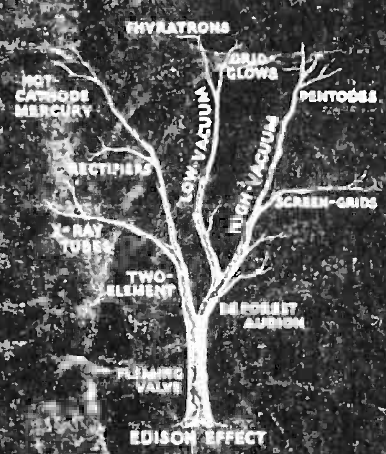
electronics

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



The family tree of the thermionic tubes

+

Developments in wide-film sound pictures

+

Organizing a competent engineering staff

+

Measuring distortion in amplifier systems

A McGRAW-HILL PUBLICATION

MAY 1930

electronics

M. E. HERRING
Publishing Director

M. CLEMENTS
Sales Manager

Contents for May, 1930

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electronics

A McGRAW-HILL PUBLICATION

New York, May, 1930

he march of the electronic arts

wave radio telephone service now he continents of North and South ca. This new regular commercial was inaugurated early in April conversations between President r and the presidents of Argentine, ay and Chile.

✦

e control of airplanes by radio emonstrated on an unprecedented luring the month, when an entire on of British bombing planes was 400 miles. The pilots aboard kept off, while the automatic equipment ctuated from ground stations.

✦

ile reproduction of an entire news- page was transmitted from San sco to Schenectady, N. Y., April 3, three hours of its issue from the Dr. E. W. F. Alexanderson's itter was used, operating on 17.3 s.

✦

onic synthesis of heavy atoms light ones, was demonstrated at a, Ga., April 9, before the Ameri- hemical Society. Dr. W. D. Har- of Chicago University showed graphs of helium building up into n.

✦

ons as wave-motions rather than scular bodies assembled in atomic systems, was argued by Dr. C. J. son before the American Philo- cal Society at Philadelphia, April The electron's properties are shown periment to be dual, declared Dr. son, satisfying both definitions.

✦

d-pictures of surgical operations are being demonstrated to students at Medical Center, New York City. pictures have the advantage of intimate close-ups, with the great ons of the day acting as lecturers, g every student a front seat at the .

Diathermic heating of the brain tissue by high-frequency fields, is being experimented with by Dr. Paul F. Schilder of Vienna. Such internal heating, it is reported, apparently stimulates brain activity and speeds up nervous and motor reactions.

✦

Building-up of matter out of energy, with the incidental propagation of very short-waves, was declared by Dr. R. A. Millikan, at New York, April 9, to be now going on out in the cold recesses of the universe. This is evidenced by the cosmic rays received on earth, from unknown sources in interstellar space.

✦

A 50-kw. broadcaster at Rome, American-built and just opened, is now the largest transmitter in all Europe. "Radio-Roma" is its designation, and its 100-per-cent modulation, brings it up to 100 to 200 kw. during peaks of transmission.

✦

Reorganization of the Radio Corporation, facilitating its new functions as a holding company for its many subsidiaries, was announced, subject to stockholders' vote on May 6. General Electric will own 40 per cent of RCA stock, and Westinghouse 13 per cent, giving them, jointly, control.

✦

X-ray and electronic tests of steel welds were demonstrated at Lehigh University, Bethlehem, Pa. The X-ray method reveals hidden faults visually; the second plan utilizes amplifiers and loud-speakers which report strains by characteristic sounds when the weld is struck.

✦

Interlocking aircraft communication systems between Canada and the United States were recommended at Washington conference, April 11. Aircraft beacon services of North America should be co-ordinated declared Dr. C. B. Jolliffe, U. S., and Commander C. P. Edwards, Canada.

The Fox Film interests are completing plans for refinancing with $100,000,000 of new capital. Harley L. Clarke, president of General Theatres Equipment, Inc., and Utilities Power and Light Corporation, purchased the controlling interest from William Fox for $18,000,000.

✦

A full orchestra of electrical instruments presented its premiere recital of "ether-wave music" at Carnegie Hall, New York City, April 25, under the direction of Prof. Leon Theremin. Its elaborate program included Brahms, Wagner, Liszt, Beethoven and Handel, and demonstrated many new timbres and acoustic qualities.

✦

Warner Brothers within the past two weeks have made a tie-up with the Kuchenemeister group. (Sprekfilm of Amsterdam, Tobis of Germany, Associated Sound Film Industries, Ltd., of London, Tobis of France) by purchase of substantial interests in the patents and licenses of these groups.

✦

Brunswick-Balke-Collender Company has just passed to the control of Warner Brothers. The assets of the former company, including the plants, structures and good will of the Bremer-Tully Manufacturing Company, radios; Farrand Manufacturing Company, loudspeakers and Brunswick Radio Corporation are included in this deal.

✦

Radio aided astronomers in photographing the eclipse of the sun visible on the west coast of the United States, April 28, by carrying time and control signals from Mare Island Navy Yard to airplane and ground observation stations.

✦

Patents of Lowell and Dunmore for operation of radio receivers from alternating current are now claimed by the Government to be public property, since the inventors were U. S. Bureau of Standards employees. The suit involves patents said to be worth twenty million dollars.

. . . Electron tubes pla[y] four national convention[s]

Association leaders send greetings to the engineers of the elect[ronics]

Electronics and the motion-picture engineer

By J. I. CRABTREE
President Society of Motion-Picture Engineers, Research Laboratory, Eastman Kodak Company

THE application of the photo-electric cell and the three-electrode vacuum tube to the recording and reproducing of sound represented a very important landmark in the progress of the motion-picture art. Many years previously sound had been recorded on wax and synchronized with the motion picture, but the quality of the resulting sound was comparatively poor.

The introduction of the vacuum tube made possible the amplification of the extremely feeble electrical currents generated by the microphone which, in turn, are translated into (1) modulated mechanical energy for recording on wax or (2) modulated light energy for recording photographically. In a similar manner the light energy falling on the photo cell from the photographic sound record is miraculously translated into electrical energy, amplified by the vacuum tube, and again converted into sound energy by suitable means.

The photo cell and its ally, the vacuum tube, are also being applied successfully in the measurement of illumination levels in the studio and theater and the measurement of the density of photographic images, and are destined to receive numerous other future applications.

The counterpart of the photo cell — the flashing lamp — is already in practical use for sound recording by the Fox Movietone process. The chief drawback of this type of light valve lies in the low intensity of its radiation, but further research will undoubtedly produce a lamp having the required brilliance. The cathode ray tube also appears promising as a means of solving the television problem while the thyratron will undoubtedly prove to be a valuable tool in the motion-picture field.

The successful motion picture engineer of the future must keep himself thoroughly informed with progress in the field of electronics. In the Journal of the Society of Motion Picture Engineers it is impossible to cover this specialized field adequately and I feel that *Electronics* will be welcomed by every motion-picture engineer.

The electrical manufacturer and the new uses of the vacuum tube

By
A. W. BERRESFORD
Managing Director, National Electrical Manufacturers Association, Past President, A.I.E.E. American Engineering Council

WITH but few exceptions—and most of those the companies whose association has been intimate from the inception—the electrical manufacturer has little realization of the enormous possibilities of the art of electronics. But it is being borne in upon him that a tool of almost limitless application is approaching availability, and he is beginning to watch keenly.

The use of amplified current in combination with the photo-electric cell interests, but leaves the impression of being apart from and not generally applicable to the materials and processes which he employs. But the device for detecting the presence of flaws in steel rails is another thing. That strikes home, and as realization comes—together with understanding of the simplicity of the principles involved and the relative sturdiness of the devices themselves—the applications which will result should surpass any present anticipation.

There could be no more timely service to the electrical manufacturer than to bring forcibly to his attention by both example and precept the present state of the art.

It is not new. Ten years ago its possibilities in the control of electrical energy in commercial vol[ume] were forecast and it has been developing slowly bu[t] substantially throughout the period. One hesitates t[o] prophesy the uses which the inventor-designer will fin[d] for this new agency as realization of its versatility grow[s] within him. Certainly the subject is one in which th[e] electrical manufacturer in much interested.

nportant roles in fields of
is month . . .

nd trace effects of the electron tube in their own industries

ectronic phenomena
pen new doors to electro-chemistry

By
DR. COLIN G. FINK
Executive Secretary, American Electrochemical Society
Professor of Electrochemistry, Columbia University

AS long as metallurgy was primarily dependent upon the analytical chemist, progress was slow, and re-
ılts and conclusions were often contradictory. Two
amples of steel would have the identical chemical com-
osition and yet, mechanically, the two samples were
ltogether different in behavior and properties. It was
e introduction of high-powered microscopes to metal-
rgy that made it possible to place the alloy steels on a
ound foundation. Metallurgists with the aid of a micro-
ope could control their processes to a nicety, and results
uld be reproduced at will.

As long as the electrochemist was solely dependent
on heats of formation as the basis of his theory and
ognostication, advance was slow and uncertain. With
e discovery and interpretation of the basic phenomena
the vacuum or electron tube, the electrochemistry of gases took on a new and brighter aspect. Reaction phenomena that could not be accounted for on a purely thermal basis were now readily interpreted on the new electrical basis. We have but just discovered in the field of electrochemistry of gases a trail which will undoubtedly lead to heights of vast scientific and industrial importance. Reactions are being brought about at room temperature which, under the old thermal interpretation, would require temperatures of several hundred to a thousand degrees. Electrically activated nitrogen is no longer inert.

coustic engineers credit recent
arked progress to electronic tools

By
HARVEY FLETCHER, Ph.D.
President, Acoustical Society of America,
Director of Acoustical Research,
Bell Telephone Laboratories

THE importance of the electronic tube as a tool for acoustic measurements, is well recognized by the
embers of the Acoustical Society of America.

In fact, the large advances made in technical acoustics
ıring the past fifteen years have been largely due to
e new tools furnished the acoustic engineer involving
ectronic tubes.

Before the invention of the vacuum tube, quantitative
easurements of sound intensities were very difficult
cause the quantities involved were so small. Micro-
ıones are now available which will transform such
ounds into an electrical form with scarcely any distor-
on. This electrical form can be amplified to almost any
xtent by means of the vacuum-tube amplifier and its
agnitude can be measured by the well-known rectifier.
ecause of these new tools, acoustic measurement is now
educed to an exact science.

Besides their new uses in the many applications of acoustic measurements, electronic devices are used as electro-optic converters, especially in connection with the recording and reproducing of sound. Oscillators and amplifiers used in connection with electro-acoustic converters furnish combinations for producing sounds which can be controlled in pitch, intensity, and quality. No doubt in the near future developments will result in such combinations being used as musical instruments.

Conventions and meetings during May. For program features, see page 101.

ociety of Motion-Picture Engineers, Vardman Park Hotel, Washington, D. C., ay 5 to 8.

stitute of Radio Engineers, Engineering Societies Building, New York City, ay 7, 7:30 p.m.

American Institute of Electrical Engineers, (District meeting) Springfield, Mass., May 7 to 10.

Acoustical Society of America, Westinghouse Institute, Grand Central Palace, New York City, May 9 and 10.

Radio Club of America, Columbia University, New York City, May 14, 8 p.m.

National Electrical Manufacturers Association, Hot Springs, Va., May 18 to 23.

American Electrochemical Society, St. Louis, Mo., May 29 to 31.

Building an engineering organization

The selection and assignment of engineers in a large staff working on electronic problems

By W. R. G. BAKER

Vice-president in Charge of Engineering, RCA-Victor Company, Camden, N. J.

IN those types of manufacturing which depend upon technical developments, the personnel problems of management assume major importance. The problem of handling the factory operators is much the same as in other industries, but the technical organization, forming the backbone of the business, requires more serious consideration. For this reason special methods must be employed to handle this phase of the problem effectively.

It has been said that industry is made up of persons working with things, and that the products of industry are skilled persons and useful things. In the electronic fields, the skill is largely technical. Since no profit can be shown on the human output, care must be taken to conserve the technical skill, develop it in every way possible, and accumulate it as one of the most valuable assets of the company.

A corporation's fourth asset

The invested capital of a company is usually shown under three general headings: (1) land and buildings; (2) machinery and equipment; (3) inventory, raw and in process. Not one of these items is capable of paying dividends without the guidance of the fourth asset, *the Organization*. New factories are frequently built almost overnight; machines can be purchased on short notice, and materials are seldom lacking. Even factory operators can be obtained with little difficulty, but without the technical skill of the engineers and manufacturing ex- utives to direct their escorts, the product might actu be of less value than the original raw material its Last but not least, a skilled organization cannot be p chased in the open market ready made, but must be ca fully trained to meet particular requirements.

It has been estimated that the cost of training average factory operator varies from $50 to $200, pending upon the degree of skill required. The train period is usually one to ten weeks. The technical orga zation requires at least one or two years training a probably costs $2,000 to $10,000 per man, again deper ing upon the skill or executive ability required.

Looking at the matter another way, each engine must contribute sufficient technical skill to more th justify his salary, since he performs no manual lab His salary is thus one portion of the net earnings of h technical ability. The other portion appears as prof Therefore, it is conservative to capitalize the salary alor at not less than 6 per cent, indicating that a $3,000 m represents an investment of $50,000, a $6,000 man $100,000 invested, etc. Of course, the individual usually responsible for the major part of this investmen accumulating it in the form of early training, school ar college work, etc., but nevertheless, when this accumu lated ability is placed at the disposal of a manufacturin company in consideration of a salary, is it not reasonab to include this investment, in some way, among th assets of the company?

Personnel turnover

Considering this question from the viewpoint of per sonnel turnover, many companies could better afford flood of fire causing a net loss of $100,000 than to los the services of one well-trained "profit engineer" at salary of $6,000 a year; yet the latter would not appea on the books as a loss. It might appear later as a unaccountable decrease in net profits, and too many suc losses in the same period may even cause a failure. I the organization is not shown as an asset, reports woul not indicate the true cause.

Scientific management has accomplished wonders i the elimination of waste in industry. There is still muc to be done, however, in the field of economic waste du to personnel turnover. The causes of this turnover ma be summarized briefly in the three general reasons wh employees leave:

(1) voluntary, because of (a) work, (b) pay, (c personal reasons;

(2) involuntary, laid off for (a) business or seasona fluctuations, (b) discipline, (c) retirement;

(3) involuntary, discharged on account of (a) unfit ness for work (b) personal character.

Changes that improve the organization

A study of the personnel records often brings to ligh surprising facts regarding the causes of turnover. I is safe to say that two reasons out of the eight (work and pay) will account for the majority of the engineer ing turnover, and these with fluctuations (2a) accoun for the factory labor difficulties. The dissatisfaction wit the work is usually lack of opportunity ahead, or indefi nite plans of promotion. The rapid growth of the indus try has been largely responsible for the competitive offer to trained men in positions of responsibility, and the bes men are not immune.

Of course, a limited turnover is healthful, particularl if the men obtain positions of responsibility with th ıde. Continued contact with such men provides an tside perspective or viewpoint of the organization and products. The vacancies created by these changes, to-ther with normal expansion, provide openings for new n, and tend to keep the organization young in spirit. Vith the engineering organization often forming so ge a part of the assets of a business, the conservation development of this organization must be planned l in advance, with the same care as any production ertaking.

'he old definition of an engineer credited him with utilization of the materials and forces of nature for uses of man. In industry he must go farther, pro-ng and maintaining profits by introducing new and roved utilities to meet and anticipate demands. It is sufficient to *produce*, but to *produce at a profit;* not ıgh to *utilize* forces, but to use them *economically;* alone to *supply* the needs of mankind, but to *create* stimulate *new needs,* in turn supplying them, at a fit. Thus, the engineer has three major functions: earch, application, and production, all measured by a mon standard—the net profit.

Requirements of an engineering staff

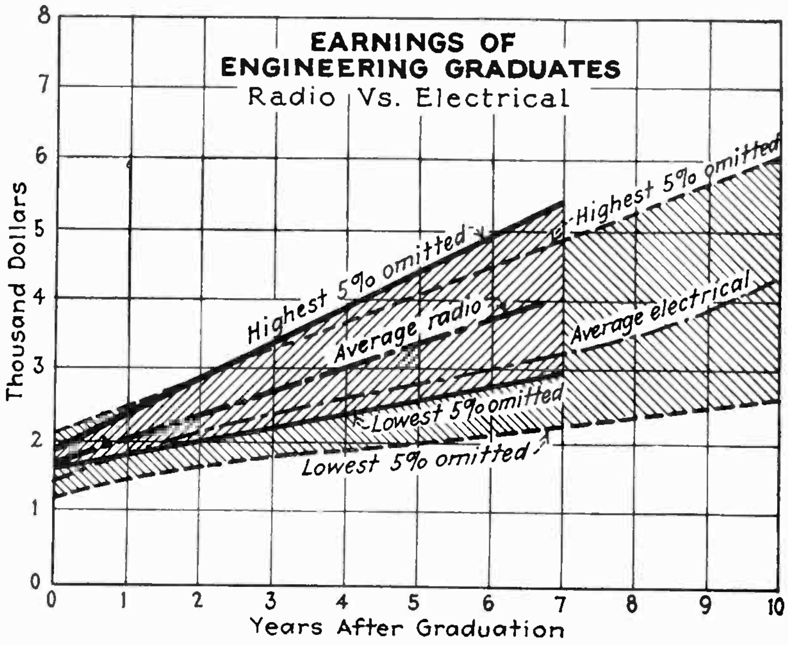
here are several requirements for a strong and flex-e engineering organization, which must be considered letail. The proper delegation of responsibility and hority is of prime importance. Responsibility without hority is of little value, and authority without re-nsibility is usually a mistake. The two must go hand and for efficient work.

esponsibility is not an inherent quality, and must be eloped gradually to obtain best results. Too much ne time will either "make or break" a man, it is e, but the risk of spoiling a man's future by an un-erved failure must be considered. The development his quality may be entirely independent of his regular k, consisting of outside trips or special work to be pleted without assistance, in a specified time. Self-fidence can be developed by similar methods, having man prepare papers for publication, or give lectures alks before groups of his fellows, for example. It irprising how few engineers are able to express them-es from the platform.

'he selection and training of assistants is also impor-t. Every man in a position of responsibility should e an assistant who is well acquainted with at least tine items of the work. If possible each man should l three jobs at one time: first, as advisor to the man succeeded him on his last assignment; second, his sent assignment; and third, as understudy for the ition he will next occupy. In this first position he is acher of his previous duties; in the second he is in rge of his present work and teacher to the man who next occupy that position; and in the third he is ning the fundamentals of his next assignment. With l-planned lines of promotion of this kind, even an epi-nic has small chance to interfere with progress.

Dangers of over-organization

Sometimes there is a tendency toward over-organiza-n—having too many men for the authority and re-nsibility available. This is often the result of hiring o mediocre men to do one job, rather than pay one od man what the job is worth; it is not economy, either payroll or space required. It certainly does not im-ove departmental efficiency, morale, or standards of ility. Furthermore, both of the mediocre men are



doubtless discontented with the job and the salary, thus accounting for increased turnover.

However, the other extreme must also be avoided. The smaller number of high-grade men must not be so overloaded with work, particularly routine details and reports, that they have no time to *think constructively* about the work in general. It is the ability to *think* and continually improve that makes this class of men the better investment.

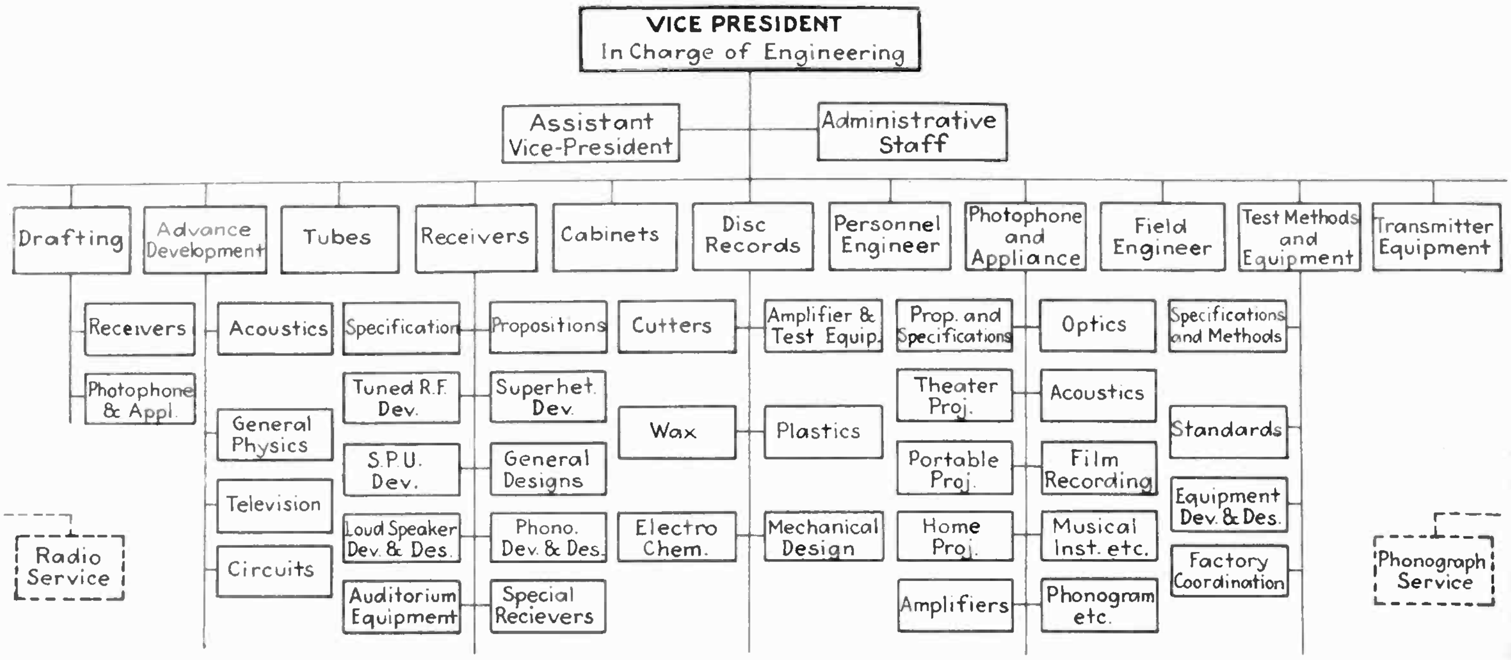
The question of salaries depends somewhat upon the relation between the supply and demand, and upon prevailing rates in other branches of the electrical industry. To maintain an organization of high calibre without excessive turnover, salaries must be above average.

The Society for the Promotion of Engineering Education recently compiled a rather complete analysis of the earnings of engineering graduates, in all branches of the profession. Since the data obtained for the electrical graduates conform very closely with the average for all engineers, it may be used for purposes of comparison. It must be remembered, however, that conditions vary slightly from year to year, and 1926 data is not directly comparable with that of 1930, nor is 1930 indicative of 1935. However, for a rough comparison, corresponding data has been tabulated for a large group of engineering graduates employed in radio, and the comparison is shown in the diagram. Assuming that these data are typical of the radio industry, it is evident why many of the higher-class graduates are interested in linking their futures with that of radio.

Value of the bonus

For the junior executives and group heads the financial return for time and effort invested should be composed of two portions. The major portion should be a salary, increased at periodic intervals. The balance may be in the form of a bonus, payable annually or semi-annually. This bonus should not be in any way proportional to the salary, but should depend upon the contribution of the individual to the profit and advancement of the department, and upon the net profits of the company for the period it covers. In this way many of the men become partners in the business venture and guardians of the profit.

In any case, the salary should be ample to attract and hold the best men. It should be limited by ability rather than by length of service or other arbitrary standards. This tends to develop a good morale and a feeling that



the organization is humanly considerate and willing to pay for further effort.

However, these efforts must be expended along proper lines, with a minimum of duplications. Each individual must have a clear conception of his responsibilities, the extent and limits of the work to be done, and the results desired.

Of course, no one type of organization will fit all conditions. Much depends upon the policy of the company and its attitude toward the industry. One class strives to add to the total knowledge of the art, as a partial return for net profits derived from it, with a view toward continuing the profits, and broadening the field. This class requires a relatively large engineering and research organization, headed by executives with foresight and patience.

Research credited with 20 per cent of profits

Another class, sometimes called "parasitic" organizations, strives to obtain the maximum profit from the art, considering the present with no regard for future progress. This class requires no research and engineering group, but a large force of high-pressure salesmen. Examples of both classes have been found in the automobile history. Hundreds of small manufacturing organizations of the latter class have had their day and are now but memories. The survivors are almost without exception in the former class. In the electrical industry, for example, one of the largest research laboratories was credited last year as being responsible for 20 per cent of the company's profits, on devices unknown or unimportant ten years ago.

There is, of course, a third alternative for the manufacturer who prefers not to engage in research and engineering work. He may utilize the facilities of independent laboratories and consulting engineering organizations. A relatively large number of such organizations usually exist in the early stages of a new industry, before requirements become stabilized.

In addition to research engineers who have specialized in physics, chemistry, and mathematics, radio requires several other types. In receiver development work, for example, electrical engineers specialize in circuits, and have only a secondary interest in the mechanical construction of a device. On the other hand, the receiver design section is primarily interested in the mechanical construction and manufacturing cost. The development engineers strive to get the utmost in operation, and the design group to obtain this degree of operation at a minimum cost.

After a device is in production another group periodically reviews and analyzes the costs and profits, suggesting improvements in both. This group must deal with the factory engineers, who are responsible for manufacturing facilities, materials, methods and processes, and must also have a broad perspective of the other elements of cost, such as overhead, development expense, distribution, etc. Other engineers contribute their efforts to the sales, service, and legal problems. Directing all of these activities are executive engineers, who must be able to correlate the various phases of the problem, including the human phase.

Radio thus requires at least seven types of engineers all with different viewpoints. No one man could perform all of these functions effectively, yet the graduate who nearest meets the need of industry today is a combination business-engineer and research scientist, capable of charting a safe course into the unknown, and then navigating it *profitably*. However, this combination is extremely rare, and industry must utilize the desired qualities as they normally occur—divided among three or four different types of individuals—by getting them to work as one man under the leadership of the executive or "organizer" type. To coöperate effectively, each type must be acquainted at least with the viewpoints and problems of the others, and the preliminary training should be arranged with this in view.

To supply the additional personnel for all of these engineering functions, a group of technical graduates is selected each year. Many of the applications come in by mail, from all parts of the United States. Others are obtained by personal interviews at some of the larger colleges and technical schools.

In selecting men, many things must be considered besides scholastic ability and character. One factor, often overlooked, is practical experience, usually indicated by vacation work. Theory is no substitute for practice, and a few months of summer work along the right lines, regardless of pay, are invaluable to a student. Foresight and purpose are measured by choice of summer work.

Another consideration is the portion of college expenses earned by the student. A good man who devotes half his time to making expenses will not obtain grades that reflect his true ability. If standing is high under these conditions the man is especially valuable.

[*Continued on page 110*]

_atest developments n wide-film pictures

By E. I. SPONABLE

rmerly Chief Engineer and Technical Director
x-Case Corporation

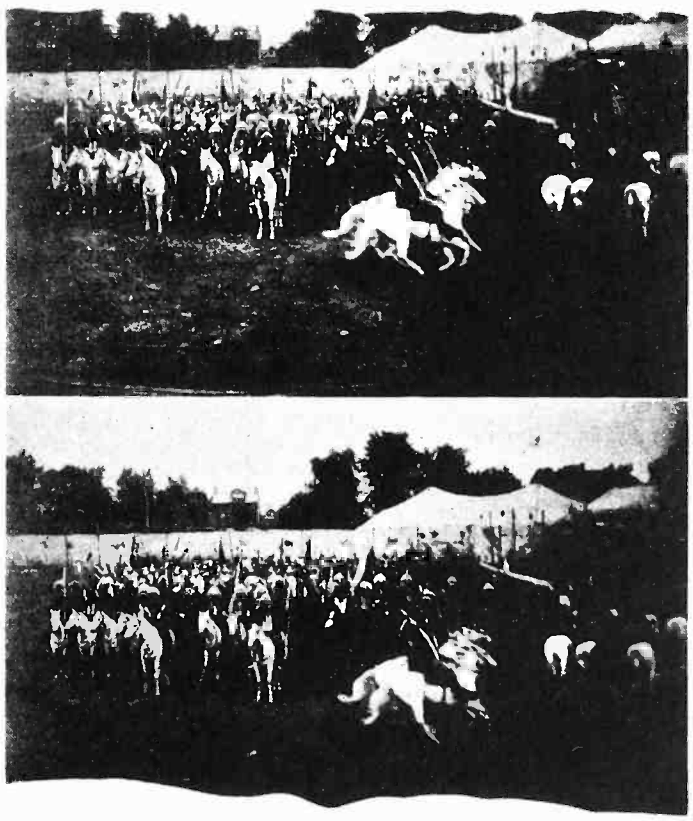
THE motion-picture industry, and those connected therewith, having received and partially assimilated the revolutionary jolt caused by the advent of ound, have evidenced during the past year certain apehensions regarding a new terror in the form of wide m.

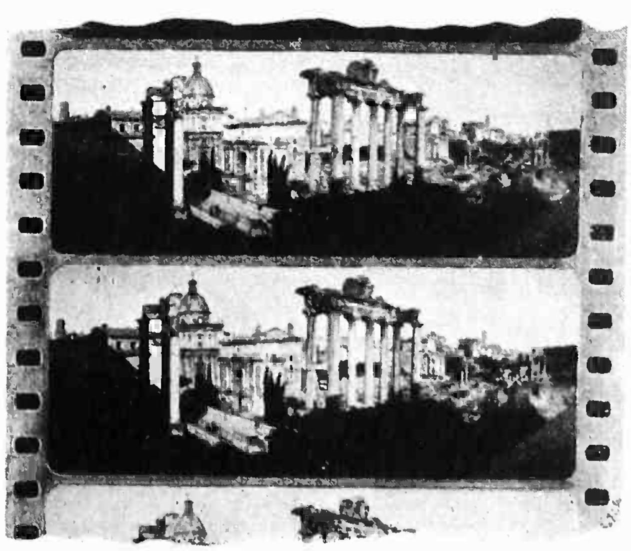
Stories and rumors concerning stereoscopic pictures, naural sound, television for theatres, and pictures of emendous size, have been so prevalent and confusing tat even technicians begin to wonder if they know what i is all about. Many in this generation have seen the otion picture grow from the child of the nickelodeon ays to the industrial giant of the present. During this me, even with the addition of sound, nothing radical as been undertaken in reference to the system as a hole. This does not mean that improvements have not een made. On the contrary, much excellent work has een done in perfecting and refining the mechanics of e art, including panchromatic nd super-sensitive films, fast nses, improved cameras, processg machines, high intensity proection lamps, better screens, and any others. Wide-film silent ictures are actually not a new evelopment. In fact, they are ractically as old as the motion icture itself.

In the accompanying views are hown two specimens of these arlier wide films. There are many thers such as Henderson, Spoor, Biograph and Widescope. To jusify those who began the developnent of wide-film sound pictures, let it be said that the original problem was definite, and resulted from the logical growth of the industry. It is now being solved in the same orderly manner as was originally contemplated.

Limiting factors in picture size

Certain factors indicated a need for such a development. The sound track cutting off 13 per cent of the space originally used for pictures has changed the original picture frame of three by four proportion, resulting in a square shaped picture that is neither pleasing nor artistic. The quality of the present 35 mm. pictures fails perceptibly when projected with the magnification now used in the larger theatres. The loss of definition particularly in the long shots of color pictures due to low resolving power of the film becomes more apparent with increased magnification. These factors, together with many other deficiencies caused certain producers to believe that the time was at hand to modify the system as a whole to meet the present and future requirements of the studio and theatre. This, then, is the reason for the development of wide film. It was not with the intent of producing chaos in the industry, nor with a thought of replacing immediately the present standard 35 mm. system; but rather with the idea of being able to reproduce picture and sound of a quality commensurate





Gripper system film 75 mm. made about 1900. This film was used in a projector that had no sprocket teeth.

Italian film (Alberini print 68 mm.) made in 1914. Ratio picture width to height 2.48.

