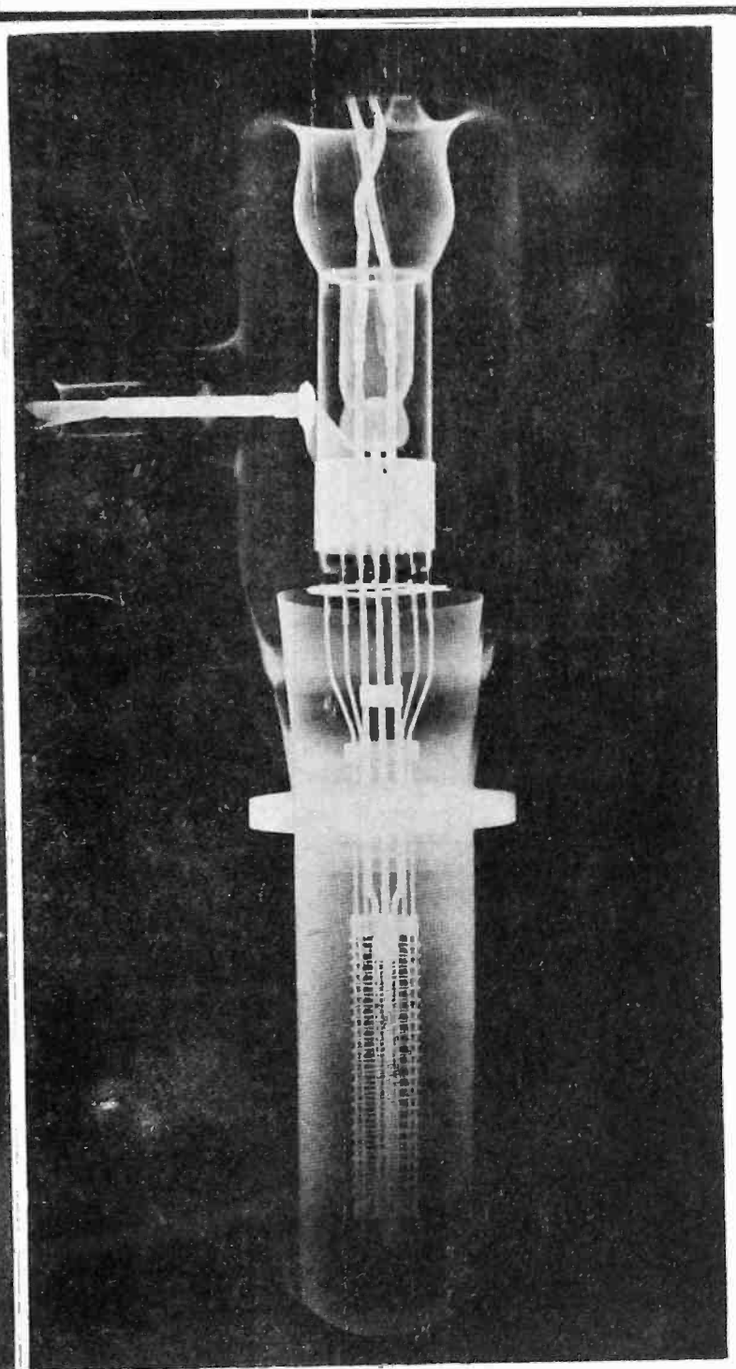
electronics

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



A large broadcast tube X-rayed for inspection

▼ ▼ ▼

A McGRAW-HILL PUBLICATION

Price 25 Cents

OCTOBER 1930

electronics

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Contents for October, 1930

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A McGRAW-HILL PUBLICATION

New York, October, 1930

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he march of the electronic arts

da widens dcast band to 520 kc.

Canadians have come forward a new idea—one which may a radical change in the whole th American broadcasting. Act- rough the proper diplomatic ns, the Canadian radio officials declared their intention of g the present broadcasting band ude the frequencies of 540, 530 0 kilocycles. This will bring sting within a few kilocycles of S ship-calling channel at 600

pening up some of the longer s—presumably for ultimate high broadcasting in the Dominion, ose waves are most suitable for ower—the Canadians hope to me to some extent the disparity ists between the United States anada in the division of the number of channels available now. At present, Canadian asting stations have the exclusive six and the shared use of 11 al of 17), out of the total of 96 ls in the broadcasting band from 1,500 kilocycles.

y modern sets already can tune longer waves immediately be- the 550-kilocycle dialing limit.

✦

atomic theory ented by Dr. Dirac

. M. Dirac, a young Cambridge ist, presented a new atomic theory the British Association for the cement of Science, September 9, in the opinion of some of the ost scientists of Britain, upsets all t concepts of space and matter. repared the following summary of ndings, admitting that they change ted theories:

"It is believed all matter is built up from the two elementary kinds of particles, the electron and the proton. Recent theoretical work seems to suggest that these two kinds of particles are not independent and that actually there is only one fundamental kind of particle in nature. The quantum theory of the electron, combined with the principle of relativity, shows there must be states for the electron in which its kinetic energy is negative—and is less the faster the particle moves—in addition to the usual state in which its energy is positive.

"To give a physical meaning to these negative energy states, we must assume that they are nearly all occupied by electrons with just one electron in each state, in accordance with the exclusion principle. We can then interpret the unoccupied negative energy state as protons. They will appear to us as things with a positive energy and also a positive charge.

"There are certain difficulties in the theory which have not yet been removed. They are, firstly, the great difference in the masses of the proton and the electron, and secondly, the fact that the theory predicates that electrons and protons will annihilate one another at a rate which is much too great to be correct. These difficulties are perhaps due to the fact that the interaction between electrons has not yet been properly taken into account."

✦ ✦ ✦

CAMDEN FACTORIES BUSY; THREE SHIFTS DAILY

To celebrate "Back-to-work Week" and the increase in RCA-Victor's payroll from 4,000 to 22,000, Camden paraded and the following notables spoke. Secretaries Lamont and Davis, Owen D. Young, David Sarnoff, and E. E. Shumaker

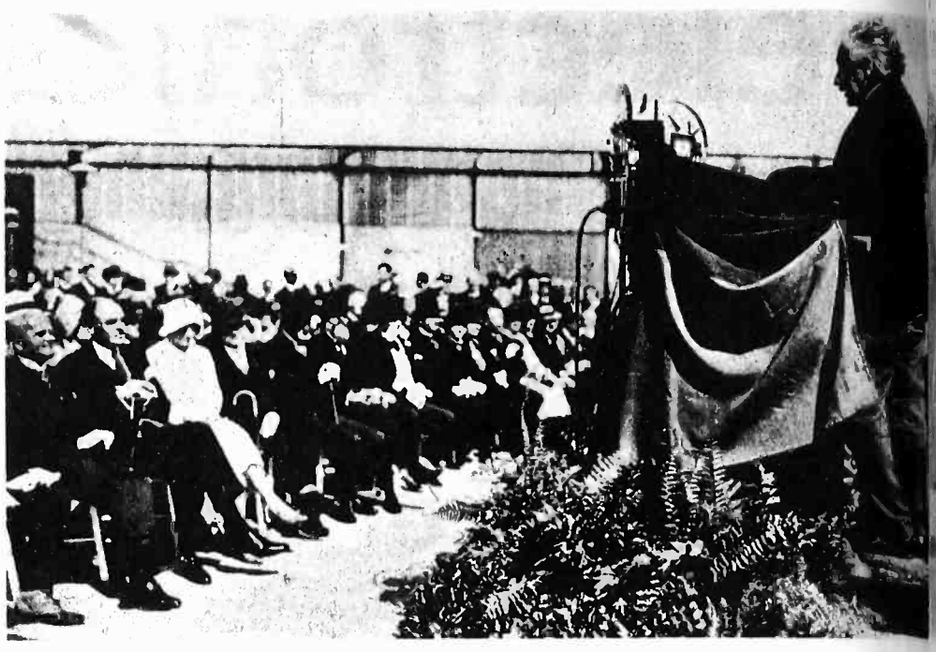
Pasadena scientists produce, 600,000-volt X-Ray

A new giant X-ray tube which its designers believe will possess healing powers which cannot be surpassed even by use of radium has been developed at the California Institute of Technology, as announced Sept. 15. The tube, measuring 10 ft. in length and 12 in. in diameter, was designed and developed by Dr. C. C. Lauritsen and his associates. Dr. Robert A. Millikan, noted physicist, acted in an advisory capacity. Dr. Lauritsen stated the tube produces X-rays at more than 600,000 volts.

In an appeal to physicists to devise a more powerful X-ray tube, Dr. Rollin H. Stevens of Detroit, secretary of the Radiological Research Institute, recently said: "We now produce X-rays of from 6,000 to 250,000 volts and if we went to 300,000 or 400,000 volts we could get practically 'radium rays' from an X-ray tube, and we know results would be much better. But we cannot go that high for we lack the tubes to stand it."

✦

EINSTEIN SPEAKING BEFORE BERLIN RADIO SHOW



This noted scientist, expounder of the theory of relativity and who recently submitted a new paper on the Field Theory, is shown addressing the radio show held at the Kaiserdamm

✦ ✦ ✦

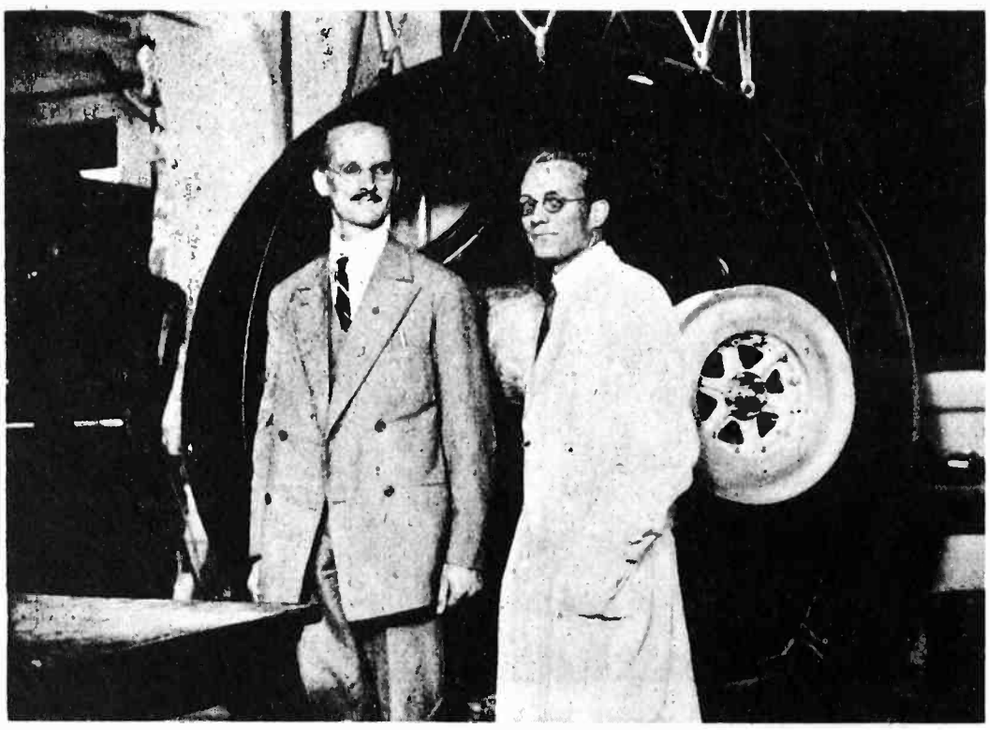
Superpower synchronism planned by KDKA and WGY

With KDKA, Pittsburgh, about to go on the air in after-midnight tests with 400,000 watts of power, Station WGY, Schenectady, revealed plans to resume its experiments with 200,000 watts in similar tests when it applied to the Federal Radio Commission for a renewal of the experimental license of W2XAG, the auxiliary of WGY. The superpower would be resumed on the frequencies of 550, 660, 790, 1,150 and 1,500 kilocycles. The 400,000 watts of KDKA and the 200,000 watts of WGY are the highest power, so far as any records reveal ever attempted by broadcasting stations anywhere in world.

Almost coincidentally with the W application, the Commission receiv request from the Westinghouse pany for a modification of the ex mental license of W8XT, the auxi of KDKA, to permit simultan operation with WEAF, New York, WGY, Schenectady, during the h of 1 a.m. to 6 a.m.

✦ ✦ ✦

PLANS TO RISE 52,000 FEET IN BALLOON



Professor Auguste Piccard, physicist of Brussels University, will attempt to obtain measurements of radio activity and ionization of the air at a record altitude of 52,000 feet

✦

German collection of historical sound films

The Tonbild-Syndikat A.G. (To in co-operation with German offi plans to create a permanent colle of sound films, which will includ the important personages of co porary history.

With the full support of al official departments concerned, the will be made under the directi Rudolf Schwarzkopf of the Mel Film Company, a subsidiary o Tonbild-Syndikat. They already i an important representative of pr day German political life as well large number of scientists, techn and artists.

Some of the films already pla the permanent collection inclu address on "Germany as a unified by Dr. Otto Braun, Presiding C Minister; Dr. Hans Bredow, Sec of State, who talks on "the miss radio in bringing the nations world together" and a talk by Dr Planch, Privy Councillor.

rnment's anti-trust suit oned until December

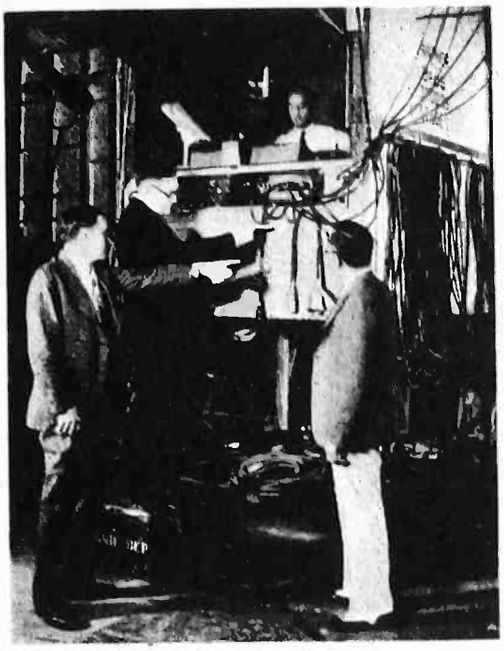
government's anti-trust suit the Radio Corporation which the docket for September 9, n postponed until the December The continuance was granted J. S. District Court at Wilming- the request of counsel for the nts because they desire more take depositions of witnesses. vernment's petition in equity d May 13. Just a week before, 6 RCA stockholders voted an in the corporation's common affect the consolidation that ive General Electric and West- e more than 50 per cent of all ling RCA stock and complete of the Radio Corporation in for all properties and facilities G. E. and Westinghouse in the ture of radio apparatus. This all the stock of RCA Photo- RCA Radiotron, RCA Victor k in General Motors Radio Cor- owned by the two companies e subsidiaries, General Electric and Westinghouse Radio, also t to use all existing and future of the primary defendants use- the manufacture of radio ap-

transfer, according to the gov- t, which is intended to perfect ke more permanent the alleged ly in radio equipment, was con- ed prior to the legal action y the Department of Justice but ernment's intervention has had ect of forestalling issuance of A stock.

defense of RCA and the other defendants rests upon the con- that their policy and perform- the past ten years, instead of ing competition as charged by vernment, has tended to promote ition in the radio industry. It ed in the first instance, that the of establishing modern radio necessary the pooling of the , patent rights and inventive of the laboratories of General c, Westinghouse, A. T. & T. and n Electric.

Radio Corporation and the other ants to the government's suit in their answer ownership and l of more than 4,000 patents but leny that the cross license agree- have had the effect of creating nopoly. It is contended that by g licenses to 43 competing manu- ers of receivers and 15 manu- ers of tubes that the defendants courted competition from those they claim had previously been ging on their patents. Royalties ed by the Radio Corporation last totaled $7,000,000 but the cor- ion maintains that licenses were ed on reasonable terms.

ARMY SOUND PICTURES



Colonel Prosser of the U. S. Army and other officers are to receive training from sound technicians in Hollywood in making talking pictures of field maneuvers for officer instruction

✦

To sink battleship Utah while under radio control

Naval warfare of the future, in which radio will perform the duties of officers and crews in the handling of "manless" fighting ships, will be demonstrated some time after October 1, when the United States Navy sinks the battleship Utah in compliance with the terms of the London naval treaty.

Naval operations have ordered the Utah equipped with the proper radio facilities to conduct experiments which include the use of the vessel as a gunnery target. A similar experiment, with radio controlling all the movements of a target ship, was conducted by the Navy in 1922 when it sank the battleship Iowa, off the Perlas Islands, Canal Zone, under the Washington treaty.

Several years ago, the Germans demonstrated how a ship without anyone aboard could be guided and operated entirely by radio. Similar experiments have been undertaken with aircraft.

✦

New Aero radio stations authorized

Aeronautical Radio, Inc., the co-operative communications subsidiary of the leading air transport lines, of which Herbert Hoover, Jr., is president, has been authorized by the Federal Radio Commission to erect aviation radio stations at Newark, Camden, Pittsburgh, Harrisburg, Columbus, Indianapolis, Springfield, Mo., Robertson, Mo., Wichita, Kan., Amarillo, Tex., Alburquerque, N. M., Las Vegas, N. M., Salt Lake City and Los Angeles.

✦ ✦ ✦

ELECTRON TUBE PROTECTS SHOWCASE

This new and scientific burglar alarm uses a grid-glow tube as a silent and invisible electric watchman. The tube when adjusted in the apparatus is so sensitive that the presence of a human being at a predetermined distance operates an alarm relay

Electronics in Surger

A bloodless operation. How the "radio knife" works—

Carrying high-frequency current (300,000 to 2,000,000 cycles per second), an ordinary cambric needle applied to living tissue instantly produces boiling, due to the high density and slight spark accompanying it. The resulting minute steam explosives separate the tissues, producing a clean cut, as with a knife, but with the advantages that:

1. **The needle sterilizes as it cuts. Subsequent healing is very rapid.**
2. **Lymphatics and capillaries are sealed, so that there is no bleeding.**
3. **Mechanical implantation of malignant cells cannot occur.**
4. **Severed nerve-ends are cooked, reducing post-surgical shock.**

NIKOLA TESLA first introduced high-frequency currents into therapeutics in the United States in 1890,—about the same time as did D'Arsonval in France. Heat has been employed in surgery for many years. An example is the electric cautery which destroys pathological tissues but piles up a mass of carbonized débris around it. After many years of experimentation, Doyen stated before the French Surgical Congress in 1907: "Of all means employed in the destruction of pathological tissues the only *certain* method is that of heat."

High-frequency and other electric currents produce heat in tissues, much as a resistor is heated by an electric current flowing within its structure, but Ohm's law does not hold for tissues where high-frequency currents are involved because of the distributed capacity cells. In medical diathermy, large sections ofte heated, but destructive temperatures are avoided. temperature produced by one ampere of high-freq current flowing in one's wrists very quickly be unbearable. Electrodes of relatively large are employed to keep the current density low where i localized heat is not desired.

In surgical endothermy (which means "heat within") the current density purposely is made so by the use of relatively small electrodes at the points of application that boiling or cooking very results. The greatest current densities occur at points.

An ordinary cambric needle applied to living

. . . THE RADIO KNIFE

CHARLES
INDERHILL

e radio inventor and
sulting engineer

The cutting and coagulating electrodes in use

A portable high-frequency surgical outfit

the proper conditions in- produces boiling, due to h current density and the t spark accompanying it. e resulting minute steam ons separate the molecules tissue, thereby producing a ut, as with a knife, with rther advantages that lym- and capillaries are sealed t there is no bleeding arteries and veins are not tered, and the mechanical tation of malignant cells cannot occur. This knife" sterilizes as it cuts o cooks the severed nerve o an extent which greatly s the post-operative or il shock, and healing is apid. With a properly- ed high-frequency surgical e, a good radio knife, and t technique, the tissue is rned any more than food ned in its proper prepara- y cooking.

ile electrical surgery is le in the treatment of can- is to be understood that it is merely an aid and not -all, although in the removal of superficial and uperficial lesions, electrical surgery is supreme. loody surgeon first cuts out and removes the living with its malignant cells mingling with the blood , to be carried elsewhere in the body, and after destroys it; whereas, the electrical surgeon first ys the lesion and then removes it as a harmless

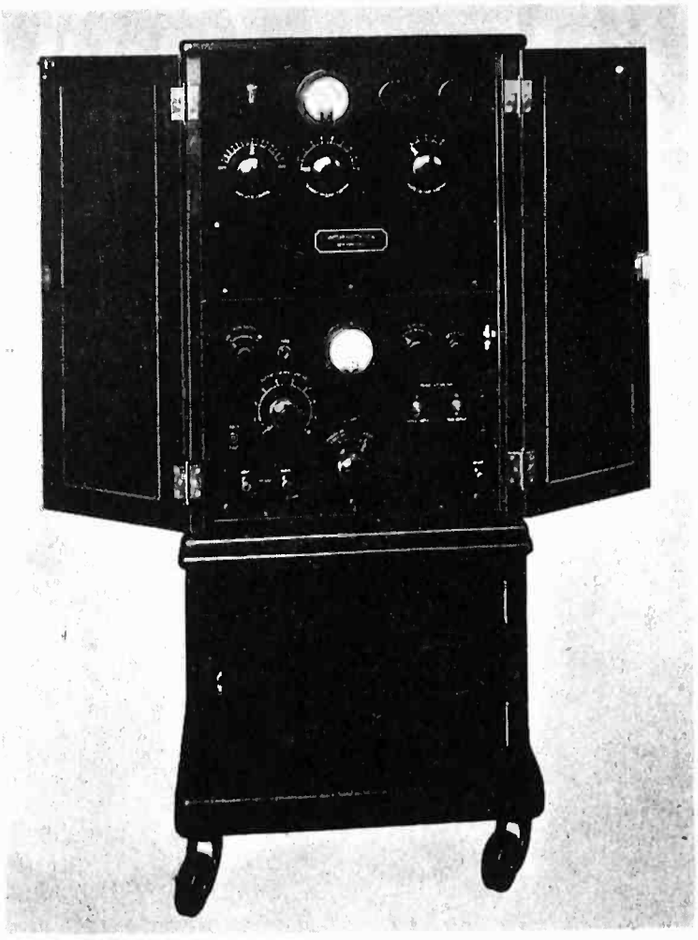
struction is accomplished through electrocoagulation dessication (dehydration or drying). Electrodes ng in size from a needle to an inch or more in ter, and also of various shapes, are used in the process of electrocoagulation so invaluable in the destruction of malignant tissue and in preventing or stopping bleeding. Generally, much stronger currents and greater time periods are required in electrocoagulation than in cutting. When desired, the cutting current may be more or less coagulating also. In both of these general processes, two electrodes are connected to the patient, the "common" electrode, usually attached to the buttocks or extremities, being of large area so as merely to make contact without the production of much heat, while the "active" electrode is the one applied to the place where heat purposely is to be developed. In the treatments of some accessible tumors by electrocoagulation active electrodes are placed on either side of each tumor to obtain the most effective results.

Warts removed by "sparking"

In the process of dessication, which also may be employed to stop bleeding, the needle is held near the tissue to be destroyed and controlled sparks are permitted to pass between the needle and the tissue. The removal of moles, warts, and so forth, sometimes is referred to as "sparking." This dessication current, which is produced by an Oudin resonator or Tesla coil, is "monopolar," the capacity between the patient and the ground sufficing as a return circuit. The machine should generally be grounded.

The three methods naturally overlap to some extent, but the machines comprising all three modalities are given different settings for the three general purposes.

The electrotherapeutist employs almost every con-



The Westinghouse-Wyeth endotherm for electro-surgical operations

ceivable modality in the various forms of direct and alternating currents which are reversed, interrupted, rectified, superposed, given long-period sinusoidal wave forms, and so forth, in the treatments of various disorders. These currents, however, are relatively weak. If they were as strong as some of the high-frequency currents employed they would quickly kill the patient.

The cells of the body are electrolytic in character, so neuro-muscular contraction results to some extent whenever the ions are displaced in the cells. The greater the frequency of the current, the smaller will be the displacement of the ions, with a consequent lessened contraction. Quite recently, however, the writer, in collaboration with a co-patentee, developed a portable set wherein some of the modalities of the contraction type were combined with high-frequency currer there are certain advantages in combining these cu in some cases, but it is generally desirable that frequency physical and surgical diathermy machines be free from any cause of neuro-muscular contra The frequency in both types of machines varies about 300 to 2,000 kilocycles, although very much h frequencies have been produced.

