electronics

electron tubes—their radio, audio, visio and industrial applications

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

Rockefeller Radio City

A $250,000,000 temple of the electronic arts

Tone control methods

Vacuum-tube dimmers

Photo-cells in industry

Recording sound pictures

Color sensitivity in cells

Facsimile transmission

Television requirements

Photo-cell characteristics

A McGRAW-HILL PUBLICATION

AUGUST 1930

electronics

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Contents for August, 1930

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A McGRAW-HILL PUBLICATION

New York, August, 1930

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The march of the electronic arts

...co engineers at Toronto ...ust 18-21

...Fifth Annual, and First Inter...al, I.R.E. Convention will be held ...ronto, Canada, August 18-21, 1930. ...ngineering Division of the Radio ...facturers Association will hold ...technical meetings with the In... of Radio Engineers during this ...ation.

MONDAY, AUGUST 18

...ches of welcome by President Lee ...est; J. M. Leslie, chairman, Toronto ...n and A. M. Patience, chairman, ...ation Committee.

...nical Papers: Some Developments ...oadcasting Transmitters, by I. J. ...General Electric Co., and C. J. Burn... Westinghouse Electric & Manufac... Co.; Design and Acoustics of Broad... Studios, by O. B. Hanson, National ...casting Company; Polyphase Recti... Special Connections, by R. W. ...rong, Westinghouse Electric & Man...ring Company.

TUESDAY, AUGUST 19

...A Photophone System of Sound ...ding and Reproduction for Sound ...n Pictures, by Alfred N. Goldsmith, ... Corporation of America, and M. C. ..., RCA Photophone, Inc.; Efficiency ...ud Speakers, by A. Ringle, RCA... Company; Low-Frequency Radio ...mission, by G. W. Kendrick, R. A. de ... Tufts College, and G. W. Pickard, ...ess Specialty Apparatus Company; ...ivity, a Simplified Mathematical ...ment with Oscillographic Demonstra... B. deF. Bayly, B.A.S.C. University ...oronto; Functional and Structural ...tion of the Vacuum Tube, by Keith ...ey, associate editor, *Electronics*, ...aw-Hill Publishing Company; The ...er Pol Four-Electrode Tube Relaxa... Oscillation Circuit, by R. M. Page and ... Curtis, Naval Research Laboratory; ...tive Antennas, by G. C. Southworth, ...ican Tel. & Tel. Co.; Aviation Com...cation, by J. S. Richardson, Northern ...ric Company; A New Frequency ...lized Oscillator System, by Ross ..., Naval Research Laboratory; A ...ue Aircraft Transmitter, by M. H. ...enk, Naval Research Laboratory; Aircraft Power Supply, by J. D. Miner, Westinghouse Elec. & Mfg. Co.; Radio Electric Clock System, by H. C. Roters and H. L. Paulding, Stevens Institute of Technology.

8:00 p.m.—Symposium on International Communication: Radio Communication Service of the British Post Office, by Lt. Colonel A. G. Lee, General Post Office; Overseas Radio Extensions of Wire Telephone Networks, by Lloyd Espenschied, Amer. Tel. & Tel. Co., and W. Wilson, Bell Tel. Labs.; The RCA World-Wide Radio Network, by A. A. Isbell, RCA Communications, Inc.; Advances in Transatlantic Cable Technique, by Hobart Mason, Western Union Telegraph Co.; The Role of Radio in the Growth of International Communication, by H. H. Buttner, International Tel. & Tel. Co.

✦

MARCHESE MARCONI

who will address the IRE convention in Toronto, Canada, on August 20, from his yacht "Electra" in the Mediterranean

WEDNESDAY, AUGUST 20

Joint meeting with the Engineering Division of the Radio Manufacturers Association. The Practical and Commercial Aspects of Sensitivity and Selectivity of Radio Receivers, by W. F. Loughlin, Radio Frequency Laboratories; Design and Theory and Tuned Radio-Frequency Coupling Networks, by W. A. MacDonald and H. A. Wheeler, Hazeltine Service Corp.; Variation of Inductance of Coils Due to the Magnetic Shielding Effect of Eddy Currents in Their Cores, by K. L. Scott, Western Electric Co.

✦

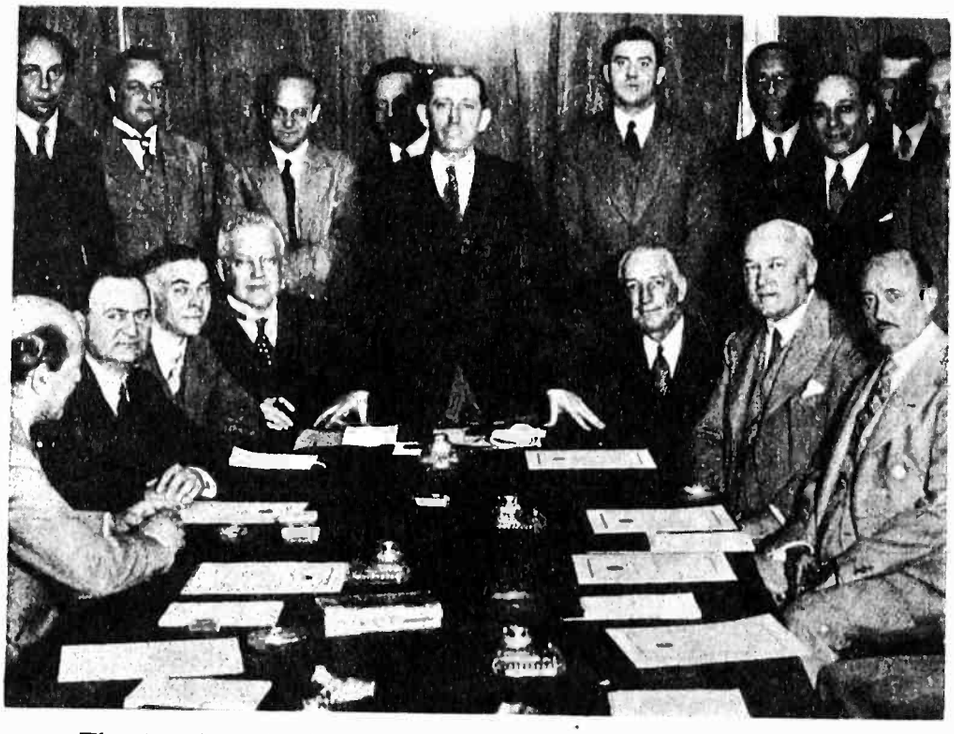
Paris sound picture conference reaches agreement

In a joint statement issued July 22, by the German and American representatives to the Sound Picture Conference meeting in Paris, an agreement has been signed, providing exchange of patent rights throughout the world.

Arrangements agreed upon make it possible for producers of all countries to obtain licenses to produce pictures in all countries, under both German and American patents. It further provides for interchangeability of pictures in all countries.

Complete interchange of patent rights and technical information was also agreed upon, to the end that apparatus incorporating the best German and American ideas may be available for installation in all countries. Under these arrangements, sound picture apparatus required in the following countries is to be made in German factories: Germany, including Danzig, Saar, Memel, Austria Hungary, Switzerland, Czechoslovakia, Holland, the Dutch East Indies, Denmark, Sweden, Norway, Finland, Jugoslavia, Rumania and Bulgaria. Apparatus required in the following countries to be made in American factories: United States, territories and possessions, Canada, Newfoundland, Australia, New Zealand, Straits Settlement, India and Russia.

SOUND PICTURE CONFERENCE IN PARIS



The Americans in the group are: Will H. Hays, chairman, John E. Otterson, J. C. Graham, Harold Smith, Ike Blumenthal, E. S. Gregg, Douglas Miller and Earle Bright. An account of the final agreement reached appears on page 215

✦ ✦ ✦

Broadcasting stations seek high power

With KOA of Denver, KFL of Salt Lake City, and KFRC of San Francisco, slated as the next additions of broadcasting stations applying for the maximum allowable power of 50,000 watts, there are only 13 stations that are left on the cleared channels, which have not applied or have not indicated their intention to apply for further power.

Some of these, however, are expected to join the rush for higher power before autumn. Eight stations now have maximum power; seven have been authorized to build to 50,000 watts, and 25 applications for 50,000 watts are pending or about to be submitted.

✦

45 nations ratify world radio agreement

The Department of State has announced that 45 countries have proclaimed their adherence to the treaty drawn up as a result of the International Radiotelegraph Convention held in Washington in 1927, at which some 80 countries were represented.

The International Radiotelegraph Convention regulates the international use of radio, setting aside the wavelengths that can be used for various types of service, and otherwise prescribing international usages. The conference which brought about this treaty was held in Washington, and was presided over by Herbert Hoover, who was chairman of the American delegation.

Another such conference is slated to be held in Madrid in 1932. By that time, it is expected that the legislatures of all the signatory nations will have ratified the action of their delegation to the Washington Conference. Meanwhile, the ratifications of Latin-American countries are notably lacking, only Mexico, Chile and Venezuela having deposited theirs.

Photo cells in steel mills

In a discussion on electron devic ing the convention of the Asso of Iron & Steel Engineers at last month, W. H. Burr, electri gineer, Lukens Steel Company, ville, Pa., reported:

"There has been an acceleratio ing the year of the installation of electric cells for use as flag sw In addition, the successful operat the photo-electric cell has created applications, such as direct and r ing temperature indicators to r the present pyrometers, counte sheets, tubes, billets and ingots prevention, etc. The field of appli for this little device is spreading r and the demand for photo-electric in steel mills in the next few will be greatly increased. The e of this apparatus lends itself to tically any application whether designed to automatize a mech operation or adjust an operating dition to obtain increased produc

✦

Radio Week—Sept. 22-2

The date of National Radio has been set to coincide with the of the Radio World's Fair in New City, September 22-27. It will be brated throughout the radio ind by manufacturers, dealers, jobbers broadcasting stations, with special grams and sales promotion campa

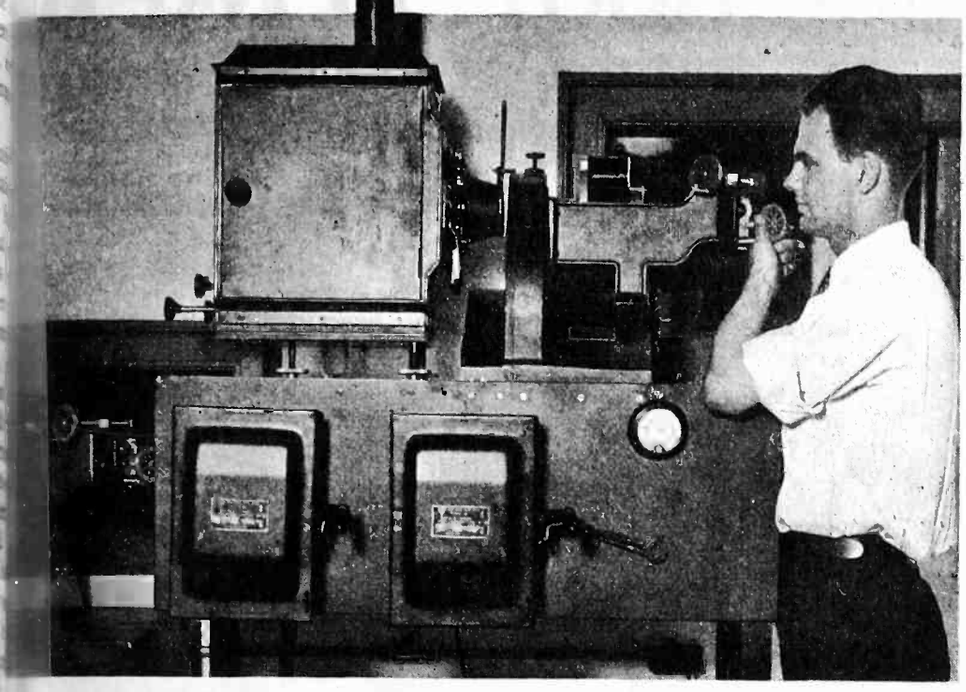
J. N. Blackman of New Yo chairman of the committee for the ers and jobbers group, and He H. Frost of New York is chairm the committee for the Radio Man turers' Association.

✦ ✦ ✦

"ELECTRICAL EYE" FOR GLASS INDUSTRY

The above device, designed by Dr. A. L. D'Adrian uses a photo-electric cell for determining weak spots in glass construction. Prisms employed indicate the amount of strain in glass vessels under test

TELEVISION STUDIO OPENS IN CHICAGO



The Chicago Daily News television studio, operating on 107 meters (2,800 c.) and 1,000 watts opens for regular programs transmitting sound over station WMAQ with pictures from this station

✦ ✦ ✦

working on pentode lems

uctive steps in the development plication of pentodes and other dio tubes, are being taken by the Manufacturers Association.

oer M. Wise, of Emporium, Pa., irman of the recently appointed Joint Committee on new tubes. mership of this committee includes s. R. F. Burnap, Allen DuMont, Perryman, N. O. Williams, Lewis, J. D. Cook, L. F. Curtis, Dickey, J. F. Dreyer, Jr., W. H. itch, and R. H. Langley. As a of the first meeting of this com- held recently in New York, l of the tube manufacturers will up experimental pentodes for the ers of the receiver manufacturers k with in laboratories with a view anging results at a later meeting. ter E. Holland, director of the ering division of the RMA, in a ent expressed the purpose of a oint committee: "In connection he introduction of any new type dio tube, there has always been a m in regard to the best design teristics. If the characteristics t by the tube manufacturers, they kely to be determined from the oint of production chiefly. If the er manufacturer sets the charac- cs, they are likely to be determined the standpoint of use, and may be cticable from a production stand-

The new joint committee on new consisting of an equal number of nd receiver engineers, was created a view to meeting this situation."

Judge Morris hands down decision on sound film patents

In a decision handed down June 30, Judge Morris of the United States District Court, for the District of Delaware, declared that the Ries patent covering the method of reproducing phonographic sound records is valid, and infringed by the Stanley Company of America, a licensee of Western Electric.

The patent involved is shown in another view (U. S. No. 1,607,480, dated November 16, 1926). This is the patent originally applied for in May, 1913, by Elias Ries, and later sold to Dr. Lee DeForest, who renewed the patent application in April, 1923. In 1926, patent rights were issued to DeForest Phonofilm and later acquired by General Talking Pictures. The latter company brought suit against the Stanley Company of America, a licensee of Western Electric, claiming that the Western Electric method of sound reproduction infringed on the Ries patent.

Western Electric has appealed the case to the United States Court of Appeals at Philadelphia, and expects a decision before December. Western Electric's view, as expressed by J. J. Lyng, vice-president of Electrical Research Products, Inc., a W.E. subsidiary, is that the Ries patent is invalid and that Western Electric apparatus does not infringe upon it; but that if it should be eventually held that the Ries patent is valid and infringed, its use is in no way essential to the operation of the Western Electric sound system.

In the opposing camp, M. A. Schlesinger, president of General Talking Pictures, holds that the Ries patent is basic and all-important; that the success of sound-on-film was only made possible through this invention; that this patent involves the use of sound-on-film reproducing apparatus whereby the light area on the film is limited by a slit; whether such slit is located in the optical system of whether it is in the slit block.

One leading authority has expressed the opinion that the final decision in this case will result in one of two possible developments. If the Ries patent is upheld, it will mean that General Talking Pictures' prominence in this field will be greatly enhanced, while if this patent is not upheld, it will mean that this important part of sound reproducing equipment will be open to the field.

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Around the world in an eighth of a second

In a recent test conducted by the General Electric Company, from Station W2XAD, Schenectady, New York, in collaboration with Philip's Radio of Holland, and the Amalgamated Wireless Company, Ltd. of Australia, Mr. C. G. Wagner's voice circumnavigated the world in a fraction of a second, establishing two records—the first round-the-world broadcast, and the longest re-recorded broadcast.

The voice of Mr. Wagner left Schenectady on W2XAD on 19.58 meters, was received in Huizen, Holland, where it was a re-broadcast or relayed by PHI on 16.88 meters, received by PLW at Bandoeng, Java, and re-transmitted on 36.5 meters to Sydney, where the engineers, using 2ME, operating on 28.5 meters, sent it on to Schenectady. Mr. Wagner was thus enabled to talk to himself. His voice came back as an echo, each syllable repeating itself an eighth of a second later, the returning words being easily understood. A phonograph record, electrically reproduced, was also sent via W2XAD over the round-the-world circuit, and reproduced on its return.

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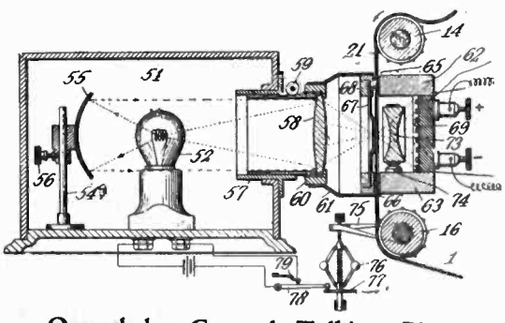
RIES SOUND-PICTURE PATENT



Owned by General Talking Pictures and which Judge Morris ruled was infringed by Western Electric Apparatus

A $250,000,000 "TEMPL

Vast buildings for radio broadcasting, sound pict in New York City by John D. Rockefeller

FOUNDATIONED on the newly developed applications of the "electronic cousins"—the thermionic tube and the photo-electric cell—there will be erected on three city blocks in New York City a great group of theaters and studios devoted to radio broadcasting, sound pictures, television, electronic music, and other developments of electronics in public entertainment and education.

This huge undertaking, being erected by the John D. Rockefeller, Jr., interests, in cooperation with the Radio Corporation and National Broadcasting groups, is expected to be ready for occupancy by autumn, 1933.

Prominent in the discussions which led to the formulation of the present magnificent plans, were Owen D. Young, chairman of the board of the General Electric Company, David Sarnoff, president of the Radio Corporation of America, M. H. Aylesworth, president of the National Broadcasting Company, and "Roxy," Samuel L. Rothapfel, the motion-picture theater manager. Todd, Robertson & Todd are the engineers, and Reinhart & Hofmeister are the architects for the entire group.

In a statement issued in connection with the plans for the Rockefeller Radio City, Mr. Sarnoff said:

"The public service which the new arts envisioned in the era of electrical entertainment can render, it is becoming increasingly clear, will depend more and more upon the liaison they are able to maintain with the entertainment and educational arts. Technical development must go side by side with artistic development. Both are vitally necessary to each other. Research and technical progress in the communication arts would be largely vitiated if the artistic output carried did not keep pace with the needs of advancing intellectual progress.

"On the other hand, the entertainment and educational arts can only find their greatest expression through the vast which the modern facilities of communication provide artist and the educator. The more intimate relationship the radio on one hand, and the stage, the screen, the conc or the rostrum upon the other, the greater the progress expect in the entertainment and educational arts."

Commenting on the proposal to bring televisic picture recording into the studio plans, Mr. Ayles said:

"Television, it is true, is still largely in the toddling sta the vast possibilities of sight added to sound in natic broadcasting cannot be ignored in planning for the futur are building our new studios, therefore, for tomorrow, as for today.

"Radio broadcasting has become the recognized means syndication of entertainment, education and information nation-wide scale. It has far from exhausted all the s that might be rendered through the medium of sound; have vastly greater opportunities when television emerge the laboratory to give radio the new dimension of sight technical and artistic experience which the National Broad Company has gained in years of operation will be embo the 27 new broadcasting studios to be completed within t two or three years. Some of these studios, to be two o stories in height, will be concert halls in effect. In a however, every one of the four great theaters will be e for broadcasting service.

"All the theaters, in effect, will be broadcasting studi will be equipped for the broadcasting of sound, and eve when technical progress has made sufficient headway, broadcasting of sight directly from the stage.

"Ten of the twenty-seven broadcasting studios will be d for photography and recording. The broadcasting buildi be constructed so that radio fans may have the opportu see the artists at work.

"Thus, with the entertainment and cultural project n nounced, broadcasting will have at its call new reserv dramatic, musical and entertainment service."

▼ ▼ ▼

MR. ROCKEFELLER'S CONTRIBUTION TO THE ARTS OF THE ELECTRONIC TUBE AND THE PHOTO-CELL

Cost of site and buildings—$250,000,000.

Twenty-seven studios for broadcasting, television, etc.

Ten studios equipped for sound-picture photography and recording.

A great symphony hall for orchestral and electronic-instrument concerts.

Four great theatres, devoted respectively to vaudeville, sound pictures, musical comedy and drama.

Between office buildings, a magnificent garden plaza.

Surmounting the whole development—a tower building 60 stories high, containing offices and studios.

Buildings ready for occupancy—Fall, 1933.

OF ELECTRONICS"

ision, and electronic music, to be erected
o-operation with the RCA-NBC group

E THREE CITY BLOCKS NOW BEING RAZED FOR THE ROCKEFELLER RADIO CITY

ing of the old structures is already under way, and the uildings will soon be started. The Fifth Avenue front nclude a huge oval building of great grace and beauty of . The other fronts will be made up of great office building groups, well set back, connected by lofty galleries, and under run by automobile traffic arteries, parking places, etc. A 60-story tower, containing executive offices, studios, and broadcasting equipment, will surmount the whole group

Color sensitiveness of photo-electric cells

By WENDELL F. HESS, D. Eng.*

IN ORDER to secure a proper perspective of the place which color sensitiveness occupies in relation to other characteristics of photo-electric cells, a brief discussion of applications and cell characteristics will precede the detailed discussion of color sensitiveness of various cells.

While the uses to which photo-electric cells can be put are too numerous to mention, they fall into three general classifications.

1. The control of a process or the indication of an event or condition.
2. The quantitative translation of variations of light intensity into corresponding variations of current in an electric circuit.
3. The replacement of the human eye in the evaluation of light intensities.

The applications of cells in the first classification almost all reduce to a variation in the amount of light falling on a cell causing a relay to operate and perform the desired operation or give the desired indication. This has been adapted to the control of oven temperatures, depending on the color of the culinary product which is passing continuously through the oven. This use depends merely on the cutting off of the light from some source, usually either an incandescent lamp or daylight. Others require that the cell be sensitive to reflected or transmitted light of a predominant color. In the first case, the maximum sensitiveness is essential; in the latter case, a knowledge of the color sensitiveness is necessary to pick the cell best suited to the requirements.

The second classification includes perhaps the most popular recent applications of photo-electric cells, namely television, picture transmission and the talking motion picture. It also includes graphic daylight recor Color sensitiveness is ordinarily of minor importan application of this class.

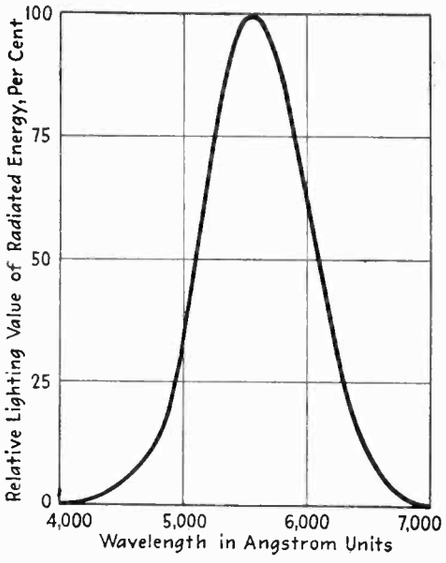


Fig. 1—Sen curve of eye

Color photometry

The strictest requirements as to color sensitivenes met with in the third class which includes the photon of lamps of different quality. The testing of batches of incandescent lamps for uniformity by m of a photo-electric cell and sphere belongs in the classification. Here the cell is used only to detect s variations in an automatically manufactured pro In color photometry the ultimate judge of light is the human eye. Consequently if a cell is to re the eye its relative sensitiveness to light of diffe colors must be the same as that of the eye. The sensitiveness has been measured by a number of inv gators and is known as the "visibility curve", re duced in Fig. 1[1]. This curve represents the ideal c sensitiveness curve for cells to be used in this work. commercial cell is available with a characteristic of kind, although the caesium cells measured by Seilers[2] show a close resemblance. The cells use her investigation had a fairly thick layer of alkali m in the sensitive coating. In this condition the cae cells are not sufficiently stable to give good comme service. The only way at the present time to dupli the eye sensitiveness is to take a cell with a fair por of its sensitiveness in the middle of the visible spect where the eye is most sensitive, and cut its sensitive down to the proper shape by means of color filter difficult process.

Desirable cell characteristics

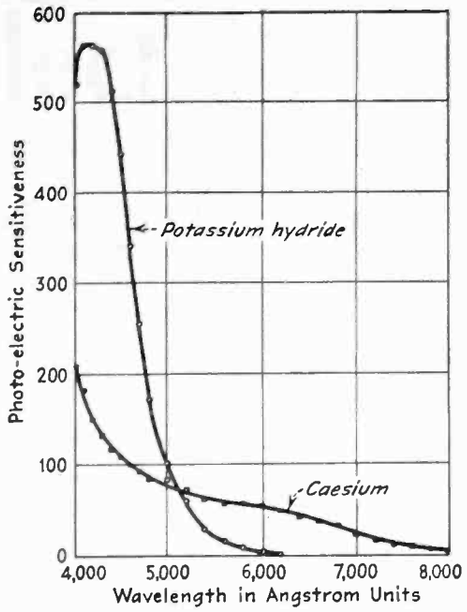
The characteristics of cells may be outlined as follo

1. Sensitivity.
2. Speed of response.
3. Linearity of response.
4. Reproducibility of cells.
5. Color sensitiveness.

Any one or several of the above characteristics may termine the choice of cell.

Sensitivity. This is obviously desirable when remembered that the currents from the best cells a small number of micro-amperes. Gas-filled cells replaced the vacuum type for most purposes bec of their greater sensitivity. Under the usual opera conditions a gas-filled cell will give from five to times the response of a vacuum cell.

*Dept. of Electrical Engineering and Physics, Rensselaer Polytechnic Institute.



—Sensitivity
es of two
of photo
cells

h larger cells used in television are not inherently
sensitive, their advantage being in the larger area
esitive surface exposed to the light. If the light
n form that will illuminate just as much surface
nall cell as in a large one; for example, if it is a
of small enough diameter to pass through the win-
a small cell, then there would be no advantage in
a large one. In television it is desired to collect
ch as possible of the light which is diffusely re-
from the small scanning spot on the subject.
three or four large cells are required to collect
of the very small amount of light available to
rrents which can be handled even by amplifiers.
laylight recorders it is possible to use a sufficiently
ell to directly operate a graphic recording instru-
Enclosing the cell in quartz in place of the usual
ulb only increases the senstivity in so far as it is
r transmitter of ultra-violet light. Consequently
no value with the ordinary incandescent lamp as
e. It does find use in cells for testing therapeutic
and glasses.

d of Response. It is this characteristic of photo-
cells which makes them superior to light-sensitive
-of-resistance cells, such as selenium, for tele-
and similar applications where it is essential for
l to follow very rapid fluctuations.

arity of Response. This means the degree of
ctionality which exists between the cell currents
e impressed illumination. Strictly linear response
iations in light intensity is most necessary in pho-
y and those applications of the second classifica-
here quantitative translation of variations is de-
although it is important in other applications, such
asurements of transmission. Most of the high
commercial cells are perfectly satisfactory in this
t.

roducibility of Cells. By this is signified the pos-
of getting another cell having the same char-
tics as one purchased at some previous date. This
be of considerable importance in applications
it was necessary to purchase special filters for a
of apparatus the operation of which was dependent
definite color sensitiveness. The matter of getting
r cell has always been considered a serious handi-
o the development of certain kinds of apparatus
photocells. With this idea in mind tests were made by the author, of six caesium cells selected at random from the stock of the General Electric Research Laboratory, to determine the uniformity of the color sensitiveness characteristic for cells of the same type and manufacture. It was known at the start, from curves supplied with the cells, that the overall sensitiveness to the light of a Mazda lamp was different, varying under similar conditions from four to six microamperes. If the shapes of the color curves are sufficiently identical, a variation of the kind mentioned above is not a serious disadvantage, since it can usually be taken care of in the circuit in which the cell is used, as for example by a slight change in cell voltage. Analysis of the data from these curves shows that, by multiplying each curve by the proper factor, the curves may be made practically coincident between 4,200 and 6,400 Angströms. For most purposes this result is sufficient and, by comparison with curves for cells made not so many years ago, indicates that considerable progress has been made in the construction of cells.

Color Sensitiveness. The above consideration of the uses to which cells may be put and of the various factors which may affect the choice of cell in a particular case, has served to indicate in a general way the circumstances under which the consideration of color sensitiveness may be important. After studying cells of the different alkali metals, the opportunity was presented the author of studying various types of caesium cells, caesium being the most red sensitive of the alkali metals, and thus the most versatile of the photo-electric cells. It was through the kindness of Dr. L. R. Koller of the Research Laboratory of the General Electric Company that most of the cells were made available.