Comparison of Dimensions and Characteristics of the Principal Wide Films

	Picture Frame, Ratio Width to Height	Sprocket Holes per Frame	Sound Track Width, Mils	Perforation Pitch, In.	Projection Speed, In. Feet per Minute	Present Signal Range Above Ground Noise	Maximum Reproducing Frequency in Cycles with 1-Mil Slit
Standard 35-mm. film..............	1.17	4	100	0.187	90	25 db.	9,000
Grandeur 70-mm. film..............	2.00	4	240	0.234	112.3	34.5–70 db.	11,250
Proposed 65-mm. film..............	2.00	5	250	0.187	112.2	34.5–70 db.	11,250
Suggested compromise 67.5-mm. film.	1.90	5	230	0.187	112.2	34.5–70 db.	11,250

Note: A full symphony orchestra has a sound signal range in power of about 1,000,000 to 1 (60 db.) Present broadcast transmission and reception handle a range of about 10,000 to 1 (40 db). Improved sound technique will increase the sound power peak from approximately 300 times the ground noise to a level much more natural.

Present broadcasting facilities permit transmission of audio frequencies as high as 5000 cycles; but most receivers have poor fidelity to these high tones. Thus in the theatre, reproduction from the wider sound track will have an additional advantage from the standpoint of frequency transmission over present broadcast reception.

with the lavishness and luxury of the modern picture playhouse.

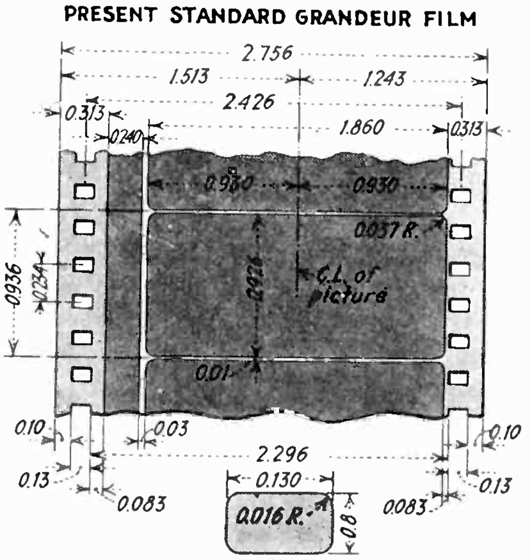
In connection with the picture a very extensive survey was made of existing large theatres, noting the size and shape of the prosceniums; the possible height a picture can be displayed without being cut off by the balconies and mezzanines; and the distance from the front row seats to the probable location of the screen. It was found that the average possible picture height was about 21 feet. Knowing this, and deciding arbitrarily upon the maximum amount of graininess of the film allowable from the front row seats, it was comparatively easy to determine a suitable size and shape of picture on the film itself. Thus, by more than a coincidence, at least three independent investigators representing three of the larg-est producers found a satisfactory picture size to b 23x46 millimeters. If the overhang of the balconies i many theatres did not limit the height of the picture, ratio of width to height of something less than 2.0 migh have been chosen and might be more pleasing from a æsthetic standpoint. However, this condition togethe with the desirability in many instances of showing pano ramic scenes led to the size set forth as a fair compro mise. It is always possible to decrease this ratio eithe by masking, or by effective composition if condition warrant.

Sound recording technique

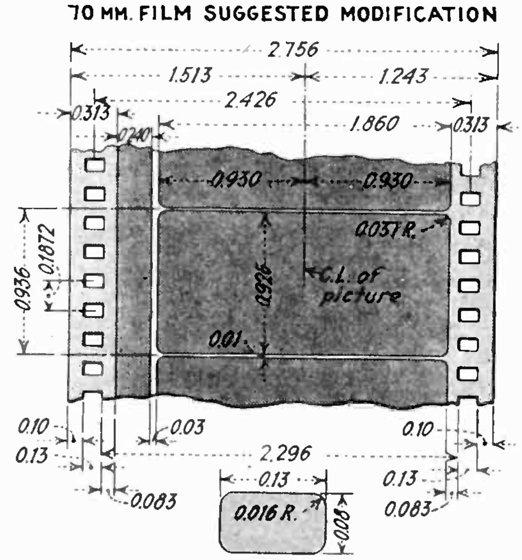
In the case of the sound track the present 100 m width permits, under average processing conditions, signal volume range of about 25 db above the ground noise level of th film. This range can be materiall increased by adding to the widt of the sound band. Optical an other practical limitations, how ever, limit the choice of a ne sound track to 250 mils. This wi permit a scanning aperture of 23 mils as compared to 80 mils o standard film. The resulting signa range will be increased approxi mately 9.5 decibels.

Through more recent develop ments in the technique of film proc essing and handling, it is now cer tain that with this new width o sound band a signal volume range even up to 70 db. above the surfac noise can be attained. This mean that all normal sound condition including the pipe organ and th symphony orchestra, will be re corded and reproduced with thei true quality and shading, thu eliminating the necessity of volum control required at the preser time. This together with an in crease in linear film speed of fror 90 feet per minute to 112.3 fee per minute produces a very notice able increase in the quality of re produced sound. Higher frequer cies are reproduced with less dis

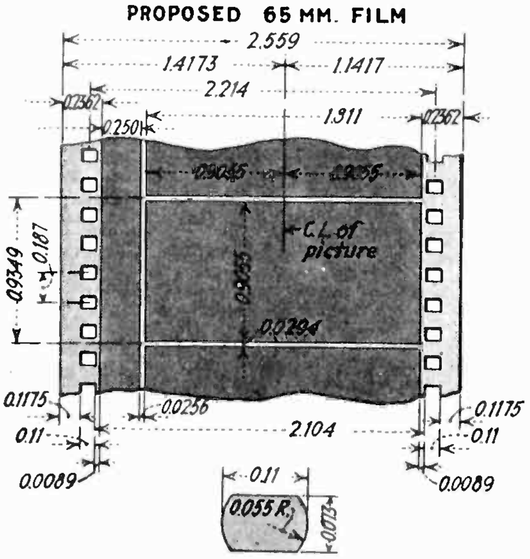
PRESENT STANDARD GRANDEUR FILM



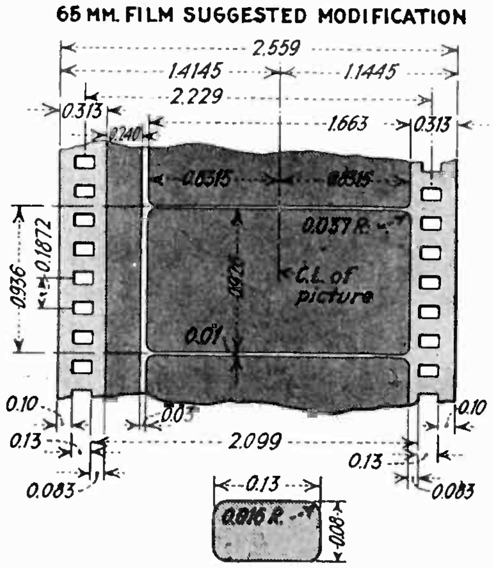
70 MM. FILM SUGGESTED MODIFICATION



PROPOSED 65 MM. FILM



65 MM. FILM SUGGESTED MODIFICATION



)rtion and surface noise is ·actically eliminated.

Under present recording ›nditions the average effec- ve recording slit width is 1 il; this limits the maximum cording frequency to 9,000 cles. However, with the in- ease in the linear film speed 112.3 feet per minute the aximum recording frequency ll be extended approximately per cent. This will also in- re better integration in the ›per register of the audible equencies.

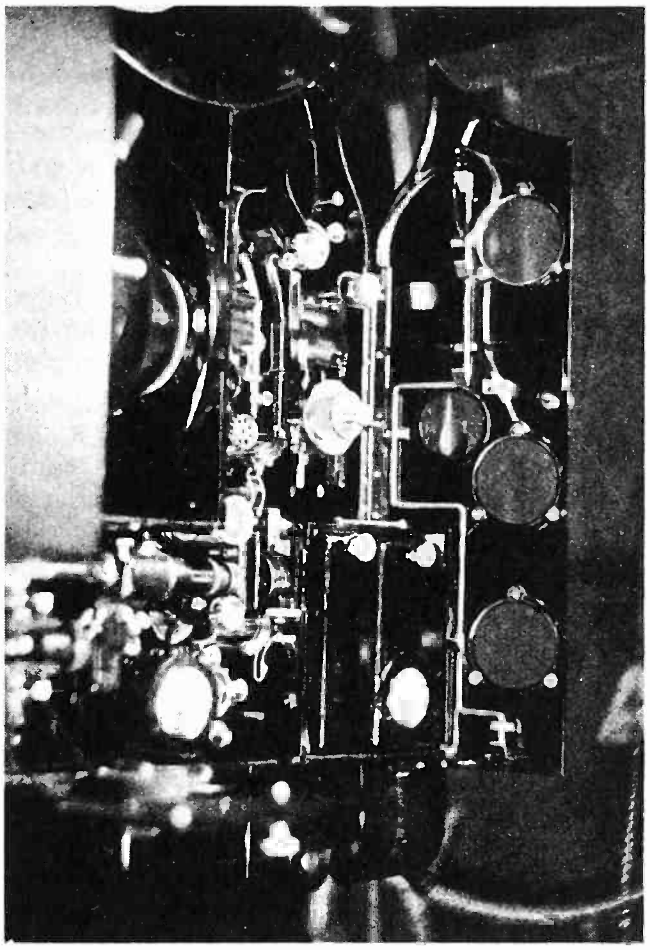
Standardization for the new films

Although the principal pro- cing companies are in sub- ıntial agreement on the size picture and width of sound nd, there is still a difference the proposed overall width the film. One company s commercially exploited a n 70 mm. wide with four rforations to the frame. her companies have devel- ed a film 65 millimeters de with five perforations r frame. These two types film are shown in the accompanying sketches. The sign of the perforations in both cases has been made allow for normal film shrinkage and proper size of n sprocket teeth. It is quite certain that both sizes film are practical from an operating standpoint, but o different sizes in practice would obviously be ruinous the industry. Efforts are now being made by the gineers of the companies concerned to effect an agree- nt or compromise in the final film size.

Certain compromises have been proposed in order to ng all producers into agreement on a standard wide n. One of these proposals calls for a film of 67.5 n. width with a sound track of 230 mils width. The ture frame dimensions for the latter would be 44.7 3.5 millimeters. Five sprocket holes per frame would used which is the same number as in the proposed mm. film.

In the standard 35 mm. projector the present length ween the center of the picture frame and sound gate 14½ inches. In the proposed wide films this distance reduced to 11¼ inches. This allows the sound attach- nt to be included in the projection head, which with sent apparatus is not possible. This will also reduce "hangover" of the sound in the present projection ads which are equipped with separate sound attach- nts.

The use of 70 mm. film in double system studio work uires new sound recording machines. These have n designed to use split film stock with perforations on e side only. A recording speed of 112.3 feet per nute is used. With 65 mm. film having a perforation ch is .187 in., which is the same pitch as standard 35 n. film, it is possible to use standard recording ma- nes provided they are speeded up to 112.3 feet per nute.



Projection head of new Grandeur projector as installed in the Roxy Theatre, N. Y. Note sound attachment combined with projection head

The most radical changes have been made in the design of the projector where only minor improvements had been made over a period of twenty years. Among the many features of the new projector model are: self-aligning sprockets to insure maximum life to the film, and also a special multiple-back shutter. An improved movement has been developed, which at a projection speed of 24 frames per second completely eliminates flicker due to the intermittent with the resulting eyestrain.

From the productions on wide film already exhibited it is evident that new problems in sound must be solved. Particularly pressing is that of sound distribution. When sounds appear in the picture to originate at the extreme sides, it is difficult in present practice to produce an illusion with all sounds emitted from a single diffused source. This problem has been recognized and several solutions are being contemplated. Fortunately in the design of the film sufficient space is available if a band is required to effect some manner of electrical control of sound distribution.

Thus, in developing wide film, an attempt has been made to give the motion picture industry the wherewithal to make pictures of a truly imposing character. It will not make production easier or prove a cure-all for careless film processing. With proper technique it should be possible to produce pictures of a most pleasing sense of depth and perspective, but they will not be stereoscopic. It should give the scenarists and directors a chance for greater expression, and result in pictures in the theaters of a scope, beauty and realism hitherto unknown.

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Mr. Sponable is an outstanding figure in motion picture engineering. He has had ten years experience on the problems related to light and sound with the Case Research Laboratories. Together with Mr. Theodore Case, he was responsible for the development of the Movietone system of sound recording. His most recent work has been in the development of wide films. The first "Grandeur" film shown with sound synchronization was made under his supervision.

—The Editors.

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Producing artificial fevers

[From a paper presented at the American Physical Therapy Association convention at Boston, April 18]

By short radio waves having frequencies of ten million cycles per second

By C. M. CARPENTER and A. B. PAGE

THE value of heat as a physical means of alleviating and curing disease has been emphasized constantly throughout the history of medicine. However, the significance of fever and its relation to the course of an infectious disease or to the healing of trauma has been debated often. It was believed that a rise in body temperature was only a sign of disease, as in pain, and, to establish the comfort of a patient, must be dissipated. Nevertheless, evidence has been accumulated during the last few years to show that a fever, disregarding hyperpyrexia of central origin, may be a phenomenon valuable to the diseased animal body, and is a defensive mechanism for the body.

Combinations of certain diseases occurring in the same individual—for example, an acute febrile disease with a chronic afebrile malady—sometimes results in an improvement or a cure of the latter. Such observations played an important role in Wagner von Jauregg's development of the malaria treatment for paresis. Because of his success, the study of the value of fever in an infectious disease syndrome is engaging the attention of many investigators. That the heat associated with the febrile phenomenon, due to the injection of a protein, is the factor that is responsible for the beneficial result suggested by the favorable results obtained in the tr ment of neurosyphilis by heat alone.

The present methods that are used to establish fe in man are unsatisfactory in one respect or another. injection of foreign proteins is hazardous. The use plasmodium malariae or spirochaetes for the treatm of general paresis often fails because of the danger c cerned with the administration of a living virus, because of a failure to infect immune individuals.

Since the observation of Dr. W. R. Whitney, direc of the Research Laboratories of the General Elec Company, that there is an elevation of the body tempe ture of men working in the field of a short-wave ra transmitter, considerable experimental work has b undertaken to adapt this energy for producing artifi fevers. Hosmer has reported these heating effects salt solutions of various concentrations and on sm laboratory animals.

Internal tissues are directly heated most rapidly

It was determined that this is a method for produci in animals any degree of fever at will, without the int duction of foreign substances. The heat is produc directly within the animal body, as occurs in the cou of a fever due to an infectious disease. This constitu a method for internal heating in which the heat is gen ated in the organs of the body as rapidly as in the bo walls, but because of the greater heat loss at the perip ery the temperature of the internal tissues rises mo rapidly.

During the last two years special types of apparat have been designed by the Research Laboratories befo mentioned and used experimentally in an endeavor cause a fever in man rapidly, without great discomf to the patient and to a degree high enough to be of val The equipment used in our experiments has been co structed on the same principle as a short-wave ra transmitter, with the exception that the energy is co centrated between two condenser plates instead of bei directed from an aerial.

The heater consists of a vacuum-tube oscillator and full-wave rectifier that supplies the high voltage for t oscillator. The high-frequency oscillator is composed two 500-watt radiotrons operating at a frequency

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Body temperatures as high as 106 deg. Fahr. have been developed without discomfort to the patient.

Such artificial fevers offer wide possibilities in the treatment of diseases, since such temperatures (1) make the body environment less favorable for the multiplication of a virus, and (2) speed up the body chemical processes that make for immunity and defense against infection.

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ɪm 10,000 to 14,000 kilocycles, the output of which is ɪcentrated between two plates. The rectifier is an ·immersed transformer having a 7,000-volt secondary ɪl feeding two half-wave, hot-cathode, mercury-vapor ɪes. In conjunction with filter system this unit fur- ɪhes the 3,000-volt direct-current supply for the oscil- ɪr. An auto-transformer is connected on the primary ·uit of the high-voltage transformer to provide plate- ·age regulation.

'he condenser plates are of aluminum, 28 in. by 18 in. ɪ$\frac{1}{8}$ in., and are covered with hard rubber plates 30 in. ·20 in. by $\frac{1}{4}$ in. to prevent arcing, should the patient ·attendant come in contact with the plates. In this ɪl of undamped waves between the plates there is a ·id alternation of 3,000 volts drop of potential. We ɪe obtained our greatest heating from the use of a ɪmeter wave that oscillated 10,000,000 times per second ·veen the plates. We have used wave lengths of 6, ɪand 18 meters, but they have not heated the body so ɪctively with the oscillator described.

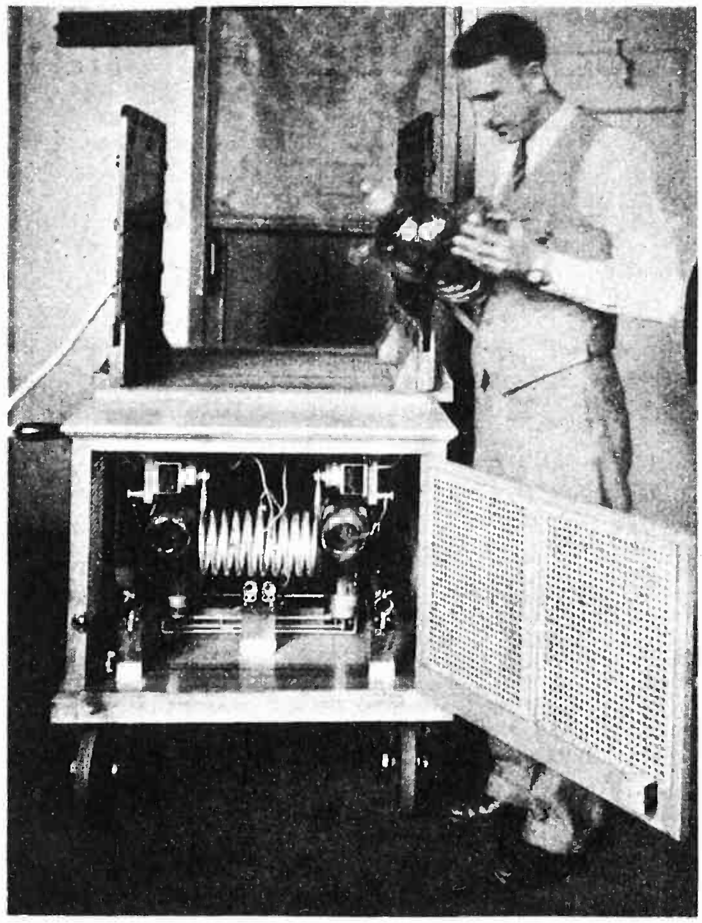
Arrangement of the patient

'he patient is suspended on interlaced cotton tapes ɪtched across a wooden frame 76 in. by 28 in. made ɪwo-by-six timbers. The under-surface of the frame ɪovered with celotex $\frac{1}{2}$ inch thick, forming an air ɪmber beneath the body. A celotex cover of similar ɪkness, 8 inches high and one foot shorter than the ɪne, is fitted over it so that the head of the patient ɪects through an opening at one end. Thus there is ɪned a fairly tight air-chamber around the body as it ɪ on the tapes. The patient rests on his back and the ɪes are placed at each side of the celotex box so that ɪwaves oscillate through the body from one side to the ɪr. The plate distance can be varied, but as a rule ɪ been kept at 30 inches. Two small hair dryers as ɪgested by Dr. Thomas Ordway are placed in openings ɪe foot, one above and one below, to circulate hot air ɪund the body. These decrease heat loss and equalize ɪhumidity throughout the enclosed atmosphere.

ɪy applying the plates in this manner and by enclosing ɪbody, it is heated rapidly without causing great dis- ɪfort to the patient. We have raised the normal ɪal temperature of 99.6 degrees F. to 104 degrees F., ɪ 105 degrees F., in from 60 to 80 minutes. In one ɪance a temperature of 106.5 degrees F. was recorded. ɪher temperatures may be obtained easily with the ɪaratus employed, but, because of our limited experi- ɪe, we have proceeded cautiously. When the desired ɪperature is reached, it may be maintained in several ɪs: First, by decreasing the voltage; second, by ɪeasing plate distance; third, by employing only the ɪair blowers.

Theories explaining heat production

ɪlthough we are able to produce successfully artificial ɪers with the radio waves as described, we realize that ɪ equipment used and the method for applying this ɪn of energy to heat the body can be greatly improved, ɪ this is rapidly being done. Various theories explain- ɪ the rise of temperature of the body when exposed to ɪrt radio waves have been discussed by Carpenter and ɪak[1] in another report. We believe that the develop- ɪnt of heat is due to the resistance of the body to the ɪduction of current between the surfaces adjacent to ɪ opposed plates. At each alternation of polarity of the ɪtes the corresponding polarities are induced upon the adjacent boundaries of the interposed body, and current is conducted through the material for a brief interval. The heating of solutions similar to the blood serum is dependent directly upon their electrical resistance. It has been shown that dilute solutions of different salts when of the same electrical resistance exhibit practically identical heating effects.



An end-view of the portable therapeutic heater showing the high-frequency tubes in place. Above the table-top are seen the two vertical condenser plates between which the patient is placed

The use of therapeutic fevers is still in the experimental stage but they have great possibilities if our conception of the significance of a febrile reaction is correct. We have studied the effect of fevers produced by short radio waves on various laboratory animals and on 25 patients, and thus far we have failed to observe any objectionable effect unless extremely high temperatures are maintained for long periods. We have proceeded, of course, with caution and followed closely the variations in body temperature, blood pressure, the pulse and respiration. The use of such a method demands conservatism and sound judgment because of the comparatively short time it has been studied. However, we are of the opinion that because of the practicality of this method of heating, it may be of value not only to the clinician but to the physiologist, the biochemist, and the bacteriologist.

Studies of infectious diseases in laboratory animals that will be reported elsewhere lead us to believe that two desirable effects are obtained by raising the body temperature. First, the increased heat within the body makes a less favorable environment for the multiplication of a virus. Second, the heat increases the rate of those chemical processes concerned with the development of immunity and with the general defense mechanism of the body against infectious agents.

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[1]Carpenter and Boak, to be published in American Journal of Syphilis.

Vacuum-tube oscillator used for continuously

Recording wire diameter

By C. W. LOEBER

THE operation of this apparatus for measuring wire diameter depends upon the well-known principle that small changes in the capacitance of a vacuum-tube oscillatory circuit produce changes in the frequency of the oscillator. Two vacuum-tube oscillators are used, one having a fixed frequency and the other having its frequency varied by changes in the thickness of the wire being measured. An audible beat-note is thus produced, the change in pitch of which will be a direct function of the change in wire thickness. The output of the oscillators passes to suitable amplifiers whose input is bridged by a resonant circuit. The latter is so adjusted that the voltage drop across the grid of

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To accurately and rapidly determine the variations in thickness of wire, especially over great lengths, becomes a serious problem in the manufacture or use of wire. Uniformity in the diameter of such wire as tungsten and nickel has assumed great importance since the advent of mass production of radio tubes, for quality of these finished products is largely a matter of filament life. Using the apparatus here described it is possible to make a continuous record of the variation in thickness of any length of wire.

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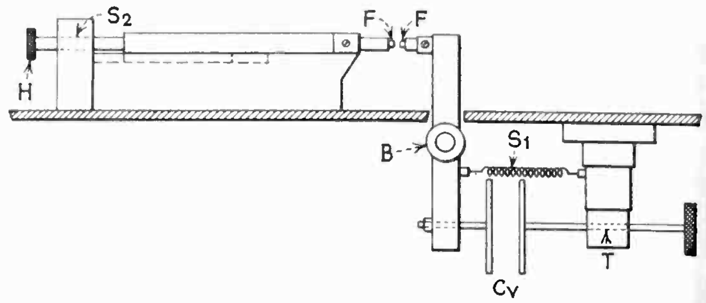


Fig. 1—Mechanical arrangement of the apparatus for measuring and recording the wire diameter.

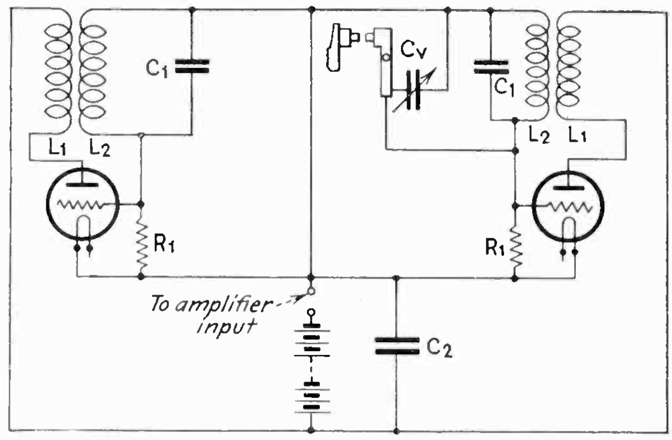


Fig. 2—Circuit diagram of the two oscillators. The beat frequency between them is amplified and used to operate a recording meter

the first amplifier bears a linear relationship to the f[r]equency variations of the beat-note. A recording mi[lli]ammeter is used in the plate circuit of the amplifi[er]. The apparatus was developed by W. W. Loebe and [...] Samson of the Physical Laboratory of the Osra[m] Company of London, England.

The mechanical arrangement of the apparatus is sho[wn] in the accompanying drawing, Fig. 1. The wire is pass[ed] through two "feelers" (*FF*), one of which is st[a]tionary while the other is movable and carries one pl[ate] of a variable air-dielectric condenser C_v which for[ms] part of the oscillatory circuit. By means of a microm[et]eter screw at *T*, the capacitance of the variable co[n]denser is changed. A light spring S_1 governs the tensi[on] on the wire being measured. Spacing between t[he] "feelers" is varied by a second micrometer screw [S_2] which moves the fixed "feeler" horizontally. Th[is] adjustment is used to calibrate the instrument and t[he] micrometer head may be marked to read directly in mi[lli]meters. In order to prevent wearing of the surfaces [of] the "feelers," these are made of a suitably hard su[b]stance such as diamond. Minimum friction on the bea[r]ing of the movable member is essential to accura[te] recording.

Shielding of mechanism

The equipment is carefully shielded to prevent t[he] effects of external electrostatic and electromagne[tic] fields. An additional precaution, that of thermally ins[u]lating the apparatus to prevent changes in circ[uit] constants caused by changes in temperature, must [be] taken where great accuracy is required. This may a[lso] be accomplished by building the apparatus of materi[als] having a low coefficient of thermal expansion.

The wavelength of the oscillators is determined beat-note requirements of the resonant circuit. tailed circuit constants cannot be given here, since ividual measuring requirements will vary. The choice wavelength is governed by the size of the variable idenser, the spacing of the condenser plates, the design the resonant circuit, and the anticipated variations wire diameter. For example: If the variable con- iser has a spacing between its plates of $\frac{1}{10}$ mm. which changed by 10^{-5} mm. due to a proportional change wire diameter, the condenser capacitance is increased decreased by 0.01%, corresponding to a change in quency of 0.005%. If the mean oscillator frequency 10,000 kc., the beat frequency is changed by 500 les per second. If the mean beat frequency is usted to 900 cycles per second, a decrease of 500 les per second will lower the note by about one octave. is therefore necessary to choose wavelengths which l give beat frequencies falling on the essentially

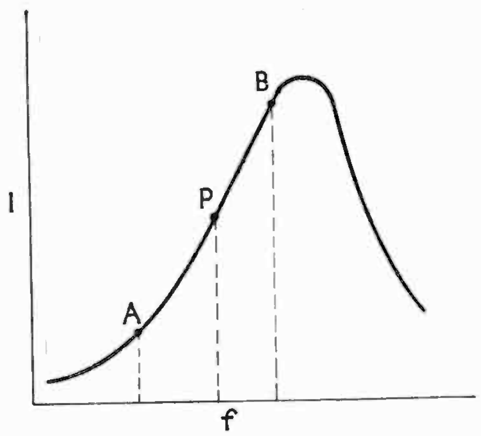


Fig. 3—The section A-B shows the part of the response curve over which the system operates

aight portion of the frequency response curve of the onant circuit.

f the resonant circuit is designed so that its fre- ency response is similar to that shown in the curve d the mean beat frequency is adjusted to lie at the int *P*, the range over which the appaparatus will give curate results is determined by the length and slope of straight portion, *A–B*, of the curve. Fairly high istance will be needed in the circuit in order to obtain curve which has a constant slope nearly equal to unity. In Fig. 2, C_1, C_1 are condensers which control the velengths of the oscillators. L_1 and L_2 are the respec- e plate and grid coils, while C_2 is the output by-pass ndenser. Grid bias may be obtained from a battery through the resistors R_1, R_1. Choice of tubes will pend upon the range of the recording milliammeter. nce no distortion may take place in the audio fre- ency amplifiers, it is essential that the transformers ve flat frequency response curves from about 100 cles to 3,000 cycles per second, and all vacuum tubes ust be operated on the straight portion of their char- teristic curves. The latter requirement may be suc- ssfully met by operating the tubes conservatively from e standpoint of peak currents and voltages.

Method of calibration

With a space between the "feelers" equal to the iameter of the wire, the apparatus is adjusted so that ne pen of the milliammeter rests in the center of the raph sheet. By means of the micrometer screw S_2 Fig. 1) the air gap between the "feelers" is then

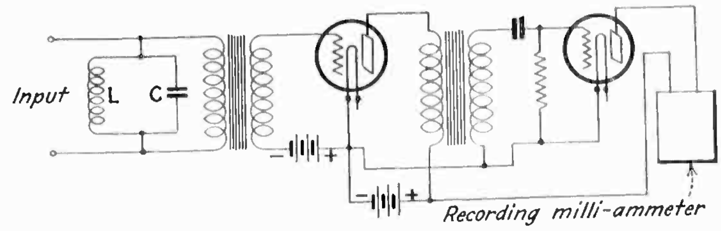


Fig. 4—Two-stage amplifier which finally records the variation in wire diameter

increased by 10^{-2} mm. Assuming that the milliammeter mechanism is in operation, the pen will trace a line to the right or left of the graph sheet. The spacing between the "feelers" is then reduced by 10^{-4} mm. This will give another straight line on the graph sheet closer to the zero position. Still further decreasing the air gap by 10^{-2} mm. will bring the pen on the other side of its zero position on the graph. Fig. 5 illustrates clearly how this calibration appears on the graph sheet. It will be necessary to calibrate the instrument for each different diameter of wire.

It has been shown above that this apparatus is capable of measuring differences in wire diameters of the order of 10^{-5} mm. However, such a degree of sensitivity can only be obtained by observing the precautions mentioned in an earlier paragraph. Nevertheless, by merely shield- ing the apparatus from external fields it is entirely pos- sible to obtain a sensitivity of the order of 10^{-4} mm. Loebe and Samson, in their early experiments, used an oscillator frequency of 1,000 kc. The air space of their variable condenser ranged between 0.5 and 1 mm. Their beat-note had an average frequency of 1,000 cycles per second. A change of diameter of 10^{-4} mm. gave a reading of 0.8 mm. on the graph. The linear speed of the wire was 2 to 3 cm. per second, while the speed of the graph sheet was one-third of the wire speed. Thus every centimeter on the graph sheet represented 3 cm. of wire length.

Measuring and recording cross-sections

In order to check the apparatus, a piece of wire was measured four consecutive times and the graphs com- pared. It was found that these were practically congru- ent, showing that the results obtained at any time may be readily reproduced.

Cross-sections of wire may be rapidly measured with this apparatus. A specimen of wire is placed between the "feelers" and rotated through 360 deg. Graphs made of such measurements furnish another check upon the accuracy since the readings from 0 deg. to 180 deg. must equal those obtained from 180 deg. to 360 deg. with the exception that they will lie on the opposite side of the zero line on the graph. It will, of course, be necessary to make measurements of each specimen of wire indi- vidually.