Muscular contraction a drawback

While slight neuro-muscular contraction may n very serious in cases of dessication, or even in el coagulation, it is desirable that no noticeable contr shall be caused by the application of the radio because twitching muscles may throw the knife a large blood vessels or organs which, if cut, might serious consequences. The cutting must be abso under the control of the surgeon. It is what m accidentally cut that makes contraction in cuttir undesirable.

While many wonderful claims have been made f various types of cutting machines, the writer h from hard experience in their development and man tion in operating rooms that many improvements r to be made. While the writer has witnessed high amputations started with competitive machines surgeons soon had to resort to the scalpel becau the contractions of the pectoral muscle that tend force the radio knife against the axillary vessels would produce disastrous results if contact was Some surgeons have placed mechanically-strong ele insulating materials adjacent to large blood vess prevent their being accidentally cut due to neuro-mu contraction.

In an endeavor to be entirely rid of contraction such operations, the writer has placed raw meat mouth in contact with the lips, tongue, gums and and then performed simple simulative operations meat with the aid of a mirror, without feeling the est faradic sensation or any contraction of any Yet when the same machine was used in opening v abdomens, while under the writer's control, no ciable contraction would result in some cases, w some others the contraction would be so great thrust the tissue upward toward the needle, endangering the organs beneath. Most of the p were young, and live, bare nerves were in direct with the radio knife.

In connection with contraction in cutting, it

▼ ▼ ▼

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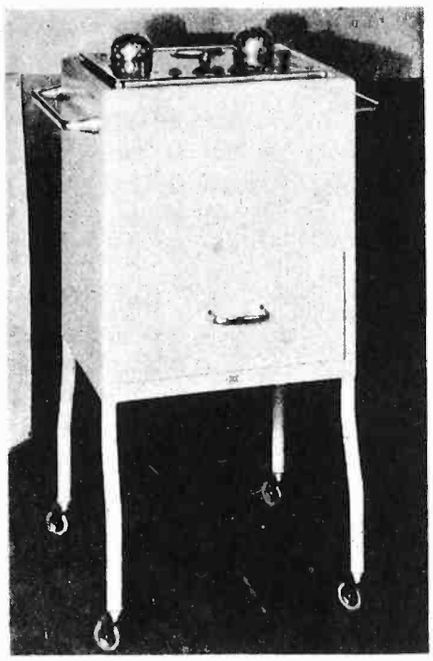
to state here that the cords con-
ng the surgical machines with
atients often are quite long and,
fore, have an appreciable capac-
tween them which varies as the
are placed near, or separated
one another. Furthermore,
one holds the electrodes of a
frequency machine in the hands
omeone interrupts the "patient"
t, a faradic sensation is no-
le.
cutting, the sparking must cause
variations in the electrical con-
s, and when it is considered that
atient circuit is not necessarily
ne with the main oscillating cir-
it is evident that there may be
for contraction under the con-
s usually imposed in operating
. The writer has never seen a
gal machine that was wholly free
contraction, but he has been
f many perfect machines.
ile spark gaps are employed in
oduction of high-frequency currents for cutting as
s for electrocoagulation and dessication, electronic
are preferably used for cutting and certain forms of
coagulation, although the latter and dessication
y are accomplished by spark-gap-produced currents
the same machine containing the electronic-tube cut-
pparatus, through the medium of a switching device
using separate output terminals. In such cases, the
transformer supplies the electrocoagulation and
ation currents while a separate transformer sup-
the cutting current.
e use of electronic tubes is largely limited to work
w power, because of the high cost of the tubes, as
ared with spark gaps, where more power is required.
wtheless, the writer and others have produced some
remarkable results in electrocoagulation, as well as
tting, in co-operation with surgeons in major
tions with electronic-tube machines. The advantage
e electronic tube over the spark gap for cutting
ses is the smoothness (lack of faradic sensation
ntraction) of the continuous-wave output current.
tating neon tube on the shaft of a synchronous
r shows this very clearly.
e spark-gap machine produces damped output cur-
. Furthermore, spark-gap machines require very
input currents as compared with the continuous-
-output electronic-tube-operated cutting and coagu-
machine. The reasons are obvious. The spark
is a spark-frequency and voltage-regulating device.
a given input-frequency transformer secondary volt-
the separation of the spark-gap electrodes requires
her voltage for spark production with a consequent
ction in the number of sparks per low-frequency
because sparking then occurs nearer the peak of
voltage wave.
he number of sparks per second is independent of
frequencies of the supply and output currents when
e is no ionization between the spark-gap electrodes
hat no feed-back can occur. Several sparks occur
ng each half-cycle of the input current. In general,
maximum number of sparks per second is obtained
keeping the spark-gap electrodes close together and



The Grisby-Grunow oscillator for supplying high-frequency power to radio knife

making the capacity of the oscillating-circuit condenser as small as practicable. Lowering the power input decreases the number of sparks per second. But stronger output currents are obtained by separating the spark-gap electrodes, and this increasingly produces neuro-muscular contraction, as well as causing the severed tissue to have a scorched appearance, and the cutting is not so easily accomplished.

Nevertheless, some spark-gap machines produce excellent results and are very compact, portable, and less expensive than corresponding electronic-tube machines. They have the further advantages that they do not have fragile parts, since portable surgical machines sometimes receive rough handling, accidentally or otherwise.

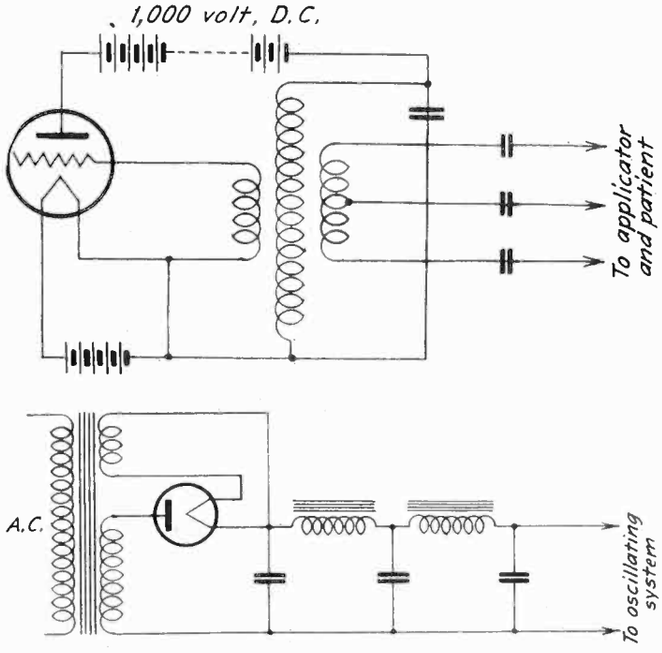
In all machines, whether spark-gap or tube operated, protection always is afforded the patient through highly-insulated inductive couplings, or by the inclusion of condensers in the patient circuit, which also tends to reduce faradic sensation and contraction.

Perhaps the simplest form of electronic-tube cutting and coagulating machine is that schematically shown in an accompanying sketch, wherein a 1,000-volt battery or dynamo is employed. While this may be suitable for hospitals, it is not portable.

The next logical step is to supply this device with direct rectified and filtered current by the well-known arrangement illustrated in the second diagram, which also employs two rectifier tubes so as to utilize both half-waves of each cycle of the supply current.

The arrangement in the third diagram employs either one or two electronic tubes which act both as rectifiers and oscillators.

(*Continued on page 362*)



Above—Circuit of simple electronic-tube device for surgical cutting and coagulating

Below—Source of direct-current supply for portable apparatus

Color definition

By photoelectric measurements

By HAROLD ELLSWORTH and PAUL McMICHAEL*

IN ITS commonly used and accepted sense the word "color" denotes the mental concept induced by incidence upon the retina of the human eye of radiant energy of certain frequencies.

Since time immemorial people have attempted to describe and define their concepts of color by words alone, and to this end have coined a multitude of terms, the meanings of which have not been clearly defined. The difficulties encountered in such attempts are such as might be anticipated if one tried to express mathematical values accurately in any terms other than those of mathematics.

The futility of attempting to define colors in words is clearly indicated when the magnitude of the task is understood.

In his paper "The Development of Thomas Young's Theory of Color Vision."† Selig Hecht states that the normal human eye can separate the visible spectrum into about 180 hues with complete certainty. In other words, the human eye can distinguish this number of *qualitative* differences. Similarly, under favorable conditions the normal eye can distinguish *quantitative* differences, i.e. variations in intensity or brightness, as as 3 per cent, or at least thirty gradations of each

Thus the minimum number of colors distinguis by visual observation of anyone with average ey is more than 5,000, and it is manifestly impossit describe and define such numbers of colors with alone.

Use of physical color standards

In recent years the confusion in color defi has been partially resolved by the use of physical s ards, but in this direction also we are limited b inability to secure permanent reproducible color s ards. To prepare complete sets of physical stan that cover the entire range of color distinguishab the normal human eye is not possible in the pr state of the art. As yet, even after several yea effort and the spectral analysis of many hundre glasses, U. S. Bureau of Standards has not succ in assembling even one complete set, approximately of Lovibond color standards.

The futility of attempting to assemble and use of physical color standards that covers the ran average eye sensitivity is further emphasized whe considers the fact that, even if it were possible t semble such a standard set, there would be no assu that the different colors thereof would remain cor for any considerable period of time. Even such c cally stable substances as quartz are subject to

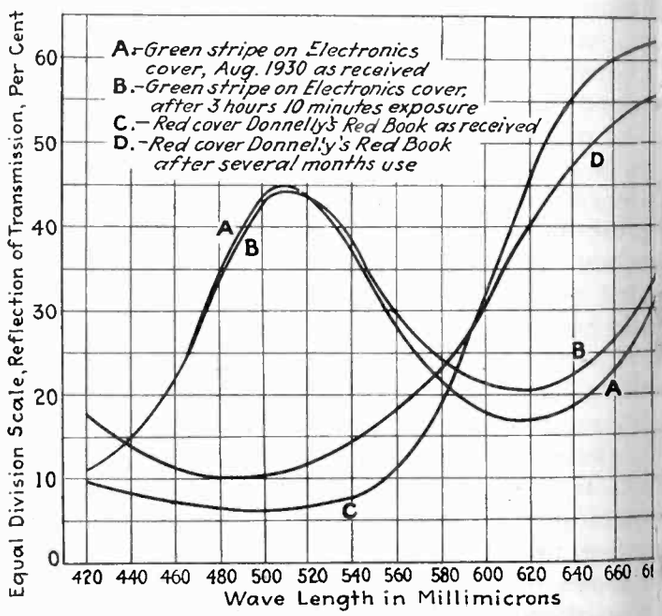


Fig. 1—Effect of exposure to light of colored magazine covers

change, and with materials such as are commonl ployed to impart color, e.g. dyes or pigments u printing inks, these changes are quite rapid.

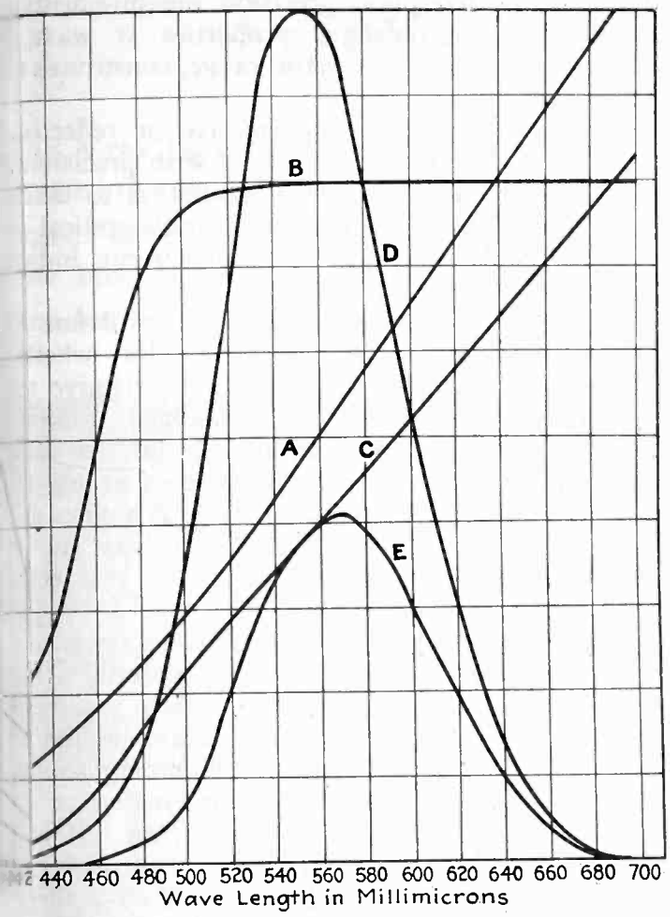
The rapidity with which such changes may oc illustrated by Fig. 1. Here are shown two spect flection curves of the green stripe on the outside cover of the August, 1930, issue of *Electronics*. (A) thereon is the spectral reflection curve of thi when the journal was received and Curve (B) exposure for 3 hours and 10 minutes to direct s on a partially cloudy day when there was some ha

Here, too, are shown two spectral reflection of the outside front covers of two successive iss *Donnelly's Red Book*, the classified directory iss telephone subscribers in many cities. Curve (C)

THE new industrial tool, the photoelectric tube, makes possible the measurement of color with a degree of precision heretofore unattainable, and its application to colorimetry permits precise mathematical description and definition in any convenient terms.

*American Photoelectric Corporation.

†*J.O.S.A.*, May, 193



2—Energy distribution and transmission curves. See text for explanation of individual curves

pectral reflection curve of the cover color of a ssue, and Curve (D) that of the previous issue e later issue was received.

al examination of these curves shows that the distribution has been greatly altered during y short periods of exposure. In fact, the change pectral composition of the green was so rapid as letectable with an A.P.C. photoelectric spectro-eter after an exposure to sunlight of only five ti. If changes of such magnitude occur in such time in materials like these, the likelihood of hange in any colored material over long periods is so apparent as to preclude the use of physical tandards. Because physical color standards are roducible, and especially because they are not ent, and, furthermore, because they are employed ods involving visual observation with its inherent to error, methods of colorimetry that employ do not yield precise data.

rder to arrive at a solution of the problem of e color description and definition it is necessary erstand the mechanism of color vision.

Mechanism of color vision

simplest process by which the sensation of color e induced is that in which the eye directly observes nous body. Here we have a body emitting visible al energy which induces an electrical response in otosensitive substance of the eye. This response ried by the nerve system to the interpretive center brain where it induces a concept of color. Thus, simplest form, a color concept is the resultant of wo factors, (1) the spectral energy distribution of mitted light, i.e. the relative proportions of energy ed at different wavelengths, and (2) the relative response of the photoelectric structure of the eye to the energy emitted at the different wavelengths.

The most common process by which the sensation of color is induced is that in which the energy emitted by the illuminating source reaches the eye only after transmission through, or reflection from, one or several materials, or both. In this process, the color concept is the resultant of three factors, (1) the spectral energy distribution of the emitted light, (2) the light absorption characteristics of the intervening material(s), and (3) the relative eye response to the residuum of emitted energy remaining after transmission through or reflection from the intervening material(s).

The mechanism of color vision is illustrated graphically on Fig. 2 in which

Curve (A) shows the relative spectral energy distribution of a black body at 2800°K—*U. S. Bureau of Standards Miscellaneous Publication No. 56;*

Curve (B) the transmission curve of an Eastman Wratten filter No. K-1;

Curve (C) the relative spectral energy distribution of the residuum of light emitted by (A) remaining after transmission through (B), i.e. the spectral distribution of the energy incident to the eye;

Curve (D) the sensitivity curve of the normal eye as determined by Hyde, Forsythe and Cady—*Handbook of Chemistry and Physics, 1925, page 587;*

Curve (E) the relative response of the normal eye to (C), i.e. to the residuum of light emitted by the illuminating source (A), which remains after transmission through the Wratten filter No. K-1.

Curve (C) is derived wholly by mathematical computation, and it is obvious that, if the spectral energy distribution of any sort of illuminating source is known, these data could be plotted just as was Curve (A), and the relative spectral energy distribution of the light transmitted through the filter could be derived in exactly the same manner as was Curve (C). Thus it may be said that if the spectral transmission or reflection curve of a material is measured with precision, the spectral composition of the light transmitted through or reflected therefrom may be determined wholly by computation in terms of any theoretical or actual illuminating source.

Effect of quality of illumination

At this point it seems desirable to direct attention to one factor in colorimetry which seems not always to be clearly understood. It will be noted on Fig. 2 that the relative absorption of the emitted light by the filter is much greater in the blue than in the red. The resultant

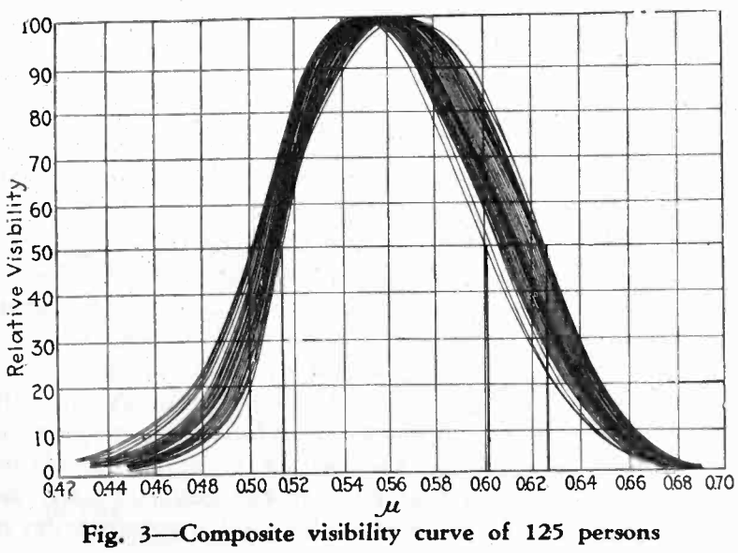


Fig. 3—Composite visibility curve of 125 persons

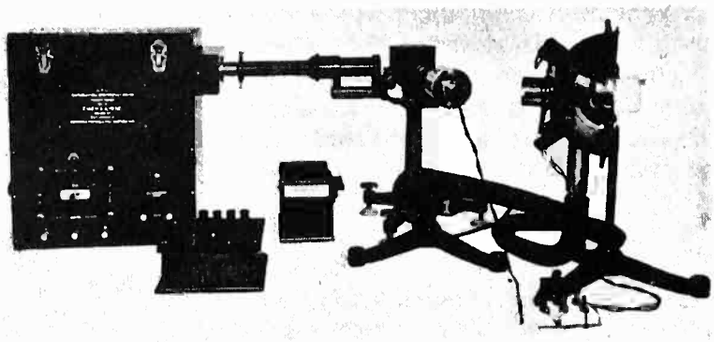


Fig. 4—Photograph of photoelectric spectro photometer for measuring color values

of this is that the light transmitted through the filter contains a greater proportion of red than the light emitted by the illuminating source.

Now if the illuminating source were theoretically pure white, which would be represented by a horizontal straight line, instead of a black body at 2800°K, as represented by Curve (A), it is obvious that the spectral distribution of the light incident to the eye would be represented by a curve coincident with Curve (B), a resultant radically different from that of Curve (C).

Thus it is seen that the spectral composition of light transmitted through or reflected from a material may be altered merely by changing the quality of the illumination. Thus if the inherent transmissive or reflective properties of a material are to be described with precision they must be expressed in terms independent of the quality of the illuminating source.

As a corollary, it must be said that two materials, which appear identical in color when viewed under one illuminating source, may appear unlike under different illumination. However, if the contours of the spectral reflection or transmission curves of two materials are identical, then these materials will always appear alike in color no matter what is the spectral composition of the light under which they are compared.

Variability of human eye

There is another difficulty—variations in the response of the eye. How widely the eye response may vary is indicated by Fig. 3, a reproduction of a composite visibility curve of 125 persons published in *Bulletin Bureau of Standards, Vol. 14.* It will be noted that even amongst this relatively small number of people there were wide variations in eye sensitivity.

It is obvious from data like these that only rarely will any two human eyes respond in identically the same manner and to the same degree to the stimulus of light transmitted through or reflected from a material.

However, Curve (D) on Fig. 2 is a reasonably accurate expression of average eye sensitivity, and because it has been clearly defined mathematically it enables one to calculate the relative response of the normal eye to any known visible energy stimulus.

Curve (E) on Fig. 2 is the final resultant of all factors that is translated into color vision, and it, too, is derived by computation, being the product of Curves (C) and (D).

Thus it is seen that it is not the spectral energy distribution of its illuminating source that establishes the color of a material, nor is it the relative eye response to the energy transmitted through or reflected therefrom. *The absorptive characteristics of the material itself are what determine its inherent color,* and a specification of these, predicated upon precision measurements transmissive or reflective properties at wave throughout the visible spectral range, constitutes a description thereof.

Furthermore, if the transmissive or reflective erties of a material are measured with precision, requires only mathematical computation to define properties in terms of any actual or theoretical sta of illumination, or in any convenient terms indicat human eye response.

On the other hand, when one tries to define so dividual's concept of a particular color, whether one or several of the multitude of descriptive ter by relation to some physical standard, fundam what actually is being sought is a limited expr definite and precise, for the resultant of at least tw tors, and usually three, one of which is always a va because of the differences in sensitivity of re among human eyes, and it is obvious that such is foredoomed to failure.

The essential precision measurements necessary fine the absorptive properties of a material are c iently expressed as a spectrophotometric curve s those on Fig. 1, in which the data are plotted in of a theoretically pure white illuminating source one that emits energy at equal intensities at all lengths throughout the visible spectrum. It is e practicable to measure precisely the absorption cha istics of a material directly in terms of a theore pure white illuminating source so long as the sou illumination actually employed emits energy thro the whole range of the visible spectrum and regard the relative distribution of the energy emitted.

The curves on Fig. 1 are plotted in terms of retically pure white, the necessary precision m ments having been made photoelectrically in terms mathematical standard, so that computation or c sion was unnecessary. Therefore the area abov curve denotes the spectral absorption factor sample, and the area below its reflection factor. F more, the contour of its reflection curve determi relative proportion of radiant energy reflected fr sample at every wave length traversed by the curve it may be said that these spectral reflection cur exact mathematical expressions that describe and the inherent colors of the samples independently factors outside the samples themselves.

Value of exact color description

The data in such a simple spectrophotometric constitute a unique description and definition of and enable one, merely by computation, to expr color or any of its characteristics by any scientific employed for its specification.

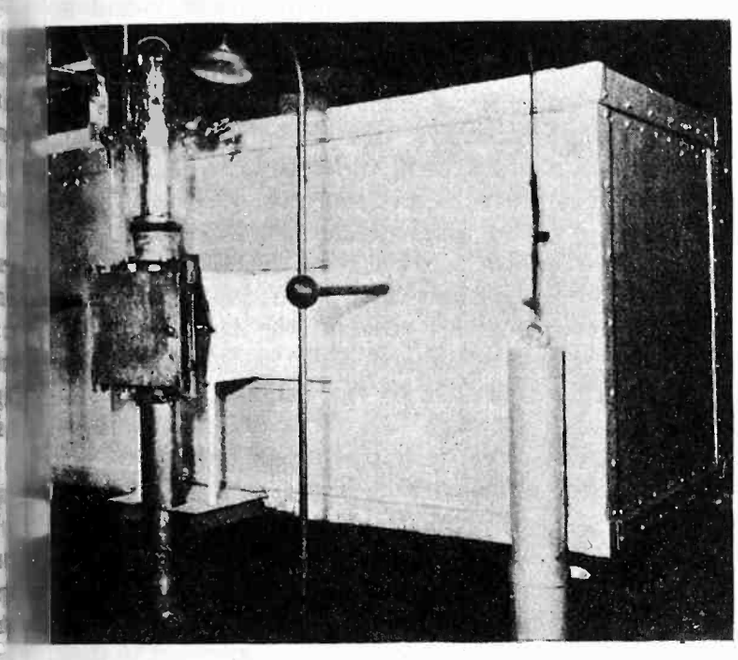
However, while it may sometimes be conver employ some one of these other methods for an sion of the visual appearance of a material under specified conditions, it should be clearly understo for reproduction, such as is necessary if exact m is to be maintained under all conditions, one mu the spectral absorption characteristics of the m and these are fully disclosed only by its spectra mission or reflection curve.