Potassium hydride cell

Figure 2 shows perhaps the most common type of cell in use, the potassium hydride cell. Along with it, for the sake of comparison, is plotted one of the thin film caesium cells. The comparison is somewhat unfair to the caesium cell because, while the potassium cell is a good example of its type, the caesium cell is somewhat less sensitive than the average cells of this kind. This was found out later when six caesium cells of the same type as the one here used, were selected and their total sensitiveness compared with this cell. However, the shapes of the two curves are very typical. This pair of curves is valuable in deciding on the choice of cell for particular requirements, showing as it does the kinds of light for which each type of cell excels the other. For example, the area under the caesium curve, or

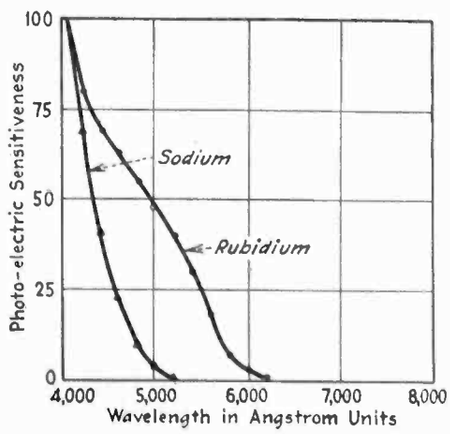


Fig. 3—Burt sodium cell; rubidium vacuum type cell

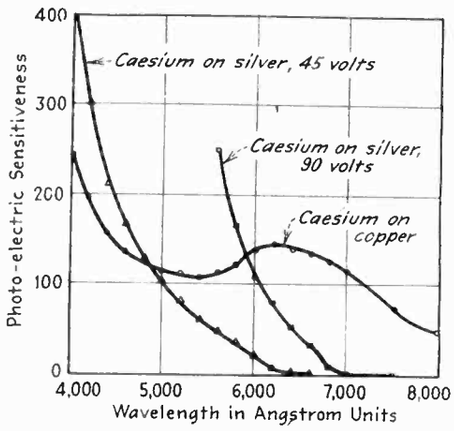


Fig. 4—High red sensitivity of caesium on metal base

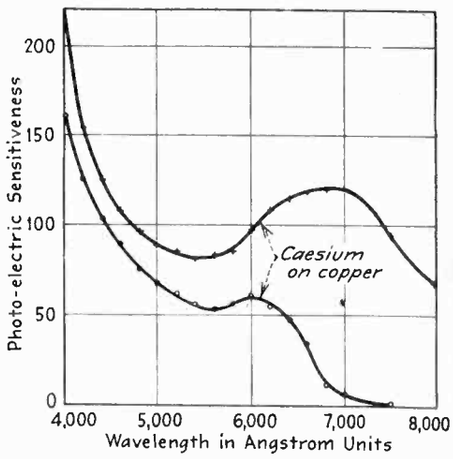


Fig. 5—Characteristic of caesium on oxidized copper

the total response to an equal energy spectrum between 4,000 and 8,000 Angström units, is but 44 per cent of the area under the potassium curve, for the same region; however, the response of the caesium cell to the radiation from a Mazda "B" lamp is more than 60 per cent of that of the potassium cell. This is due to the fact that the radiation from the lamp is relatively low in the region where the potassium cell is most sensitive. If we wanted the cell to respond to red light, such as that from steel in a hot rolling mill, the caesium cell would be much more sensitive than the potassium cell which responds not at all to red light, and but slightly to orange light.

Color sensitivity comparison

The curve shows that potassium is unsuitable for replacement of the human eye in color photometry and that filters would be of no use, because in the center of the visible spectrum where the eye is most sensitive, at about 5,600 Angströms, the potassium cell has lost all but a very small portion of its sensitiveness. The caesium cell retains a fair amount of its sensitiveness in the middle of the spectrum, and thus offers possibilities for using filters.

Figure 3 shows the Burt sodium cell, well-known because of the unique method of obtaining the sodium surface. The sodium cell is the least red sensitive of the alkali metal cells, which limits its usefulness for light of visible wavelengths. The rubidium cell shown is of the vacuum type.

In the G. E. caesium cells the layer of caesium is very thin; in fact, it is of the order of only one atom thick and of course invisible to the eye. Under such conditions it is logical to expect that the characteristics of the cell will change with different underlying materials, and such is found to be the case. Silver is the underlying material adopted for the commercial caesium cells. These cells give the largest total response to a Mazda "B" lamp, the light by which they are judged. The thin film of caesium is assisted in adhering to the underlying metal, by oxidizing the latter, as in the case of the caesium coating on tungsten vacuum tube filaments.

Cells with gold and copper as the underlying material were studied, and curves of the latter are shown in Fig. 4 to illustrate the remarkable red sensitiveness which can be obtained with these cells. Cells having high sensitiveness throughout the visible spectrum, such as the one giving the upper curve, are very useful for measuring transmission of filters.

The cells so far discussed are of the type havi sensitive surface on the inside of a spherical glas Many cells are now made with the sensitive surf a metal plate. Cells with cathodes of this type also studied and found to give curves very sim shape to the other type. Figure 5 is an example o curves. It may be noticed that the caesium-o silver cell of the plate type has almost no sensiti beyond 7,000 Angströms; while cells of the sam terial, but of the bulb construction, continue to be tive to 8,000 Angströms. This difference wa observed in another cell tested later. A peculia was noted in connection with the silver cell. Com the 90 volt curve with the 45 volt curve, it is see the sensitiveness is extended to longer waveleng the change in voltage. This fact was noted while the data and an immediate check was made to veri result. The reason for this unexpected behavior be sought from future investigations. Whethe effect is produced by positive ion bombardment o action directly on the electrons, needs investig Figure 5 also shows a caesium on oxidized, copp of the sensitive-plate type, which exhibits the sam red sensitiveness as the spherical bulb copper c Fig. 4. Cells of the sensitive plate type, having cathode surface a relatively thick layer of caesium also showed high red sensitiveness, but seemed somewhat unstable in tests made by Mr. J. L. Le the Renssalaer Polytechnic Institute under the w direction. This instability chiefly affected the red tiveness of the cell, and the cause has not been det ascertained.

The above information as to color sensitiveness enable the engineer to decide upon the proper cell considering new applications, since the curves are representative of available cells. Just as in all fie new development there are many factors of sec importance in the early stages, which rise in impo as the development proceeds; so it has been with electric cells. In the early stages of developmen the physicist was concerned with the relative eff light of different colors on the photo-electric ce engineer finds it necessary to concern himself wit characteristics as the one we have here considere

BIBLIOGRAPHY

[1]Taken from "Visibility of Radiant Energy," by K. S. and E. P. T. Tyndall, U. S. Bureau of Standards Scientifi No. 475, Aug. 11, 1923. The authors' recommended val used.

[2]"Color Sensitiveness of Photo-electric Cells," E. F. *Astrophysical Journal*, 52:129-53, October, 1920.

he Electron Tube as a saver of life

By DR. LEE DE FOREST

A message from the President of the Institute of Radio Engineers, convening at Toronto, Canada, August 18 to 21

'HOUGH the "omipotent tube," as it as been styled, has it most general appli- n the causes of com- ion, point-to-point he and telegraph and wireless), and s contact in radio broadcasting, I like at times to what the audion tube has today accomplished in e of the salvage of human life; and to speculate me of its future possibilities in this humanitarian

sof all has been its service in marine communica- abling listening operators at sea or on shore to ble calls of distress when distance or wrecked or fast failing batteries have made the SOS otherwise far too weak to be heard without the vable sensitivity of the tube as amplifier of radio Since the *Republic* and *Titanic* disasters, the tube has played a critical part in well nigh every rescue at sea. Thousands of the living today owe their salvation to the electron tube. Nor would I here forget for an instant the sterling service played by its companion piece in radio marine signaling and locating, the direction finder, as developed chiefly by Dr. Fred Kolster.

But in other fields of saving or prolonging human life the electron tube is already invaluable. In surgery the "cold cautery" or scalpel energized with low-voltage high-frequency currents makes possible delicate bloodless operations, even in the brain.

Similarly it is used for the generation of endo-thermic heating currents within the human body; and "electric-fevers," of corrective or curative effects not possible by other means known to medical science.

Also in germ and gland stimulation, elimination,, or control, the uses of intense vibratory currents of exceedingly high-frequencies are but now beginning to be realized, and earnestly investigated.

In aviation the radio tube is proving a more and more vital factor for safety of human life. In radio beacons, compasses, for direction and advice to pilots at all hours, regarding weather, flying and landing conditions, it is daily proving more valuable. But as yet aviation and radio are scarcely acquainted. The radio tube as sonic generator and amplifier must soon provide constant indication of exact altitude of the plane above the earth's surface, its approach to cliff or mountain side, or to another plane, so that every plane will carry with it its own invisible block-safety zone.

And for ships at sea. Too long have mariners been helpless prey to the dangers of fog or from icebergs. The radio-tube oscillator of the future will provide each craft with a directive beam of ultra short wave-length of the order of a few centimeters, effectively penetrating fog for a mile or more, automatically revolving like a search-light, "flashing" its invisible warning signal to be picked up in form of automatically repeated code or sound-on-film recorded words, by a radio detector on any neighboring vessel.

For here again stands the oscillating electron tube ever ready to play its part in saving human life.

(For I.R.E. convention program see page 217)

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Dr. Lee de Forest is perhaps best known for his revolutionizing invention of the three-electrode electron tube and the oscillating audion circuit. He has been a pioneer worker in all fields of vacuum-tube applications. He early established the first commercial wireless telegraph system in America; developed the first practical radio telephone system in the world; he set up an experimental broadcasting station in 1909 and the first regular nightly service in 1916; he pioneered in talking pictures years before other inventors offered their products to the public; and the records of many other branches of the electronic art show that Dr. de Forest's active mind had led the way to formulating and carrying out actual experiments long in advance of others, in a dozen different fields now materialized. Editor, *Electronics*.

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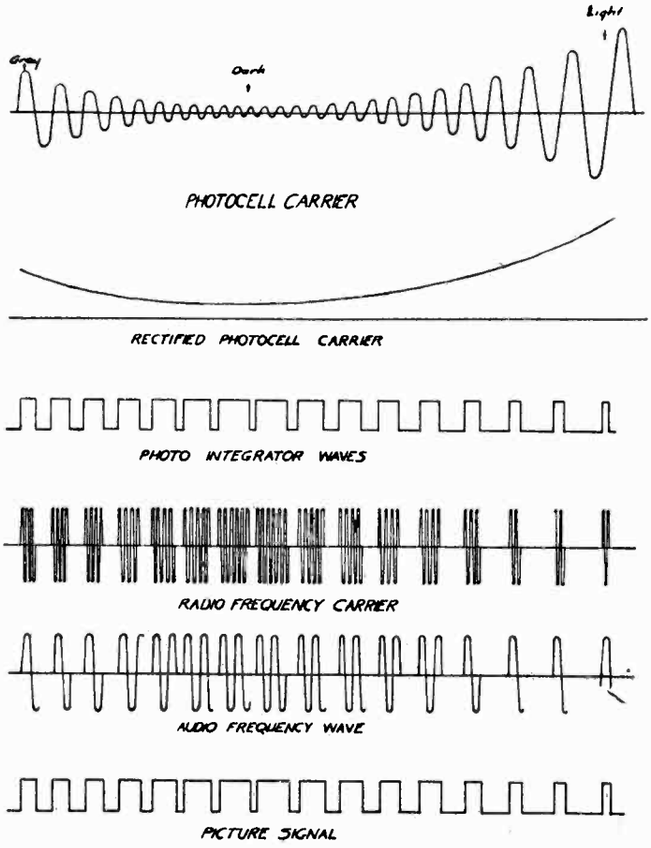
Vacuum-tube applications

and relay circuits in

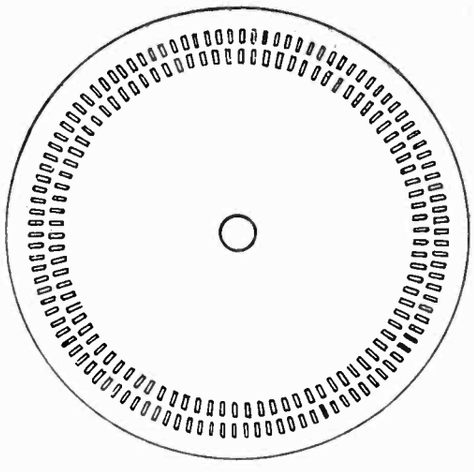
Trans-oceanic photo-radio

By RICHARD H. RANGER*

ALEXANDER GRAHAM BELL had an original application of the use of tone over land wires for purposes of telegraphy, with particular reference to its capabilities for multiplexing several channels over a single circuit, but it takes the vacuum tube of today to make his thought feasible. And this is the general basis of modern relay action; the use of tone over circuits as the means of indicating on and off conditions, and the use of vacuum-tube apparatus to put this tone on the line



Graphs of photo cell and radio carriers, and picture signal



The light-chopper disk which produces a 3000-cycle tone

and to take the tone off and make it perform the r
sary on and off functions at the receiving point.

The actual length of the tone circuit may be lo
short; across the continent for telegraph purpose
between one portion of the apparatus in one set-
another portion of the same apparatus in the same r
but its use permits of far greater facility in oper
far greater accuracy and far greater freedom fro
turbances, due to the fact that another tumbler has
added to the combination which gets into lock step
only the properly keyed procedure.

This article, in order not to be carried over too w
field in the possible replacement of mechanical
with tubes, may be best confined to a consideratio
the steps taken in the complete photoradio set-up
the adaptation of the same principles to other field
be obvious.

One-tenth micro-ampere from photo-cells

A minute current of the order of a tenth of a n
ampere is realized by the action of the reflected
from the point of the picture being transmitted o
photocells. One method of making such minute cu
useful would be by straight vacuum-tube amplific
with resistance coupling between stages. But the
sensitiveness required for such extreme amplific
means that the set-up would be disturbed by extra
effects. Therefore, the light is chopped to make it
duce an electric tone in the photocell, on the actio
light, instead of the minute direct-current change,
making a combination which is less susceptible t
traneous disturbances.

This chopper consists usually of a rotated disk
breaks up the light path somewhere between the or
source of light hitting the paper and the photocell
the photo-radio equipment, this chopper consists
glass disk about three inches in diameter placed ju
fore the photocell. This glass disk is compound,
made of two thin pieces of plate glass, each silvere
the silvered sides in contact. But the silvering is la
the glass in slotted form such that a thin strip of s
ing, about a sixteenth of an inch wide, alternates
clear strip of the same width. Now, when this d
rotated in the path of the light reflected from the p
being transmitted, the light either passes throug
disk to a photocell in back of the disk, or it refle
the silvered strip to hit a photocell off to the si
front of the disk. The net effect of this arrangem

*Engineer, Radio Corporation of America.

ıke the light always active on one photocell or the thus doubling the effectiveness of the chopping, nabling the photocells to be connected push-pull. ame reasons which make push-pull effective in or- amplification are here likewise effective. Fur- ore it has the interesting feature of balancing out irect components in the photocell action, which be produced by the modulation of the black and portions of the picture itself on a single photocell, hich would otherwise load up the following stages plification. This would give undue emphasis to the nd last changes of the picture parts. The net of such over-emphasis is to widen out the char- The push-pull action gives clean cut characters the right length.

ight chopper produces 3,000-cycle tone

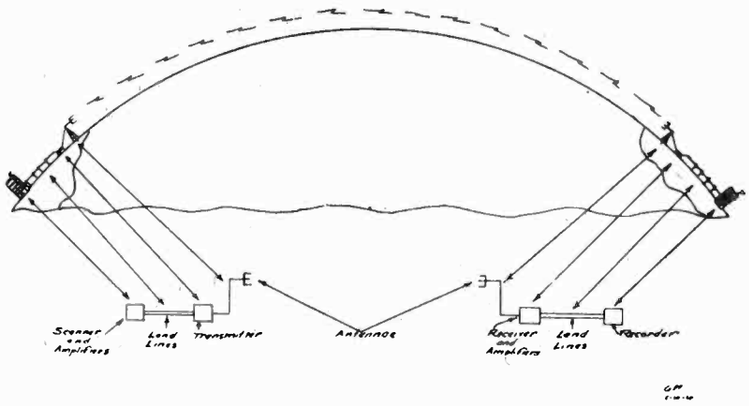
pitch of the tone produced by this light chopper e of the order of three thousand cycles or better. igher the frequency, the more carrier cycles that tained for a short picture impulse; and the more alternations that are obtained for such short por- the better the subsequent filter arrangements will e to isolate them. Likewise the higher frequency above any of the extraneous voltages from other s which might interfere, and which are conse- more easily eliminated in the filtering. By such ements it is possible to run the picture signals as from the scanning equipment back to amplifiers racks. All this makes for operating efficiency. ese racks the picture signals are filtered, amplified ctified. The rectification is necessary in order e signals may be "squared" before they are sent the long line to the radio transmitter. This ng is done because to date, on-or-off radio trans- n is used. It is easier for such transmission to be d successfully over radio channels through mod- ading than modulated intensity transmission would or short distance radio operation, the modulated ission is satisfactory, but it takes very elaborate ent to maintain intensity levels on long distance circuits.

on-or-off squaring is a species of limiting. ely enough it is the same sort of thing by which ns that all our nerve reactions telegraph signals brain, as shown by the "all or none" studies of ysiologists, notably Hart and Porter.

Photo-radio squaring

oto-radio squaring is accomplished in a special m-tube circuit such that for low intensities of tone g from the picture machine, full intensity, but very dashes are formed to be sent out over the line. corresponded to the dark parts of the picture. for gray parts of the picture, again full intensity, qually on and off dots are sent out to operate the transmitter; and then for the white parts of the re, which give good strong tones to be rectified to te the photo-integrator, very short and widely sepa- dots are sent out over the landline.

e basic principle of this photo-integrator is the fication of the rate of charge of a condenser. When ondenser is charged to a certain point, the system rses to allow another condenser to charge at a rate mined by the picture modulation intensity at that ific time. The rate at which the two condensers ge is differentially proportional to the picture modu- n intensity. That is, with a strong picture intensity,



Schematic diagram of trans-oceanic photo-radio transmission

one condenser will charge rapidly and the other slowly. It is virtually a vacuum-tube voltmeter which determines the switch-over point, when the condenser has reached its proper point of charge. The diagram brings out the complete operation.

Integrated impulses use tone carrier

It may well be appreciated that this photo-integrator may have other uses than picture transmission; uses over any system where intensity changes may better be transmitted as "all or none" impulses. It is a form of integrating device as well, and may be used to make discreet counting of variable quantities. The farmer may measure the total sunlight falling on his land!

Now that the photo-variations have been turned into integrated impulses, it is then necessary to send these

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Anyone who has slaved with regular relay contacts is convinced of the wisdom of replacing them with electronic tubes, from the point of view of increased sureness of action. But the simplicity of the regular mechanical relay is not quite so easily replaced by the electronic substitute. Therefore there has been the necessity of a compromise of certainty of action, against simplicity. But with increasing experience in the use of vacuum tubes, and the greatly increased demands in relaying, the use of vacuum tubes for relay purposes is steadily rising.

In photo-radio transmission, mechanical relays have now been completely dispensed with,—from central-office transmitting point, through landlines, to radio station, thence through the air to the receiving station and over a landline into the central receiving point.

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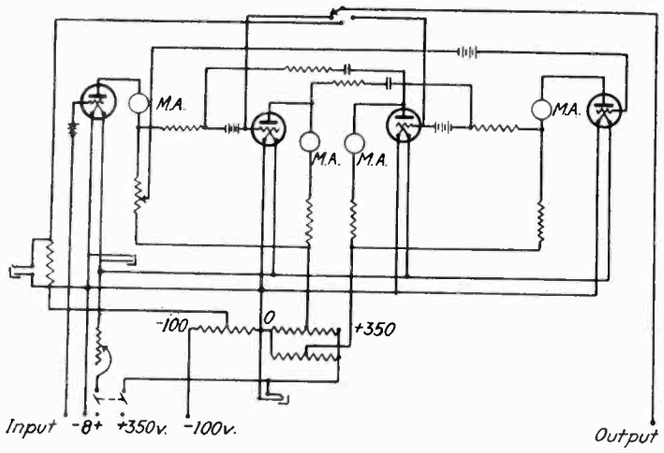

Circuit diagram of apparatus used in photo-radio transmission

impulses over the circuit. For this purpose, tone carrier is again used. As a fairly long landline is generally used, it is necessary to use a lower tone such as will be transmitted satisfactorily by the usual line. Fifteen hundred to two thousand cycles is generally best. This tone is produced by a vacuum-tube oscillator of the usual form. A portion of its output is then fed to a balanced tone keyer which is so constructed that spurts of tone corresponding to the integrated dots and dashes to represent the picture values are sent out over the line.

At the transmitting station, a second square-wave keyer is used to control the bias on the radio transmitter. This second keyer has as its basis neon tubes which are distinctly of the all-or-none form. Their use irons out any irregularities in the strength of the tone received over the landline. Thus clean-cut, square impulses are sent out over the air on a radio carrier which has now been increased to millions of cycles a second for the effective short waves.

Reception on three antennae

At the receiving station, a series of three separate antennae picks up the signals in three separate receivers. Each of these receivers is set to give a high heterodyne beat note as its contributing output, which in turn is rectified and made to operate a tone keyer similar in principle to the tone keyer which sent the tone signals from the photo-integrator to the line. But this time, it keys a tone which sends an appropriate tone over the landline into the receiving central.

At the receiving central, the audio tone is filtered and amplified, and again rectified. If recording on photographic paper is to be used, this rectified output is made to operate a gas lamp such as a neon, which registers its spot of light on the paper.

If visual recording is to be used, the rectified output is made to operate a most generally useful device, a self-contained vacuum tube relay amplifier. This device has the necessary "A" and "B" eliminators in it to operate the unit with nothing but alternating current power supply. It takes the small rectified-curren and amplifies it by two push-pull tubes to give e much higher direct-current output, or the two tubes are more likely separated and each tube o one winding of a balanced pair of windings in speaker unit, which in turn operates the recorder. form of this recorder is that devised by C. J. consisting of two such loudspeaker units driving edge steel bar against a revolving spiral to ma picture impulses through carbon paper. Or a such loud-speaker unit is made to turn on and almost impalpable jet of vapor which records the p impulses in a striking purple color suitable for copying. The chemical fluid used in the marking p is the development of F. G. Morehouse.

Ink-stream deflected electro-statically

Another most ingenious recording method has developed by Mr. Hansell at the Rocky Point Stati the Radio Corporation. This consists in deflect very minute stream of ink by electro-static means. high-voltage direct current is applied to a deflecting placed near the issuing stream of fine ink; the ink is one pole of the output voltage. When the v rises between the ink and the plate with the inc signal, the ink is deflected. He has obtained spe one thousand words a minute, using such recordin code signals. In applying the method to picture re ing, a jet of water is used which is deflected fro straight position by the incoming signal. In its st position it acts as a shutter to cut off the same ver jet of colored vapor mentioned above. When the deflects the water, the vapor hits the paper surfa make the picture signals.

One very important phase of the entire picture pr remains to be considered, and that is synchron This is done in the photo-radio system by mea tuning forks held rigorously constant at each end o circuit. No means of sending synchronizing im during picture transmission is found necessary, a forks maintain independently their equal rates of tion to one part in two hundred thousand. These are mounted in thermostat controlled boxes; the vacuum tube driven, and have vacuum tube voltage lators to prevent the frequency variations cause power supply changes.

So, the entire operation of the picture circuit de everywhere on the accuracy and speed of perfor of vacuum tubes. Alternating current supply is generally for the production of the necessary pla filament currents. Vacuum tube oscillators produc carrier currents of high and low frequency on the bits of picture intelligence are flashed as the n of the system, and facsimiles of the transmissio produced at the receiving centers thousands of from the sending point, all to the greater servi industry and society.

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NEED OF CENTRALIZED RESEARCH

What we need most in radio research today in order to forge ahead rapidly is centralized research. Today there is too much duplication of effort. One man's negative finding might often save some positive idea that another man is working on.

JOHN HAYS HAMMOND, JR.

he photo cell applied to dustrial problems

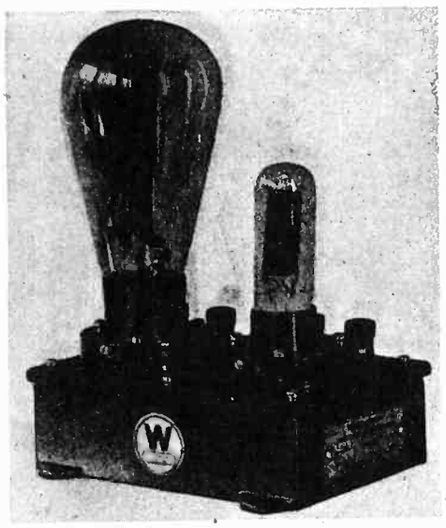


Fig. 1—Photo-electric cell and amplifier unit

J. V. BREISKY*

WHILE the photo-electric cell can be used alone it is usually associated with another vacuum tube working either as an amplifier or as a relay. The t cell coupled to an amplifier tube or a grid-glow nd made into a unit, for example, is a versatile and nient device rapidly finding its way into many in- es. It can be used as a part of other equipment or e applied to many tasks directly. It is useful in ol or industrial laboratories for experimental pur- e and is especially practicable where engineers desire dy how the photo cell may be used in relation to l problems.

ch a combination of electronic devices may perform rtant functions in industry now carried out by more lex, more expensive, less versatile apparatus. It tined to play an important industrial rôle.

working with such an amplifier unit, it is desirable several megohms as load impedances for the photo urrent to pass through and create a drop of voltage hich will actuate the amplifier tube. In this manner mum sensitivity will be obtained from the unit. n the impedance is as high as 50 megohms, as is sary in many cases, a small amount of moisture and may lead to serious difficulties, in operation, owing akage of the minute current. In this manner, the tive impedance of the grid impedance may be re- d to a very small value and as a result the sensitivity be greatly affected. A typical unit is shown in Fig. 1 a circuit diagram in Fig. 2.

Light relays

nother unit in which the photo cell plays a stellar is the light relay. These operate directly from 110 s, a.c., and are applicable to many types of work, e they will give automatic indications, records, or ection. Industry is finding many applications for e devices, for they will initiate any operation by ns of the making or breaking of a beam of light by opaque object.

wo types of light relays are available, one (Fig. 3) is use where the distance between the light source and relay is respectively ten inches or less. It consists of a photo-electric cell, grid glow tube, relay, and transformer with the necessary auxiliary equipment enclosed in a metal box. A glass window in the case permits light to fall on the photo-electric cell.

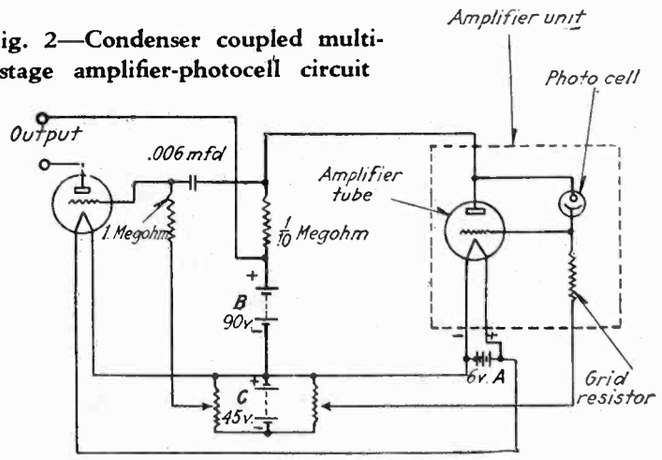
The second light relay, Fig. 4, is intended for applications where the distance between a light source and the relay may be any distance up to a maximum of 14 feet. It has a slightly different mechanical arrangement, and a spherical condensing lens is used instead of a plain glass window. If used in conjunction with a light source of the type shown in Fig. 5, a spacing of up to 14 feet between the two units can be used. The light source is a projector contained in a metal box and consists of a transformer, a small concentrated filament lamp, a focusing device, and a lens for concentrating the light from the lamp to a parallel beam.

Photo cell applications

Applications for these devices are almost too numerous to mention. They will replace human labor or replace mechanical devices, as well as make possible other automatic operations previously considered impractical. Following is given a partial list of uses.

Counting items—where mass production requires speed; where products such as hot ingots would wear out a mechanical counter rapidly; where items cannot be

Fig. 2—Condenser coupled multi-stage amplifier-photocell circuit



Westinghouse Electric & Manufacturing Company.

readily counted by present mechanical counters and human labor is used at present.

Initiating operations—such as ringing an alarm on paper machines when breaks occur in paper. Automatically starting and reversing sheet or bar mills from the position of the bar. Opening garage doors; limit switch; control of pilot lamp on radiation pyrometer.

Position indicator—safety device, indicating position of doors; position of moving cars through dangerous places, such as freight cars or trucks leaving a building and crossing a thoroughfare; warning signal for autos and other vehicles entering a one-way thoroughfare, such as a ramp from a street to the basement of building; warning signals in ramp type garages to denote the position of cars on ramp.

Safety device—on machinery where workmen may come in contact with moving machines accidentally.