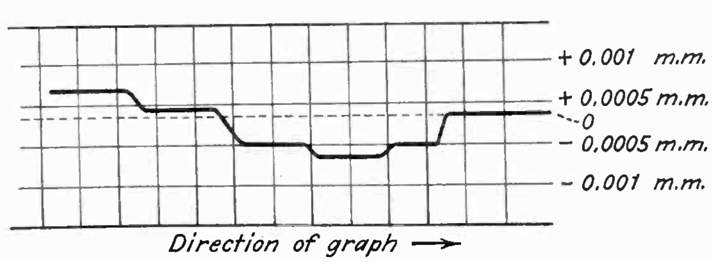
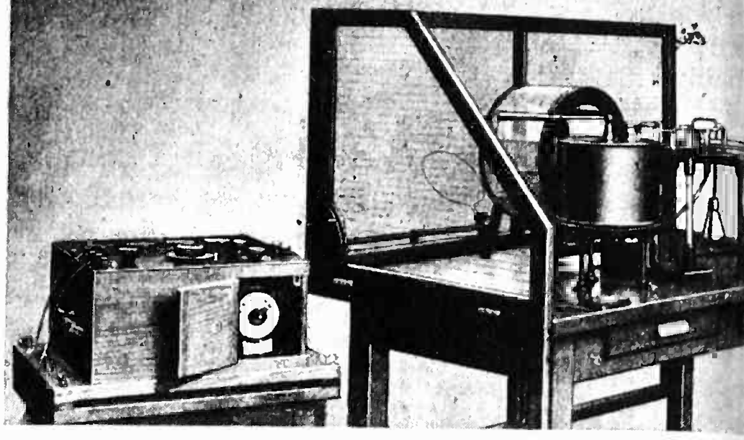


Fig. 5—The graphic record of the wire diameter secured when the instrument is calibrated.

Applying engineering research to

Development of insulating materials

By ROBERT KRUSE



Laboratory apparatus for measuring losses and dielectric constant of insulators.

WIDER distribution of high-powered broadcasting stations, the advent of high-sensitivity receivers, and the desire for more selectivity, have all forced upon radio engineers the problem of designing tuning circuits with a minimum of resistance. Attention has been directed at the form-factor of coils, and the size of wire and shield, and now research has been directed at the form upon which the coil is wound.

In this article, the research that led to a new insulator, of specified properties, is described. The purpose was to find an insulating material which would make possible coils with less resistance than usual, and therefore, tuned circuits with greater selectivity. The work was carried out at the Radio Frequency Laboratories, Inc., by Dr. L. M. Hull and H. A. Snow, at the instance of t[he] Boonton Rubber Manufacturing Company.

There is a general feeling among engineers not actively engaged in designing radio receivers, that such design consists in juggling circuits alone, and that the component parts have not changed appreciably for a long time. This, however, is not the case. Sooner or later every individual unit or raw material that goes into a radio receiver comes under the microscope of the technician, and is revamped, and brought up to date. Research never ceases.

Moulding compositions in general consist of a fill[er] and a binder. In the case of the common phenolic co[m]positions the binder is the raw phenolic-derivitive res[in] which undergoes a chemical change when heated a[nd] compressed in the mould, and may therefore be spok[en] of as a reactive binder. Investigation of the vario[us] phenolic resins has shown that they may be produc[ed] to yield pure resin-moulded products with a power fact[or] as low as 1 per cent, which is to say a phase-angle [of] about 34 seconds. The use of such moulded parts of t[he] pure resin alone is not economical for a number [of] reasons, especially if any machining of the finished pa[rt] is necessary. Therefore, the desired low-loss compos[i]tion should contain a filler of some kind which will yie[ld] good mechanical properties while not destroying th[e] requisite electrical ones.

The proper filler must not only avoid extreme har[d]ness and granularity but must also avoid participatio[n] in undesired chemical reactions.

Experiments with series of test compositions

A long series of test compositions was prepared an[d] tested as to power factor and mechanical propertie[s]. Since the immediate purpose was to produce a materi[al] for radio use, the more promising compositions we[re] given "R" numbers, and as the 29th of these selecte[d] compositions proved desirable, the result of the tests no[w] appears under the commercial designation of R-29.

This composition uses mica as the non-reacting fille[r], raw silk as a fibrous ingredient to increase the toughnes[s] of the material and small percentages of fluxes an[d] hardening agents, the proportions of all these variou[s] materials to the binder changing with the mechanica[l] and heat requirements. The "flux" just referred to ma[y] be the natural wax of the silk itself, although othe[r] waxes are sometimes used.

The use of silk, rather than cotton, asbestos or wood fibre is due to the relative power factor of these ma[terials]. This is shown clearly in the accompanyin[g] curves. This chart also shows that the resin itself i[s] of great importance since the same asbestos filler, o[f] which 20 per cent could be used in the special resin without raising the power factor above 1.8 per cent wi[ll] produce a composition having a power factor of 7.5 pe[r] cent when the resin is of an ordinary quality. Althoug[h] some samples of asbestos show up rather well as t[o] power factor they do not contribute as much strengt[h] as does silk. Wood-fibre also ranks somewhat low i[n] i regard. When a composition is wanted which is ewhat cheaper than the one containing silk it is al to employ carefully chosen, well-dried cotton. h the silk and the cotton are usually cut into short to permit better mixing and to improve the appear- e of the product.

Method of measurement

he power factor measurements were made in the iliar manner of using a sample of the material as ondenser plate and measuring the resistance of this denser. The power factor may be derived easily n this resistance since the frequency and capacity known. The test sample was a disk $7\frac{1}{2}$ in. in diam- having a raised rim and an even thickness across the ion inside the rim. The sample was floated on cury in a glass dish and more mercury was poured n he specimen, being retained by the rim. The con- was very intimate, assuring that the condenser so duced had only the test material as its dielectric. erring to the picture of the entire set-up; r.f. power n the oscillator in the case at the left of the table is dthrough a shielded line to the single-turn coil seen nd the static-screen of the table. The r.f. field his coil is coupled through the static-screen to the ctance coil on the table and thence through a thermo- ple to a highly insulated switching mechanism which nits the closing of the circuit through either the test eimen or through a high-grade quartz-insulated vari- l condenser.

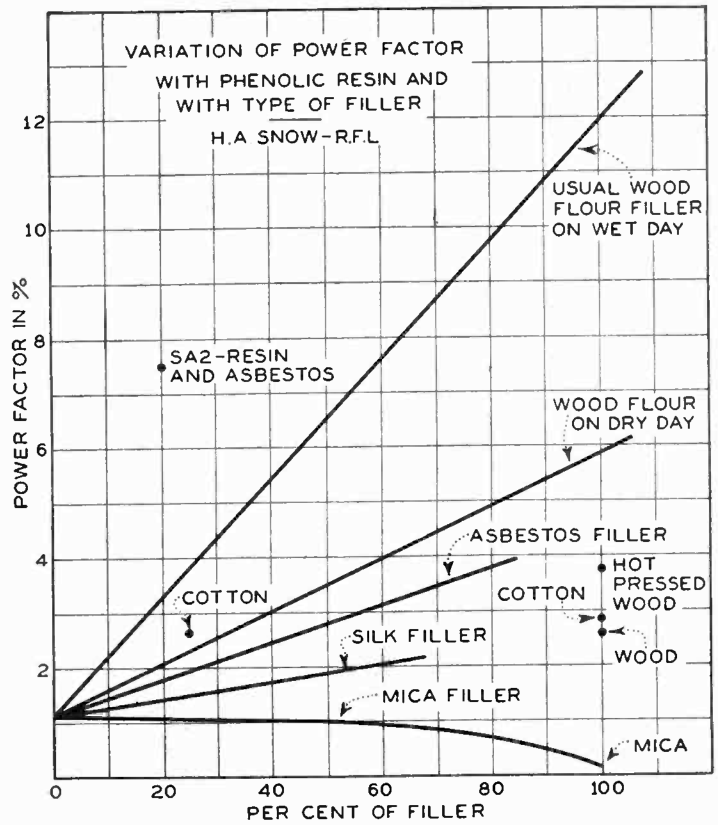
he procedure is to switch to the test piece, set the clator at the resonant frequency, and adjust the pling to secure a convenient current as shown by a galvanometer connected to the thermocouple. The s piece is then switched out and the calibrated air denser substituted. When it is adjusted for reso- nce the capacity of the test piece may be read from econdenser calibration. Next the current is reduced he same value as that found with the test piece by rting small straight-wire resistance links of negligible uctance. The resistance required to reduce the cur- t to the former value is obviously equal to the dif- ence in resistance between the test condenser and the condenser. Usually the resistance of the air con- ser can be neglected and one may say that the test denser has a resistance equal to the inserted series stor. Contact uncertainties are avoided by a scheme ich keeps the total number of contacts the same at all res, all contacts being between mercury and amalga- ted copper to insure low resistance.

he power factor, dielectric constant, and phase angle all be calculated rapidly since the capacity and re- ance of the test condenser are now known and the frequency may be determined easily by the fre- ency meter. When other frequencies are considered inductance in the tuned circuit is changed, and the illator is adjusted accordingly.

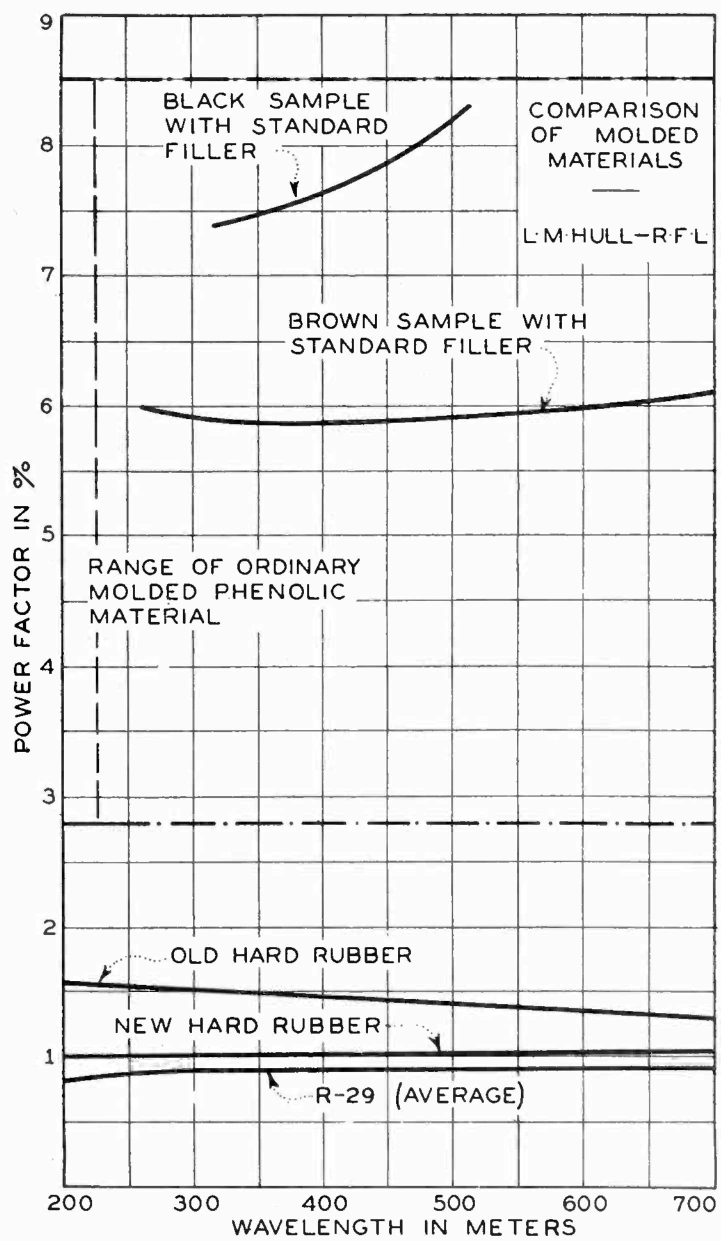
Electrical and mechanical properties

Some of the electrical constants of the material are own. In general the power factor is in the vicinity 1 per cent as compared with 2.7 to 7 per cent for more usual phenolic compositions. The puncture ength of such a composition may be made equal to more than that of compositions containing wood flour d other normal fillers. The high-frequency puncture pecially may be made materially better since this de-

[*Continued on page 110*]



The low-loss resin was used in all the above compositions except the point marked "SA2."



Comparison of power factor of various molded materials. A good insulator has a low power factor.

Industrial uses of the photo cell

By J. V. BREISKY

IF AN industrial expert should tabulate all the operations now partly dependent upon visual judgment, but otherwise mechanical and routine in performance, he would be able to give a fairly comprehensive view of the place photo-electric applications will hold in the future. Mechanisms are replacing human labor wherever it is possible, in order to reduce expense, waste, and loss of time. Moreover, for purely mechanical tasks human labor is imperfectly suited, because it is "only human" for attention to stray, for hands and eyes to suffer fatigue, and for differences in individuals to be responsible for differences in output.

Not only do machines relieve men from unduly arduous labor, but they perform their tasks with flawless regularity. Many routine operations are now dependent upon human labor only because so far no mechanical means have been devised to perform the task satisfactorily.

Of vital interest to the industrial world are those inventions which apply not only to a specific problem but which are based on a principle which makes them applicable to a group of problems. Such an invention is the photo-electric cell. It has been a privilege for those engineers who first sought practical applications for t new device to assist in the solving of many troubleso problems in widely separated fields. Its initial use, an indispensable factor in television and talking mot pictures, is sufficiently well known not to be discus here. Although it is only within recent years that t photo cell has been developed to its present stage workaday efficiency, industry has already made use many instruments now complete for certain applicatio The photo-electric smoke recorder, for example, has specific piece of work to do, and is an established pie of equipment. Other apparatus, such as the light rela and photo-cell amplifier units, are applicable to ma types of work, and are being used wherever it is foun that they supplement or replace present methods adva tageously. As engineers become more familiar wi the possibilities of photo-electricity they will be enabl to simplify many present operations and to reduce loss caused by the variable human factor.

Mr. Breisky, the author of this article, is in charge of photo-electric cell applications in the supply engineering department of the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

A mechanical "sense of sight"

What the versatile photo-electric cell is able to d is of interest to everyone looking for better methods o getting work done. Machines have long been perform ing superhuman tasks in response to mechanical im pulses. The new thing which the photo cell contribute is the automatic response of machines to variations i light. It is almost as if "the mechanical man" had de developed a sense of sight. What the hitherto irreplace able human eye is actually able to do when one analyze its functions—apart from the intelligence which in terprets optical impressions—is mainly to note variation in light and shade, color, size and shape. This, the phot cell is also able to do, and like the eye with its optica nerve, it is equipped to send an impulse which report what it sees.

In studying the applicability of the photo cell in rela tion to any particular problem, it is necessary to under stand the action of the cell itself and of the method b which the impulse is amplified. Figuratively speaking to put the "electric eye" to work the engineer must giv his apparatus "intelligence" to analyze or interpret wha it sees. For example, in one application the photo cel is trained upon packages, in order to cause those to b thrown aside where a label is missing. No very com plex adjustment was necessary to enable the photo cel here to replace human eyesight for inspecting the count less specimens produced daily. But naturally, for ever special operation certain requirements are slightly dif ferent. However, when once a clear understanding i

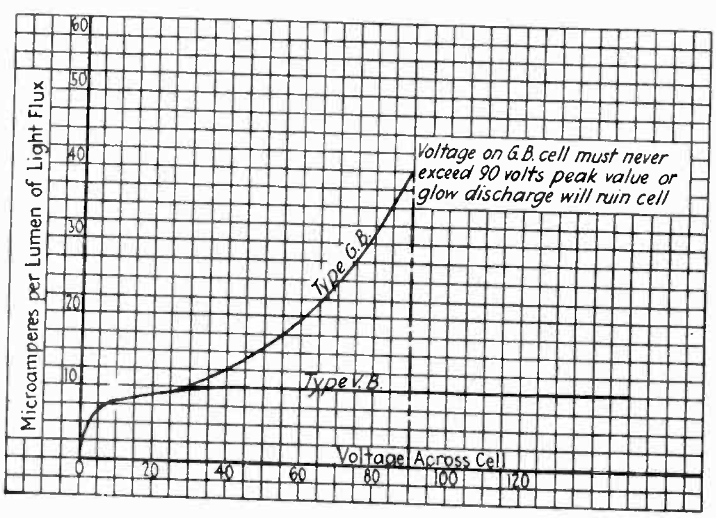


Fig. 1—Photo-cell output in terms of voltage applied

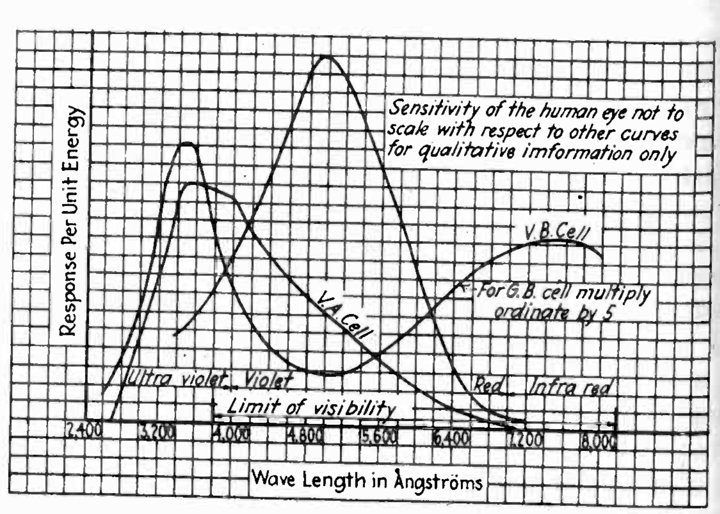


Fig. 2—Color sensitivity of cell compared with eye

of such devices as are described herein, further ap-ıtions can readily be made by the use of ingenuity. full explanation of the operation of the photo cell given in the April issue of *Electronics*, (pages 16 29).[1] It goes without saying that by now the photo is a practical and inexpensive device, with a very factory record for length of life. There are two ndard types of cells: a vacuum type cell, and a gas-d cell.

Types of photo-electric cells

he vacuum-type VB cell gives constant output at ing voltages, and should be used for most applica-. The gas-filled type GB cell gives increased output t an increase in voltage and is recommended when itivity is the chief consideration, not constancy.

g. 1 shows typical curves of cell output as a func-of applied voltage at one lumen of light flux. For r quantities of light, the current is proportional to ight. The cells will respond to b frequency as well as standard uencies.

hoto-electric cells used for grad- or matching colors usually ire a suitable color filter in con-on with the light source so that percentage change in cell re-se may be a maximum following ange in color. A special vacuum l type VA, is available having a re more closely corresponding in e to the human eye, but with one-fifteenth the sensitivity of VB cell. Fig. 2 shows color itivity of the VA, VB, and GB .

he two standard type VB and cells are alike in mechanical struction. The photo cells are nted on a standard four-prong e and consist of a cathode and an de. Although four prongs are plied, only two are connected—anode and cathode prongs. The ode plate is coated with caesium he light-sensitive material.

t will be most helpful here, perhaps, to describe first methods by which impulses from the photo cell are plified; and second, actual complete apparatus em-ying photo cells, and some of their applications.

ince the current of a photo-electric cell is but a few microamperes, it is too small to operate a relay without amplification. In most applications two types of devices of modifications of these are suitable for this use, according to the class of work required of the cell. Where continuous indications or records of certain light effects on the cell are required, the thermionic amplifier is best used, as this has an *output directly proportional to the light falling on the cell,* thus a continuous graphic record can be obtained. In other photo-electric devices it is desired to cause an operation to be performed only when a beam of light is partially or completely interrupted, as in counting. Here a glow discharge device of the grid controlled type operates as a relaying tube, since when a specific point is reached in the amount of light falling on the cell, current flows or stops flowing through the glow tube, setting auxiliary apparatus into operation.

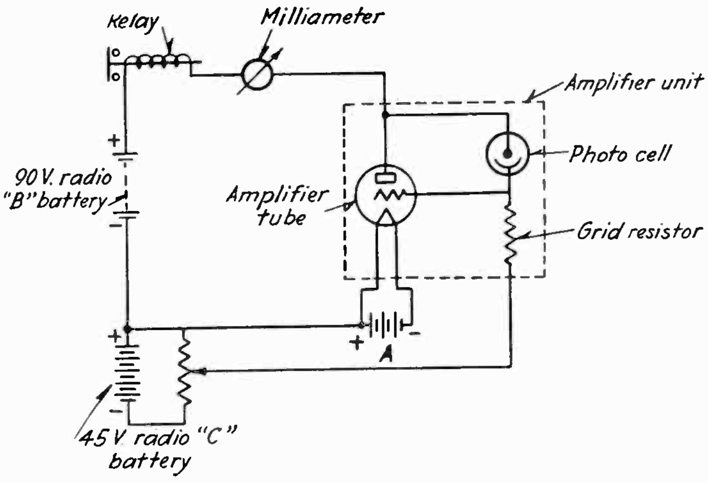


Fig. 3a—Amplifier circuit for direct-current use

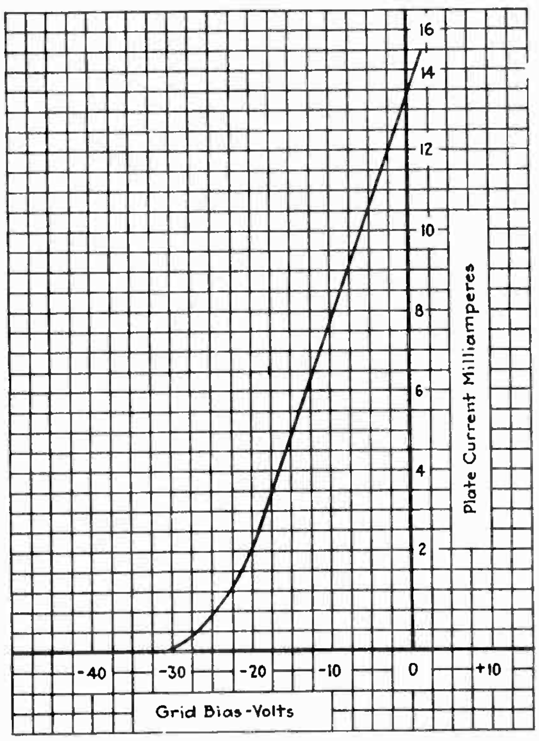


Fig. 3b—Characteristics of tube shown in Fig. 3a

Fig. 3a shows a diagram of a typical photo-amplifier tube circuit, intended for d.c. operation, except that the amplifier tube filament may be heated by a.c. The operation of such a circuit can best be understood by also referring to the amplifier tube characteristics as shown in Fig. 3b.

Assuming the photo cell is dark (infinite resistance), it can be seen that the grid will be at a negative potential with respect to the filament, as determined solely by the potentiometer adjustment and the value of the "C" battery. If the photo cell is illuminated, a current will flow under the influence of the B and C battery through the relay and through the photo cell, and will return to the negative terminal of the C battery after passing through the grid resistor across which as a result will exist a difference of potential. The polarity of this voltage drop over the grid resistor will be such as to tend to cause the grid to become more positive with respect to the filament. In other words, the effective negative bias will have been reduced. From Fig. 3b it can be seen that this reduction in negative bias voltage will result in the flow of more plate current, and as a result the relay in the plate circuit will be energized.

Assuming an initial bias voltage of 25 volts and assuming a 50 megohm grid resistor in use, it is seen from Fig. 3b that upon illuminating the photo cell slightly, if

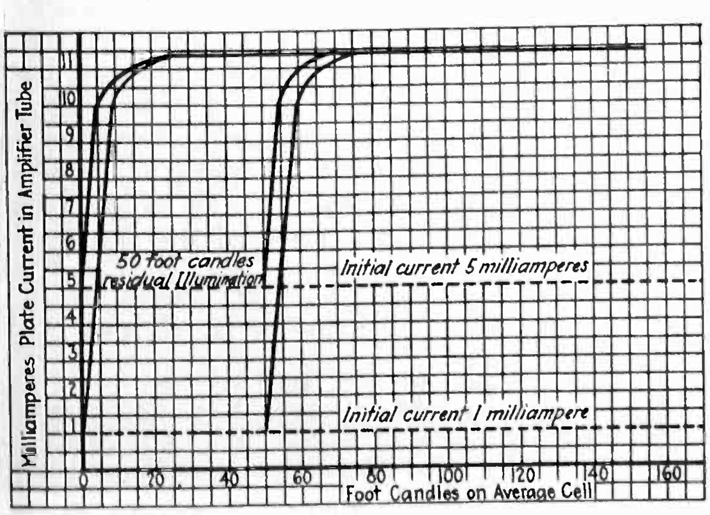


Fig. 4—Current flow for various intensities

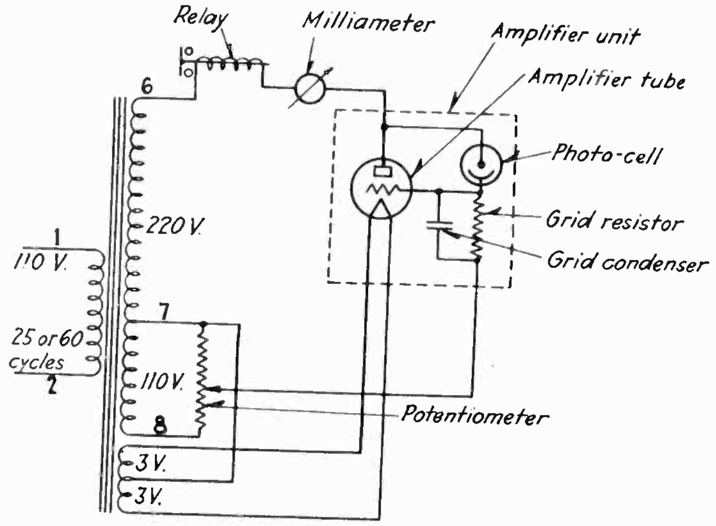


Fig. 5—Amplifier operated directly from a.-c.

0.3 micro-amperes should flow, the voltage drop over the grid resistor would rise from 0 to 15 volts, which subtracted from the negative grid bias leaves 10 volts, and the plate current would rise from 1 milliampere to 8 milliamperes. From the typical curve in Fig. 4 it is seen that an illumination intensity of about 7.5 foot candles should produce this result.

By some minor changes in the circuit, the plate current can be made to decrease with an increase in light, which will be found desirable for some applications.

The d.c. circuit is the most sensitive obtainable. However, because of the fact that both the photo-electric cell as well as the amplifier tube are rectifiers, it is possible to operate them from alternating current directly. In this circuit the amplifier current will also be proportional to the illumination on the photo cell, but the sensitivity is smaller than that of the d.c. circuit. A typical circuit is shown in Fig. 5.

Photo-cell and grid-glow tube

This circuit is mainly intended for a.c. operation. The current output is either zero or a definite value depending on the illumination on the cell. A grid-glow tube is used as the amplifier instead of a thermionic amplifier tube such as is used in the other circuits. This circuit should be applied chiefly where most of the light is interrupted quickly. It is the most simple circuit obtainable.

The grid-glow tube is a three-element neon-gas-filled

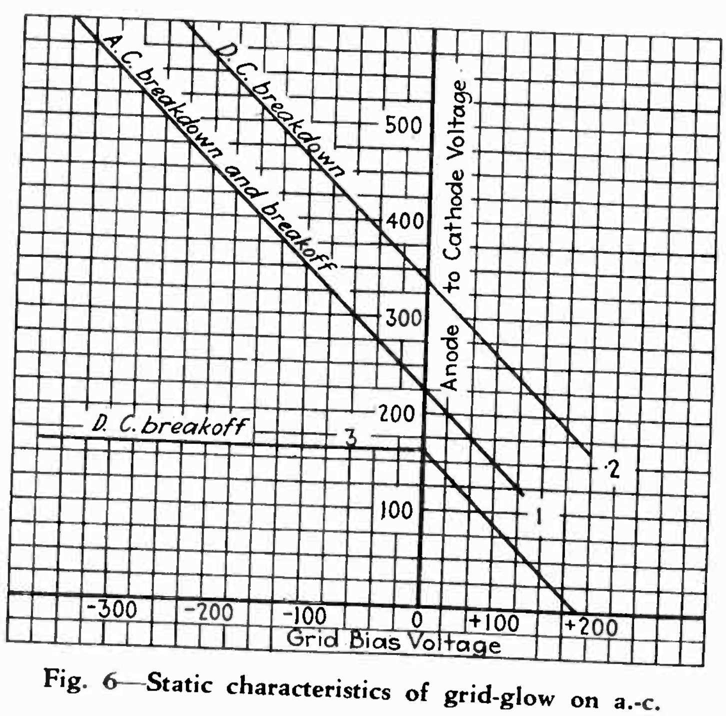


Fig. 6—Static characteristics of grid-glow on a.-c.

tube, consisting of cathode, anode, and grid, mou a standard four-prong base.

This tube, developed by D. D. Knowles[2] of th inghouse Electric Research laboratories, operate unique principle. When the grid is free, a hig tive charge is built up which blocks the flow of between the cathode and the anode. However, ducting path from the grid to the anode drains the away from the grid and permits current to flow, ing the orange glow from which the tube deri name. The conducting path may be a condense resistor.

The conducting path between the grid and the needs but a small current-carrying capacity—a ne characteristic when a photo-electric cell is to be th ductor. Therefore, the grid-glow tube is an ideal fying device for the "electric eye."

Fig. 6 shows the static characteristics of the gri tube when used on alternating current. It may b that in the circuit shown in Fig. 7, the photo-elect and the condenser act as a potentiometer on tl supply in such a way that when the photo cell is the grid is essentially at cathode potential, whereas the photo cell is illuminated, the grid of the gric tube approaches anode potential. In this manner

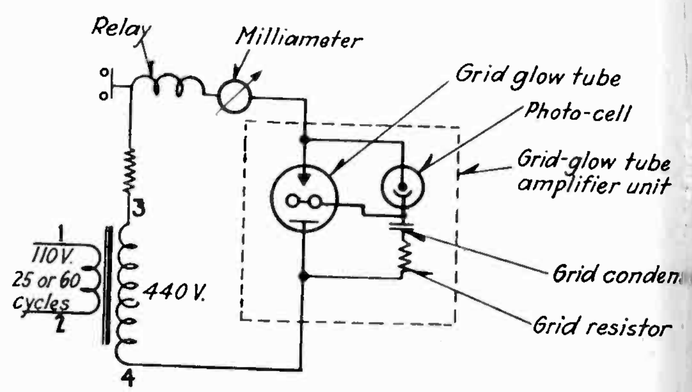


Fig. 7—Potentiometer circuit used with grid-glow.

bining the characteristics of the photo cell and the glow tube, it is possible to cause the grid glow tul pass current or not pass current, depending upon value of illumination on the photo cell. The resu characteristic of the combination of photo cell grid glow tube is shown in another diagram.

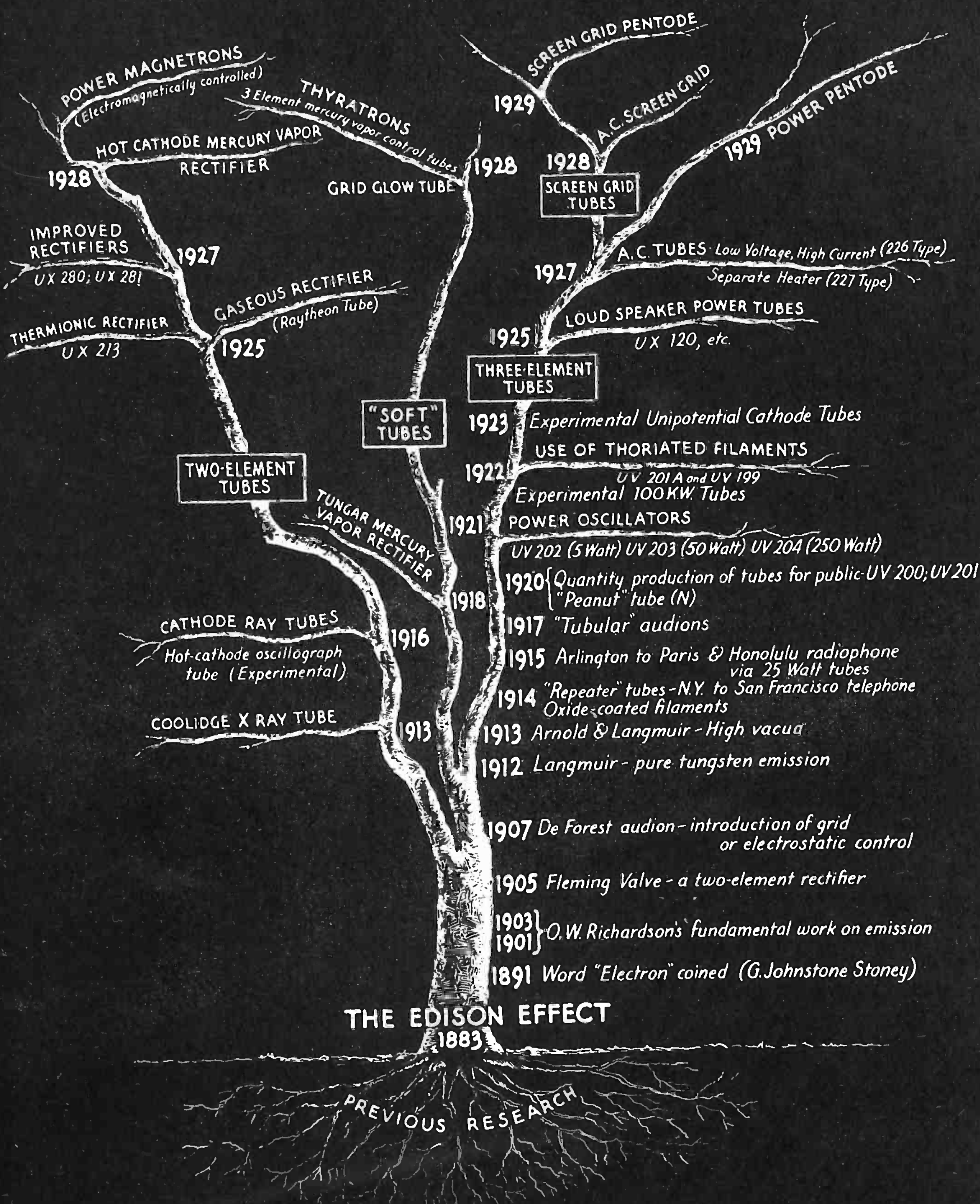
The d.c. photo cell-amplifier tube circuit show Fig. 3a responds very quickly to changes in illumina The time lag is generally of the order of 0.001 to 0. seconds. This figure is for the plate current in amplifier tube. When a relay is used, an additional lag enters, depending on the speed with which the n ing armature picks up and closes its contacts.