It is possible to reproduce substantially the transmission or reflection curve of a material fr a few accurately measured data, e.g. the spectra

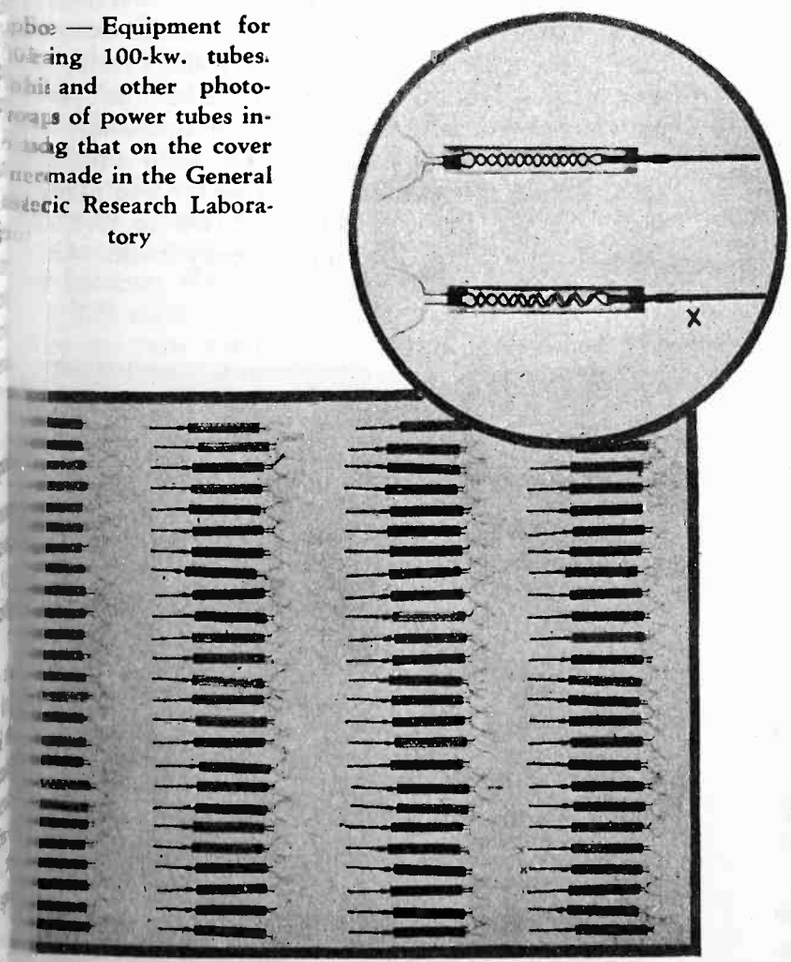
[*Continued on page 360*]

X-rays in Testing Tubes

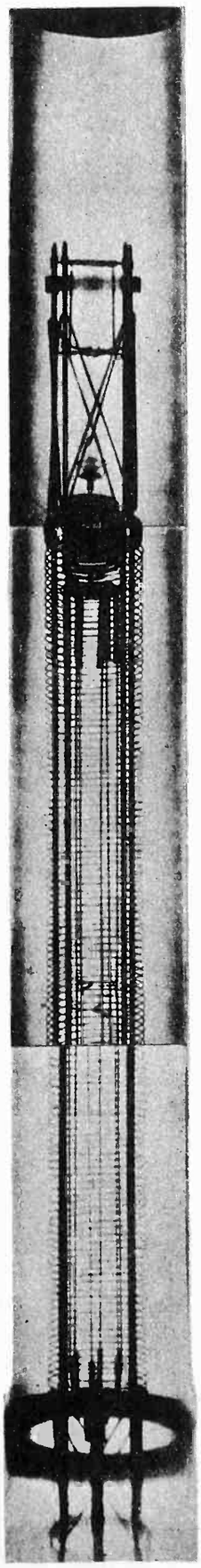
he X-ray tube—an electronic device—may e used to test radio tubes,—themselves elec- onic devices. These photographs show w hidden faults in construction may be vealed by X-rays.



bo — Equipment for ing 100-kw. tubes. and other photo- s of power tubes in- g that on the cover made in the General cic Research Labora- tory

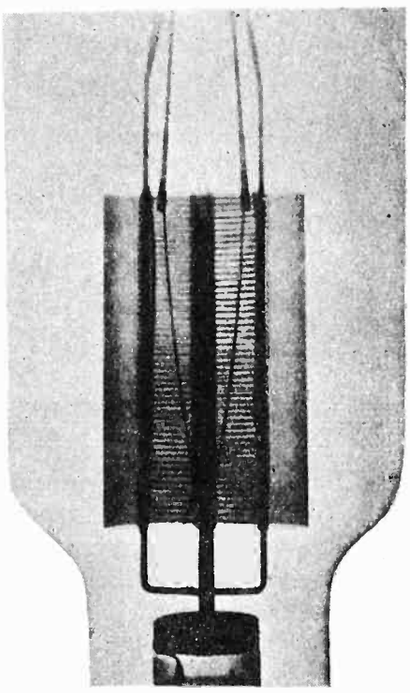


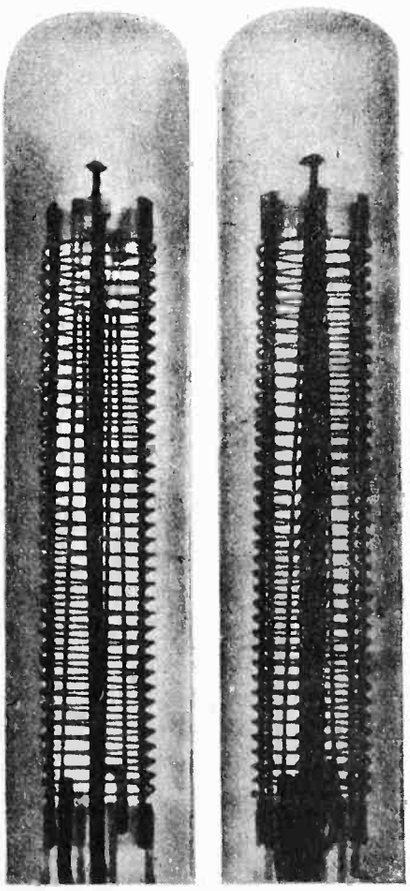
X-ray picture of tray of 100 radio-tube cathodes in Raytheon laboratory. Defectives are marked with an X



An X-ray photo, made in three sections, of a 100-kw. tube

Below—X-ray photo- graph of 250 - watt power tube





Two shadowgraphs of grids in UV-207 (20 kw.) tubes made by X-rays

Some prospects for the electron tube in

Power transmission

By O. H. CALDWELL

Editor, Electronics

THE electrical engineers and the electrical utilities of the United States are today facing a major revolution in methods of power conversion and transmission—the third such major change in the history of the electrical art.

Edison's invention of the incandescent lamp brought the first great upheaval and opportunity for vast expansion.

Westinghouse's introduction of alternating current was the second sweeping change, which spread power networks over the face of the continent.

And now comes the third great advance—the introduction of electronic tubes of various types into utility power systems, for service as rectifiers and converters, and for circuit control and circuit protection.

Probably the greatest economic saving resulting the use of vacuum-tube equipment by utilities lies transmission of direct current instead of alter current over existing high-tension power lines.

Every alternating-current line today has to be pro with extra insulation to withstand the momentary age peaks during each cycle—that is, has to be ins for 1.41 times the nominal alternating-current vo Substitution of direct current instead of alter current therefore would at once make it possible to the direct-current potential up to the full ex insulation of the line,—reducing the current in the of 1.41 to 1 (for equivalent powers) and so di the energy losses by two ($I^2 = (1.41)^2 = 2$).

But the chief difficulty experienced in loading nating-current transmission lines to their full cu carrying capacity, lies in their impedance, amounting to several times the ohmic resistance, in excessive voltage drop and wide swings in te voltage with load changes. To avoid such voltage lation troubles, a.c. lines can usually be operated a a fraction of their actual current-carrying capaci

But with direct current, the full current capac the line can be utilized, and this gain, together wit resulting from use of the full insulation voltage, a total advantage of three to six times in p transmission capacity, for direct current as against ing alternating-current lines.

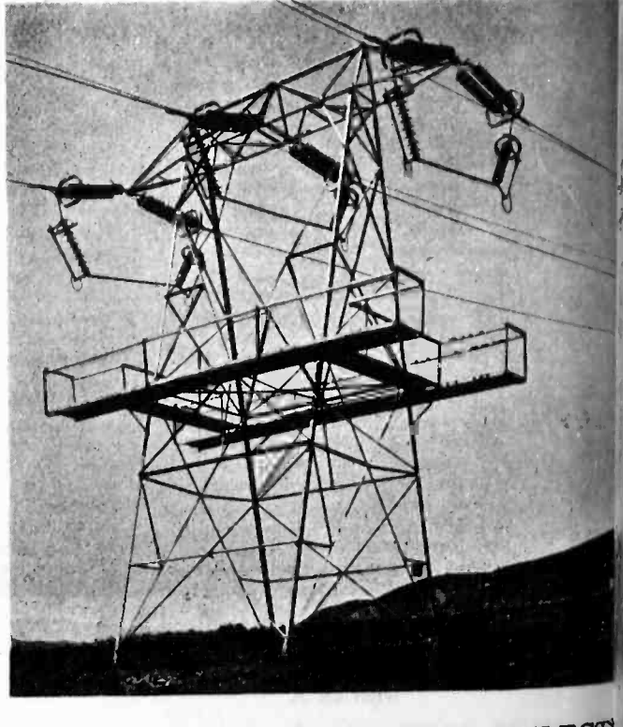
Creating millions in additional facilities

For example, a certain 220,000-volt line tra 60-cycle alternating current 200 miles into a l Western city. Were this line converted to direct c the existing insulation would safely withstand a current potential of 300,000 volts. And sinc direct current, reactance vanishes, while the ohm diminishes with the square of the voltage ratio, it b evident that from three to six times as much powe be transmitted, with comparable performance, at 3 volts direct current as at 220,000 volts alternati rent. Thus, introduction of converter and inverte would create the equivalent of two to five ad transmission lines, like that already built. Or,

If Carrying High-tension Direct Current, This Line Could Transmit Three to Six Times As Much Power

INSULATED for 220,000 volts alternating current, it is actually insulated against 300,000 volts. Operated at 300,000 volts, direct current, the corresponding decrease in line current would mean half as much loss as before. Meanwhile the elimination of reactive drop and regulation troubles, would permit the line to be loaded to its real carrying capacity. Combined, these savings would mean three to six times as much power transmitted.

At the receiving end, alternating current could be taken off at various frequencies desired—133, 60, 40, 25 cycles.



e dollar standpoint, since the original line cost nately five millions, the introduction of tubes will acilities corresponding to ten to twenty-five lollars' worth of additional line equipment, in of this one company alone.

rtional savings could be shown for other trans- systems.

y, successful experiments in this direction have ried out, transmitting power up into the thou- kilowatts. Experimental lines are reported to n operated up to 4,000 to 5,000 kw., receiving imput, converting this to direct-current for sion, and then reconverting at the delivery end les, or to other frequencies. This possibility of f various distribution frequencies, all from the ect-current line, for the operation of different f loads, is an interesting aspect of the new art.

tant technical progress has been made in equip- d.c. transmission, in the production of electron r high voltages and fairly large carrying capac- as-filled rectifier tubes have been built up to olts, capable of carrying 100 amp. These tubes ciencies of 90 to 95 per cent. Vacuum-tube have been produced up to 100,000 volts.

e of the foregoing types have useful lives of 10,000 hours, and their equivalent overall g cost is comparable to that of motor-generator rotaries.

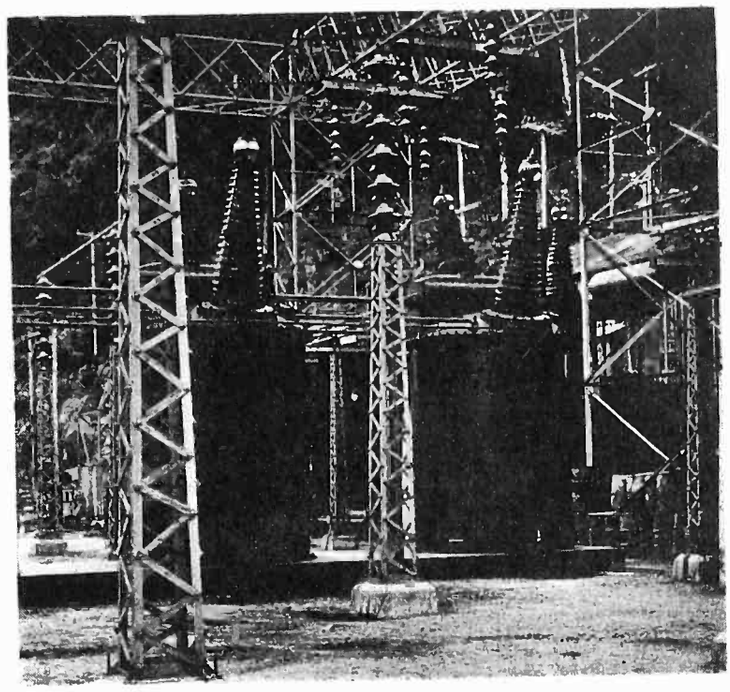
Switching and lightning protection

place oil-switches on high-tension lines, electron- vices offer surprising possibilities. In place of lky and heavy oil-switches, there may be sub- small compact vacuum tubes which break the nstantaneously, silently, and without setting up ges. A vacuum-tube switch the size of a five- ottle, can take the place of oil-breaker mechanism g two or three tons, and occupying the volume ordinary room. Such vacuum switches have been built up to 300 amp. and are designed up 00 volts. They can continuously break large es of power without burning. One such switch successfully breaking the inductive load of an hammer 400 times per minute, interrupting 100 220 volts.

ts are now used by utilities for relays, for long- e metering, for remote control of circuits, for ng generators, for synchronizing, for warning of stence of dangerous voltages, for dispatching sys- tem orders over long-distance high-tension lines, and for broadcasting music directly over the electric-light wires.

A remarkable property of the electronic tube is its speed of operation. Electron tubes used as relays, operate in one ten-millionth of a second—far, far faster than any conceivable mechanical switch or relay. Such electronic relays also have the capacity to control up to a million times the actuating energy.

Again, in some of the uses already applied to utility-line protection, photo-electric tubes are so quick-acting that they can virtually "see" the beginning of a flash-over on a rotary or a generator, and operate to cut the power off before the flash can develop far enough to do any damage. In fact, the whole process of alarm and response is so quick that the human eye does not even see any flash.



Huge Oil-switches May Eventually Be Replaced by Five-gallon Vacuum-tube Switches

In the electron-tube switch the current is not broken, it simply dies out when the current cycle goes through zero

From an address before the Western Society of Engineers and the Chicago Section of American Institute of Electrical Engineers, Chicago, September 15.

▼ ▼ ▼

ELECTRON TUBES IN ELECTRIC TRANSMISSION

-current high-tension trans- ion
ers
ers, d.c. to a.c.
ency converters
ency dividers
tension switches
ning arresters
rator-voltage regulation
sformer regulation
Carrier-current dispatching over transmission lines
Phase-control
Synchronizing equipment
Tele-metering (distant metering over power lines)
Remote switching
Relays and contacts
High-voltage voltmeters
High-voltage energy meters
Detecting flashovers on commutating machines and automatically extinguishing
Remote control of two-rate meters
High-tension aviation marker lights, operating directly from transmission-line voltage
High-tension safety equipment and interlocks

An analysis of high modulation transmission

By G. F. LAMPKIN

THE Heising constant-current system of modulation usually fulfills the requirement of fidelity, but not that of degree. It cannot completely modulate an oscillator, and do so without distortion. Starting with the conventional explanation of the Heising modulator, a picture may be drawn which shows why such is true.

The oscillator and modulator tubes are fed with plate voltage through an audio choke, called the constant-current reactor. (Fig. 1.) Audio variations on the grid of the modulator swing the modulator plate current up and down. Because the total current to the tubes is constrained to a constant value, the oscillator plate current must drop as the modulator current rises, and vice versa. If the modulator current touches zero, the oscillator current reaches twice normal, and the modulation is said to be complete. Such is the conventional explanation of the constant-current modulation.

Now let us consider the choke as a unity-ratio auto-transformer, and the oscillator tube simply as the load impedance being fed audio power by the modulator.

▼

THE invariant carrier frequency, strictly necessary in present day broadcasting, of itself conveys no entertainment. It cannot be heard in a broadcast receiver, and only manifests itself as it carries in hiss or background noises. The carrier must be modulated, and on the fidelity and degree of this modulation depends the effectiveness of any station.

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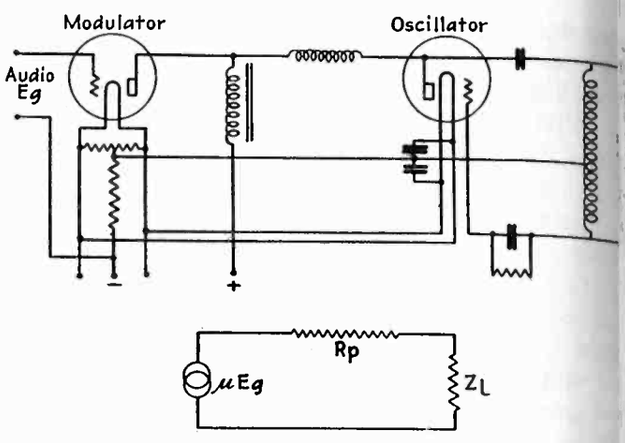


Fig. 1—Conventional diagram and simple equivalent of modulator-oscillator system

The conception then of the modulator tube is as an put tube in the last stage of an audio amplifier.

Again assume audio variations to be present at the of the modulator, which create a tendency for the m lator plate current to likewise vary. There cann much more than the tendency toward variation, be of the inductance of the auto-transformer. The i tance in suppressing the current variations generat alternating back e.m.f. $L\frac{di}{dt}$, and transformer a feeds this audio voltage to the load impedance, or lator equivalent. This conception allows the use o conventional diagram for an audio amplifier, in F of a source of voltage μE_g, R_p the internal impedan the amplifier tube, and Z_l the load impedance. Ir circuit the audio currents in the amplifier and the are in phase, since the two are in series; while i usual Heising description the modulator and osci currents are out of phase. Thus appears a corrobo reason for the auto-transformer viewpoint of the reactor, since the transformer action is accompani a reversal of phase. With the modulator reduced standard audio circuit, the family of plate-current voltage curves applicable in such a case may be bn in and used to show why, in practice, 100 per cent m lation cannot be attained without distortion.

Figure 2 gives such a family for the UX-250 The load line for the recommended 4,000-ohm l drawn through the operating point of —80 volts and 450 volts plate. This same plate voltage wou applied to the oscillator, and if 100 per cent modu be realized, the instantaneous plate voltage on both lator and modulator must swing from 0 to 900 That this is impossible may be seen at once. Alo load line to the left the operating point is halted at voltage, corresponding to a minimum plate volta 243. To the right the peak voltage of 900 could be reached—the load line intersects the twice-n grid voltage at only 630 volts. These figures a the tube working into that load which gives ma undistorted power. Such is not the optimum co for a modulator tube; if and when said condition i nearly realized, somewhat better performance may

The oscillator tube operates with a given, fixe voltage, and the desideratum is a maximum perc modulation; i.e., a maximum audio voltage. In th respect does the modulator tube requirement diffe that for an audio power output tube, or a voltage fier tube. The power amplifier must deliver a ma

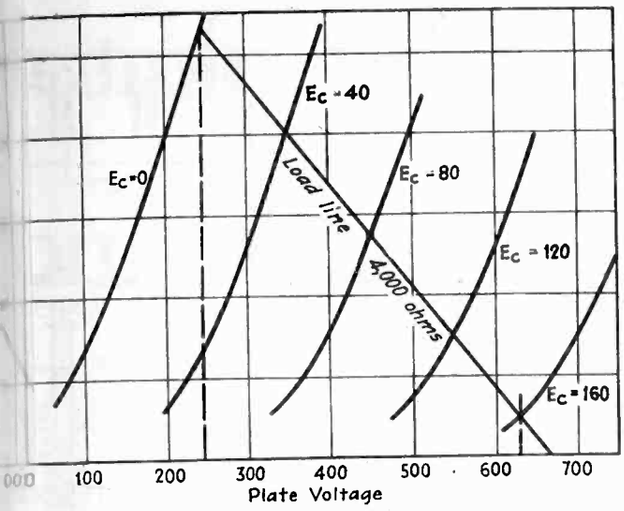


Fig. 2—Characteristics of power tube of the 250 type

r to a load which may be chosen accordingly; voltage amplifier must deliver a maximum of to a load which may be chosen accordingly; the modulator must deliver a maximum of o a load already determined. Thus the load, and voltage of the modulator, are given conditions of olem. The procedure is to make use of the plate- plate-voltage family, and find the maximum grid which the tube may be operated and not exceed nt second harmonic distortion. This entails ap- o several load lines the usual calculation for tn:

ent second harmonic =

$$\frac{(+ I_{min}) - I_o}{\text{max} - I_{min})} \; 100.$$

the maximum allowable E_g, then the percentage lion which may be realized in the constant current ris

ent modulation $= \dfrac{\mu E_g Z_l}{(R_p + Z_l)\, E_p}\; 100$, where E_p common plate voltage for modulator and oscil- It is apparent that the expression is simply the f the peak audio voltage across the load to the te voltage.

expression shows the trend which must be fol- n order to more closely realize complete modula- Could the load impedance, Z_l, be increased, the percentage modulation would increase on two counts: a higher grid bias could be used for the same 5 per cent distortion, and a greater proportion of μE_g would appear on Z_l. In the limit, when Z_l approached infinity, 100 per cent modulation with the Heising system could be realized, but the case is too far removed from practicality to be of value.

The straight Heising system with load impedances of from two to four times the modulator impedance can attain modulation percentages of 40 to 60. The modification employed to allow full control is to use a series resistor in the branch supplying plate current to the oscillator. The resistor must of course be by-passed for audio frequencies. Its value must be such as to drop the oscillator plate voltage to the peak of the audio voltage available, and is given by

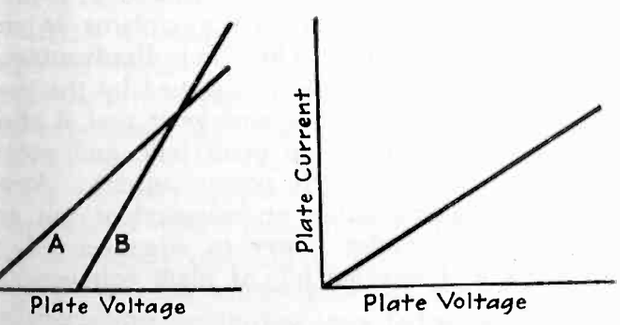
$$R = \frac{E_p\,(1 - m)}{I_o}$$

where E_p is the modulator plate voltage, m the modulation factor attainable in the straight Heising method, and I_o the oscillator plate current. The equation comes from the relation for the oscillator plate voltage,

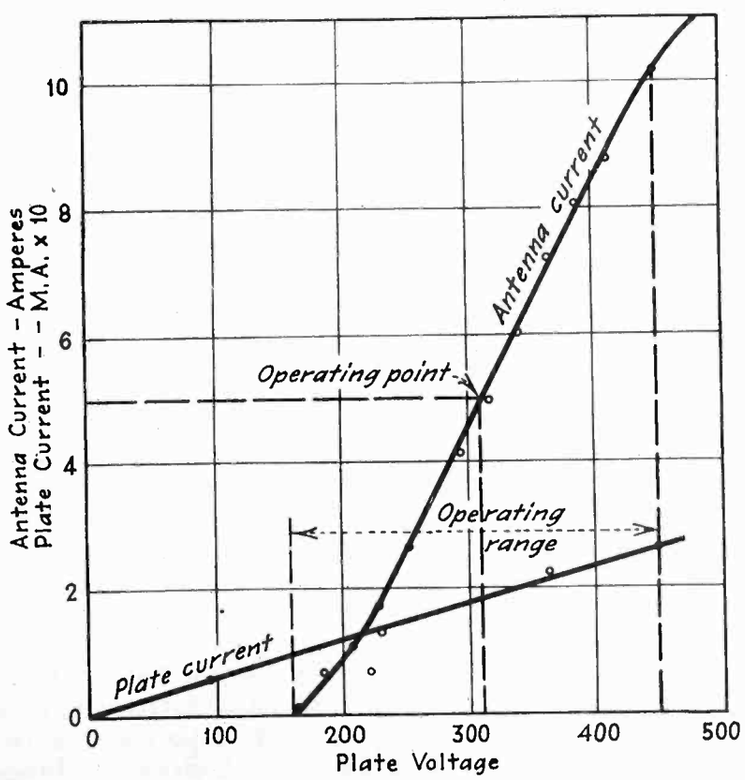
$$E_o = E_p - I_o R = mE_p.$$

Increased power requirements

In the preceding discussion an oscillator, or Class C amplifier has been assumed, in which the plate current and the r.f. current are proportional to the plate voltage. Then the d.c. plate potential with the equal peak alternating voltage superimposed will give rise to the completely modulated r.f. wave. The plate power input to the oscillator when not modulating is simply $E_o I_o$, the product of current and voltage. When modulating completely, an additional plate power input of $\frac{1}{2}\, E_o I_o$ is required, since the alternating peak voltage is equal to E_o, and the r.m.s. $\dfrac{E_o}{\sqrt{2}}$, while likewise the r.m.s. current input is $\dfrac{I_o}{\sqrt{2}}$. The modulator must be able to supply an undistorted power output of $\frac{1}{2}$ the d.c. input to the oscillator. Another convenient fact may be arrived at thus: *the*



Above: Fig. 3—Relation between plate voltage, plate current, and antenna current in distortionless system



Right: Fig. 4—Operating characteristic of highly-biased transmitter

power input to the tube increases by a factor of 1.5 during complete modulation. Therefore the r.f. power increases by a like amount, or the r.f. current by a factor of $\sqrt{1.5}$, or *1.224*. The r.f. current in either tank or antenna circuit, should increase 22.4 per cent when modulating 100 per cent.