Examples in industry

Citing some specific examples, Fig. 6 shows an installation of light relay for controlling the operation of flying shears in a bar mill. This scheme is of especial advantage in the case of small bars where a mechanical flag switch cannot be used and a man must pull a trigger every time a shearing action is desired. In one particular steel mill where one laborer for each of the two shifts is required, the old method of operation cost $6,000 a year (two men and overhead), whereas the light relay, including the expense of installation, can be had for less than $300. Besides, since the bar is moving at a speed of 400 feet a minute, the substitution of an automatic device results in more accurate shearing of the ends and is therefore a saving in steel.

Another steel mill application is shown in Fig. 7, for the operation of soaking pit covers by the crane operator. In the past, this was accomplished by sectionalized rails, running the entire length of crane travel. These rails completed an electric circuit from the crane to the pit cover mechanism. With the new method, a beam of light is the connecting link between the crane operator and the pit covers. Referring to Fig. 7, the crane is moved over the desired pit, then the light source (opposite the light relay for that pit) is flashed once by the crane operator; the pit cover is thereby removed. To replace the cover, the same light is flashed again. The other light source controls the other pit in the same row and the operation is identi This new control can be installed for about the s expense as the former method and will result in sim and more reliable operation.

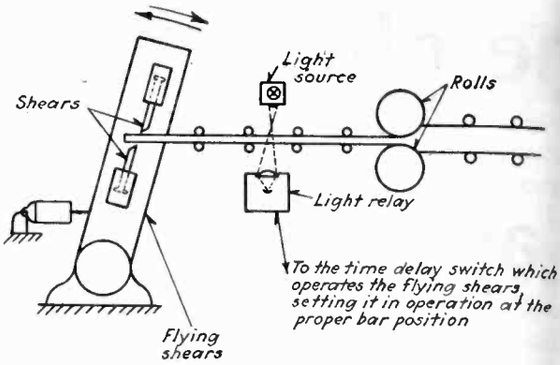


Fig. 6—Application of light relay to automatic control of flying shears

Smoke detector for fire extinguishing

Prompt detection of fires is desirable everywhere; where highly inflammable materials are handled, fire r be detected and extinguished instantly. Most fire tinguishing devices must be operated by hand. If equipment is dependent upon a temperature change fore it acts, then seconds are lost before the appar is motivated. As a "smoke detector" the photo-ele cell acts with a promptness which suggests parlor ma The instant smoke floats across the beam of light w is directed on the cell, a flood of harmless carbon dio gas is released and the fire is extinguished before m rial damage is done.

Wherever automatic fire detection is desired and wl temperature-controlled extinguishers are inadequate, photo-electric fire detecting appar is unexcelled.

One of the most useful ph electric devices now in everyday s ice is the smoke recorder and indica This is a reliable and accurate ins ment which gives the operator a tinuous indication of the condition combustion, by keeping a gra record of smoke density. As ex sive smoke is evidence of impr combustion, it can generally be duced. The difficulty has usually l that means of determining sn density have been unsatisfactory cause the stack is not visible f

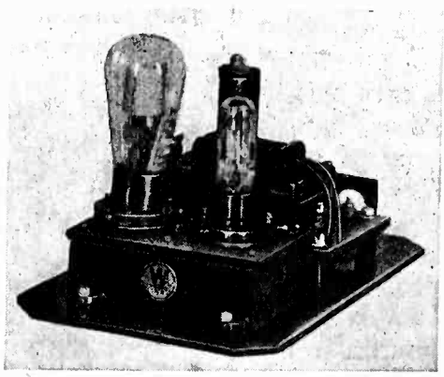


Fig. 3—Combination of photo cell and grid glow tube—a light relay

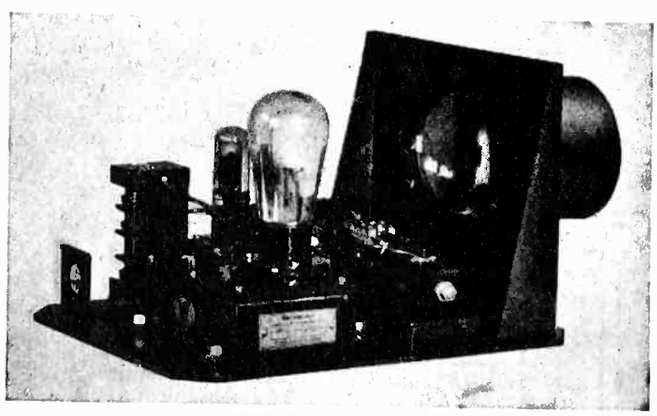


Fig. 4—Light relay equipped with a lens for greater sensitivity

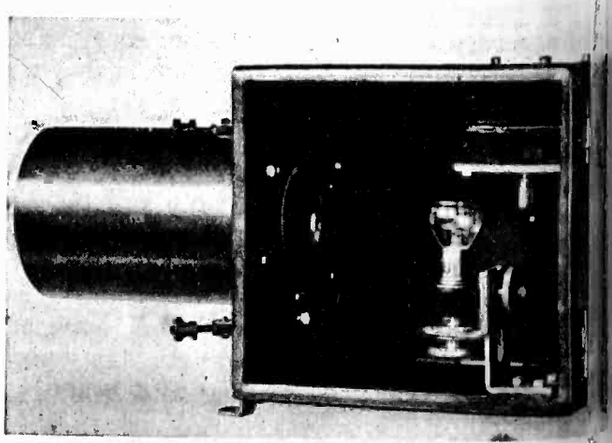


Fig. 5—A light source to be used with lig relays

oiler room, and because ocular estimates of smoke y are extremely inaccurate, especially under vari- weather conditions or at night. The smoke re- consists of a light source and a photo-electric ier and control unit, mounted on opposite sides e stack or breaching. These connect with indi- and recording instruments as well as the bell or indicating lamp located in the boiler room or her convenient location.

h functioning of the photo-electric smoke recorder trolled by light striking the cell as smoke crosses am from the light source in varying degrees of r. Used in conjunction with a CO_2 meter, the electric recording apparatus gives the operator an nent by which he can obtain a maximum of CO_2 the same time a minimum of smoke.

h cost of the smoke recorder including a graphic plus the installation expense, is in the neighbor- f $650. While it is very difficult to arrive at the savings resulting from a reduction of smoke, it consensus of opinion that the savings obtained will the expense. In many large plants an observer stationed on the roof to watch the stacks; this e can of course also be eliminated.

Lighting control unit

omatic control of indoor lighting means that ade- illumination can be provided at all times without e Everyone is aware of the close relationship be- proper illumination, good health, steady nerves, od work. Yet how rare is the workroom where avering supply of light is provided. When day- ades during a storm or at dusk, how often the who is responsible neglects to turn on artificial s and fails again to turn them off when they are ger needed.

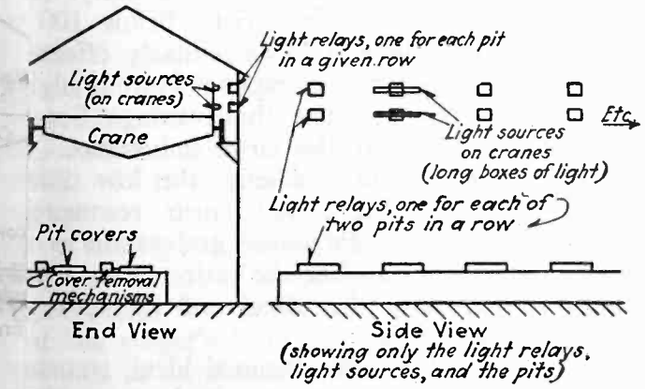


Fig. 7—Soaking pit cover control by means of light relays

w the photo cell is used as the heart of a unit automatically switches on artificial lights whenever l light falls below a predetermined minimum. In ng aisles of large manufacturing plants light con- nits at intervals can turn on and off the banks of in their particular region. The unit is so con- ed as to receive light from all directions, and is effective when installed at the point where the intensity is to be adjusted, that is, on a plane with ork bench, the desk, or the test floor.

rge outdoor electric signs are being similarly lighted matically, whenever darkness is sufficient to make effective. By a connected mechanism the signs be darkened altogether during certain hours of the when they are not needed. Store windows, street s, and various types of displays may be automatically

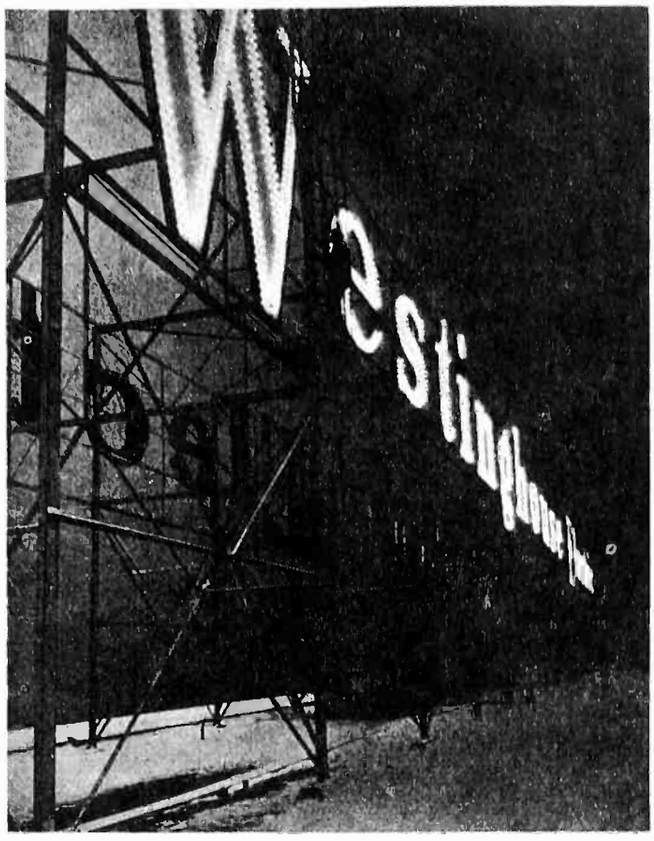


Fig. 8—Large electric sight controlled by photo-electric cells

controlled by means of the photo cell unit. This device also makes use of the photo cell-grid glow tube combination described previously.

Figure 8 shows a 108-kw. sign controlled by a photo cell. In this particular case the unit is installed indoors, while ordinarily it would be outdoors, in close proximity to the sign.

Sorting apparatus

Reference has already been made to the use of the photo cell for sorting operations. Many of the most toilsome tasks now performed by human beings are those where material must be inspected or sorted according to size, shape, color, or imperfection. Moreover, even with experienced operators, the human element is responsible for a percentage of error, so that defective material is made into a finished article without being discovered until it is too late.

That such sorting apparatus can result in real savings to the manufacturer may be gleaned from the following example. One industry now employs several thousand women to perform a certain sorting operation. If successful photo-electric sorting machinery should be developed, which will no doubt be in the near future, one machine costing not more than $4,000 to $5,000 will easily do the work of these women and will pay for itself within one year.

Sorting problems having received attention include such articles as metal, glass, varnishes, and oils, fruits, ores, textiles, paper, tiles, wood, cigars. Many properties of material can be utilized to advantage, such as reflection, transmission, refraction, polarization, etc.

Ultra-violet ray recorder

In recent years ultra-violet light has been used increasingly for medical treatment, production of vitamines in food products, and for bringing about certain chemical

[*Continued on page 266*]

The design of tone control circuits

By KENNETH W. JARVIS*

TONE control practice may be divided into three general heads. The first is a compensation control, attempting to make a perfect response curve. The second is a compromise, sacrificing a perfect fidelity to avoid other troubles. The third division refers to volume level-tone correction.

Researches by telephone engineers and others have disclosed many circuit arrangements for giving substantially any transmission characteristic desired. These fall into the classes where the system is made as nearly flat as initially possible, or where correcting networks are used. A few principles of flat transmission now well recognized are to keep shunt inductances (transformer windings) high, shunt capacity (distributed or lumped) low, and series resistance low. These principles

▼

Transmission of intelligence by electrical energy requires many types of translating devices. These devices are not simple channels through which energy flows, they are complex networks, each section of which leaves its imprint on the character of the signal. Such changes are often undesirable; the communication engineer must avoid or compensate them. That portion of the art which refers to such correcting and changing of the frequency response characteristics is known as tone control.

▲

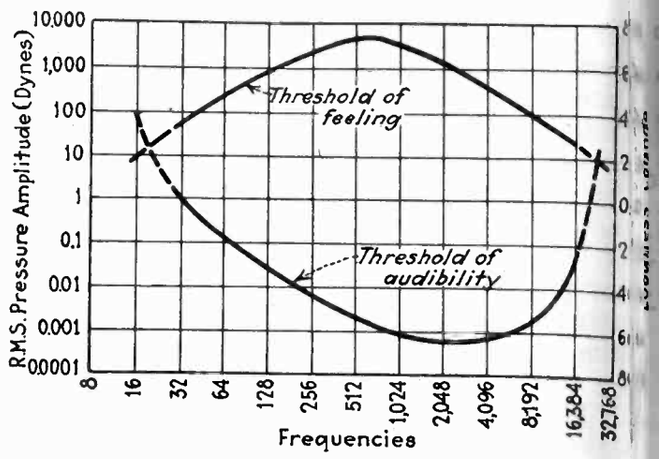


Fig. 1—Sensitivity of the ear as a function of frequency and "volume"

have largely governed the design of all audio freq amplifying systems. To obtain equal bass respons audio transformer primary impedance is increase

While usually more complicated, it is often economical to use frequency response correcting ci It is possible for example, and increasingly popul make the audio amplifiers compensate for some def some other part of the system. As such defects m a large deviation from a flat characteristic, some fo compensating system is necessary. Quite often s remedy is simple. The audio transformer may be resonated to increase the bass response which otherwise be lost in another transformer or in the bass recording of a phonograph record. The amp tion is the ratio between the transformer reactan the resonant frequency and the resistance of the circuit and may reach 4 or more. Assume such a resonated circuit adjusted to 50 cycles. By the tim cycles is reached, the resonance effect is practically and the amplification is back to normal or unity. Thi correct for a dropping characteristic below 100 to 50 cycles. The method is particularly effectiv low impedance pickup phonographs. Here a high can easily be obtained. The disadvantage lies i energy storage ability of the large inductance. the applied signal is cut suddenly, the low decr of the circuit keeps the signal (near resonance quency) from instantly following and produces a lag or hangover. The higher the ratio obtained th resonance the worse is the effect and the more tional the quality.

The result of a flat, and assumed ideal, transm characteristic is a great increase in hum as the response is increased to the general level. This re greater filtering, lower audio amplification, less sen power detectors, a combination that costs both in and sensitivity. The proper balance is secured through evaluating the listener's discrimination. a radio receiver with a poor bass reproducing s has been sold on the basis of having absolutely no Another compromise which gives apparently better ity is to remove the bass response when listening speaking voice.

There is another defect existing particularly in receivers which militates against the use of flat fiers. This is due to static and other noise havin quency components largely in the upper frequency As high frequencies are eliminated the noise con is usually improved more rapidly than the quality

*Radio engineer, Sears, Roebuck and Company.

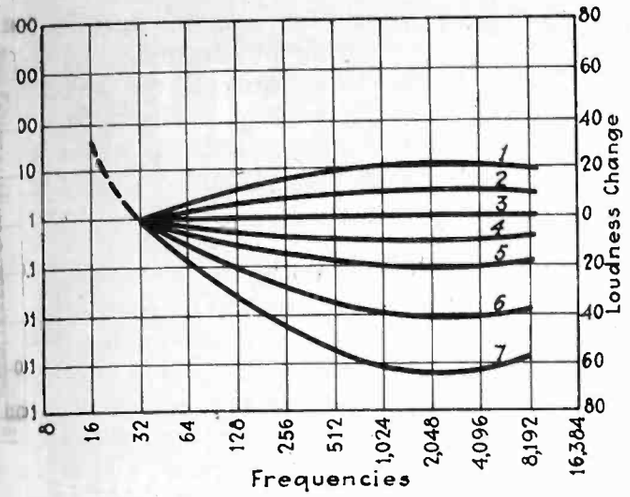


Fig. 2—Curves showing how amplitude changes can be corrected

s depreciated, with a net increase in enjoyment. s led to a growing use of tone controls which cut n frequencies in an amount controllable by the e. In radio receivers such a control often makes g possible in otherwise unbearable conditions. In graph amplifiers the needle scratch may be partially d.

high frequency cutoff is of further value due to ge in intensity between high and low frequencies. minating against the high frequencies *seems* to e more bass due to the change in relative fre- response. This seemingly regulates the bass se, an effect certainly inconsistent with the actual acy change! While this is popularly accepted as ct tone control, a music lover will very quickly he falseness of the bass and the lack of overtones gh frequencies.

Perfect quality still lacking

years' experience in the reproducing art, however, adually forced upon the engineers the belief that ter how flat may be a response curve, the repro- sound is still unlike the original. It sounds ical. It is still only a radio, or a talkie, or a graph.

at is lacking? Imagine a singer at some distance in of the listener. The ideal translating system would e in which the reproducer could be placed at the of the singer's head, and would emit exactly the sounds in amplitude and frequency *as the singer if present.* This implies a flat frequency charac- and a translating circuit of zero attenuation. Let system be provided. The reproduction would be t. Now raise the amplification of the system to r twice the energy radiation. The frequency curve flat but the energy level is up about 6 db. Would producer now fool anybody? Would the resultant be the same as if the artist had increased the ity of the note?

correction for the change in quality as the ampli- is varied is extremely desirable, so that the desired y is secured regardless of the energy level.

nsider the data regarding the aural sense impres- as given in Fig. 1.* These curves are based on urements of approximately 100 normal ears. The r line represents the threshold of audibility. In r to be perceived as sound, the air pressure at any uency must be of a value greater than this threshold e. Thus 64 cycles must have an R.M.S. pressure of more than 0.1 dyne to be perceptible, while 1,024 cycles only needs a pressure of 0.001 dynes to be audible. The upper curve gives the threshold of feeling, beyond which the ear is conscious of pain as well as sound. Between the upper and lower curves and the frequencies of their crossing points lies the useful auditory sensation area, any point in which is located by frequency and amplitude. For convenience a loudness scale is given on the extreme right, based on 1 dyne as a zero point.

It has been found that the apparent loudness of sounds is proportional to their loudness *above the threshold of audibility.* For explanation assume frequencies of 32, 64, 128, 256, 512, 1,024, 4,096 and 8,192 be present, all having an amplitude of one dyne. The apparent loudness of each frequency (neglecting the masking of the high frequencies by the low frequencies) is noted on the table. Listening to such a complex note would give a definite sense impression. Now let the same frequencies be decreased equally to an absolute level of 0.1 dyne. The apparent loudness of each frequency is also noted on the table. All response to frequencies of 64 or below has disappeared! If a flat amplifier response curve is adhered to, changing the absolute amplitude of the energy level produces major changes in apparent frequency response.

It is this change in quality which has been one of the most elusive factors in reproducing "perfect" quality. *The elusiveness of reality demands more than identical frequency distribution.* Correct loudness ratio between each frequency component is necessary to bring Sousa and his band into your music room.

Therein lies one of the biggest problems in reproduction. For this apparent loudness ratio to be correct with our flat amplifying systems we must reproduce, as noted before, at exactly the same energy level as the original. This is a condition which a radio user will not (often can not) adhere to. His reproduction must run at all amplitudes from almost inaudibility to public address system volume. The change in quality must be corrected or endured.

Another method of portraying the greatness of the variation in quality, and at the same time a means for correction, is shown in Fig. 2. Taking the initial condition assumed in discussing Fig. 1, of all frequencies between 32 and 8192 being present and of equal amplitude, 1 dyne R.M.S. value, we make a mental (or theo-

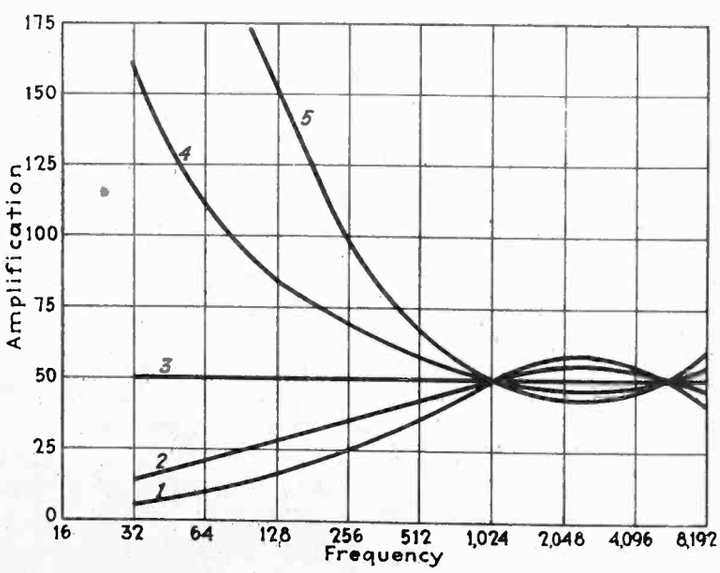


Fig. 3—Instead of 32 cycles as the equal-amplification point, 1,024 cycles is used as the pivot

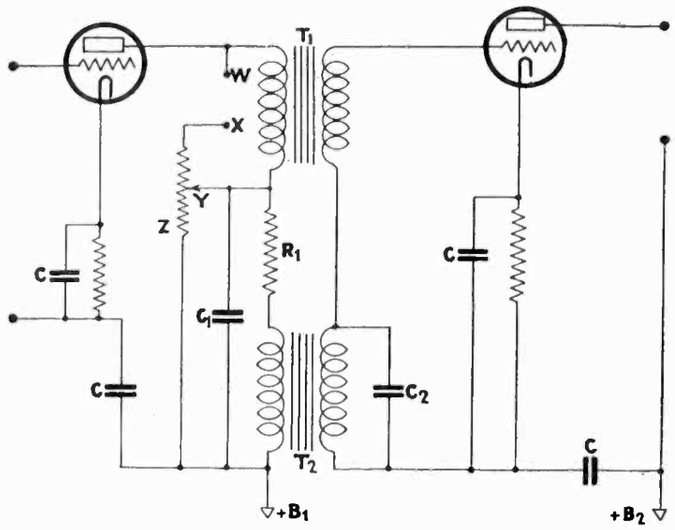


Fig. 4—Circuit diagram of a workable tone control system

retical) estimate of the quality. The problem is to keep the same apparent quality as the apparent sound intensity is varied. This means keeping the sound intensities above the threshold of audibility in a constant ratio (loudness units) regardless of the absolute amplitude. A series of curves has been drawn showing how the curve shape varies when correcting for changes in amplitude. The apparent volume or intensity of most speech and music is determined by the amplitude of frequencies in the region between 700 and 2,000 cycles. The apparent loudness of our assumed sound can be roughly taken as the number of loudness units above the threshold value at 1,024 cycles. The intensity range shown, neglecting the threshold value, is about sixty loudness units from minus forty to plus twenty, corresponding to an intensity change of 1,000 to 1. This is perhaps more than customary but is not an impossible or unusable variation.

Consider now the type of amplifier to effect such a quality correction. Its fidelity curve would be variable from curve 1, Fig. 2, to curve 6, Fig. 2. Certain peculiarities may be noted. Regardless of volume output, the amplification at 32 cycles remains constant, while that at other frequencies varies somewhat less than that at the peak frequency, about 3,000 cycles. Visualizing such an amplifier gives a picture of a volume control which is more than a device for changing the amplification; it must be a variable frequency attenuator. Such an amplifying or translating system could easily be built, but its use would be restricted (if operating properly) to the few cases when the initial energy level corresponded to the 1 dyne amplitude.

The amplification should be variable, thus enabling the system to be set in conformance to any initial amplitude. Such amplifiers have been built and tested against the theory as outlined with more than pleasing results. It has been found that the most satisfactory arrangement is one in which the tone control produces no sensation of volume control. As this means that the amplification at 1,000 cycles must stay about constant, it is apparent that the low frequencies must be of variable amplitude.

The curves marked 1, 2, 3, 4, and 5 of Fig. 2 have been re-drawn in Fig. 3 to a scale giving equal amplifications at 1,024 cycles. The amplification is given as a linear ordinate as contrasted with the logarithmic ordinate of Fig. 2. This scale, drawn in conformance with the usual method of plotting fidelity curves, shows the extreme change in response curve shape necessary to correct for amplitude-quality variation. The amplification ratio necessary for the lowest bass note for which cor is desired (and which is roughly determined by the energy level) is about the same as the volume desired to use. That is, in Fig. 3, the ratio of cycle amplification in curves 1 and 5 is about 10 responding to the relative amplitudes of the 1,024 notes of 1 and 5 in Fig. 2.

Tone control design

In actually designing an amplifier to correct for tude-quality variation, the initial energy level is c as about the mean of the amplitude variation an and minus bass corrections calculated. The min bass frequency is determined by the intercept c chosen energy level and the threshold of audibility While this method is theoretically correct only a energy level chosen, actually individual ear resp vary so much and are so non-critical of any reas deviation (say 25%) that the desired correction is closely attained.

One circuit arrangement which has proven to be effective is given in Fig. 4, and represents an ampli stage between two vacuum tubes, of which the firs detector. The following stage is omitted from th cuit, being the conventional pushpull type giving an all amplification (with 245's and 4,000 ohm load about fifty. The theoretical curves of Fig. 3 were d with the 1,024 cycle frequency having an amplific of fifty to make comparison of Fig. 3 and Fig. 5 Briefly it consists of a very small transformer T_1 in s with a large step up transformer T_2. The transfo

f	Energy Level-Amplitude 1 Dyne		Energy Level-Amplitude 0.1 Dyne		Energy Level-Amplitu 0.01 Dyne	
	Apparent Loudness	Ratio to 1024	Apparent Loudness	Ratio to 1024	Apparent Loudness	Ratio t 1024
32	0	0				
64	17	0.24				
128	33	0.52	13	0.29		
256	44	0.72	24	0.60	4	0.18
512	54	0.86	34	0.79	14	0.64
1,024	62	1.00	42	1.00	22	1.00
2,048	66	1.06	46	1.09	26	1.18
4,096	65	1.05	45	1.07	25	1.14
8,192	57	0.92	37	0.88	17	0.77

T_2 is shunted by a condenser C_1 to peak the transfo at low frequencies. This is fundamentally not a nance peak, as resonance and energy storage ten increase the hangover and destroy the clean-cutnes the sound. R_1 may be the resistance of the primar T_2 or an added resistance to decrease the resonance e The condenser C_1 acts merely as a cutoff for high quencies and is of a value, compared to R_1 and the mary inductance of T_2, to give the desired curve. a small bypass condenser to allow the secondary vo of T_1 to act across the grid-filament capacity instea being lost in the high secondary impedance of T_2. to leakage reactance, the condenser C_1 does not effectively bypass the secondary reactance.) The densers C are merely normal bypass condensers.

Figure 5 gives the curves of the individual transf ers and the various values obtained by addition. erence to both Fig. 4 and Fig. 5 is necessary ir following discussion. T_1 is designed with a very primary inductance so that its characteristic alone duces the curve approximating curve 1, Fig. 3. variable resistance XYZ may be short circuited wi set on Z, in which case T_1 alone is acting in the c

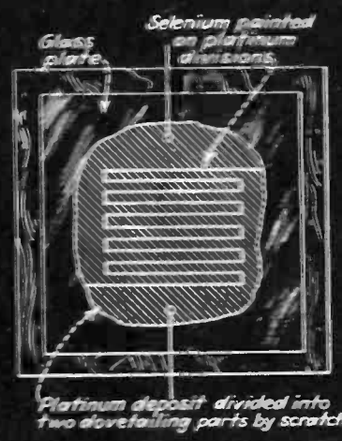
[*Continued on page 266*]

LIGHT-SENSITIVE CELLS

Several types of cells in which an electric current is controlled or produced by light are described below. They are destined to play rôles of increasing importance in science and industry, and to contribute materially to human progress.

Photo-conductive cells—Selenium, etc.

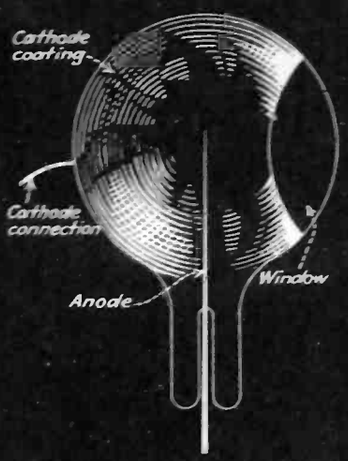
Cells in which a change in ohmic resistance occurs on exposure to light. Selenium is the metal most commonly used; improved technique is bringing it into greater use. Current



changes of the order of one-half to 20-30 milliamperes may be secured. Ratio of dark to light resistance may be ten or more. They will pass sufficient current to operate relays.

Photo-electronic cells—Alkali metals, etc.