The a.c. photo cell amplifier tube circuit show Fig. 5 as well as the photo cell-grid glow tube cir shown in Fig. 7 have a greater time lag inherent in unit itself, since it is necessary for the voltage wav reach the proper half of the cycle before any p current can flow.

[To be concluded in Electronics for June]

[1]Also refer to: "Photo-electric Cells," by E. H. Vedder, *Ele Journal*, March, 1930, page 152, and "Photo-electric and C Discharge Devices and Their Applications to Industry," by J Breisky and E. O. Erickson, abridgment in *A.I.E.E. Journal*, A 1929, page 118. (For unabridged article refer to *A.I.E.E.* rep 28-146).

[2]"The Theory of the Grid Glow Tube," D. D. Knowles, *The Ele Journal, February*, 1930, page 116.

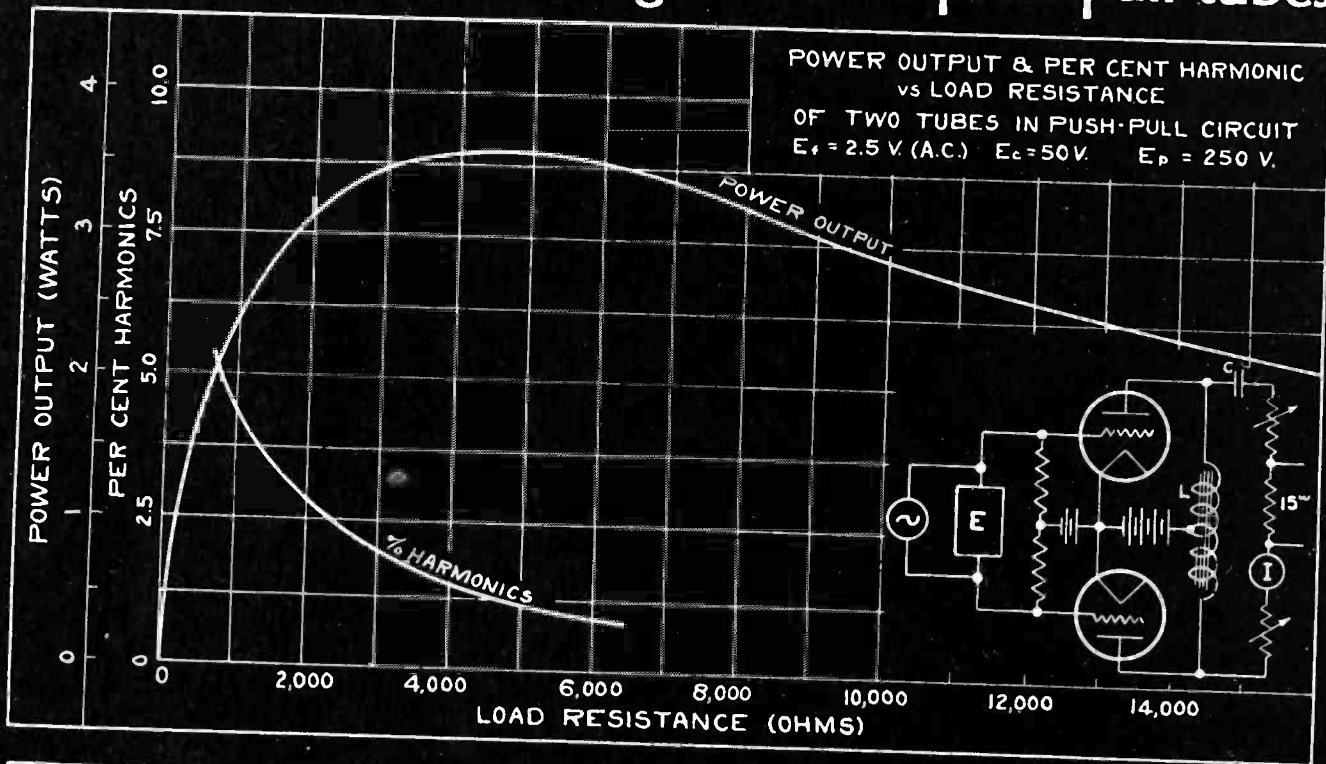


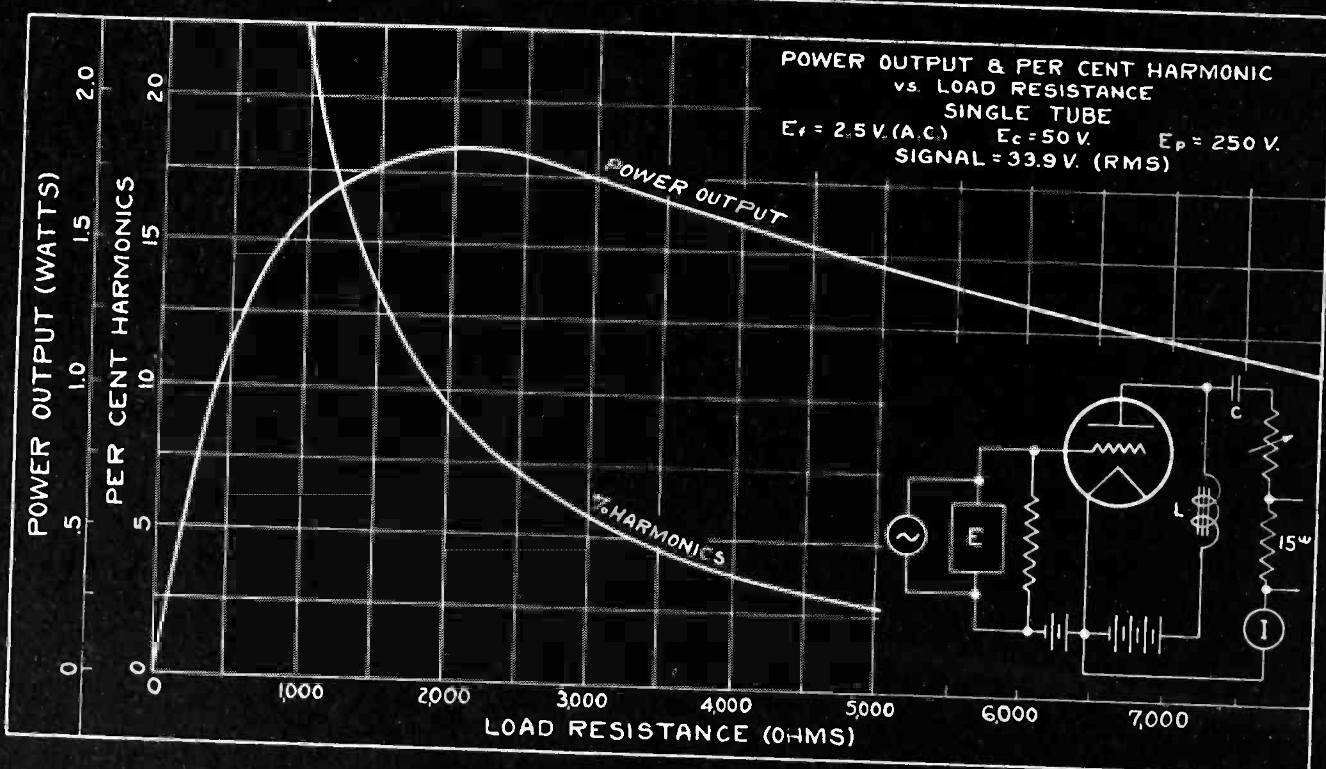
The family tree of the thermionic tubes

— ELECTRONICS, MAY, 1930.

POWER and DISTORTION

Single tube vs push-pull tubes





These curves demonstrate the superiority of two tubes in push-pull compared to a single tube, not only from the standpoint of increased power output but from the greater freedom from harmonics; i. e. greater fidelity. The output is double that obtainable from a single tube provided the proper load is used, and the distortion with the load giving the greatest power output is roughly one-sixth that of a single tube

Measuring Harmonic Distortion

in tube circuits

By D. F. SCHMIT and
M. STINCHFIELD
. *Cunningham, Inc.*

AN ALTERNATING current which is not a pure sine wave is equivalent to two or more pure frequencies. If these frequencies are simple multiples (2 times, 3 times, etc.) of the fundamental, they are called harmonics. If a pure sine or cosine wave signal voltage be connected to the grid of a vacuum tube and if the output a.c. plate current is not a pure sine wave, then distortion of the signal has occurred. This distorted waveform of the a.c. plate current is equivalent to a sine wave of the fundamental (signal) frequency and a series of sine waves which are two, three, four, etc. times the fundamental frequency. These are the second, third, etc., harmonic distortion components. In the study of tube design and application, waveform analysis and total harmonic distortion measurements are important, and the purpose of this discussion is to describe a complete test set which makes the measurement of distortion a comparatively simple procedure.

In general the distorted a.c. waveform may be represented by a Fouriers Series, thus:

(1) $E_i = E \sin \theta + E_2 \sin \theta_2 + E_3 \sin \theta_3 + \dots E_n \sin \theta_n + \dots$

where,

E_i = the voltage of the distorted a.c. plate current.

E = the amplitude of the fundamental (signal) frequency.

E_2 = the amplitude of the second harmonic.

E_n = the amplitude of the n^{th} harmonic.

$\theta_n = 2\pi$ times the n^{th} harmonic frequency times the time plus its phase angle $= 2\pi f n t + \phi_n$.

Where E, E_2 and E_n are peak values

The percentage of any one harmonic is usually given as the ratio of the amplitude of the harmonic to the fundamental expressed as a per cent. It is also equal to the ratio of the r.m.s. of the harmonic to the r.m.s. of the fundamental. When two or more harmonics are compared with the fundamental the per cent of the total harmonics is usually defined as the ratio of the r.m.s. of all the harmonics to the r.m.s. of the fundamental.

From equation (1) the per cent second harmonic will be,

(2) $$H_2 = \left(\frac{E_2}{E}\right) \times 100 \text{ per cent}$$

The per cent total harmonics will be,

(3) $$H = \sqrt{\frac{E_2^2 + E_3^2 + \dots}{E^2}}$$

where the E's may be either r.m.s. values or peak values.

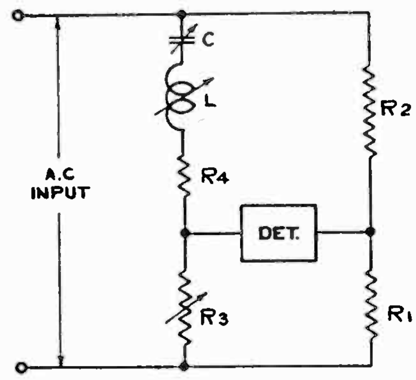


Fig. 1—Resonance type of bridge used for harmonic measurement

A method which has been found convenient for measuring the total harmonic content of an alternating current was described by I. Wolff in the Jour. Optical Soc. of America, Vol. 15, p. 163, Sept. 1927, entitled, "The A.C. Bridge as a Harmonic Analyzer." It has been used also by others and was described by G. Belfils in the Rev. Gen. d'Elec., April 3, 1926, and by C. Chiodi in L'Electtrotecnica, Vol. 15, p. 166, March 5, 1928.

The circuit of an a.c. bridge is shown in Fig. 1. It is similar to a Wheatstone bridge except for the inductance and capacity in one arm. A resistance balance can be obtained on this bridge for the one frequency at which the reactances are equal. At all other frequencies the bridge will be unbalanced as indicated on the detector—which may be a tube amplifier and meter. The amplifier has a high input impedance so that no current flows in this branch. (This is the only difference between Wolff's and Belfil's circuit.)

In operation the bridge is balanced with L, C, and R_3 for a minimum reading on the detector, the values of L and C corresponding approximately to resonance at the fundamental frequency. The residual voltage across the detector due to the frequencies for which the bridge is unbalanced will be mainly the voltage across R_1 since the voltage across R_3 will be small. Accurately the volt-

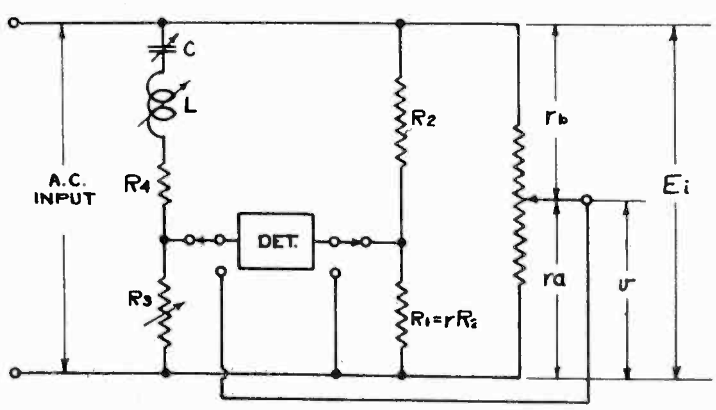


Fig. 2—Addition of a backtone potentiometer to the bridge circuit

age across the detector is the difference between these, or

$$(4) \qquad v = (E_{R_1} - E_{R_2})$$

where

v = the voltage across the detector when V volts of a single frequency f are applied to the input.
E_{R_1} = the voltage across R_1
E_{R_2} = the voltage across R_3

Suppose the bridge is balanced for the fundamental frequency. If a voltage V of any other frequency is applied to the input, the voltage across the detector (derived from equation (4), see Wolff's article) is found to be,

$$(5) \quad v = V \left(\frac{r}{r+1}\right)\left[\frac{1}{\sqrt{1+\left[\frac{R_4\,(r+1)}{\omega_1 L_1 \left(n - \frac{1}{n}\right)}\right]^2}}\right]$$

where,

v = the voltage across the detector due to the n^{th} harmonic
V = the n^{th} harmonic a.c. input voltage to the bridge
r = the bridge ratio (R_1/R_2)
n = 2 for the second harmonic, 3 for the third, etc.
ω_1 = 2π times the fundamental frequency
L_1 = henries inductance required to balance out the fundamental frequency.
R_4 = the resistance in the LC arm, usually the a.c. resistance of the inductance.

Equation (5) shows that if the term in brackets is close to unity, the voltage across R_3 is negligible and the voltage across the detector is equal to that across R_1. The ratio of the harmonic voltage across R_1, to the harmonic voltage in the input $(R_1 + R_2)$ will be,

$$(6) \qquad \frac{v}{V} = \frac{R_1}{R_1 + R_2}$$

or replacing, $R_1 = r\,R_2$.

$$(7) \qquad \frac{v}{V} = \frac{r\,R_2}{r\,R_2 + R_2} = \frac{r}{r+1}$$

$$(8) \qquad v = V\left(\frac{r}{r+1}\right)$$

which is equation (5) when the bracket term is unity.

When the ratio of inductance (L_1) to resistance (R_4) is chosen so that $\omega_1 L_1/R_4$ is equal to 5, and the bridge ratio $r = R_1/R_2 = \frac{1}{2}$, the term in brackets of equation 5 is equal to 0.98 for the second harmonic and 0.995 for the third harmonic. For all higher harmonics, and for inductance values or frequencies which make $\omega_1 L_1/R_4$ greater than 5 this bracket term will be nearer uni[ty] the equation (8) will be sufficiently accurate for [engi]neering purposes.

It then remains merely to measure the voltag[e] r.m.s. of all the harmonics across the detector) a[nd] total r.m.s. harmonic voltage in the input (V) [is] known from the equation $V = v\left(\frac{r+1}{r}\right)$.

If the total input voltage, that is, the r.m.s. of f[unda]mental and harmonics is E_i, and E is the r.m.s. [of the] fundamental part, the relation between these is:

$$(9) \qquad E_i^2 = E^2 + V^2 \text{ or, } E_i = \sqrt{E^2 + V^2}$$

The per cent total harmonics (H) is then,

$$(10) \qquad H = \frac{V}{E} \times 100 \text{ per cent}$$

If the detector consists of a tube amplifier, whic[h has] negligible frequency discrimination, and has a th[ermo]meter on the output, the meter readings will be pr[opor]tional to the r.m.s. voltage applied to the detector [. If] the detector input is then switched from the bridge [to a] backtone voltage of known r.m.s. value, the reading[s can] be readily interpreted in r.m.s. volts. Note that the [back]tone need not be a pure single frequency wavefor[m, as] true r.m.s. indications are shown on the detector.

Referring to Fig. 2 the backtone potentiometer [may] be connected across the a.c. input to the bridge. [The] detector is then switched to the backtone potentiom[eter] for the same detector reading as shown with the br[idge.] The backtone is then at voltage v while the total vo[ltage] across the backtone potentiometer is E_i.

Their ratio is from equations (8) and (9)

$$(11) \qquad \frac{v}{E_i} = \frac{V\left(\frac{r}{r+1}\right)}{\sqrt{E^2+V^2}} = H\,\frac{\left(\frac{r}{r+1}\right)}{\sqrt{1+H^2}} = \frac{r_a}{r_a + r_b}$$

Solving for H where $r = \frac{1}{2}$ and $(r_a + r_b) = 3{,}000$ ohm[s]

$$(12) \qquad H = \frac{r_a}{1{,}000}\left[\frac{1}{\sqrt{1 - \left(\frac{r_a}{1{,}000}\right)^2}}\right] \times 100\%$$

$$(13) \qquad H = \left(\frac{r_a}{10}\right) K \text{ in per cent}$$

where K is a correction factor to be applied when [the] distortion is of the order of 10 per c[ent] and above. The per cent harmoni[cs is] indicated by a reading of a dial o[f the] decade box without knowledge of [the] input or output voltage.

The arrangement described below [and] diagram shown in Fig. 3 have b[een] used to study total harmonic distort[ion] of tubes and amplifiers where the in[di]vidual components were not of inter[est.] The amplifier employs two CX-[340] high-mu tubes in a resistance coup[led] circuit having a flat characteristic fr[om] 30 to 3,000 cycles. The thermal met[er] which is slow in operation and requi[res] a power tube in the last amplifier sta[ge] has been replaced with an r.m.s. tu[be] voltmeter. This tube voltmeter e[m]ploys a CX-322 tube with 45 volts [on] the plate, 22.5 volts on the screen-gr[id,] 3.0 volts negative bias on the contr[ol] grid, and the filament voltage adjus[ted] to give square law response. This [is] usually about 2.8 volts. The stea[dy]

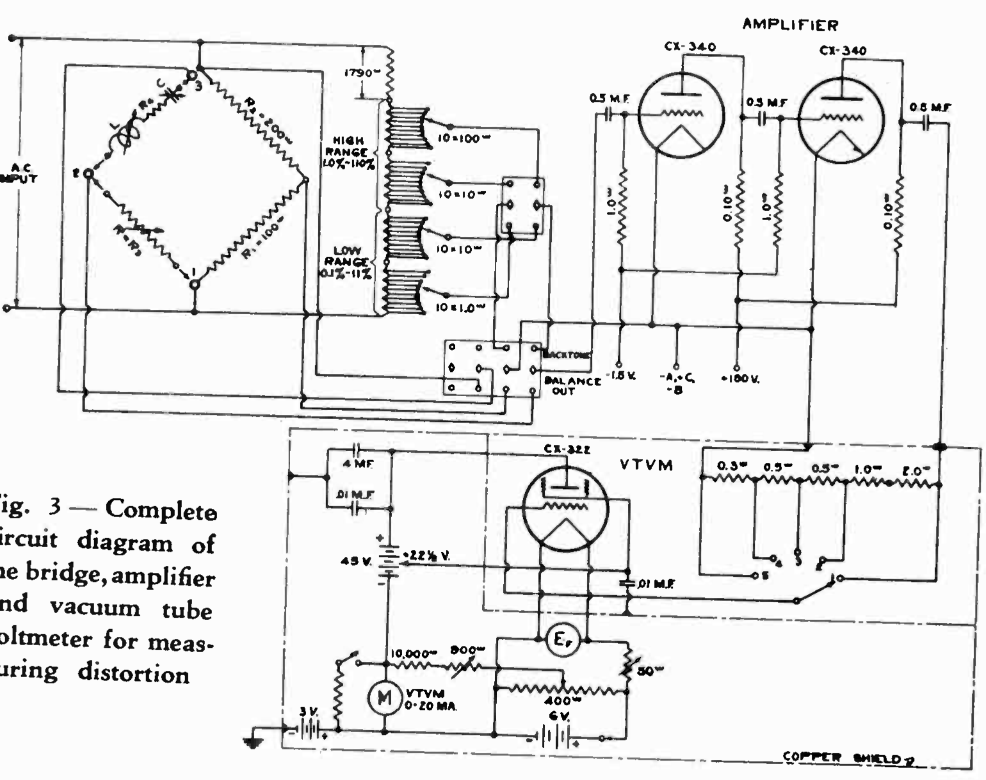


Fig. 3 — Complete circuit diagram of the bridge, amplifier and vacuum tube voltmeter for measuring distortion

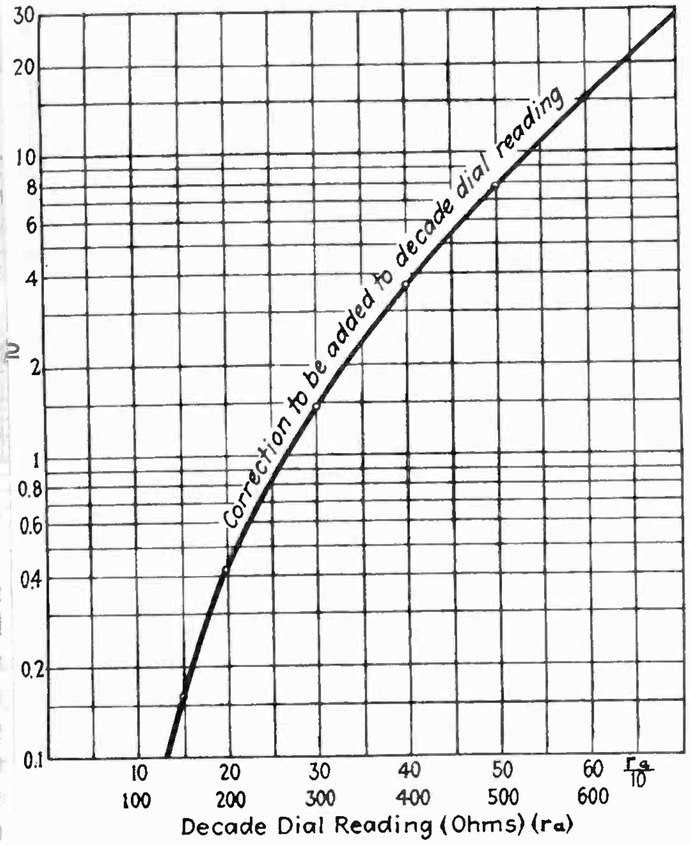


Fig. 4—Graph of correction to be added to dial readings

ponent of the plate current is balanced out of the meter M with a potentiometer connection to the ...ent battery. The meter M is a 20 microampere ...nometer, which gives a full scale deflection on ...tly less than 1.0 volt r.m.s. The input of the tube ...neter is connected through a tapped potentiometer ...ch may consist of several high grade resistors totaling ...or more megohms so that the input resistance remains ...ntantly high. The values shown were chosen so that ...range is doubled at each tap, with a maximum range ...pproximately 15.0 volts. With this maximum the ...lifier will not be overloaded if the meter indicates ...cale. The last tap shorts the input to the voltmeter. ...is found convenient to protect the meter and permit ...zero balance adjustment.

...he input resistance to the bridge is 300 ohms (R_1 + ... and 3,000 ohms ($r_a + r_b$) in parallel, or 273 ohms. ...the backtone position this is constant. For the bridge ...tion the variable resistors $R_3 + R_4$ are in parallel ...ss the input for the fundamental frequency. For the ...r frequencies the input resistance remains close to ... ohms. This will cause the input voltage of the ...damental frequency to drop when the bridge is bal...ed. The harmonic voltage will not be changed how...r. If the voltage generated at the source remains ...stant this will not introduce an error since the funda...ntal is merely balanced out and not used in the bridge ...ition and will return to its normal value when it is ...d in the backtone position.

When the bridge is connected in the plate circuit of a ...e it becomes part of the plate load resistance. If the ...dge is then balanced for the fundamental frequency, ... 273 ohm bridge resistance will be reduced for the ...ndamental frequency due to the parallel resistance ...$_3 + R_4$). If the resistors R_3 and R_4 are fairly large ...$_4$ cannot be too large for good balance on low fre...encies) and the bridge constitutes only a small part of ...e plate load on the tube the error will be negligible. If ...itching the bridge from backtone to balance position ...uses an appreciable change in the load on the tube, the ...rcentage of harmonics generated, in this case, would change. This would require a readjustment of the load. If sufficient a.c. plate current is available a low resistance shunt on the input to the bridge will be effective. If a constant resistance attenuator is available it will usually eliminate any readjusting of the load and is a convenient control on the input current to the bridge.

With the arrangement shown in Fig. 3 harmonic percentages as low as one per cent can be read with two milliamperes current to the bridge. For higher percentages of harmonics the current may be about this value or may be less.

The backtone consists of two decade boxes having two dials, and a 1,790-ohm. resistor. One decade box has units and ten ohm steps, the other ten and one hundred ohm steps. Dividing the dial reading by ten, one box reads 0.1 to 11.0 per cent harmonics in 0.1 per cent steps. The other box reads 1.0 to 110 which usually must be corrected for the high percentages of harmonics. The correction curve is shown in Fig. 4. When the dial reads 10.0 the correct reading is 10.05 per cent so that the correction is less than $\frac{1}{2}$ of one per cent for readings below ten per cent. For convenience and accuracy in applying the curve, Fig. 4 has been so calculated that the correction is an addition to $r_a/10$ rather than a multiplication.

Method of application

To illustrate the method of using the circuit arrangement of Fig. 3 the following example is given. In the chart facing the first page of this article the power output and per cent total harmonics from a power amplifier tube are shown. The audio frequency input to the tube was 33.9 volts r.m.s. of 400 cycles. The choke L and condenser C were large enough so that practically the entire a.c. output passed through the load resistance consisting of two decade boxes arranged to give the required load and to shunt part of the current across the harmonic analyzer. The thermal meter I was 30 ohms. The analyzer was shunted with 15 ohms. The balance of the load consists of 1,456 ohms to give the required total 1,500 ohm load. The meter indicated 34.2 milliamperes. The capacity C connected to the harmonic analyzer was 0.10 mfd. The tuning was done with a variometer about 1.6 henries being required. With the bridge key (see Fig. 3) in the balance-out position the variometer and the resistor R_3 were carefully adjusted until a minimum reading was shown on the vacuum tube voltmeter. The bridge key was then moved to the backtone position and the per cent harmonic dials adjusted to bring the vacuum tube voltmeter reading to the same value. The low range dial was found insufficient, so the range key was switched to the high position and the high range dial adjusted for the required vacuum tube voltmeter reading. The reading on these dials was 130 or roughly 13.0 per cent. The correction curve (Fig. 4) shows that this reading should be increased 0.1 per cent to give the true reading 13.1 per cent. The correction here is less than can be read on the smallest dial and was neglected. The power output was calculated as $I^2R = (0.0342^2 \times 1{,}500) = 1.76$ watts. The harmonics were less than 5.0 per cent when the load was increased to 4,000 ohms. The results of measurements on two tubes in pushpull are shown in the second diagram on the opening chart. The signal input voltage was increased to twice that used in the other case and the load was connected from plate to plate of the tubes. The per cent total harmonics was found to be about 1.4 per cent with a 4,000 ohm load. The load resistance was decreased to 730 ohms before the harmonics reached 5.0 per cent.

Antenna coupling systems

as applied to radio receivers

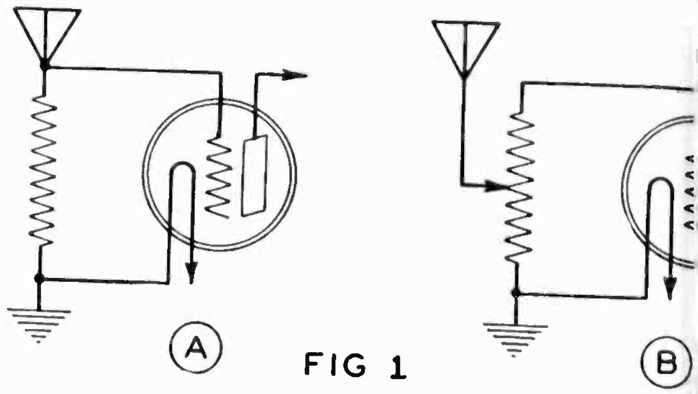


FIG 1

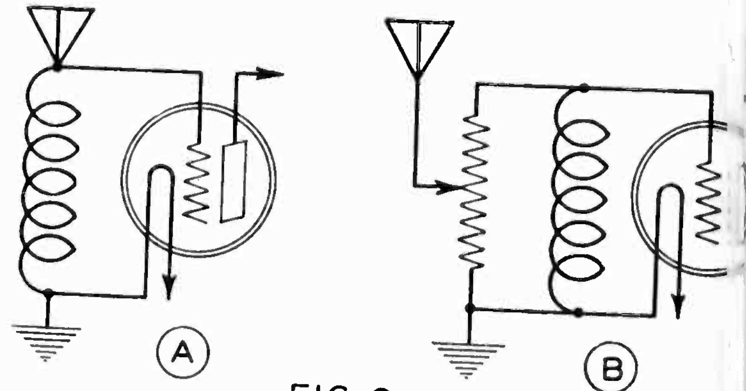


FIG. 2.

Well known methods of connecting antenna systems to a radio receiver.

By JESSE MARSTEN

THE ANTENNA coupling unit is a single impedance or a net-work of impedances which couples the antenna of a receiving set to the grid of the first radio-frequency tube. Its primary function is to transmit to the grid of the first radio-frequency tube the signal which is developed in the antenna.

The design of this unit must be considered with relation to the performance of the receiver as a whole. The major factors to be taken into consideration in its design may be enumerated as follows:

1. *Selectivity.* Owing to the great number of broadcasting stations and the increase of power the selectivity problem has become more and more severe, particularly at the higher frequencies. It is highly desirable, therefore, that, if possible, the antenna coupling unit contribute a certain degree of selection. This relieves the burden imposed on the rest of the receiver of supplying the requisite selectivity. In fact, with very high gain receivers, this consideration is imperative on account of the appearance of a new difficulty.

▼

In this article, Mr. Marsten, a radio engineer of some thirteen years standing, discusses a problem which at first sight seems very simple, that of connecting a radio receiver to the antenna system which has its existence in a sea of ether waves. Various methods have been used; the author discusses nearly all of them.

—The Editors.

