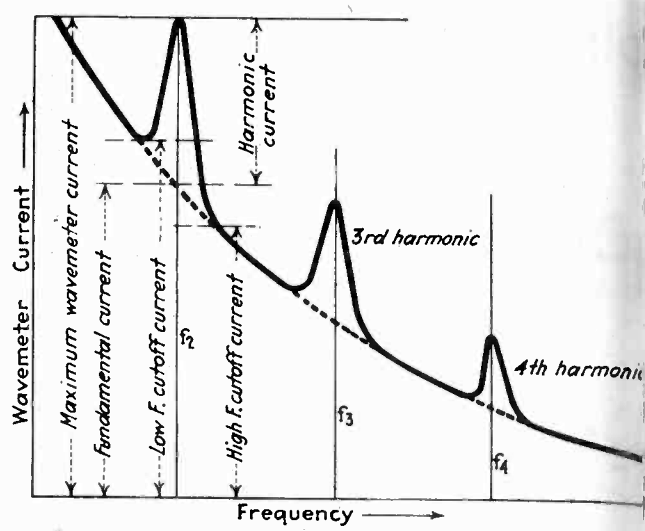


Fig. 2—Current-frequency response of wavemet[er] to transmitted wave

is a current-squared instrument, the square root [of the] readings ratio is to be substituted for I'_n/I' in [eq.] It is to be noted that the wavemeter should re[main in] fixed coupling with respect to the primary for a[ll read]ings at any one harmonic, but may be moved cl[oser for] measurements at other harmonics if necessary t[o obtain] sufficient meter deflections. The measurement [of har]monics by means of the above method has been [made on] several broadcast transmitters and oscillators, a[nd has] been found convenient in determining the effectiv[eness of] harmonic suppression schemes.

▼ ▼ ▼

NEW BOOKS ON ELECTRONIC SUBJECTS

Recording sound for motion pictures

Comprising 25 special papers covering the fundamentals of sound recording. McGraw-Hill Book Company. Profusely illustrated. Price $4. Published this Autumn.

THIS VOLUME represents the combined papers of 25 leading authorities in the sound picture industry. It is the outgrowth of a special course on fundamentals of sound recording and technique as given under the supervision of the Academy of Motion Picture Arts and Sciences, Hollywood, Calif. The contents include an introduction by William C. De Mille, president of the academy, and 25 chapters covering the following general subjects: Sound recording equipment, the film record, studio acoustics and technique; and sound reproduction.

The appendix includes a very complete glossary of technical terms which answer every possible question covering the technique of motion pictures. The glossary alone is a small dictionary, and worth the price of the book. All chapters are profusely illustrated, with circuit diagrams and photographs of special sound equipment.

"Recording Sound for Motion Pictures" should be the official reference and instruction book in the library of all technicians in the various branches of motion picture production, projectionists, exhibitors and engineers in the electrical and related professions.

✦

An introduction to the study of wave mechanics

By Louis De Broglie, D.Sc., Paris, translated by H. T. Flint, D.Sc.; E. P. Dutton & Co., New York. 246 pages. Price $4.25.

THIS VOLUME SHOULD clarify in the mind of the advanced student of physics the various theories proposed in explanation of the newer puzzles of wave mechanics. Price De Broglie, winner of the Nobel prize for Physics in 1929, has outlined the mathematical development of most of these theories and has indicated at what points the conceptions are no longer satisfactory. He discusses clearly and in sufficient detail the theory of Jacobi, the conceptions underlying wave mechanics, the equations of propagation of the wa[ve asso]ciated with a particle, the pri[nciple of] interference, the diffraction [of elec]trons by crystals and the scatt[ering of] charged particles by a fixed ch[arge, the] theory of Bohr and Heisenb[erg, the] propagation of waves, the sta[tes of] quantised motion from the point [of view] of wave mechanics, the meanin[g of the] waves of quantised systems, etc.

The author appears to favor [the con]ception of Bohr and Heisenber[g which] holds that the wave does not [represent] a physical phenomenon taking [place in] a region of space; rather it is [a] symbolic representation of [what we] know about the particle. In [summing] up, he says: "The physical in[terpreta]tion of the new mechanics re[mains an] extremely difficult question. [Neverthe]less, one great fact is now w[ell estab]lished; this is that for matter [and for] radiation the dualism of wa[ves and] particles must be admitted, [and that] the distribution of the particles can only be foreseen by the [propaga]tion of waves. Unfortunately [the pro]found nature of the two me[mbers of] this duality and the precise [relation] existing between them still [remain a] mystery."

utput

nsformer

sign—Part II

. C. HITCHCOCK
V. O. OSBON*

'HE first part of this article (November ctronics) the general aspect of transformer design discussed, the mathematics of transformer 'as given and the general groundwork laid for esign which is discussed in this article.

g. 1 is an alignment chart giving the relationship e f_o, R_p, and L_p based upon the ratio $\omega L_p/R_p = 1$ ssed in Part 1. Let us now consider a typical nere the primary must carry steady plate current ually does. Under this condition the design of asformer is a simple matter since a direct method n developed by C. R. Hanna for calculating oils and transformers which carry direct current. ign curves shown in Fig. 2 for 4 per cent silicon d for hipernik (50 per cent nickel and 50 per n), respectively, are taken from his paper.[1] In rves the notation is as follows:

nductance of coil in henries.
direct current in amperes.
volume of iron core in cm.[3]
number of turns.
mean length of magnetic circuit in cm.
length of air gap in magnetic circuit in cm.

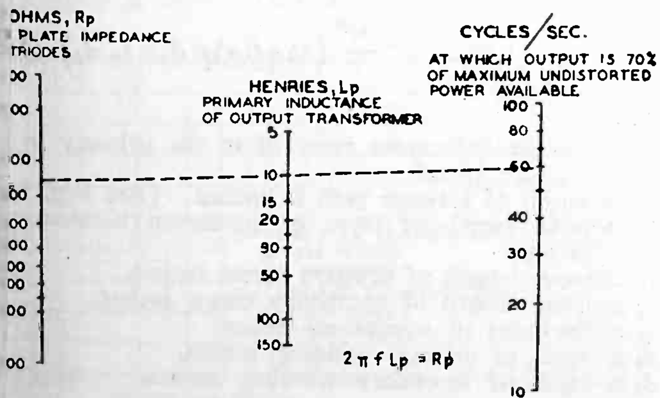


Fig. 1—Alignment chart for determining primary inductance

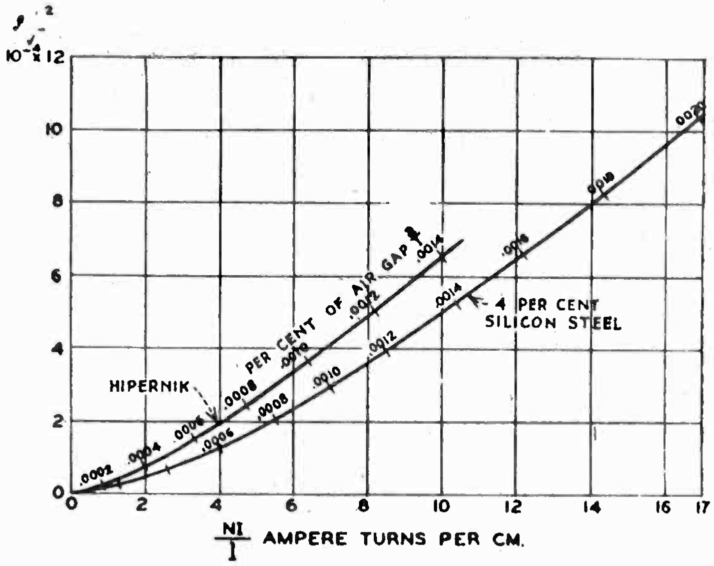


Fig. 2—Design curves for 4 per cent silicon steel and for hipernik

The value of the inductance is determined as outlined in Part 1 and the amount of the direct current is known when the output tube is decided upon, so that the quantity $\frac{LI^2}{V}$ can be found for an assumed value of core volume. The corresponding values of ampere turns per centimeter, NI/l, and per cent air gap, $\frac{a}{l}$, are read from the curve for the particular kind of iron being used. The required length of air gap to be inserted in the magnetic circuit and the number of turns are then readily determined. It may be that in order to get the required number of turns in the window of the core selected, the size of wire will have to be so small as to make the resistance of the winding excessive. If this is the case, either the volume of the core must be increased by stacking the punchings higher or punchings with a larger window must be used. If the volume or mean length of core are changed, it will be necessary to go through the calculations for N and a again.

When the transformer is to work out of a push-pull stage, it is customary to assume 10 per cent unbalance in the plate currents of the two tubes. For example, with a UX-250 push-pull stage, a difference in plate current of 0.0055 amperes would be assumed for the two tubes. This current flows through only half of the winding, which is equivalent to 0.0027 amperes through the total winding. The value of current to be used in calculating the number of turns is, therefore, 0.0027 amperes.

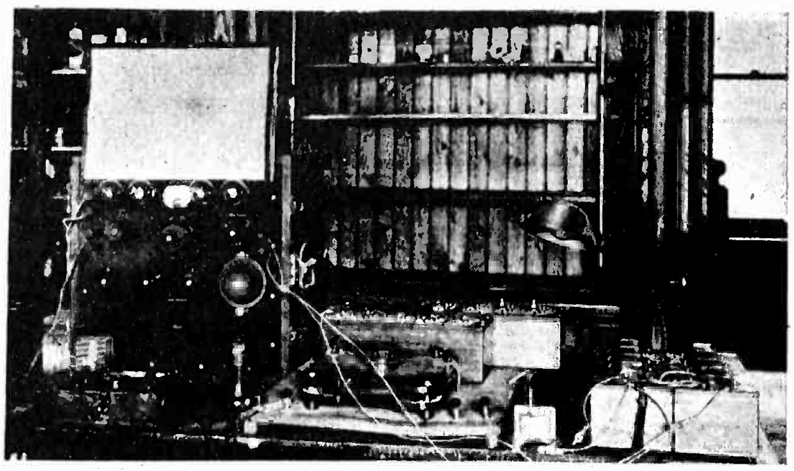
Several writers[2,3] have worked out design curves similar to Mr. Hanna's for other kinds of core material.

In the arrangement using a combination of output choke and transformer, there is no direct current in the transformer primary. The calculation of a coil under such conditions is not as easy a matter as one might think. The formula for the inductance is simple enough, being merely—

$$L = \frac{0{,}4\pi N^2 A\mu}{l}$$

The question which arises is, of course, the value to use for the permeability μ. The permeability is affected by a number of factors, such as the magnitude of the

*Research Department, Westinghouse Electric & Manufacturing Company.



Transformer testing equipment used by author

signal current flowing through the winding, the amount of handling and bending the iron has received, and its previous magnetic history. A fourth important factor is that unless the core is made up of ring punchings instead of E or L punchings with lap joints, there will always be a small air gap in the magnetic circuit which will affect the apparent permeability of the iron. None of these factors are definite, so that the permeability and hence the inductance, are also indefinite quantities.

These factors also affect the permeability in a transformer which is carrying direct current, but where an

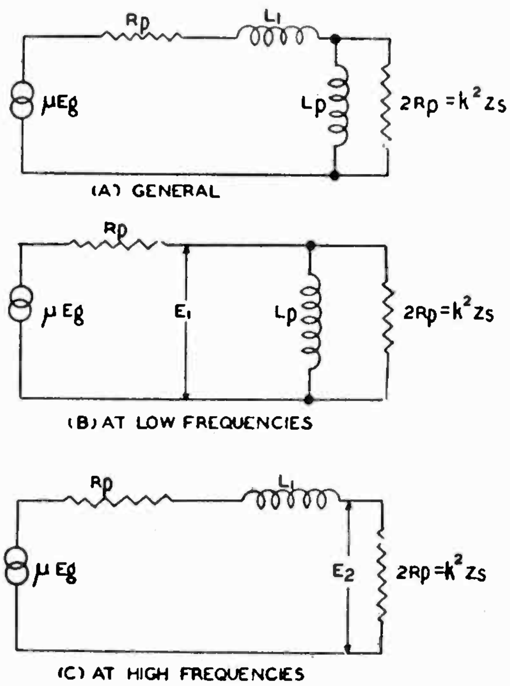


Fig. 3—Equivalent circuit of output stage

appreciable gap is purposely inserted in the magnetic circuit, and where there is a relatively large and definite value of steady magnetization, the effect is not nearly so pronounced.

It has been the experience of the writers that, under conditions ordinarily met with in practice, the inductance of a transformer primary when it is carrying a small amount of direct current does not differ greatly from the inductance when there is no direct current. Under conditions where the difference is appreciable it is always to the advantage of the coil without direct current. A paper by Prof. H. M. Turner[4] presents some excellent data confirming these statements.