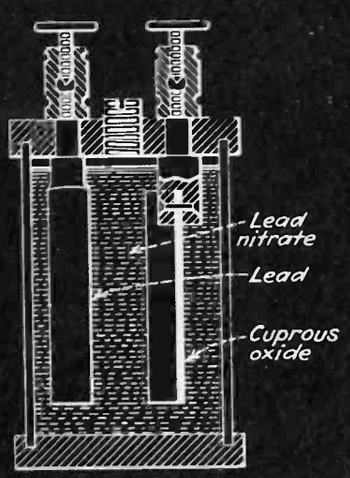
Under exposure to light, electrons are emitted or liberated. Emitting surface is usually an alkali metal or compound. Currents are of the order of a few microamperes; but large



voltage changes are easily secured. Gas-filled cells are more sensitive; vacuum cells are more stable and linear in output with respect to illumination.

Photo-voltaic cells—Chemical

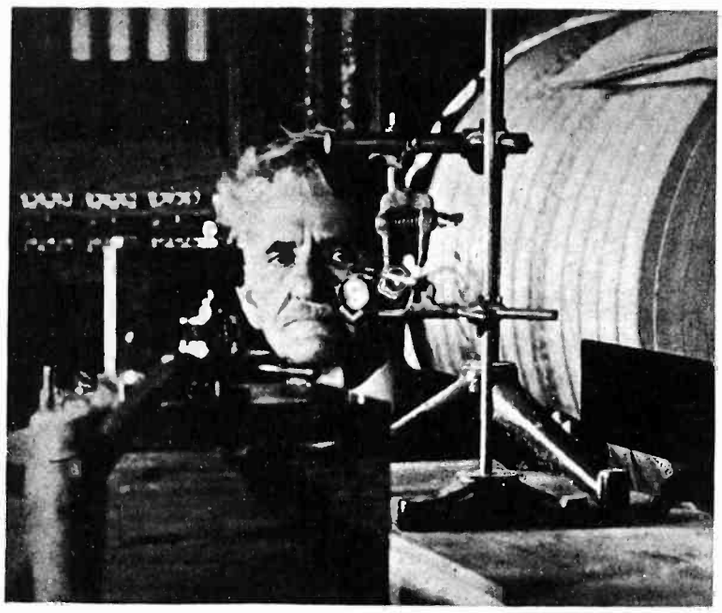
An electromotive force in an electrolyte is created on exposure to light. Currents as high as 150 milliamperes may be secured from cells of sufficient electrode surface. A cell of



approximately 6 square inches of electrode surface will deliver about 25 milliamperes when exposed to indirect sunlight. The cell is really a light battery.

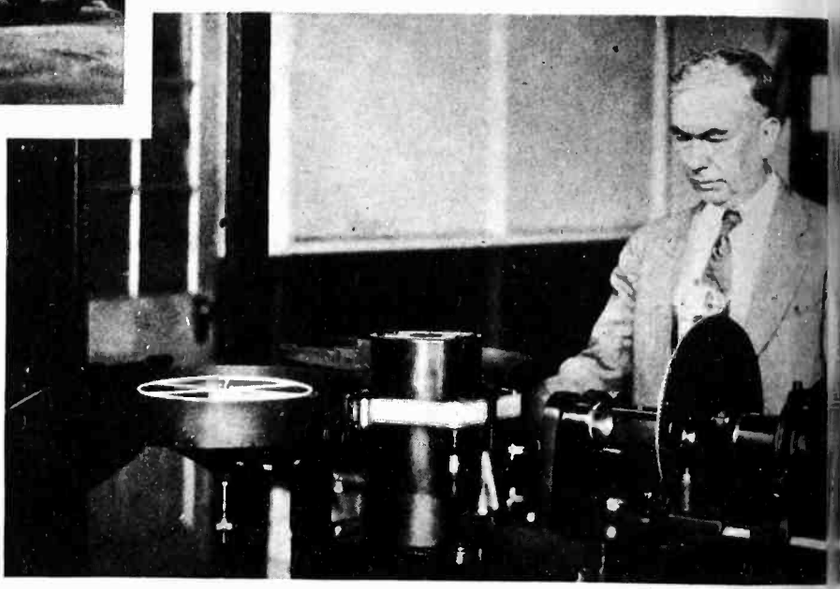
Well Known Workers in Electronics

"On the Jo



Dr. A. A. Michelson, famous physicist of Chicago and California, at the eye-piece of the great mile-long evacuated pipe, in which he is measuring the velocity of light and other ether waves.

Dr. A. Hoyt Taylor, director of radio research at the Bellevue, D. C., Naval Research Laboratories, and junior past-president, I.R.E., interrupts his studies of short-wave echoes to greet a visitor



Dr. Harvey Fletcher, sound expert for the Bell Laboratories, measures the noise level in New York City streets

Dr. Frank Conra
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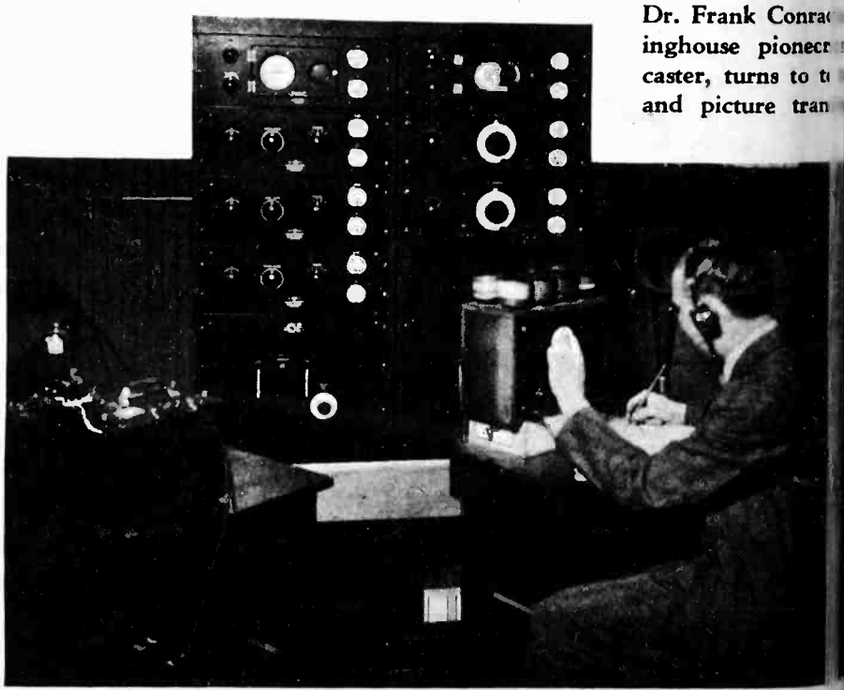
caster, turns to t
and picture tran



J. W. Horton, chief engineer of the General Radio Company,
a wave meter by listening to the chirps produced by two vacu
in his laboratory at Cambridge, Mass.

equirements of evision

of entertainment

ommercial value

DGAR H. FELIX

IEW of the great interest in television and the anticipated commercial realization, it is profitto appraise the performance requirements of sm of a character warranting public support solely grounds of its entertainment service. Such an si will aid in determining the significance of curogress and how much of the road remains still to aled. It will show us the stumbling blocks to mmercial realization in their correct proportion ke possible a more accurate judgment of the im- of current developments.

Some television terms defined

nomenclature of television has not been sufficiently dized to permit rating the performance of existtems without first setting up a few simple definiTelevision, in its restrucited sense, is the radio ssion and reproduction of visual representations ing subjects. Television, utilizing wire networks communication channel, is not subject to the probvolved in employing a radio channel. Therefore m "wire television" should be employed to differ- that type of television demonstration from those employing radio channels.

process of television in general is to disintegrate oject matter or images to be transmitted, into a of electrical impulses, the intensity of which indiading, and timing, their relative position. The s of disintegration is known as *scanning,* the area d is the *field of view,* the area illuminated in repro- n is the *field of reproduction.*

minimum area scanned at any instant is a *picture t.* When the field of view is scanned in parallel s progressively covering it, each sweep is called a The conventional spiral apertured scanning disk up the field of view into as many lines as there ertures in the disk. The number of picture ele- per line, in such cases, is equal to the average of the path traveled by the apertures in making sweep, divided by the effective diameter of the scanning aperture. The total number of picture elements per field of view is equal to the product of the lines and the picture elements per line.

Each scanning of the field of view is called a *frame* and the number of times per second that a frame is completed is the *repetition rate* or, merely, the "repetitions." Thus, if a scanning disk revolves twenty times per second, the system is one of twenty repetitions.

The amount of detail that can be faithfully transmitted is determined by the number of picture elements into which a given field of view is disintegrated. The ability of the system to maintain accurate reproduction during motion is determined both by the number of picture elements and the repetitions. The only basis for rating a conventional television system is by number of picture elements per frame and by number of repetitions per second. These two elements are as significant to a television system as brake horsepower and number of cylinders in estimating the performance to be expected of an automobile.

Minimum picture elements

The starting point of an investigation to determine the number of picture elements into which a given field of view must be disintegrated to secure satisfactory reproduction is the minimum area which must be clearly reproduced. That minimum area must be no larger than the smallest item of detail required for good reproduction. A television system confining itself to reproduction of simple close-ups of the human face must, to justify widespread home utilization, be capable of following closely changes in facial expression of some minuteness of detail. While crude reproduction without the ability to reproduce minute changes in expression would be of temporary interest, we could hardly expect the home reproducer to be used for several hours a week, unless one could not only recognize the face but also observe every shade of facial expression. The observer would expect to discriminate the wrinkles about the eyes and mouth when the speaker smiles, see the eyebrows change their position, and observe the eyelids open and close because it is such details which make up expression. I would hesitate to concede that entertaining television of faces could be expected to hold a fascinated general public on the basis of recognizability alone. An analysis of what constitutes expression reveals that it is the product of rather minute dimensional and shading changes; in other words, commercially attractive television requires that even the rather limited field of view involved in sending faces be broken up into exceedingly small picture elements.

Fifty lines make an easily recognizable face, while 72 show marked improvement in detail. With a square field of view the number of picture elements per frame is 2,500 and 5,184 for 50 and 72 line scanning respectively. But, even with the latter, the detail is insufficient to show normal wrinkles or the division between teeth spaced the average distance apart. One hundred lines might constitute a television service of good quality for reproduction of close-ups of faces. If the field of reproduction is viewed ten to fourteen inches from the eye and is one inch square, a hundred line reproduction would give average magazine half-tone quality. This quality constitutes the minimum which might be expected to attract and hold continued public attention.

Much more active public interest could be expected from a television system capable of showing two figures in action. This would permit the reproduction of prize-

Frequency requirements for television pictures of various degrees of detail

Lines	Picture elements per Frame	Picture elements per second — Repetitions			Maximum picture signal frequency — Repetitions		
		16	18	20	16	18	
24	576	9,216	10,368	11,520	4,608	5,184	
48	2,304	36,864	41,472	46,080	18,432	20,736	
72	5,184	82,944	93,312	103,680	41,472	46,656	
100	10,000	160,000	180,000	200,000	80,000	90,000	
200	40,000	640,000	720,000	800,000	320,000	360,000	
500	250,000	4,000,000	4,500,000	5,000,000	2,000,000	2,250,000	2
1,000	1,000,000	16,000,000	18,000,000	20,000,000	8,000,000	9,000,000	10

fights and simple dramatic reproductions. With the addition of action, great detail of facial expression would not be required to maintain interest. If we maintain the same number of lines per inch of reproduction as is necessary for good facial images alone but merely increase the area of the field of reproduction fourfold, two prize fighters in the ring could be watched with intense interest. This requires scanning in 200 lines, breaking the scene into 40,000 picture elements. Even with so great a number of elements, each boxer's face, now reduced to a small proportion of the whole field of reproduction, would be scanned by approximately only 30 lines and defined by but 720 picture elements, if the major part of a boxing ring is to fall within the field of view.

If we extend our ambition to outdoor athletic contests, the number of picture elements required per frame increases enormously. A football game, even with means of concentrating scanning to the active area of the field, could hardly be reproduced by less than 1,000 lines, bringing the total number of picture elements to 1,000,000 per frame, a number so tremendous that the whole proposition appears hopeless. It is by no means hopeless, however, because undoubtedly some fundamental discovery will be made which will alter our entire conception of television. The assumption that our present method of progressively scanning the field of view is the only one conceivable is as erroneous as predicting the possibilities or radio communication on the assumption that nothing better than a coherer is available for detection purposes.

The synchronizing problem

The correct position of each picture element in the field of reproduction is determined by the time of its transmission. The scanning motor controls the rate at which picture elements are exposed to the light sensitive device. The motor driving the receiver distributing device (i.e. scanning disk or distributing switch) must perform in perfect synchrony with the transmitting motor. The greatest deviation which can be tolerated is approximately half a picture element; a greater swing will cause annoying distortion of the texture if the reproduction is at all fine. Half-a-picture element accuracy means that the scanning disk at the receiving point revolves no further out of step than it normally travels in half the time allotted to the reproduction of a picture element.

For 24 line scanning at 16 repetitions, 9,216 picture elements are sent per second; for 200 lines, the number is 640,000. These figures reflect the relative magnitude of the synchronization problem. Considering that the phase angle of synchronous motors changes both with fluctuations in line voltage and in load, it is obvious that reliance upon 60 cycle power line synchronization for more than 24 or 48 line television is entirely impractical. Synchronization must be positive and automatic. Popular approval cannot be secured by any system requiring accurate manipulation of a control, equivalent stunt of maintaining zero beat in radio telephone tion with a regenerative receiver. Experience has proven that the only practical solution is synchron through a frequency which is a large proportion carrier frequency itself. This involves cost featu additional channel facility requirements of a consi magnitude.

For the present, however, we must confine ou sideration to known methods. Because of the motion in a prize fight, the field of view must be s at least 20 times a second. With 200 lines, the r of picture elements is 40,000, making a total per scanned of 800,000 picture elements. The ma rate of change encountered is from black to whit one element to the next. This produces one alter making the maximum frequency which must be modated 400,000 cycles. The frequency capac every element of the television system, from cell response to reproducing element, must be eq

$$f_{max} = \frac{p \times r}{2}$$

where f_{max} is the highest picture frequency requ the number of picture eltments per frame and repetition rate.

It has been argued that these theoretical requir are somewhat in excess of those necessary in practi the technical papers describing the Bell 50-line s 17.7 repetition rate and theoretical maximum frequency of 22,125 cycles, it is stated that falli of quality becomes noticeable only when the ma frequency cut-off was brought down to 15,000 Similar tests have been made with other systems. believed, however, that in all such instances eithe other element of the system, optical or electrica preventing response to the higher frequencies finer details of reproduction were not necessary b little detail of the subject matter was being repr in any case.

As fineness of scanning increases, finer detail be reproduced and its loss becomes quickly notice the high frequency cut-off is lowered. In the 72-line Bell system, requiring 40,000 cycles, the theoretical frequencies were found necessary to tenance of detail in reproduction. As the den picture elements increases, the maximum frequen quired become of greater and greater importance assertion that the theoretical maximum is not util practice proves to be merely an admission that more elements of the system do not measure up needs of the scanning system.

Patently, the magnitude of the problem grow much faster rate than the number of picture el The accompanying table shows the maximum fre requirements for television systems of various

[*Continued on page 266*]

ne vacuum tube stage d mobile umination

. A. BREEDING*

E Thyratron tube is an electron discharge tube hich allows current to flow in only one direction rough it and in amounts depending on the phase o of the grid voltage with respect to the anode g. When these two voltages are in phase the full f alternating current voltage is rectified. When rid voltage lags the anode voltage, only a portion of ol wave is rectified. The power output to a given o the rectified current circuit will, therefore, depend h phase relation of the grid to the anode voltage. hifting the phase of the grid voltage from in phase 8 degrees lagging, the load can be varied from um to zero. Incandescent lamps do not require ng to zero to be dark enough for practical pur-. Twenty per cent of normal voltage, or approx-el 39 per cent normal current for Mazda C lamps tely satisfactory dimming for most work in mo-or lighting.

ible exceptions to the above are lighting appli- where the lamps are directly visible. In these t is necessary to go as low as 8 per cent normal e, or 22 per cent normal current in order to black e filament.

en continuously changing lights are required, a p similar to Fig. 1 is used. In this diagram a ron motor is shown driving a small induction tor. It is this small regulator, about 3 inches in er by 5 inches long, combined with resistances e, R_3 (and capacity C_1 in some cases) and the cor-rid transformer which gives the desired dimming

hangeable gear transmission between the Telechron motor and the voltage regulator determines the length of the total cycle. The gearing provided with the standard Novalux Thyratron controller gives total cycles of 6, 15, 21½, 30, 42, 60, or 150 seconds. The shape of the dimming curve is determined, mainly, by the position of the phase-splitting potentiometers R_1 and R_3. (See Fig. 1.) They are equipped with screwdriver slot adjustment.

Means are provided in the circuit and apparatus for shifting the phase of grid and anode voltages so that for greater or lesser portions of the cycle will the lamps be dimmed or burned at full intensity.

If the grid voltage is in phase with the anode voltage during most of the cycle, the result will be a maximum brightness on the lamps throughout the greater part of the cycle. By increasing the phase angle between anode and grid sufficiently the lights can be kept partly dimmed throughout the cycle.

Efficiency; Thyratron versus resistance dimmer

An idea of the flexibility of control can be reached from the above discussion. The equipment flexibility is almost as great. The load which can be controlled with one pair of tubes supplying power directly to the lamps is about 600 watts at 120 volts with the type FG-27 tube. A comparison of efficiencies of a direct-control unit of this type with the efficiency of a resistance dimmer on a 500-watt load is shown in Fig. 2.

With loads of one kilowatt and over, the Thyratrons supply power to reactors which in turn control the load circuit. With this type of setup and using the present reactors one pair of tubes can control from one to 60 kva.

The saturable core reactor has both an a.c. and d.c. winding, so arranged that there is no transformer action between the a.c. and d.c. coils. The d.c. coil surrounds both the a.c. coils. When no d.c. flows the coils act as an iron cored choke and the lights are dim. When d.c. flows the iron is saturated and the choke effect decreased so that with enough d.c. supplied the lamps are at full brilliancy. The reactors used at present are manufac-

▼

The new electron tube, the Thyratron (Greek, "a door") is a versatile servant. In illumination its most important application at the present time is the control of mobile lighting —where it excels the resistance type of dimmer when dimming loads larger than a very few kilowatts. The only reason for considering resistance dimming is because the first cost of the tube and control equipment excluding reactors is the same, whether for dimming a one-kilowatt or a sixty-kilowatt circuit.

▲

ysicist, Illumination Engineering Laboratory, General Electompany.

tured in 1-2-3-4-6-8-10-12 and 15-kva. sizes. All sizes can be operated in parallel and up to a maximum of four 15 kva. reactors, will operate from one pair of FG-27 tubes. Efficiency curves for the 2 kva. and 8 kva. reactors and comparable resistance dimmer are shown in Fig. 3.

Control of circuits in sequence

At times it becomes necessary to control a number of different circuits according to a given sequence. This type of equipment lends itself to such a control scheme very readily up to four separate circuits. In such a case a Selsyn motor used as an induction regulator can be substituted for the induction regulator. The Selsyn may have either a three phase or a four phase (quarter phase) winding, and so can be used to supply voltage to two, three, or four grid circuits in a setup similar to that in Fig. 1. Each separate circuit must have its own equipment, as follows:

1—Grid transformer
1—Filament transformer
2—Thyratron tubes
1—Grid current-limiting resistor
Reactors enough in parallel to carry the load.

The remainder of the equipment is common to all circuits up to four dimming circuits, and consists of—

1—Anode transformer
1—Potentiometer R_1
1—Potentiometer R_2
1—Potentiometer R_3
1—Selsyn Motor, used as voltage regulator
1—Changeable gear transmission
1—Driving Motor

The above setup is for automatic mobile color lighting. When manual control is desired on each separate circuit a separate induction regulator equipped with hand dial is supplied for each circuit instead of the special regulator and driving equipment described above.

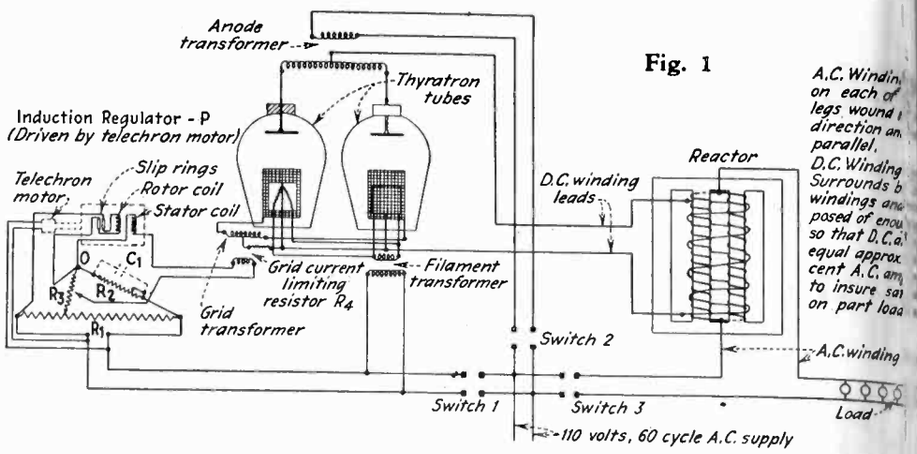


Fig. 1

Shifting the dial then gives the manual control. setting can be maintained as long as desired wit danger of burnout of the equipment. If both ma and automatic control are desired then both the matic control and the separate regulators are sup and a throwover switch is located between the two cutting out the one not in use.

Remote control simplicity

Remote control is very simple with this type of eq ment since the voltage regulator may be located at desired control station and an annunciator cord nected back to the grid circuit of the proper pai tubes. The grid current is only a few milliampere very little copper is needed.

Some applications to which the equipment is e cially adapted are:

1. Theater and auditorium lighting
2. Floodlighting of buildings
3. Interior decorative lighting—Colorama
4. Show windows
5. Signs

Some advantages of the Novalux Thyratron con equipment over ordinary types of dimming and con equipment are:

1. No moving parts carrying load current.
2. No flickering of lights—a gradual transition f one setting to another can be effected.

A *Two FG-27 Thyratron tubes adjusted to give 120 volts and dimming 500 watt lamp.*
B *Resistance dimmer for any load*

Shaded portion under each curve represents actual operating range when lamps are dimmed to 20 per cent normal voltage

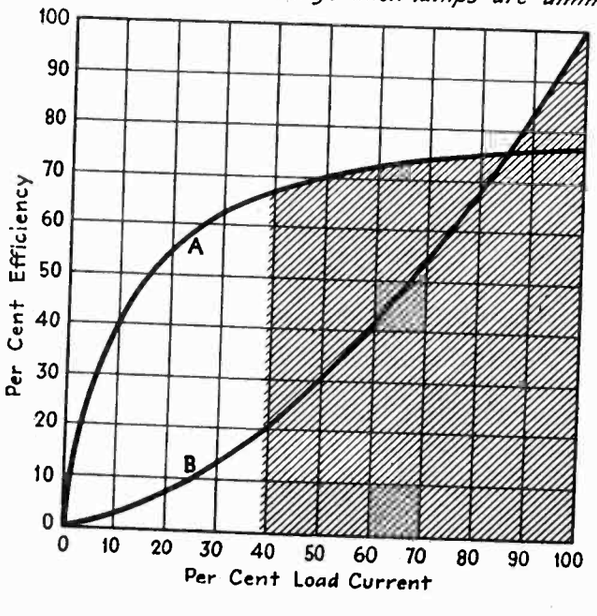


Fig. 2

A *8 Kva. Thyratron controlled reactance dimmer*
B *2 Kva. " " " "*
C *Resistance dimmer for any load*

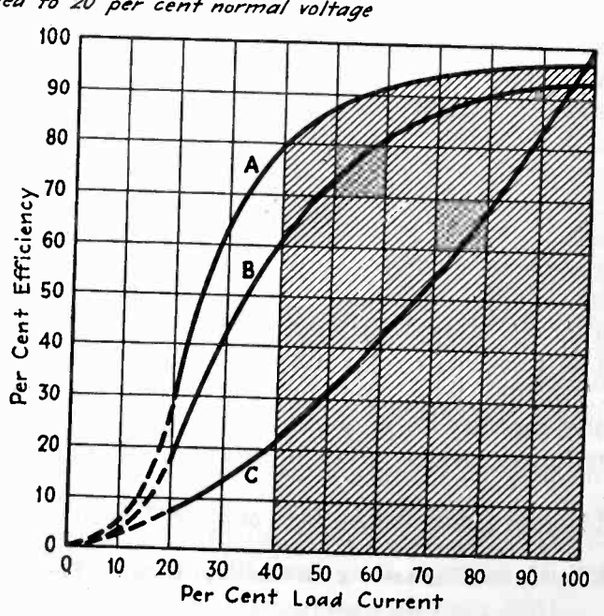


Fig. 3

/ery high efficiency over the required dimming ycle on incandescent lamps, consequently very ttle heat to be dissipated.
'ractically noiseless—the only rotating parts are Telechron motor driving a small induction volt-ge regulator through a changeable gear trans-ission.
'ery flexible as to
a) Load per pair of tubes
b) Total time cycle for complete effects
c) Shape or gradient of dimming cycle
d) Relation of each dimming circuit to others on small phase shifting device
lectrically, rather than mechanically, connected pparatus promotes:
a) Remote control, when desirable
b) Long life since there are few wearing parts
c) Easy repairs in case of failure
pace required for installation is smaller than for any other type of dimming equipment when comparable loads are considered.
8. Reactor drop at full load is low enough to permit use of 115 volt lamps on 120 volt circuits, or 110 volt lamps on 115 volt circuit.
9. Number and size of auxiliary control parts greatly reduced.
10. Ease of adjustment for different effects.

A notable example of control equipment of this type which is in operation at the present time is the Chicago Civic Opera. The opera has completed a most satisfactory season using Thyratron control equipment with remote control for setting up all scenes.

An example of interior decoration with light (Colorama) which is controlled by Novalux Thyratron control equipment is the dining room of the Great captain's island Beach and Yacht Club, located about a mile and a half off shore from East Portchester, Conn.

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earch in electronics will

incomplete without study of

The nature of music

JOHN REDFIELD*

GENERATION ago telephony was entirely innocent of any interest in such recondite subjects as speech and hearing. Grown fat and plethoric from *itting* speech, without bothering to know anything it,—any suggestion that it might be advantageous *erstand* speech would have been met with the patg smile traditionally reserved for the lean pos- of information only.

f a generation ago the Bell laboratories were instiin the hope of developing improved methods of transmission. Today these laboratories spend than a million a month, a goodly portion of which oward learning the tricky ways of speech and hearemselves, as distinguished from methods of speech nission *per se*.

Electronics offspring half musical

day the new art of electronics, has hatched out a of very active musical chicks, is running around cles trying to prevent the little devils from escapvery-which-way, all at the same time. That each breast is a-flutter with a dual impulse, musical as as radio-active, has not yet occurred to the apoplecld cluck.

e should have sense enough to know that half their mosomes would be musical, but this seems to have escaped her attention entirely for the moment. She'll remember it though; they'll see to it that she does.

It is impossible for electronics longer to disregard with impunity the musical aspects of transmitting and reproducing music. Mechanical and electrical engineering talent of the highest order, and unstinted in quantity, is brought to bear upon the problems encountered. Even auditorium acoustics is attacked with heroic determination.

Turn research onto musical principles

But there the matter ends.

The nature of music itself, melody, harmony, counterpoint, scales, even the production of music by musical instruments, is as little understood, and of as little interest, to those investing billions in electronic industries dependent upon these phenomena for their very existence, as would these same phenomena be to a tribe of digger Indians.

By tomorrow the situation will be radically changed. Some one will break the ice, and then what a scramble there will be to secure researchers in music; in scales, instruments, orchestration, composition, counterpoint, harmony, melody, musical esthetics. The number of workers engaged upon such researches will be commensurate with those found in the various great laboratories of manufacturers today.

It is even conceivable that the great musical compositions of the future will be the work of researchers employed in such laboratories; for at last there is money in music for big business.

*Professor of Musical Physics, Columbia University, New York City.

Sound motion-picture photography

By JOHN P. LIVADARY, E.E., M.S.*

THIS article discusses a few fundamental principles underlying sound motion-picture photography. In particular, the "variable density" method of sound recording will be considered and most definitions will be derived from theoretical considerations rather than arbitrary assumptions.

Figure 1 represents the cross-section of a semi-transparent substance. If a light of intensity I_o falls upon it, part of the light will be absorbed and part will emerge from this substance reduced to intensity I_b. Assuming that this material is homogeneous and its coefficient of absorption is K, we have the following fundamental equation:

$$-d\,I_x = K\,dx\,I_x$$

That is, the amount of light absorbed per unit surface is proportionate to I_x the amount of light falling upon the element dx, the volume of this element and the coefficient of absorption K, which coefficient may as well be defined by the above equation. Solving this equation and applying the initial conditions we have:

$$\log \frac{I_o}{I_x} = K_x \text{ or } \frac{I_o}{I_b} = \text{Constant}$$

The quantity $\log \frac{I_o}{I_b}$ is defined as density; $\frac{I_o}{I_b}$ is defined as opacity; the reciprocal of the opacity is defined as transparency, ordinarily called transmission; we further have the relation

$$\text{Opacity} = \frac{1}{\text{Transparency}} \text{ by definition.}$$

Transparency will be designated by the letter T and opacity by $\frac{1}{T}$.