▲

2. *Elimination of cross-talk.* This phenomenon become more evident with increases in the radio-quency gain of receivers. It is a form of interferen which a station may be tuned-in on one or more car other than its own, or its harmonic frequency, in tradistinction to the more usual form of interfer resulting from mere broadness of tuning, where the s bands of carriers on adjacent channels overlap. It erally occurs when receiving in the proximity o powerful local which delivers extremely high strengths at the receiver. If this interfering local sig reaches the grid of the first radio-frequency tube sufficiently high level it is amplified in the usual man but at the same time partial rectification takes pl This rectified signal in the plate circuit of the first ra frequency tube modulates the carrier to which the ceiver is tuned, thus producing the cross-talk. From nature of this interference it is seen to be independ of the frequency separation of the interfering and terfered stations (although it may be much worse at second harmonic of the interfering station) and of amount of signal selection occurring after the first tube. The only way to reduce this type of interfere is to prevent this interfering signal from reaching grid of the first r.f. tube. This calls for a certain amou of selection in the antenna coupling system.

3. *Sensitivity.* Depending upon its design, the a tenna device may or may not contribute a step-up received signal voltage. It is desirable, of course, th it should, in view of the trend towards high-gain se

4. *Uniform sensitivity.* In view of the desirabili of securing substantially uniform gain over the broa cast band, the design of the antenna coupling devi should be such that its gain curve should be the reci rocal of that of the radio-frequency amplifier.

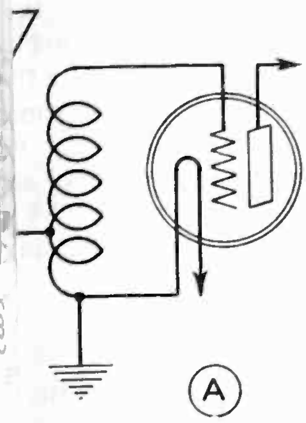


FIG. 3.

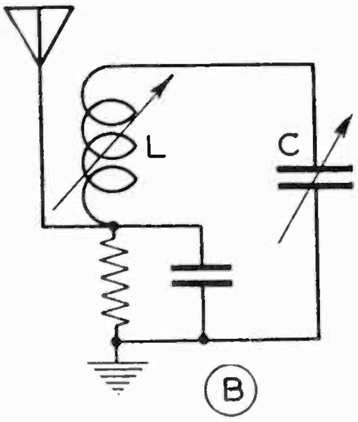


FIG. 4.

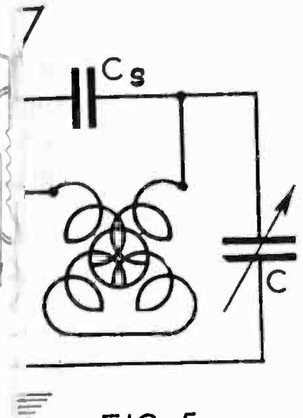


FIG. 5.

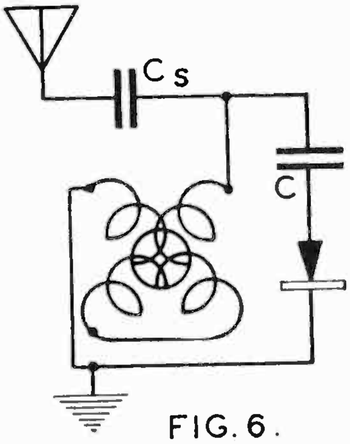


FIG. 6.

More complicated methods of transferring voltages from an antenna to the first circuit of a radio receiver.

. *Practical elimination of antenna capacity reaction.* c unicontrol receivers it is essential that the antenna denser, or condenser coupled to the antenna, track n the others. Due to the coupling between the anna and the first tuned stage there will be a capacity or actance reflected from the antenna into the first ge. It is essential that this reflected capacity or inducce be substantially constant over the frequency band, 1 it is desirable that it be substantially constant for n size antenna, in order to avoid making an adjustment different sizes of antennas.

Aperiodic systems

)ne of the simplest means of avoiding the unicontrol blem of antenna circuit tracking consists in the use an aperiodic system in the antenna. There being no ed circuit in the antenna or coupled to it, the problem antenna effect disappears. Three primary means of coupling the antenna to the first r.f. tube have been ployed commercially. These are (1) resistance couhg; (2) choke coil coupling; (3) auto-transformer ipling. Combinations of these may also be used, as example, choke and resistance coupling.

This aperiodic antenna coupling was employed to some tent in battery-operated unicontrol receivers, but bene more popular with the advent of the a.c.-operated e because the 226-type tube in radio-frequency cirits presented a difficult problem in the control of volne, and the use of a variable resistance in the antenna esented one solution—though far from satisfactory.

All that can be said for this type of antenna coupling that it meets the unicontrol problem. It contributes thing to the selectivity of the receiver. It accepts all signals at all frequencies and results in very severe crosstalk. The resistance coupling contributes no voltage gain to the receiver. The choke coil coupling and auto-transformer may contribute some voltage gain if the inductance of the choke tunes the antenna capacity to some frequency in the broadcast band. The amplification thus secured is confined, however, to a narrow band of frequencies around the resonant frequency. At all other frequencies the gain is practically nil. Also the frequency at which some gain is obtained due to resonance will vary with different antennas.

A further objection arises when the volume control of the set is used in conjunction with this type of antenna coupling unit as in Figs. (1a) and (2a), namely the noise-signal ratio for powerful signals becomes too great. This is particularly prominent in high-gain receivers with good high-frequency response. With this system of volume control the loud speaker signal intensity is adjusted by varying the attenuation of incoming signal between the antenna and the first r.f. tube. The amplification of the receiver is maintained at its maximum level. Any noises inherent in the receiver such as tube noises and circuit element noises, are therefore amplified to the maximum capability of the receiver at all times. These noises modulate the incoming signal. This noise level is a fixed quantity for any set. The weaker the desired signal, the greater the noise-signal ratio. For very powerful signals in the antenna, it is essential to attenuate them considerably for reasonable loud speaker level by means of this antenna volume control. Hence the noise becomes very conspicuous, and all the more so as the loud speaker level is lowered. This effect is more pronounced at a given loud speaker level on powerful locals than on weak distant signals, because in the latter case atmospheric noises mask the receiver noise effect. With other types of volume controls which act after the first tube to reduce r.f. amplification this effect is not so bad, first because we start out with a high signal level instead of a low one, and secondly because the amplification of the receiver is reduced for lower speaker levels.

From every point of view, therefore, the aperiodic type of antenna coupling unit is undesirable.

Separately tuned antenna stages

Coupling systems in which the antenna tuning is separately controlled sidetrack the unicontrol problem by eliminating the antenna capacity reaction on the first tuned circuit. However, experience has shown that there is no serious public reaction against the use of an antenna tuning adjustment, especially if it gives satisfactory results.

Fig. 4 represents a system which is a true vernier control. The antenna is connected across an impedance in the ground side of the tuned circuit L. C. The variable condenser is one section of the gang tuning condenser in the set. The effect of the antenna capacity in the tuning of this circuit is practically negligible no matter what the antenna capacity is. The inductance L, therefore, need be designed only to give vernier control, and a variable range of about 10 or 20 per cent in nominal inductance is sufficient. This is obtained by the motion of a copper sleeve in and out of the field of the coil. The resistance is used to complete the circuit for biasing the first r.f. tube.

In the system represented by Fig. 5 the inductance must have a much greater range because the antenna

TABLE I

Selectivity characteristics of several coupling systems showing effect of loading

Antenna System	Band Width at ½ Amplitude	
	at 1200 kc.	at 500 kc.
Fig. 4	45 kc.	23 kc.
Fig. 5	90 kc.	30 kc.
Fig. 6	68 kc.	24 kc.
Tightly Coupled Transformer Low Imped. Primary Fig. 7	92 kc.	12 kc.
Loosely Coupled Transformer Low Imped. Primary Fig. 7.	42 kc.	12 kc.

TABLE II

Selectivity characteristics of loosely coupled transformer with variable primary

Primary Turns	Band Width at ½ Amplitude		Transformer Data
	At 1200 kc.	At 550 kc.	
10½	12 kc.	38 kc.	Form—1¼" O.D. Secondary—100 Turns No. 28 Enamel Close Wound
7½	12 kc.	35 kc.	Primary wound at Low Potential End.
4½	12 kc.	32 kc.	.010" spacing between
2½	12 kc.	42 kc.	Primary and Secondary.

capacity is in shunt with the whole tuned circuit (through the series antenna capacity C_s) and therefore raises the initial capacity of the circuit considerably. Thus the usual 9:1 range of capacity ordinarily secured with a variable condenser no longer obtains, and may be as low as 3 or 4 to 1. The inductance must, therefore, supply the necessary additional variation to enable a 3 to 1 range in frequency to be secured. Secondly, because different sizes of antenna capacities have to be handled in practice, it is necessary that the combined range in the variable tuning elements be much greater than the usual 9:1 range. A variometer having as high a ratio of maximum to minimum inductance consistent with securing the proper inductance values is needed. By designing the stator and rotor so that very tight coupling is secured, it is possible to secure a range of approximately 6:1 in inductance. In this particular case the range is 35 to 175 microhenries.

In Fig. 6 all of the tuning from 1500 kc. to about 900 kc. is accomplished by the inductance L. At 900 kc. a fixed mica condenser is automatically shunted across L and the inductance L again is the variable tuning element up to 550 kc. The antenna coupling is made very loose by making the antenna series condenser C_s very small, about 100 micro-microfarads, so that the effect of antenna capacity variation is reduced. L and C are so chosen that for all antennas met with in practice tuning over the entire broadcast band is easily accomplished with the inductance L. This, again, must be a variometer with as large a ratio of maximum to minimum inductance as possible. In practice this ran from 65 to 375 microhenries.

The voltage step-up of the system is shown in the accompanying curves. The abrupt change in the gain curve for Fig. 6 system occurs at the point where the L C ratio system changes radically when the shunt condenser C is thrown across the tuning variometer.

The selectivity data in Table I shows the effect of antenna loading. In the system of Fig. 4 the loading of the antenna on the tuned circuit plays a neg part due to its position in the circuit. The othe systems have the antenna loading in shunt with the circuit through a coupling condenser. Broader reso results, the values of the band width depending the size of the antenna coupling condenser, a small ling condenser, as in Fig. 6, having the advantage. systems give practical relief from cross-talk d modulation.

Transformer coupling

There are two types of antenna transformers in one having a high-impedance primary and the otl low-impedance primary. Both these transformers properly designed give good selectivity characteri gain, and practical freedom from cross-talk. They meet satisfactorily the problem of antenna stage t ing for unicontrol sets.

The transformer employing the high-impedance mary was described by W. A. MacDonald in Au 1929, Radio Broadcast and the gain characteristics given. The primary of this transformer has a high

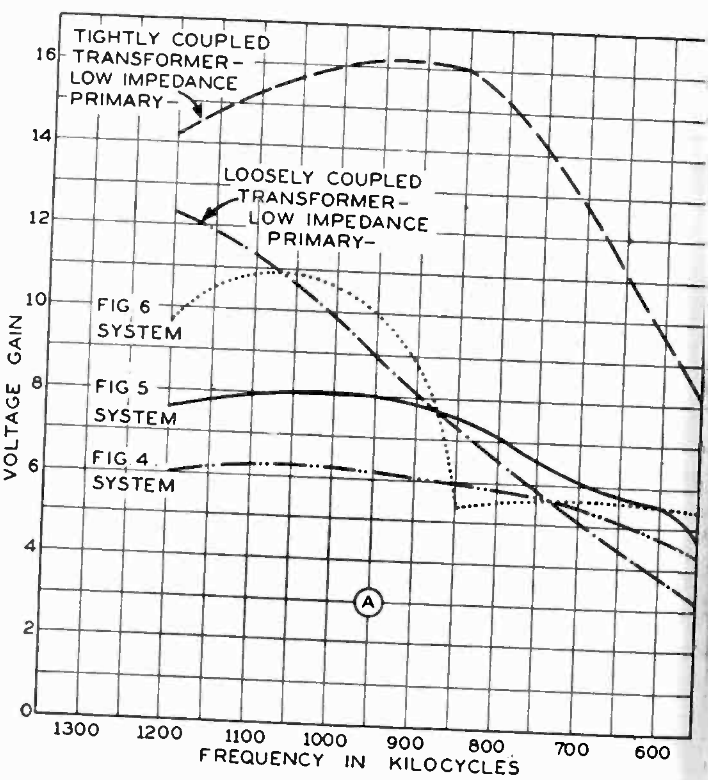


Fig. 7—Effect of using transformers of various characteristics as coupling devices is shown above

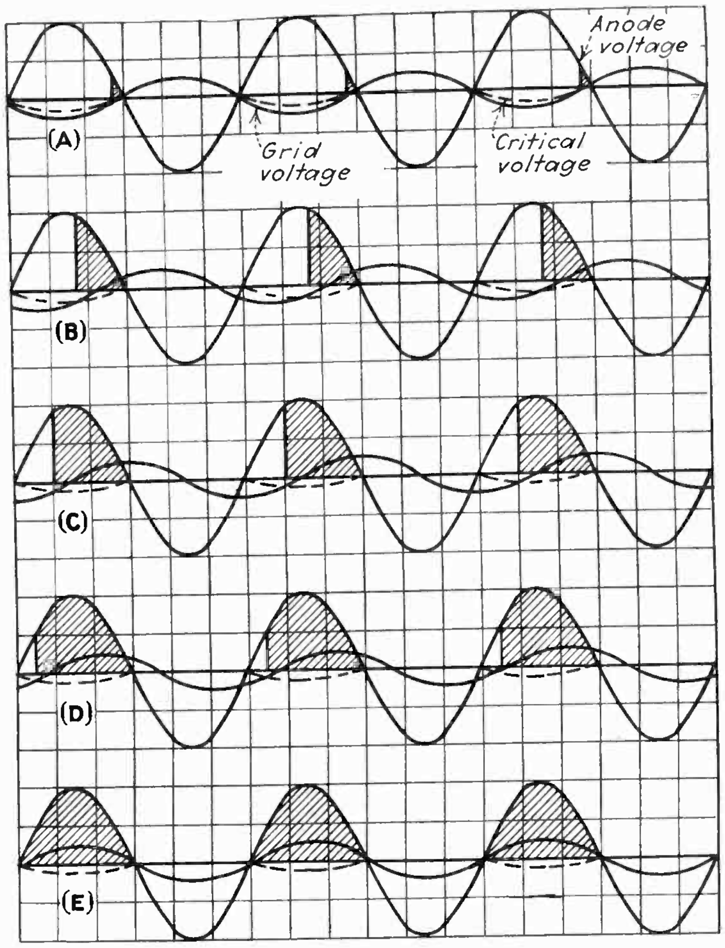
ductance, of the order of 400-700 microhenries. It tun the antenna capacity to a low frequency just outside t broadcast band. Long-wave gain due to resonance therefore high in comparison to the short-wave gai Very loose coupling of the order of 10 per cent is en ployed. Antenna reaction reduces the effective secon ary inductance, but, owing to the very loose couplir employed, this is of small magnitude, and easily con pensated. The gain of this system decreases with i creasing frequency, but it tends to straighten out t over-all gain curve of sets employing conventional typ r.f. interstage transformers.

The antenna transformer with low-impedance pr mary, was the most widely used system in battery set especially two-and three-control sets. The primary cor sisted, generally, of about 6 to 20 turns (depending upo

[*Continued on page 108*]

ower control thru ·id-regulated ·leavy-Current ·ubes

O. W. PIKE



Control of thyratron plate current by variations in the grid voltage.

WITH the increased use of electron tubes, especially for non-radio purposes, there has been an increased need for a design which would handle ıer currents. The high space-charge voltage drop he usual high-vacuum tube results in a large internal- ver loss which has hitherto prevented these tubes from rying the high currents desired. This article de- bes a new type of electron tube, called the thyratron, ch minimizes this limitation and also utilizes new e cathodes of high efficiency for the production of the h emission that is required.

For the past two years there have been available hot- hode mercury-vapor rectifier tubes. These tubes differ m the pool-type mercury rectifiers in that their cur- t carrying capacity is due to electron emission from ot cathode, the same as in high-vacuum rectifier tubes. ey are an improvement over the high-vacuum rectifiers, however, in that they contain a small amount of mercury. The vapor resulting from this mercury becomes ionized and neutralizes the space-charge electrons, resulting in a constant voltage drop of only about 15 volts when the tube is carrying current in the forward direction. The mercury vapor pressure, however, is so low that the plate can withstand high voltages when negative. The result is an almost ideal rectifying valve.

▼

Wide interest has been manifested in this new type of electrostatically controlled mercury and gas-filled tubes for use in control and power circuits. These tubes have been designated as "thyratrons," from the Greek word *thyra* meaning *door,* and this term has been adopted as the trade name by the General Electric Company in whose Schenectady research laboratories they were developed.

▲

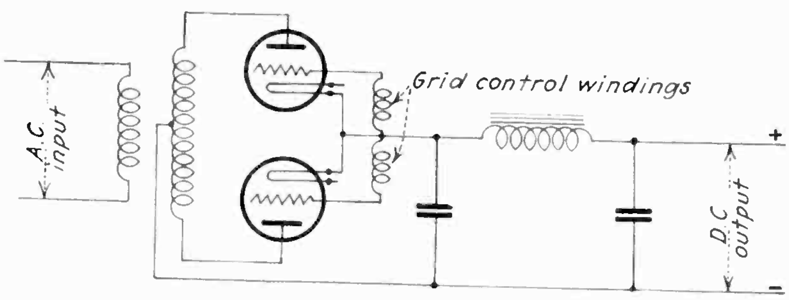
A development of hot-cathode rectifiers

The thyratron is a development from this form of rectifying tube, and incorporates in addition a control electrode. Inasmuch as the method of control is quite different from that in the usual three-electrode tube, we shall describe it in detail. For a given plate voltage there is a particular grid voltage at which ionization will just occur, thus allowing the tube to draw current. Let us consider this as the "trigger" point. The actual grid voltage at the "trigger" point may either be positive or negative, depending upon the particular tube design. If, however, the grid voltage is more negative than the "trigger" point, no discharge will be set up. As soon as the grid potential passes the "trigger" point, ionization occurs and the tube draws current. Unlike a vacuum tube, however, once this discharge starts the grid potential has no appreciable effect on the anode current, control being restored to the grid only when the discharge ceases long enough for deionization of the mercury vapor to occur.

The reason for this is clear. In the simple rectifying tube we mentioned the fact that the positive ions neutralize the space charge. In the thyratron they also tend to neutralize the charge on the negative grid as well as the space charge. The result is that in most cases a prohibitive current would have to be supplied to the grid before it could regain control with plate current flowing. In order to allow the grid to act the plate voltage must be reduced to practically zero for a long enough period for the mercury vapor to deionize.

If an a.-c. voltage is applied to the plate, the grid has an opportunity of regaining control once each cycle and can delay the start of the arc for as long a period during the cycle as the grid voltage is sufficiently negative. Therefore, if the grid as well as the plate is supplied with an alternating current, the phase relation between the grid and plate voltages determines the amount of current passing through the tube. The result, then, is a control valve which in itself has little resistance and hence low internal loss. The illustration shows the wave shapes obtained by a shift in phase between the grid and plate. Example *a* shows the wave forms with the tube in an almost non-conductive condition, while *e* illustrates rectification throughout the entire half wave. The other diagrams show several intermediate stages of grid control.

In addition to the phase-shift method of thyratron control it is possible to obtain a partial control by a variation in the magnitude of either direct or alternating grid voltage, and of course it is possible to obtain an on and off action with either d.-c. or a.-c. provided the anode voltage is alternating. In general, the phase-shift method



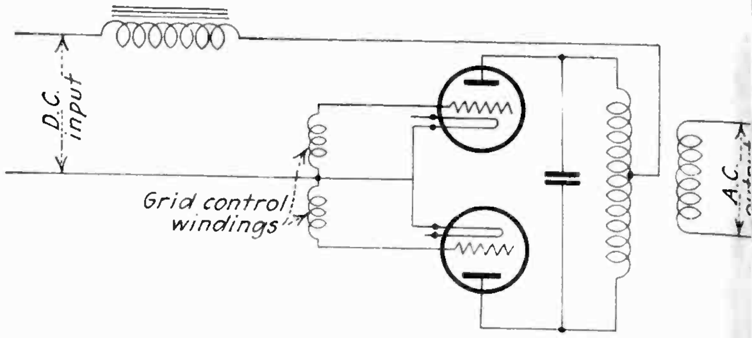
Controlled rectifier and filter circuit, single phase. Polyphase circuits are employed with larger thyratrons.

is the most satisfactory in that it almost entirely eliminates the effect of variation of tube characteristics with temperature and the effect of variation in grid currents. It should, therefore, be used even where it is necessary to obtain it by inductance and resistance. The on and off control presents no difficulties, although it is necessary to supply ample grid voltage from a sufficiently low-impedance source.

New cathode design

There has been considerable advance during the past year in the design of cathodes for these tubes. While there are a variety of different designs, the general trend has been toward a unipotential surface heated by a separate non-emitting filament. This surface is inclosed in heat reflecting shields in order to reduce the wattage necessary for heating. The result is that cathode efficiencies have been increased until now it is possible to obtain, in the more recent designs, useful electron emissions greatly in excess of an ampere for every watt of cathode heating power. At present there appears to be no fundamental limitation on the possible size of cathodes. Development samples have been built which will give an instantaneous current of several thousand amperes. Cathodes may take the form of an (1) open filament, (2) indirectly heated cathode, (3) shielded filament, (4) coiled filament. The choice of these designs for any given tube depends upon the service required. For instance, the first-named is the quickest heating, while the second is the most efficient.

There are two general methods of thyratron operation



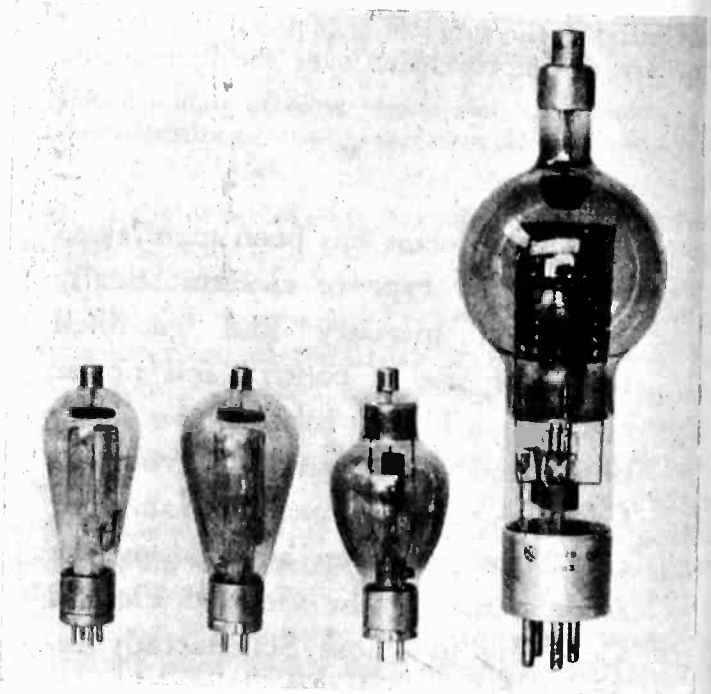
Single-phase inverter employing two thyratron tubes. Such a circuit and tubes will convert direct current into alternating current.

with regard to control characteristics, and the gener design of the tubes depends upon this characteristic.

The first is known as the negative control type. Th is, the grid voltage necessary to just prevent ionizati is negative for all but the very lowest anode voltage This characteristic is very desirable where the tube is be used for relay purposes, because the grid power r quired is very small and therefore the power amplificati of the tube is very large. It can be seen that this ty of tube is a very useful tool in that it not only rectifi alternating current, but allows a control of the amou of current rectified with the expenditure of a negligib amount of power.

The second class is known as the positive grid typ and in this case a positive grid voltage is required t start the tube except for the very highest plate voltage This type of tube is used for control purposes wher it is wished to have a tube remain normally off and pas current only with the application of an appreciabl amount of grid power. Its greatest use, however, i found in power circuits, and the requirements of thes circuits impose a number of additional design considera tions on the tube. The most important of these is th time required for the tube to deionize at the end of cycle. In many power circuits only a few microsecond are allowed for this action and this necessitates particula design features. With this type of tube appreciabl power is required for driving the grid and the gri structure must be designed to accommodate this power

An example of the improvement of the thyratron ove


A series of thyratrons, from a small tube handling a plate power of five kilowatts, to a large tube which will control 100 kilowatts.

high vacuum type of tube in the control field of ce can best be illustrated in comparing a typical high vacuum tube with a similar thyratron. These ubes are of about the same size and are of approx-ly the same cost. Also, the amount of grid power red is about the same in each case. The vacuum will handle approximately 0.75 ampere, while the tron has a comparable rating of 2.5 amperes.

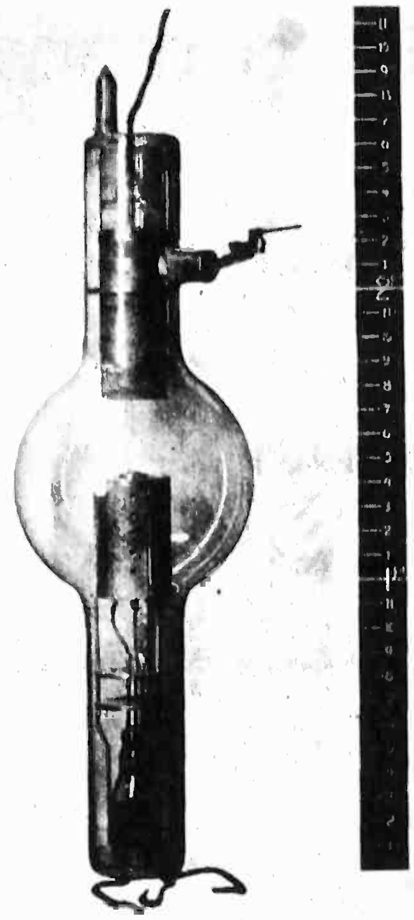
course, the thyratron has a higher cathode wattage, would not be possible to utilize the larger cathode e vacuum tube due to the space charge drop. In words, the current carrying capacity of the new has been increased some 30-fold over that possible vacuum tubes of the same size and cost.

Fundamental circuits

There are a few fundamental circuits upon which applications of thyratrons are based. We have dy indicated the controlled rectifier. This should be lered as the fundamental means of changing con- potential alternating current to variable potential current. In addition to its many control appli-ns the thyratron is applicable to power circuits where current is required from an alternating-current e. With the larger thyratrons polyphase circuits are y employed in order to minimize the amount of required for smoothing and to attain the usual tages of such circuits. A single-phase controlled ier circuit is shown.

other fundamental application principle is the in-. This changes direct current to alternating current nay be either separately-excited or self-excited, de-ng upon the source of power applied to the grids. are several types of inverters, but the general iples are similar. In every case d.-c. voltage is ed to the plate of the tubes and the grid is supplied the frequency it is desired to obtain, or else from cuit tuned to this frequency. In this respect an ter may also be considered as a thyratron amplifier scillator. The function of the tubes is to com-te, or in other words, perform a switching opera- In all inverters some form of power storage is ssary in order to supply power during the commu-n period. This may be in the form of static con-ers, or a power system with leading power factor, rotating apparatus.

e fundamental action is simple and may be illus-d by the accompanying diagram. The anodes of tubes are positive. Assume that the grid of the r tube is positive. Current will flow from the posi- d.-c. source through the transformer to the negative line by way of this tube. The grid of the lower is negative and allows no current to pass. The condenser is charged with the potential drop across the output transformer due to the current flow in the upper half of the winding, the upper terminal becoming nega-tive and the lower positive. Toward the end of the cycle the grids exchange polarity. This has no direct effect on the current flow through the first tube, but allows current flow through the second, which in effect con-nects the lower side of the condenser to the negative lead. This places a negative voltage of short duration on the upper plate allowing the upper grid to regain control. As this action continues voltage is generated in the output winding. As with the controlled rectifier the usual power applications would be polyphase.



A thyratron with a peak current rating of several hundred amperes.

A number of types of thyratron tubes have been devel-oped. These range in peak current capacity from 1.0 to 75.0 amperes and in voltage from 1,000 to 20,000. Different tubes are designed to meet various require-ments, such as short heating time for the cathode, low cathode power, short deionization time, etc. Tubes of various power ratings are now being manufactured and thyratrons capable of handling considerable power are under development.

▼ ▼ ▼

The cathedral builders of the past— and the electronic designers of the present

Just as every medieval cathedral had a soul—a part of the soul of its designer and of the souls of the pious men who built it—so every modern machine has a soul; it is a part of the soul of its inventor and of the patient souls of the men who developed it.

Prof. MICHAEL I. PUPIN,

Hazards from induced emfs

Metal structures in high-frequency fields develop unexpected voltages

RADIO or high-frequency currents may create unexpected hazards in metal buildings, garages, steel ceilings and other metallic structures, as well as on shipboard, according to investigations which have recently been concluded by government experts. The Naval Research Laboratories at Washington, in cooperation with the U. S. Navy ships, have determined that under certain conditions fire and explosive hazards may be introduced by the use on shipboard of high-frequency radio transmitters.

It has been common knowledge for some time that currents of considerable magnitude are induced in conductors placed in the vicinity of an energized antenna, especially when their electrical length is such as to approach resonance with the antenna. Also, that high potentials are induced in large metallic bodies when insulated from the ground and placed in a strong field under an antenna. The first case is illustrated by the high currents induced in standing rigging aboard ship if not broken up by insulators, while the second case is in the strong spark drawn from an automobile, parked under an energized antenna. High frequencies will naturally cause the greatest danger as there are more conductors on board ship likely to be of the right electrical length to produce resonance with the different high frequencies in use.

Dangers on navy ships

The greatest danger on shipboard may arise from a resonant condition set up between the transmitting frequency and a conductor placed in the proximity of explosives and inflammables. On board a Navy ship some of the serious conditions are:

(a) The danger of premature firing of exposed broadside guns caused by the resonance between the transmitter and the firing leads of the gun. This can occur only after the breach is closed and the firing circuit completed to the firing lock.

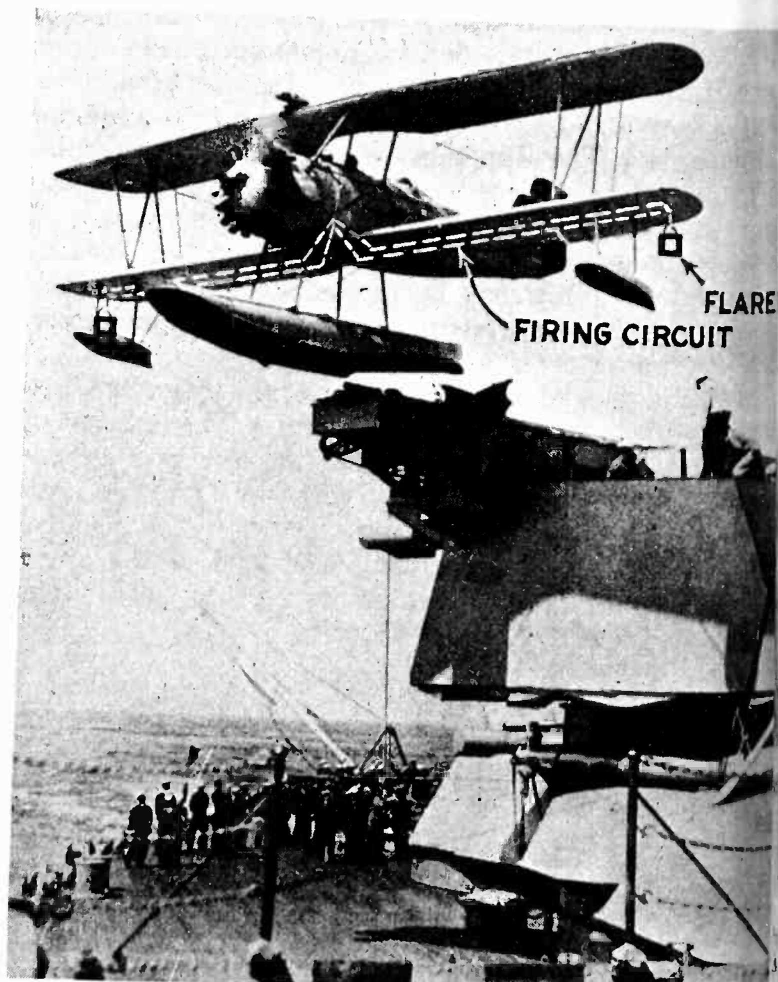
(b) Resonance set up between the transmitter and a gasoline filling hose may result in a spark setting off the gas vapor usually present.