In view of the above it has been customary with the authors, when designing transformers which do not carry direct current, to assume that there is a small amount direct current flowing through the winding. The proc dure is then the same as has already been outlined. F ordinary output transformers a current of 3 to 5 mil amperes is suitable.

Effect of leakage inductance

At high frequencies ωL_p becomes large compared $2R_p$, so that the equivalent circuit of Fig. 3-A reduc to that shown in Fig. 3-C. The voltage drop across t load at high frequencies is—

$$E_2 = \frac{2R_p \mu E_g}{3R_p + j\omega L_1} = \frac{2R_p \mu E_g}{\sqrt{9R_p^2 + (\omega L_1)^2}} \quad (1)$$

At low frequencies $(\omega L_1)^2$ becomes negligible compar to $9R_p^2$, and E_2 attains its maximum value, E_m $2/3\mu E_g$. The voltage across the load expressed as percentage of the maximum is, therefore—

$$\frac{E_2}{E_m} = \frac{1}{\sqrt{1 + \frac{1}{9}\left\{\frac{\omega L_1}{R_p}\right\}^2}} \quad (2)$$

Here again the power is proportional to the square the voltage, so that the percentage of maximum und torted power delivered to the load is given by—

$$\frac{P_2}{P_m} = \left\{\frac{E_2}{E_m}\right\}^2 = \frac{1}{1 + \frac{1}{9}\left\{\frac{\omega L_1}{R_p}\right\}^2} \quad (3)$$

Formulas (2) and (3) are represented graphically Curves 1 and 2 of Fig. 4 respectively.

Fig. 5 shows the calculated curves for two typic output transformers. Transformer No. 1 was for a pus pull circuit and its leakage inductance was 0.152 henri Its response is quite satisfactory. Transformer No. was for a single tube and its leakage inductance w 0.288 henries. The low R_p out of which it works a the high value of L_1 combine to make its response at hi frequencies very poor. On the other hand, this po response may have been intentional, for this particul transformer is used with a loud speaker which has prominent peak in its response at high frequencies.

Leakage inductance

Fig. 6 shows a section through a typical output tra former. E. G. Reed in his book, "Essentials of Tra former Practice,"[5] has developed an approximate fo mula for the leakage reactance of a transformer whi when modified to suit our needs, takes the form—

$$L_1 = 1{\cdot}05 \times 10^{6}\, \frac{N^2}{l}\left(3 l_g G + l_p d_1 + l_s d_2\right) \quad (4)$$

where:

L_1 = leakage inductance referred to the primary in henrie
N = primary turns.
l = length of leakage path in inches. (See Fig. 5).
l_g = mean length of layer of insulation between windin inches.
l_p = mean length of primary turns, inches.
l_s = mean length of secondary turns, inches.
g = thickness of insulation, inches.
d_1 = depth of primary winding, inches.
d_2 = depth of secondary winding, inches.

It will be noted that the terms $l_g g$, $l_p d_1$ and $l_s d_2$ respectively the cross-sectional areas in a plane perp

to the coil axis of the in-
, the primary winding and
ondary winding. Values
age inductance calculated
is formula agree satisfac-
with actual measured

value of this formula lies
usefulness in checking a
rmer design to see if its
equency response will be
tory. If the designer of
rmer No. 2 in Fig. 5 had
e formula, he would have
d that this leakage induc-
was high and could have
teps to lower it, had he
it desirable. Assuming
thickness of insulation
ed, there are two ways he
have done this. First he could have split one of
dings into two sections and interleaved the other
between them. Or, he could have reduced the
of primary turns and then compensate the de-
n primary inductance by using a larger core.
example, from Fig. 4 we see that to get 70 per
the maximum power requires that $\omega L_1/R_p = 2$.
re satisfied with 70 per cent at 5,000 cycles, the
inductance may be no more than—

$$L_1 = \frac{2 \times 1{,}800}{6.28 \times 5{,}000} = 0.115 \text{ henries.}$$

n 4 shows that L_1 varies as the square of the
of turns, so that in order to reduce L_1 from
0.115 henries it is necessary to decrease the
of turns by a factor $\sqrt{\frac{0.288}{0.115}} = 1.58$. The
inductance is reduced in the same ratio as the
inductance, and the primary inductance varies
the first power of the core area, so that it is
y to increase the core area by $(1.58)^2$ or 2.5
n order to retain the same value of primary
nce.

information presented in the foregoing para-
although specifically applicable to the output
rmer, may also be applied to other forms of
g devices. For instance, the same considerations
atio and primary inductance apply as well to the
of an output choke as to a transformer. If the
not tapped, however, it is an auto-transformer of
io, so that its primary and secondary windings
tical and occupy the same space. There is then,
age flux between the two windings and the leak-
uctance is zero. In the case of the tapped choke

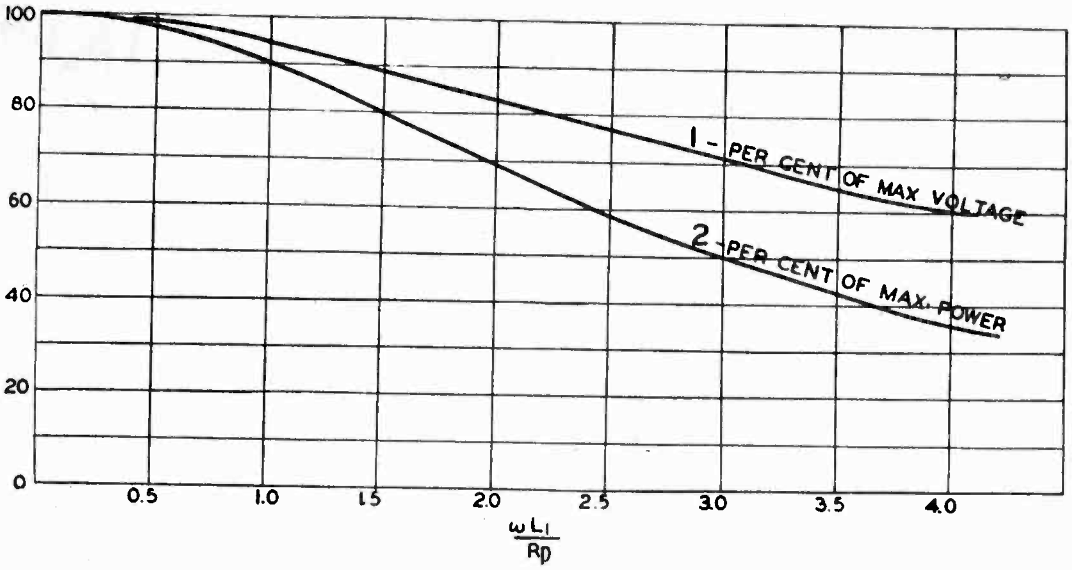


Fig. 4—Effect of leakage reactance of an output transformer

there will be a leakage flux between the primary and secondary, but the formula for calculating the leakage inductance given above will not apply in this case.

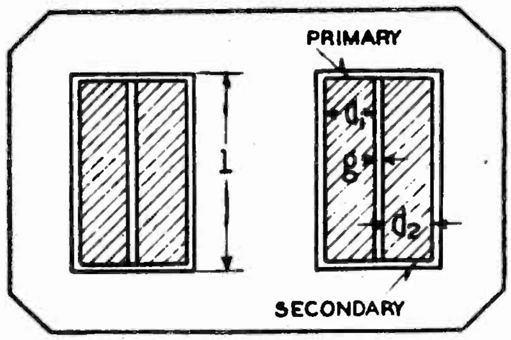


Fig. 6—Section through typical output transformer

Another formula must be developed using the same method as was used in the text referred to previously.[5]

When an output choke and condenser are used in combination with a transformer, the inductance of the choke, with the plate current flowing through it, should be at least as great as the primary inductance. The blocking condenser in such a circuit must be large enough so that its reactance at the lowest frequency it is desired to reproduce is low compared to the primary equivalent of the loud speaker impedance.

This type of output circuit has a very distinct advantage over the one using an output transformer alone. It is generally used with a single output tube where the direct plate current is considerable. By shunting this plate current through the choke coil, the number of primary turns necessary to give a suitable value of primary inductance is considerably lower than it would be if the relatively large plate current were required to flow through the primary winding. Since the leakage inductance is directly proportional to the square of the primary turns, this will result in an appreciable reduction in the effect of the leakage reactance.

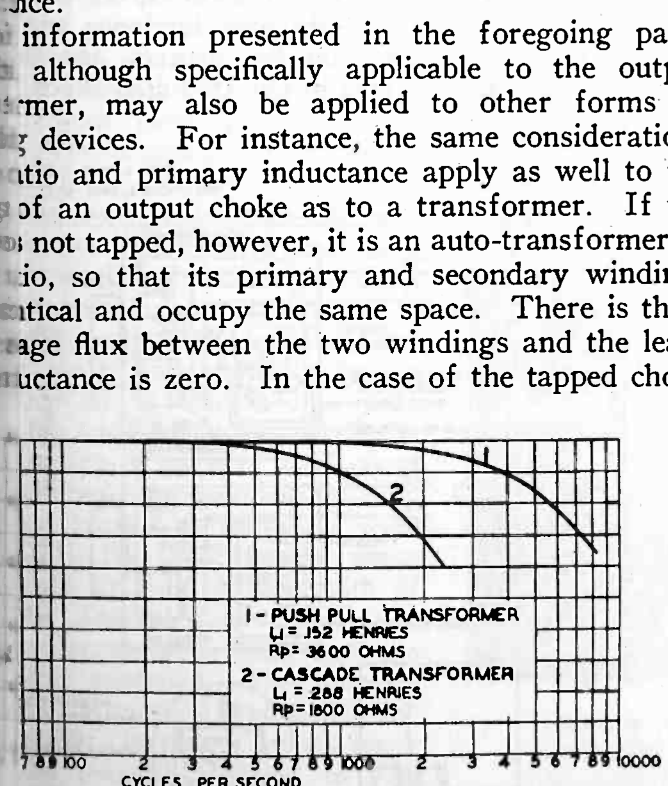


Fig. 5—Effect of leakage inductance on power output for two typical transformers

[1] C. R. Hanna, "The Design of Reactances and Transformers Which Carry Direct Current." *Jour. A.I.E.E.*, 46, 108; Feb., 1927.
[2] A. A. Symonds, "Loop Permeability in Iron and the Optimum Air Gap in an Iron-Core Choke with D.C. Excitation," *Experimental Wireless and the Wireless Engineer*, vol. 485, September, 1928.
[3] D. E. Replogle, "Notes on the Design of Iron-Core Reactances Which Carry Direct Currents," *QST*, XII, 23; April, 1928. Also "Additional Notes on Iron-Core Reactances," *QST*, XII, 46; August, 1928.
[4] H. M. Turner, "Inductance as Affected by the Initial Magnetic State, Air Gap, and Superposed Currents," *Proceedings I.R.E.*, Vol. 17, No. 10, October, 1929.
[5] E. G. Reed, "Essentials of Transformer Practice," Second Edition, pp. 117-120; D. Van Nostrand, Inc., 1927.

HIGH LIGHTS ON ELECTRONIC

Electric eye separates chemicals

Many chemical analyses, basic processes in every industry, depend upon the detection of color changes. The more elementary among these are the shade variations of "indicators" used to show whether a solution is alkaline or acid or when these two chemical conditions neutralize each other.

"As we all know," says Walter Krahl, chief engineer with the Arcturus Radio Tube Company, Newark, N. J., "the sensitivity of the human eye to color changes varies with the individual. Some of us are color blind. Such persons are unable to discriminate among delicate color changes. To a mild case of color blindness, pink and yellow appear the same color, and so do blue and green. A bad case of color blindness sees photographically — that is, everything appears like a photograph, in varying shades of black and white. Many people are color blind without knowing it, and often hold down positions where a certain degree of color discrimination is desirable or even necessary.

"An artificial eye however, employing the photo-electric cell, can be designed that is sensitive to color changes the normal eye cannot detect. Automatic mixing machinery can be designed for industrial chemical plants, in which the flow of different chemicals will be automatically stopped when an acid or alkaline neutralization is achieved, the neutral point being instantly noted by the photo-electric cell, and the associated apparatus made to control or stop the addition of the neutralizing agent."

"In the final analysis," concludes Mr. Krahl, "this may mean anything from a cheaper toothpaste to a better soap!"

Unique animated chart controlled by photo-cells

Photo-electric cells control a striking demonstration of the effect of voltage changes upon the wattage, candle power, and cost of electric lamps in an ingenious animated chart on exhibition at the Westinghouse Lighting Institute in Grand Central Palace, New York City. The animated chart consists of five illuminated columns, under the headings of voltage, wattage, candle power, total cost, and cost per candle power. Ordinates are in percentage of normal. As the height of the column headed percentage of normal voltage is increased above the 100 per cent mark, all the columns of light are lengthened but in varying proportions to correspond with the actual variation in these factors with the voltage. The height of these columns is controlled merely by placing the hand between a light source and one of two photo-electric units located at the side of the chart.