A light of a given intensity acting upon photographic emulsion for a time t is defined as exposure, being expressed mathematically as the product It. This expression is only true under certain conditions; we shall avoid using it in this discussion and will designate light exposures by E.

Suppose that we have a sound recording system capable of translating linearly sound intensities i responding light intensities, and that frequen their phase displacements are not disturbed by th fer. The problem of sound photography co obtaining an image of these light intensities in t of a series of transparencies, each transparenc directly proportional to the light intensity wh produced it. This is necessary because a sound p consists essentially of a constant beam of light modulated by the transparencies of the interposed track," before reaching the photo cell where it verted into electrical energy.

Without going into the chemical reactions caus photographic emulsion by light exposures we will that their net effect is equivalent to changing th cient of absorption of the film from a consta variable quantity. This quantity becomes a func the exposure, type of emulsion, chemical com and temperature of the developer, time of d ment, etc.

The effect of exposures may be studied separa keeping the other factors constant and varying posures in the manner illustrated in Fig. 2. This illustrates the principle of operation of the sensit in which a light of intensity I_o exposes a section through a tablet made up of squares of varying parencies. After a fixed chemical developme above exposures will appear on the film in the f opacities which can be measured by means of a de eter. These opacities may be plotted again exposures which have produced them, as shown in

It is well to point out that absolute units a essential; opacities and transparencies are just nu and exposures need only be considered in rela each other.

In order to determine a mathematical expression

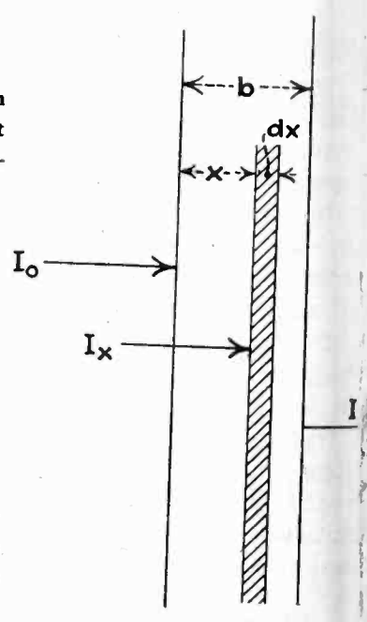

Fig. 1—Cross-section view of semi-transparent substance such as photographic film

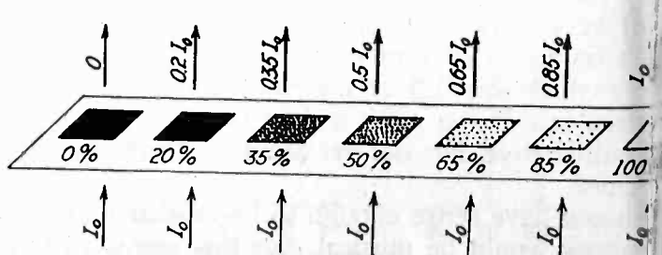

Fig. 2 — Sensitometer tablet made up of squares of varying transparencies

*In charge of Sound Department, Columbia Pictures Corporation.

resent a portion of this curve, for the purpose llowing analysis, we plot log. of opacity against xposure as shown on Fig. 4. Designating the the straight line portion of this curve by gamma express opacities in terms of exposures between s A and B as follows:

$$\frac{\log \frac{1}{T} - \log \frac{1}{T_o}}{\log E - \log E_o} = \gamma \qquad (1)$$

and log. E_o are the coordinates of any point A and B. This expression reduces to the form:

$$\frac{T}{T_o} = \left(\frac{E_o}{E}\right)^{\gamma} \qquad (2)$$

nd-film record that we have obtained so far es what is known as the "Negative" and it is d for printing.

nteresting to note that if we recorded sound as bd above by limiting the exposures between A he "Negative" would be unsuitable for sound tion because even if gamma was unity the best get out of it would be an inverted speech, as y the relation:

$$\frac{T}{T_o} = \frac{1}{\frac{E}{E_o}} \qquad (3)$$

possible however to explore the portion of the Fig. 4 beyond the points A and B and set up theory whereby the negative may become repro-

Factors governing the sound-print

rocess of printing consists in exposing film with ntnt source of light P modulated by the transis of the interposed negative, which remains in with the film during this operation. This relamay be expressed as follows:

$$E_p = P\,T_n \qquad (4)$$

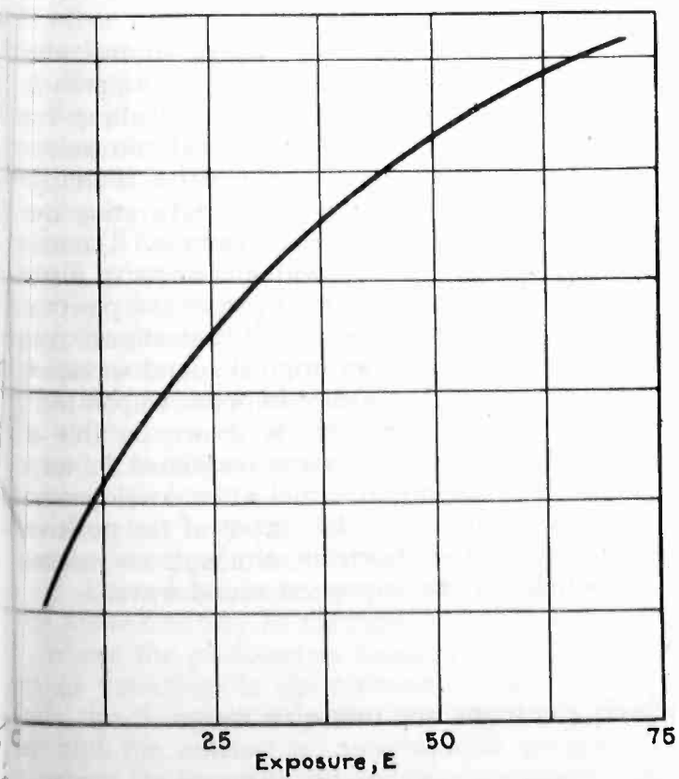

Fig. 3—Characteristic curve of photographic emulsion. Exposure vs. opacity

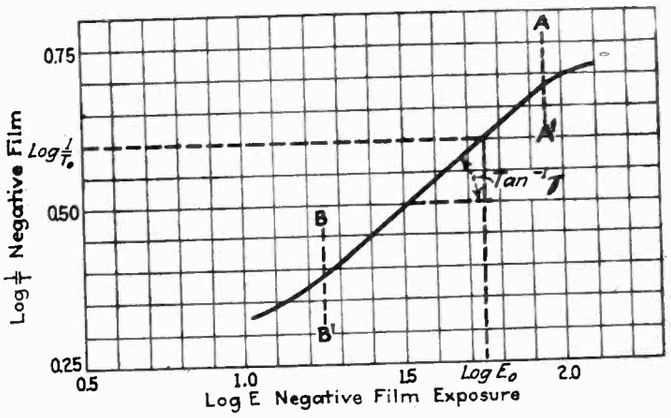

Fig. 4—Typical H and D curve of which the straight line portion is the region of correct exposure

That is, the exposure of the print is equal to the exposure caused by the printing light P modulated by the transparencies of the negative. Such a print is called a "Positive," and is ordinarily developed in the same manner as the negative although the composition of the developer and time of development may be different.

Considering the developed positive we have a relation between its transparencies and exposures similar to equation (2).

$$\frac{T_p}{T_{op}} = \left(\frac{E_{op}}{E_p}\right)^{\gamma_p} \qquad (5)$$

the subscripts meaning a positive print. It is needless to say that this relation only holds for a series of exposures covering the straight line portion of the log of opacity—log of exposure curve. This curve is called an H and D curve from the initials of the two original investigators, Hurter and Driffield, who were the first to use it.

Our problem is to relate the exposures of the negative to the transmissions of the positive print; this can be done by combining equations 2, 4 and 5 and leads to the following expression:

$$\frac{T_p}{T_{op}} = \left(\frac{E_n}{E_{on}}\right)^{\gamma_n \gamma_p} \qquad (6)$$

Determining the correct exposure points

Before proceeding further we should emphasize the significance of the point T_o and E_o. Voice frequency currents are complex wave form alternating currents. When they are converted into light exposures by a suitable device such as the light valve used by the Western Electric Company or the Aeolight used in the Fox Case system, varying amplitudes are translated into varying light exposures and the zero axis of the amplitudes assumes the form of a steady exposure E_o which produces a very definite transparency T_o on the positive print. We must not overlook the fact that the theory developed above holds only for exposures, the logarithm of which lies on the straight line portion of the film characteristic. It is therefore necessary that the unmodulated exposure of the negative, E_o, as well as the corresponding transmission of the positive print, T_o, lie in the logarithmic middle of the H and D curves so that we may register amplitudes above and below these points without exceeding the limitations imposed by this theory. This is accomplished by careful control of the exciting lamp current in the film recording machine and the proper assignment of printer light in the film laboratory.

Equation 6 will give a linear relation between transparencies of the positive and exposures of the negative if the product $\gamma_n \cdot \gamma_p$ is equal to unity. This is easily accomplished as gamma is a function of the time of development, all other factors remaining constant. Means of exposing film in a recording machine or sound camera, have not been discussed but it has been assumed that exposures can be obtained which will faithfully record sound within a given frequency range.

Controlling factors in film development

The above theory relating transparencies and exposures of negative and positive film has brought out certain quantities which can be used to control film development.

These control quantities are:

(a) The unmodulated exposure of the negative E_o.
(b) The unmodulated transparency of the negative T_{no}.
(c) The unmodulated transparency of the positive T_{po}.
(d) The slope of the negative H and D curve γ_n.
(e) The slope of the positive H and D curve γ_p.

The fundamental properties of these quantities are:

(a) The product of $\gamma_n \cdot \gamma_p = 1$.
(b) E_o must lie in the logarithmic middle of the negative curve.
(c) T_o must lie in the logarithmic middle of the positive curve.

There is a limitation imposed on this theory from the fact that exposures of negative and positive films must lie within certain limits, as shown on Fig. 4. The practical means employed to determine the above mentioned control quantities do not always represent accurately conditions in the film recording and printing machines, on account of the difficulty in developing a suitable mathematical expression to represent adequately exposures as a function of light intensities and time, thus introducing correction factors for both gammas.

Most control instruments utilize *diffused* light, whereas the optical system of the sound projector is considered *specular*. This introduces an additional correction factor.

The corrected relationship between gammas is as follows:

$$\gamma_n \cdot \gamma_p = K$$

When sound is released on disc by transferring the sound from film to disc, any particular γ_n and any particular γ_p may be used so long as their product is equal to the constant factor K. However, when releases are made on a "movietone" print, which is a composite print containing both picture and sound track, the development of the positive sound track is bound to be the same as that of positive picture. Therefore, the value of γ_p is determined by the picture development. This le only one control factor γ_n which is determined by relation $\gamma_n = \frac{K}{\gamma_p}$

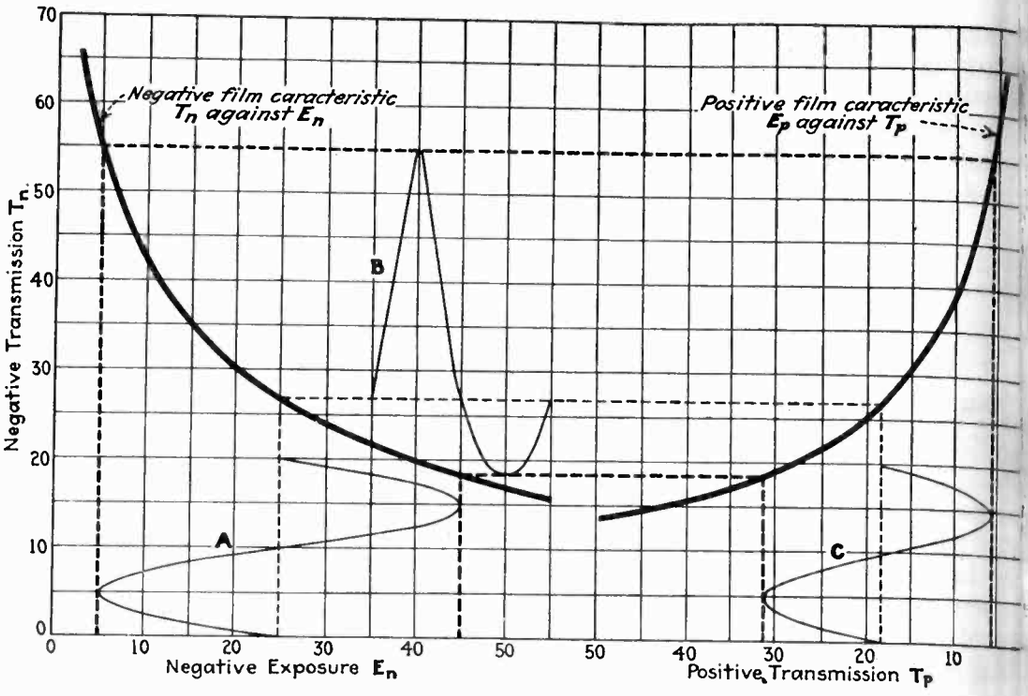

Fig. 5—Curves showing how negative and positive film, through a series of compensating distortions result in faithful reproduction of original sound wave

Average control quantities used

This theory is particularly adaptable to the We Electric Company's recording system because the intensities used in the film recording machine happe lie within the range investigated in this article. following are average values of the control quant described herein for this type of development, as enc tered in actual practice.

T_{no} = 18 per cent — 25 per cent
T_{po} = 18 per cent — 25 per cent
γ_n = 0.55 — 0.65
γ_p = 1.9 — 2.3

The distortion resulting by faulty control eithe determining gammas or unmodulated transparencies be shown mathematically. Distortion resulting fron error in the value of the unmodulated transmissio the positive or exposure of the negative is much r pronounced and the result is more aggravating than distortion from faulty control of gamma. Gamma vary as high as 30 per cent without excessive distor

Figure 5 illustrates how the negative and positive through a series of compensating distortions, resul faithful reproduction of an original sound wave. C A shows a sinusoidal exposure impressed upon the n tive film whose characteristic is shown on this fig Curve B shows the same wave translated in term transmission of the negative film after development, curve C shows the sinusoidal output of the positive which preserves the character, although not necessa the amplitude, of the impressed sound wave.

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We are reaching the newer era in which electrons are made to move through space unguided by wires.

DR. A. N. GOLDSMITH
Vice-president and General Engineer, Radio Corporation of America

e of the
oto-electric
l in
otometry

AYTON H. SHARP, Ph.D.*

FALL the applications of the photo-electric cell prhaps its use in photometry exacts more of it an any other. While, in other applications, iate linearity of response and approximate con- sensitivity are sufficient and the question of ponse is, in general, of no great importance, in ry some or all of these requirements are much id, so that deviations from the ideal condition, other cases might be of no practical practice, ome major factors.

simplest form a photo-electric photometer the photo-electric cell, a battery and a gal- er or electrometer which measures the current d under the influence of the illumination on the , hence, gives a reading proportional to that ion. This simple method of application, useful in a great deal of laboratory work, is not well to photometry on an industrial scale, largely of the practical difficulties of the rapid and cer- asurement of small electric currents. For this he obvious step has been taken of introducing ation by means of valves, thereby enabling better and less delicate apparatus to be employed.

on as the principle of amplification is adapted abundant opportunity for devising different and systems of measurement, and a considerable of these have been proposed. Three general of procedure may be distinguished in this regard: , where the photometric measurements are made s of variations in the plate-circuit of a vacuum hus, involving directly the linearity of the tube e and the amount of amplification introduced: , where the linearity and amplification of the tube do not enter directly into the result but only the linearity of the cell response is involved; Class 3, where the linearity of neither cell or amplifier is required.

An example of the first class is the photometric arrangement developed and used by the Westinghouse Lamp Company. The diagram of Fig. 1 shows the circuit employed. A milliammeter is connected between the filament and a suitable point *P* on the plate battery, so that with the cell in the dark, suitable adjustment of *R* will produce the condition that the milliammeter indicates zero. Next, the photo-electric cell is exposed to the illumination of a standard lamp of known value and by adjusting either the distance between the cell and the source of an iris diaphragm placed in front of the cell, the milliammeter is brought to a reading which corresponds to the assigned value of the standard lamp. Thereafter, the readings of the milliammeter are directly interpretable in terms of the output of the lamps being measured.

It will be seen that the results vary in accordance with the characteristics of the photo-electric cell, of the amplifier and of the voltages applied thereto. A disadvantage of this arrangement is that the voltage on the photo-electric cell, when it is delivering current, is less than the voltage on the cell when dark, by an amount equal to the voltage drop of the photo-electric current in the high resistance connected between the grid and filament. Unless a vacuum type of photo-electric cell is used and the applied voltage is well above the saturation voltage of the cell, a departure from linearity of response may readily occur. In fact, in using this arrangement it has been found necessary to adapt the photo-electric cell to the rest of the circuit in order that linearity may be attained. With respect to convenience and speed, this arrangement leaves little to be desired.

Bridge circuit photometer

An example of Class 2 photometers where linearity of the response of the cell is required, but where the characteristics of the vacuum tube are eliminated as direct factors, is the apparatus shown in Fig. 2, developed and used at the Electrical Testing Laboratories.* With this arrangement an amplifier bridge is used with the cathode of the cell connected to the grid of one tube. To operate, the variable bias on the first tube is made zero with the cell dark and the bias of the second tube is adjusted to the point where the bridge is balanced. Then, when the cell is exposed to light the bridge is thrown out of balance and the balance is once more

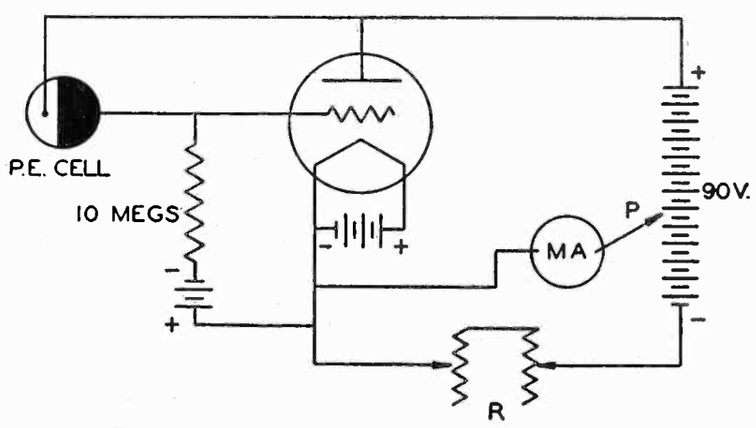

Fig. 1—Circuit in which tube characteristic and amount of amplification are important

nical Adviser, Electrical Testing Laboratories.

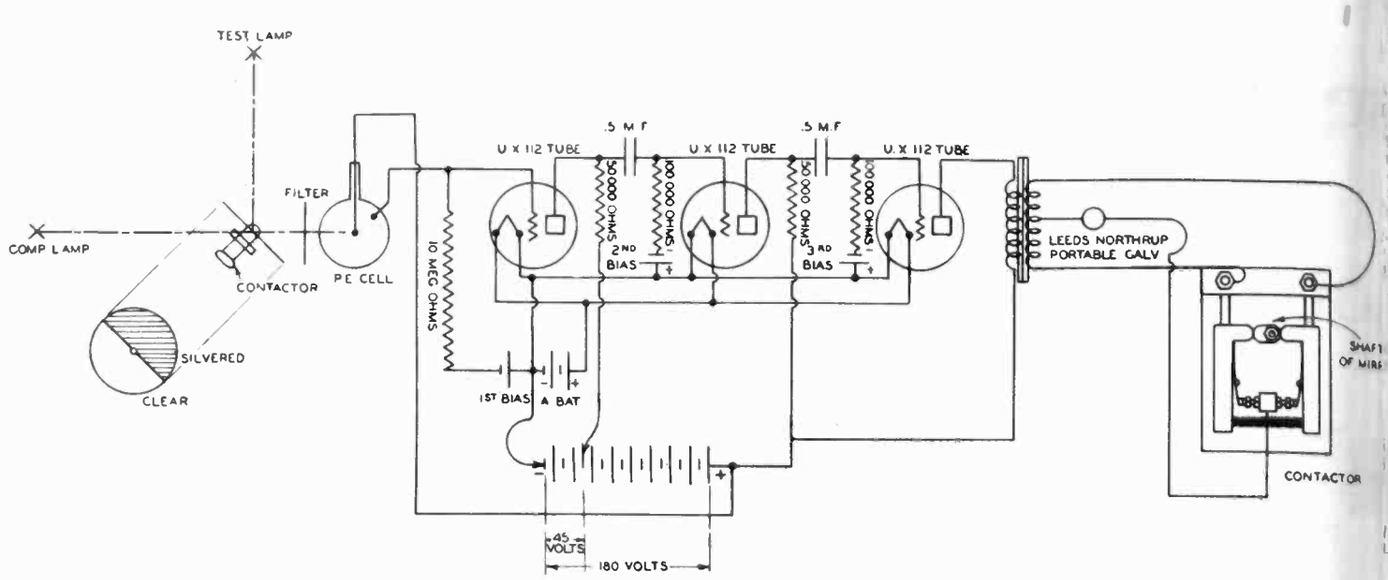

Fig. 3—By this circuit a known lamp is compared to an unknown illuminant

restored by applying an additional biasing voltage to the grid of the first tube. The amount of the voltage so applied is a measure of a photo-electric current and hence of the intensity of the light falling on the cell. This voltage may be read either by a suitable voltmeter or simply from graduation on the potential divider and may be made to read directly in candlepower or lumens as required.

This procedure has the ordinary advantages of a zero or null method. The voltage on the photo-electric cell is undisturbed, the amount of amplification and the linearity of the grid voltage-plate current relationship of the tubes does not enter in and at the same time any small variations of filament voltage have little effect on the dark balance. The vital points are that the cell should have a linear response and that the grid resistor should be stable and constant. The rest of the apparatus serves simply as a voltmeter to read the fall of potential on the grid resistor.

In Class 3 photometer the photo-electric cell serves simply to balance the illumination produced by the test lamp against the known illumination produced by a comparison lamp. The apparatus in Fig. 3 may be
Here the test lamp, usually in an integrating sphere
the comparison lamp, which travels on a track w
scale graduated in photometric quantities, shine
nately, on the photo-electric cell. To produce this
dition of alternation a glass disk which is silvered or
half is placed as shown in the diagram and the
from the comparison lamp shines on the cell whe
clear portion of the disk is in its path while th
lamp shines on the cell when the silvered half con
line. The disk is rotated by a motor and drives wi
shaft a contactor, the use of which will be refer
later.

The cell is connected to a conventional amplifie
in the plate circuit of the last tube is introduce
primary of a transformer. The secondary of the
former is tapped at the midpoint and the tap
through a rugged galvanometer to the midpoint
contactor. The terminals of the secondary windin
to the other contacts and the contactor is driven by
on the shaft of the rotating element as stated.
whole arrangement is so timed that one contact is
during the transit from test lamp to comparison
and the other contact during the transit from comp
lamp to test lamp the switching being done in the
mediate periods while the light on the cell is co
and hence, there is no current in the secondary
of the transformer. With this circuit, if the illu
tion on the cell produced by the test lamp, is highe
that produced by the comparison lamp, the galvano
deflects in one direction and vice versa. When th
are balanced the galvanometer remains on zero.
condition of balance is produced by moving the
parison lamp, and the corresponding photometric
is read from the scale connected therewith. It w
seen that the linearity neither of the amplifier n
the photo-electric cell comes into the question. Th
serves the same purpose as does the eye in the or
photometer and indicates merely when the conditi
equality between two illuminated surfaces has
attained.

In the case of all the above appliances the
electric cell with its modifying train is placed in a
box of copper or aluminium for the purpose of
out electric and magnetic disturbances.

For ordinary photometry the experience of the

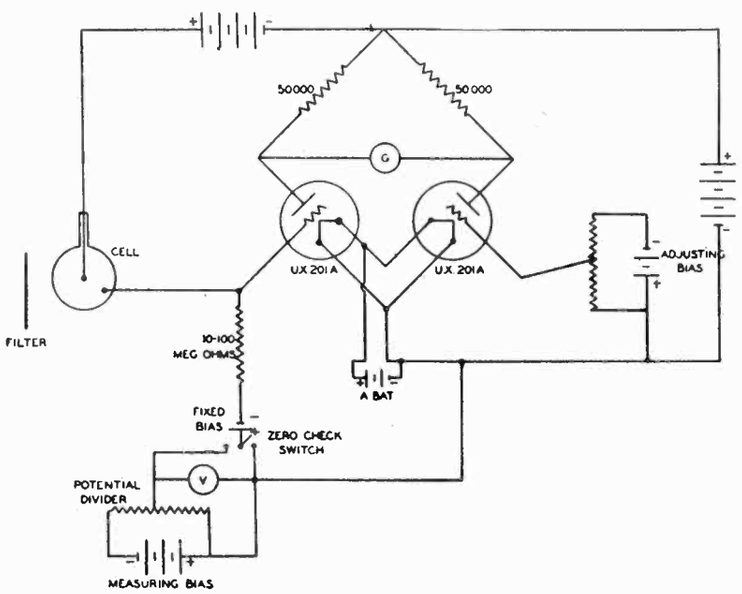

Fig. 2—Bridge or null method of using vacuum tubes and photo-electric cell in photometric measurements

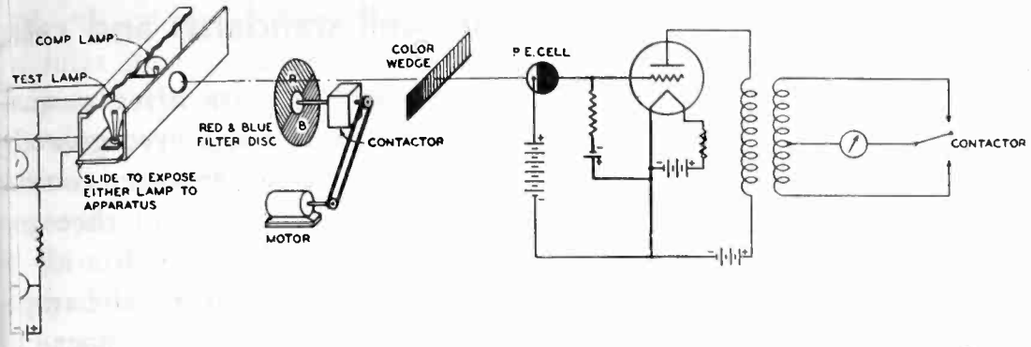

Fig. 4—Rotating disk method of matching colors or for temperature determination

esting Laboratories has shown that of the three nsidered, Class 3, namely, the rotating mirror ts, is on the whole somewhat more reliable and ory than Class 2. Five integrating spheres are usly at work with photo-electric photometers of o types and optical photometry in the ordinary f incandescent lamps has been abandoned with nt notable increase in accuracy of the work and s of cost.

easuring bias apparatus is used with great advan- onnection with the measurement of the distribu- candlepower about lamps with reflectors or . In doing this sort of work the entire lamp with ctor is rotated at a relatively slow speed so that asurement at any given vertical angle may repre- average intensity for the corresponding zone. v speed is required in order not to disturb the ents and hence, the intensity of the lamp. It owever, in many cases, in a very strong flicker ght and this flicker in the case of optical photo- akes accurate settings practically impossible. photo-electric photometer the flicker is shown sponding excursions of the galvanometer spot de and the other and the true zero reading can ated with satisfactory accuracy.

Measuring color filter transmission

ame type of apparatus is used in getting trans- values of color filters. In this work a broad is focused on the slip of a spectrometer and o-electric cell is placed to receive the emergent e eyepiece having been removed. Any one of rocedures can be used in making such meas- rs.

e amplifying bridge is balanced with the cell ark and galvanometer deflections are read with he full light and with the filtered light.

e measuring bias is adjusted to reduce the read- ngs to zero successively with the full light and the iltered light.

Brodhun adjustable sector is put in the enter- ng beam. The filter is interposed, the sector is pened to the division marked 100 and the reading f the galvanometer is noted. Then, the filter s removed and the sector is closed to the point where the galvanometer gives the same reading. The reading on the sector then gives the trans- mission in per cent. The last procedure is found to be the most convenient within the visible spectrum.

atter allied to photometry in which photo-electric ls are applicable with advantageous results is that r matching, particularly the matching of the colors ndescent lamps with each other and hence, deter- their equality in color temperature. Dr. Camp- bell of the General Electric Company's research laboratory at Wembley, England, was the pioneer in this field and developed methods of great sensitivity.