(c) Danger of setting off primers on airplane w tip flares when resonance occurs between the transm and the wiring lead to the primers.

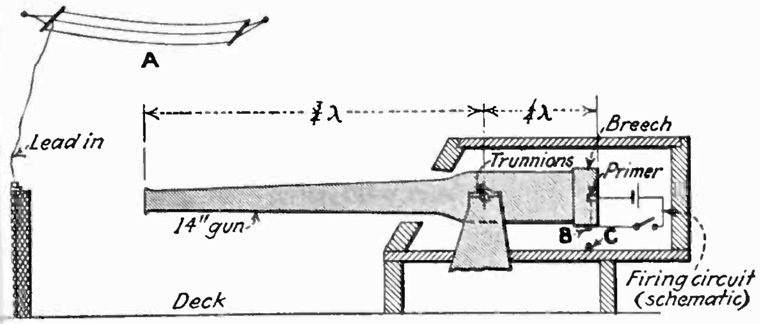
The danger from condition (a) may be correcte placing a small choke coil in series with the firing and electrode, with a 0.06 microfarad mica conde connected from a point between the pick-up wire choke to ground. This modification made it impos to fire the primers under extreme test conditions. M chant vessels, especially oil tankers, might well cons the hazards caused by high frequencies if used du fueling operations. In conducting the tests aboard N ships, the Research Laboratory intentionally exagger the conditions while under certain normal conditions concentrated electric fields due to poor antenna arran ment may result in a dangerous accident. These t indicated that the use of ground strips are not alw effective when the lengths of such paths to ground comparable to quarter wave lengths. In the test c ducted on one ship, it was found that the muzzle of 14 inch gun in one turret was quite hot electrically wh an antenna close by was excited at 16,000 kilocycles b one-kilowatt transmitter. The distance between trunnions of the gun and its muzzle was approximat three-fourths of a wave length. At intermediate lower frequencies the muzzle was effectively ground

Big guns as antennae

The length of guns aboard ship are now comparal to quarter wave lengths or multiples of quarter wa lengths. This introduces the possibility of produci standing electric waves by excitation from a nearby hig frequency antenna. The existing conditions are show more clearly in the accompanying figure. In this cas



A Vought-Corsair seaplane being catapulted from the turret of a battleship. A tracing of the firing circuit for the wing-tip flares is shown



Simplified sketch of battleship turret showing conditions for producing standing electric waves in the gun by excitation from a nearby antenna

ı length of a 45 calibre 14 inch gun is a full wave ɤth for certain high frequencies, the trunnions are ɥroximately one-quarter of a wave length from the bɾech and three-quarters of a wave length from the ɯzzle end. With the muzzle end of the gun exposed tɧ high-frequency field, it is possible to set up electrical oɕllations with the result that low but readily measur- ɞ: voltages can be detected at the breech of the gun. ɪs condition can exist even though the rear part of t ɥgun is shielded from the electric field of the antenna ɓ :he turret.

ɣy setting up the worst conditions it was found pos- ɛ to light an 18 or 24 volt lamp by connecting it be- ɫen the breech (B) and turret (C). Voltages as high ɔ ,000 volts were set up under the right conditions. It ɜ also found possible to explode a primer in the breech by utilizing the energy picked up by the gun and induced in the firing circuit with a special tuned circuit arrangement. Another hazard exists in setting off primers on airplane wing-tip flares when such aircraft are exposed to the field of a high-frequency antenna. This condition exists when the flare circuits are in resonance with the antenna circuit. It was found possible to light airplane running lights because of a similar condition. The airplane pictured shows the wiring leads to the flare wing-tips. This circuit when in a high-frequency field is capable of picking up an induced current sufficient to set off the flares.

Some figures on clearances

The above experimental tests showed that the radiating portion of high-frequency antennas should be located as far as possible from objects whose electrical lengths are such that resonance effects may be set up. The radiating portion of the antenna should be placed at least 50 ft. from any possible resonant object, when an antenna output of 500 watts is used on frequencies in excess of 10,000 kilocycles. In case the output is increased, the distance should be increased and for less output, it may be decreased. It has also been recommended that two-wire feed lines should be employed for all antennas which will be operated at 10,000 kilocycles or above or where it is not practical to maintain the lead-in spacing equal to that specified above for the radiating portion. Planes designed for use on board ship should have all electric wiring shielded and this shielding should be bonded where practical.

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NEW BOOKS ON ELECTRONIC SUBJECTS

ɛments of electricity

y Anthony Zeleny, Ph.D., New ork, McGraw-Hill Book Co., Inc. 27 pages. Price $3.

ɽTHIS TEXT BOOK by the professor of ɦsics of the University of Minnesota, ɑ nique method of presentation is followed, which while departing widely ɱn customary concepts, nevertheless ɔows closely present views concerning ɛtric current. The best explanation of ɦ method used is found in Professor eny's own words: "All the major ɩnomena are explained in terms of ɸsical concepts which are reducible two basic phenomena. This explanaɑ is made possible by taking the point view that electric fields have inertia, erpenetrate freely, and are insepɩble from their elemental charges. perposed fields are then construed to ist as independent fields, even though ɛy neutralize one another's action on ctric charges. It follows that an uncharged body is surrounded by both a negative electric field, which is the resultant of the superposed elemental fields of all its electrons, and an equal opposite positive field due to the fields of all its protons. It also follows that when electrons are in motion within or with a conductor, each electron is surrounded by a magnetic field which is inseparably associated with the moving elemental electric field. A magnetic field is therefore regarded as an aspect of a moving electric field. From this point of view a large number of the most important phenomena, such as induction and the production of electro-magnetic waves, which usually are only inadequately described, are readily explained in a satisfactory manner. Since clearness of exposition is materially improved by referring to the direction of electron flow rather than to the conventional direction of the current, all explanation are made in terms of the flow, and arrows in the figures are drawn to represent the direction of the flow."

Electron physics

By J. Barton Hoag, Ph.D. New York; D. Van Nostrand Company, Inc. 208 pages. Illustrated. Price $3.

THE UNDERLYING PURPOSE in this work is to present by text and by experiment the evidence for many of the concepts of modern physics. It is the outgrowth of a course given at the University of Chicago for many years, called "Radio-activity and Discharge through Gases," a laboratory course in the experiments which have brought the modern scientist such phenomena as X rays, the photoelectric effect, the three element vacuum tube—and hence radio, sound movies, and the field of electronics in general.

The book is well indexed, contains experiments that the student can perform, such as the well known oil-drop experiment of Millikan, and a series of problems on electronic subjects. The pages are clearly illustrated.

electronics

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O. H. CALDWELL, *Editor*

Volume 1 — MAY, 1930 — Number 2

Don't limit broadcasting power

AT LAST the iniquitous Davis Act, assigning broadcasting facilities proportionally to state populations, appears to be in way of repeal and revision. Even Senator Dill who was the principal advocate of this unsound and destructive legislation of 1928, has deserted his former protégé since he discovered that its practical application cut broadcasting facilities in his own state of Washington by 50 per cent.

He now proposes as law a new rule-of-thumb combination, by which states will be awarded broadcasting facilities on a basis of 25 per cent proportional to their "equal states' rights," 25 per cent proportional to their areas, and 50 per cent proportional to their respective populations.

In so far as this new plan departs from the population proportionality and the limit on power it is an improvement. But any plan which attempts to set up a strict mathematical formula for the assignment of usable power, is bound to cause needless trouble to broadcasting and indefensible waste of the nation's broadcasting facilities.

Only "clear" or exclusive channels can render service to the largest public.

On clear channels, there is no conceivable sense in setting up broadcasting power limits—proportional to population, area, or anything else. The only sound principle is to allow *all possible power* on each such clear channel, to enable the surrounding public to be served as well as possible.

Only in this way can true proportionality of broadcasting opportunity be secured, with maximum service to the public. The radio and electrical industries must see to it that the next radio amendment avoids the wasteful inefficiency of the Davis-Dill amendment of 1928.

Standardization of the new "wide films"

THE question of whether the new wide filr are to be 70 mm., 65 mm., or a compromi somewhere in between, should be settled by tl motion picture industry in the near future. Tl standardization committee of the Society (Motion Picture Engineers should be given eve support by the executives of the producing cor panies. No group is better qualified to answ the engineering and economic problems involve

The success which this industry is reaping toda is due to the standard and universally adopted 3 mm. film which permits films made in Hollywoo to be shown in Hindustan. The national barrie that American films now cross, should cause som consideration of the new standard width to b adopted. It is quite clear that 35 mm. films wi be used for some time to come. However, i order that progressive development of the equip ment for making the new wide film may receiv the necessary impetus, it is obvious there shoul be an early agreement on the new standard widt

High-frequency hazards

AS THE applications of vacuum tubes an circuits increase, the presence of high fre quencies around metal structures is bound t develop some unexpected hazards which must b carefully guarded against.

In the presence of high-frequency electro stati or electro magnetic fields, ordinary metal object and housings may have set up in them emfs whic can give rise to dangerous currents. Metal gar ages, steel walls and roofs, steel ceilings, coppe gutters, ship's hulls, automobiles, and airplane may thus unexpectedly become carriers of consid erable voltages or currents, the discharge of whic may occur through inflammables and do seriou damage.

The safe guarding of metal structures agains induced high-frequency currents is a problem fo the engineer to consider at the outset. So mys terious and incomprehensible are the manifesta tions of high-frequency effects to the ordinar layman, that ignorant attempts at prevention ma do more harm than good, and actually multipl hazards.

enever metal structures exist around high-ency circuits involving any power, fugitive es and currents are likely to be set up. They be watched for and guarded against. The ner's responsibility does not end with his rcuits and equipment. He must scrutinize metal conductor within inductive range and it it is rendered safe and harmless.

Vanted, another Nipkow

HE limits of the present available systems of elevision are apparently being rapidly hd. From now on, it would appear, search be made in new directions. Any system of ion depending upon the successive point-by-transmission of the image is bound to be et to all the present fundamental limitations, ich point-by-point systems involve tremen-high frequencies. This means the the chan-dth for either wire or radio transmission be excessive (necessitating hundreds of kilo-e) or else the picture must lack in detail.

e basic theory of all our present systems of ion dates back to Nipkow's work in the mid-cian eighties. Even with all the refinements oped since by patient research, its possibili-ow seem to have been about exhausted. We look for new principles of transmission. We start building on new foundations, if we are tend, over distances, anything approaching uality of the marvelous multi-linear linkage een eye and brain.

Do side-bands exist?

ROM time to time doubts as to the physical xistence of side-bands in radio transmission arise in the minds of those who have no ready ns of actually detecting them by means of ply tuned devices. But such doubts are dis-ed in private and an engineer who values his tion will not raise such questions before a nical audience.

n a recent issue of *Nature,* a scientific periodi-a scientist whose name has been connected with the electronic industry for two generations says that side-bands are the result of mathematics, and that they really do not exist. He says in effect that two television stations could operate on closely adjacent channels without interference.

This will be disconcerting news to telephone engineers who have spent years in designing and building filters to suppress not only an occasional side-band but often the carrier as well. In such cases, is anything transmitted? Experience gives an affirmative answer. Our British scientist says no.

If modulation takes places in a given circuit and the output of that circuit is amplified, less power will be required if only one side-band is transmitted than if the entire product of modulation is amplified, viz, carrier and two side-bands. Surely no scientist no matter how much he may wish otherwise will state that the figments of a mathematician's imagination will work a watt hour meter.

Custom-built tubes for measurements

IN a great power system, a vacuum tube controls a time-clock network and thereby controls the frequency of the system. But the engineer in charge complains that vacuum tubes differ so much in their constants that when the tube finally wears out and is replaced, the system must be rebalanced to get accuracy of time again.

Last month, in these pages, the chief engineer of a company building measuring equipment said of the tube: "Due to its variability and the consequent impossibility of relying upon a single calibration it is necessary to employ methods in which the vacuum tube may be calibrated as it is used."

Is there not a challenge in these complaints? Is it not possible that a series of tubes, hand-made if necessary and expensive, could be sold for measurement and control purposes, tubes whose characteristics would duplicate each other, that would have long life, and would be readily obtainable? Could not some tube company build up a nice business for itself by "custom-building" vacuum tubes for use in laboratories and other places where constancy, uniformity, and reliability would be in demand?

REVIEW OF ELECTRONIC LITERATUR

HERE AND ABROAD

Trans-oceanic telephone service short-wave equipment

[A. A. OSWALD] The application of short-wave radio transmission to trans-oceanic telephone circuits is developing apparatus and stations designed distinctively to meet the needs of these services. This paper describes from the radio point of view the important technical features and developments incorporated in the new transmitting and receiving stations of the American Telephone and Telegraph Company, located respectively at Lawrenceville and Netcong, N. J., and it outlines some of the radio problems encountered in the station design. A brief description of the transmitting equipment and antennas at Lawrenceville is given. One of the methods of obtaining a sharply directive characteristic is to arrange a large number of radiating elements in a vertical plane array, spacing them at suitable distances and interconnecting them in such a manner that the current in all the radiating members are in phase. This method is employed at Lawrenceville and depends upon the manner in which standing waves are formed on the conductors. At the receiving end the radio wave is collected by means of a directional antenna array whose prime function is to improve the ratio between the desired signals and unwanted noise or other interference.

This is done in two ways: viz., (1) by increasing the total signal energy delivered to the receiver and (2) by discriminating against waves whose directions of arrival differ from the chosen ones. Since, under many conditions, the direction of arrival of static and other disturbances including unwanted radio signals are random, it is obvious that sharp directive discrimination aids very materially in excluding them from the receiver.—*Journal A.I.E.E., April, 1930.*

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Radio stations at Algeria and Strasbourg

[MICHAEL ADAM] This article contains a detailed description of two new French stations, one at Algiers in North Africa and one at Strasbourg in Alsace-Lorraine. The purpose of these stations is frankly political. The North African Station is already in operation and the Alsace-Lorraine Station will be before the end of 1930.—*Revue Générale d'Electricité, March 8, 1930.*

Recent progress in atomic physics

[L. G. CARPENTER] This article is a résumé of recent experimental and theoretical advances in the field of atomic physics. The author outlines De Broglie's concept of the electron as the basis of the new wave mechanics and its experimental confirmation by G. P. Thompson in Scotland and Davisson and Germer here; he mentions Einstein's "Unitary Theory of Gravitational and Electrical Fields"; he shows how Summerfield, using de Broglie's concept of the wavelength of electrons has been able to successfully explain the relation between thermal and electrical conductivity and several related phenomena. The emission of electrons from cold metals is given some consideration as is the change of resistance of metals w subjected to intense magnetic fi The article concludes with a section voted to Millikan's experiments cosmic rays and the theoretical expla tion of their origin.—*World Po London, March, 1930.*

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Micro-cinematigraph for 16-mm. camera

[HEINZ EISENBERGER] Description method of mounting commercial hc motion-picture camera (16 mm.) use in connection with microscope l system for making motion pictures biological and scientific experimen By slow timing of photographs, succ sive growth can be illustrated.—*Scien March 7, 1930.*

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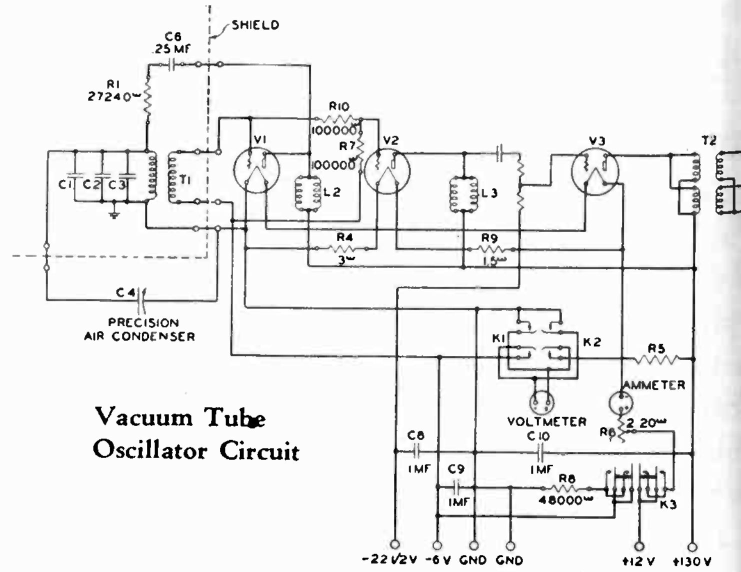
Thousand-cycle frequency standards

[L. ARMITAGE] For a long time ordinary tuning forks were considered satisfactory secondary standards of frequency, and were used for adjusting vacuum tube oscillators. The process was simply to strike the fork and then to adjust the frequency of the oscillator until the beat note, produced by the combination of the frequencies of the fork and the oscillator, could no longer be detected by the operator. The over-all accuracy of this method limited by the accuracy of the fork and the personal error of the operator is about 2.5 cycles in 1,000.

Later, a resonance type of frequency meter was introduced as a secondary standard. It is limited in accuracy only by the precision with which the values of its circuit constants may be determined. Frequencies from 100 to 50,000 cycles may be measured to one part in 1,000 with this type of meter. During the past few years the accuracy requirement of secondary standards of frequency have become more rigorous. The higher requirements are due largely to closer limits in the testing specifications of such apparatus as coils and filters, the measurement of whose constants t frequency of the testing current must known.

Accurate knowledge of frequen is also important when measureme are made with the resonance ty of bridge. Recently a vacuum tu oscillator has been developed by the la oratories for use as a secondary standa of frequency. This standard oscillat is designed to produce a frequency high stability. The frequency of tl oscillator is 1,000 cycles. Its frequen control unit is assembled in a compa ment isulated by means of an air cha ber, so as to be unaffected by rap changes in low temperatures. T tuned circuit of the oscillator is co pensated for temperature changes by t use of two types of condensers, havi temperature coefficients of opposite sig —*Bell Laboratories Record, Apr 1930.*



Vacuum Tube Oscillator Circuit

e work of Louis de Broglie

DAUVELLIER] M. Louis de Broglie in 1929 awarded the Nobel ;ics Prize for his theory of wave anics as a substitute for the classi- nechanics. The author, a colleague [. de Broglie's, gives us a concise iption of the work which led up ie new concept, an outline of the wave mechanics, and an interpre- n of the significance of this con- in the physical world. It is ny of note that the experimental ication of this new theory has been pied by American scientists; by sson and Germer of the Bell Tele- Laboratories, who demonstrated wave-nature of electrons and by nster of the University of Chicago demonstrated the wave-nature of tns.

e ideas which M. Louis de Broglie rth re-established harmony in the of physics with regard to the ex- ge of energy between matter and ition. From the wave viewpoint k had established the notion of a and Einstein had definitely local- the energy in corpuscles. Now ouis de Broglie, working from the ial to the undulatory, had endowed rains which are protons and elec- with a wave motion of a new sort mission is to pilot these grains gh fields of force.

he words of Arthur Holley Comp- imself a recipient of the Nobel cs Prize, "this, the most important bution of the 20th century physics, t the physical world can be reduced ee kinds of particles—protons, elec- and photons—and that each of s particles have also the char- stics of waves."—*Revue Générale ctricité, March 22, 1930.*

✦

king along a beam of light

). BROWNE] The modulation of a beam and its reconversion to elec- oscillations of acoustic frequency he two essential features of a light ding and reproducing system. In ystem described in this article the ified currents from the microphone up are used to modulate the light sity of a glow lamp. Either neon, or helium gas-filled tubes may be but in this particular system the m is preferred since the modulated waves are used to energize a graphic film so that a permanent rd of the speech may be obtained the light from the helium lamp has er actinic value than that from the r two. The light beam so modu- , passes through a system of lenses onto a photographic film. After lopment, the amount of blackening esponds to the sounds picked up by the microphone. If this film is subjected to a steady beam of light this beam is modulated in accordance with the original signal waves and this modulated beam falling upon a photo-electric cell produces variations on the electric current output which being amplified and sent through loud-speakers reproduce the original signal.—*Wireless World, March 5, 1930.*

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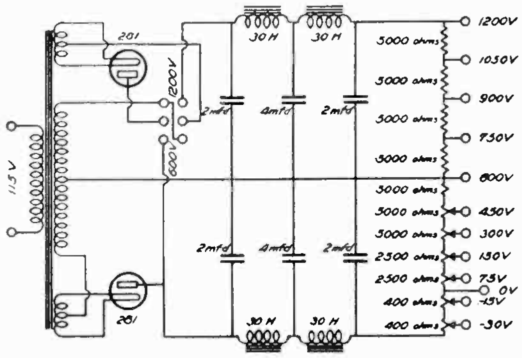
Laboratory B-voltage supply

[FREDERICK BEDELL and JACKSON G. KUHN] Various B-eliminators now on the market, while adequate for their intended use with radio receiving sets, are inadequate for more varied purposes. The laboratory B-voltage eliminator



described is relatively free of ripples usually present in radio B-eliminators. The wiring diagram of this eliminator is shown in the accompanying view.—*Review of Scientific Instruments, April, 1930.*

✦

Thermionic emission of oxide cathodes

[A. L. REUMAN and R. MURGOCI] The following observations were made:

(1) The electrical conductivity, c, of a "formed" alkaline earth oxide varies with the temperature T according to a law of the form $c = \alpha \, \varepsilon^{-\beta/T}$ where α and β are constants.

(2) During the process of forming, both the thermionic emission and the electrical conductivity grow similarly, and after its completion both are "poisoned" similarly by exposure of the oxide to

(a) oxygen (b) a discharge in carbon monoxide, and

(c) a discharge in hydrogen.

Complete recovery of the formed condition by reforming is possible only a few times in succession after poisoning by (a) and (b) but any number of times after poisoning by (c).

(3) At current densities comparable with those in the coatings of oxide cathodes from which saturated thermionic space current is being taken, the current conducted through an oxide powder between two electrodes, embedded therein, saturates.

On the basis of these observations, together with the results of related work by other investigators, the following theory of the action of oxide cathode is formulated:

1. The coating conducts the space current, which, of necessity, passes through it, electrolytically. Practically only the metallic ions are mobile, the oxygen ions playing no part in the electrolysis.

2. The whole surface of each crystal of oxide of a formed cathode is covered with a mobile monatomic layer of alkaline earth metal. The passage of space current is accompanied by a continual circulation of this metal which diffuses outward along the surfaces of the crystals and inward through the crystals in the form of electrolytic ions.

3. At the usual operating temperatures of oxide cathodes the average life of alkaline earth metal particles on the emitting surface is of the order of 10^{-3} seconds and the rate of flow of the metal over the surface of an idealized independent of circulation.

4. The coating is probably in very imperfect contact with the core metal so that the space current passes from core metal to coating mainly in the form of thermionically emitted electrons. Sufficiently copious electron emission of the core metal at the low temperatures of operation of these cathodes would be made possible by a continuation of its surface with adsorbed barium or with barium and oxygen.

Explanations are suggested for

(1) the eventual life failure of oxide cathodes;

(2) the observed phenomena relating to poisoning;

(3) the considerable variation in the published values of the thermionic constants of oxide cathodes.—*Philosophical Magazine, London, March, 1930.*

✦

Stabilized oscilloscope using cathode ray

[FREDERICK BEDELL and JACKSON G. KUHN] One stage of amplification is included in the stabilizing circuits of the Bedell-Reich oscilloscope, which comprises a cathode-ray tube with linear time-axis for observation of periodically varying quantities. It extends the frequency range of the instrument and permits stabilization without disturbance to the circuit under test. Although not primarily intended for use beyond the audio range, the instrument has in this way been stabilized above 100,000 cycles. Curves are given showing the use of the instrument for the study of non-electrical quantities (as sound and light) as well as of electrical quantities (as in the study of modulation and rectification).

The freedom from inertia of the cathode beam and the fact that no appreciable amount of energy is required to deflect it, makes possible the use of this type of instrument, in cases where an instrument with moving parts possessing mass could not be used. The linearity of the time-axis is highly important. Some interesting photographs are included which show the modulation of a 50,000-cycle wave, also the wave form of a 107,000-cycle oscillator. The linear time-scale is obtained by impressing upon one pair of plates of the cathode-ray tube a saw-toothed wave of controllable frequency, obtained from a neon oscillator, consisting of a condenser periodically charged at a uniform rate through a saturated thermionic tube and automatically discharged through a neon lamp when a definite breakdown voltage is reached. The oscilloscope makes it possible to observe the effect produced by changing experimental conditions while they occur. For permanent records, the curves when stabilized may be photographed, either by direct contact prints or by means of a camera.—*Review of Scientific Instruments, April, 1930.*

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"Grandeur" wide-film system

[R. H. McCullough] The writer gives a brief description of the Grandeur projectors installed in the Fox-Carthay Circle Theater in Los Angeles. Photographs of the new wide-film projectors are shown. The projection angle at this theater is 23 degrees. It was found necessary to install special glass prisms in front of each lens so as to eliminate any vertical distortion. The prisms are adjustable so that objects may be adjusted in height to eliminate such distortion. The addition of extra reproducing horns was found necessary because of greater screen width and an adjustment of the horns was necessary to insure proper illusion with respect to natural sound from the screen personnel. Large-screen installations should be made as close to the stage floor as possible to enhance the illusion of a stage presentation. — *Motion-Picture Projectionist, April, 1930.*

✦

Our eyes and the movies

[Donald A. Laird, Ph.D.] An outline of the physical, pysiological and psychological principles on which the satisfactory vision of moving pictures is based. High screen intensities are necessary to overcome flicker. Utilizing too large a visual angle will produce a sense of flicker, owing to the greater sensitiveness of the outlying edges of the human retina. Animals do not "see" movies as do humans, their eyes apparently lacking the photochemical elements which cause persistency of vision or fusing of successive pictures.—*Scientific American, March, 1930.*

Filaments in hydrogen—electronic collisions

[H. Copaux] Hydrogen may be activated by heat, as Langmuir discovered in 1912. The heat lost by a filament of tungsten in such gases as argon, nitrogen, mercury vapor, and hydrogen, is dissipated by radiation, convection, and conduction. For argon, nitrogen, and mercury vapor the loss by conduction and convection, that is, the difference between the total loss and the loss by radiation, measured in vacuum, is proportional to the 1.9th power of the absolute temperature, up to the highest temperatures supportable by the filament. For hydrogen, however, from 1,500° to about 2,300° C. the loss of heat by convection and conduction is proportional to the fifth power of the temperature, because of the consumption of energy in the dissociation of H_2 into 2H. The product of this dissociation is active, reducing, with change of color, such oxides as those of molybdenum and tungsten in a cool part of the tube. The other method of activating hydrogen is by the action of the electrical discharge upon the rarefied gas. This does not last more than a second, however. It is not at all certain that the active hydrogen is composed entirely of atoms.

It has been shown within the last few months that hydrogen, subjected to collisions with electrons, begins to reduce copper oxide in the cold as soon as the accelerating potential applied to the electrons reaches 11.4 volts. The study of the spectrum shows that the first degree of resonance of the molecule H_2 is situated at 11.6 volts. It may be that metastable molecular hydrogen is present in the active hydrogen, as is the case in nitrogen.—*Chimie et Industrie, Paris, February, 1930.*

✦

Film foundation of Harvard University

There has been established at Cambridge a university film foundation by the aid of a gift made last fall by Mr. John D. Rockefeller, Jr. The Foundation is able to make completely both silent and talking films in its plant. A soundproof studio has been installed, and in connection with it, a complete sound-on-film recording equipment, loaned to them by the R.C.A. Photophone. A well-equipped laboratory has been built for developing and printing the film, both standard width and 16-millimeter size. The Foundation has a staff of twenty persons and includes specialists such as sound engineers, projectionists and laboratory men. The Foundation is about to start making a photographic record of eminent professors and personalities connected with the university. It is planned not only to record the professors speakin[g] also to show them illustrating th[e] [ex]periments and making demonst[rations] of scientific material.—*Science, 1930.*

✦

Two-way airplane radio communication

[G. E. Everett] A description [of a] radio set developed for the T[...] Maddux Air Line is given by the [...] also a discussion of the faults ex[...] in previous sets. The new set c[...] of a single unit installed on a rem[...] panel hung on a shock-absorber [...] rear of the fuselage. The trans[...] itself weighs only 29 lb., and wit[h] installation and operation acces[...] involved for remote control, it w[...] 85 lb. Fuses have been used to p[...] all the circuits, and a five-point irr[...] ible plug makes all the necessary [con]nections to the transmitter and gr[...] The entire set may be removed [...] another installed within three mi[nutes.] —*Aviation, April 12, 1930.*

✦

Progress of sound films in France

[P. Hemardinquer] A descripti[on of] the Gaumont system of sound-pi[cture] projection, with illustrations and d[...] of the reproducing apparatus. [...] mechanism follows in general the [prin]ciples of construction of American [pro]jectors, although somewhat more [...] in mechanical arrangement.—*La Na[ture], Paris, March 15, 1930.*

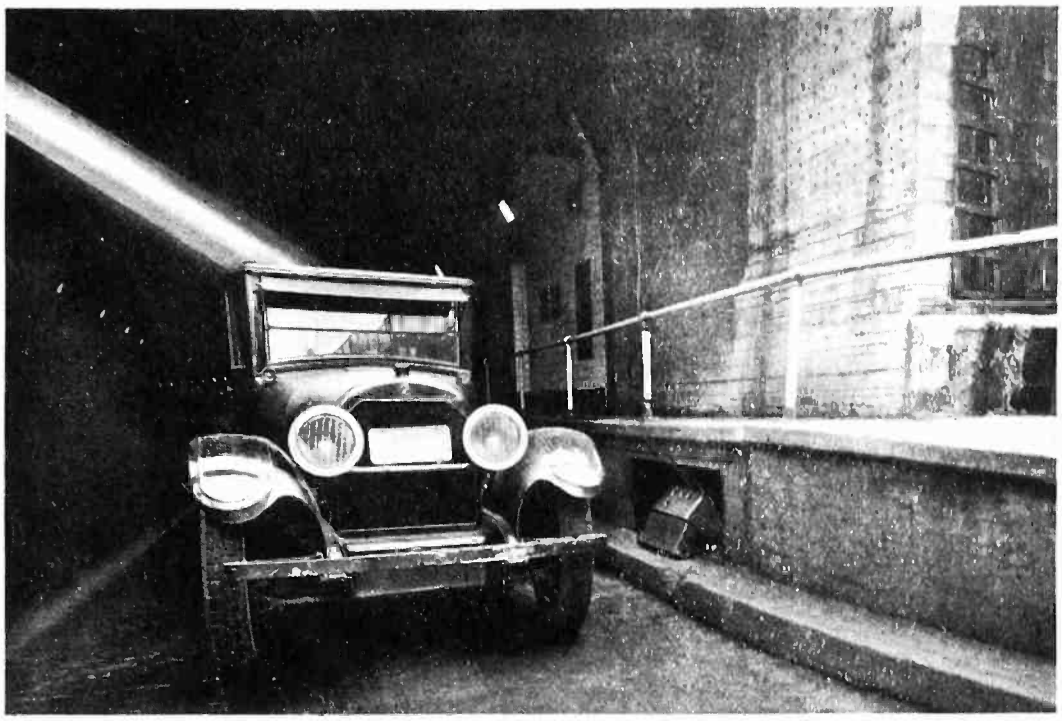
✦

Architectural acoustics of auditoriums

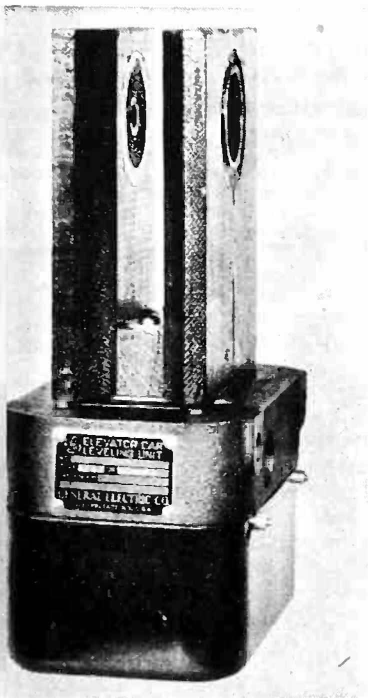
The usual acoustical defects of a[udi]toriums are echo, dead spots, and re[ver]beration. Reverberation (inclu[ding] echo, which is a particular kind of [re]verberation) is a serious defect since[...] prolongation of one sound such a[s a] musical note or spoken syllable, may [in]terfere with the next sound, produ[cing] hopeless confusion. A certain am[ount] of reverberation is however desira[ble.] A table of acceptable limits of rever[ber]ation time for rooms of different [vol]umes, and formulas for calculating reverberation time are given. Va[lues] are likewise given for the sound [ab]sorption powers of different mater[ials] as compared with an open window w[hich] constitutes an almost perfect absor[ber.]