The movement of each of the columns is accomplished by an individual shutter which moves before a vertical row of ten-watt lamps in a box behind each column. The shutters are operated by cams of different sizes on a common cam shaft rotated through reduction gears by a small electric motor. The action of the photo-cells is merely to start, reverse, or stop the motor simple and striking way. This i complished as shown in the accom ing circuit diagram.

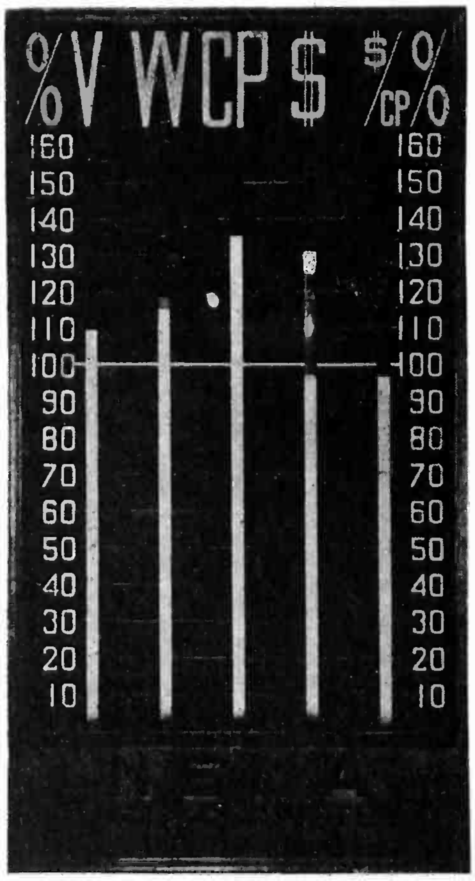
In two of the columns a porti the column length is colored to additional information. The co portion of these columns is pro by inserting colored translucent rial in the shutter mechanism. I "watts" column the red represen watts due to losses in the wiring, a the "cost" column a red and a portion represents the fixed charge the cost of lamp renewals. colored films or screens are asso with the shutters but driven by sep cams and gears at their own p speed.

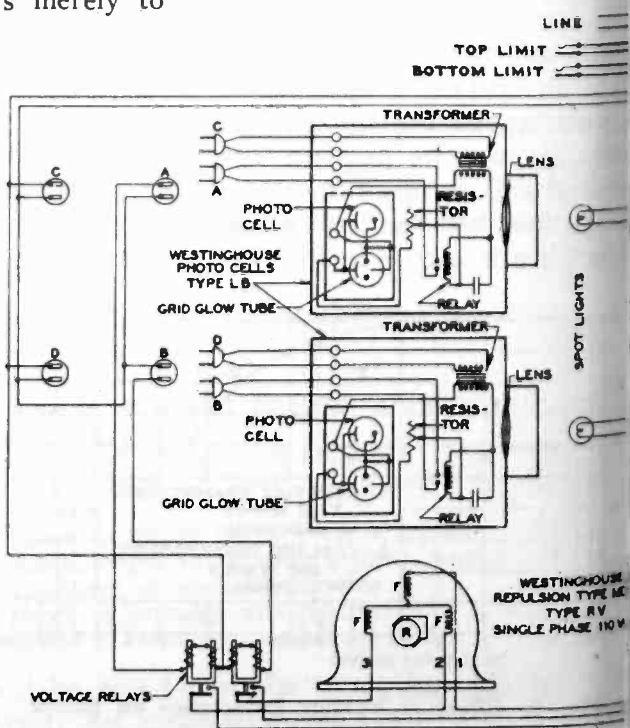
This chart was designed by Merrill of the National Lamp W for the N.E.L.A. Lamp Committe was first exhibited in the Lamp mittee's booth at the last N.E.L.A. vention at San Francisco, its pu being to demonstrate the effect of age variations in industrial lightin

Ultraviolet light shows up check raiser's changes

The treatment of check paper aesculin, a white powder obtained the bark of the horsechestnut tree, it possible for the bank teller to with ease erasures and changes otherwise might escape notice.

Aesculin fluoresces, or glows, placed under ultraviolet light. erasure on paper treated with this stance would show up as a dark on an otherwise luminous surfac patent on the process has just granted to Dr. D. Julian Block.

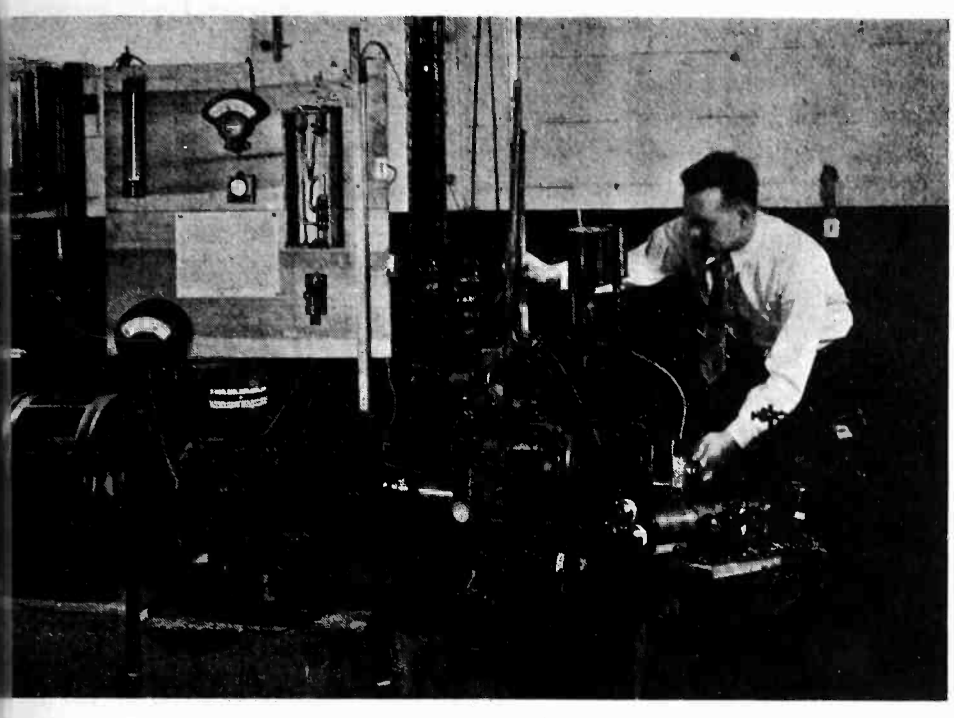




The moving columns on this chart bear fixed relations to each other, and their movement for various "lamp-voltage" values is controlled up or down by intercepting with the hand, one of two photo-cells, through the circuits at right.

Such mechanism has, of course, many other applications in industry.

ICES IN INDUSTRY + +



Normal engine noises are screened out by "high pass" filters, allowing only the knock, which has a frequency of 3,000 cycles per second, to pass through the vacuum tubes

+ + +

ging wire
sure twist of shaft

piano wire used to measure :wist which the great engines an liner give to the great steel forms the propeller shaft is a ication of the science of elec- erfected recently in Germany ı in first practical test on the the steamship *Bremen.*

:tal ever is absolutely rigid. the great propeller shafts of t liners are made amply strong the gigantic horsepower of the without twisting apart, such twist a small fraction of an er their load of engines and ngineers need to measure such :urately, not only to detect any ed weakness of the metal which ke trouble later on but also to ove designs and specifications e shafts and engines. In the hod of measuring this tiny, too small to be seen while the otating, a piece of steel piano retched between projections on rs clamped to the shaft some t. If the shaft between these vists by even a hundredth of the distance between the two ıs increases a trifle and the re is stretched. This changes of the musical tone which the es out, just as a piano tuner the tone of a string in that ıt by stretching it more or less. le piano wire fastened to the shaft is kept singing by an electric device and the tone which it emits is compared with that from a similar wire stretched to a known degree. Any twist of the shaft is thus measured.

Tube device controls gasoline "knocks"

Electronic science has entered a new field and is now controlling anti-knock qualities in gasoline.

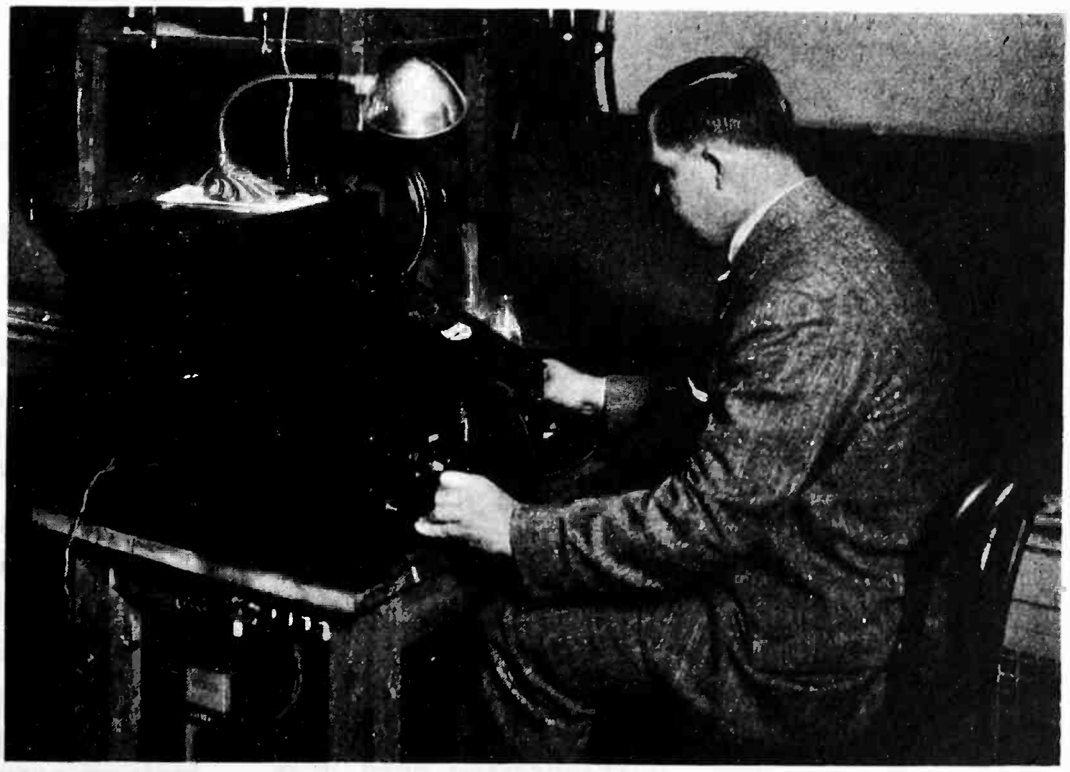
Microphone and vacuum tubes, magnifying sounds a hundred-fold, have been combined with other delicate instruments to form an electrical ear to detect the faintest whisper of a knock and yet to remain deaf to other engine noises!

The apparatus, sensitive to sounds far beyond the range of the human ear, was developed by scientists of the Atlantic Refining Company, according to Dr. T. G. Delbridge, head of the company's research laboratories. It was designed in the course of research leading to a new type of gasoline, perfected after years of study and an expenditure of more than a half million dollars. Necessity for the device arose when scientists were able to find none capable of interpreting engine noises, or delicate enough for their purpose.

In operation, the "mike" is suspended from coiled springs near the engine testing the gasoline. Sounds that could not be heard by man are picked up by the microphone, and the rest of the apparatus then selects and magnifies the knock and registers the sound intensity.

+ + +

CAN COMPARE WIDELY SEPARATED COLOR SAMPLES



The new color comparator designed by Dr. H. H. Sheldon of New York University, New York City, enables dyers to compare tints with an accuracy impossible to the eye. Used under the artificial light of winter afternoons, when the peak of textile manufacture comes, it greatly increases the productive hours of the dye-room. Samples compared can be in diffent rooms

electronics

McGraw-Hill Publishing Company, Inc.
Tenth Avenue at 36th Street
New York City

O. H. CALDWELL, *Editor*

Volume 1 — DECEMBER, 1930 — Number 9

The press, radio and sound-pictures to the rescue

THE three greatest forces available for overcoming the present economic depression in the shortest time comprise the press, radio and sound pictures. Through these agencies every person in this country can be informed daily and even hourly of improvements in trade progress. It is interesting to note that two of these mediums are basically electronic. Past depressions did not have their assistance for the come-back. The electron tube has already served mankind well—it stands ready today to carry the glad tidings of progress to the four corners of the globe.

Such forces alone cannot cure the business ills of the nation but they are already alleviating the pain by the entertainment offered the public. Motion-picture producers are planning record expenditures for 1931. Radio broadcasters stand ready to spend millions if granted high power. And, indication of the optimism of the press, the McGraw-Hill Company has contracted for a new $7,000,000 building now being erected.

The bottle-neck

"MUSIC put on the air," says Leopold Stokowski, conductor of the Philadelphia Symphony Orchestra, "is compressed until it is out of shape, because radio can carry only a certain amount of energy."