The rotating mirror photometer scheme has been adapted to color matching by substituting for the rotating mirror a rotating disk one half of which is red and the other blue (see Fig. 4). The apparatus is placed so that the light from the lamp to be measured passes directly through this disk to the photo-electric cell. Evidently, when the disk is rotated the cell receives in alternation red filtered and blue filtered components of the light of the lamp and with a proper combination of cell and filters the corresponding currents will balance each other at some one value of the color temperature of the lamp filament. If a yellowish filter is interposed, the apparent color temperature of the lamp becomes lower and it is necessary to raise its temperature in order that the balancing point can be found. It follows that by the use of a combination of fixed filters either blue or amber and a corresponding tapering or wedge filter; a balancing point can be obtained for any desired color temperature. After such a balance has been obtained the corresponding color temperature can be determined by substituting a standardized lamp and finding the voltage at which it causes a balance with the same combination of filters. From the calibration curve the temperature of the standard, and hence of the lamp being measured is read off. This arrangement will readily indicate the difference in color of a lamp caused by $\frac{1}{10}$ per cent change in the voltage at its terminals.

By attaching the color-matching apparatus to a sphere which is used also for photometric purposes, two operators can get, simultaneously, photometric measurements and color temperature measurements. Not enough experience has been had with his apparatus in every day use by non-scientific operators to enable the statement to be made that it is thoroughly in shape for industrial applications. However, with care, color temperature can be measured without difficulty to a much closer degree than is possible by optical means and there is no reason to suppose that it will not prove to be adequate for industrial requirements.

In concluding the writer wishes to emphasize that although the methods which have come under his observation are by no means perfect and introduce certain troubles and applications which are all their own yet, the practical results of their use have proven them to be on the whole so much superior to the optical methods, at least, in connection with the production and testing of incandescent lamps on a large scale that the older methods are rendered obsolete. Undoubtedly, the superiority of the photo-electric method will be increased as the future produces improvements in the practices and apparatus of the present day.

*Paper presented at a joint meeting of the *Optical Society and Physical Society* in London, June 5, 1930.

electronics

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O. H. CALDWELL, *Editor*

Volume 1 — AUGUST, 1930 — Number 5

The new mechanics of the imponderable

FORMERLY light was useful chiefly to *see with.*

But now light finds many industrial uses which have *nothing to do with seeing,* and for which no optic nerve ever functions.

For light has become a material part of many modern mechanisms, and we use it as a mechanical linkage in our machines, just as we would use steel, aluminum, glass. Light—being weightless, substanceless, frictionless, and instantaneous—makes an ideal mechanical part for many purposes.

Indeed, one may say that the mechanics of 1930 is becoming "the mechanics of the imponderable and the infinitesimal."

Thus we employ levers more frail than a beam of moonlight, yet exerting the smashing power of 12-inch steel. We fashion gears with diameters one-thousandth of the thickness of the film of a soap bubble, yet which, "geared up" can control and reverse great rolling mills weighing many tons.

Speeds of a hundred million r.p.m. have become common in our miracle machines of 1930. And we have shuttles that noiselessly flash back and forth at velocities a million times that of Lindbergh's fastest flight.

We can, one instant, create 50 to 100 feet of a weightless lever of light, and then the next instant destroy it, so that other mechanical parts may swing through it, unimpeded. As a result, our machine designers and inventors have gained new versatility, and the possibilities of infinite ingenuity, as we put "light linkages" in place of gross physical parts.

It is the photo-electric cell and the vacuum-tube amplifier which have harnessed light and put it to work in a hundred ways.

Photo-cell standards and ratin

FOR a number of years after vacuum came into use there was no recognized n of rating them so that an engineer could t from another. Then developed three co which completely define a tube for all or functions and circuits. These are the amplif factor, the internal plate resistance, an mutual conductance.

At the present time there are no such cor by which an engineer can tell one photo-cel another. Granted the problem is somewha complex, in that the photo-cell is a translat tween light units and electrical units an merely between two electrical quantities, as vacuum tube,—but some system of nomenc needs to be worked out. Then a circuit de would not have to go into the laboratory to terminal apparatus for the cell—he would at once into what the cell should work. He tell whether or not one cell was better for h pose than another of different characteristi

The big tube family

WHILE the field of electronics is buil largely around two devices now most public eye, namely, the so-called radio tube a photo-electric cell, there are many others old, some new, which are of vast potential i ance to the industry and to human-welfare

Among old friends, we have the X-ray tul its myriad helps to the physician and the trialist; the cathode-ray tubes of Lenard, C and Slack—the fields of which are varied yet, almost untouched; and the hot-c mercury rectifiers, used at present in rad with many power applications.

More recently developed are the powe glow tubes and thyratrons, which promis useful forms of control by means of adc electrodes incorporated in high-current and for certain purposes change direct to a ing current in a most interesting manner. M and gas-filled tubes, while well known in forms are now undergoing intensive new d ment. One of our electrified railroads i gas-filled power regulator tubes for control

ghting circuits. Neon markers on trans-
n lines give added protection to aviators,
n power circuits they are used as warning
around central and switching stations.
tector tubes of novel design are being tried
:graphic, fire alarm and other signal lines,
as in the control of oil burners and other
lay devices.
new magnetrons and Barkhausen oscilla-
oduce extremely short waves which not only
:ful in radio, but promise to the physician
rculous new tool for use in internal medicine,
control and cure of diseases at present
reach.
aoration would of course give a more vivid
r, but these few simple statements present,
ieve, some idea of the enormous field of
nics insofar as the plethora of devices is
ned.

hoto-cells and variable stars

IE possibility of a real "music of the
spheres," actually audible to mankind through
s of telescopes, photo-electric cells and ampli-
has been suggested by W. C. White of
ctady, N. Y. Mr. White's idea rests on
ell known fact that many stars are what
nomers call "variables;" which means that
tars change considerably in brightness from
time. In some of these variable stars the
gs are very slow, the whole cycle of waxing
aning light requiring weeks or months.
increase and decrease in brightness much
rapidly, only a few hours being needed for
mplete cycle. Careful measurements have
ted that many such stars have separate light
ions superposed on each other, not unlike
nics superposed on a fundamental vibration.
s not improbable, that some of these short-
l "harmonic" variations in a star's brightness
e rapid enough to yield a musical tone. If
ch tiny "ripples" in the starlight undoubtedly
be picked up by a suitable photo-electric cell
e focus of a telescope and converted into
, so that astronomers might listen to the
of the star, much as physicists or musicians
isten to that of a tuning fork.

New markets for American tubes?

EVEN if those American tube manufacturers who now lament the poor sales of their products were to break their license agreements and sell to the export market, all would not be plain sailing. According to reports from South America where all tubes are imported, the products of American tube plants do not sell in competition with those from the single European manufacturer who does perhaps 80 per cent of the foreign tube business.

American tubes, so it is said, not only are poorer in characteristics but do not last as long as the products of this single manufacturer. Indeed so far has the life been improved that the manufacturer fears his tubes last too long; there is no replacement market.

It is interesting to note that American products, which are believed, here at least, to be superior to all have difficulty in selling themselves in comparison with European tubes, even though in some cases our prices are lower.

"Who won?" The photo-cell in sports

ALMOST daily, excited crowds look to human judges for the answer to that question. And those judges frequently are in doubt. In the case of one championship footrace the judges' decision was reversed by the evidence of motion pictures. Six of America's speediest runners finished inches apart. The judges thought that Borah had finished first; but the motion pictures proved Bowman to be the winner. Even in that case the pictures were taken by a human being and therefore were subject to error. Whereas a picture of the finish triggered by a photo-cell would, for the first time in history permit such contests, no matter how close, to be decided beyond the question of a doubt.

There is a steady and growing market for such devices; to decide the thousands of races, on foot, on horseback, in motor cars, motor boats, and otherwise, involving championships, records, and millions of dollars, held every year, in the United States alone.

REVIEW OF ELECTRONIC LITERATUR

HERE AND ABROAD

Radio guidance of ships and planes

[DAVID] An indispensable article, summarizing present-day practice, with a full bibliography. Descriptions are given, with maps, diagrams, and photographs, of the principal alignment methods, especially as applied in France: ground or shore compass stations taking bearings on plane or ship transmitters, plane or ship compass stations taking bearings on ground or shore transmitters (and the direct-reading "radio compass" developed as a variant of this), revolving beam transmitters, fixed directional twin transmitters where equality of reception indicates that the receiver is on the straight-line course desired, fixed and swinging "line of silence" systems (along which the carrier-wave appears to be unmodulated), etc. Somewhat shorter descriptions are also given of systems for indicating sinuous courses such as harbour-entrances, by submerged cables (these digests, June), by the intersection of rotating beams transmission, etc.—*L'Onde Electrique, Paris, May, 1930, published June 12.*

✦

New fundamental frequency standard

The bureau has recently installed equipment which materially advances the accuracy of the frequency standard. The new equipment comprises essentially a group of four piezo oscillators, each having the frequency 100 kilocycles. Three are alternative standards, the fourth is a reference point against which to check the others. Beats between each of the first three and the fourth are automatically counted by three telephone message registers. An automatic camera takes a picture of the counters each 1,000 seconds, from which record the number of beats per 1,000 seconds of each standard against the reference point can be obtained.

To obtain the absolute frequency the output of one oscillator is fed into a submultiple generator from which currents of 10 kc. and 1 kc. may be drawn, these frequencies being as accurate as the original oscillations. The 1 kc. frequency drives a synchronous motor clock, which is geared to keep exact mean solar time when the input frequency is exactly 1,000 cycles.

The rate of the clock is obtained by checks with Arlington time signals. The percentage gain or loss then is numerically equal to the deviation of the oscillator from 100 kc.; that is, if the clock gained 1 second per day, it would be fast 1 part in 86,400, so the frequency of the piezo oscillator is 100,001.16 cycles per second.

The crystals are of 30° cut and vibrate on a thickness frequency. They are doughnut shaped, that shape being chosen as giving a low temperature coefficient. The temperature and atmospheric pressure in which the crystals operate are carefully regulated, as are the filament and plate voltages. Stand-by batteries take care of power failures.

Measurements show that the average short-time variations of each of the crystals are less than 1 part in 10,000,000. The standard maintains an absolute value of frequency which is known to 1 part in 10,000,000.—*U. S. Bureau of Standards Bulletin, May, 1930.*

✦

Radiotechnique and the deaf

[HÉRMARDINQUER] A description of the principal methods used at the present day for the benefit of those of defective hearing: more especially the Phonophone (receiver, microphone and battery), Optophone (similar but with the receiver reduced in size so as to be placed within the ear itself), Balbo (powerful receiver with tube extension into the ear itself, and with a device for accentuating the low or high notes according to the type of deafness), and Radiophone (electrostatic receiver in which the body itself forms one pole of a condenser).—*La Nature, Paris, July 1, 1930.*

✦

The Spielmann photo-electric piano

[WEISS] To each note there corresponds an electric lamp, throwing a beam of light onto a photo-electric cell through a series of perforations in a revolving disk: the pitch is thus determined by the number of perforations and the speed of revolution of the disk. In practice twelve disks on a common axis are used, each with 8 concentric series of perforations, thus giving 8 octaves. The feeble currents from the photo-electric cells are amplified and fed to a loudspeaker. For operation, a keyboard is employed, each key of which controls the circuit of one photo-electric cell: a variable resistance is so actuated by the key that as this is more fully depressed the strength of c and hence the volume of soun duced increases. (*Note.* Ther pears to be some confusion; the as given, but the diagrams, althou clear, appear to indicate that th and its rheostat are associated wi circuit of the electric lamp rathe with that of the cell).—*La Paris, July 1, 1930.*

✦

Telephotography (Belin)

[DELATOUR] A description o latest modifications of this system. image to be transmitted is wr round a cylinder and explored luminous spot, the reflected beam interrupted about 1,000 times per s on its way to the photo-electric which is followed by the usual amplifier. At the receiver a bea light is thrown onto the mirror oscillograph, the reflected beam pa through a V-shaped slot before ing the photographic paper wr round the revolving cylinder, in s way that a large current (corresp to white in the transmitted in causes the beam to pass freely th the base of the V, whereas smalle rents deflect the beam towards the rower portion of the V, thus interce more or less of the light. By r reversing the V, positive or ne images can be produced at will. chronism in the latest pattern is obt by two tuning-forks, having a n period of about 600 periods: exact chronism is obtained at the receiv means of a small iron-core coil between the limbs of the tuning- in this a current circulates, the str of which is controllable by means resistance. A stroboscopic method observation of a neon lamp, illumi at the frequency of the transmitter through holes in the revolving cy of the receiver) is used to obtai check this exact synchronism. is a further synchronism, that of tion (as distinct from that of spee that a signal is transmitted onc revolution of the transmitting cyl and this through relays release receiving cylinder in such a way th images occupy the same position c two cylinders.

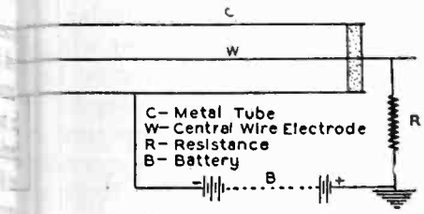
In another pattern, for amateu the image is produced by a sty electrolytic paper, and the sole chronism is that of position jus scribed, this giving results suffic precise for this purpose.—*Radio tricité et Q.S.T. Français, Paris, 1930.*

copper oxide rectifier

ON] Microphotographic exam- permits the reconciliation with pted theory of crystal detection pparent reversal of the rectified by demonstrating the existence cond incomplete contact within le layer, the rectifying effect of s greater than that of the con- veen the electrode and this layer. fects on rectification of the pres- rcised by the contact-electrode, ture, and of the voltage applied studied.—*L'Onde Electrique, ay, 1930, published June 12.*

✦

tube electron counter



URTISS] Experiments are de- which show that the sensitive of the Geiger tube counter is he wire electrode, but on the rface of the tube. This result the previously observed result th operation of the counter is ightly affected by the condition urface of the wire electrode. anation of the operation of the ris offered which takes account dditional information.—*Journal earch, Bureau of Standards, 30.*

✦

tonic waves, light quanta, lanck's Law

THOMSON] This paper is an to give, by the aid of electronic physical interpretation of light their relation to electrons, and hanism of light. The electron regarded as consisting of two ne, the core, carrying a charge ive electricity equal to *e*, while r is a system of waves surround- core, the velocity of the core e group velocity of the waves eighborhood. The wave system as the core may have both and momentum, and if the core enly stopped the waves will go travel away from the charge. ew taken in this paper is that anta consist of a special type of ave systems, and thus that the e of light quanta is very closely ed with that of electrons. first case considered is that of tem of waves associated with an which travels, like those inside m, around a closed path. In this he electronic waves travel in paths with their wave fronts always perpendicular to the paths of the electron cores. The waves circulate in closed paths and as the energy also travels in closed circuits none of it will escape: i.e., there is no radiation. The mechanical properties of this system of waves have many analogies with those possessed by a fluid in which there is vortex motion.

If the core is detached the wave system will persist and may escape from the atom, carrying with it the energy of the waves and the atmosphere of the electron. The author regards this system of waves as a quantum of light, so that, on this view, light quanta are disembodied electrons.—*Philosophical Magazine, London, June, 1930.*

✦

Measuring mechanical impedance

[E. B. MALLETT] An electrically driven tuning fork has one prong connected to the device whose mechanical impedance is to be measured; the other prong is loaded until there is no vibration of the fork support, under which condition the load added to the second prong is equal to the mechanical impedance of the device being measured. This impedance may then be divided into resistive and reactive components.—*Journal I.E.E., London, May 1930.*

✦

X-ray for boils

X-rays have been found helpful in the treatment of many diseases for which they are not generally used. Among these conditions are boils, carbuncles, certain cases of pneumonia, erysipelas, inflammation of the kidneys, inflammation of the parotid gland and many other inflammatory conditions, Dr. Arthur U. Desjardins, of Rochester, Minn., told the American Medical Association.

Irradiation tends to destroy the white blood cells or leucocytes, which gather to defend the body against infection. It would seem that a destruction of these defender cells would do more harm than good, but Dr. Desjardins explains that the white cells contain a substance that enables them to destroy the invading germs. Irradiation, by destroying the cells, liberates the protective substance and makes it even more readily available for defensive purposes than when it is in the intact cells.—*Journal American Medical Association, June, 1930.*

✦

Electro-musical instruments

[TRAUTWEIN] Extracts from the author's book "Electrische Musik" with some examples of simple instruments using neon lamps and quenched radio-frequency oscillators. The circuit shown is particularly interesting as being one of the few practical examples of the control of pitch by a resistance.—*Funk, Berlin, June 13, 1930.*

Pick-up construction

[SCHWANDT] Constructional details, with photographs, of the leading German makes, with details of tone-arms, and curves.—*Funk, Berlin, June 13, and 20, 1930.*

✦

Television and Telecinematography

[HÉMARDINQUER] Descriptions, with photographs and diagrams, of the Baird television and Vin (Philips) telecinematograph systems, the latter based on recent demonstrations in Paris.—*La Nature, Paris, June 15, 1930.*

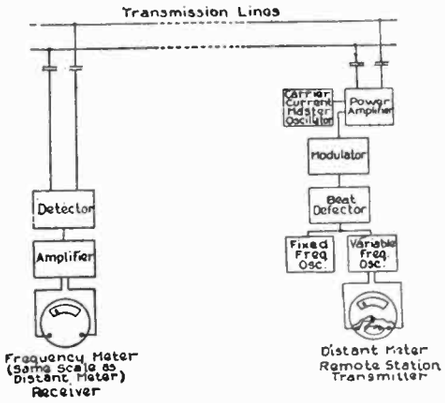
✦

New double-grid tube

[HÉMARDINQUER] Description and curves of a newly-produced French tube, intended specially for use as the frequency-changing tube in superheterodynes, and working on wavelengths down to 15 meters.—*La Nature, Paris, June 15, 1930.*

✦

Electron-tube telemetering system



[A. S. FITZGERALD] The paper describes a varying-frequency telemetering system which employs an electron-tube beat-frequency oscillator, the frequency of which is controlled by a small condenser mounted upon the movement of the instrument whose reading is to be transmitted. The reading is reproduced at the receiving end by a frequency meter having a scale corresponding to that of the transmitting meter. When furnishing a single indication, the outstanding feature of this system is that except for the movements of the transmitting and receiving instruments themselves, there are no contacts or moving parts. The system does not require instruments of unusual type, and it is not limited only to the transmission of electrical readings, but may readily be applied to any deflection instrument; for instance, indicating pressure, temperature, etc. The accuracy of the system is not affected by changes in the impedance of the channel of transmission.—*Journal A.I.E.E., July, 1930.*

The law of stifling of sound

[Sir Joseph Larmor] In the *Journal of the Washington Academy of Science* for 1929 Heyl, Chrisler and Snyder, of the U. S. Bureau of Standards have published experimental results purporting to show that the relative absorption of energy of incident sound waves by a stifling medium such as a carpet or curtain is independent of the angle of incidence. The author takes issue with this conclusion and by a mathematical analysis shows that it is in opposition to current theoretical views.

Other points brought out in the article, which are sometimes neglected are, (1) that the act of reflection of waves of long period traveling in a fluid medium may involve sensible dissipation of energy and, (2) the tacit assumption that the medium at the reflecting surface behaves as a perfect fluid is not valid.—*Cambridge Philosophical Society, April, 1930.*

✦

Matching colors by photo-cell comparison

A function heretofore left entirely to the human eye has been relegated to a laboratory apparatus of such simplicity of operation that it can be handled much as a modern radio set. The new "colorscope," built for the mechanical matching of two colors to a degree much closer than the eye could possibly achieve, is the invention of Dr. H. H. Sheldon, Professor of Physics of Washington Square College, New York University. Two photo-electric cells are used, creating a "balanced" circuit under a normal light source. That is, they are connected to a galvanometer in such a manner that when both are receiving the same amount of light they will hold the pointer at zero. If one or the other receives more light, movement is produced from it and the needle will deflect to the side registering the heaviest radiations.

A piece of the material, a sample of dye, or any standard color to be matched, is inserted in one side of the apparatus, before one cell, and reflecting the light from a single light source into the cell. The needle is now brought to zero by a dial control similar to a radio tuning dial. A sample of another material of supposedly similar color, or of another vat of dye, etc., is set before one cell in place of one of the standard samples.

If there is a difference of shade, even though it be too slight for the human eye to detect, the galvanometer needle will slip off, if darker, toward the standard sample, if lighter, toward the test sample. A variation of three points either way will register a shade difference of enough importance to be considered faulty matching; although it has been found that a variation up to five or six is often undiscernible to the naked eye.

Weave and sheen effects, in the case of cloth, must be taken into consideration; as these create variations in readings which do not come from color differences. The former is overcome by rotation, which melds the thread pattern into one solid mass of color; and the latter can be counteracted by the use of a spherical photometer, in which the light strikes on the cloth and is reflected in all directions, so that a concentration of light at any one point is eliminated.

This apparatus was first developed at the request of a large textile manufacturer; but the speaker pointed out the fact that as is often the case with some scientific work done for a specific case, the potential applications are so much broader than originally expected that it would seem to reach into the very heart of every industry using paints, dyes, colored lights, or in fact any forms of color.—*Bulletin New York Electrical Society, June, 1930.*

✦

Emission of X-rays by cathode

[A. Dauvillier] If a highly evacuated kenotron has both cathode and anode energized by a.c. the cathode will emit electrons during the period when the anode is positive. During this period some of the electrons come to rest on the glass globe. During the next half cycle, the cathode now being positive, these electrons are drawn over to the cathode and give rise to the emission of X-rays.

Since repeated exposure to these rays may be dangerous and since any kenotron may give rise to these rays, the author advocates the test with an X-ray dosimeter to discover their presence and if necessary to protect against them either by a rubber shield or by inserting a small amount of a rare gas during the process of manufacture.—*Revue General de Electricité, Paris, May 24, 1930.*

✦

Energies of electrons in gases

[J. S. Townsend] In this article, Professor Townsend, who is a recognized authority on the subjects discussed, attacks some of our commonly accepted theories in regard to conduction of electricity in gases. In particular, he criticizes the theory of ionization by collison which says that until an electron acquires a certain velocity or energy the impact of electrons and molecules or atoms is perfectly elastic; at some critical velocity or potential, due to the absorption of energy upon impact the atoms may be caused to radiate or alternatively may ionize molecules of impurities present in the gas; at some still higher potential, usually about five volts above the critical potential the atom may be disrupted or ionized.

Professor Townsend questions the bases upon which this hypothesis is founded, since the experimental results are obtained by projecting a strea electrons into a volume of gas. main objections are (1) no allow has been made for the "space-cha effect of the electrons so projected, the potential of the electrons v from boundary to interior of vo due to this and other effects. He phasizes the fact that ionization doubtedly occurs in the positive col of a gas discharge and yet the pote drop along this column is not suffi to produce ionization according to theory outlined above.

Several series of experiments been performed with currents of rious intensities and with various va of gas pressure and electric force, ally in the region where the n energy of agitation of electrons about five volts. In particular, exp ments have been performed with pl electric currents over a region in w a steady state has been found to e The results of these experiments used to refute the theory generally cepted and to support the theory w the author has previously enunciate *Philosophical Magazine, London, J 1930.*

✦

Thermionic-valve potentiometer for audio frequenc

[W. S. Stuart] The potention voltage is obtained in two compon one from the IR drop in a known riable resistance and the other, therefrom, from the secondary coil calibrated variable mutual induct These two components control the i to thermionic valves, either individ or collectively. Another valve has unknown voltage applied to its i terminal. A telephone is connecte means of a transformer, to the com leads of the output valves and give sound when the input potentials to valves are equal and opposite.

The instrument has been foun read voltages up to 3.3 V within 1 over the entire audio range. It has been used to measure frequency an input admittance of thermionic va —*Journal I.E.E., London, June, 19*

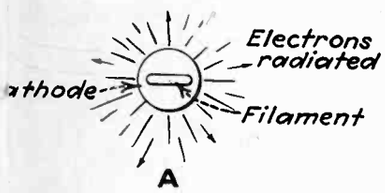
✦

A new system of televisio

[Brun] The system, which is scribed very fully, with numerous structional and mechanical diagran chiefly interesting for the use of scanning-disks, co-axial, one wit radial slots and the other with 21 inclined at 45 degrees to the These revolve at unequal velociti the ratio 11 to 12, and the sca beam is thus made to travel ove object. Synchronism is obtained electric clocks, no synchronizing s being transmitted. The system is cially adapted to telecinematograp *T.S.F. pour Tous, N° 65, May, published June 1.*

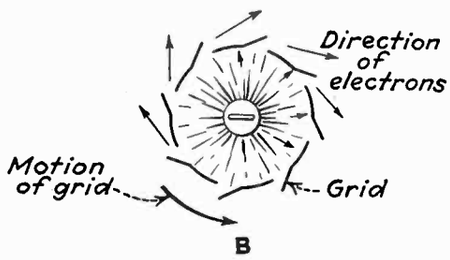
An electronic motor

Details of a vacuum tube in which the grid rotates under impact of an electron stream



A

Electrons leaving the cathode of a vacuum tube possess kinetic energy, which in the new DuMont tube, is put to work



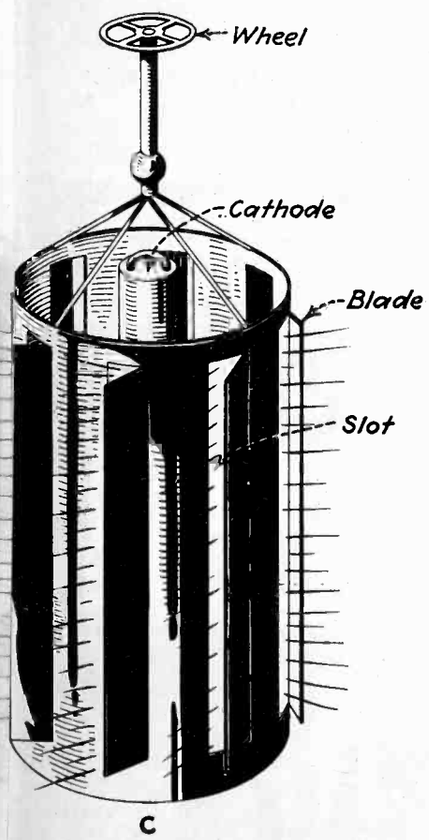
B

Electrons from the cathode strike the blades of the grid much as steam strikes the blades of a turbine

▼

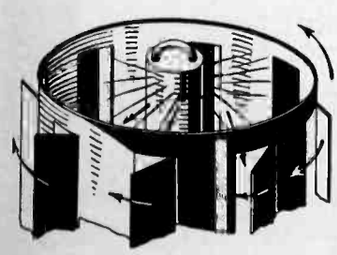
Details of a new type of electron tube invented by Allen B. DuMont, chief engineer, DeForest Radio Company. In this tube the impacts of electrons on a grid which is free to move, impart a rotary motion to it. Although the amount of power developed by the rotating grid is small, it is possible that the future will discover important uses of the device. An electron clock, a source of a.c., a synchronous motor and other uses have been suggested

▲

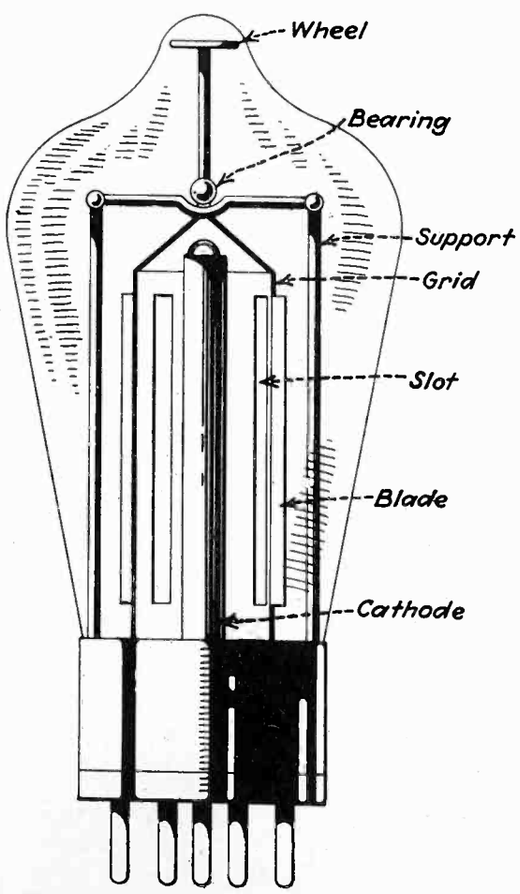


C

The grid is constructed with open slots through which the electrons escape but not before impacting the turbine blades. At the right is a drawing of the complete tube. At the left, below, is a view looking down into the cathode-grid construction