Attainment of greater efficiency

Reference was made above to r.f. units in which both the r.f. current and the plate current were strictly proportional to the plate voltage. Such a condition is not necessary—it is sufficient if the antenna current be linear with respect to plate voltage. The difference is diagrammed in Fig. 3. If the proportional relation holds, as in curve A, the line goes through the origin, and the equation for r.f. current I_a and plate voltage E_o is

$$I_a = K E_o.$$

On the other hand, the relation may be linear, but not go through the origin, as curve B, and

$$I_a = K_2 E_o - C,$$ where C is a constant.

The latter type of curve may be had in an oscillator-modulated-amplifier-power-amplifier setup. Along with the I_a-E_o curves is the plate-current plate-voltage curve for the modulated stage. That is,

$$I_o = K_3 E_o.$$

It must be remembered that the I_o-E_o curve is for the I_a-E_o curve; the saturation point. Its value in this case curves are antenna current vs. plate voltage of that same modulated stage, no matter how many intervening r.f. amplifier stages there are. The linear feature of this latter curve must be retained, even though the proportional phase is not.

For instance, in Fig. 4 are given these curves for a 1,712 kc. 500-watt crystal-controlled transmitter. The tube layout was a 210 crystal oscillator, a 210 buffer amplifier, a push-pull 210 modulated amplifier, a push-pull 852 intermediate amplifier, and a push-pull 851 power amplifier. All the push-pull stages were operated with the plate current past cutoff, when no input was present.

From these curves at once can be obtained the peak output of the transmitter, the correct point at which to operate the transmitter, the audio power necessary for 100 per cent modulation, and the load impedance into which the modulator must work. All this is in addition to checking the very necessary linear relationship of I_a-E_o.

Use of operating characteristic

The peak output of the transmitter is the knee of the I_a-$E_o$curve; the saturation point. Its value in this case is some 10 amperes, which in an antenna of 27 ohms resistance represented a peak power of 2,700 watts. Thus the transmitter when operated with its rated 500-watt carrier is easily capable of fulfilling the 2,000 watt peak power requirement on 100 per cent modulation.

The operating point is at half the peak antenna current, or at 5 amperes. This is attained by adjusting the plate voltage on the modulated stage to the corresponding value of 310 volts. Then the antenna current has an equal region of swing above and below this point —from 0 to twice 5 amperes. The adjustment is made under the assumption that transmitter capability is the sole criterion.

The antenna current swings from zero to twice normal. The plate voltage swing necessitated is correspondingly from 160 to 450 volts. The plate impedance of the modulated tube is the reciprocal of the I_o-E_o curve. From

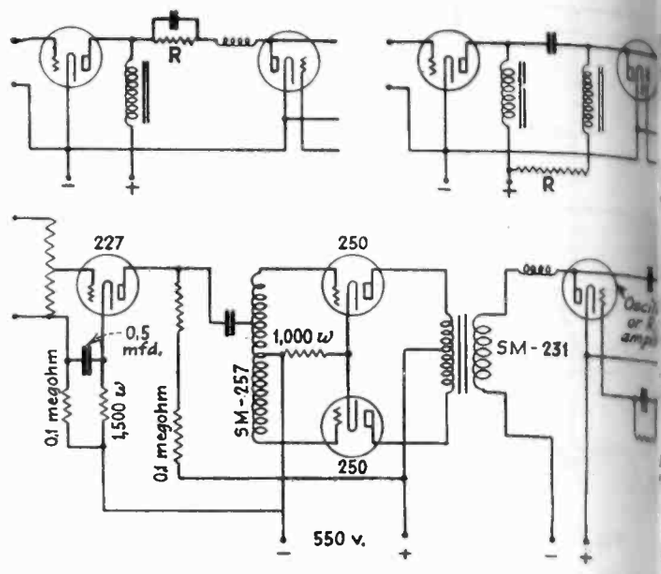


Fig. 5—Circuits adapted for high modulation

0 to 10 milliamperes plate current the plate volt changes from 0 to 172 volts, giving a plate impeda of 17,200 ohms, which is a pure resistance load at au frequencies. Into this impedance the modulator t must work. Since the plate voltage variation requi for 100 per cent control is 290 volts, the peak au voltage is half this, and the audio power, using the fo $\frac{E^2}{R}$, is 0.613 watts.

If the I_a-E_o and the I_o-E_o curves are run on any tra mitter, and the transmitter adjusted therefrom; if th is a decent margin between the required and availa undistorted audio power, and if attention is paid proper plate voltage on the modulated tube; then a m mum increase of 22 per cent in antenna current i good indication that 100 per cent distortionless mod tion has been attained.

One means whereby the Heising system could changed to meet the requirements of 100 per cent mo lation has been detailed, namely, a by-passed resisto the oscillator plate lead. Another means is impeda coupling, in which the oscillator and modulator are c fed through a choke, a coupling condenser inserted tween them, and the voltage dropping resistor inse in the oscillator branch. These two methods are dr in Fig. 5 as is a third method of transformer coupl This scheme has both advantages and disadvantage compared with the modified systems above; it is mor accord with the idea that the modulator is simpl source of audio power. The chief disadvantage is loss in fidelity that may be occasioned by the use of output transformer. An advantage is that it allows of two modulator tubes in push pull, and accordi increases their undistorted power output. Anothe that the modulator becomes an independent unit, and be used to feed audio power to whatever r.f. un desired, without interlocking of plate voltages.

A typical modulator-oscillator

The schematic in Fig. 5 shows simply a two-s power amplifier with gain control, two UX-250 tub push pull feeding through an output transformer to plate circuit of the modulated tube. By virtue of push-pull connection, the audio output approache watts, which will easily put a 100 per cent wallop a UX-210 working with rated input.

earch, radio
omobiles

e observations by the
eering genius of General Motors

ETTERING*

RCH has become
of the most powerful
forces for advance-
or modern civilization.
stries have grown up
sult of the painstaking
experimentation of
each contributing a
ever-completed whole.
een true in practically
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our largest ones are
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esearch.

s always searched for
d better. He wants things to aid him in his
ve him greater pleasures. We can but imagine
houghts of the first man were in prehistoric
he first used fire to protect himself and cook
What were his thoughts when he first used a
axle in the ancestor of all our present systems
rtation to carry his burdens? We do know
uld never foresee the tremendous effect of his
on future civilization. But we know now that
arting an uninterrupted chain of discoveries
directly to man's supremacy over the other
of the world. Neither could he foresee that it
necessary to organize and collect all the pain-
ed experience and established facts into scien-
which would be available to all. He could
e the necessity for the large industrial and other
aboratories where thousands of highly trained
re constantly laboring to discover new facts
uld assure the continuation of the unbroken
advancement he started long before history.
ew discovery makes man's life a little more
ing, helps cure his ills, eases his burdens or
more pleasures. The true value of any one
can never be evaluated. Discoveries made in
more often than not, can be applied to entirely
fields. An example in the chemical field is the
discovery of nitro-cellulose. This material was first used in explosives and to make smokeless powder, so that during war the position of a gun was not disclosed by a telltale cloud of smoke. But man's ingenuity did not stop when he had discovered this powerful means of disfiguring and destroying. He proceeded to turn the sword into a plowshare. A method of making silk, the raiment of kings, from this material of war was found. Now we can all wear a material similar to that which formerly adventurous men gave their lives to bring back from the East. But artificial silk is not the only product made from nitro-cellulose. Lacquer finishes, now used to finish all automobiles, and celluloid are made from the same source.

This application of old facts to new purposes has been going on in other branches of science also. The rapid rise to popularity of radio is an example well known to all. In one decade radio has become one of our largest industries supplying entertainment to the public. In 1929, the value of the radio sets sold was over $500,000,000. By the end of this year there will be over 14,000,000 sets using 84,000,000 thermionic tubes in the homes in the United States.

But radio is not the only use of these tubes. The talking moving picture, while first tried years ago, had to wait for the development of the amplifier tube before it could be a success. These tubes also made possible transcontinental and transatlantic telephones and rapid elevator controls in tall buildings. Future uses of this valuable tube cannot readily be foretold, but its use in the long distance transmission of power is one of its great possibilities.

Research has also been busy in the automobile industry. Although it had a little earlier start than the radio industry, of late years there has been much in common between the two. The radio industry, patterning after the automoblie industry, has brought out yearly models. Both industries began in and depend for their continued improvement on the research laboratories. Where the automobile engineer has been interested in making smoother, quieter, more comfortable and better appearing automobiles, the radio engineer has been interested in better tone quality, more easily operated and more beautiful radio sets. Cellulose finishes which have improved the appearance of automobiles, have also improved the appearance of radios. The automobile industry produced 5,500,000 cars in 1929, the radio industry 4,000,000 sets. There were 24,000,000 cars in operation at the beginning of this year and 11,900,000 radio sets.

Radio principles in automotive research

Then, too, radio principles have been used in automotive research. The vacuum tube is much used to amplify small currents from measuring instruments to give large scale readings. A distortion-free amplifier is used in a sound analyzing and measuring instrument. This instrument has been used to study automobile and engine noises and replaces the inaccurate human ear for evaluation of sound intensity. (*Continued next page*)

esident, General Motors Corporation, General Director, otors Research Laboratories.

We have followed the course of radio development and discovered that in the majority of cases its development has closely paralleled automotive research. Recently, however, the two have become more closely allied, or one might even say, merged. This was brought about by the automobile radio.

More time is being spent in cars, particularly in cross-country driving. Undoubtedly the radio furnishes a means of relaxation to the driver. He can enjoy a musical program or ball game, or keep in touch with stock-market fluctuations, while touring the country. It is hard to predict just what the future of the a radio will be.

But what is the meaning of all of this? W purpose do the automobile and radio serve? have served to bring Kansas and New Yo together—the farmer and the business man. one cannot see of the other, he can hear.

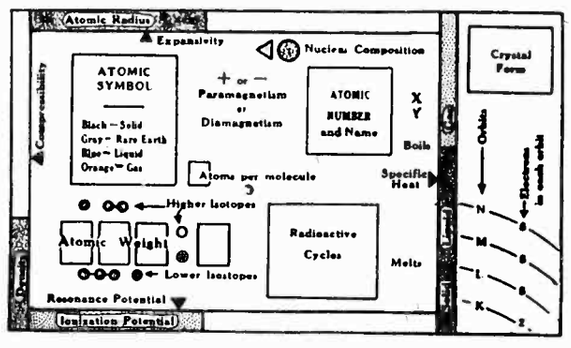
But back of it all we can see the hand of r how it has made possible these things. Researcl the wheels of progress and will in the future, there will be no change, and without change the stuck in a rut.

▼ ▼ ▼

Periodic chart of the atoms and their electron make-up

THE orbital groupings of the electrons making up the ninety-odd elements of which the universe is composed will be found on the chart opposite. This chart gives not only the positions of the elements in the Mendeleeff periodic table but the atomic weights and numbers of the many new elements discovered since the time of Mendeleeff; the valence, the boiling point, and other physical and chemical properties.

Every atom consists of negative particles circling about an equal number of positive particles (not counting dead weight neutral pairs in the nucleus). Each atom row begins and completes a new layer of planets whose orbits are concentric with those of the preceding row. The arabic row numbers (entitled "Orbits") give the number of such orbit layers in the atoms of that row. Row 2, for example, contains only atoms with



Key to information concerning each elementary atom, as given in units of chart on opposite page

two concentric orbit layers. Every atom of row 3 has a system of three such layers, and so on. The total number of planets in an atom is the atomic number. In each atom there is a characteristic distribution of these planets. This distribution determines the properties of the atom.

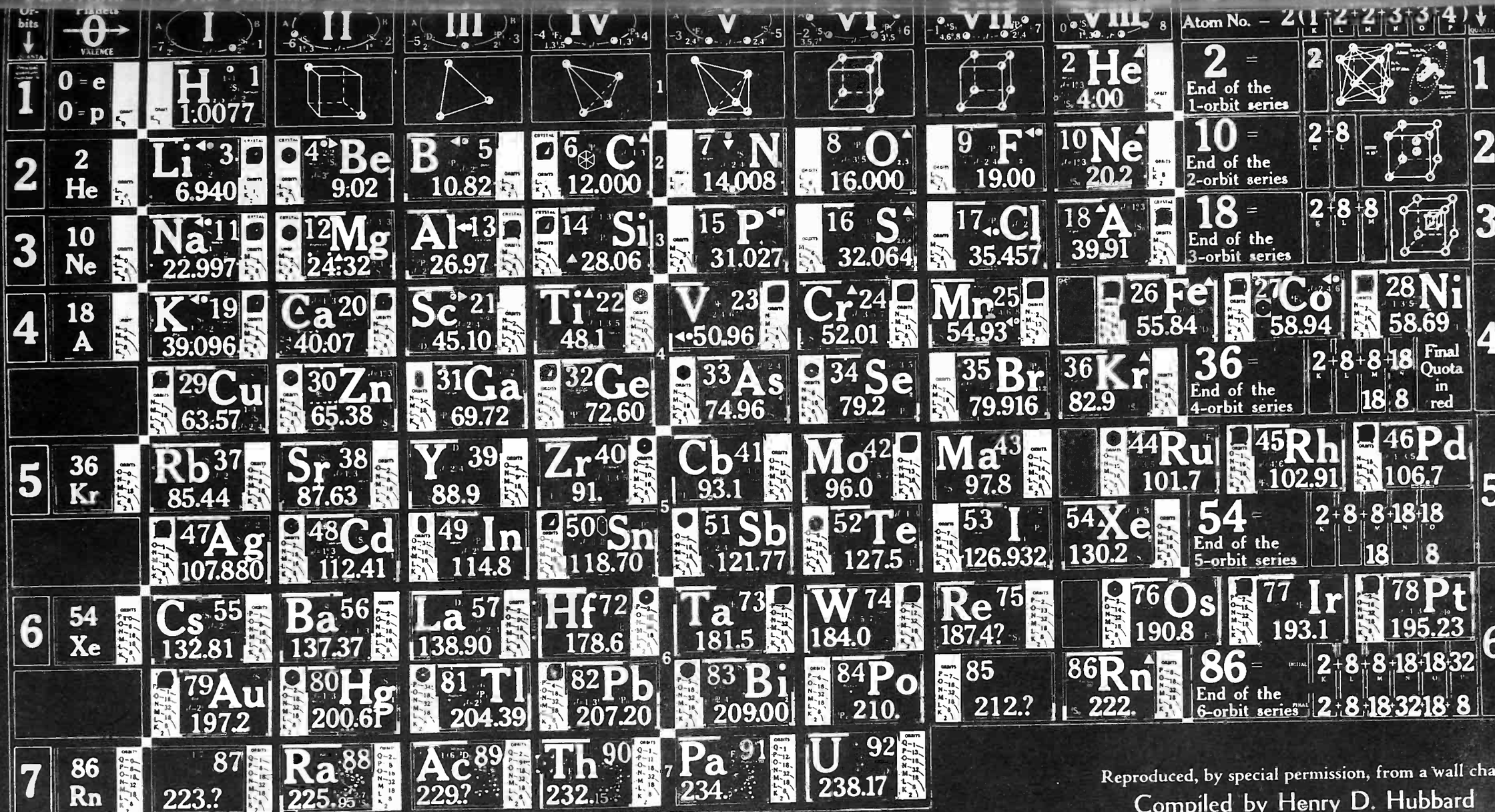
The Atomic Number is numerically the net number of positive nuclear units of electrical charge, and measures the nuclear attraction on the planetary electrons. The Atomic Number thus equals the number of negative electrons held in the orbits, circling about the nucleus as planets. The orbit structure of each atom (number of orbits, and number of electrons in each orbit) is shown in the chart opposite.

In this chart the worker in electronics as well as the chemist and the physicist has available at a g more important characteristics of the building of which all matter is made. In addition to th ties mentioned above there is given the nu electrons in the various orbits, and the number according to recent theories of atomic structu chart shows hydrogen as the simplest of all at uranium, one of the unstable radioactive subst the heaviest and most complex. The chart shoul ful to the student and the practicing scientist as

Alphabetical Index and Atomic Numbe

Element		No.
A	(Argon)	18
Ac	(Actinium)	89
Ag	(Silver)	47
Al	(Aluminium)	13
Antimony (Sb)		51
As	(Arsenic)	33
Au	(Gold)	79
B	(Boron)	5
Ba	(Barium)	56
Be	(Beryllium)	4
Bi	(Bismuth)	83
Br	(Bromine)	35
C	(Carbon)	6
Ca	(Calcium)	20
Cb	(Columbium)	41
Cd	(Cadmium)	48
Ce	(Cerium)	58
Cl	(Chlorine)	17
Co	(Cobalt)	27
Cr	(Chromium)	24
Cs	(Caesium)	55
Cu	(Copper)	29
Dy	(Dysprosium)	66
Er	(Erbium)	68
Eu	(Europium)	63
F	(Fluorine)	9
Fe	(Iron)	26
Ga	(Gallium)	31
Gd	(Gadolinium)	64
Ge	(Germanium)	32
Gold	(Au)	79
H	(Hydrogen)	1
He	(Helium)	2
Hf	(Hafnium)	72
Hg	(Mercury)	80
Ho	(Holmium)	67
I	(Iodine)	53
Il	(Illinium)	61
In	(Indium)	49
Ir	(Iridium)	77
Iron	(Fe)	26
K	(Potassium)	19
Kr	(Krypton)	36
La	(Lanthanum)	57
Lead	(Pb)	82
Li	(Lithium)	3
Lu	(Lutecium)	71
Ma	(Masurium)	43
Mercury	(Hg)	80
Mg	(Magnesium)	12

Element		
Mn	(Manganese)	
Mo	(Molybdenum)	
N	(Nitrogen)	
Na	(Sodium)	
Nd	(Neodymium)	
Ne	(Neon)	
Ni	(Nickel)	
O	(Oxygen)	
Os	(Osmium)	
P	(Phosphorus)	
Pa	(Protoactinium)	
Pb	(Lead)	
Pd	(Palladium)	
Po	(Polonium)	
Potassium (K)		
Pr	(Praseodymium)	
Pt	(Platinum)	
Ra	(Radium)	
Rare Earths		
Rb	(Rubidium)	
Re	(Rhenium)	
Rh	(Rhodium)	
Rn	(Radon)	
Ru	(Ruthenium)	
S	(Sulphur)	
Sb	(Antimony)	
Sc	(Scandium)	
Se	(Selenium)	
Si	(Silicon)	
Silver	(Ag)	
Sm	(Samarium)	
Sn	(Tin)	
Sodium	(Na)	
Sr	(Strontium)	
Ta	(Tantalum)	
Tb	(Terbium)	
Te	(Tellurium)	
Th	(Thorium)	
Ti	(Titanium)	
Tin	(Sn)	
Tl	(Thallium)	
Tm	(Thulium)	
Tungsten	(W)	
U	(Uranium)	
V	(Vanadium)	
W	(Tungsten)	
Xe	(Xenon)	
Y	(Yttrium)	
Yb	(Ytterbium)	
Zn	(Zinc)	
Zr	(Zirconium)	



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For explanatory key to information in atomic units, see opposite page

Builders of the electronic arts

HARRY M. WARNER

President, Warner Brothers Pictures, Inc., and Vitaphone Corporation. First producer to introduce sound pictures into commercial theaters. ("Don Juan," with John Barrymore, August 5, 1926, Warner Brothers Theater, New York)

HERBERT E. IVES

Physicist and inventor, Bell Telephone Laboratories, New York, since 1919. Formerly U. S. Bureau of Standards. Inventions in color photography, picture transmission, and television by wire and radio, including color television

JOHN V. L. HOGAN

Consulting engineer, inventor, author. President, Radio Inventions, and Radio Pictures, 41 Park Row, New York. Began radio with DeForest, 1906; Fessenden, 1909. Inventor of detector heterodyne and single-dial control. Consulting work since 1921. Specialist in broadcasting

DR. BALTH van der POL

Physicist, mathematician and radio investigator. Evolved fundamental theories in radio, mathematics and physiology. President, Netherlands Radio Society. Director, Radio Research Laboratory, N. V. Philips' Radio, Eindhoven, Holland

ound noise in nd-on-film ures

two of an analysis of noise to film recording

MER G. TASKER*

M recording, we encounter a phenomenon s an exact counterpart of the granular struc- o disc record stock. It is known as emulsion emulsion comprising the light sensitive portion h used for this type of recording. Although ph ordinarily appears to consist of homo- ghts and shades, when greatly magnified it n to consist of many minute black spots. In ffect is very much like the half tones used in photographs except that the spots are not spaced but are scattered in a very hetero- anner. This fact is very well illustrated in hich is a magnified portion of a variable nd track. From this, it is very clear that the ng through this film as it moves past the light projection apparatus will not vary as smoothly nded but will have superimposed on the desired many irregular changes due to this granular

eless this effect is not quite as severe as might ded from the photograph. The slit of light employed to reproduce sound from this track ver some three-quarters of the width of the ck. Consequently, there is a tendency to the effect of the large number of small varia- ch would be introduced by the film grain, voiding a great deal of this noise.

different methods of film recording are in se and it is interesting to note that the impor- grain noise is different for each of these three. er illustration in Fig. 2 is taken from variable ound track made by the light valve method in

nt chief equipment engineer, Warner Brothers Pictures, wood, California.

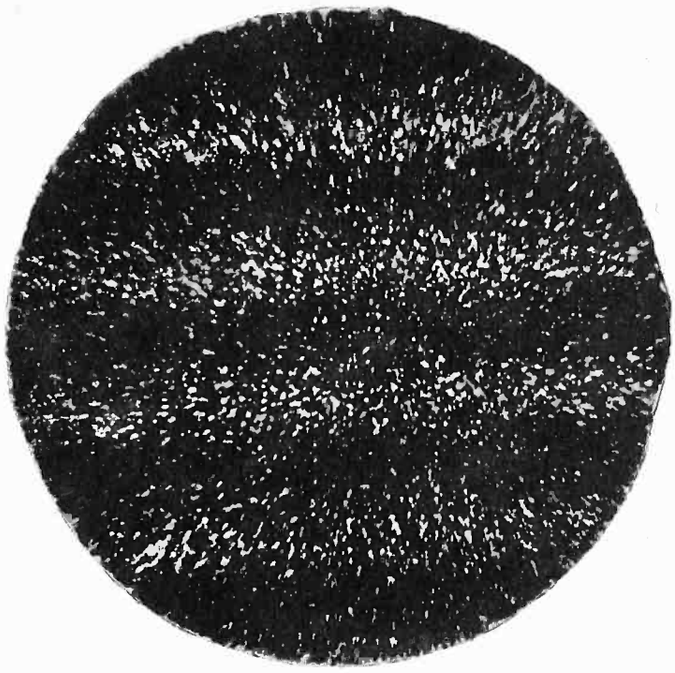


Fig. 1—Photomicrograph of sound track on positive stock. A magnification of 250 times shows grains and grain clumps

which the importance of grain noise has already been discussed. Variable density recording which uses a constant slit with a light source of variable intensity would be subject to the same grain noise as the light valve method if similar photographic conditions were involved. It happens, however, that the intensity of light available in such recording systems is comparatively weak and the resulting low density of the negative track makes grain noise slightly less severe for this method.