The celebrated conductor whose orchestra is heard via radio through the courtesy of is partly correct and partly not. A full or has an output range of volume of abo million to one (60 db). Telephone lin necting pick-up with transmitter can hand about 30 db. Here is a two-to-one comp in volume before the radio program real started.

When the pianissimo passages of the or threaten to be lost in line noise, the pick erator must artificially increase the sounc when the fortissimo passages threaten to talk into adjacent wire circuits, the operat reduce these peaks of power which give v the rendition.

The radio is not at fault; it is the wire No amount of engineering to eliminate fr distortion at transmitter or receiver can el amplitude compression. No satisfactory of combating this inherent distortion has b into practice.

Electronics—a wide field

RADIO engineers frequently claim th profession calls for a greater knowl physics and chemistry than that of the el engineer.

It is probable that the electronic enginee future will be even better equipped. The tion of a photo cell to industry demands mc a knowledge of electron emission. It i such deep and, to most engineers, closed as the quantum theory, and realms of phy chemistry quite often hurried through by their way to the brighter—and more fields of communication or power.

Optics plus photo cells have made poss recording of sound on motion picture film vision awaits some optical, mechanical, or cal genius who will get around the scanni

All new industries attract to them equipped consultants who are willing to their knowledge at the expense of the clients. It is to be hoped that the indust built up around the adaptation of photo vacuum tubes to other services than r sound pictures will be in the hands of engi the widest possible training and experienc

eeding up the fireman!

nterprising team of dealers and service-n in a middle western city have applied tubes and associated apparatus in an ng manner. In this city a number of out- departments are in communication over wires with a central bureau. At this cen- someone is always on duty. To get the apparatus into action the central bureau ed to the other offices.

ew system consisted in putting a micro- the chief's desk, a power amplifier and aker in each station house. Now the ks to all the stations at once and in such n tones that in the middle of the night, can get their orders on their way down ery pole from the sleeping room.

test those districts equipped with loud instead of the older system got under arrived at the fire sooner than the others quipped.

und-movies for the deaf

ADING authority of the American oustical Society tells us that approxi- 0 per cent of our population or 12,000,- ple in the United States, suffer from de- earing in one degree or another. With ge-over from silent to sound moving pic- ousands of such people have been cut off from the one form of entertainment they enjoyed most.

Means are now available to equip theaters with individual ear phones so that such persons can still enjoy the movies with the addition of sound. Usually from 20 to 50 seats equipped with ear phones, depending upon the size of the theater, would take care of this 10 per cent. The return to the theater management in a short time would pay for such equipment, besides building up good will in the community.

"Electronic knife" third great advance in brain surgery

THE application of electro-surgery to surgery of the brain and nervous system marks the third great advance that has been made in the field of neuro-surgery, according to Dr. Ernest Sachs, of St. Louis, speaking before the American College of Surgeons at Philadelphia, last month.

By means of the "radio knife" brain tumors that were formerly considered inoperable can now be dealt with, and other types of brain tumors can be removed more safely than before.

The technique of the method takes time to learn, but Dr. Sachs prophesied that more and more will be accomplished with it in the future as surgeons become increasingly familiar with it and learn to realize its possibilities.

▼ ▼ ▼

umulative index of 1930 issues of Electronics, see page 446

ELECTRONICS points with some pride to pages 446, 448 and 450 of this issue where an index of its first nine issues (Volume I) will be found. A perusal of this summary of editorial material will make clear to the curious reader the *raison d'être* of *Electronics*—to bring to the engineers who design and manufacturers who build electronic apparatus (radio, sound pictures, industrial applications of tubes as well as electronic tubes themselves) the advances in their art and the news of their industry.

Such an index in a new art like electronics provides a unique and invaluable history of pioneer work, a fascinating disclosure of the wide application of electronic tubes to industrial problems, and a source of technical and manufacturing information on specific subjects.

LETTERS TO THE EDITORS

E-lectron-ics—the wedding of the sciences!

Editor, ELECTRONICS:

I was very much interested in your recent editorial regarding the typography of Electronics, entitled "That little 'e'; its big significance."

Electron comes from a Greek word which is usually translated "amber." If the first "e" is omitted, we have the Greek word "lectron," which means "bed." In the plural the word means "marriage bed." So that first little "e" is rather significant.

I always make it a point in my classes that the word electron be always pronounced "e-lectron," so as not to offend classical students and purists. I think that the point is rather well taken.

WALTER J. SEELEY,
Professor of Electrical Engineering.
Duke University, Durham, N. C.

▼

An astronomer comments on the photo-cell

Editor, ELECTRONICS:

The photo-electric cell has not been very widely used in astronomy, partly due to its erratic nature. For about fifteen years, however, a photo-electric cell photometer has been used with success by Professor Joel Stebbins of the Washburn Observatory, Madison, Wis. Photo-electric photometers are also used in Babelsberg Observatory, Berlin, and three or four others have been made for different observatories. One has just been made by Stebbins for the Yerkes Observatory.

But nearly always photo-cells are unsuccessful because of "dark currents," instability of the cells, and too great sensitiveness for the irregularities of our atmosphere. Stebbins has used his instrument to get some of the most accurate light curves of variable stars there are on record, but it has taken a lifetime of technical work to develop the photometer and use it with moderate success.

We keep saying to ourselves that some day the photo-electric photometer will be simple and practical.

HARLOW SHAPLEY,
Harvard College Observatory,
Cambridge, Mass.

▼

Blind in need of 600 radio sets

Editor, ELECTRONICS:

The American Foundation for the Blind has, during the past two or three years, dstributed several thousand completely equipped radios throughout the country to needy blind people who had not the means to secure these for themselves.

We have on file hundreds of letters, telling of the great boon that this has conferred upon them, and of the inestimable blessing that these radios have brought to their lives, otherwise spent in monotonous darkness.

Mr. Powel Crosley some time ago was good enough to donate to us one thousand sets for this purpose — Mr. Atwater Kent kindly sold us at a nominal price two hundred and fifty obsolete models, which we also distributed among our needy blind friends throughout the country.

We now have applications from approximately six hundred more needy blind people, to whom a radio would be a gift from Heaven, but who are unable to procure such sets.

I am wondering whether yo[u] possibly help us enlist the int[erest of] some manufacturer or manuf[acturers] who might have a quantity of [obsolete] models that they would be wi[lling to] let us have for this purpose—or [to] sell us at a nominal price; th[ey need] not be an expensive type, in [fact the] cheapest kind would do, so long [as they] are efficient.

Mr. William Ziegler, Jr., and [I per]sonally will donate most of the [funds] to cover the above expense, if th[e sets] are not available as a gift.

M. C. MIGEL,
President American Founda[tion]
for the Blind,
125 E. 46th St., New Yo[rk]

▼

Chicago's future "Hall of Electronics"

Editor, ELECTRONICS:

I want to express my apprecia[tion of] your recent news item concerni[ng the] Hall of Electronics in the new M[useum] of Science and Industry, now bei[ng com]pleted in Jackson Park, Chicago.

We are setting aside several th[ousand] square feet for the development [of the] electron theory and the engineeri[ng and] industrial applications of the e[lectron] tube.

This was the idea of your ma[gazine] and you deserve the fullest credit [for it.] I think we shall be the first mus[eum in] the world which will pay adequ[ate at]tention to the subject of electro[nics in] this manner.

WALDEMAR KAEMPFFER[T]
Director, Museum of Sc[ience]
and Indust[ry]
300 West Adams St., Chicago

▼ ▼ ▼

Albert Coates expects new art in microphone technique

Albert Coates, noted English conductor, guest-leader of New York's Summer symphonic concerts at Lewisohn Stadium, who studied science at Liverpool University under Sir Oliver Lodge, believes that radio's microphone picks up sound waves like a person who listens with only one ear. Mr. Coates declares that he is convinced, notwithstanding the perfection claimed for present-day broadcasting, that music sent over the radio or reproduced from phonograph records a few years hence will be vastly superior—more nearly like the original sound—than engineers are able to produce at present. He believes that this will evolve through advances in the art of microphone technique, which will create a new era in music appreciation.

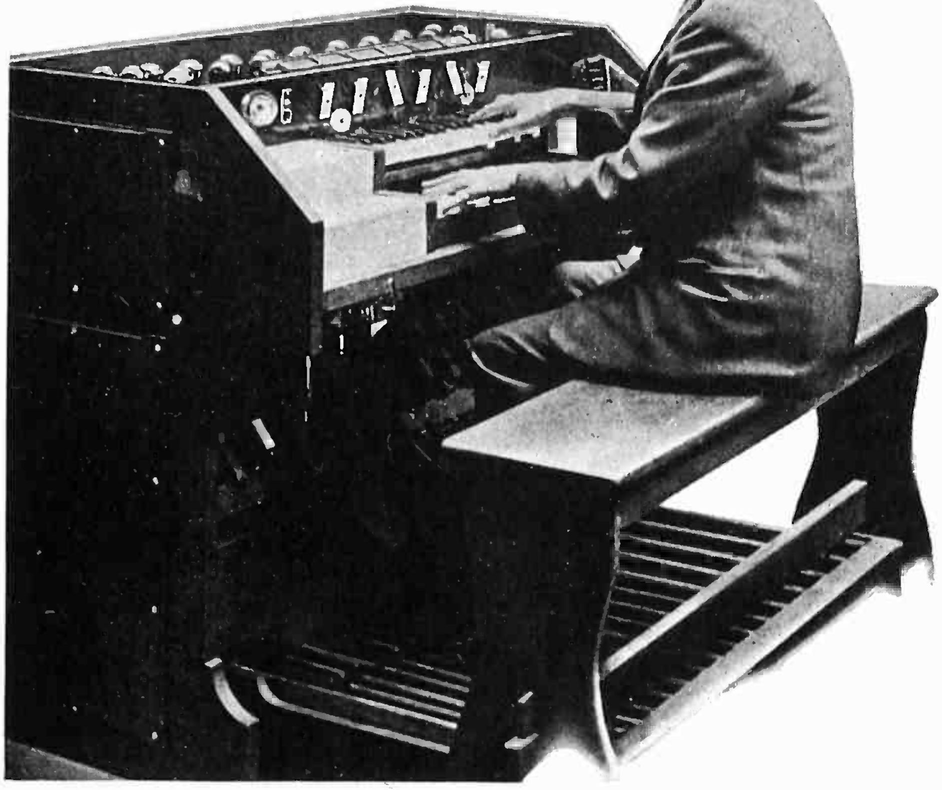
As a motion picture is given the effect of depth through a system of twin exposures and projections of a scene, the broadcasters will learn to use microphones in a way to give the effect of natural sound, which is now largely lacking in many presentations, Mr. Coates said.