E



D

The photo-cell in spectacular roles

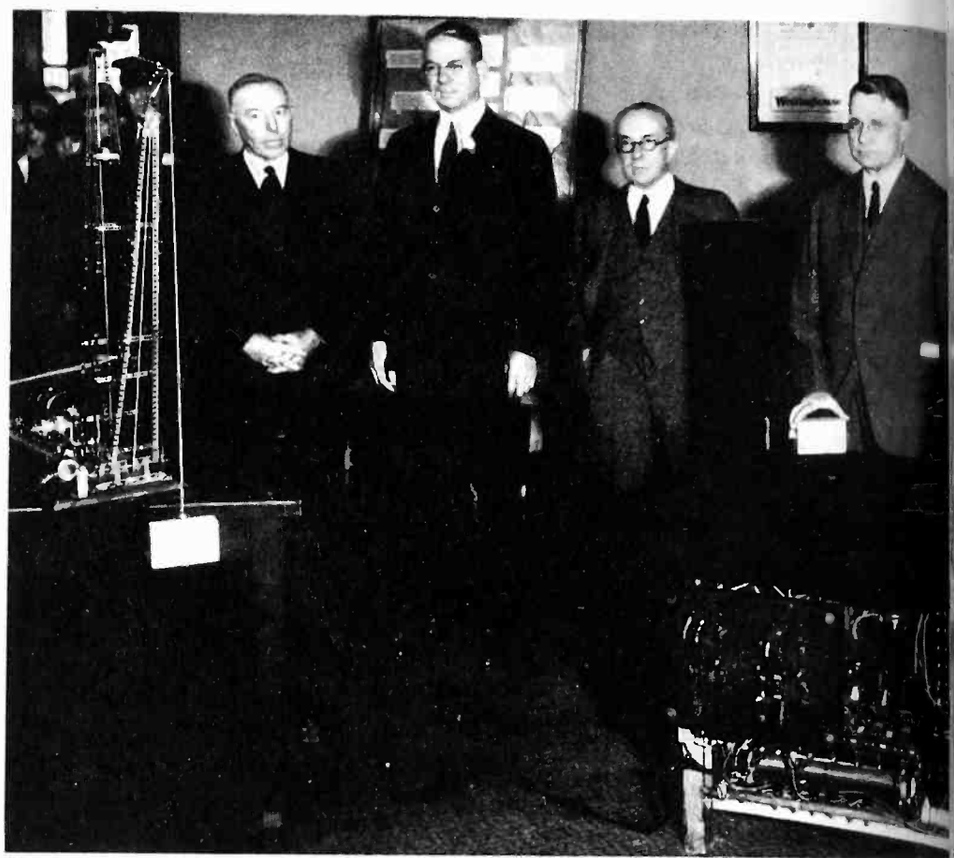
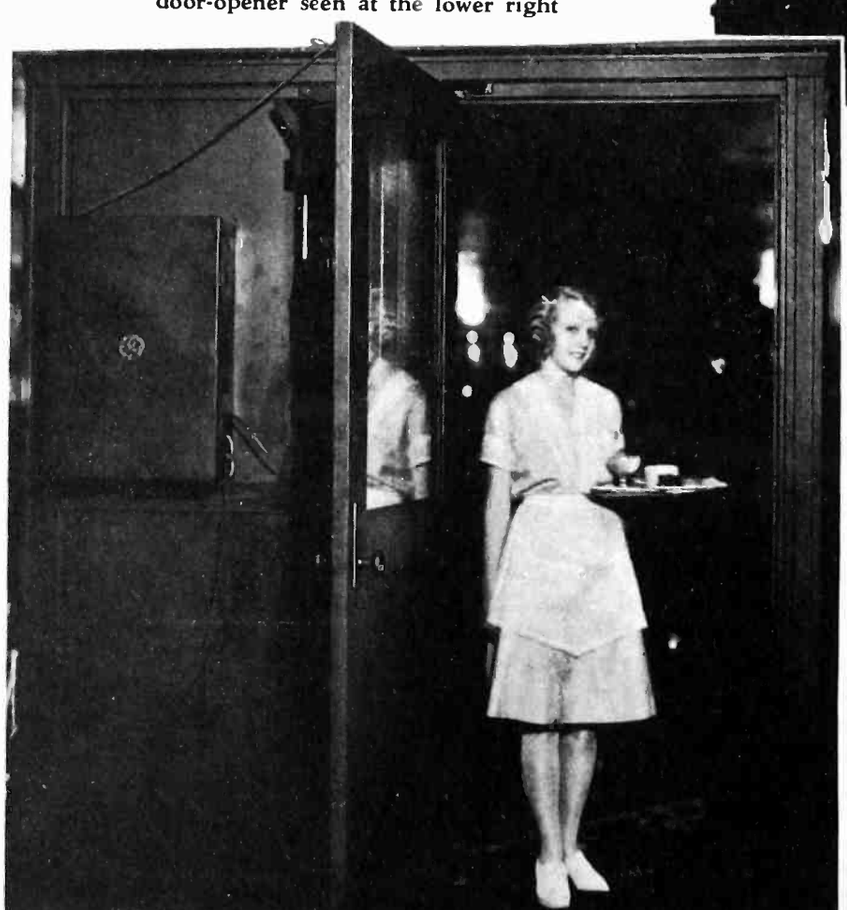
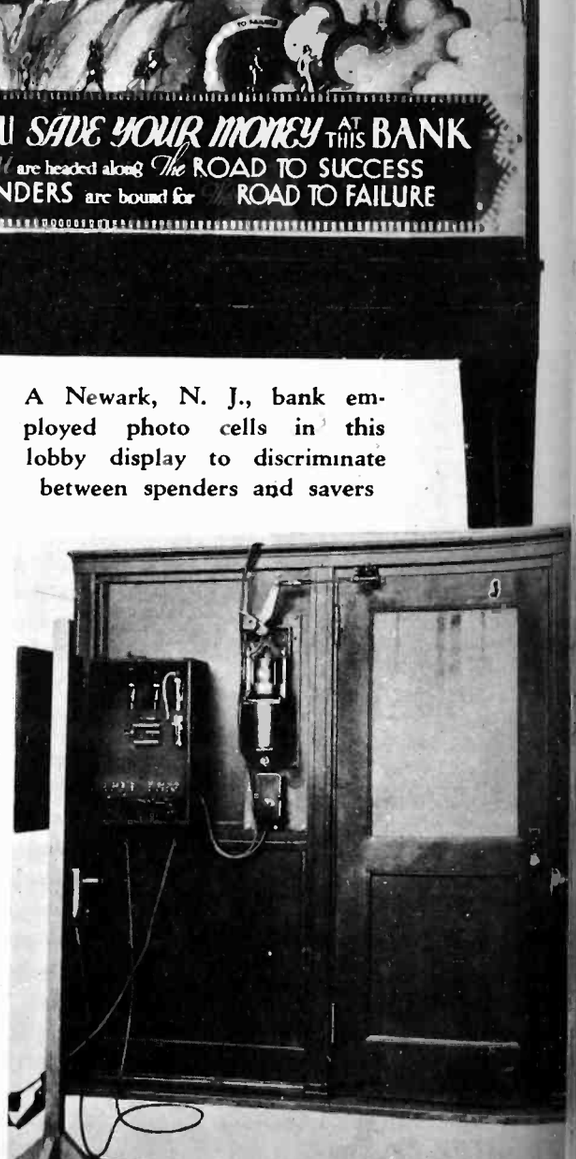


Photo cells controlled the laying of the corner-stone of the new Westinghouse engineering laboratory during a heavy rain storm outside. As W. S. Rugg, right, lowered a model of the stone by hand, intercepted light beams operated the outdoor ten-ton derrick, whose motion was then reported back in miniature at the left

Photo cells for kitchen doors were demonstrated by the General Electric Company at Atlantic City. As the pretty waitress approached the door, her shadow falling on a photo-cell, operated relays and the hydraulic door-opener seen at the lower right

A Newark, N. J., bank employed photo cells in this lobby display to discriminate between spenders and savers





NEWS
THE ELECTRON INDUSTRIES

✦

tube makers plan ement policy

ndard replacement policy is sidered by radio tube manufac- the Radio Manufacturers' on. B. G. Erskine of Em- a., Pa., is chairman of the RMA oup.

rpose of a questionaire being to all tube manufacturers is ain fully the present policies on as to future policies of the rs with regard to tube replace- his was one of the principal discussion by the RMA Tube ring the Convention and Trade Atlantic City. Another meet- e tube manufacturers will be lowing completion of the pres- sonaire, and it is expected that jects of especial interest to ers will also be considered. It as a result of this questionaire out a standard replacement ich will be standard for the Ideas have been requested, replacement policy that can be effect by all tube manufac- hich will hold under present s.

▼

ondenser Corporation of Amer- y City, N. J., recently appointed S. Hill and Associates as Illi- sconsin and Michigan represen- The offices of the Hill organ- e located in the Michigan-Ohio Chicago, Illinois. Mr. Hill is ainted in this territory and was vice-president of the Herbert Company.

F. Muter has been appointed ident in charge of sales of Utah roducts Company. Mr. Muter neer in the radio industry and actively associated with it as of the Leslie F. Muter Com- ce 1921. He is a director in o Manufacturers Association, as General Chairman of the RMA ommittee. Due to his contacts industry, he is thoroughly ac- with the requirements of turers for radio parts.

ylvania Products Company, Em- Pennsylvania, will in the future esented in the Chicago territory tory branch office, located in the son Building at 605 West Wash- Street, Chicago, Illinois. The ice is now in complete running nd will serve a territory includ- cago and parts of the states of Wisconsin and Iowa. Frank J. Foster of Evanston, Illinois has been appointed branch manager. The office will also handle the recently renamed line of Sylvania incandescent lamps, made by the Nilco Lamp Works.

E. A. Tracy, vice-president of National Union Radio Corporation has announced the appointment of Henry A. Hutchins, Jr., merchandising expert, as sales manager. National Union's new sales director graduated from Annapolis in 1917 and was in the midst of naval operations during the World War. Mr. Hutchins later received his M.S. degree from the Massachusetts Institute of Technology. He combines both merchandising experience and technical knowledge with his present appointment as sales manager. Mr. Hutchins has been connected with the tube industry since 1923 and is known personally by jobbers and dealers in nearly every state in the Union.

Stewart-Warner Corporation signs contract with C.I.T. An exclusive contract has been signed by the Stewart-Warner Corporation of Chicago with the Commercial Investment Trust, Inc., of New York, whereby C.I.T. will act as the official financing organization for this manufacturer's dealers and distributors throughout the United States and Canada covering sales made on the installment plan.

The Jenkins Television Corporation of Jersey City, N. J., has announced the appointment of Oliver Ayer as sales manager. Mr. Ayer has had wide experience in radio merchandising and servicing, mainly with the F. A. D. Andrea organization for the past few years. He has engaged extensively in the technical development of radio, particularly along the lines of power amplifiers and public address systems. He is a member of the Institute of Radio Engineers and the Radio Club of America.

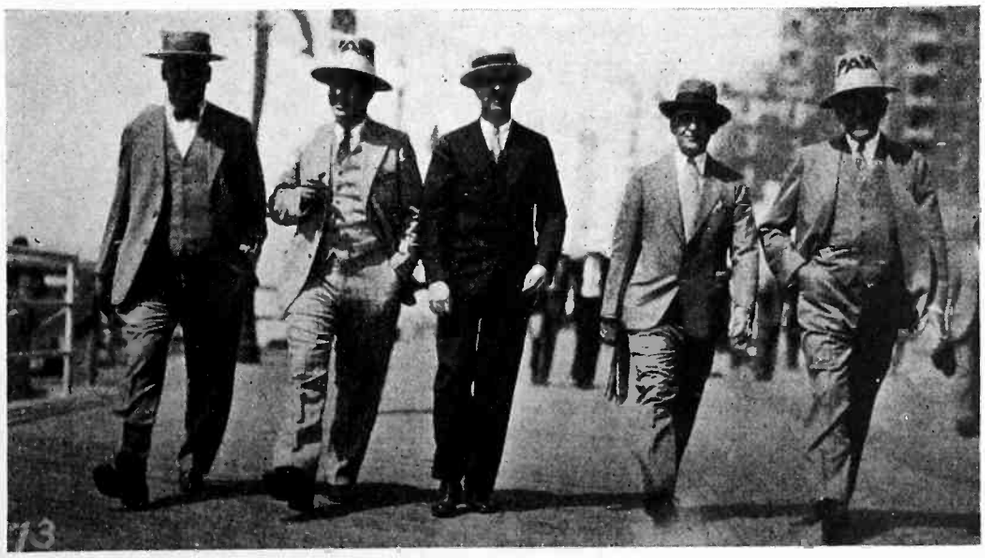
The Westinghouse Electric and Manufacturing Company has announced the appointment of Frank E. Eldredge as assistant to manager of the Radio Department. In this capacity, Mr. Eldredge will continue to supervise Westinghouse activities on radio with the United States government and relations with associated radio interests. In 1917, while Second Lieutenant of the Signal Reserve, he took a special course in radio engineering at the University of Maryland. Later he was inspector of all radio material made for the United States Army in the Signal Corps area and, in 1919, was appointed secretary of the Signal Corps Claims Board, later being appointed officer in charge of the Intermediate Supply Depot. In 1924, he was placed in charge of the government section of the Radio Department of the Westinghouse Company, conducting negotiations with the Radio Corporation of America and the United States Government.

The National Vulcanized Fibre Co., of Wilmington, Delaware, has purchased the leatheroid and vulcanized fibre business of the Rogers Fibre Co., of Boston, Mass., and Kennebunk, Maine. This company has long been identified in the fibre industry as manufacturers of trucks, cans and boxes and of a certain type of fish paper. Their trade name "Leatheroid" is well known throughout the industry. Mr. Leon B. Rogers has jointed the N.V.F. organization.

The Pacent Electric Company has announced the appointment of Joseph Sara of New York City as special export representative for the Continent of Europe, aside from Great Britain and Switzerland. Mr. Sara is now engaged in an extended trip to the various European countries. Prior to his present appointment he had been operating in export fields for many years under the firm name of J. & L. Sara which he owns.

▼ ▼ ▼

WELL KNOWN AMPLIFIER MEN ON BOARDWALK



Representatives of the Samson Electric Company, of Canton, Mass., are shown taking a stroll on the boardwalk at Atlantic City. Reading from right to left: H. C. Sanderson, B. J. Fitzner, Mr. Lyons, R. W. Cotton and a friend of the "family"

✦ NEW PRODUCTS

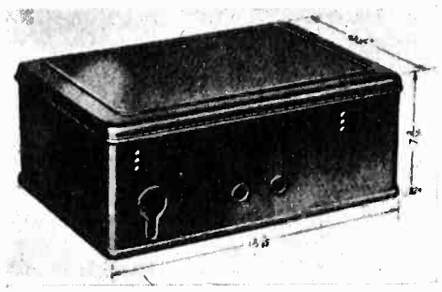
THE MANUFACTURERS OFF

This section is prepared by the editors of Electronics purely as a service to readers. Its aim is to present announcements of all new products, devices and materials of interest in the field of the paper. All items are published solely as news, and without any charge or any advertising consideration whatsoever.

✦

Built up steel cabinet

LIGHT steel radio set cabinets are being built by the Geuder, Paeschke & Frey Co., Milwaukee, Wis. These cabinets are of pieced construction, which allows the use of light steel, while the covers are seamless drawn. The body seams are spot-welded and the bottoms are spot-welded to the bodies. The bottom edge of the bodies are bulged and turned inward to do away with any sharp edges. The bottom edge of the covers are beaded and the panel is pressed into the top surface of the



covers to stiffen them. The cabinets are ventilated with louvres and all holes through which wires or fittings pass are beaded to remove all sharp edges. The steel used has a smooth and bright finish which makes it possible to apply a very high grade lacquer finish at a minimum expense.—*Electronics, August, 1930.*

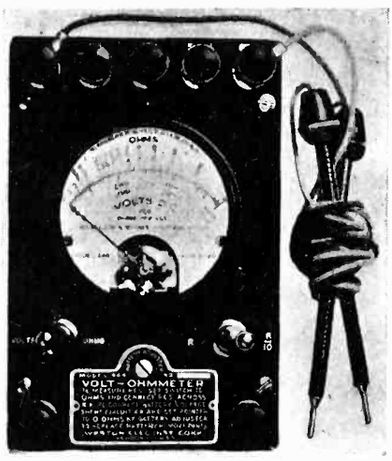
✦

Synchronous electric phonograph motor

THE Hammond Clock Company, 2915 North Western Avenue, Chicago, Ill. has brought out an ingenious synchronous phonograph motor for home use. The accuracy of speed of this phonograph motor makes it possible to reproduce music at the precise pitch in which it is recorded. The rotor is a simple laminated ring, having 92 teeth on its inner periphery. It is secured to the under side of the turntable concentrically around a heavy shaft which is pressed into the turntable. The stator assembly is free to turn through an arc of 50 deg. but is held against rotation by light tension springs secured to a radial arm. By this means a definite amount of friction against rotation of the stator is introduced which plays an important role in the operation. Advantages claimed for this motor are constant speed, absence of noise and no effect on speed due to fluctuation of line voltage from 90 to 135 volts.—*Electronics, August, 1930.*

Volt-ohmeter

FOR use in laboratories or service work where extreme accuracy is not required a model 564 volt-ohmeter has been brought out by the Weston Electrical Instrument Corporation, Newark, N. J. This unit consists of a model 301, 3½ in. diameter meter with ranges of 3, 30, 300 and 600 volts and two



resistance ranges 0-10,000 and 0-100,000 ohms. These ranges are brought out to binding posts as shown in the illustration. Two toggle switches serve to connect the meter in circuit. A pair of 30-inch cables with long test cords are provided with each instrument. The weight of this instrument is 2.3 lb. including the self-contained "C" battery. List price $37.50.—*Electronics, August, 1930.*

✦

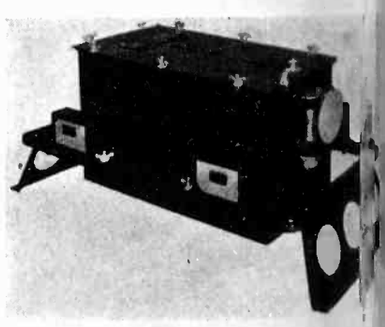
Resistor units

THE Lynch Manufacturing Company, Inc., of 1775 Broadway, announces that a new and heavier type "C" filament is now used in their metallized resistors. This improvement has a quadruple purpose—to give an extra margin of safety, to assure greater current carrying capacity, to provide lower temperature coefficient, and to increase ruggedness. This same company is now making the Lynch precision wire wound resistor, designed for precision and sen cision uses. This resistor wa veloped from a careful study following factors of construction: the type of winding wire to be the method of winding, and inst against atmospheric humidity tions; second, the necessity for manent, non-variable contact b the windings and terminals; thir need of a non-inductive unit c distributed capacity and a low te ture coefficient of resistance; the general design and expansi efficient of the supporting form —*Electronics, August, 1930.*

✦

Aircraft beacon receiver

AN AIRCRAFT receiver desig use in conjunction with airway transmitters has been developed Radio Marine Corporation of A 66 Broad Street, New York City. receiver is known as model A It is also useful for long distance flights which require radio comm tions with the existing interr



frequency marine shore station circuit arrangement of this consists of three stages of tune frequency amplification, a dete ranged for plate rectification a stages of audio frequency ampli The frequency range of the rec 270-500 kc. (600-1100 meters) covers the established intermed quency marine stations, as wel aircraft weather and beacon s *Electronics, August, 1930.*

ole
e control amplifier

: in broadcast stations and out-es requiring remote control n amplifier especially designed urpose has been developed by Radio & Supply Company of Ill. This unit is mounted in etal trunk with dry batteries, fier being mounted in a steel It has three stages of amplifi-ing standard 201A, 112A and

ts. It has a combination im-capacity and transformer amplifications which, it is ives remarkable quality. The has a practically flat curve to 6500 cycles, with a slight at 40 cycles, and a sharp cut-off 6500 cycles. The input im-; 200 ohms which will match bon or condenser microphone he output impedance is 600 atch standard telephone lines. *nics, August, 1930.*

✦

ometers

which provide for an adjust-ntial from .000001 volt to 1.7 ch can be extended to 17 volts ded in the Model E 3040 otentiometer, manufactured by en Gray Company, 64-70 West St., Philadelphia, Pa. The use circuit" for this potentiometer e use of a single turn of slide-the last setting in place of a of ten or eleven turns, thus the operation of turning the rough ten or eleven complete ns. This slide-wire is further by mounting inside of the List price $300. This company nufactures various types of es and standard resistances nt measurements.—*Electronics, 1930.*

✦

ding light
und movies

LGO LIGHT" is the name for a new recording tube for g sound on film, with newsreel nt, as developed by the Vitalgo tion, 5050 Sheridan Road, Chicago, Ill. This recording tube and special sound gate is adaptable to any standard Bell & Howell camera, which has been silenced, and equipped with a high speed shuttle. This company has also designed a portable recording equipment for newsreel cameras. The whole unit can be carried in the back of a standard sedan.—*Electronics, August, 1930.*

✦

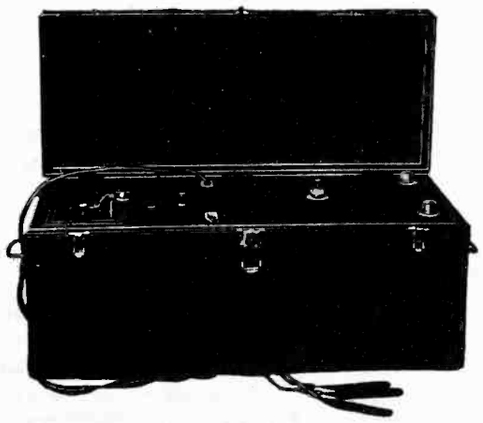
Instruments for high frequency

INSTRUMENTS specially designed to measure the constants of high frequency circuits are described in a bulletin issued by the Cambridge Instrument Company, Inc., 3512 Grand Central Terminal, New York City. This bulletin (No. 162) includes a number of instruments which will be found useful not only in many commercial tests required by the electrical engineer, but in connection with research work. One of the instruments described includes the thermionic voltmeter designed by E. B. Moullin. This instrument absorbs practically no power from the circuit and possesses low capacitance. At low voltages it is claimed to be about forty times as sensitive as an electrostatic voltmeter.—*Electronics, August, 1930.*

✦

Electro-cardiograph

AN INTRUMENT for recording on photographic film the electric currents that accompany heart action is a new product announced by the Westinghouse Electric and Mfg. Co., East Pittsburgh, Pa. This instrument is extremely light in weight; the complete apparatus is included in a compact, self-contained cabinet, and requires no outside source of energy as it operates exclusively from



dry batteries contained within the case. The operation of the Electro-Cardiograph briefly is as follows: The minute currents generated by the heart are transmitted to the instrument through the electrodes attached to the two arms and the left leg of the patient. The heart current is amplified by tubes. The amplified current causes the vibration of a tiny mirror in the galvanometer upon which is directed a beam of light. —*Electronics, August, 1930.*

Nickel cathode sleeves

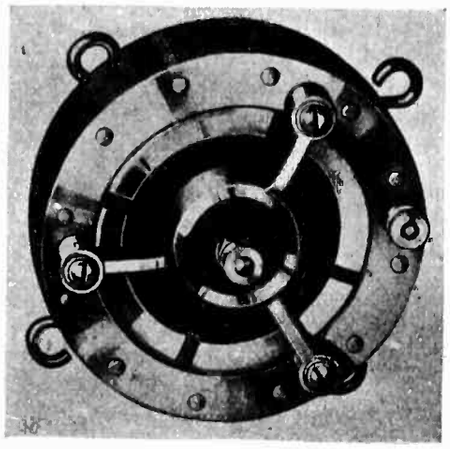
RUFUS CROWELL AND COMPANY, 188 Gore St., Cambridge, Mass., is the manufacturer of nickel tubing that claims a high grade of purity. A sample lot of this tubing showed only the following percentages of impurities: copper .06; iron .004; manganese .02; silicon .01; carbon .04; sulphur .00. Small or large lots may be obtained for experimental purposes or regular use.—*Electronics, August, 1930.*

✦

Microphones

THREE types of microphones are now produced by the Ellis Electrical Laboratory, 337 West Madison St., Chicago, Ill.

A feature of these microphones is the micrometer adjustment on each button.

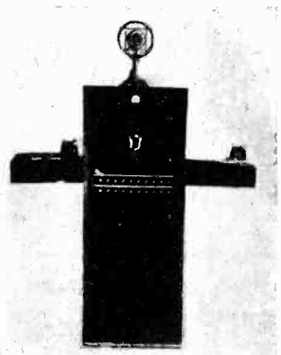


A rigid three-pillar construction is provided to withstand rough handling. Model 20, list price $45, models 29 and 30, list price $75 each.—*Electronics, August, 1930.*

✦

Public address system

A COMPLETE public address system to which any number of speakers may be added, each individually operated through the speaker selector switchboard is made by the Simplex Radio Co., Sandusky, Ohio.



One or more electric phonographs may be used. They are ordinarily bolted to the frame as shown in the illustration, but may be installed elsewhere if desired. The entire system is portable and may be used indoors or out.—*Electronics, August, 1930.*

Amplifier chassis

IN ADDITION to supplying many of the large receiver manufacturers with condensers, coils, transformers, etc., the Thomas Engineering Manufacturing Company, St. Charles, Ill., has recently announced a complete line of two and three-stage amplifiers to be known as

"Thomas Amplifiers." Their model C-245 amplifier uses one 227 tube, two 245 tubes, and one 280 tube. This unit may be used with 1,000 ohm d.c. dynamic field speaker, or four a.c. dynamic speakers, or eight magnetic speakers. List price is $74.00. — *Electronics, August, 1930*

✦

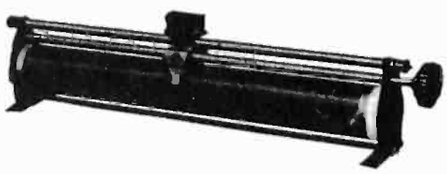
High vacuum pump

VACUUM pumps ranging in size from .5 hp. to 35 hp. are now being made by the Kinney Manufacturing Co., 3529 Washingtton St., Boston, Mass. A feature of these pumps is that no internal packing is used. The piston and other parts needing to be airtight are oil sealed by a unique method whereby only the amount of oil necessary to prevent leakage is admitted. No flooding of the pump while in operation is possible. The ultimate vacuum on closed systems to within .05 mm. of mercury, as measured by a MacLeod gage, may be consistently obtained.—*Electronics, August, 1930.*

✦

Tubular rheostat

HARDWICK, HINDLE, INC., Newark, New Jersey has announced the addition of a line of tubular rheostats to their resistor products. Among the novel features which may be mentioned are: the screw engagement mechanism is so arranged that the act of grasping the knob to adjust the slider by hand



automatically disengages the screw engagement mechanism. This mechanism is self-supporting, self-aligning, with no binding. The heavy phosphor bronze contact shoe maintains firm contact with the wire but cannot tear it. Due to new spring arrangement on the contact shoe no current is carried through it, consequently the pressure springs cannot overheat.—*Electronics, August, 1930.*

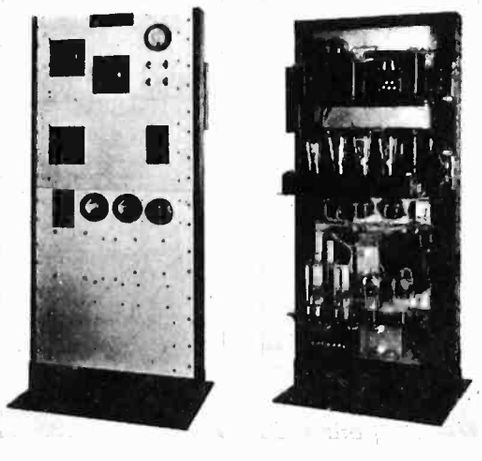
Molding compound in colors

DUREZ molding compound as manufactured by General Plastics, Inc., North Tonawanda, N. Y., can be supplied in all colors and shades for tube bases, sockets, instrument panels, dials, etc. Colors available include nineteen different colors and other colors can be prepared on special orders. This company maintains a staff of engineers to assist manufacturers in their consideration of the adaptability of Durez to their products.—*Electronics, August, 1930.*

✦

Power amplifier

FOR use in outdoor work, such as race tracks, baseball grounds, airplanes, public amusement parks or large auditoriums, an amplifier having an output



of 50 watts, has been brought out by the Radio Receptor Company, 106 Seventh Avenue, New York. This unit consists of a three-stage power amplifier, having a gain of 87 decibels. It is operated from 60 cycle, 110 volts, alternating current. It will amplify from a radio set, electric pick-up or a microphone. This model known as P-50W may be used where great power is required. On recent test it is claimed the amplifier was clearly heard at a distance of three miles from directional loud speaking horns. — *Electronics August, 1930*

✦

Coil testers

FOR detecting short-circuited turns in coils an instrument which makes use of a thermionic tube has been developed by the Rubicon Company, 29 North Sixth Street, Philadelphia, Pa. This instrument is the development of N. E. Bonn and is designed to detect the presence of a single short-circuited turn in a coil or wire regardless of the total number of turns. It will also detect defective insulation between layers and terminals. It will indicate how serious a given defect is, that is the number of shorted turns and the degree of insulation impairment. The unit is designed for operation on 110 volts, 60 cycle supply. The coil teste of a vacuum tube circuit, wi is associated a reflecting gal of very short period. The s may also be supplied for ope direct current which require of a 6-volt storage battery and "B" battery. List price $16 *tronics, August, 1930.*

✦

Cellulose acetate sheeti

AMERICAN PRODUCTS FACTURING COMPAN Oleander Street, New Orleans developed a cellulose acetate which is finding application a electric for electrical equipme requires a very thin insulating of high dielectric value, a specific inductance capacity. terial has possible applicatio dielectric in the manufacture densers in the telephone and dustries. Thicker forms of this have been used as an insulati for coil winding, both around between layers. — *Electronics, 1930.*

✦

Electrolytic condenser with special mounting

DESIGNED especially to mee quirements specified by seve ing manufacturers, the new electrolytic condenser is no marketed by the Condenser Co of America, 259 Cornelison Av City, N. J. The single 8 mcfd unit was decided upon becau greater efficiency as compared types, there being no cros leakage between the anodes or sistance in the common lead. plify chassis assembly, the fixture is of the one-hole single and all anode connections are neath the chassis, thus elimin sightly wiring. A tapere terminal with two rubber tightened under pressure pre leakage of the electrolyte. comes in an attractive sanded finish which also may be easil if desired by the set design *tronics, August, 1930.*

✦

New handbook

THE Callite Products Comp 39th Street, Union City, N nounces its new catalog and on Tungsten, Molybedenum a Alloy Products. This handl tains useful information on th tion of its extensive line of me products for the radio tube, cent lamp and electrical Copies may be procured by r neers and executives writing the Callite Products Compa *tronics, August, 1930.*

PATENTS

IN THE FIELD OF ELECTRONICS

A list of patents (up to July 29) 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

Acoustics

graph pick-up. The stylus coil to rotate and to generate in a magnetic circuit. W. J. Dayton, Ohio. No. 1,767,610.