In the third method of film recording, the film is exposed to light of high intensity which is applied to a variable width of the sound track. The lower part of Fig. 2 is an enlarged view of a portion of variable width sound track. These two tracks are recordings of the same sounds and, therefore, offer an interesting comparison of the two methods. The presence of grain in the edges of the variable area track is clearly discernible.

An attempt to measure grain noise involves a measure of the total noise introduced by unmodulated sound track. Some segregation of true grain effect might be had by making an enlargement of several diameters on positive stock and measuring from this new film.

In Fig. 3 the results of film noise measurements on both positive and negative stock are reported. Although considerable amounts of photo cell noise and mechanical rumble of vacuum tubes are present the film noise is in excess of these components by more than 10 db except in the fifth and sixth octaves where they approach within 6 and 9 db respectively of the noise from positive stock.

A striking characteristic of these measurements is the large amount of energy in the lower frequencies, especially the third and fourth octaves. A moment's consideration shows that this noise cannot be due to individual grains for the highest frequency in these bands, 1,000 cycles, has a wave length of 0.018 in., which is many times the dimensions of the largest grains. The explanation of this noise must, therefore, be sought in other places. Most probable of these are faults in the processing of the film and faults in the material of the film itself.

It is apparent that any dirt or irregularities of development which occur in the sound track will result in

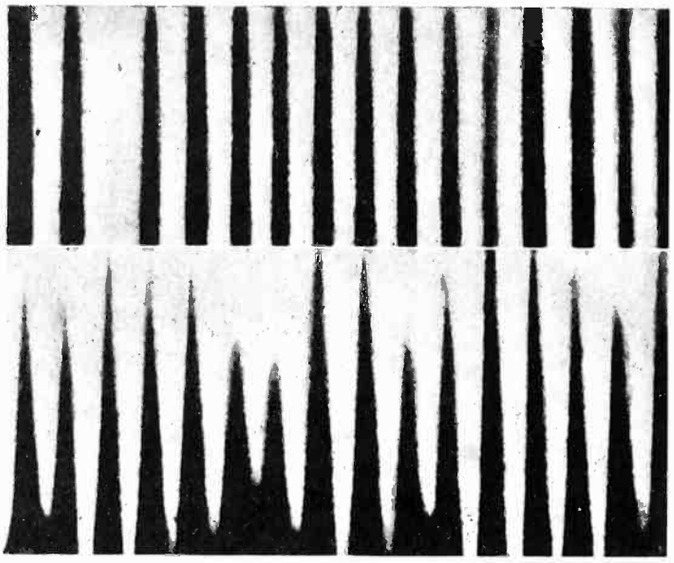


Fig. 2—Photomicrograph of a typical variable density sound track (at top) and variable area (at bottom). These two sound tracks are recordings of the same sounds

variations of the light reaching the photocell and hence produce noise in the theater. The most serious example of improper development occurs when the film must be mounted on racks for development. At each point where the rack makes contact with the film, the development will be non-uniform and a series of evenly spaced pulses of sound will result. The use of continuous development machines, in which the film passes over rollers so that it is never in more than momentary contact with any support, eliminates this difficulty but involves the outlay of considerable capital.

It is also important that the temperature of the developing bath be kept within proper limits, since high temperatures result in coarser grain. Trouble is often encountered from incomplete fixing and insufficient washing of the film, and also from finger marks and the accumulation of dirt, particularly in the handling of negatives. Thorough agitation of the developing bath with respect to the film is essential, and even with the greatest of care "air bells" frequently occur which result in uneven development and consequent noise.

Faulty film materials often contribute irregular noises due to metallic spots in the emulsion or to a varying thickness of either the emulsion or the celluloid base. While any of these troubles may be very serious, due care in the choice of materials and control of the developing processes will result in a very uniform and satisfactory product.

Recorded mechanical noise

Film recording, like disc recording, is subject to difficulties from mechanical vibration, although in a somewhat different manner. Components of vibration at right angles to the motion of the film will introduce noise into variable width recording but not in the variable density method. Components in the direction of motion of the film produce small changes of film speed which alter the exposure. If the frequency of this vibration is high, the result is noise and if low, the effect is to produce a flutter in the sound heard. In general, the latter effect is much more important as well adjusted film recording machines are quite free from noise from mechanical vibration.

An interesting contrast between disc recording and film recording lies in the fact that the disc reproducing device does not in itself introduce any ground noise, while in the film recording system the reproc responsible for a large part of the ground noise in the theater. A part of this noise originate photo cell and is known as the "Schott effect."

When light falls on the sensitive surface of cell, electrons are emitted from this surface, the of which is exactly proportional to the strengt light arriving. Although the number of these e emitted per second is constant for a uniform is not true that the number per ten thousandth second is uniform,—that is, the emission of elec a probability effect in which the electrons are g by groups or bunches, even though the light i may be absolutely uniform. This results in a v siderable amount of ground noise. Fig. 4 sh quency analysis of this noise in terms of an factors. The reproducing system used is the that used for total film noise (Fig. 3) but the at rest. It is interesting to note that the import this noise increases with frequency to the fifth and then falls off.

Reproducing noises

Particularly annoying noises sometimes origina faulty adjustment of the reproducing equipmen example, if the guides which center the slit of the sound track are out of adjustment, the light i in the edges of the sprocket holes, introducing noise whose base frequency is 96 cycles and v very rich in harmonics. Similar noises may b duced by moving the film too far in the other d whereupon the slit of light is intercepted by th lines between successive pictures, resulting in of one-fourth the frequency of the sprocket hol

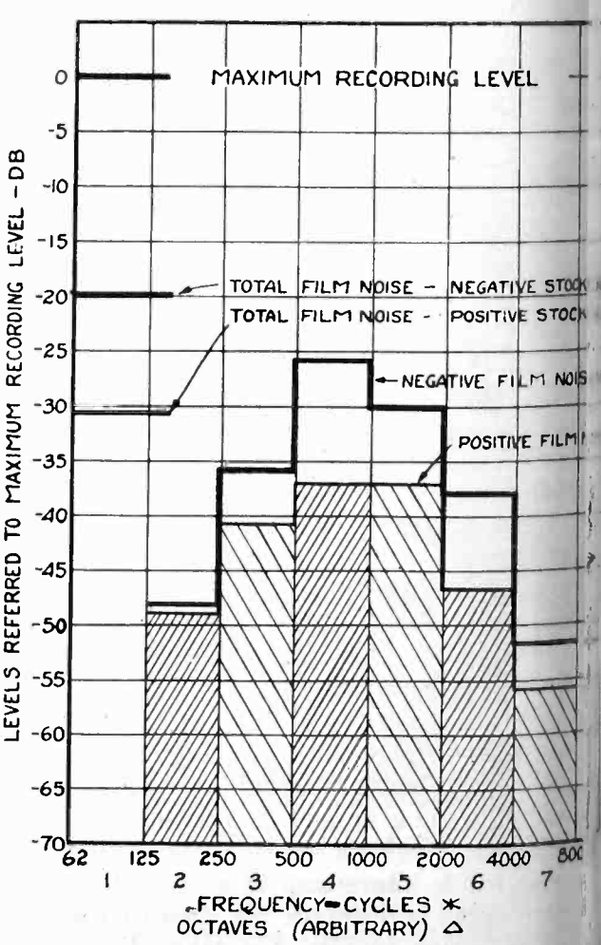


Fig. 3—Annoyance analysis of total film repr duction noise, comparative measurements f negative and positive stock are shown

are four sprocket holes per frame in motion

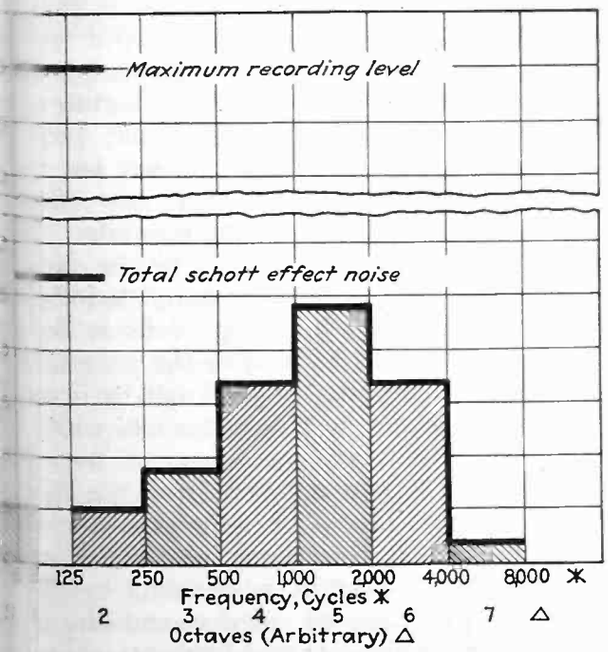
record has a considerably longer life than disc record but its age is by no means In the course of time the sound track will tched and may accumulate oil and dirt which e noise. It is interesting to note that the a of dirt in the disc record is not nearly as nce the needle effectively plows out this dirt ds.

l vibration of the projection machine does e any noticeable noise into the photo cell, es where an amplifier is mounted directly on n machine very prominent microphonic tube e expected. An analysis of mechanically oise for a typical theater installation indi- is noise is nearly as important as Schott rovements in mechanical supports of the changes in the photo cell circuit to permit amplifier at some distant point will assist in n of this noise.

tion of noise level in film recording

case of disc recording, it is important to lesired sounds on film at the optimum level nd noise will become relatively unimportant. ethods of film recording impose three dif- of limitations on this optimum recording

variable intensity fixed slit method the prin- ion is the amount of light available from g lamp. In case of variable width record- ncipal limitation is the width of the sound n the case of variable density recording by alve method, the principal limitations are c over-load and light valve clashes. The total



4—Annoyance analysis of photo-electric cell due to Schott effect

nge available with each of these methods is limited and its further extension will depend special procedure either in recording or in g. Certain photographic methods are avail- h increase the average density of the sound ing periods of low volume, thereby reducing t of Schott effect noise.

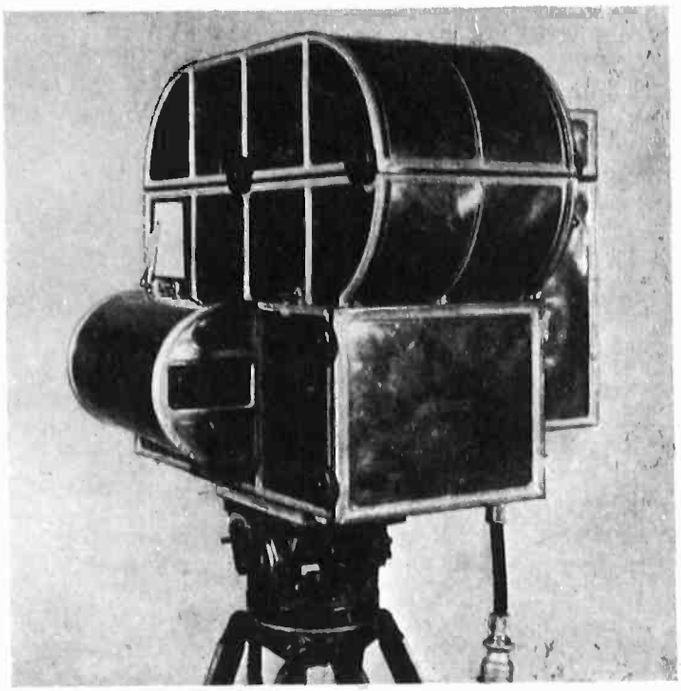


Fig. 5—Rear view of light-weight camera cover designed to overcome camera noise during recording

In any amplifying system, there are certain residual vacuum tube noises which may be unimportant for certain types of work, but which become quite important when the total amplification required is very great. This is certainly true of talking picture requirements both in the studio and in the theater. The electrical disturbances introduced into the early stages of amplification will be increased by each succeeding stage to the same extent as the sound currents. For this reason it is important that the sound currents should be very much higher in level than the residual vacuum tube noise even at the lowest level point in the system.

The condenser microphone which translates sounds into electrical currents meets this requirement for average speech originating at moderate distances but the margin of safety is small enough so that an unusually noisy vacuum tube may make the system unusable. When such troubles as bad tube contacts, leaky condensers or noisy resistors develop in the early stages of the amplifying system, the effect is quite disastrous.

While it is true that there exists in every vacuum tube, a continuous disturbance which is identical in origin with the noise introduced by photo cells (Schott effect), it happens that the output level of the condenser microphone is enough higher than this effect to render it unimportant. However, vacuum tubes are subject to other troubles of an intermittent sort such as bad terminal contacts. This difficulty can be minimized only by good maintenance or by improved tube socket design.

The very high impedance of the condenser microphone requires provision of a very high impedance input circuit connecting it to the first vacuum tube of the amplifier. The only suitable circuit for this purpose is the resistance-condenser coupling arrangement and for efficient operation the resistor should be on the order of 20 to 50 megohms. Such resistors are difficult to manufacture and most of the non-fluid types very soon become noisy. Even the liquid type of resistor may become very noisy due to the condensation of moisture on its surface, but painting the entire resistor, including its terminals and its mounting with a high quality insulating material, will reduce this trouble to negligible proportions.

HIGH LIGHTS ON ELECTRO

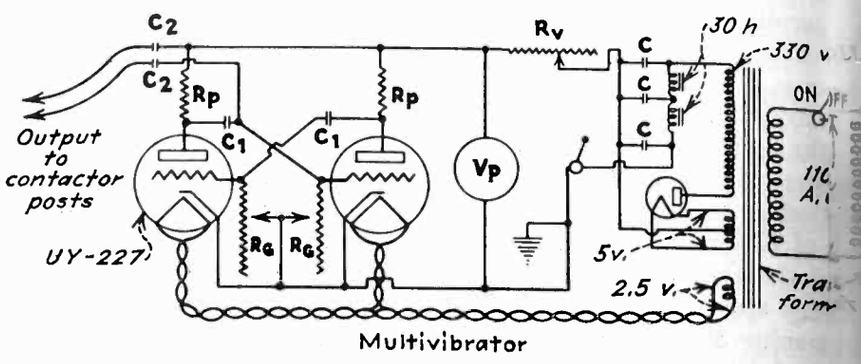
Inspecting high-speed machines with the Stroboglow

The grid-glow-tube stroboscope, or "Stroboglow," which has been developed in the Westinghouse Research Laboratories, is a device for making fast rotating or vibrating machinery appear stationary, thus enabling the study of such moving machinery.

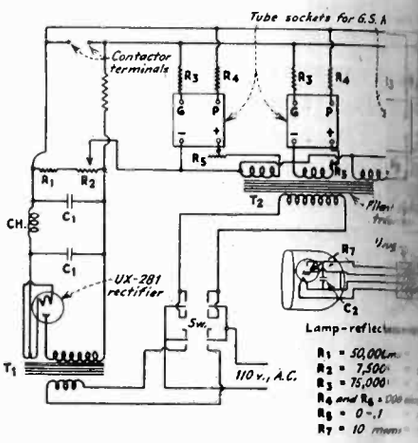
With this apparatus, beams of light, flashing on and off in synchronism with the moving part, are focused upon it, forming a stationary image which can be observed and photographed. The rapid flashing of the light is accomplished by the quick charge and discharge of the grid-glow tubes.

The Stroboglow set consists of two parts. The larger case contains the foundation unit with three reflector units, the mechanical timer, and the necessary tubes. The smaller case contains the electrical timer.

The wiring diagram of the larger unit and the lamp-reflector assembly are shown. The unit is built in a welded iron frame, and is fitted into a travelling case 25 in. x 10 in. x 14½ in. A panel 14 in. long is placed on the top of the frame, and the controls on the panel are the power switch, three filament-control rheostats, and the grid-voltage control. The contactor or timer is connected to this by means of two cord-tip jacks at one end of the panel. The three light unit cords are connected to the set by means of three UX sockets mounted on the front of the panel. The three light units consist of parabolic reflectors adapted to the GS-10 tube, the circuit condenser, a six-foot cord, and a UX plug for connecting to the socket on the set panel. The reflector units can be disassembled for fitting into a small space. The contactor is of the rotating-contact type coupled to the rotating shaft by means of a rubber friction tip on the end of the contactor shaft. Power for the unit is supplied from a 110 volt a.c. light socket.

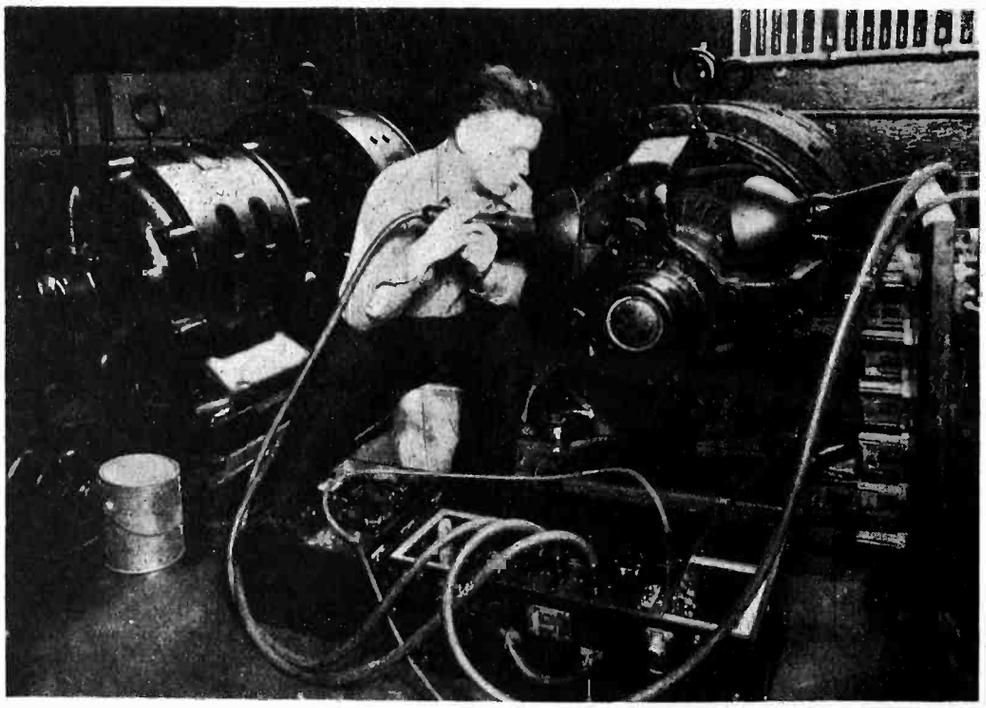


Operating circuits of the grid-glow-tube stroboscope



The wiring for the oscillator or electrical timer unit appears in a second diagram. The primary of the transformer in this unit is wound for 110 volts, and the secondaries consist of one for 330 volts at 40 mills, one for 5 volts at 2 amperes, and one for 2.5 volts at 4 amperes. The filter consists of two 30-henry choke coils and three 6 mfd. condensers. With the drop through the filter and plate resistors, the voltage impressed on the plates of the Y-2 is about 190 volts. A variable resis ance of 7,500 ohms was put i ser with the plate supply and this vario the voltage from 170 to 190 vo especially constructed grid resta operates both tubes from one on

The Stroboglow has many applic tions. In aviation, for instance its u can be extremely important. It enable observation of propeller quiver crac if such exist, engine valve actn, a weak cylinders during the warn period before the flight.



Inspecting the commutator and armature connections of electrical machine while running under full-speed conditions

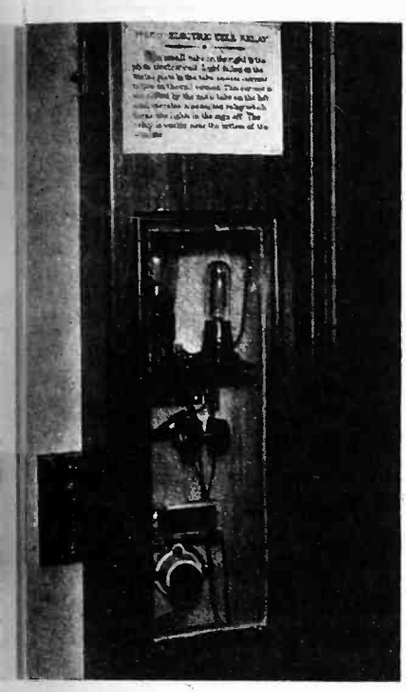
✦

Light-beam train contr in Germany

A new device being tried out o stretch of several hundred mile of th German State Railways, betwee Berl and Munich, employs a small sea light on the front of the locomotiv from which a narrow beam of light is thrown upward all the time the locomotive is in operation. A ring of light-sensiti cells are located around the sea light lens. When the train comes to sign post, the mirror on the post ref light back to one of the cell starts an electric current, whic make a visible signal in the engine cab, remains until the engineer acts on it, or if he does not respond promptly, the train is stopped automatically.

VICES IN INDUSTRY ✦ ✦

ndoor sign operated by photo-cell



pproach of a visitor intercepts ght falling on this cell, actu- ating sign through relay

ng will attract the attention more kly than an electric sign sud- nl lighted as one enters a darkened or Such a device is used in the it of the Edison Lighting Institute rrison, N. J., to focus attention on kroom sign.

one passes over the threshold, he pts a beam of light projected ro the doorway and focussed on the tcell assembly, illustrated herewith, is located in the opposite casing. ll operates a relay which turns on m.

same arrangement can be used to e an advertising sign, concentrat- he spectator's attention on the ising message. Or the photo-cell e employed to trip a phonograph which will greet the newcomer vords of welcome, followed by an dvertising message.

✦

ing plates made hoto-cell method

g the unexpected applications of oto-electric cell or electric eye is reparation of printing plates or ings directly from the copy itself, ing to J. E. Smith, president of ational Radio Institute of Wash- , D. C.

ording to Mr. Smith the actual whether it be type matter, draw- photograph, can be placed on a drum and revolved past a photo-electric cell optical system. The dot of variable light reflected from the copy to the photo-electric cell, serves to actuate the photo-electric cell, which in turn operates an electromagnetic engraving tool working directly in soft metal such as zinc, producing the final printing plate.

✦

"Breath relay" for operating electric lights

The "breath relay," a newly-invented device which is being exhibited for the first time at the Westinghouse Lighting Institute, Grand Central Palace, New York City, enables one to actuate a relay switch without having to touch it.

It consists of special contacts mounted in a small tube with a mouthpiece like that of a telephone, and is so designed that it responds only to a puff of air. Speaking into it, shaking it, or striking it has no effect. It is the invention of Dr. E. E. Free of New York City.

This relay is made of two thin laminations of phosphor bronze springs, having special metal contacts at their extremities and so mounted within a modified voice transmitter mouthpiece that a very minute puff of wind by the operator is amplified in its mechanical effect upon the springs, due to the large spring ultimately exposed to the force. This closes the contacts and completes the electrical circuit through the sensitive relay, the auxiliary contacts of which are designed to carry an electrical current necessary for controlling the apparatus.