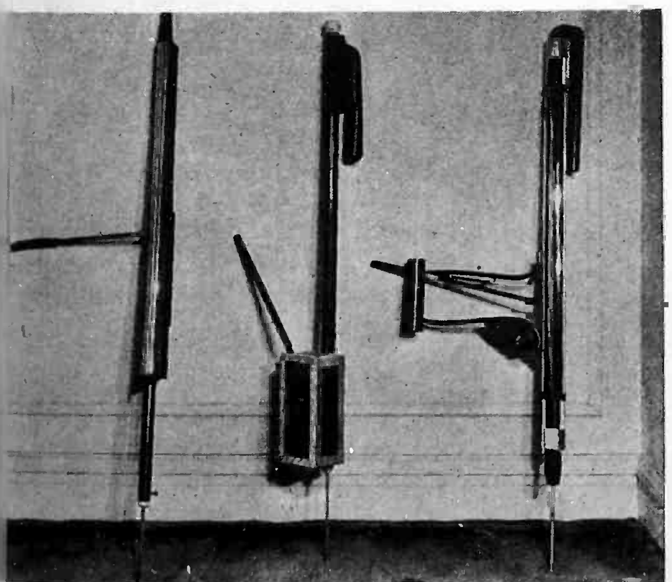
Higher altitudes better reception

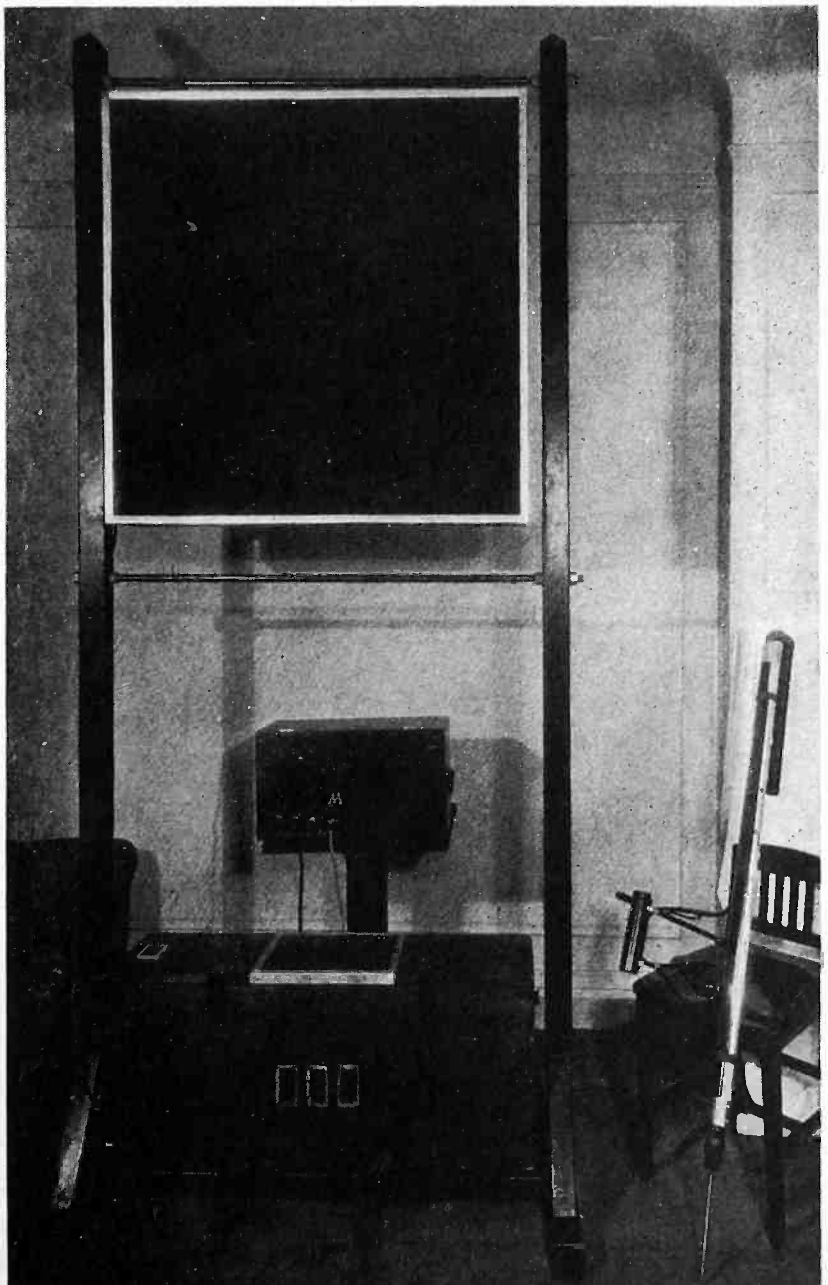
The higher the altitude the [better] radio reception conditions becom[e, says] Federal Radio Commissioner [Harold] Lafount, who draws this con[clusion] from his own recent experie[nce in] dialing 32 stations on a porta[ble re]ceiver at an elevation of 11,2[00 feet] during a recent tour of the [Rocky] Mountain region. Radio, Mr. L[afount] adds, is a godsend to the ranchers, rangers and sheepher[ders in] the mountains.

ECTRONIC MUSICAL
STRUMENTS

ombining fundamentals and overtones, onic musical instruments make possible mbres and qualities never before heard. oles of such instruments are the elec- organ of M. Coupleaux of Paris, France at the right), and the new keyboard of the American theremin (illustrated). See also *Electronics* for September, 1930, page 272



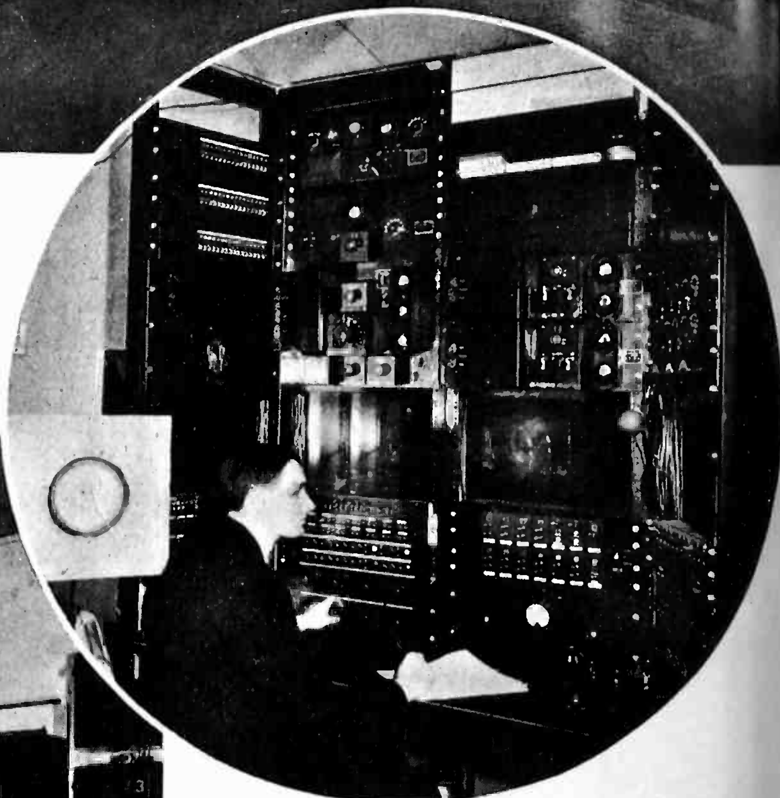




To accommodate musicians familiar with tringed instruments, these new forms of an- enna control for the theremin have been de- eloped, both with separate pick-up and with attached loudspeaker and amplifiers

Electrical transcriptions for broadcasting

View of the main recording studio of the Judson Radio Program Corporation, New York City. Here electrical-recorded phonograph records used in broadcasting stations are made



The monitoring room of the studio (above) where proper balancing of the various microphones and correct volume is maintained in recording

One of the disk recording machines (left) where an electrically-operated sapphire stylus transfers the sound vibrations from the amplifiers to the wax record. The suction tube seen leading from the ceiling is provided to remove the wax thread which is cut by the sapphire knife

NEWS

THE ELECTRON INDUSTRIES

w RMA directors

directors elected unanimously
:MA board at its meeting,
18, in Cleveland, Ohio, were
. Farny of the All-American
Corporation, North Tona-
. Y., and A. S. Wells of the
n Company, Chicago, Ill.
re elected to fill vacancies
the resignations of Lester
of Springfield, Ohio, formerly
nited Reproducers Corp., and
Tully of Chicago, formerly of
ner-Tully Company, both of
e not now actively identified
radio industry. Messrs. Noble
served for several years in
capacities in the RMA. Mr.
as formerly chairman of the
n's Merchandising Committee,
Tully its treasurer. The new
are prominent and active
radio manufacturing.

Vacuum Products & Co., Inc.,
Ogden Ave., Chicago, Ill., has
ganized with the following
A. F. Maitland, president,
aylor, chief engineer and vice-
and W. M. Craig, secretary,
and sales manager. Mr. Tay-
formerly connected with the
ng staff of the United Air
Corporation of Chicago. Mr.
s been associated with the tube
fields for a number of years.
mpany is specializing in making
eavy-duty, 250, 281, 866, 845-B,
tubes; in custom building of
ibes and the designing of tubes
ts. The general superintendent
ompany is Mr. W. W. Dwyer
had 15 years' experience in the
d and was formerly with the
Electric Company.

ming meetings

e American Physical Society—
al meeting, Cleveland, Ohio,
mber 30-31, 1930.

oustical Society of America—
Angeles, Calif., December 12-13,

**nerican Association for the Ad-
ement of Science**—Cleveland,
, December 29-Jan. 3, inclusive.

**nerican Institute of Electrical
ineers**—Winter Convention, New
City, January 19-23, 1931.

McMurdo Silver, president of Silver-Marshall, Inc., has just returned from the East where he addressed dealer meetings at Newark, New York City and Boston. He reports that public acceptance of superheterodynes has been greater than the most optimistic expectations.

Standard Transformer Corporation, 852 Blackhawk St., Chicago, Ill., has announced the appointment of Everett E. Gramer as Chief Engineer. Mr. Gramer is widely known among the users of transformers and is considered an authority on transformer design and production. He was formerly active and instrumental in the success of the Transformer Corporation of America during the period in which it made transformers exclusively. The Standard Transformer Corporation also announces the addition of approximately 5,000 square feet as added production space. This was necessitated by the substantial volume of business the company was obligated to produce.

The Ward Leonard Electric Company, Mount Vernon, N. Y., announces the appointment of R. C. James as sales representative in the Seattle district. Mr. James' organization will be located at 2321 Second Avenue, Seattle, Washington.

JOHN W. MILLION, JR.

John W. Million, recently appointed chief engineer Audiola Radio Company, Chicago, Ill. He was formerly with the Brunswick-Balke-Collender Company in the same capacity and later research engineer with the Utah Radio Products Company

W. R. G. Baker, formerly with the General Electric Company at Schenectady, N. Y., has assumed charge of manufacturing activities of the RCA-Victor Company at Camden, N. J., according to an announcement of the RCA-Victor company.

Mr. Baker, who was vice-president in charge of engineering at this plant, will have the added responsibility of production scheduling and manufacturing at the Victor company. Mr. Baker succeeds Alfred Weiland who was in charge of manufacturing for the old Victor Talking Machine Company and who continued in this capacity when the company was taken over by the Radio Corporation of America.

The Magnavox Company, with general offices at 155 East Ohio Street, Chicago, Ill., announces the opening of a factory branch in Sydney, New South Wales, Australia. The opening of this branch has been warranted by the increased demands for Magnavox dynamic speakers in Australia and New Zealand, and will now place the company in much better position to render immediate delivery to its manufacturing and distributing trade in this territory. The factory is in actual operation, fabricating, assembling and marketing speakers throughout this territory. The name of the operating company is—Magnavox (Australia) Limited, and is under the managership of Mr. Don T. Hinchen, who has been associated with The Magnavox Company for many years in building up the loud speaker division of the radio industry in the Australian markets.

White Engineering Corporation, 32nd and Arch Sts., Philadelphia, Pa., appoints Walter H. Kelly sales director. Mr. Kelly is well known from his many years' association with the radio industry. He has represented Brunswick, Lyric, Crosley and Sonora, and is well recognized among the dealers and jobbers of the eastern seaboard. Mr. Kelly brings to the White Engineering Corporation, in addition to his radio experience, a long background of general sales experience.

Westinghouse General Catalog, 1931-1932, comprised of 1352 pages presenting descriptions and illustrations of apparatus representative of the myriad of products manufactured and sold by the Westinghouse Electric and Manufacturing Company, of East Pittsburgh, Pa., has been announced recently by that company.

The Newark Wire Cloth Company, 351 Verona Ave., Newark, N. J., manufacturers of wire cloth for all industrial purposes, announces that it is now manufacturing wire cloth of stainless steel. This cloth is made in all meshes, widths and lengths, and will be made as fine as 200x200 (40,000 openings per square inch) provided quantity orders will warrant.

Mr. Harry Kalker, sales manager of the International Resistance Company, manufacturers of Durham metallized resistors recently paid a visit to the Pacific Coast using Air-rail T-A-T route. Mr. Kalker visited his company's many accounts who are at present busy with the manufacture of mantel-type receivers. The International Resistance Company reports running close to peak production in order to fill the increased demand for metallized resistors.