Practical general directions for [de]signing an auditorium are inclu[ded.] Copies of this circular (No. 380) ma[y be] obtained from the *Superintendent [of] Documents, Government Printing O[ffice,] Washington, D. C.*, at 5 cents each.

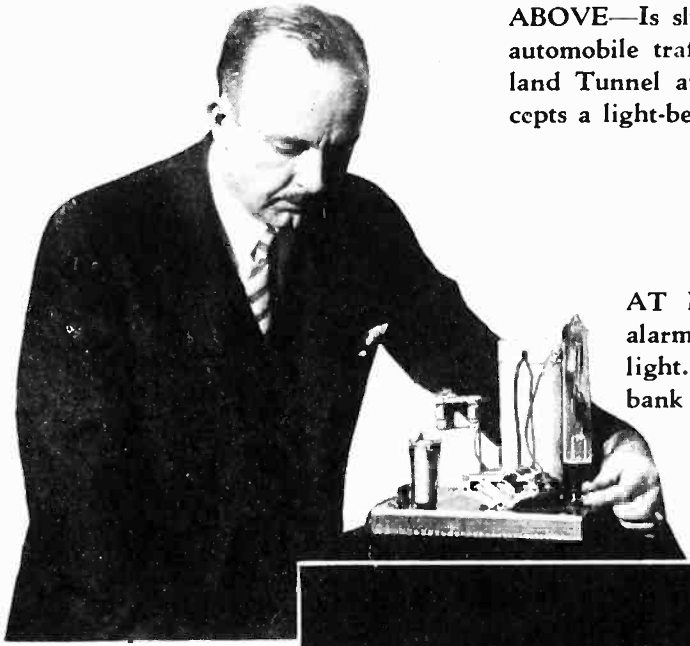
counts, alarms, controls



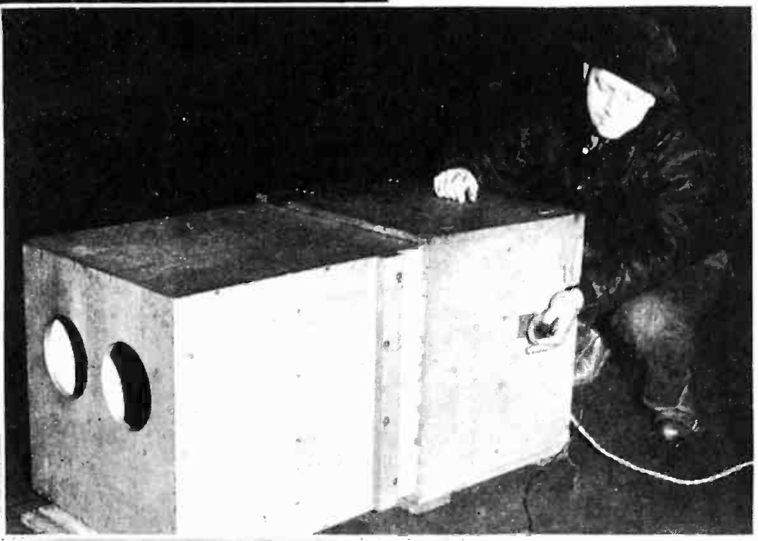
ABOVE—Is shown the method of counting automobile traffic passing through the Holland Tunnel at New York. The car intercepts a light-beam directed into a photo-cell.



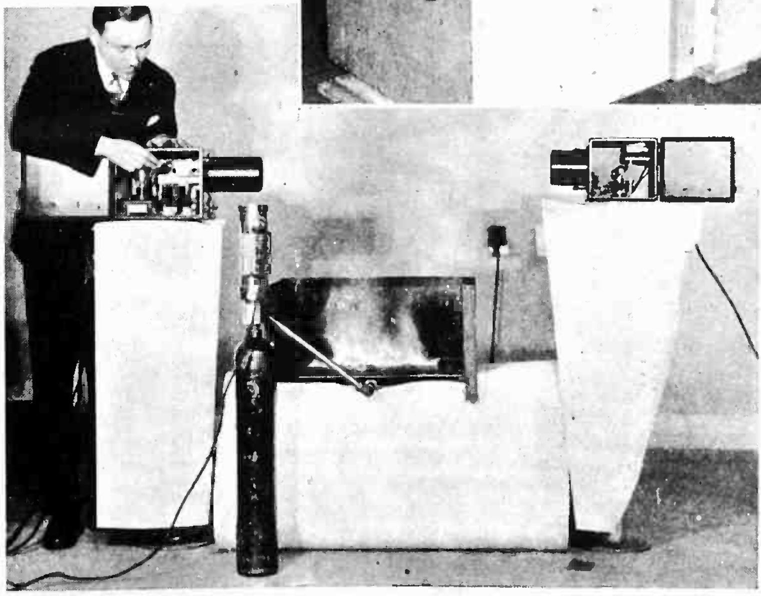
OVE—The active part of the vator-levelling control unit ich brings the car quickly to stop flush with the floor. cuum tubes form the heart this device. Such self-level- equipments are used on all new button-controlled eleva- s in big city buildings.



AT LEFT—A photo-cell burglar alarm, sensitive only to ultra-violet light. It is used for guarding safes, bank vaults, etc.



AT RIGHT — A gas detector. The gas is less transparent to infra-red rays than is air. Hence when gas is present, an alarm rings.

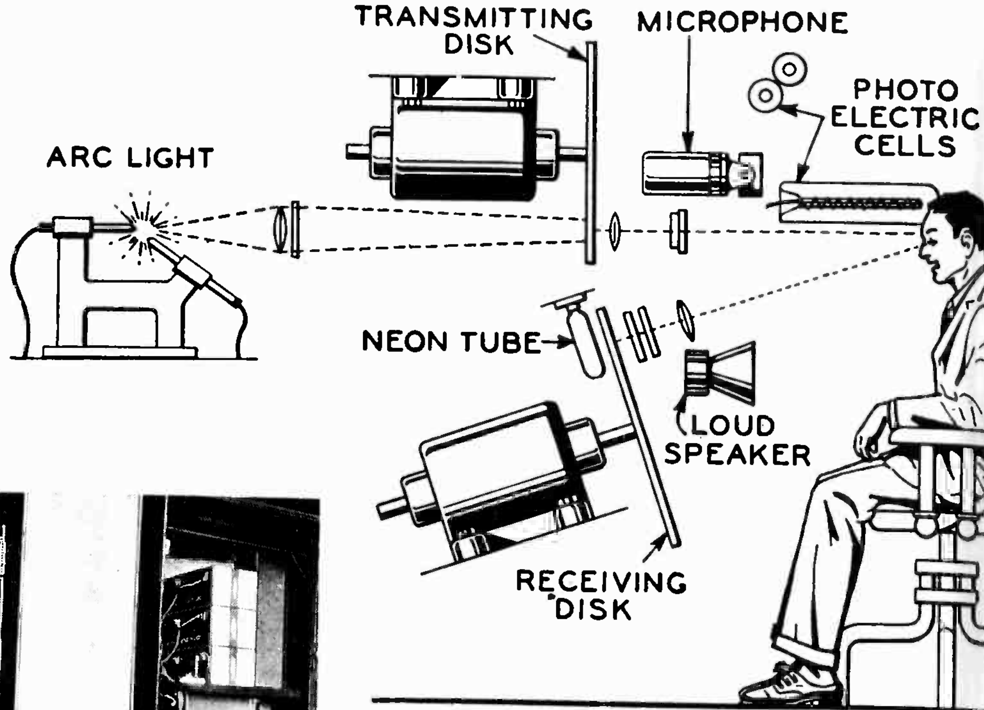


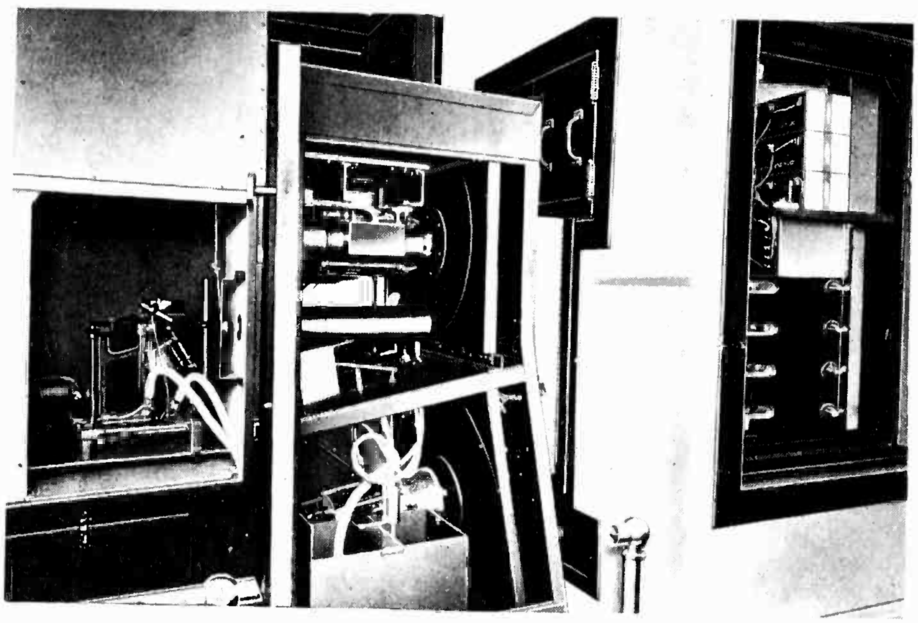
RIGHT—The photo-electric l as an automatic fire alarm d extinguisher. When an in- mmable liquid is ignited in pan, the smoke it produces ercepts the light-beam falling a photo-cell. This causes an plifier circuit to open the lve of a tank of carbon-diox- e, which drowns out the fire.

A few of the tube's many uses

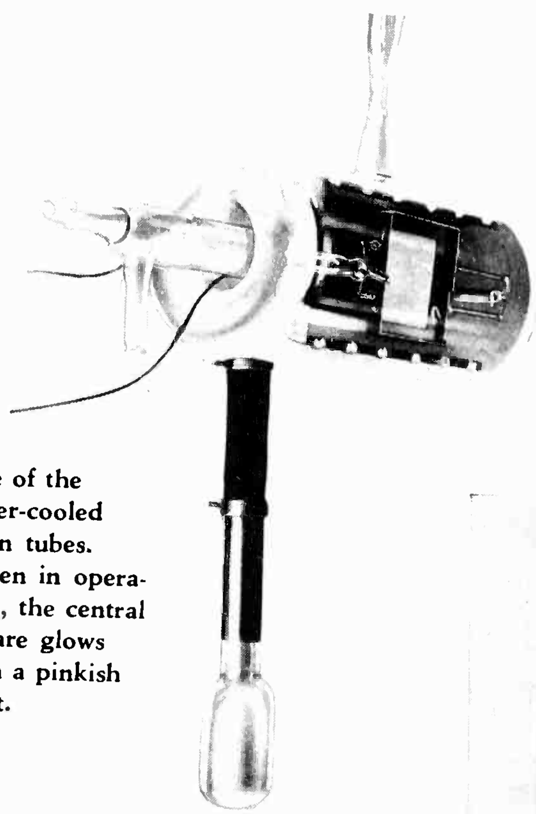
Two-way television

enabling both parties to a telephone conversation to see each other as they talk





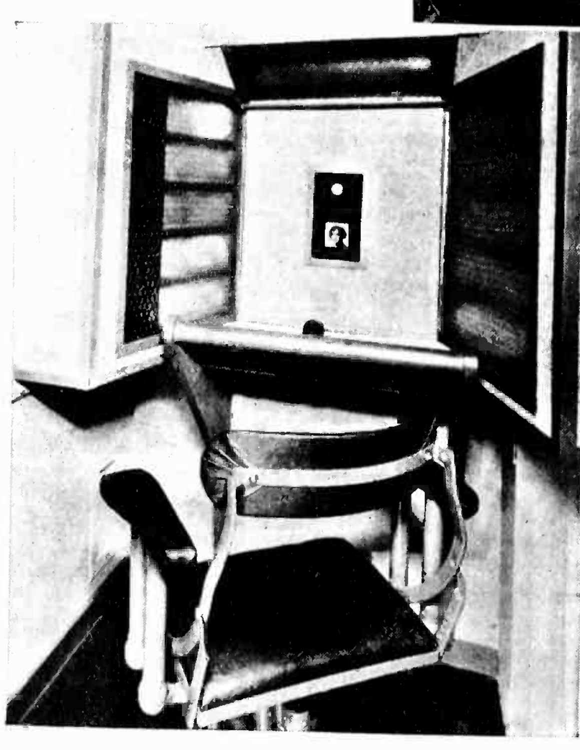
Above is shown the working equipment in diagrammatic form, and at the left is a photograph of the actual apparatus correspondingly arranged. The booth in which the "television-user" sits, is seen through the window.



One of the water-cooled neon tubes. When in operation, the central square glows with a pinkish light.

At right — W. S. Gifford, president, A. T. & T. (sitting), and Dr. H. E. Ives, one of the engineers largely responsible for the Bell television apparatus shown on this page.

At right — the interior of a television booth. The party at the other end of the wire is "seen" in the small rectangle. Around the sides are the light-sensitive photo cells which transmit the local image.



Among the improvements which have made two-way television possible are: The increase in sensitivity of the newest photo-cells, which have three times the former response. These cells employ a central anode and use potassium sensitized with sulphur. The voltage on the cell runs from 60 to 100. The glow tubes have a gas pressure of 12 mm. of mercury. A Sperry arc furnishes the light for the scanning beam. Vacuum tubes are used to keep the scanning-disk motors in synchronism.

NEWS

OF THE ELECTRONIC FIELD

...tion Picture Engineers ...Vashington, May 5-8

...LOWING are papers of especial ...ctronic interest, to be presented ... convention of the Society of ...n Picture Engineers, May 5-8, at ...'ardman Park Hotel, Washington,

MONDAY, MAY 5

...ress by President J. I. Crabtree, East- ...odak Company; "Recent and Future ...nic Changes in the Motion Picture ... by Franklin S. Irby, Associate Edi- ...ectronics, N. Y.; "Home Radio Movies ...e Cathode Ray Tube," by V. Zwory- ...Radio-Victor Corporation, Camden, ... "A Silhouette Studio," by C. F. Jen- ...Washington, D. C.; "Medical Motion ...s in Color," by H. B. Tuttle, Eastman ... Company, Rochester, N. Y.

TUESDAY, MAY 6

...d-Speakers and Theater Sound Re- ...tion," by T. Malter, R. C. A. Photo- ... Inc., New York; "Factors Govern- ...e of Sound Reproducing Equipment ...eaters," by W. J. Sette, Electrical ...ch Products, Inc., New York; "Sound- ...g and Acoustics," by A. S. Ringel, ... Victor Corporation, Camden, N. J.; ... Reproduction—Disc vs. Film," by ...Evans, Warner Bros. Eastern Studios, ...lyn, N. Y.; "Acoustical Characteristics ...nd Screens," by H. F. Hopkins, Bell ...one Laboratories, Inc., New York; ...w Recorder for Variable Area Record- ...y E. W. Kellogg, Radio Victor Cor- ...n, Camden, N. J.; "Phonofilm," by ...pan, General Talking Pictures, New ... "Acoustic Principles of Recording ...eproduction of Speech and Music," ...re film by Harvey Fletcher; "Gal- ...eters for Variable Area Recording," ... L. Dimmick, Radio Victor Corpora- ...amden, N. J.; "A Type of Acoustic ...tion in Sound Recording," by R. L. ...n, Bell Telephone Laboratories, Inc., ...ork; "The Becquerel Effect and Its ...ation to Talking Picture Systems," by ...h Miehling, Universal Sound System, ...hiladelphia, Pa.; "An Experimental ... of the Reverberation Characteristics ...Small Room," by C. F. Eyring, Bell ...one Laboratories, Inc., New York; ...ratus for the Analysis of Photographic ...n Records," by O. Sandvik, Kodak ...ch Laboratories, Rochester, N. Y.; ...graphic Treatment of Variable Area ... Films," by J. A. Maurer, R. C. A. ...phone, Inc., New York; "The Meas- ...nt of Density in Variable Area Sound ... by C. Tuttle and J. W. McFarlane, ... Research Laboratories, Rochester, ... "A New Microphone Boom," by E. C. ...rdson, Mole-Richardson, Inc., Holly- ... Cal.

WEDNESDAY, MAY 7

...levision System," by C. F. Jenkins, ...ington, D. C.; "Aeo Light Recording," ...obert Nicholson, New York; "Some ...ng Problems Affecting Sound Qual- ...by J. Crabtree, Bell Telephone Lab- ...les, Inc., New York.

THURSDAY, MAY 8

...nproved Synchronizing Apparatus for ...m. Films with Disc Records," by ... H. Bristol, Wm. H. Bristol Talking ...res Corporation, Waterbury, Conn.; ...ew Power Amplifier System," by L. ...pson, Wm. H. Bristol Talking Pictures ...ration, Waterbury, Conn.; "The Meas- ...ent of Light Valve Resonance," by ... Ceccarini, Metro-Goldwyn-Mayer ...os, Culver City, Calif.; "Talking Pic- ...—the Great Internationalist," by ...ld B. Franklin, West Coast Theaters, ...porated, Los Angeles, Calif.

Electrical Engineers at Springfield, Mass., May 7-10

AMONG the papers of special interest to *Electronics'* readers to be presented at the New England district convention of the A.I.E.E. May 7 to 10, are the following:

WEDNESDAY, MAY 7

Morning

"New Portable Oscillograph," C. M. Hathaway; "Self-Compensating Temperature Indicator," I. F. Kinnard and H. T. Faus; "Generator Speed and Retardation During Loss Measurements," O. E. Charlton and W. D. Ketchum; "M.I.T. Network Analyzer," H. L. Hazen, M. F. Gardner and O. R. Schurig; "Phase Difference in an Air Condenser," W. B. Kouwenhoven and C. L. Lemon.

Afternoon

"Research and Design with the Field as a Laboratory," F. A. Andrews and C. L. Stroup; "1928 Lighting Experience on American G. & E. Lines," Philip Spron; "Arcing Grounds and Neutral Impedance," J. E. Clem.

THURSDAY, MAY 8

Morning and Afternoon

"Transient Currents in Transformers," H. M. Turner; "Effect of Transient Voltage on Power Transformer Design," K. K. Palueff; "Reduction of Eddy Current Losses," J. M. Lyons; "Transformer Ratio and Differential Leakage of Distributed Windings," R. E. Hellmund and C. G. Veinott.

FRIDAY, MAY 9

Morning

"Co-operative Courses," K. L. Wildes, M.I.T.; "Ship-To-Shore Telephone Service," L. Espenschied and W. Wilson; "Relations of Measurements on Rubber Cable," C. L. Kasson.

Afternoon

"Concatenated Cone Speaker," A. V. Bedford, Research Laboratory, General Electric Co.; "Binaural Localization of Pure Tones," E. R. Wightman and F. A. Firestone, University of Michigan; "High-Scale Acoustic Phenomena," R. B. Bourne, The Maxim Silencer Company, Hartford, Conn.; "New Instruments in the Iowa Laboratory for the Psychology of Music," C. E. Seashore, University of Iowa; "The Reverberation Time Bridge," Harry F. Olson and Barton Kreuzer, R. C. A. Photophone, Inc., New York; "The Octave Interval," Wilmer T. Bartholomew, Peabody Conservatory of Music, Baltimore, Md.; "Teaching Control of the Human Voice," Louis Simmions, 210 Fifth Ave., New York.

SATURDAY, MAY 10

Morning—Symposium on Loud Speakers

"Theory of the Electrostatic Loud Speaker," C. R. Hanna, Westinghouse Electric & Mfg. Co.; "Theory of the Horn Type Loud Speaker," C. R. Hanna; "Radiation of Sound from Loud Speakers," Irving Wolff, RCA-Victor Co., Inc., Camden, N. J., and Louis Malter, RCA Photophone, New York; "Loud-Speaker Sound-Pressure Measurements," Edward W. Kellogg, RCA-Victor Co., Inc., Camden, N. J.; "An Efficient Loud Speaker at the Higher Frequencies," L. G. Bostwick, Bell Telephone Laboratories.

Acoustical Society at New York, May 9 and 10

THE third annual meeting of the Acoustical Society of America will be held in the auditorium of the Westinghouse Lighting Institute, Grand Central Palace, New York City, May 9 and 10. Following are the papers scheduled:

FRIDAY, MAY 9

Morning—Symposium on Noise

"New York City's Noise Abatement Commission," Dr. Shirley Wynne, Health Commissioner; "Results of Noise Surveys," "Noise Out-of-Doors," Rogers H. Galt, Bell Telephone Laboratories; "Noise in Buildings," Rexford S. Tucker, American Telephone and Telegraph Co.; "Noise Reduction," John Parkinson, Johns-Manville Corp.; "Objective Measurement of Machinery Noises," F. A. Firestone, University of Michigan; "Elimination of Noise in Machinery," Arthur L. Kimball, General Electric Co.

Coming Meetings, Institute of Radio Engineers

AT the New York City meeting of the Institute of Radio Engineers to be held Wednesday evening, May 7, at the Engineering Societies Building, O. H. Caldwell, editor of ELECTRONICS, will speak on "Radio's Contributions to Modern Civilization."

The June meeting of the New York Section, I.R.E., will be held at Atlantic City during the annual Radio Trade Show.

The annual convention of the Institute of Radio Engineers will be held at the King Edward Hotel, Toronto, Canada, August 18 to 21. Six hundred delegates are expected to attend this first international gathering.

Radio Week at Atlantic City, June 2 to 7

IN connection with the annual Radio Trade Show and Radio Manufacturers' Association convention to be held at Atlantic City during the week of June 2, there will be meetings of other radio organizations.

The Institute of Radio Engineers will hold engineering sessions at 10 a.m. and 2 p.m. on Tuesday, June 3.

The Radio Manufacturers Association will meet on Wednesday and Thursday, and R.M.A. Committees will assemble on other days of the week.

The Radio Wholesaler's Association will meet on Wednesday morning. The directors of the National Association of Broadcasters will convene the same day.

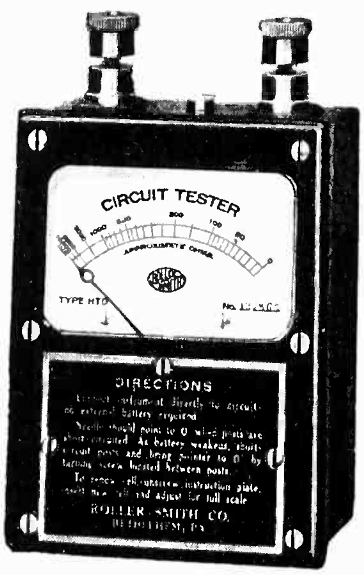
✦ NEW PRODUCTS

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.

Portable direct-reading circuit tester

THE Roller-Smith Company of Bethlehem, Pa., has marketed a portable, direct-reading circuit tester shown in the accompanying illustration. The instrument can be used to ascertain if there is an electrical circuit existing between conductors applied to the terminals of the instrument and also the resistance in ohms of the circuit under



test. The instrument measures $4\frac{1}{2}''$ x $3''$ x $1\frac{1}{2}''$ and weighs only 19 ounces, making it a convenient pocket size. The manufacturers recommend it particularly for use by wiremen, repair men, and on coil and other electrical installation work which necessitates identification and checking of various circuits. These testers may be obtained for 10,000, 100,000 or 200,000 ohms. No. 3009 S Type HTD circuit tester, 10,000 ohms is listed at $21.—*Electronics, May, 1930.*

Photo-electric relay unit

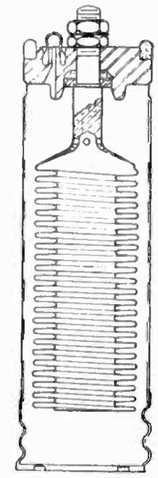
THE G-M Laboratories, Inc., Grace and Ravenswood Avenue, Chicago, Ill., have announced a new sensitive relay for use in conjunction with photo-electric cells. The relay embodies a one-stage amplifier, using a standard UX 199 type tube. This unit can be used for conversion of photo-electric reactions into electrical impulses, thus permitting the operation of auxiliary apparatus.—*Electronics, May, 1930.*

Tube Checker

A NEW and simplified tube checker for a.c. tubes has just been perfected by the Jefferson Electric Company, 1500 S. Laflin St., Chicago, Ill. With this tester it is possible to know if the plate and grid are shorted, the plate is open, and the filament is open or shorted. It has six sockets, one each for the 226, 227, 224, 247, 171A and 280 type tubes; a milliameter; a push button; and the connection for testing screen-grid tubes. The net price to the dealer is $13.50.—*Electronics, May, 1930.*

Electrolytic condenser

THE Sprague Specialties Company of Quincy, Mass., has announced an electrolytic condenser of entirely novel construction. It has a one-piece anode made entirely of aluminum. Some of its other features are: no welded joints, a protected vent, a pressure seal, and a shield which precludes possibility of



short circuit. This type of condenser lays claim to increased life, less leakage and better shelf characteristics. Leakage current is guaranteed not to exceed $\frac{1}{10}$ milliamperes per mfd. at 350 volts after 5 minutes. Another feature is the mounting arrangement which is of the screw type.—*Electronics, May, 1930.*

Photo-electric cell and amplifier unit

THE Westinghouse Electric & M facturing Company, East Pittsb Pa., has placed on the market a p electric cell with an amplifier whi now sold as a unit. The amplifier shown in the illustration, consists die-cast aluminum box in which mounted the necessary coupling dev

The top, which is a Micarta pane provided with two four-prong bases mounting the photo-electric cell and amplifier tube. All of the wirin concealed, connections being mad binding posts on the top panel. unit is dust-proof and moisture-p The short connections in the unit r possible a very high speed respon between .0001 and .001 seconds. some applications, complete appa has been developed and can be sup as a unit; but for most applica where no standard apparatus is a able, the photo-electric cell with amplifier is sold as a unit to be ap by the customer. Price complete tubes, $60.—*Electronics, May, 1930*

ortable amplifier

[E Operadio Manufacturing Com-y of St. Charles, Ill., who have spe-ized in public address equipment for door use, has recently produced an plifier designed for this type of serv- It is a portable model and is en-ly self contained, capable of driving r standard electrodynamic speakers, two of the large bowel speakers, a ent development of the same com-y. The complete unit contains a rophone with extension cord; a con- panel; and electric phonograph, as l as the line amplifier. A key switch rovided which permits the operator hift from voice to music instantly. A npartment is provided for the storage the microphone, and power supply d.—*Electronics, May, 1930.*

✦

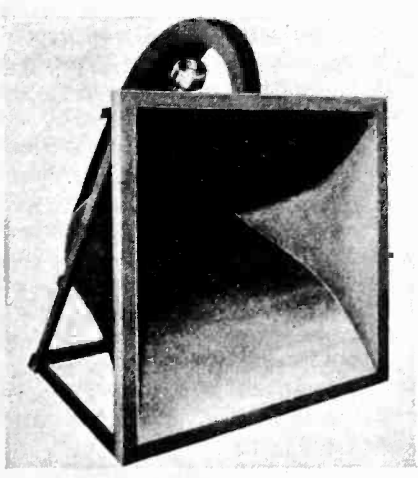
ectrodynamic speaker

FORD Radio Corporation, 3200 roll Ave., Chicago, Ill., has an-nced eight new models of dynamic eakers for 1930. Universal trans-mers are used with tapped connec-ns, permitting connections to sets ing various outputs. Direct con-ctions can be made to two No. 250, 4 or 171-A tubes in push-pull and sets arranged for use with a magnetic aker.—*Electronics, May, 1930.*

✦

ir column horn

HE Macy Manufacturing Corpora-n, 1449 39th St., Brooklyn, N. Y., nufactures exponential type horns of sizes. The accompanying view ows Model S-120, which has a depth 36 inches and an air column 10 feet length. This horn is designed imarily for use in theatres, large audi-triums, churches, rinks, etc. It is



itted with Macy electric dynamic re-ceiver units GAC-1 for interiors or nit GAC-2 for exterior use. Price omplete, including one receiver $250.—*Electronics, May, 1930.*

Water-cooled 5-kw. audion

THE DeForest Radio Company, Passaic, N. J., is the manufacturer of the 5-kw. audion shown in the accompanying view. This tube is designed for use as an oscillator on frequencies below 3,000 kilocycles, or as a radio-frequency amplifier on even higher frequencies. It may also be used as a modulator, by using several in parallel, to modulate a radio-frequency power amplifier. One of the principal features of the audion 520-B is the water jacket

construction. The jacket is an integral part of the tube itself, the water-cooling installation calling only for the attaching of two lengths of hose to the water inlet and outlet.—*Electronics, May, 1930.*

✦

Multiple coil winding machine

THE Acme Electric & Manufacturing Company, 1444 Hamilton Ave., Cleveland, Ohio, has obtained exclusive rights to manufacture and sell these machines. The multiple coil winding machine has a capacity of from 6 to 12 coil windings at a single operation, winding sizes of wire from No. 26 to No. 42. The winding of sizes of wire above No. 36 is difficult, and very few winding machines are capable of handling the fine sizes, especially when several coils are wound at the same time. At the end of the layer, through a cam mechanism, together with a mercury switch, the glassine paper is automatically inserted in the winding, and the machine winds another layer over this paper and then the operation continues. —*Electronics, May, 1930.*

✦

Electrolytic condensers

THE Aerovox Wireless Corporation, 70 Washington St., Brooklyn, N. Y., has recently announced a new dry type electrolytic condenser. This condenser is dry, is very compact for a given capacity and voltage rating and has a maximum peak voltage rating of 500 volts, making it suitable for use in connection with 245 type power amplifiers.—*Electronics, May, 1930.*

✦

Precision wire-wound resistors

INTERNATIONAL Resistance Company, 2006 Chestnut St., Philadelphia, Pa., has recently announced a new line of resistors. These resistors are non-inductively wire-wound to provide for an accurate and stable resistor to be used as a voltmeter or milliameter mul-

tiplier for laboratory use or wherever non-inductive resistors wound to accuracies of ½ of 1 per cent or 1 per cent are required. The resistors are made in all values of from 500 ohms to ½ megohm in the size shown, and can be provided in values even higher with slightly larger winding forms.—*Electronics, May, 1930.*

✦

D.C. converter for neon signs

THE Motorless D.C. Neon Sign Co., 180 East 123rd St., New York City, has recently placed on the market a direct-

current high-voltage transformer for luminous-tube sign operation. This device employs standard-26 vacuum tubes in place of a mechanical vibrator. It is designed for d.c. districts but will operate on a.c. though in this case the brilliancy of the luminous tubes is one-half. The manufacturers claim no interference with radio sets when using the device. Price of the complete set with three De Forest tubes $15.00.—*Electronics, May, 1930.*

PATENTS

IN THE FIELD OF ELECTRONICS

A list of patents (up to April 15) 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

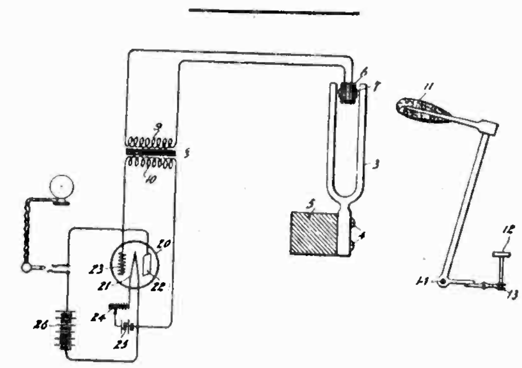
Acoustic Devices

Loud speaker. A reasonant body actuated by several electromagnets arranged in a square about it. George Maehren, assigned to Rocco Elio and Francis H. Davis. No. 1,751,284.