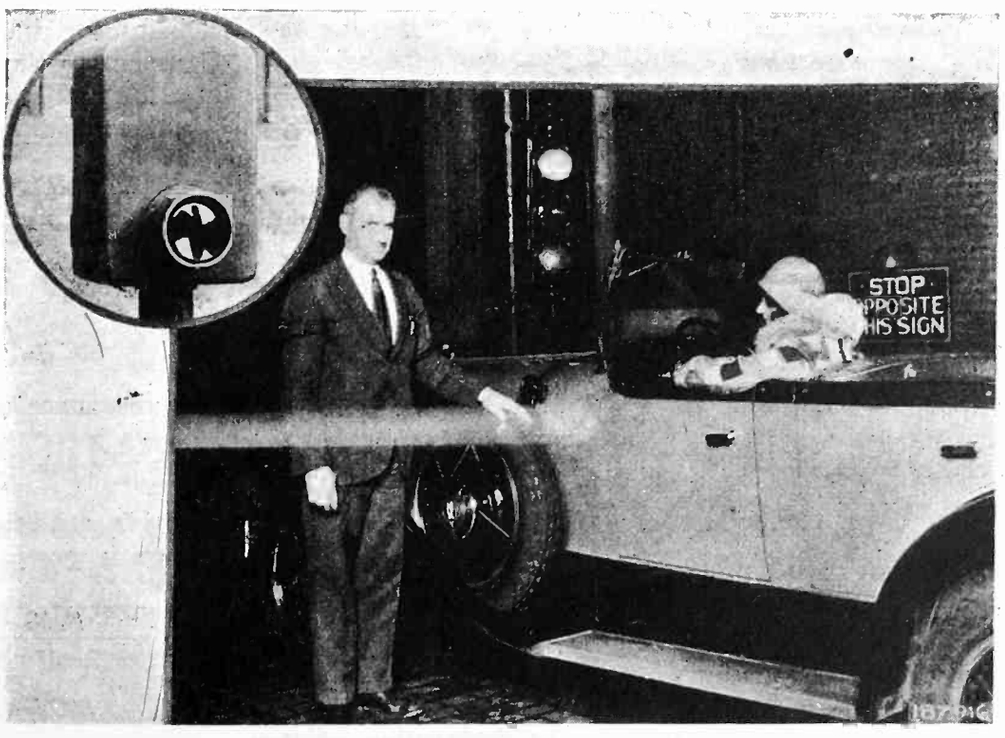
The general purpose of this relay is to provide a switch that can be operated without the use of either hands or feet, and it is expected to prove useful for safety devices of wide variety and for extending the operator's control of automobiles, airplanes, scientific apparatus, punch presses, and other machines requiring the full use of the operator's hands and, in many cases, his feet.

✦

Photo-electric cell used in traffic control

A light that "sees" automobiles as they approach the intersection of South and Coal Streets, Wilkinsburg, Pa., and operates the traffic control signals has been in successful use for several months. This equipment was designed by Dr. Phillips Thomas of the Westinghouse Research Laboratories. It is an adaptation of a photo-electric cell to one of the many new uses this device is applicable to.

It is heralded by local residents as a great boon to traffic because it eliminates the time wasted by the driver of a car in the side street while waiting when the main arterial street is clear, for the light to change to green. Usually, the light on the main arterial street is green, speeding traffic. With cars on both intersecting streets, the green and red signals flash on a pre-determined time schedule, as do ordinary traffic signals.



When the driver approaches a main traffic artery, the interception of the light beam shown, sets the signals to let cross-traffic go ahead

Tuned condenser-coupled amplifiers

By LOUIS COHEN, Ph.D.*

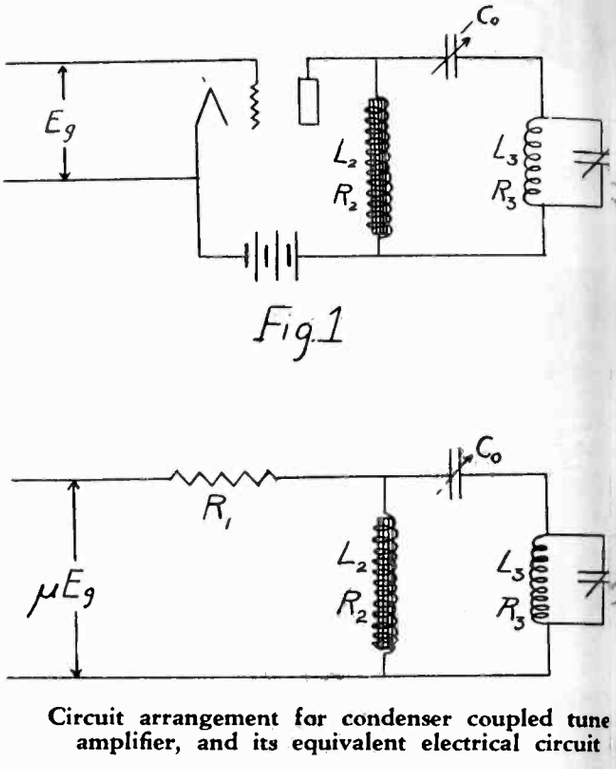


Fig. 1

Circuit arrangement for condenser coupled tune amplifier, and its equivalent electrical circuit

IN A previous article† I have discussed the magnetically coupled tuned amplifier, and I have shown that the problem is essentially a coupled circuit problem, both the amplification and the selectivity being readily determined by the application of well established formulae for coupled circuits. The same considerations should hold, of course, for other types of coupling, and we shall accordingly present here an analysis of the condenser coupled amplifier and compare the results with those obtained for a magnetically coupled amplifier. It will be shown that either from the standpoint of sensitivity or selectivity condenser coupling is as efficient as magnetic coupling, provided care is taken in the design, that is, the proper choice of values of electrical constants of the circuits.

It is believed that the reason that the condenser coupling did not come into use is because there has never been formulated an adequate theory to assist the designer or experimenter in the proper choice of electrical constants to enable him to obtain best results. The sporadic experimental efforts that may have been made from time to time to utilize the condenser type of coupling in amplifiers may have failed because there were no mathematical formulae available to guide the experimenter and point the way. From a mathematical standpoint the theory of the magnetically coupled amplifier is somewhat simpler than the condenser coupled amplifier, and the facts, therefore, on which a successful design depends were better known for the former type of coupling than the latter. It may be that it is because of this that the magnetic type of coupling is widely accepted in preference to the condenser type of coupling.

Mathematical Solution

It will be shown here, however, that once the mathematical formulae are derived, the design problem of the condenser coupling does not offer any greater difficulties than the magnetic coupling. This will become evident from the following considerations.

In the accompanying figures, the designation of the symbols is obvious. We shall also designate the currents in the branches by the same subscripts as those of the symbols of the branches; that is, I_1, I_2, I_0, I_3, and I_4. The following equations give the voltage distribution in the circuits:

$$\left.\begin{aligned} R_1 I_1 + (L_2 j\omega + R_2) I_2 &= \mu E g, \\ R_1 I_1 + \frac{1}{C_0 j\omega} I_0 + (L_3 j\omega + R_3) I_3 &= \mu E g \\ R_1 I_1 + \frac{1}{C_0 j\omega} I_0 + \frac{1}{C_4 j\omega} I_4 &= \mu E g \end{aligned}\right\}$$

We also have the auxiliary equations,

$$\left.\begin{aligned} I_0 &= I_3 + I_4, \\ I_1 &= I_0 + I_2 = I_2 + I_3 + I_4 \end{aligned}\right\}$$

From the second and third equations of (1) we get the relation,

$$I_3 = \frac{1}{C_4 j\omega (L_3 j\omega + R_3)} I_4$$

Substituting the value of I_3 from (3) into (), we obtain expressions for I_0 and I_1, which on introducing into the first and third equations of (1) and eliminating I_2 gives a single equation in I_4.

$$I_4 = \frac{\mu E g (L_2 j\omega + R_2)}{\frac{R_1}{C_4 j\omega (L_3 j\omega + R_3)} \left\{ \frac{1}{C_0 j\omega} + \left(1 + \frac{C_4}{C_0}\right)(L_3 j\omega + \right.} \\ \frac{L_2 j\omega + R_2}{C_4 j\omega (L_3 j\omega + R_3)} \left\{ R_1 + \frac{1}{C_0 j\omega} + \right. \\ \left. R_1 C_4 j\omega (L_3 j\omega + R_3) + (1 + \frac{C_4}{C_0})(L_3 j\omega + R \right\}$$

The resonance condition obtains when

$$\frac{1}{C_0 j\omega} + L_3 j\omega \left(1 + \frac{C_4}{C_0}\right) = 0, \text{ or } \omega^2 = \frac{1}{L_3 (C_4 + C_0)}$$

For this condition the current in the tuning condenser branch is given by

$$I_4 = \frac{\mu E g (L_2 j\omega + R_2)}{\frac{R_1 R_3}{C_4 j\omega (L_3 j\omega + R_3)} \left\{ 1 + \frac{C_4}{C_0} \right\} + \frac{L_2 j\omega + R_2}{C_4 j\omega (L_3 j\omega + R} \left\{ R_1 + \right. \\ \left. R_1 C_4 j\omega (L_3 j\omega + R_3) + R_3 \left(1 + \frac{C_4}{C_0}\right) \right\}$$

R_2 and R_3 are small in comparison with $L_2\omega$ and $L_3\omega$ respectively, and may be neglected, also $\frac{1}{C_4}$

*Consulting engineer, Washington, D. C.
†*Electronics*, April, 1930.

$1 + L_3 C_0 \omega^2$, and for these conditions (6) re-
e to:

$$\frac{\mu E g L_2 j\omega}{\frac{R_1 R_3}{-1 + L_3 C_0 \omega^2}\left(1 + \frac{C_4}{C_0}\right) + \frac{L_2 j\omega}{-1 + L_3 C_0 \omega^2}\left\{R_1 L_3 C_0 \omega^2 + R_3\left(1 + \frac{C_4}{C_0}\right)\right\}} \quad (7)$$

C is large compared with C_0, of the order of twenty
irty times, then the unity term may be neglected in
parison with $\frac{C_4}{C_0}$, and also $L_3 C_0 \omega^2$ is small compared
unity. For these approximations (7) reduces to

$$I_4 = \frac{-\mu E g L_2 j\omega}{R_1 R_3 \frac{C_4}{C_0} + L_2 j\omega\left(R_1 \frac{C_0}{C_4} + R_3 \frac{C_4}{C_0}\right)} \quad (8)$$

e term $L_2\omega$ is large, of the order of magnitude of
f R_1, the second term in the denominator will be
in comparison with the first term, and equation
educes to the simple form

$$I_4 = \frac{-\mu E g}{R_1 \frac{C_0}{C_4} + R_3 \frac{C_4}{C_0}} \quad (9)$$

n be readily shown that the current I_4 is of maxi-
m value when

$$\frac{C_4}{C_0} = \sqrt{\frac{R_1}{R_3}} \quad (10)$$

or this condition

$$I_4 = \frac{-\mu E g}{2\sqrt{R_1 R_3}} \quad (11)$$

his precisely the same expression that obtains for
e current in the tuning condenser of a magnetically
ued amplifier. The voltage across the tuning con-
ser is

$$E_2 = \frac{I_4}{C_4 j\omega} = -\frac{\frac{1}{C_4 j\omega}\mu E g}{2\sqrt{R_1 R_3}}$$

he amplification is given by,

$$\frac{E_2}{Eg} = \frac{\mu \frac{1}{C_4 j\omega}}{2\sqrt{R_1 R_3}} \quad (12)$$

or

$$\frac{1}{C_4\omega} = 1{,}500,\ R_1 = 10{,}000,\ R_3 = 10,$$

$$\frac{E_2}{Eg} = \frac{\mu\ 1{,}500}{2\sqrt{10^5}} = 2.4\mu.$$

he amplification is of the same order as that which
tains in a magnetically coupled amplifier under the
o favorable conditions.

The condenser coupled amplifier has the advantage that the coupling, which is the ratio of $\frac{C_0}{C_4}$ can be maintained at a fixed value for all positions of the tuning condenser thereby securing uniform amplification for the entire range of frequencies for which the circuit tunes. The coupling condenser C_0, is very small. a single moveable plate is sufficient, and all that is necessary to do is to mount back of the tuning condenser at proper distance an additional plate, which by its movement will produce a variation in the coupling condenser in the same ratio as the variation in the tuning condenser, and thereby maintain the ratio fixed.

The reactance element L_2 may be replaced by a resistance of the same value in ohms as the reactance. For the ordinary tube a resistance of the order of 10,000 ohms is required, and for the screen-grid tube a much higher resistance is required, of the order of 100,000 ohms or more. Introducing in the plate circuit a resistance of the order of magnitude of the plate filament resistance would require doubling the plate voltage, but this is not an important consideration in a.c. sets.

The above analysis shows clearly that a condenser coupled amplifier, when due regard is had to design, will give as good amplification as that of a magnetically coupled amplifier. It can be also shown that in the matter of selectivity the condenser coupled amplifier is as efficient as a magnetically coupled amplifier. The mathematical expression for selectivity, which is merely a ratio of the expressions for the current in the tuning condenser at resonance and off resonance, is in this case not of such a simple form as to show by mere inspection of the formula the dependence of the selectivity on the constants of the circuits, and it will, therefore, serve no purpose to write down the formula here. An indication of the selectivity obtained can be had, however, from numerical examples in some typical cases, and such calculations show conclusively that the same degree of selectivity is obtainable from a condenser coupled tuned amplifier as that of a magnetically coupled amplifier.

In some of the patent literature pertaining to tuned amplifiers it has been insisted that for the most satisfactory operation of a tuned amplifier, it is necessary to adjust the mutual inductance between the plate and tuned circuits so as to make the input conductance substantially higher than the plate conductance. This may be a necessary condition for the successful operation of a magnetically coupled tuned amplifier, but it does not necessarily hold for the condenser coupled amplifier. It can be shown that for the circuit system discussed in this article the input conductance is of the same order of magnitude as the plate conductance.

▼ ▼ ▼

THINGS YET UNDREAMED OF IN OUR PHILOSOPHY

It is conceivable that many other forms of stimulation exist in our environment for which we have as yet evolved no receptors whatever. Our conception of our environment and of the processes going on within it, must therefore be imperfect and incomplete, and may forever remain so.

DR. C. J. DAVISSON,
Bell Telephone Laboratories, New York,
Co-author of the wave-theory of the electron

A slow acting vacuum tube relay

By DALE POLLACK

A NUMBER of electrical devices and apparatus require a desired action to take place at some interval after the starting impulse has been given. Thus, in Fig. 1, a device *R* is interposed between the switch *S* and the contacts *C*, which are to be bridged some seconds or minutes after the switch has been depressed. The device delays the action of the original impulse, so that the contacts are closed at a definite interval subsequent to the starting impulse. An apparatus of this sort is called a delayed time relay, or, better, a slow acting relay.

With the increasing use of vacuum tubes for the generation of high power radio frequency currents for transmission the need for slow acting relays became more general. It is well known that the characteristics of large audion filaments are such that, if the tub to be injured, the filament must be permitted t its full operating temperature before the plate is applied. If this procedure is not followed, t mature application of the plate voltage, which m thousands of volts with most transmitting tubes, certain to impair its emitting properties. The will be forced to supply electrons to the highly plate before a sufficient number of electrons boiled to the filament surface by the heating Failure to follow the proper procedure may r damage to expensive tubes. The station operato be depended upon infallibly and consequently th delayed time relays becomes desirable.

The evolution of the mercury vapor rectifier l ther hastened the development of slow acting re addition to the danger from de-activated filamen tioned above, mercury vapor rectifiers suffer more serious defect. If the anode voltage is to one of these tubes before the filament has a sufficiently high temperature, a flashover wi between the plate and the filament because of t conductivity of the mercury vapor even befor comes ionized. This flashover often results in plete break in the filament, or, if the filament completely severed, a weak spot will be develope will be in permanent danger of sudden rupture.

At least one manufacturer has acknowledg fault by correcting it in subsequent design. A this new tube does not suffer from filament from this source, an annoying flashover still if the plate voltage is applied while the filament All mercury vapor tubes may be protected by i a delayed time relay in the high voltage supply The problem, then, is to design the proper relay.

Several types are in use today. The commer at present generally used makes use of two elec nets wound in the same magnetic field, as in One of these *A* is the regular high resistance which is connected directly to the starting key tery. The other coil *B* usually consists of c short-circuited turn of heavy gauge strip, of c

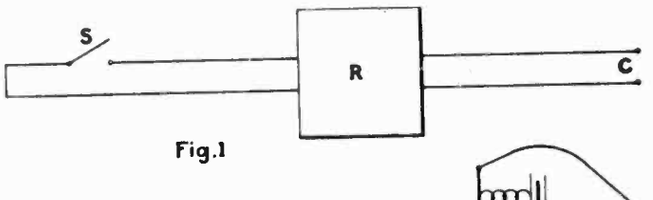


Fig.1

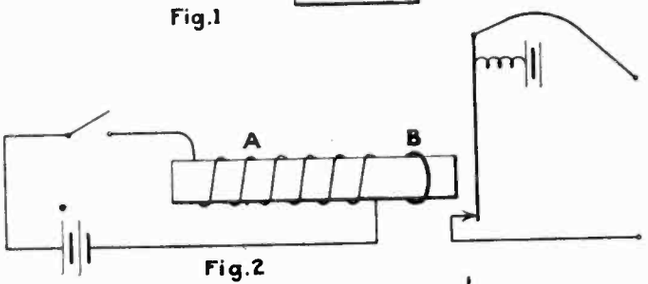


Fig.2

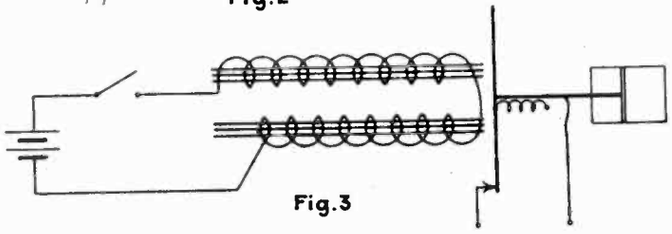


Fig.3

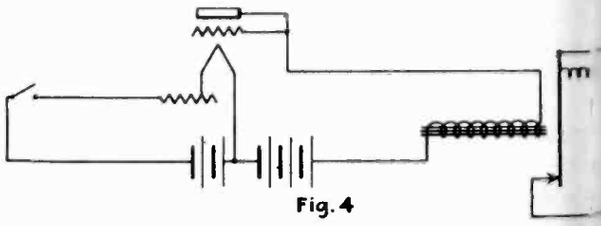


Fig.4

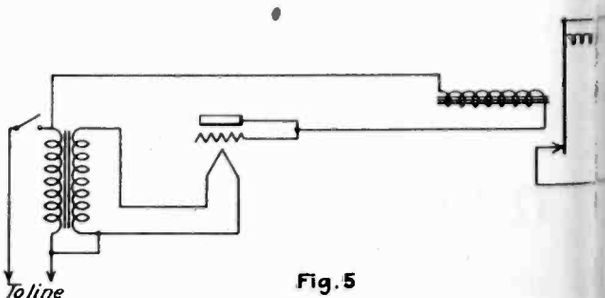


Fig.5

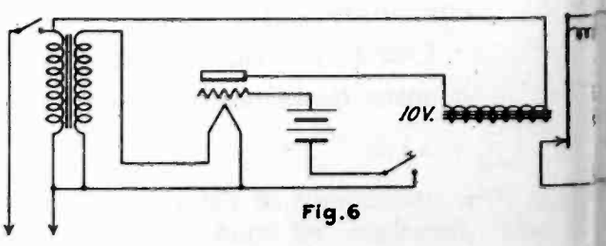


Fig.6

Above: Electromagnetic time delay devices

Right: Types of vacuum-tube delay circuits

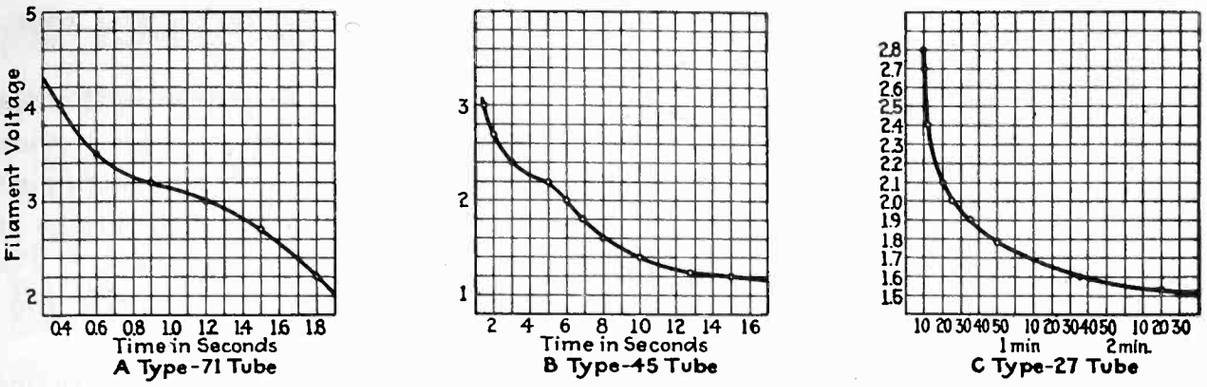


Fig. 7—Typical time-delay curves for three types of tubes covering usual range for delay action

low resistance. When the battery current is sent gh the high resistance coil, a current will be in- into the other coil. The current in the turn B will t the high resistance coil from magnetising the until the induced current has died down in the circuited coil. The length of time required for lay to act will depend, primarily, on three factors tension of the armature spring, the coupling be- the two coils and the power absorbed by the r coil. The power which it will absorb will be ined by its I^2R. Its resistance should be kept as possible in order to increase the time interval. fore, a single turn coil is used for this purpose.

er types of delayed time relays depend upon me- al means to obtain their retarded action. The method is to pull a piston through a viscous liquid action of a pair of electromagnets. The friction ped between the liquid and the piston will delay tion of the relay and so give the required action. levice is illustrated in Fig. 3.

device illustrated in Fig. 2, though used exten- in vacuum tube work, is expensive and delicate ather difficult to maintain in proper adjustment. e $150 worth of relays to protect each $100 worth es would hardly be justifiable. The liquid type is sable where a thoroughly dependable apparatus is ary. The delay interval will be found to vary derably, even on successive depressions of the key. liquid, in addition, will evaporate, and, as the t used is small, it must be replenished often. In ns where these defects are offset by special con- s it may be found of value.

Vacuum tube relay

types of vacuum tubes have an interval between stant that the filaments are lighted and the time they begin to draw plate current and to function lly. If a common high resistance relay is con- l in the plate circuit of the "relay" tube (Fig. 4) be used to control the desired device. The plate rid are connected together to decrease the plate nce, to facilitate the use of relays of lower resis- directly in the plate circuit.

avoid the use of batteries to supply current to the tube, the entire apparatus may be operated from 10-volt a.c. line in a self-rectified circuit similar t shown in Fig. 5. The transformer, since it will e required to insulate high voltage, or to deliver a amount of power, may be of the bell-ringing y. The vacuum tube, besides serving as the time ng mechanism, also rectifies the alternating current t it may be used for the plate relay.

The choice of a tube will of course depend essentially upon the interval through which it is desired to make the relay act. Only small receiving tubes will be considered useful for this purpose. The thoriated and tungsten filaments, in general, operate too quickly for any but the shortest intervals, that is, less than one second. For short intervals a type —12, or a type —45 will be found satisfactory, but for longer intervals, of from eight seconds to two or more minutes the type —27 will serve to better advantage. Adjustment of the time interval to its final value may be accomplished by varying the filament voltage of the relay tube; a rheostat in one leg of the tube filament will serve.

The graphs in Fig. 7, have been prepared as a guide for approximations, though it should be remembered that the shapes of the curves given are under the influences of the tube used, the relay design, and particularly upon the relay resistance and the tension of the armature spring. However, the curves will be found of assistance in determining the proper tube and the approximate filament voltage to use to obtain the desired interval. The three types of tubes whose curves are given may be used to cover the entire range of time intervals from a tenth of a second to three minutes. Very few other types of delayed action relays offer such a wide band. The plate circuit relay with which the curves were taken had a resistance of 200 ohms. The circuit in Fig. 5 was used with a line voltage of 115. The armature return spring was so adjusted that the relay required a current of five milliamperes to operate.

Special applications for relays

Slow acting relays of this sort find a multitude of applications in fields separate from the protection of power tubes. Certain alarms are designed to operate only after the actuating (or "alarming") force has been applied for a definite length of time. Photo-electric fire alarms, for example, will turn in false alarms if a ray of light is permitted to fall upon the operating device, or, if, as in another type, the beam of light falling steadily upon the light sensitive cell is momentarily interrupted by a foreign body or by a variation of the supply voltage. Similarly, power companies utilizing photo-electric devices to automatically illuminate and darken street lights would be saved the annoyance of flickering lamps when an extraneous light falls upon the cell operating the system by the installation of a slow acting relay designed to operate in perhaps, five seconds. The lamps would then only be darkened by the action of a light, in this case the sunlight, falling upon the cell for at least five seconds.

[*Continued on page 360*]

electronics

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O. H. CALDWELL, *Editor*

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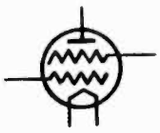


High-power broadcasting should be demanded; not limited

FEDERAL commissions concerned with routine become futile things; and in its efforts to administer radio with one ear held close to the lips of its political masters, the Federal Radio Commission is no exception to this rule.