REVIEW OF ELECTRONIC LITERATU

HERE AND ABROAD

Electricity, ether and quanta

[F. PRUNIER] After having again derived Maxwell's equations as the most general equations of the movements of the ether, the author deduces certain properties of the ether. He then shows how these properties permit giving it certain electric, magnetic and gravitational characteristics. He is thus led to introduce into the theory of these phenomena some new types of waves and vibrations. These types of waves are precisely those which correspond to the famous Schrödinger equations. The author's conclusion is that wave-mechanics is not essentially different from the classical-mechanics, but that it can appear as a division of the latter just as in previous publications he has shown that the dynamics of relativity may be considered as a division of classical dynamics.—*Revue General d'Electricité, October, 1930.*

✦

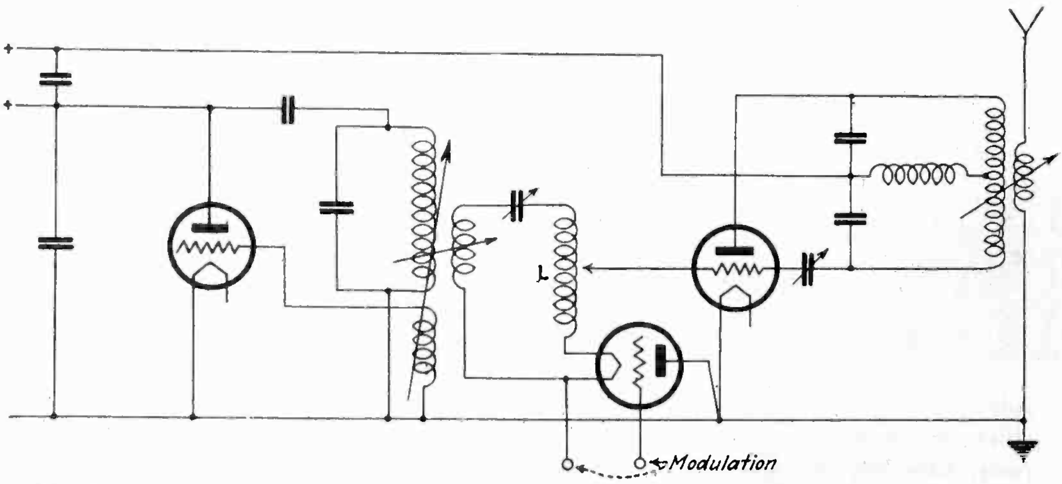
A simplified modulation circuit

[WEICHART AND LANGEWIESCHE] Communication from the Postal Department laboratories. With the grid modulation normal in German Broadcasting stations the insulation of the modulator tube filament supply is difficult and the capacity to ground troublesome. It is suggested that this can be overcome by using radio-frequency current for this filament and experiments have shown that results are entirely satisfactory. A further refinement is to obtain in a similar manner the necessary polarizing voltage for the modulator tube grid, by inserting in the same circuit the filament of a rectifier tube and feeding its plate with a radio-frequency voltage picked up by a coil coupled to the inductance L. (See circuit diagram below.)—*E.N.T., Berlin, October, 1930.*

✦

Electrical properties of soil at radio frequencies

[J. A. RATCLIFF AND F. W. G. WHITE] In the transmission of wireless waves over long distances the character of the earth may play a very prominent part. The effect of the earth has been determined from attenuation measurements and from measurements on the tilt of the wave front. The results are normally expressed in terms of the dielectric constant and the conductivity of the soil. The authors show that there is no sound basis for assuming *a priori* that these constants are independent of the frequency. By laboratory tests on samples of earth from two widely different locations and using two different methods of measurement, one a cathode-ray oscillographic method and the other a resonant method, they show that between one and ten million cycles the dielectric constant may show a four to one ratio, having smaller values at the high frequencies. The conductivity characteristic is a saddle-backed affair with a minimum at some intermediate frequency and showing only about a 25 per cent variation. The conclusion is reached that the only satisfactory way of measuring these quantities is to measure them for ground *in situ* and at the frequency required, either by the tilt method or by means of attenuation curves.—*Philosophical Magazine, October, 1930.*



Modulation circuit in which r.f. current is supplied to the filament to avoid ground capacity. Similarly a rectifier filament is fed with r.f. to supply grid voltages (Weichart and Langewiesche)

Triode generator and amplifier

[L. B. TURNER AND L. A. MEA It is common usage to state th ideal efficiency of a linear oscilla amplifier is 50 per cent. This, ho presumes that it is possible for th voltage to drop to zero and als no grid current flows. By confinin swing of plate potential to the portion of the lumped characterist so adjusting coupling and voltage the grid potential never becomes tive these authors show, both th cally and experimentally, that the mum output is obtained when th resistance is twice the plate resis and that the maximum efficiency tained for very large values of resistance and small outputs, is 2 cent. In the experimental worl harmonics are measured in the plat rent by means of a calibrated ampl if these harmonics are translated terms of plate potential it is show the most prominent harmonic (the was less than one thousandth o fundamental.—*Cambridge Philoso Society, October, 1930.*

✦

Three-tube local receiver with the new "flat" tubes

[UNSIGNED] Of interest as being first published description of a rec developed independently of the manufacturers (in this case in "Funk" laboratory) using the new pacity controlled "grid-less" tubes page 346, October, *Electronics*). P specially mentioned are the existen somewhat more hum than with the mal indirectly heated tube, and the treme critical nature of the regenera setting.—*Funk, Berlin, November 1930.*

✦

The differential condenser loudspeaker

[SCHWANDT.] Details of the new loudspeaker in which the membran negatively polarized and rests betw two positively polarized (1,000 v gratings, the secondary of the transformer being connected to t two latter. Curves are given and claim of tenfold sensitivity as comp with the dynamic loudspeaker is m —*Radio B.F.f.A., Stuttgart, Oct 1930.*

...e theory of ...amplifiers

[...TERWORTH.] Technical litera... replete with solutions of the ...l type of wave filter, consisting ...rent similar sections. Here we ... analysis of a new type of filter ... each section is separated from ... by a thermionic tube. In other ...e problems of amplification and ... are combined as in the simple ...eiver.

...g with a simple series-resonant ... be used in a low-pass filter ...r shows that the voltage across ...enser is equal to the input vol... ...tiplied by the factor $\frac{1}{\sqrt{1+X^4}}$ ... is the ratio of operating fre... ... cutoff (resonant) frequency, ... the constants of the circuit are ... related. Generalizing this re... ... shows that $F=(1+X^m)^{-\frac{1}{2}}$ ...$=E_{out}/E_{in}$ and m is a factor ...creases with the number of ...used in the filter. The con... ...which must be satisfied in the ... one or two element filters are ... From this simple theory the ...xpands to include (a) multi-...ier amplifiers, (b) band-pass fil-... band-stop filters and (d) high-...ers. For each class a design ...ncluded which shows the values ...nstants to employ in the filter ...ing any given tube.—*Experi... Wireless, October, 1930.*

✦

...rement of small currents

[...S V. RAGHAVA RAO AND H. E. ...] Increasing use of photo-elec... ... has made the measurement of ...rrents a matter of prime im... The circuit normally used for ...ng small currents from a photo-...cell or other source is one in ...e cell and its attendant battery ...nged so as to charge the grid ...ermionic tube either positively ...tively and the resulting change ... current is measured on a gal...ter balanced with respect to the ...late current. Experiments showed ...erent types of tubes show widely ...t sensitivities. Even the very ...cuum tubes show some reverse ...rrent or "back lash" and this ... is of extreme importance in ...easurements. When the cathode ...ode) of the photo-electric cell is ...ted directly to the grid of the ...onic tube the grid current is ...o the photo-electric current. The ... in plate current then depends on ...riation from "free-grid" potential ($_0=0$) to the potential which per...his current to pass and the mutual ...tance of the tube. Since the ...ash is partially due to leakage caused by the anode voltage it is desirable to reduce the latter provided the mutual conductance is not decreased more by this same change.

The conclusions arrived at are: The main requirements in a valve to give high magnification of small direct currents are: extremely good insulating of the grid (a conducing factor being low filament temperature) high mutual conductance and low impedance and anode voltages much lower than normal. (See *Electronics, September, p. 290*).—*Experimental Wireless, October, 1930.*

✦

Some interesting television problems

[NOACK] Brief discussions of recent developments: Kirschstein's experiments showing that gas-filled photo-cells are not independent of frequency when high polarizing voltages are applied; Okolicsanyi's experiments tending towards greater clearness of image; the Zworykin system using the Braun tube—it is stated that this system has not come up to expectations and seems to be making little progress; the colored television systems of Aronheim (twelve colored rotating filters) and of Andersén (three such filters); synchronization problems in general and Korn's suggestion of a central radio station emitting nothing but a synchronizing frequency for the whole continent.—*Radio B. F. f. A., Leipzig, November, 1930.*

General new tendencies in loud-speaker construction

[NESPER] A general survey of recent German products—more especially the Isophon 4-pole, 4-watt; Pyreia 8-pole; Wufa Giant 60-pole; recent dynamic loud-speakers with permanent magnets; and the Vogt electrostatic in its latest form.—*Funk Magazin, Berlin, November, 1930.*

✦

The screen-grid tube as detector

[KAPLAN] Article specially for the short-wave telegraph amateur. Normal regenerative coupling is used but control of the regeneration is by variation of the screen-grid voltage, a variable series resistance of 50,000 ohms being inserted in this lead (with a large parallel condenser to reduce noise in operating). Claims of greatly increased sensitivity and easy operation (no change in frequency with change of regeneration) are made.—*Funk, Berlin, October 31, 1930.*

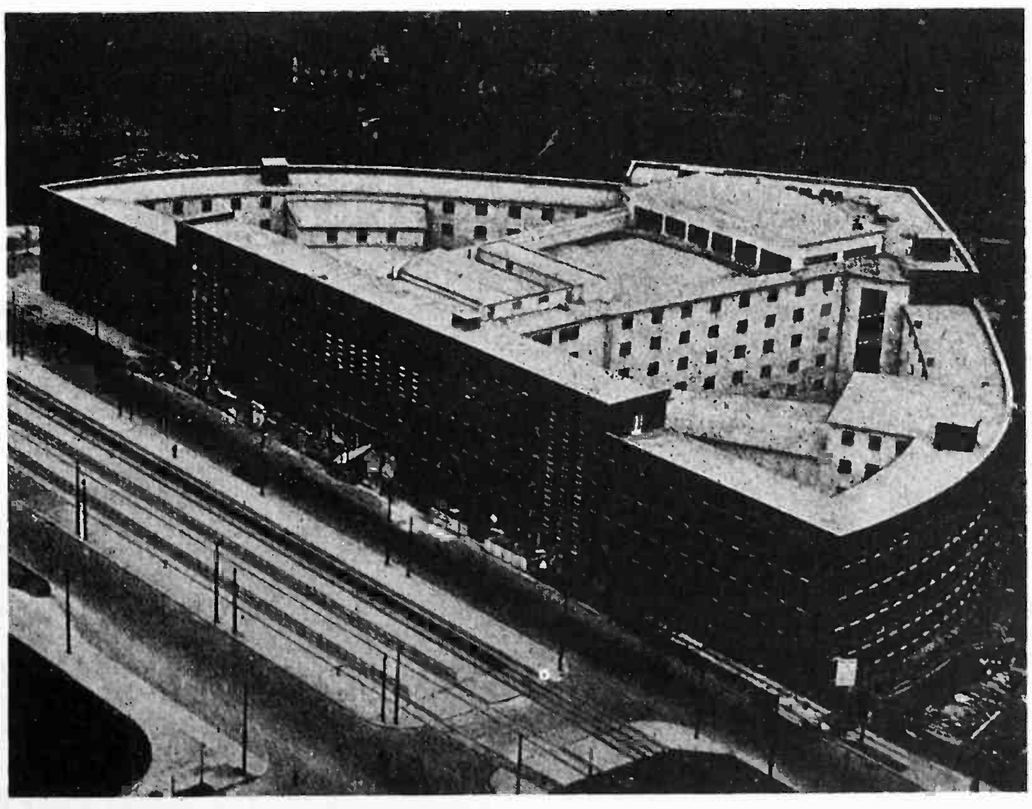
✦

Detection of ore-masses by radio

[VINOGRADOW] Simple description of a system using a small transmitter on 6,000 meters wave-length with a loop antenna capable of rotation about a vertical axis and a receiver with a loop antenna capable of rotation about both horizontal and vertical axes.—*Science et le Vie, Paris, November, 1930.*

✦ ✦ ✦

GERMANY'S "NBC"



The new radio center at Berlin was dedicated December 1. Broadcasting studios, a museum, research laboratories and the general offices of the commission are combined in one building in the German capital

Producing sinusoidal l.f. currents; their measurement

[J. G. BEDFORD AND H. JOSEPHS] Where a very wide range of output voltage and constancy of frequency are desirable, particularly at low frequencies, say from 5 to 100 cycles per second, thermionic valve methods of generation are at a disadvantage. The alternative solution adopted here is to provide a square topped wave with negligible transit time, filter this and measure the output frequency by means of a modified Maxwell's Commutator Bridge. The square topped wave is derived from a motor driven Baudot distributor; the filter consists of six 6-henry coils and a total of 40 mfd. capacitance. Oscillograms are included showing the wave form obtained at various frequencies.—*P.O.E.E. Journal, October, 1930*

✦

Logarithmic tube-characteristics

[FACAL] It is suggested that the normal characteristic curves may with advantage be replaced by curves of *Rp/Ep*, "Durchgriff"/*Ep* (or μ/*Ep* since the "Durchgriff" is 100 divided by μ), and mutual conductance/*Ep*, in which curves the values of *Ep* are plotted linearly but those of *Rp*, "Durchgriff" and mutual conductance logarithmically. It thus becomes possible, if the *Ep* scale is the same in all cases, to read complex characteristics such as the "Güte" (μ multiplied by mutual conductance) directly, and a permanent check on the correctness of the curves is given by the fact that the three ordinates for *Rp*, "Durchgriff" and mutual conductance respectively for any given value of *Ep* must total 1 (since the product of these three quantities is unity). Methods of obtaining the curves directly are given: or they can be calculated from the usual curves.—*Funk Magazin, Berlin, November, 1930.*

✦

The use of discharge tubes in electric circuits

[RICHARD RUEDY.] This paper discusses first the voltage-current curve of a typical glow discharge through gas at a low pressure. The greater part of the article then describes the many types of devices that have been developed to utilize the characteristics of this curve. These are discussed as follows:

1. The use of such tubes as voltage reducers, voltage regulators, and rectifiers.
2. Mathematical analysis of gas-incandescent cathode rectifiers.
3. The use of discharge tubes as relays.
4. Their use and analysis as glow tube buzzers in self-interrupting circuits.
5. The uses of gas-filled photoelectric tubes, particularly in the measurement of very small illuminations.
6. The discharge tube as a light source for neon lights and talking pictures.