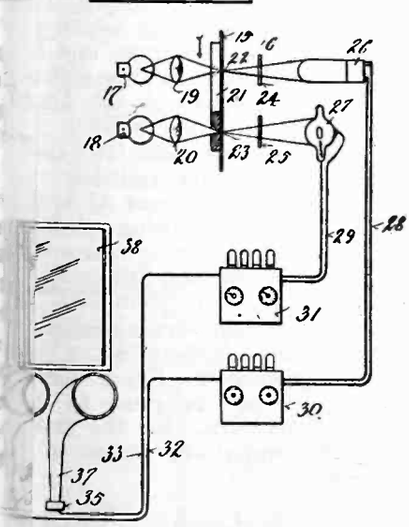
speaker. Magnetic field con- escape of compressed air for g sound. Lee DeForest, as- General Talking Pictures Corp. ,612.

-dynamic device. A rigid m, an acoustic chamber whose te combined with the mechani- lance of the diaphragm so that ing impedance of the diaphragm ly proportional with frequency. Vente, assigned to Bell Tele- bs., Inc. No. 1,766,473.

static loud speaker. P. E. a, assigned to Ephraim Banning, Ill. No. 1,767,656.

ound Recording, etc.

recorder. A combination of ource, a slit, a condensing lens m for photographically record- reproducing sound. T. H. Nak- gned to Nakken Products Corp. ,547.



ral recording and reproduction. ng motion picture film having inct phonographic sound records g from the same source, com- two positive films secured . Lee DeForest, assigned to Talking Pictures Corp. No. 7. Also No. 1,769,908, assigned to e Corporation by the inventor, Forest.

rding system. A recording sys- the variable slit type, in which tortion produced is compensated reproducing system. Erwin Ger- ssigned to Siemans & Halske, gesellschaft, Berlin, Germany. 67,790.

Sound recording. A system of actuating an engraving tool by means of an interrupted light beam. R. V. Terry, assigned to Bell Telephone Labs., Inc. No. 1,768,273.

Sound recorder. A system of anlyzing electric waves into their component frequencies and recording the sound waves in individual groups. A. W. Geyer, Chicago, Ill. No. 1,764,786.

Recording system. A system for recording upon wax records by means of vacuum tube amplifier circuits and frequency correcting network. H. B. Wier, assigned to W. E. Co., Inc. No. 1,765,517.

Radio Circuits

Reflex amplifier. Two vacuum tubes connected in an out-of-phase parallel relation for radio frequency amplification, and in-phase parallel relation for audio frequency amplification. E. J. H. Bussard, assigned to the Crosley Radio Corp. No. 1,767,508.

Remote control system. A system for translating electrical signals into light signals which, by means of relays, controls the movement of a vehicle. H. J. Murray, Brooklyn, New York. No. 1,767,609.

Radio receiver. A circuit, apparently of the super-regenerative type. E. T. Flewelling, Jr., assigned to Buell Mfg. Co., Chicago. No. 1,767,751.

Neutralizing system. A circuit for neutralizing capacity coupling between grid and plate circuit of a vacuum tube amplifier. P. W. Willans, Towcester, England. No. 1,768,182.

Directional antenna. A receiving antenna of wave type, extending in the general direction of the source of the wave, having a wave length of the order of the wave and being substantially aperiodic. C. R. Englund, assigned to W. E. Co. No. 1,768,239.

Receiving system. A radio receiver in which the tubes are operated from a.c., in which oscillation in the r.f. amplifier is prevented by a reversed winding in two circuits, in combination with a reversed input feed-back in one circuit. W. E. Brindley, assigned to Westinghouse E & M Co. No. 1,768,661.

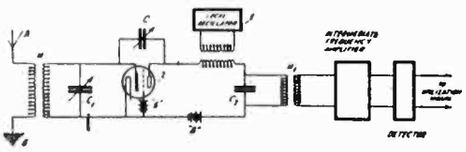
Attenuation equalizing circuit. An amplifier for a telephone system in which the high frequencies are naturally attenuated more than the low frequencies. The amplifier is provided with a means for neutralizing the plate-grid capacity of the tube and compensating the line characteristics. C. W. Green, assigned to Western Electric Co. No. 1,768,248.

Power amplifier. A push-pull amplifier system for high frequency operation, in which a means is provided to prevent parasitic oscillations. J. C. Schelleng, assigned to W. E. Co. No. 1,768,269.

Radio receiver. Two detectors connected in parallel, so that one produces low frequency waves, while the other produces low frequency waves only when the amplitude of the carrier exceeds a pre-determined value; otherwise, the detector acts as an amplifier for the carrier frequency. Nathaniel Bishop, assigned to Bell Telephone Laboratories, Inc. No. 1,768,286.

Multiple modulation transmitter. A system for transmitting messages by successively modulating lower intermediate frequencies upon a high frequency carrier, to obtain a multiplicity of message waves. Ernest Bräuer, Voigtsdorf, Germany. No. 1,768,287.

Combination receiver. A system whereby either a radio receiving system or an audio frequency source such as a phonograph pick-up, can be connected to an audio amplifier. J. R. Balsley, assigned to Westinghouse E & M Co. No. 1,768,658.



Superheterodyne. A reactance is connected between the grid and plate of the frequency-changing tube so that the grid potential due to local oscillations is opposite in phase to the plate potential. W. V. B. Roberts, assigned to R. C. A. No. 1,764,751.

Parasitic oscillations. A transmitting system in which parasitic oscillations of a frequency higher than the carrier wave are suppressed by introduction of a shunt path of high impedance to the desired frequency and low impedance for the undesired oscillation. A. A. Oswald, and J. C. Schelleng, assigned to W. E. Co., Inc. No. 1,768,418.

Uniform amplification system. A radio frequency amplifier in which a combination of electro-magnetic and electrostatic couplings is used to secure uniform amplification over a desired wave-band. S. Y. White, assigned to R. C. A. No. 1,765,473.

Uniform transmission system. Radio tubes connected together by non-resonant impedance network of resistances and capacities to obtain an over-all frequency transmission which is flat throughout a band of frequencies. O. C. Ceccarini, assigned to Bell Telephone Labs., Inc. No. 1,765,523.

Radio amplifier. A system in which part of the output is coupled back to the input circuit, apparently for stabilization purposes. Byron B. Minnium, assigned to Story & Clark Radio Corp. No. 1,765,603.

Radio compass. Received signal energies produce light of characteristic color. F. A. Kolster, assigned to Federal Telegraph Company. No. 1,767,140.

Radio compass. F. A. Kolster, assigned to Federal Telegraph Company. No. 1,767,141.

Harmonic transmitter. An arc transmitter in which a series of harmonics is utilized to provide other transmitting channels. F. A. Kolster, assigned to Federal Telegraph Co. No. 1,767,245.

Radio tuning. A system of resonating an antenna. O. E. Marvel, assigned to General Motors Radio Corp. No. 1,768,703.

Double grid amplifier circuit. The input coil of the amplifier has its mid point connected to the filament and the two ends to the two grids of a double grid tube. L. M. Hull, assigned to R. F. L. Inc. No. 1,764,565.

Radio system. A combination of a polyphase mercury arc rectifier and thermionic tubes for transmitting and reception purposes. C. P. Sweeney, assigned to G. E. Company. No. 1,769,868.

A. C. receiver. A system using a crystal detector and radio and audio tubes operated from alternating current. A. H. Mackley, Bedford, and W. S. Flight, Ealing, London, England. No. 1,769,443.

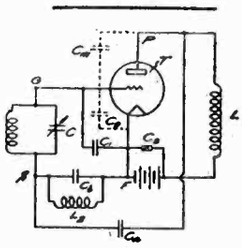
Radio transmitter. A system whereby high frequency signalling currents are impressed upon a low frequency supply line. E. W. Braendle, assigned to Associated Electrical Industries, Ltd., London. No. 1,768,883.

Radio compass. C. H. Beal, and C. E. Miller, assigned to Western Company, a corporation of Nevada. No. 1,769,100.

High frequency amplifier. High frequency components are partially separated from the low frequency components, and are then operated upon by re-shaping them to produce a plurality of impulses of opposite polarity for each incoming signal impulse. When the changed high frequency components are re-combined with the low frequency components, they give a sharp discreet signal. E. C. Burton, assigned to Bell Telephone Labs., Inc. No. 1,763,880.

Radio compass. In a direction finder in which nearby circuits cause an error in the magnetic direction, compensating means are provided. The loop acts as an electrostatic shield. H. O. Peterson, assigned to R. C. A. No. 1,764,747.

Piezo electric amplifier. Several vacuum tube amplifiers connected together by means of a Piezo electric element. D O. Whelan, assigned to G. E. Co. No. 1,765,293.



Neutralized amplifier. L. M. Hull, assigned to R. F. L., Inc. No. 1,764,564. Also a patent on a neutralized amplifier, granted to F. H. Drake and assigned to R. F. L., Inc. No. 1,764,552.

Distortionless receiver. A pair of push-pull tubes interposed between an antenna system and a third single tube arranged so that a wide band of frequencies can be transmitted. V. A. Griffin, assigned to W. E. Co., Inc. No. 1,765,421.

Capacity antenna. Two plates situated above ground and a means for driving these capacity antennas. A. Meissner, Berlin, Germany, assigned to Gesellschaft für Drahtlose Telegraphie, Berlin, Germany. No. 1,765,438.

Radio frequency amplifier. The interstage coupling devices have three windings—primary, and two secondaries, each of which is connected to a grid of a tube. E. A. Kuen, Cincinnati, Ohio. No. 1,764,454.

Radio transmitter. A combination of a variable impedance device, a vapor electric device for transmitting or receiving purposes. E. F. W. Alexanderson, assigned to G. E. Co. No. 1,768,433.

Radio receiver. H. F. Elliott, assigned to Victor Talking Machine Co. No. 1,768,196.

Indicating system. A system whereby lamps are lighted when certain circuits are interrupted. P. H. Betts, assigned to Bell Telephone Labs., Inc. No. 1,765,396.

Harmonic transmitter. High frequency transmitter, crystal controlled, with an output circuit in which the fundamental is tuned to one antenna and the harmonic to another. A. H. Taylor, assigned to Federal Telegraph Co. No. 1,766,047.

Multiphase high frequency transmitter. A source of constant frequency, a means for amplifying the energy of fundamental frequency, and for amplifying the energy of the harmonic frequencies. L. C. Young, assigned to Federal Telegraph Co. No. 1,766,050.

Harmonic suppressor. Admitting the energy of undesired harmonics to two coils so that the undesired energy is neutralized in the transmission circuit. F. A. Kolster, assigned to Federal Telegraph Co. No. 1,766,040.

Reflector antenna. A wave reflector of the paraboloid type. F. A. Kolster, assigned to Federal Telegraph Co. No. 1,766,041.

Superheterodyne receiver. A system of radio amplification whereby prior to detection the radio frequency currents are amplified at their natural frequency and are mixed with a radio frequency of a locally-generated source. The beats produced are rectified and prior to observation the rectified product is amplified again. G. W. Pickard, assigned to Wireless Specialty Apparatus Company. No. 1,770,143.

R. F. amplifier. Interstage network having a terminal voltage characteristic which drops as the frequency of the desired band decreases. Mechanically coupled to this circuit is another circuit which compensates for the drop in voltage characteristic. Patent No. 1,770,524. Also patent No. 1,770,525 on a radio receiving system involving pre-selecting the desired signal and passing it into an amplifier which gives resonance over the desired frequency band without mechanical tuning. Both patents granted to Lester L. Jones.

Reflex amplifier. Three tuned stages and two vacuum tubes arranged to be coupled to each other so that the maximum useful feedback occurs without oscillation. F. H. Mackenzie, Bywood, Pa. No. 1,770,541.

Generation, Detection, Etc.

Harmonic producer. Two tubes connected with the output in parallel. One tube has a fundamental frequency impressed upon it, and the other tube generates a frequency which is a harmonic of this fundamental frequency. The two frequencies are synchronized. R. S. Ohl, assigned to A. T. & T. Company. No. 1,769,270. Also patent No. 1,765,606, granted to R. S. Ohl and assigned to A. T. & T. Company, in which the plate of two vacuum tubes can be connected in parallel when even harmonics are desired, or in series when odd harmonics are desired.

Protective system. Generators at the two ends of a distribution circuit superimpose current on the line during alternate half-cycles of different fre cies, and a protective means respo to the beat frequency produced b generators. N. P. Hinton, assign Westinghouse E. & M. Co. 1,768,688.

Polyphase high frequency gene R. D. Duncan, Jr., assigned to F Telegraph Company. No. 1,769,018

Linear detection. System com of a source of modulated carrier w a detector whose response is essen linear with respect to the perce modulation, an audio amplifier a loudspeaker. W. L. Carlson, ass to G. E. Company. No. 1,770,838.

Double-grid tube transmitter. lations are put on a so-called screening grid while a second or charge grid is a source of high freq current. Gunther Jobste and Roder, assigned to Gesellschaft Drahtlose Telegraphie, Berlin, Ger No. 1,770,486.

Current supply device. Plate circuit in which a resistance con the output circuit back to the pr of the input transformer. Wm Grimditch, assigned to Philad Storage Battery Co. No. 1,771,330.

Oscillation generator. Crystal o tor composed of two tubes one of is tuned to the fundamental an other to the harmonic frequency grid of one tube being connected plate of the other. I. F. Byrnes, as to G. E. Co. No. 1,771,375.

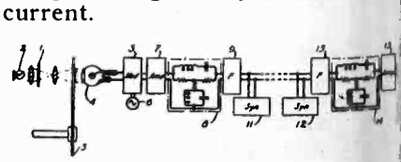
Keying circuit. Hartley oscilla which key is inserted in lead conn grid return and minus B to the fila Key is shunted by a resistance a pacity in parallel. I. F. Byrnes, as to G. E. Co. No. 1,771,376.

Television, Facsimile, et

Synchronizing apparatus. App for comparing frequencies. Me provided for indicating which of frequencies is the higher, and for a direct indication of the differen tween frequencies. A. P. Davis, York, N. Y. No. 1,769,988.

Television system. A syste simultaneously transmitting tel signals, requiring about 43 kilocy speech signal requiring about cycles, and a 6 k.c. synchronizin A. N. Goldsmith and Julius Wein assigned to RCA. No. 1,770,20

Electro-optical transmission Patents No. 1,769,918 to 1,769,9 clusive, granted to Frank Gray R. Hefele, and assigned to Bell phone Labs., Inc., for the trans of optical signals by means of el current.



Light-electricity conversion. tem for converting light energ electrical energy and vice ver Franklin Mohr, assigned to Bel phone Labs. No. 1,768,288.

Television system. A catho tube television system. Al Dauvillier, Paris, France. No. 1,

Television system. A carrier continuously modulated in acc with the varying illumination image, and at the receiving en

PATENTS—

in discontiuous steps. W. H. n, Jr., and T. R. Goldborough, ni to Westinghouse E. & M. Co. 58,874.

re transmitter. A manual syn- ng system and means for indi- when synchronism is secured. R. d, assigned to G. E. Co. No. 3.

ision reflector. A mirror ar- d to reflect the light coming a lens system after passing a scanning disc in any desired io. G. P. Schmidling, assigned la J. Carter, Chicago. No. 3.

cronizing system. C. F. Jenkins, he to Jenkins Labs., Washington, No. 1,766,644.

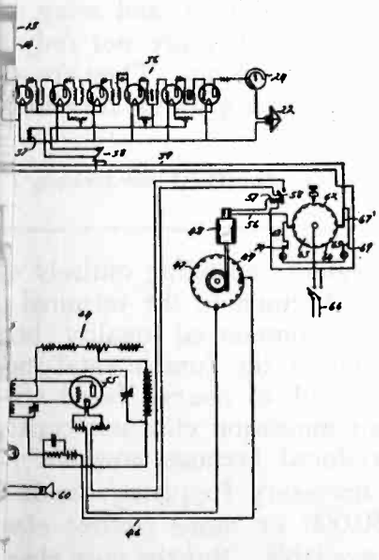
sellaneous Vacuum Tube Applications

ay light signal. Two-element dyig tubes are used in the "pro- id "caution" lamps of a three- stem. If both the "proceed" and " lamps are extinguished, a amp is lighted by ionizing the rrounding the filament of the vo lamps. C. W. Prescott, as- o General Railways Signal Co. 6,535.

tion regulator. Vacuum tube for controlling the speed of a n body. Walter Bock and Karl ssigned to C. Lorenz, Aktienge- hit, Berlin, Germany. No. 26.

eynamic control. A method of oing the movement of a vehicle dance. E. H. Loftin, New York, No. 1,766,524.

ifying device. A metal cylinder dwith a conducting compound of al, and arranged so that a volt- a be applied between the metal compound, and an electro-mag- eld for controlling the electron . F. Ohl, assigned to A. T. & T. o. 1,765,607.



collision preventer. A vacuum system for the purpose of prevent- ips from colliding. C. R. Fisher, F. V. N. Bradley, Rogers City, No. 1,767,749.

ctron tube relay. Two vacuum with plates in parallel, and grids connected to opposite ends of an impedance so that they receive voltages equal in amplitude but opposite in phase, and coupled to output so that plate load does not react upon grid voltage. Mauritz Vos, assigned to T. L. M. Ericsson, Stockholm, Sweden. No. 1,771,021.

Photo-electric amplifier. Two photo cells which are balanced during the light portions of a record which is to be transmitted by the cells and then through an amplifier. During the dark portions of the record, only one cell is actuated. Fritz Schröter, assigned to Gesellschaft für Drahtlose Telegraphie, Berlin, Germany. No. 1,770,497.

Vacuum Tube Manufacturing, Etc.

Light valve. A system for supply di- electric material to a Kerr cell. Gilles Holst, assigned to R. C. A. No. 1,767,132.

Cathode ray oscillograph. Otto Ackermann, assigned to Westinghouse E. & M. Co. No. 1,768,875.

Hot cathode convertor. A two-element tube designed to convert a.c. to d.c. Q. A. Brackett, assigned to Westinghouse E. & M. Co. No. 1,768,660.

Vacuum tube structure. A manufacturing patent covering the support of vacuum tube elements. Lee Sutherlin, assigned to Westinghouse E. & M. Co. No. 1,765,636. A similar patent to Ilia Mouromsteff, assigned to Westinghouse E. & M. Co. No. 1,765,605.

Hum reducer. A system of operating vacuum tubes from a.c. whereby the hum introduced into the filament circuit is introduced with the proper phase into the anode-cathode circuit, so that the effective hum is reduced. Walter Schaffer, assigned to Gesellschaft für Drahtlose Telegraphie, Berlin, Germany. No. 1,765,542.

Copper oxide rectifier. A rectifier having a portion of its surface covered with a layer comprising a phenolic condensation product and graphite. Joseph Slepian, assigned to Westinghouse E. & M. Co. No. 1,765,502.

Magnetic materials. A method of securing high permeability in magnetic materials. T. S. McCann, assigned to W. E. Co., Inc. No. 1,765,436.

Wire drawing apparatus. Samuel McMullan and A. E. Schulz, assigned to Western Electric Co., Inc. No. 1,765,437.

Alkali metal tube. A manufacturing patent on vacuum tube using an alkali metal therein. William A. Ruggles, assigned to G. E. Co. No. 1,768,421.

Resistance. A wire-wound resistance. John Geloso, assigned to Pilot Radio & Tube Corp. No. 1,763,772.

Alkali tube. A process patent for introducing into a vacuum tube an alkali metal. Jans H. DeBoer and Pieter Clausing, assigned to M. B. Phillips, Gloeilampenfabriekan, Eindhoven, Holland. No. 1,767,437.

Heater type tube. A heater type tube and five-terminal base. C. E. Huffman, assigned to Westinghouse Lamp Company. No. 1,765,487.

Piezo electric crystals. A group of patents assigned to the Federal Telegraph Company by A. M. Nicholson, Alfred Crossley, Neal H. Dawson, on crystal-mounting apparatus. Patents Nos. 1,766,042 to 1,766,045, inclusive, and Nos. 1,766,036 and 1,766,037.

NEW BOOKS

Television, today and tomorrow

By Sydney A. Moseley and H. J. Barton Chapple, New York; Isaac Pitman & Sons; 129 pages. Price, $2.50.

ONE GETS the idea in reading this book that is is largely a defense of Mr. Baird and an explanation of why he has not put television into the homes of the millions. Mr. Baird need not apologize for not having accomplished this feat in spite of the fact that television has had no more undefeatable, or indefatigable worker. Television like the electron still defies the world.

The book deals to a considerable extent with Baird's work. It relates the essential history from the first demonstration of the transmission of outlines to the television of the human face from one room to another and almost to present-day practice. It is unfortunate that the work of other television laboratories had to be neglected in the book in favor of one system, but it is probable that a book dealing at equal length on the efforts of other untiring searchers for the missing link of television would assume an uncomfortable —if not unsaleable—length.

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Photocells and their application

By V. K. Zworkyin, Ph.D. and E. D. Wilson, Ph.D., Westinghouse Research Laboratory; John Wiley & Sons, New York; 209 pages. Price $2.50.

DUE TO the increasing interest in the applications and use of photo cells the engineer will find this book a valuable addition to his library. The authors give a brief, historical introduction leading to the first practical cell. The chapters following cover the general theory of radiant energy and photo-emissive effect; the mechanical features of cells; methods of preparing photo cells; the vacuum photocell; gas filled photocell; photo-conductive, and photo-voltaic cell; typical photocell circuits used in connection with the radio tube; the problem of amplification, in which various types of circuits using cells are explaned, with suitable diagrams; the use of photo cells in sound movies; the photo cell in facsimile transmission and in television; miscellaneous application for photo cell use. The authors make a brief forecast of photocells in the future. The appendix of this book gives some definitions concerning illuminating engineering nomenclature and photometric standards.

The design of tone control circuits

[*Continued from page 232*]

and gives a response curve ideal for volume above normal. T_1 and T_2 are phased to add, and so with Y set on X, allowing the full operation of T_2, the resultant curve is given by *a*, Fig. 5, and is the correct response curve for volume below normal. Intermediate positions of the shunting resistance YZ give a smaller amplification of T_2 and a variation of the response curve having typical values shown by the curves *b*, *c*, and *d*. The lower frequency of correction is shown by the vertical line *A-A*, at about 85 cycles. The curve shapes to the right of this line are quite similar to those theoretically necessary as shown in Fig. 3. This may be more clearly seen if a card is placed over the portion of the curves to the left of the line. The ratio of the intercepts on *A-A* of the curves *a* and T_1 shows the amplification ratio this network will correct. In this case a complete tone correction for a fifteen to one amplitude variation is possible. In the radio receiver in which the above circuit is being used a small condenser is connected between W and X. When set correctly for low volume, the high frequencies may be further reduced to mitigate against static and noise.

The above discussion, it is felt, has given a logical justification for tone control. We need not apologize for the necessity, for it is not due to the lack of true tone or the impossibility of obtaining a flat ideal characteristic.

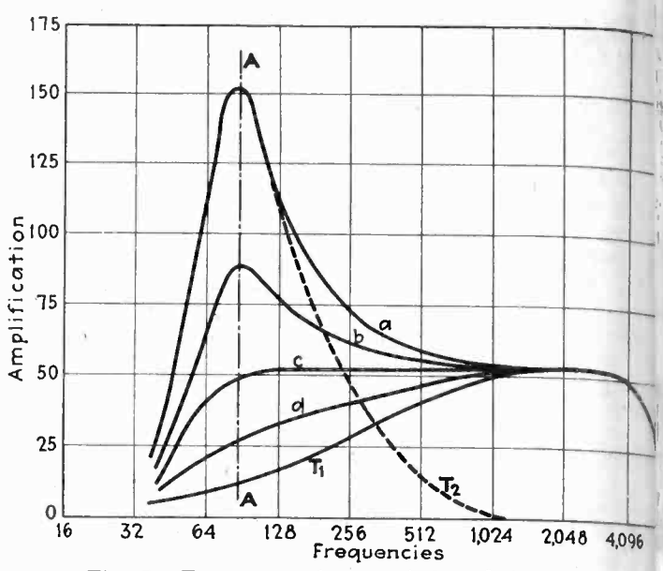

Fig. 5—Frequency characteristics of the system indicated in Fig. 4

Apparent quality changes with sound amplitude; rection is necessary to maintain identity of sense imp sion at all volume levels. Without such correcti without a proper tone control, we can never expect reproducers to fool anyone. Properly used, such a control, matching volume and quality, adds immeasur to the versatility and effectiveness of a sound reprodu

*Harvey Fletcher. Bell System Technical Journal, Vol. No. 4, October, 1923, page 148.

The photo cell as applied to industrial problems

[*Continued from page 229*]

reactions. Several methods of producing these rays artificially are in use and various methods have been employed for measuring their intensities. None of the latter, however, have been adequate so far as portability and simplicity of operation are concerned.

Dr. H. C. Rentschler recently developed a photo-electric cell sensitive only to ultra-violet light, and also developed an ultra-violet light meter* embodying this cell. It is a very simple portable instrument and can be used in conjunction with an indicating and portable instrument. It no doubt will find a great field of usefulness.

As was said at the outset, a comprehensive view of the possible uses of photo-electric devices would include countless operations now dependent upon visual ju ments. We have seen that many practical devices now in everyday use in different types of industrial ap cations. It has not been possible to describe all of th Besides these, many other applications are now in process of development, such as automatic bur alarms, motivated by an interruption of a beam of visible light, traffic control, heat control, and light in sity meters for photography, moving and still.

It is clear that a device is required of which an in pensable requirement is long life and constancy. is the main achievement of research study on this p lem during recent years. From laboratory instrume the photo cell, glow tubes, amplifiers, and relay dev have reached the place where they are not only re to serve as dependable industrial tools. They are alre in use, and are a vital part of apparatus functionin many complex tasks.

**An Ultra-Violet Ray Meter*, by Dr. H. C. Rentschler, A.I. Reprint No. 30-34.

Requirements of television

[*Continued from page 236*]

of detail, assuming square proportions and the present progressive scanning method.

Considering the magnitude of the difficulties to be overcome to produce television of really satisfactory detail and program scope, really high-grade television appears to be a hopeless undertaking. But it is noteworthy that wherever pure electronic action is concerned in its transmission and reproduction, even the highest frequencies appear to be within the scope of known phenomena. Light waves, of course, cover these frequency ranges without difficulty; so do electron streams in high vacuua. Eliminate the mechanical elements and the conduction of electric currents through metals, in other words, devise a system depending entirely on control of electrons in a vacuum in the terminal a ratus, and television of commercial quality beco feasible without alteration of the fundamental met now employed. We are still, of course, faced with difficulty of finding communication channels capabl handling the signal produced because nowhere in other spectrum do the necessary frequency bands f television system of 50,000 or more picture elem per frame appear to be available. But the pure electr amplifier system will undoubtedly uncover a vast w of frequencies below the limits of the spectrum uti at present. Perhaps television is just around the co after all, particularly if we grant that a fundamen new conception of the whole problem may be evolve any time.