Its recent regulation preventing half of the broadcasting stations on clear channels from having high power, (even though such stations are willing to spend hundreds of thousands of dollars for high-power equipment and thus to serve the public with high-intensity signals), is but an example of the Commission's absurd struggles to comply with the politicians' behests, even at the cost of public service.

If high power is good on four channels out of eight in each zone, certainly it is just twice as much in the public interest to have *all eight* go to high power.

For it is *power—high-power* broadcasting—that has *made radio reach the ranches and farms.* Putting *power* behind the programs has enabled rural listeners to hear great speakers, great musicians and great events of the day, with all the crispness and clarity with which they can be heard in the city, a hundred miles away. And so, today, the names of KDKA, WJZ, WGY, WEAF, WGN and WLW are household words in farm homes everywhere. On them, and on stations like them, millions of farm homes have learned to depend, for news, markets, education and entertainment.

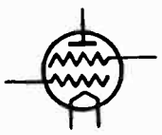
Power and *power* only can drive strong sharp signals through the racket and roar of su interference.

Power, and *more power* is the answer t farmer's plea for better radio service.

Power will bring in his market figures cle unmistakable, his musical programs unmar volleys of musketry from "static." Power e the radio message to over-ride the inter natural interference.

In its present attitude of restricting and ing the use of high power on half of the clear channels, the Radio Commission is ope directly in opposition to the public interes contrary to the consensus of all expert an neering opinion.

It is deliberately wasting the priceless u resource of the radio channels, and impo senseless hobble on the enjoyment of good casting by millions of our people.



A time to build up for the future

MANUFACTURERS in the field c tronics are business men and th readily recognize the opportunity which re industrial conditions put before them, in pr for the big developments ahead.

At the moment, general prices are low; b efficient and is not likely to be cheaper; i ments made now will not interfere with r tion. At present levels, the purchaser more for his dollar than he has gotten f past.

This is a time for research, for self-s for studying old products and considerin ones. It is a time to get ready to sup demands of the future.

Credit resources are abundant, and lo borrowing is sound, when undertaken materials, for modernization of plant, fo tion of costs, or for preparation to meet tition.

Prices are not likely to decline furthe bottom has been reached, and the tide has The present is the time to "dig in and get the big days of the expanding electronic ahead.

hall radio cabinets vs. v frequency response

SOLE radio receivers displayed at the dio World's Fair, Madison Square New York City, were smaller than simi- els of previous years. Without a doubt, rs do not desire a houseful of radio and ct favorably toward the more compact s. It is difficult, however, to reconcile for greater fidelity of response with de- baffle size for the ubiquitous dynamic e

e is a definite relation between the size housing for the speaker and the lowest ental note which will be transmitted. Thus e baffle of nearly three feet square is neces- t transmit without destructive interference s low as 100 cycles. Putting a cabinet the baffle may decrease the required dimen- omewhat, but a too great decrease will te low notes back to 1926 levels. At the me troublesome resonances become objec- e.

ctively small cabinets are desirable; so are notes.

ecifying colors by noto-electric spectrum analysis

e article on a preceding page, *Electronics* ts the way to a new definition of color in terms of graphs of *spectral energy dis- n.*

specifications would be definite, permanent adily reproducible, as contrasted with *color charts* or *color samples,* which fade e difficult to compare or to reproduce uni- in quantities.

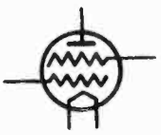
h a number of electronic color-analyzing de- ow on the market, it would appear that a ethod of rigorous color specification could iched, which will have the most widespread ce on countless industries where accurate nd tint are important factors.

feel that the time is now ripe to undertake move, even though, as we well appreciate, ties still stand in the way of such a needed n.

Teach them to change their tubes

IT has taken several years to drive home to the public the necessity and advisability of changing crankcase oil every 500 miles. This has resulted in a profitable repeat business for gas stations and longer life to every motor. And the idea, through constant repetition, has become fixed in the public's mind; it was not done overnight.

There have been only sporadic efforts up to now to urge a renewal of tubes. Perhaps a concerted effort of all tube and receiver engineers coordinated with the commercial forces in this field can build up a tube consciousness in the public that will result in better reception and increased tube consumption.



Industrial X rays— revealers of secrets

ELECTRONS traveling at speeds of the order of 100,000 miles per second strike a metallic target. The result is the production of X rays, a radiation of light of such a small wavelength that they penetrate substances opaque to visible light. The human flesh—as in taking photographs of broken bones—cement, steel castings or lead, all are penetrated by the all-seeing X ray.

Permitted to expose a photographic plate after being projected at a casting suspected of internal flaws, this short-wave light shows immediately whether or not the metal is of homogeneous construction, or whether flaws hidden from sight will endanger life or property.

A wire is twisted and hidden within the cathode of a heater-type vacuum tube. If the twisted wire is out of alignment, it may short circuit or fail mechanically in a few hours. An X ray photograph of a box full of cathodes shows at once the defectives, and they never get into vacuum tubes. They are rejected at once.

Testing of metals and other solid substances by this method is unique; the X rays have no competitors. Their use in industrial plants increases daily. Hardly a solid factory product will exist in the future that will not feel the effects of rapidly vibrating X rays searching out its secrets.

REVIEW OF ELECTRONIC LITERATUR
HERE AND ABROAD

Gridless vacuum tubes

[R. RAVEN-HART] One of the most interesting items at the Berlin Radio show was the new Telefunken "gridless" tube, in which the control element is formed by the external metallic coating on the glass wall of the tube.

Figure 1 shows, in cross-section, the internal construction of the new tube. The base is also rectangular shaped and has three pin connections for the plate and filament, the connection to the coating being made by a spring. The closeness of the control element to the electron stream should be noted: it is this which has permitted an increase in amplification factor from 2 or 3 to 25 or 30. The anode is a vertical cylinder of approximately pear-shaped cross-section, not surrounding the filament but beside it.

The types of tubes at present being produced, are: a high-vacuum (hard) tube for audio-frequency amplification, and a soft (gas-filled) tube for use as a detector. Both are intended to be used with resistance coupling only, in accordance with standard German practice.

Taking the case of the hard tube first, it is to be noted that if an external fixed positive voltage be applied to the coating, the result will be that an equivalent negative voltage will appear as an electron charge on the inside of the glass wall, and the effective voltage as regards the anode current will be zero. This point is of interest, since it makes the use of grid condensers, to keep the B voltage off the "grid," unnecessary, and thus greatly simplifies the circuits (see Fig. 2).

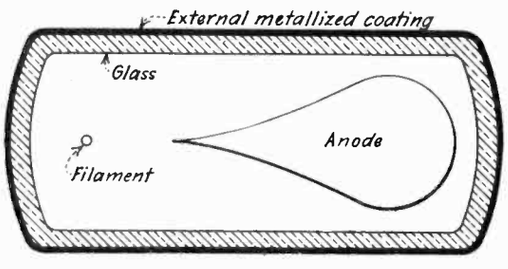
If however an alternating external voltage be applied to the coating, the electron charge will be formed during the first applied positive quarter cycle, but will then remain there substantially unaltered (the insulation being good) so that after this quarter cycle the effect on the anode current will be that of the applied signal voltage minus a fixed amount, which for amplification purposes is the same as if the signal voltage alone existed.

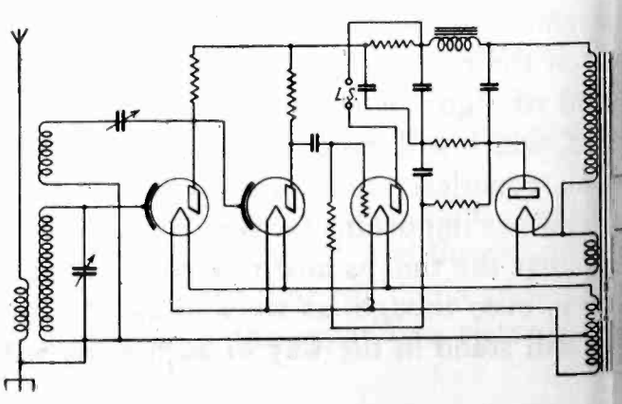
In the case of the gas-filled tube the effect (or absence of effect) of a fixed voltage will be the same as for the hard tube. With an applied alternating voltage, on the other hand, the results are completely different. Here, if the applied alternating voltage is of a low frequency, there will be the same electron flow to the glass wall during a positive quarter cycle, but there will also be an iron flow during the applied negative quarter cycles, so that the inner side of the glass wall will always be charged equally and with opposite sign to the coating, and the resultant effect on the anode current will be nil. Only as the frequency of the applied voltage increases does the difference in inertia of the electrons and ions become noticeable, the ionic charge not having time to annul the negative charge; until at frequencies above about 10,000 the tube really begins to amplify. A steady negative charge builds up on the glass and has (as in the case of the hard tube) to all intents and purposes no effect on the anode current, which is thus controlled by the applied voltage as if it alone were present. At really low frequencies such as 50 or 100 cycles the tube actually "de-amplifies," reducing the applied voltages by about 99 per cent: the tube is thus extremely insensitive to commercial power and light frequencies.

Figure 2 shows a circuit recommended by the manufacturers; no values are given. The only difference from a normal set (other than those already mentioned) is that the regeneration coil must be somewhat larger than usual. Grid condensers and leaks are not required.

Berlin radio and phonograph exhibition

In this year's radio show at little change from last year i noted. The four-tube receiver v screen-grid leads among the l tance sets, but the most stri crease is in the number of ch for "local" reception, chiefly wi tubes (detector and two audio, re coupled). Battery receivers great decrease, except as regar able sets, to which more attem been paid this year. Receive into the loudspeaker (as distin cabinet sets with built-in louds are becoming very popular. M are so fitted that a pentode can in the last stage. Practically ceivers with more than two scre tubes are shown, and very fe heterodynes. In loudspeakers t pole permanent magnet dominat number of dynamic loudspeake an increase, and they are b decidedly cheaper. Electrostat are still rare. In general one impression that in this section or less stationary stage of dev has been reached, no sudden ip ment being probable. As regard nent parts, among the most in items are the improved conden fixed (mica, etc.) dielectric, small and cheap dry electrol densers (e.g. of 150 microfara the tubes, the only striking n the new flat Telefunken controlled tube. Increasing is shown in interference-filte A.E.G. now fit all their elec pliances, fans, vacuum-clean with such filters at a very sm cost. Some television sets a but the general impression pr that this field is very far fr for the general public.—*Funk August 29, 1930.*





Above: Cross-section of gridless tube
Right: Circuit for the gridless vacuum tube of the Telefunken Company

...e developments of ...hermionic voltmeter

MOULLIN.] An excellent article ... of the oldest workers in the field ...ll of detailed information. As ...w we cannot do better than quote ...im the author's summary.

...this paper various ways are con...d in which a 3-electrode valve ... be used in a thermionic volt... and the accumulated experience ...eral years' work by the author in ...g valve voltmeters for various ...es is described. No one arrange...can possess every desirable prop..., nd it is shown how to produce a ...ter to fulfill specified require... The effective input resistance ...d various arrangements, and the ...nic currents produced by grid ...t, are considered analytically and ...mentally. The effect on range ...nsitivity of providing additional ...es is also discussed, extra batteries ...found to be an advantage only in ...w range instruments."—*Journal, ...stitute of Electrical Engineers. ..., 1930.*

✦

...surement of space-...ntial in h.f. discharge

...NERJI and R. GANGULI.] Using ...thod developed by Langmuir and ...mith *(Phys. Rw. 28, p. 727,* ... for the measurement of space-...al as well as the average velocity ...ncentration of the electrons and ... the different parts of a discharge ... d.c. discharges, the authors have ...led in measuring the same quan... a.c. discharges.—*Nature August ...0, p. 309.*

✦

...o discharge in hydrogen

RUSK.] It has been suggested ... e glow discharge in hydrogen at ...es below 0.1 mm. of mercury is ... by resonance of neutral mole...ecause it has little or no relation ... distribution of the electric field; ...r suggestion is that the primary ...of the glow is radiation rather ...electron impact. Measurements ...ade in a hydrogen glow tube, by ... of a cold exploring electrode, of ...ential in the tube on the side of ...hode opposite to the anode. It ...und that the space potential rose ... behind the cathode (heated) to ... the value of the anode potential ...opped again sharply at the ex... of the glow. Electrons ac...ed in this region would produce ...ion and excitation and at the ... potentials would seem to be more ...sible for the glow than excitation ...diation.—*Philosophical Magazine, ..., 1930.*

Transmitter and receiver for 1-8 meter wavelengths

[SPORNHAUSEN] Full description with constructional details and photographs. The transmitter uses a Hartley, the receiver a super-regenerative circuit. Adjustments, measurements, and telephony (plate modulation) are also described. — *Radio B. F. f. A., Berlin, September, 1930.*

✦

Mechanism of the electrodeless discharge

[JOHN THOMSON.] The mechanism of the self-sustained discharge between metallic electrodes maintained at constant potentials is not yet clearly understood. The presence of the electrodes associated with the constant difference of potential between them causes the "life" of a gas ion to be very short. This difficulty may be in part removed by the use of high frequency alternating potentials; it may be almost entirely removed by applying the high-frequency oscillations to the discharge tube by means of external electrodes. Under these circumstances ions produced in the discharge can only disappear owing to recommendation or to diffusion to the walls, and consequently a self-maintained discharge will take place when the rate of formation of the ions is just more than sufficient to compensate for these losses. The purpose of this paper is to give a brief account of a simple theory of the discharge with external electrode.—*Philosophical Magazine, August, 1930.*

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Half-million-volt X-rays

[W. D. COOLIDGE.] X-rays at 500,000 volts, more than twice as high a voltage as is being used in today's most powerful therapy tubes, have been attained by Dr. Coolidge, associate director of the General Electric research laboratory at Schenectady. Such a decided increase in voltage, and hence increase in penetrating power of the rays, was made possible by a system of "cascading."

The announcement of the new tube was made at the convention of The American Roentgen Ray Society, on September 24, when the Caldwell lecture was given by Dr. Coolidge. In his talk, wherein he reviewed the development of modern X-ray generating apparatus, Dr. Coolidge not only announced that X-rays at a half-million volts had been attained in the Schenectady laboratory, but he also stated that another X-ray tube is now being developed there to operate at 900,000 volts.

Earlier attempts in the Schenectady laboratory to build experimental X-ray and cathode-ray tubes for voltages appreciably in excess of 250,000 ran into difficulties due to a "cold cathode" effect, whereby current flowed through the tube even when the cathode filament was not heated. Continued investigations showed that this limitation could be removed by dividing the voltage applied to the tube between different pairs of tubular electrodes. By thus dividing the tube into sections, each of which may be good for as much as 300,000 volts, a three-section cathode-ray tube for 900,000 volts was constructed some years ago. Such a cascade or multisectional system, Dr. Coolidge found, promises to permit the building of vacuum discharge tubes for as high voltage as can be generated—and voltages of millions are being produced in the Pittsfield laboratory of the General Electric Company. The use of the cascade tube applies equally well to X-ray and cathode-ray tubes, since the latter may be converted into the former by the addition of a suitable target.

The highest-voltage Coolidge X-ray tubes used commercially at the present time are of 200,000 volts peak capacity, and are of two types—water-cooled and air-cooled. Both are adaptable for X-ray therapy. The air-cooled type has been used to considerable advantage in industrial applications of X-rays, since the high voltage gives the necessary penetration required for examining the heavier metal objects. Industrially, higher voltages would permit radiography of thicker metals, and shorten times of exposures.—*Paper American Roentgen-Ray Society, West Baden, Ind., September 24.*

✦

Hydrogenized iron of high magnetic permeability

[B. CIOFFI.] Single crystals of iron produced by high temperature treatment in an atmosphere of hydrogen were found to have initial and maximum permeabilities of 6,000 and 130,000 respectively. For such specimens the coercive force is 0.05 gauss and hysteresis loss for Bm = 14,000 is 300 ergs /c.c./ cycle. The factors which determine the results are temperature and time of treatment, pressure of hydrogen and thickness of the metal.—*Nature, August 9, 1930, p. 200.*

✦

Amplitude, frequency, and phase modulation

[LOEST] Full discussions are given, especially from the point of view of the width of sidebands produced, of these three methods of modulation. Circuits and curves are given, especially for the two latter, less well-known methods, and the treatment of phase-modulation is particularly full, with mechanical analogies. — *Funk, Berlin, September 8, 1930.*

New photo-electric cell

[VON HARTEL.] Describes a new cell developed by Lange, in which the cathode is a metal film, so thin as to be transparent, separated from the anode by a semi-conducting layer (similar to that used in the copper-oxide rectifier, for example), this being also very thin in order to reduce the electrical resistance. Most metals can be used, and the anode and cathode can be of the same metal: for example, copper-copper oxide-copper is a suitable combination. The sensitivity extends over the whole visible spectrum, with a maximum towards the infra-red. The sensibility is stated to be ten times that of the normal cell, and the cost of production far lower.—*Radio B.F.f.A., Berlin, August, 1930.*

✦

The "thory bometer," for measuring street noises

This device comprises a microphone plus an amplifier and a sensitive relay. When a noise is received, it trips the relay which puts a charge on two plates

in a gas chamber causing the latter to expand which forces a liquid up a tube. This the height of liquid is a measure of the amount of noise in a given period of time.—*La Nature, August 1, 1930.*

✦

Electric machine to measure thought

[E. E. FREE.] Records of a philosopher's thinking activity, made second by second during the day and night as engineers keep records of the performance of a great electric dynamo in a powerhouse, are promised by Professor Hans Berger, distinguished psychiatrist of the University of Jena, in Germany, by means of a machine which he has invented to register the electrical energy set free in the brain in the course of mental activity. Similar attempts were made some years ago by an Italian physicist, Dr. Ferdinando Cazzamalli, using a radio receiver of special design to pick up what were believed to be electric waves from the brain; a real example of a "brain wave." Difficulty was encountered, however, in sorting out from these waves of "brain radio" other impulses generated by the flow of the blood, the beating of the heart, the action of muscles and other vital activities. These difficulties Professor Berger believes that he has overcome by a special apparatus using electrodes attached to the body to pick up the supposed brain impulses instead of depending on accompanying radio waves. There are still difficulties, Professor Berger admits, in interpreting the electric impulses from the brain but it is believed that the apparatus already is capable of providing regular, continuous records of the intensity of mental activity. Nothing of the nature of "thought reading" is anticipated but it is hoped that these new and purely physical records of brain activity may be useful to psychologists in studying both the nature of thought and of the control of the body by the brain.—*Week's Science, September 1, 1930.*

✦

Stroboscope for observation of loud-speaker diaphragms

[VON ARDENNE] It is possible to examine a vibrating diaphragm through slots in a revolving disc, the loud-speaker being fed with the audio frequency desired and the speed of revolution of the disc being adjusted to give an absolutely stationary image or one which slowly alters. It is however preferable to use periodically interrupted illumination (through the slots in such a disc) since the observer can thus place himself in any desired position relative to the disc: a magnifying-glass or microscope can also be used, especially for the higher frequencies where the amplitudes of vibration are small. The production of overtones can be studied by making the frequency of the light nearly a multiple of that of the note. For photographic or measurement purposes where an absolutely stationary image is essential more elaborate methods must be used, and these are fully described. Examples of the results obtained are also given, with special reference to the new Loewe loud speaker. — *Funk, Berlin, August 22, 1930.*

✦

Automatic anti-burglar protection

[KUENTZ.] Three types of apparatus are described: A small instrument which detects the approach of a person by the "hand-capacity" effect, this unbalancing two circuits and thus setting off an alarm. A set of delicate microphones which can be built into a wall, etc., to detect and if desired register any sounds within their range, being however uninfluenced by vibrations at a distance such as the passing of heavy trucks in a neighboring street, finally an invisible barrage of infra-red rays, normally actuating a photo-electric cell, which when de-energized by the interception of the rays by a foreign body sets off an alarm.—*La Nature, Paris, September 1, 1930.*

Effect of ultra-short wa on living organisms

[GÜNTHER] Description of th ments of Dr. Schliephakes of given. Waves of 3 meters are in a simple circuit with a one and a half kw., the organis placed between the plates of denser in a circuit coupled Among observed effects may tioned the immediate killing of slower deaths of rats, mice, an pigs (up to several minutes bei sary in the case of the larger preceded by increases in body ture. Experiments with hum have shown a sensation of usually unpleasant althoug erably high temperatures are within the body (higher t diathermy). If a half or qua antenna is coupled to the os place of the closed circuit wit denser-plates, persons remain field of radiation complain ache, nervousness, sleeplessn other cases extreme sleepines of 5 and 6 meters give stri marked effects: it is suggeste is due at least in part to th imate resonance of the bo normal person to waves of For curative purposes a great over diathermy is that all the of the body (bone, flesh, are heated to approximately degree, whereas in diatherm substances are the most affect proportion of the heat thus in the superficial tissues and ing the deeper organs or th *Radio B. F. f. A., Berlin, 1930.*

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Characteristics of photovoltaic cells

[FINK AND ALPERN] Ope and characteristics of a voltaic cell, designed for ind poses, are given. Sensitiv cell is 150 microamperes per current *vs.* illumination char linear between 0 and 100 square foot. It is most about 4600 Angstroms.

The cell is of the copp oxide—lead nitrate (Wein) paper gives the results of physical analysis of the characteristics. Curves of s various light frequencies, plotted against illuminatio of output resistance upon are given.