A table is included which gives the characteristics of both the older and the more recent types of gas-filled photoelectric tubes. Dr. Ruedy in this paper has given a valuable summary of some of the many uses of glow discharge tubes.—*Journal of the Franklin Institute, November, 1930.*

✦

Amplifying tubes with photoelectric emission

[VON ARDENNE] Such tubes, in which the cathodes emit electrons under the influence of light and not of heat as in the case of the normal tube, these electrons being attracted by an anode and the flow controlled by a grid in the usual way, can be used with high coupling resistances only (5 to 10 Megohms) on account of the high internal resistance. Audio frequency voltage amplifications of 10 to 30 per stage can thus be obtained.—*Z.f.Hf.T., Leipzig, October, 1930.*

✦

Compensated v.t. voltmeter with balanced bridge output

[W. G. HAYMAN] Due to its high input impedance the anode-bend type of rectifier is often preferred for use in measurements where the measured circuit must suffer a minimum disturbance. The question of the best output circuit to use brings up several interesting problems in regard to safety, sensitivity and stability. The author reviews the published literature in regard to this subject and then describes a "push-pull" or balanced bridge circuit in which one tube is used as a dummy to balance out the galvanometer current when the signal voltage is zero.—*Experimental Wireless, October, 1930.*

✦

New giant loud-speaker

[NEUMANN.] Details of the new type in which a very great increase of sensitivity has been attained, chiefly by the increase of the magnetic field to 20,000 gauss, this having been made possible by a new arrangement of the coils relative to the poles and by improved materials. Loads up to 800 watts can be handled and approximately 25% is radiated as sound energy, giving easily-understandable speech at 500 meters distance.—*Siemens Zeitschrift, Berlin, October, 1930.*

Modern receivers

[Lz] Continuation of the ser scriptions of modern German cial products (see previous The Schaub, Owin and Pollux described, with photographs ar diagrams. All are fully electr have one screen-grid radio-f tube regenerative detector, resistance-capacity coupled a quency stages. Prices range f to $90 approximately.—*Radio Leipzig, November, 1930.*

✦

On the operation of externally-controlled tu

[VON ARDENNE.] Interesting r ments on the new flat Telefunk with external "grid" (these previous months). In the case high-vacuum tube, the effective ity between the active part of ternal element and the space-ch the glass within is of the o 1 micromicrofarad, bridged by ance (the leakage-resistance glass) of about 10,000 megohm "gas" in the soft type of the mercury vapor. Curves of the "grid volts—anode current" typ obtainable in the normal manner got by the use of the oscillogra from these the amplification fac about 25) and plate resistance 400,000 ohms) were calculated actual voltage amplification coupling resistance of 1 to 3 m is about 20, and with 70,000 about 15. Very little distorti curred with "grid" voltages of practically none with 1 volt. pacity between anode and cathod 3 to 4 micromicrofarads, betwee element and anode or cathode 6 to 7 micromicrofarads. Micro effects are relatively small. D ments are suggested: firstly direction of increased amplif factor by a reduction in the size anode; and secondly by the us second grid around the anode tween anode and cathode (corre ing to the screen-grid tube).—*Berlin, October 3, 1930.*

✦

The multistage valve am

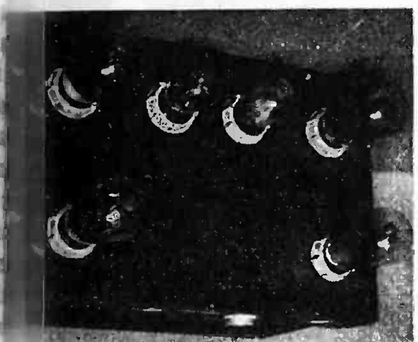
[A. C. BARTLETT] The autho siders the multistage amplifier fr point of view of recurrent netwo commonly applied to transmissio The effective voltage in the pla cuit of the tube is replaced by stant current generator $G_m V_g$ G_m is the mutual conductance the input voltage. The ratio of voltage to input voltage, and ratios, are obtained in terms of perbolic functions of the circuit meters.—*Philosophical Magazine ber, 1930.*

+ NEW PRODUCTS

THE MANUFACTURERS OFFER

ier unit for table mounting

IFIER DESIGNED for operation volt 60 cycle a.c. has been ut by Ferranti, Inc., 130 West New York City. The unit 10del 250 D-3 Amplifier, is for table use. It can also be for 245 tubes and for rack This amplifier has a gain and the manufacturers claim m response within 2½ db. o 8,000 cycles. The principal



stics of this unit are: three transformer coupling; an out- watts; low operating tempera- type transformers and chokes erolytic condensers, eliminating ns; input and output im- as desired; and low hum reedom from distortion and reproduction over a wide range and music is claimed.—*Elec- December, 1930.*

+

ic automobile speaker

D ESPECIALLY FOR operating with le radio sets, is the Junior 10-B speaker, announced by the adio Products Company, 1737 lichigan Ave., Chicago, Ill. It of a No. 510 six-volt battery amic unit, built into an oxidized ame mounted in an octagon x 8½" wide and 4½" thick. The etal grille is silk lined, making aker dust-proof. The octagon nd compact size permits instal- a very limited space. It is sup- th convenient mounting brackets 5-foot cord. Operating current , one ampere. List price, $12. Carter Radio Company, which is ion of Utah Radio Products y, at the same address, has re- nnounced a 1931 catalog cover- lio components, copy of which obtained by writing to the com- direct. — *Electronics, December,*

A 110-volt vacuum tube

DESIGNED TO OPERATE from the 110-volt lighting circuit, either direct or alternating current, a tube developed by the Lestein Corporation of America, 26 W. 17th St., New York City, has been announced. This tube is of the heater type and because of the excellent filament emission has a very high mutual conductance. Contrasted with a 112-type of tube, which it is designed to replace, the "Lestron" 110-volt tube has a mutual conductance of over 2,000 micromhos compared to 1,600 for the 112-type under the same conditions, i.e., 135 volts on the plate and 9 on the grid. The manufacturers expect a life of 3,000 hours, the tungsten filament operating at the comparatively low temperature of 1400° C. — *Electronics, December, 1930.*

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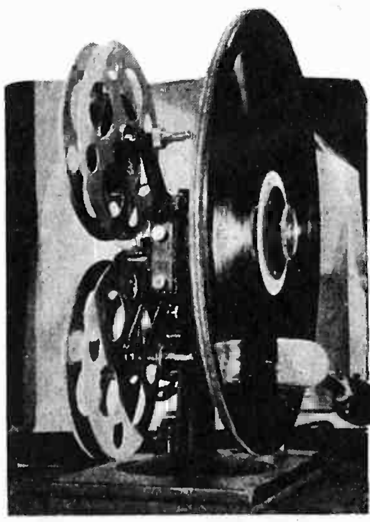
16 mm. sound movie equipment

FOR HOME, BUSINESS OR SCHOOL use, a new type of 16 mm. sound equipment has been announced by Victor Animatograph Corporation, Davenport, Iowa. This unit consists of the newly designed



Victor Model-5 Projector and No. 33 "Animatophone," assembled in one unit in which the turntable becomes an intimate part of the projector mechanism to insure perfect synchromism. A new feature of the "Animatophone" is the vertical mounting of the record instead of the usual horizontal mounting. Two models of amplifier speakers are offered for use with the "Animatophone." Amplifiers and speakers are compactly assembled in a carrying case, the No. 245 being about the size of the projector case and the No. 250 about half again larger.—*Electronics, December, 1930.*

D.C. circuit tester.

COMBINED IN ONE UNIT, a compact, portable instrument, accurate within 2 per cent, is the Model 563 d.c. circuit tester announced by the Weston Electrical Instrument Corporation, Newark, N. J. It consists of a Weston Model 301 meter, 3¼ inch diameter having two resistance ranges — 5,000 and 50,000 ohms — mounted in a black Bakelite case. It contains a toggle switch for

range selection; a self-contained 1.5 volt flashlight cell; a leather strap carrying handle and a pair of 30-inch leads with test prods. This unit is particularly useful for checking resistance values and continuity of circuits during the process of manufacture and for service and installation work on many types of electrical apparatus such as: Telephone apparatus and circuits, radio transmitting and receiving sets, small electric motors, transformers, etc. List price, $21. — *Electronics, December, 1930.*

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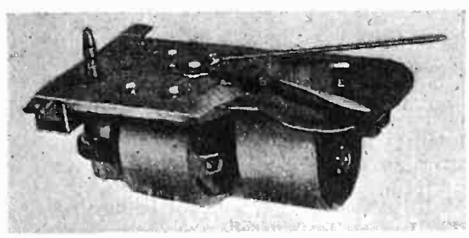
Phonograph turntable motor

MODEL "G" TURNTABLE MOTOR, as brought out by the L. S. Gordon Company, 1800 Montrose Ave., Chicago, Ill., is equipped with Spanish felt gears to



assure silence in operation. It is also equipped with automatic stop control. This equipment can be installed easily and the manufacturers claim a quick starting torque and long life. List price, $30.—*Electronics, December, 1930.*

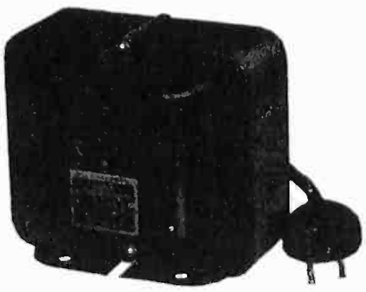
Lead-in-weld for tubes

THE AMERICAN ELECTRO METAL CORPORATION, 65 Madison Ave., New York City is introducing a new "Elmet" product a lead-in-weld for use in radio tube and incandescent lamps. An addition to their plant in Lewiston, Maine, has just been completed, where the newest type machinery for the manufacture of these welds has been installed. These welds are claimed to be of the highest obtainable quality. The American Electro Metal Corporation is prepared to serve the trade with these welds in the same efficient manner as with their well-established moly wire.—*Electronics, December, 1930.*

✦

Voltage compensator

A VOLTAGE COMPENSATOR which delivers regulated voltage to a.c. radio receivers and many other applications of vacuum tubes and relays, has been announced by the Sola Corporation, 2525 Clybourn Ave., Chicago, Ill. This compensator is designed to maintain the incoming line voltage within narrow limits and



it is claimed to lengthen the life of vacuum tubes, because of operation of the voltages within safety limits; protection of condensers from early breakdown, and elimination of trouble from the power compact. This unit has the following characteristics: capacity, 100 watts; input—95 to 135 volts—output 0.90 amperes at 110 volts. It is designed for operation on 60 cycles a.c. only, and weighs 7¼ lbs. This unit is also applicable to furnishing regulated voltage for film printing lamps, synchronous sound equipment, relay applications, and signalling devices. List price, $8.—*Electronics, December, 1930.*

✦

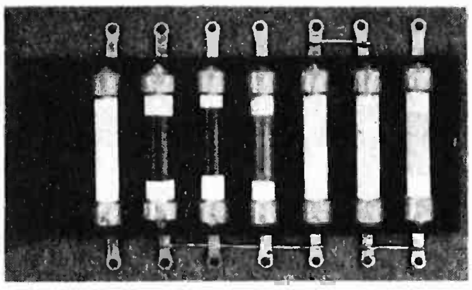
Photo-electric cell bulletin

AN INTERESTING BULLETIN describing the various types of photo-electric cells manufactured by the National Carbon Company, 30 East 42nd St., New York City, has been issued by this company. This bulletin gives a brief description of the types of vacuum and gas cells, and characteristic curves of the Eveready Raytheon Type Fotocells. It also gives an analysis of the photo-electric cell as a circuit element and suggestions regarding proper operation, when using these cells. Typical photo-electric cell circuits are shown to enable one to use these cells in different applications. —*Electronics, December, 1930.*

✦

Gang type metallized resistors

WHERE COMPACTNESS and simplicity are prime requisites, the gang type metallized resistor unit is particularly applicable. The International Resistance Company, 2006 Chestnut St., Philadelphia, Pa., has designed a new unit for small console or "mantelpiece" receivers. The unit comprises the necessary num-

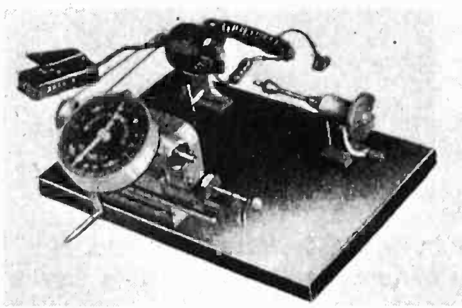


ber and values of standardized metallized resistors mounted on a strip by means of lead tips passing through holes in the strip and crimped on soldering lugs on the reverse side, making for ready wiring. The resistors may be supplied in practically any resistance value and in a wide range of current-handling capacities to meet the requirements of all types of receivers.—*Electronics, December, 1930.*