Deaf aid. An electrical arrangement enabling deaf persons to hear conversation, etc., composed of acoustic filters to attentuate the lower frequencies and a receiver which selects the high frequencies and discriminates against low frequencies. Bernardt Langenbeck, Leipzig, Germany, and Helmut Sell, Berlin, Germany, assigned to Siemens and Halske, Berlin. No. 1,750,960.

Acoustic wave filter. A means for converting non-acoustic energy into acoustic energy in the form of a standing wave having several components. Several energy-dissipating means are situated in the system at the proper places and of the proper character to dissipate energy other than the desired component of the standing wave. Included in the device is a method for reconverting the non-dissipated acoustic energy into non-acoustic energy. Harvey C. Hayes, Washington, D. C. No. 1,751,035.

Sound transmitter. Combination of a diaphragm, a rigid member, a conical member containing ground-up resistance material and a number of superimposed interconnected angular leaves between the rigid member and a conical member for damping purposes. Earl Wensley, assigned to Western Electric Company. No. 1,752,515.



Sound generator. Vibrating tuning fork varies the reluctance of a magnetic circuit which in turn controls the grid circuit of an amplifying vacuum tube. Max. Schumm, Port Jefferson, N. Y. No. 1,753,069.

Acoustic signaling. Consists in repeatedly exciting a sound generator by individual sound impulses that succeed one another at intervals of less than one third of a second. Heinrich Kuchenmeister, Berlin, Germany. No. 1,752,185.

Electrostatic loud speaker. Comprising a fixed prism and vibrating coverings over the external faces of the prism. Georg Seibt, Berlin-Schoneberg, Germany. No. 1,753,137.

Loud speaker. Several intersecting sound amplifying horns each resonant to a different portion of the audible frequency range and actuated by separate movements. John Preston Minton, and Abraham S. Ringel, Brooklyn, N. Y., assigned to Radio Corporation of America. No. 1,750,900.

Phonograph records. A phonograph record having an extension projecting inwardly from the innermost groove to cause the stylus to move inwardly and an independent outwardly directed inner groove to engage the stylus and move it outwardly. Isadore E. Neft, Los Angeles, Calif. No. 1,751,166.

Loud speaker. Two cone-shaped fabric diaphragms joined together at the apex of the cone, and two frames to hold the fabric. The reproducing unit is attached to the apex. Edward Freund, Long Beach, N. Y. No. 1,752,981.

Loud speaker. Loud-speaking telephone apparently of the balanced armature type. This patent was filed July 3, 1922, and has 23 claims. A. A. Thomas, New York, N. Y. No. 1,753,812.

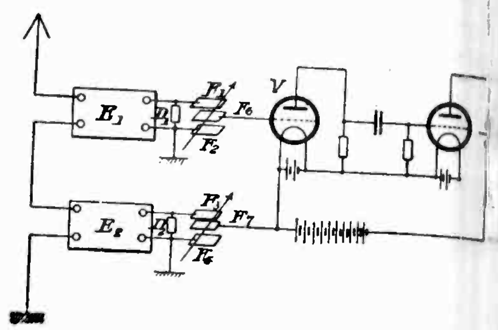
Radio Circuits

Signaling system. A method consisting in transmitting waves having a band of frequency components and dividing this band into several short spans which overlap each other. These short bands are modulated on several carrier waves of different frequencies, one corresponding to each sub-band so as to produce a plurality of five bands within practically the same frequency limits as were occupied by these sub-bands before modulation. These sub-bands are separate from each other in the frequency spectrum and are transmitted simultaneously. Ralph K. Potter, New York, N. Y., assigned to A. T. & T. Co. No. 1,750,688.

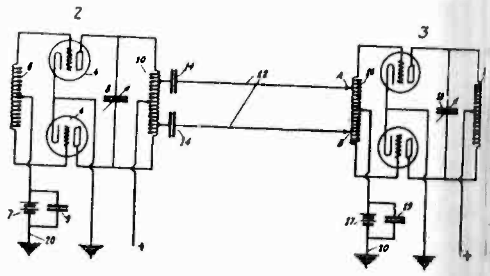
Short - wave system. Short wave antenna consisting of several rods separated from the earth and tuned to the frequency of the transmitter. All the rods being in the same plane are separated by the same angular distance and a hot wire ammeter is at the point of junction. These rods are not conductively coupled to the transmitting system. Russell F. Ohl, assigned to A. T. & T. Company. No. 1,753,715.

Receiving circuit. Another interesting member of the large family of Wheatstone bridge arrangements of vacuum tube circuits. Byron B. Minnium, assigned to Story & Clark Radio Corporation. No. 1,751,706.

Transmitting circuit. An oscilla amplifier, harmonic generator, and final amplifier which is coupled to antenna. The method involves sup ing a vacuum tube with oscillations modulating currents and causing tubes to produce oscillations of a quency which is a multiple of the fuency of the supplied oscillation. produced oscillations are modulated the supplied wave. John F. Farringt assigned to Western Electric Co., I No. 1,751,271.



Receiving circuit. In the diagra above E_1 is tuned to the desired sign but E_2 is tuned somewhat away fro the desired signal. E_1, therefore, receiv not only the desired wave, but also an disturbances that may exist, while th second circuit receives the disturbanc only. The two disturbances are balance against each other and do not appea in the output while the desired signa appears in the output. Siegmund Loew assigned to R.C.A. No. 1,751,588.



Coupling system. In the circui shown, 2 and 3 are amplifier circuit which are coupled together by the trans mission lines between them. To reduc the interaction between the circuits an to improve the accessibility of the sev eral stages the transmission line ha considerable length and is so tappe onto the output of the one circuit an the input of the other that the im pedance between the coupling equal the characteristic impedance of the line Clarence W. Hansell. Assigned t R.C.A. No. 1,751,996.

Signaling system. Several receivin systems of the double-detector type i which quartz crystals or other piezo electric substances control the frequenc generated by the oscillators. Russell S Ohl, assigned to A. T. & T. Company No. 1,753,444, No. 1,753,445 and No 1,753,446.

Interference-reducing system. Vol tages are induced in the antenna of receiving system which are equal an opposite to those induced there from magneto on an internal combustio engine. W. A. Loth, assigned to Societ Industrielle des Procedes, W. A. Loth Paris. No. 1,753,610.

requency changer. Two tubes in a · of push-pull Meissner circuit, de- ·ed to modulate the high frequency ·e with a low frequency voltage. ·les V. Logwood, Jersey City, N. J. ·gned to De Forest Radio Telephone ·Telegraph Company. No. 1,751,485.

·terference reducers and suppressors. ·ral patents assigned to the A.T.&T. ·pany are described in the following ·nts 1,752,303; 1,752,325; 1,752,326; ·,330; 1,752,344; 1,752,360; 1,752,342. ·patentees are Leo A. Kelley, Elm- ·, N. Y.; David B. Branson, River ·, N. J.; Robert H. Clapp, Ramsey, ·; Newton Monk, New York; Vaugn ·horp, River Edge, N. J.; Herman A. · Ridgewood, N. J.; Frank A. Leibe, ·llen, N. J. The methods in general ·ve balancing a signal plus inter- ·ce against interference alone, either · electrical circuit or in the mechan- ·output circuit (relay.)

·ve filter. A net work composed of ·tances and capacities across the ·and equivalent to a more compli- · network composed of three filter ·ns of the series shunt type. ·thy E. Shea, assigned to Western ·ric Company, No. 1,752,579.

·nsmission network. A wave filter ·ped to transmit electrically a pre- ·ged broad band of frequencies. In ·articular patent, a method is pro- · for neutralizing the effect of stray ·aity on the circuit. Timothy E. Shea, ·rford, N. J., assigned to Western ·ric Company, No. 1,752,461.

·-discharge communication. Sound ·nitting apparatus composed of a ·lled container having a sound open- · hot cathode and anode arranged to · ionization of the gas. A thermi- ·current is discharged through the · and audio signals are impressed · its discharge for modulation pur- · Samuel Ruben, assigned to Ruben ·ts Company, No. 1,752,811.

·nd ranging system. A sub- ·e sound ranging system comprising ·m tube repeaters, artificial lines and ·ory apparatus. George R. Lum, ·ned to Western Electric Co. No. ·346.

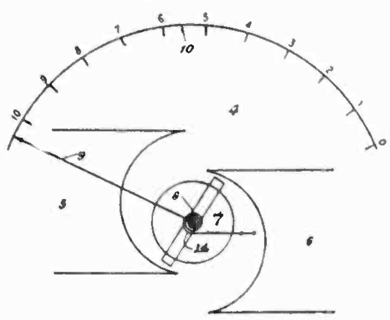
·tmeter. A gas-filled cell; pair of ·odes in this cell and a means of ·cing an initial ionization of the ·. Apparently the voltage put upon ·ll causes ionization and the extent ·e ionized column is used as an ·tion of the voltages involved. ·rt E. Bragg, assigned to Bell Tele- · Laboratories, Inc. No. 1,753,330.

·nning system. Reflecting and scan- · apparatus including several rec- ·lar units arranged side by side. ·mere B. Gardner, Los Angeles, Cal. ·1,753,697.

·naling system. A facsimile or ·re transmitting system in which a ·r wave is modulated with a num- ·f other frequencies representative of ·r portions of symbols adjacent to ·nother in a message to be trans- ·d. Vladimir K. Zworykin, assigned ·Vestinghouse E. & M. Co. No. ·961.

Circuit Devices

·ctifiers. A series of rectifiers op- ·ng on the dry surface contact prin- ·. One of the rectifiers is composed ·agnesium and an element formed ·n alloy of the metals copper, and · compounded with a chemical element from the sixth periodic group. Samuel Ruben, assigned to Ruben Rectifier Corporation. No. 1,751,359, No. 1,751,363, No. 1,751,460.



Meter. A meter having a scale reading in transmission units which are logarithmic functions of the current to be measured. The scale is made uniform by so positioning the coil with respect to the pole pieces and so shaping the latter that the pointer will move to a uniform distance at any part of the scale in response to a change in current corresponding to one transmission unit. Fred H. Best, assigned to A. T. & T. Company. No. 1,753,230.

Resistor for electrical measuring instruments. A vacuum tube used as a resistance for a measuring meter. A movable cylinder surrounding the cathode for screening it against the anode can be shifted by means of an external magnet. Werner Esbe, assigned to Siemens - Schuckertwerke Gesellschaft, Mit Veschrankter Haftung, Berlin, Germany. No. 1,754,152.

Vacuum-tube rectifier. An incandescent cathode rectifier for medium voltages having two anodes which are screened from each other by a glass or other non-conductor, each having a protected portion between the anodes and the base. Bruno Donath, Berlin, Germany. No. 1,754,012.

Process and Manufacturing

Glass machinery. Method and apparatus for producing tubular glass, etc. Leonard Souvier, Toledo, Ohio, assigned to Owens-Illinois Glass Company. No. 1,750,971; No. 1,750,972; and No. 1,750,973.

Getter. A mixture of a phosphorus compound and a reducing agent which vaporizes upon heating the mixer to clear up residual gases. Ernest A. Lederer, assigned to Westinghouse Lamp Company. No. 1,752,747.

Leakage preventer. Vacuum tube containing an alkali metal current conductor sealed into the tube and the coating of an inorganic salt containing oxygen on the interior surface of the envelope between the current conductors. Earnest A. Lederer, assigned to Westinghouse Lamp Company. No. 1,752,748.

Transformer-coil process. Process for the manufacture of coils comprising a fibre absorbent core tube, and a coil of wire thereon. Prior to winding the core it is treated with a liquid having the characteristic when solidified of being impervious to hot impregnating liquids. Marshall Barnum, New Haven, Conn., assigned to the Acme Wire Company. No. 1,751,971.

Radio inductance. A tubular form machined to a pre-determined diameter, with a number of apertures at one end and at least one aperature at the other end for the conductors. Robert C. DaCosta, assigned to Atwater Kent Manufacturing Company. No. 1,751,854.

Variable coupling device. Mechanical method of varying coupling between primary and secondary of a radio frequency transformer. Lloyd A. Hammarlund, Rockville Center, N. Y., assigned to Hammarlund Manufacturing Co. No. 1,753,182.

Vacuum-tube wire. Composite metal, comprising an alkaline metal with a magnesium coating, the alkaline metal being more readily oxidizable than the magnesium, and both metals being capable of acting as "getters." William Andrew Ruggles, assigned to the General Electric Company. No. 1,752,813.

Purifying rare gases. Method of purifying rare gases by passing an electric discharge through the gases which are in a proper container. Richard E. Miesse, assigned to New Process Metals Corporation, Newark, N. J. No. 1,753,298.

Inductance system. Method of connecting water supply to a transmitter inductance for cooling purposes. Louis A. Gebhard, assigned to Wired Radio, Inc. No. 1,753,408.

Electrolytic condenser. The well-known electrolytic condenser. Samuel T. Woodhull, assigned to the Amrad Corporation. No. 1,753,912.

Vacuum tube. Apparently a construction patent defining methods and position of placing the various elements to attain rigidity. Ernest Yeoman Robinson, assigned to Metropolitan-Vickers Electrical Company, Great Britain. No. 1,754,120.

Vacuum Tubes

Vacuum tube. A tube comprising an evacuated container, a conductor through the container comprising several parallel elements about the conductor, and an anode in the form of a revolute about the cathode and a means whereby a current different in value from the current may be supplied to the conductor. Wm. E. Powell, assigned to General Electric Co. No. 1,751,418.

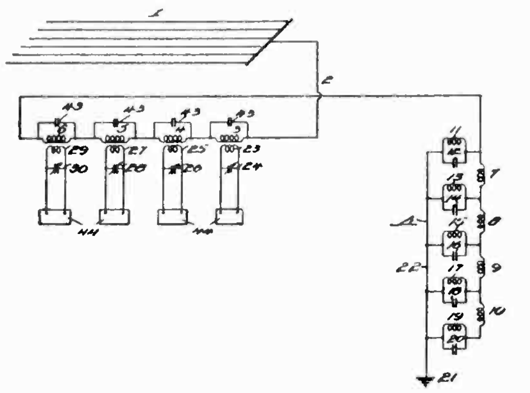
Cathode-ray oscillograph. Cathode ray tube, provided with a screen at one end, having a curved surface whose curvature is such that at least one plane intersection thereof will lie in a straight line. Ralph Bown, Maplewood, N. J., assigned to A. T. & T. No. 1,750,661.

Control apparatus. A combination of an electrical circuit and an electron-discharge device with anode and cathode heating circuit. A method is provided for disconnecting the heating circuits and maintaining them disconnected for a predetermined interval of time. Adolf Waltemath, Oberschoneweide, Germany, assigned to General Electric Company. No. 1,751,374.

Vacuum tube. A tube in which the pulsations in the filament voltage can be balanced out by means of a direct current connected between the mid point of the filament and the mid point of a high resistance connected across the two filament terminals. Charles F. W. Bates, Cleveland Heights, Ohio. No. 1,753,260.

Relay system. A relay connected to a glow tube arranged to transmit current only at a voltage exceeding that of the supply system. Franz Hirt, Berlin, Germany, assigned to G. E. Co., No. 1,751,330.

Signaling system. In the plate circuit of a vacuum tube are two inductances connected in series acting as a primary of a transformer. The secondary of the transformer is connected to a succeeding vacuum tube and has several sections so connected to the primary that a second voltage is built upon the grid of the tube in phase. Anatol Gollos, Chicago, No. 1,751,081.



Radio receiving system. Multiplex radio receiving system consisting of an antenna in series with a number of tuned circuits. A number of receivers each tuned to a frequency corresponding to one of the tuned circuits in series with the antenna picks up the desired signal whence it is detected and amplified. Louis Cohen, assigned to Federal Telegraph Company. No. 1,753,308.

Projection and Recording

Recording apparatus. A method of modulating a light beam and reflecting it onto a photographic film. Roscoe Royal, Chicago, Ill. No. 1,750,863.

Photographic apparatus. A method of producing distorted pictures of an object by placing a refractive distorting element in front of the lens of a camera. George W. Ford, Brighton, England, assigned to H. G. Ponting, London, England. No. 1,750,883.

Color photography. An optical method for producing color pictures consisting of a mirror partly light impervious and lenses arranged so that two paths are provided for the light to reach a film. One path receives the rays reflected from the mirror while the other path receives the rays transmitted through the mirror. After transmission through the optical system, the rays are turned into parallel halves, registering with the two halves of a film. Karl Martin and Paul Pietee, Rathanow, Germany. No. 1,752,680.

Color film. Multi-color picture-positive having four component images in two half pictures, supporting layers, etc. John Edward Thornton, assigned to John Owden O'Brien, Manchester, England. No. 1,753,140.

Projector. A combined prismatic and cylindrical lens designed to shift decentered images so that they will be projected on the center of the screen and then spread to cover the entire screen. Andrew J. Timoney, assigned to Harold Williams & Gus Durkin. No. 1,753,222.

Sound-recording system. The sound vibrations after being amplified by a vacuum tube amplifier, are passed to the coils of two electromagnetic devices in series. These devices actuate diaphragms which in turn control a light shutter and thereby affect the quantity of light flowing from a light cell onto a moving film. Freeman H. Owens. No. 1,753,530.

Power and Oscillatory Circuits

Oscillatory circuit. An inductance consisting of wire wound on a core of nickel iron, so constructed as to reduce any current losses to a low value is in series with a circuit tuned to the desired signals of a given strength. When the signal strength increases beyond this value the inductance of the nickel iron core coil changes to such an extent that the circuit is no longer resonant. Alexander Meissner, Berlin, Germany. No. 1,751,592.

Electric-discharge producer. A device for producing a current of constant intensity at pre-determined small duration having a range of less than one one-hundreth-thousandth second to several seconds duration. Two condensers are connected in series and a battery is across the remaining terminals. Across each condenser is a resistance. A method is provided for suddenly producing in the circuit a voltage having a predetermined value and decreasing afterwards according to an exponential law to a second pre-determined value. These voltages are impressed upon the grid circuit of a vacuum tube whose plate current falls to zero during the exponential decrease of voltage. The plate potential of the first vacuum tube is impressed upon the second vacuum tube. Leon Nicolas Brillouin, Paris, France. No. 1,752,228.

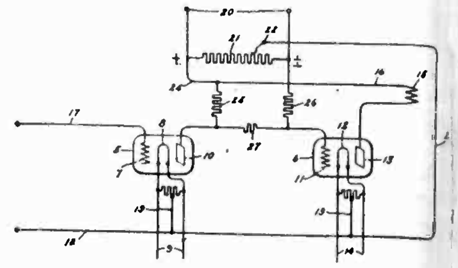
Power-converting apparatus. Two electric valves, a capacity and charging circuit, including one of the tubes and a capacity discharging circuit including the other vacuum tube. An alternating-current circuit is common to the charging and discharging circuits and a means is provided for successively changing the conductivities of said tubes. Alan S. Fitzgerald, Schenectady, N. Y., assigned to General Electric Company. No. 1,752,247.

Power-converting apparatus. Two vacuum tubes and an oscillatory circuit including inductances and capacitances connected in series with one another, and provided with opposed terminals. A direct current circuit is connected between these opposed terminals through one of the tubes and through a means of subjecting the other vacuum tube successively to the resultant difference between the inductive and capacitive voltage drops of the oscillatory circuit and to the resultant sum of the voltage drops. Camil A. Sabbah, assigned to General Electric Company. No. 1,752,205.

Oscillation producer. A static transformer, a rectifier, a discharging air core transformer, a condenser and a method for increasing and decreasing the electomotive force from the rectifier in a rhythmical fashion. Julienne Beaumont and W. H. Blum. No. 1,752,632.

Tube Applications

Picture-transmission system. Light sources are arranged in spiral formation about a scanning disk. The disk is rotated in synchronism with a similar disk at the transmitting station. The received signals are connected to corresponding light on the rece[...] disk by means of a commutator arra[...] ment. The lights on the receiving [...] are permanently biased by means [...] battery to eliminate the effect of la[...] the periodic flashing of these li[...] Fred Schroeder, Berlin, Germany. 1,751,606.



Amplifier. A direct coupled ampli[...] comprising two tubes and a resiste[...] net-work between the grid and plate. potentiometer with variable tap c[...] nected to the filament of the tube [...] sures the proper voltage relation betw[...] the grid of the second tube and the pl[...] of the first. Paul C. Gardiner, assign[...] to The Gardiner Company, No. 1,752,8[...]

Movement and position detector. Sy[...]tem by which a moving object can ha[...] its position and movement determin[...] at a distant point. At the observi[...] station, a frequency is generated; b[...]tween the fixed and moving statio[...] other frequencies are transmitted who[...] phase bears some relation to the fr[...]quency generated at the observing st[...]tion. The phase of the frequen[...] generated at the observing station [...] compared with the phase of a frequen[...] which has been shifted in phase by tran[...]mission. By changing the effective pha[...] of one of the waves with respect to t[...] other, a measurable instantaneous chan[...] of direction is noted and thereby da[...] are obtained from which the distan[...] between the fixed station and the movin[...] object may be determined. By makin[...] similar observations from another fixe[...] station, the absolute position of the mo[...]ing object may be computed. Estill [...] Green, East Orange, N. J., assigned t[...] A. T. & T. Co. No. 1,750,668.

Picture transmission. A method [...] transmitting a picture having sever[...] shades by selecting the respective shade[...] transmitting code signals for thes[...] shades and causing a record to be mad[...] of the shades as determined by the cod[...] signals. Ernst F. W. Alexanderson, as[...]signed to General Electric Compan[...] No. 1,752,876.

Amplifier. Circuit composed of sev[...]eral three-element vacuum tubes and [...] vacuum tube rectifier and low pass filte[...] The amplifier tubes are apparently con[...]nected in what is popularly know[...] to-day as a direct-coupled circuit. Harr[...] Nyquist, Milburn, N. J. Assigned t[...] A. T. & T. Company. No. 1,751,527.

Transmission apparatus. Apparatu[...] for locating the direction of a sourc[...] of sound composed of a pair of soun[...] detectors and a pair of transmittin[...] devices connected by a pair of transmis[...]sion lines. One of the transmission line[...] is varied to compensate differences [...] time of arrival of a sound wave at th[...] sound detectors. Also a means fo[...] indicating the direction of the source o[...] sound. Frances A. Hubbard, assigne[...] to Western Electric Company, N[...] 1,752,528.

Antenna Coupling Systems

(Continued from page 84)

ype of transformer employed). The coupling co- ent was as high as 40 per cent and it was necessary sort to very tight coupling in the antenna stage der to get better transfer of signal voltage at long s. This tight coupling, however, was very unsat- ory at short waves. In the first place, the capacity cted from the antenna circuit into the secondary was eat that it was not always possible to tune the first down to 1500 kilocycles. In the second place, the ng due to the antenna, and the dielectric loss be- the primary and secondary were both increased, ting in very poor selectivity characteristics for the stage. It was, therefore, necessary either to reduce oupling by reducing the primary turns by means of on the primary, or to shorten the antenna elec- y by the use of an antenna series condenser. The f a single antenna connection was therefore not actory over the entire frequency band.

e performance of the tightly coupled antenna trans- er with low primary impedance is shown by the voltage gain curve, Fig. 7, and band widths in the s and Table I. The transformer consists of 78 of No. 30 enamelled wire space wound on a 2¼ in. with a primary of 18 turns of No. 30 enamelled wire. wound, and .010 in. spacing between it and second- The gain starts falling above 1000 kilocycles due to na loading and dielectric loss in the transformer. w 1000 kc. the gain falls due to a reduction in ge transfer with falling frequency.

hile the gain in this type of transformer is satisfac- its selectivity characteristics at short waves are not. ad width of 92 kc. at 1200 kc. is very poor, and is o antenna loading and excessive dielectric loss re- ing from too tight coupling. The coupling also pro- s the use of this system in a unicontrol set.

e loosely coupled transformer with low-impedance ary overcomes the disadvantages enumerated above. educing the coupling to about 10 per cent the antenna ion is made less and loading and dielectric loss are ced to a point where they are not objectionable. performance of such a transformer is shown in the appropriate curve of Fig. 8. This transformer consists of 100 turns of No. 28 enamelled wire close wound on a 1¼ in. tube, with a primary of 10 turns of No. 28 enamelled wire close wound and spaced .010 in. above secondary. Due to the very loose coupling the long-wave gain has dropped considerably. It is therefore necessary to employ interstage r.f. transformers having high long-wave gain in order to equalize the over-all gain curve. The selectivity characteristic at 1200 kc. is 42 kilocycles, which is a satisfactory figure. The curves in Fig. 8 show what happens as the coupling is still further reduced. The long-wave gain is reduced considerably as is to be expected. Table II shows the improvement effected in selectivity with this reduced coupling. It is possible to utilize this loose coupling and still obtain uniform gain over the frequency band by the use of interstage transformers in which the short and long-wave gain are independently controlled, in this way securing all of the advantages of a very loosely coupled antenna circuit for unicontrol sets.

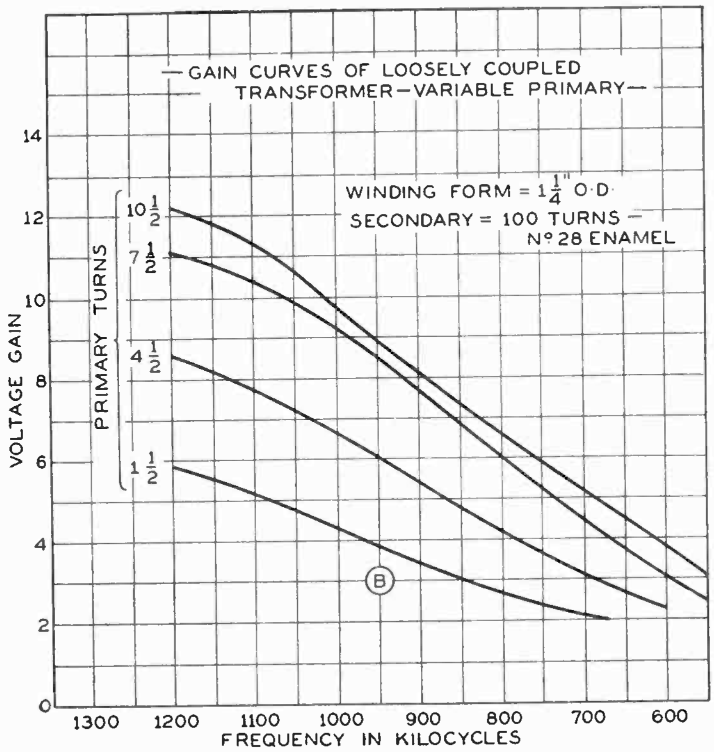


Fig. 8—Relation between frequency, voltage gain, and primary turns is shown in the above curves.

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Adjudication of the oscillating-tube patents

itor ELECTRONICS:

Ve have been interested in the first e of ELECTRONICS and wish to con- tulate your organization on the very job that has been done on this er. We believe that this magazine l answer very well in keeping engi- rs interested in "electronics" in ch with new developments.

n the April issue, however, in an icle by Mr. S. M. Kintner, we would e to call your attention to the state- nt by him, which follows:

"E. H. Armstrong discovered the feed-back circuits and proved that the audions could be made to generate oscillating currents of nearly any desired frequencies. The Armstrong discovery stimulated a new interest in the audion which was at once recognized as offering the best opportunity for getting continuous-wave generators to displace the old damped-wave types for radio sending stations."

The final decision in the controversy between the Westinghouse Electric & Mfg. Co., owners of the Armstrong applications, and the DeForest Radio Company, owners of the DeForest oscillating audion patents was given by the Supreme Court of the United States on October 29, 1928. This decision stated that the DeForest patents, 1,507,- 016 and 1,507,017 were held to be valid and the Armstrong interfering patent was wiped out. These two particular patents cover any form of oscillating circuit.

ALLEN B. DUMONT,
Chief Engineer, DeForest Radio Co.

▲ ▲ ▲

Building an engineering organization

[*Continued from page 64*]

for he has developed the "work-habit" that many men lose in four years of care-free college life.

Unexplained gaps in a man's employment record are usually worthy of investigation, particularly if the applicant has been out of college several years.

For commercial or other work requiring outside contacts, personal appearance is often considered important, as the customer must depend upon first impressions. For laboratory work, particularly research, appearance is of secondary importance, although untidy dress by no means indicates an abstract thinker.

In addition to electrical engineering graduates, physicists and chemists are required for research and development work; mechanical engineering graduates for design and factory problems, and business administration students for commercial, general office, and legal work. All of these students go through the same general training course, spending the first year on six assignments of two months each, in several different sections of the engineering department, to obtain a broad foundation and perspective for their future work. The second year is divided into two assignments in the general type of work for which the student is best fitted, after which a permanent assignment is made. During the first th years students attend regular classes and lectures, dur working hours, and after the first year may enroll approved courses, leading to an additional degree, at of the nearby colleges.

To assist students in choosing the work for wh they are best fitted, an advisor is assigned to every or eight men. He is also able to advise them on ot matters, and help them get acclimated to their n environment.

As the organization expands or a new problem occu an additional section is formed, headed by the best m available in the organization. Vacancies and addition requirements are filled from the junior engineers a from the student course. Ability, initiative, characte and personality all have more weight than length service in considering a man for promotion, and man positions of considerable responsibility are now held b young men, with only a few years' service. While t engineering organization is made up of several function divisions, the personnel of all divisions is considere when a vacancy occurs. It is, therefore, necessary to a man to be well informed in several related fields, an to maintain a broad, coöperative viewpoint.

[An additional article by Mr. Baker on engineerin personnel management will follow in the June issu of *Electronics*.]

Development of insulation materials

[*Continued from page 73*]

pends to a considerable degree on the hysteresis and leakage losses both of which are lower than for the usual compositions.

The mechanical strength of these materials varies somewhat with the changes mentioned above but is in general very high in compression, somewhat less than that of standard compositions in tension and bending, and materially lower in shock. The last must be allowed for when designing parts which are to endure violent treatment. The mechanical strength may be increased by alteration of the proportions of the flaked mica filler and the fibrous filler (silk or cotton), without greatly damaging the electrical quality of the material.

The performance in moulding is normal. The usual moulds may be used in the usual presses. Intricate parts have been moulded without incident, inserts behave as usual, and details such as threads on coil-forms or lettering on the piece come-up as usual. Dimensions may be held as closely as with standard compositions.

The dielectric constant is about 5.9 and remains fixed with time. The power factor does not stay constant but for a time *decreases* slowly.

R-29 can be shaped readily by either wet or dry grinding and takes a good surface under such working. When machined with cutting tools there is some tendency toward chipping unless a light cut is taken. It may be drilled readily and cleanly, and most of the forms used in radio may therefore be produced readily and with entirely satisfactory surface. The color is that of ochre, some variation of shade being possible through alterations of composition and heat treatment during moulding.

A tuned circuit may be improved materially by the use of such an insulation. This can best be shown by examples.

If a tube of the 199 type were to be operated with a coil shunted by 90 micromicrofarads of tuning capacity we would find results about as follows by merely changing the material of the tube base:

	Normal Bakelite	*R-29*
Capacity of tube base	1.6 mmfd.	1.1
Equivalent series R in tuned cct.	5 ohms.	1.5 ohms.

The resistance of the accompanying coil, which was of good design as to form of coil and spool, was about 15 per cent lower when using the R-29 form at 300 meters and about 25 per cent lower when using it at 200 meters.

The tuning condenser is a less promising point of attack. In some of the older designs, using insulating end-plates, the radio-frequency resistance was reduced as much as 10 or 12 ohms by replacing other compositions by the low-loss material. In the newer designs less insulation is used, and it is placed more carefully. As a result the reduction to be expected is frequently not over an ohm.

In typical cases the reduction of equivalent series resistance for the tuned circuit as a whole, for modern tubes and construction, may be expected to fall in the vicinity of 5 to 15 ohms if normal insulations can be replaced by a low-loss material. The value of such an improvement must be judged for each case and a general statement cannot be made.

The requirements of a transmitter are basically the same as those of a receiver but are more severe because of the higher electrical field intensity and necessity for greater mechanical strength. Transmitter construction is such that the insulating members are not necessarily mouldings but may be manufactured conveniently from sheet, rod, and tube.

A molded material with such a combination filler as has been described is applicable to transmitting practice, where "low loss" is equally appreciated.