✦

Transformer winding machine

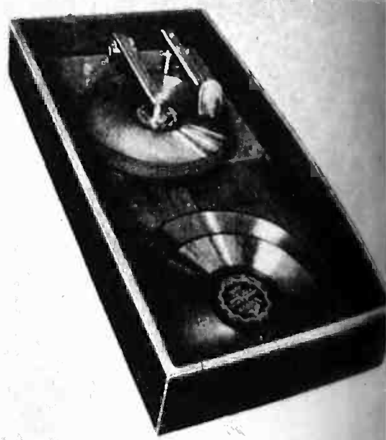
A SPACE WINDING MACHINE, designed primarily for winding radio frequency transformers, has recently been developed by the Meissner Manufacturing Company, 522 South Clinton St., Chicago, Ill. In the Model 30 machine, the turns of wire are accurately spaced by the spacing arm producing a uniform distributed capacity practically eliminat-



ing difficulty in matching. Various sizes of wire ranging from No. 20 to 38 inclusive can be wound and accurately spaced on this machine. The transverse mechanism, operating in any direction can be set to any desired length up to approximately six inches. The revolution counter combined with this mechanism permits operation at high speed and counts accurately from one to 10,000 turns. — *Electronics, December, 1930.*

Automatic record changing unit

AN INTERESTING AUTOMATIC re changing unit, has been announce the White Research Laboratories, 33rd and Arch Sts., Philadelphia, The standard production models be made in a Queen Anne wall for the jobbing trade and will co the automatic record unit, withou amplifier, equipped to be plugged the regular radio set. There will be a portable unit for installatio sound equipment, and a standard ch for the radio manufacturer to insta



combination sets. On this unit records are stacked in a pile on the table. It will hold up to 12 recor all makes. Ten and twelve inch re can be mixed in the pile and ha automatically by this machine. M are provided to prevent records slipping under the tone arm thu suring good reproduction.— *Electr December, 1930.*

✦

Screen-grid tube for midget sets

A SCREEN-GRID TUBE designed espe for midget sets, to provide as much age gain as possible, has been nounced by the DeForest Radio pany, Passaic, N. J. It is rep that this new type of tube has checked in a number of midget set it has been found that the sensitiv the average midget set can be do by using the new type tubes. Fo ample, if a set has a sensitivity microvolts per meter, with the screen-grid tubes, the sensitivity be increased to 10 microvolts per with the new type tubes. Althoug new type tubes were essentiall signed for use in midget sets, the interchangeable with the standa tubes and can be re-employed i of the present-day radio sets fo purpose of doubling the sensitivity DeForest Company is prepare supply the new type screen-grid known as 424 High Gain Audi the same price as the standard pr —*Electronics, December, 1930.*

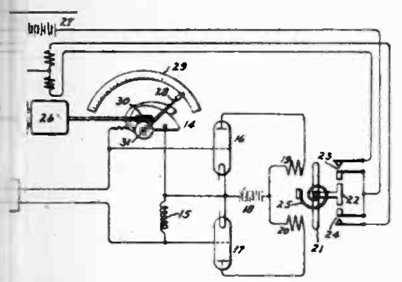
PATENTS

IN THE FIELD OF ELECTRONICS

A list of patents (up to Dec. 9) granted by the United States Patent Office, chosen by the editors of *Electronics* for their interest to workers in the fields of the radio, visio, audio and industrial applications of the vacuum tube

...tronics Applications

...cy meter. Across a device ...quency characteristic is to ...a coil and condenser in series. ...h of these reactances is the ... vacuum tube in whose plate ...the winding of a differential ...hen either the capacity or the ...c of the device changes, the ... relay operates to bring the ...k to normal. An indicator on ...le reactance indicates what ...s occurred in the circuit. W. ...nd R. Schimpf, Berlin, Ger- ...gned to G. E. Company. No. ...



...a control. Control of a block- ...ilway circuit by means of a ...ibe and corresponding relays. ...k and James Clark, assigned ...uous Train Control Corp., No. 1,780,416.

...ne conversation recorder. A ... connecting phonographic ap- ... a telephone line, so that com- ...as can be recorded. M. H. ... assigned to Bell Telephone ...ies, Inc. No. 1,780,919.

...or magnetized objects. A ...ibe method of locating faults ...ucture of a magnetized object. ...Chappuzeau and Otto Emers- ...l, Germany, assigned to Neu- ...uhnke. No. 1,782,462.

...current railway control. An ... tube makes and breaks the ...ent, opening automatic circuit ... a direct current railway. Ul- ...ss, Berlin, Germany. No. ...

...nic tone producer. A tube ...ral grids has attached to each ...it a tuned circuit. In the plate ... the tube is an inductance, so ...ral frequencies can be gen- ...Frank E. Miller of New York, ...o. 1,782,542.

...one recorder. A core and wind- ...gnetic and inductive relation to ...and winding of a telephone re- ...ks up the sound current, after ...ey are amplified by electronic ...d impressed on a record. M. J. ... assigned to Dictaphone Cor- ... No. 1,782,619.

Viscosimeter. A tube in which the liquid flows has wound about it inductances to the grid and plate circuit of two vacuum tubes. Variations in viscosity are indicated by the device. E. M. Symmes, assigned to Hercules Powder Co., Wilmington, Del. No. 1,780,952.

Explosion recorder. Apparatus using vacuum tubes to record the time of arrival of mechanical vibrations, involves translating these vibrations into electrical impulses, combining them with other impulses of higher frequencies, and recording the resultant combination. Frank Rieber, San Francisco, Calif. No. 1,780,567.

Frequency regulating system. An oscillation generator has coupled to it a constant frequency heterodyne which produces a beat frequency. This beat frequency is rectified and is used to maintain a constant relationship between the heterodyne frequency and the generator frequency. Henri Chireix, Paris, France. No. 1,782,807.

Sound receiver. A method in which the dielectric constant varies with certain vapors which in turn are varied by sound waves. A. B. Peterson, Fredericksburg, Denmark. No. 1,783,138.

Sound reproducing apparatus. Transformer connects a loud speaker to a vacuum tube amplifier. A second loud speaker is connected to the amplifier between the amplifier and the mentioned transformer. A. T. Bradshaw and M. J. DeForest, assigned to United Research Corporation, Long Island City, N. Y. No. 1,780,899.

Railway traffic control. An a.c. current is put on the track of a railway. Coupled to the tracks is a vacuum tube circuit so that the current flowing in one track neutralizes the current of the vacuum tube device induced from the other track. E. W. Bauman, assigned to Union Switch & Signal Co. No. 1,780,737.

Electrical testing system. Determining the relative values of two waves by comparing one with the magnitude of a given wave, and comparing the other with a given wave having a magnitude bearing a known relation to the first wave. A null method is used. Edmond Bruce, assigned to Bell Telephone Laboratories, Inc. No. 1,781,363.

Communication

Telegraph signal receiver. Stray frequency currents and dot frequency currents are filtered out from the incoming signal current. The remainder of the incoming signal is combined with a locally-generated signal of dot frequency and predetermined shape, whose frequency depends upon the dot frequency of the incoming signal. August Jipp, Berlin, assigned to Siemens & Halske. No. 1,782,524.

Radio amplifier. Tuned radio-frequency amplifier in which the effective input impedance of each coupling transformer at resonance is so adjusted that the ultimate amplification of all stages is substantially constant. W. A. MacDonald, assigned to Hazeltine Corp. No. 1,781,759.

Radio receiver. A method of trapping an induced charge upon one of the electrodes of an electron device. Oscillations to be detected and amplified are conveyed through the electrode having this induced charge. M. J. Rittenhouse and O. V. Maurer, Cleveland, Ohio. No. 1,781,861.

Radio-frequency amplifier. An amplifier known to radio engineers as the "Loftin White Circuit" in which the response of the amplifier can be pre-determined and adjusted to any desired characteristics whether flat over a frequency range or otherwise. F. W. White, assigned to RCA. No. 1,780,611.

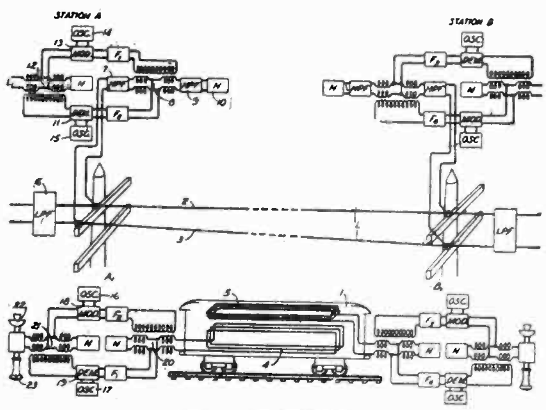
Current regenerative radio circuit. Tuned radio frequency stage in which an impedance is in series with the low potential end of the input tuned circuit and the filament of the tube. Octavius Knight, Westfield, N. J. No. 1,782,993.

Carrier current communication. A system of communication whereby stations on different lines, although operating at different frequencies, can be interconnected. F. W. Frink, assigned to G. E. Company. No. 1,783,037.

Radio-frequency amplifier. Combination of an antenna and a loop to the input of a radio frequency amplifier. H. H. Snow and W. T. Loughlin, assigned to Radio Frequency Laboratories, Inc. No. 1,780,987.

Radio transmitter. A means of coupling one oscillator to another by radiation from an antenna system. W. M. Brower, assigned to Federal Telegraph Co. No. 1,780,167.

Train communication system. A system of communicating by modulated high frequency signals between a mobile body and a fixed station, and a method of changing the transfer efficiency between the transmitter and the moving body, to provide a substantially constant transmission equivalent. J. W. Horton, assigned to Bell Telephone Laboratories, Inc. No. 1,780,921.



Signal control system. Two oscillatory circuits tuned to different frequencies. G. W. Cattell, assigned to Federal Telegraph Co. No. 1,779,585.

Untuned radio system. An untuned detection circuit and means whereby the effect of variable tuning is obtained by positively-controlled generation. L. W. Chubb, assigned to Westinghouse E. & M. Co. No. 1,781,268.

[*Continued on page 450*]

PATENTS—

[*Continued from page 445*]

Electronic Apparatus

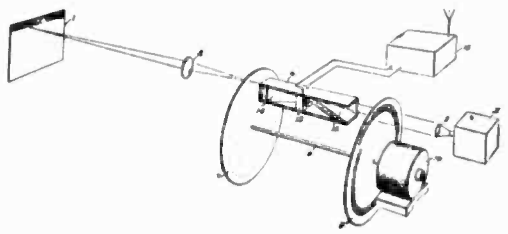
Oscillograph. A cathode ray oscillograph. Otto Ackerman, assigned to Westinghouse E. & M. Co. No. 1,779,794.

Rectifier. A full wave rectifier of the type having a large anode surface and small cathode surfaces. Jacques Risler, Paris, assigned to Risler Corp. of America, Kansas City, Mo. No. 1,780,504.

Vacuum tube. Apparently a tube in which the grid is replaced by a coil of wire wound on magnetic material. E. E. Blackman, assigned to Cleveland Redfield, Ogden, Utah. No. 1,780,698.

Television

A television transmitting system, including a Kerr cell, etc. E. F. W. Alexanderson and Ray D. Kell, assigned to G. E. Co. No. 1,783,031.

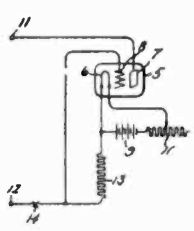


Generation, Detection, Etc.

Oscillation generator. A Piezo-electric device capable of vibrating simultaneously in several modes at different frequencies. E. I. Green, assigned to A. T. & T. Co. No. 1,780,229.

Double-wave rectifier. A system employing two vacuum tubes for rectifying a.c. C. B. Bartley and V. H. Dake, Pittsburgh, Pa. No. 1,782,228.

Linear detector. A resistance is inserted in the cathode lead to which the grid is attached, so that the volt-ampere rectifier characteristic of the device is substantially rectilinear. G. E. Spitzer, assigned to G. E. Company. No. 1,783,059.



Piezo oscillator. A means for manually adjusting the air gap between one conductive plate and the surface of the piezo crystals, as well as a means for indicating the distance between them. Russell F. Ohl, assigned to A. T. & T. Co. No. 1,783,130.

Piezo crystal device. Method of indicating intensity of high frequency oscillations by reflecting light upon mirror near piezo crystal. Vibrations of quartz cause movements of mirror when the light is reflected upon a screen. Alexander Meissner, assigned to Gesellschaft für Drahtlose Telegraphie, Berlin, Germany. No. 1,783,297.