The authors are respecti Division of Electrochemistr University, and Assistant Electrical Engineering, College.—*Paper presented b ican Electrochemical Socie 1930, Detroit.*

Electronic Ears for Millions

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d world that is not
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ectronic arts of radio
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be mediums, millions
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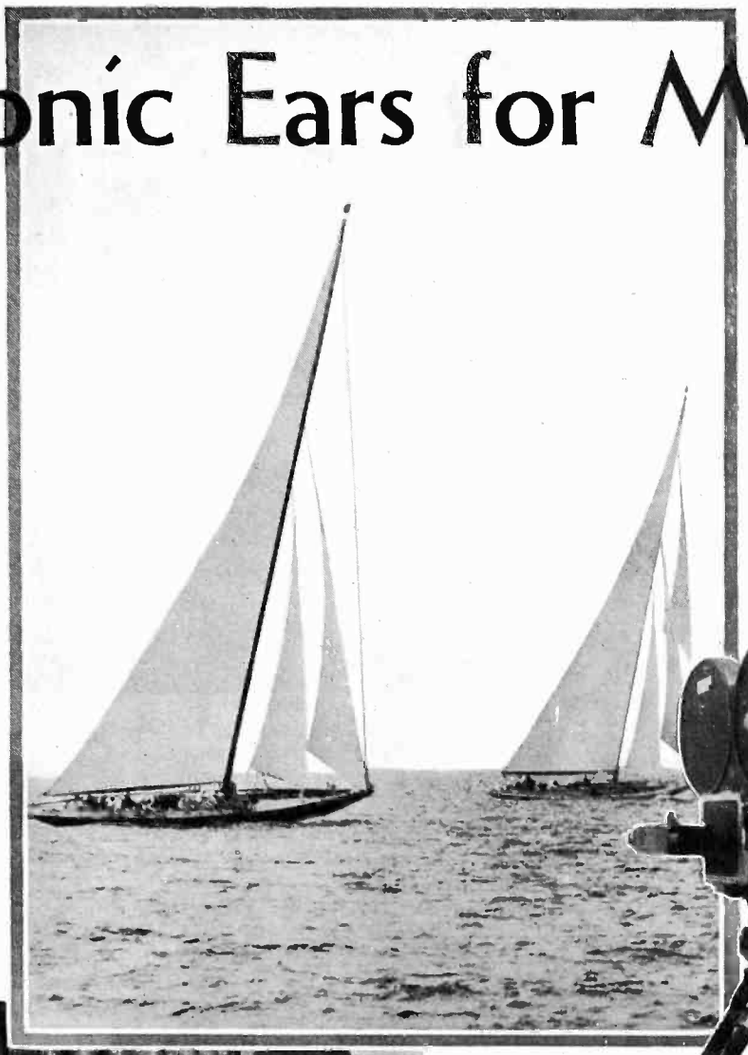
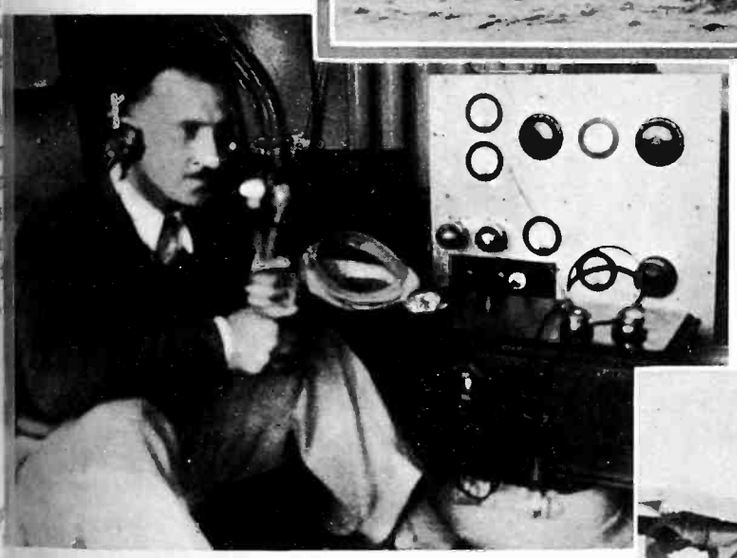
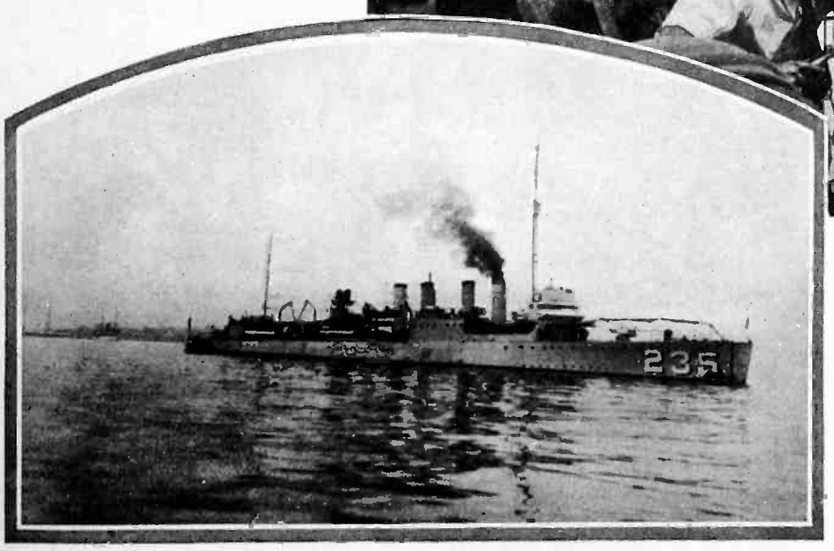


How the yacht races off Newport, in September, were broadcast over the American networks and, by short wave, to Europe, —while cameramen were making pictures and sound records for the "talkie" audiences



lumbia's portable short-wave transmitter on the
ward deck of the U.S.S. Kane. CBS trans-
ted on 15.44 meters to its receiver at Sakonnet
Point, R. I., and thence over its network



C's short-wave
smitter was
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the U.S.S. Kane
ght) and trans-
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this network at
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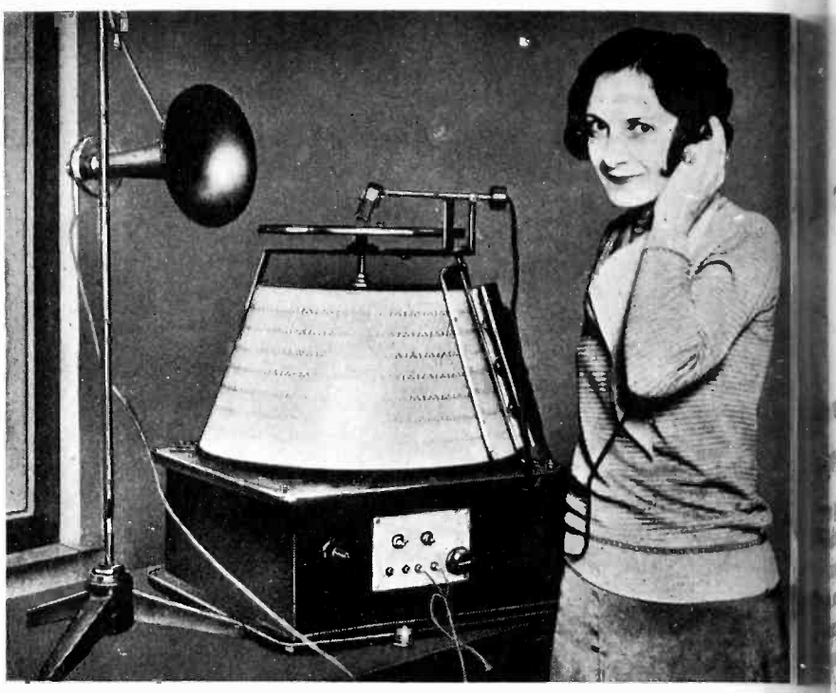
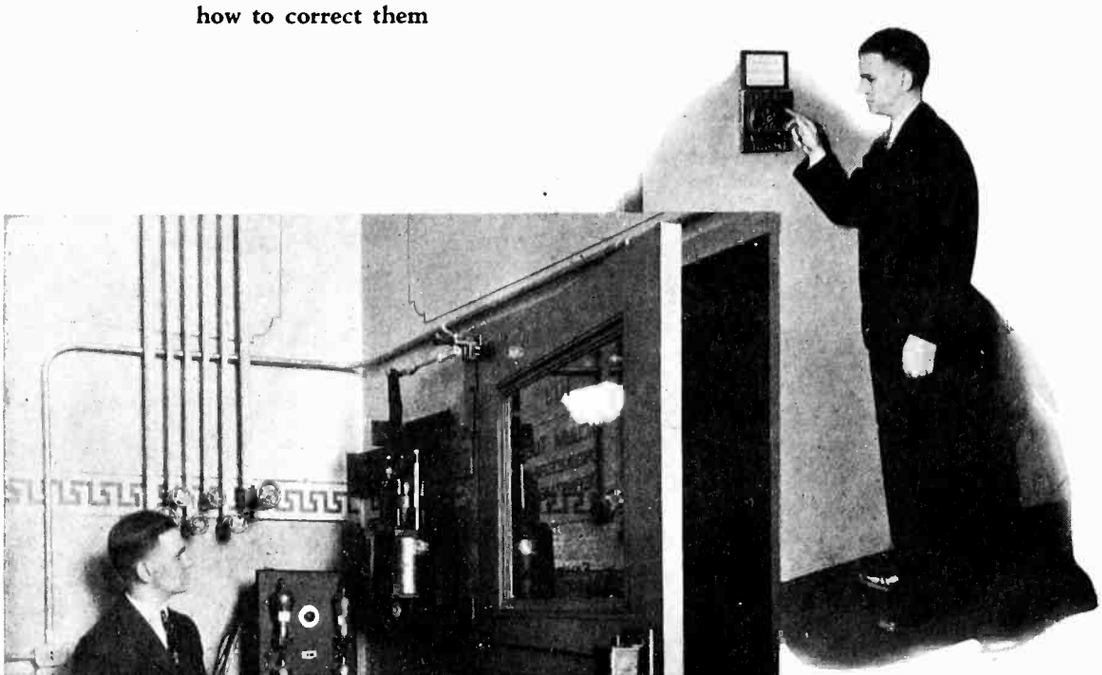
ing station, off
wport (about 30
miles away)

One of the sound cameras making a picture and sound-on-film record of the race. Note the monitoring head phones of the operator

Vacuum tubes in the day's news



Right—The new recording tonoscope of the University of Southern California. It registers the waveforms of voices of students in the school of voice culture, and if modulation and delivery are wrong, shows how to correct them



Below—Infra-red be for killing insects in C fornia orchards, w which Henry Fleur San Francisco has be experimenting

The famous "open sesame" door to the electronics research laboratories of the General Electric Company, at Schenectady, N. Y. Upon knocking the proper number of times, with intervals, a series of thyratons operate relays, and the door swings open

NEWS

THE ELECTRON INDUSTRIES

✦

o retail trade
ging forward

ns point to improvement in the business, the month of Septem- rking the beginning of the season er reception, improved programs nsequently greater incentive to se radio sets. According to Mar- T. Jones, chief of the electrical ent division of the Department merce, the maintenance of sales es shown in previous years and this year should bring the total turnover of radio apparatus in ountry to approximately $645,-) for 1930.

ng the first six months of this American dealers sold $231,-) worth of radio sets, tubes and according to Mr. Jones. This es with $224,000,000 during the months of 1929. The estimates sed on returns from the survey nation's radio dealers conducted ly by the government depart-

e was the usual seasonal slump the second quarter of 1930, only),000 worth of apparatus being fter first quarter sales of $144,-). Third quarter returns have been gathered. The best retail , of course, is found during the quarter months of October, ber and December.

rican export trade in radio is its own very well, Mr. Jones d. During the first six months year, American exports of radio ted to $8,525,396, which repre- n increase of $725,570 over the onding six months of 1929.

✦

ming meetings

ty of Motion Picture Engineers— w York City, Fall meeting, Oct. 23, Hotel Pennsylvania. Sec'y H. Kurlander, 2 Clearfield Ave., oomfield, N. J.

rican Institute of Electrical Engi- ers—New York City, Oct. 24, "The ectron Tube—A New Tool for the ectrical Engineer." O. H. Cald- ll.

ute of Radio Engineers, Rochester, w York, Nov. 21, 1930.

rican Chemical Society, Richmond, ., Dec. 12. "The Electron Tube in emistry." O. H. Caldwell.

Electrad, Inc., 175 Varick St., New York City, in developing foreign markets has enlarged its export department, according to a statement by Arthur Moss, president of the company. Xavier de Nice has been appointed export manager. Mr. de Nice was formerly merchandising counsel for the American Exporter, and for ten years was export manager for the American Chain Company and associated companies.

The Aerovox Wireless Corporation, 70 Washington St., Brooklyn, N. Y., has recently published a new 32-page manual on electrolytic condensers; their uses, advantages and limitations, with detailed data and characteristics of the Aerovox Hi-Farad dry electrolytic condenser. Copies of this booklet may be had free of charge on application to the Aerovox Wireless Corporation.

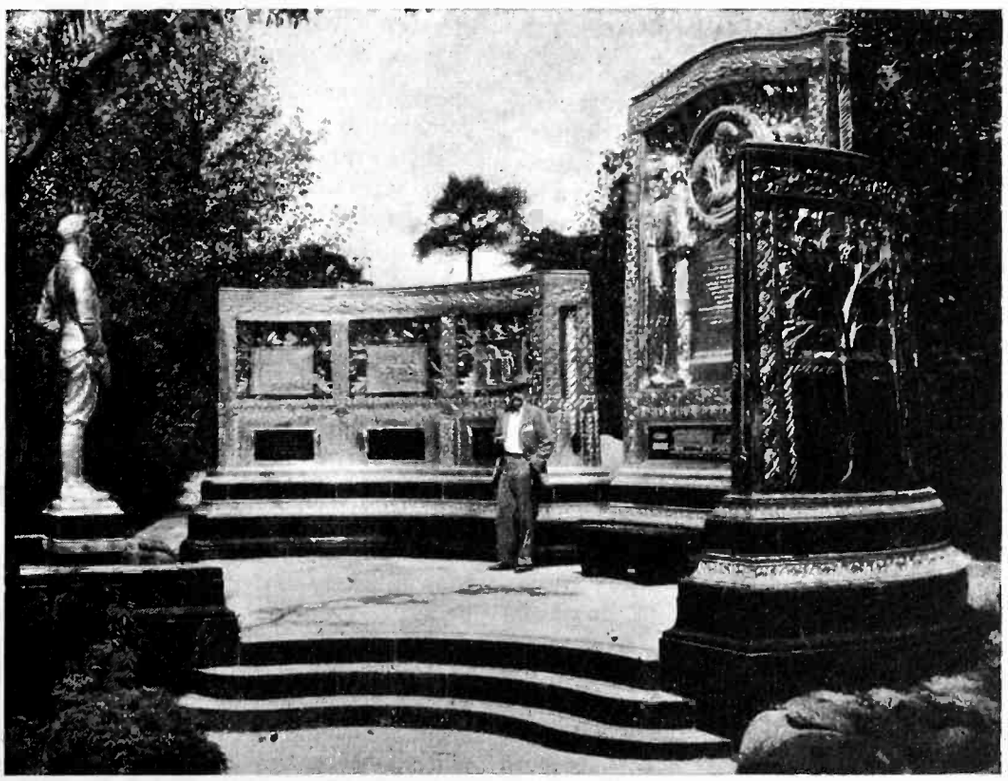
American Lava Corporation, Chattanooga, Tenn., has announced the completion of many months of development work and is regularly serving the tube industry with extruded Pure Magnesia-MGO for tube insulation. This company has an engineering service organization which is glad to cooperate with manufacturers in any special requirements for their products. Inquiries are invited. Grade "I" Lava, also manufactured by this company, is specially designed for radio and vacuum-tube construction.

Arthur L. Walsh of Thomas A. Edison, Inc., who is third vice-president of the RMA, has been appointed by President Morris Metcalf to be chairman of the receiving-set manufacturers' group, under the group organization plan of the Radio Manufacturers' Association. This group holds frequent meetings to consider various problems of primary concern to set makers. Mr. Walsh succeeds Captain William Sparks of the Sparks-Withington Company, Jackson, Mich., who felt compelled to resign as chairman of the set group because of his plans for an extended absence in Europe during this fall and winter.

The Eisler Electric Corporation of Newark, N. J., announces that it has won the last court decision against the General Electric Co., in which the latter organization sued Charles Eisler and the Eisler Engineering Company, now known as the Eisler Corporation, for infringement of a sealing method, essential in the manufacture of incandescent lamps and radio tubes. This last action was the result of an appeal which was made by the General Electric Company, on the decision of Judge Bodine to the United States Circuit Court of Appeals of the Third Circuit. Judges Buffington, Wooley and Davis upheld the decision of the lower court, and also declared invalid all four patents brought to bear in this suit. This last decision was filed September 5, 1930. The Eisler Company specializes in machinery specifically designed for the manufacture of radio tubes, lamps and allied products.

✦ ✦ ✦

TO WESTINGHOUSE, A.C. PIONEER



To George Westinghouse, whose vision gave the world many revolutionary ideas, including alternating-current electric service, paving the way for Westinghouse pioneer broadcasting and electronic research, this beautiful memorial was dedicated at Pittsburgh, Oct. 6.

✦ NEW PRODUCTS

THE MANUFACTURERS OF

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.

✦

Oil-damped pick-up

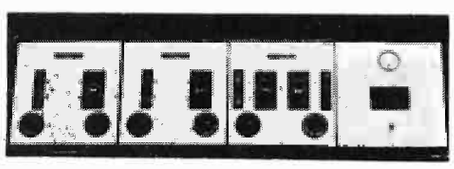
THE OIL-DAMPED pick-up, already in successful use for theatre reproduction, is now available to the radio manufacturer for use in radio-phonograph combinations, according to an announcement by the Pacent Electric Company, 91 Seventh Ave., New York City. This

oil-damped pick-up is said to provide many desirable features, which include better record tracking, less record wear, no rubber bearings, constant viscosity oil making possible the elimination of undesired resonance, and a full octave added to the frequency range. In place of the customary counterweight, an adjustment has been incorporated in the base of the tone arm, so that the pressure of the needle upon the record can be varied at the will of the operator. The oil-damped pick-up can be had with or without tone arm.—*Electronics, October, 1930.*

✦

Short-wave receiver units

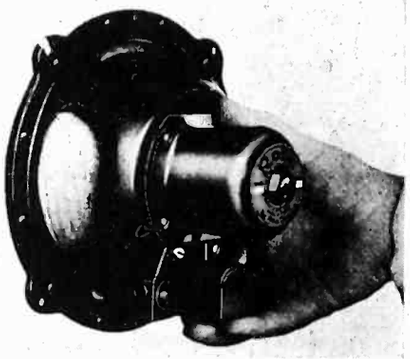
A NEW SHORT-WAVE RECEIVER, Model L, is announced by C. R. Leutz, Inc., Altoona, Pa. This receiver is built up of two, three, or four individual units: the detector unit, the three-stage audio unit, and two r.f. units, which may be obtained separately and added as desired. Since each unit is in a separate aluminum case, a double shielding



between units is provided. The receiver is particularly adapted to short waves, and is unsuited for ordinary broadcast wavelengths. The Model L is provided with larger shielding space than that of the similar model C, and has greater amplification and sensitivity, and a more elaborate design of dial control. Both receivers are sold without coils, which may be purchased separately to cover any wave-bands desired. — *Electronics, October, 1930.*

Compact loud speaker

A NEW, COMPACT LOUDSPEAKER weighing less than 5 lbs., with a depth of 5 in. and a height of 8 in., is being manufactured by the Rola Company, 2570 Superior Ave., Cleveland, Ohio. This type, Model K-5 has been specially designed to meet the increased demand for a very compact unit, which will give a performance comparable to that of larger



speakers. The new K-5 has the same construction, but on a reduced dimension scale, as their standard "K" series, with full reproduction of high and low frequencies, and dependability.—*Electronics, October, 1930.*

✦

Adhesive tape dispenser

THE INDUSTRIAL DIVISION of Johnson & Johnson, New Brunswick, N. J., has recently developed a new adhesive tape dispenser for the particular use of the electrical and radio manufacturers who make radio coils and find it necessary to have a method of dispensing adhesive tape directly to the operator at the bench. A cutting knife is mounted on the dispenser, and when dulled, may be replaced with very little effort. By the use of this dispenser all pre-handling is eliminated, and the actual cost of using adhesive tape is thereby considerably reduced. The apparatus has been designed to carry a full-length roll of tape up to 1¼ in. wide. — *Electronics, October, 1930.*

Voltmeter multiplier u

FOR VOLTMETER MULTIPLIE
Ohmite Manufacturing Comp
N. Albany Ave., Chicago, Ill.,
nounced a series of vitreous e
single-layer wound resistance un
an accuracy of one per cent or
of one per cent, as required. T
made in the standard sizes of
and four inch lengths, with
minals, the two inch up to 100,0
and the four inch up to 250,000
Electronics, October, 1930.

✦

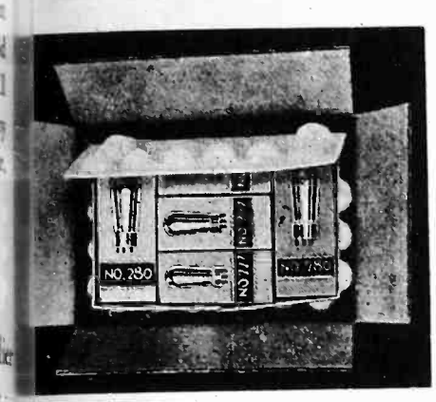
Portable test oscillator

A TEST-SIGNAL radio frequency
tor, type 404, of the General Ra
pany, Cambridge, Mass., pr
means of reliable comparison
radio receiving sets, or of t
receiver under different condit
may also be used in the neutrali
alignment of radio receivers.
generator is connected to the
the receiver, and an output
placed in the output of the
When the test generator is adj
give a standard reading on th
meter, the output of the test g

gives a measure of the sensi
the receiver. The generator'
range is roughly 10 to 1,000 mi
with a 0.1 volt output also
The accuracy of adjacent rat
per cent, and the cumulative
the attenuator does not exceed
cent. Change in output volta
frequency is plus or minus 5
over a frequency range of 500-
Price, $95.—*Electronics, Octob*

king material hipping tubes

DED PULP PACKING PADS made by -Tite Packing Corporation, 100 2d St., New York City, have been d to shipping tubes and other equipment or materials in kits or quantities. First cost is said to s than other packing materials.



of light weight and permits the small exterior cartons. Trans- ion charges are reduced. Even lled shipping-room help can pack kly without muss and waste. The l-Tite pad provides what is called nsion" packing, absorbing the s and suspending the tubes away damaging impacts. Radio tubes ntities of 5 to 50 are being ship- alf-way around the world in per- ndition. A staff of packing engi- is maintained by the company to r advisory service to any one ested in radio tube packing.— *onics, October, 1930.*

✦

low-depth d projector unit

NSIVE EXPERIENCE IN designing manufacturing sound reproducers ind the Model 37 sound projector of the Rochester Reproducers Cor- ion, 45 Halstead St., Rochester, . This model is for use in all where the depth space for the er is limited. The overall depth e unit is 2½ in., making possible ounting of this speaker where it l be impossible for larger speakers. shipping weight is approximately ., height 12 in. and width 12 in.— *onics, October, 1930.*

✦

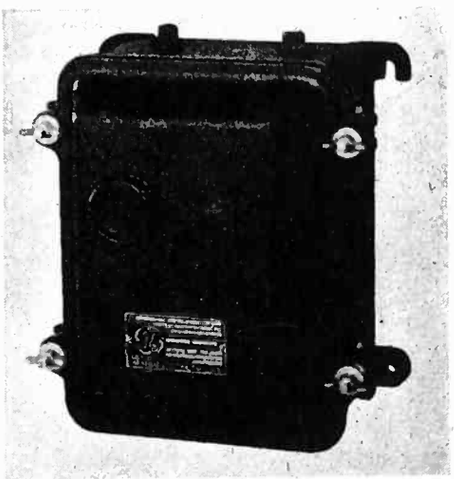
neral purpose tube portable receivers

EET THE REQUIREMENTS of portable vers, Sylvania Products Company, orium, Pa., has developed its SX- general purpose tube. The two re- ments especially stressed in this have been low filament power con- tion and freedom from microphonic s. The tube is built for operation ther an r.f. amplifier, a detector, or an intermediate audio amplifier. It employs an oxide-coated filament and has a filament drain of 0.06 amperes at 2 volts. Plate current, 2 milliamperes; amplification factor 8.8. Maximum overall dimensions 4¼ in. long by 1⅛ in. diameter. The tube fits the small-sized UX-type socket. — *Electronics, October, 1930.*

✦

Photo-electric relays for outdoor use

PHOTO-ELECTRIC RELAYS for outdoor service are among several new items which have recently been added by General Electric Company, Schenectady, N. Y., to its line of photo-electric devices for the control of industrial machinery and processes. The type CR-7505-C2 relay, enclosed in a cast-iron weatherproof case, is entirely self-contained, with both the relay mechanism and the photo-electric tube with window in the



same case. It is made, as so far announced, only for alternating current circuits. This new relay makes possible a great number of outdoor photo-cell applications, such as alarms in outdoor garage ramps, outdoor counting operations, etc.—*Electronics, October, 1930.*

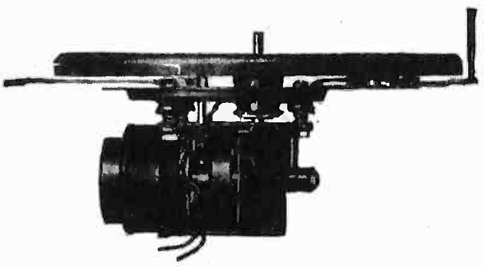
✦

Improved hook-up wire

PARALAC, an improved push-back type of insulated wire for radio connections, with a high break-down voltage, is offered by the Cornish Wire Company, 30 Church St., New York City. Beneath the cotton braid is a smooth black covering, impregnated with a mixture of beeswax and cerowax, rather than the paraffin ordinarily used for the purpose. The insulation is certified to withstand a voltage of 4,000 volts in air and 1,430 volts in mercury. This wire is available in either stranded or solid tinned copper, in sizes from No. 14 to No. 24 B. & S. gage. The braided covering can be obtained in the usual range of colors.—*Electronics, October, 1930.*

Radio-phonograph turntable motor

A NEW TURNTABLE MOTOR for phonographs, combination radio-phonographs, and sound projection machines, and incorporating many novel features of design, is being manufactured by the Diehl Manufacturing Company, Elizabethport, N. J. An improved automatic stop of unusually simple and efficient design is furnished with the motor if desired. The

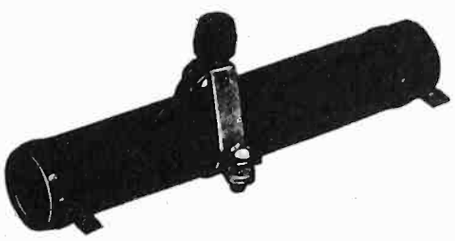


motor is built for all voltages and frequencies, and for either 78 or 33 r.p.m. It incorporates uniform speed, silent operation, high starting torque, compactness, and light weight. It is attractively finished in black lacquer, with all steel parts nickel-plated to prevent rust, and fittings finished in statuary bronze, Power consumption is 18 watts; shipping weight, including molded composition turntable and stop, 11½ lbs.— *Electronics, October, 1930.*

✦

Vitreous enamelled slide resistor unit

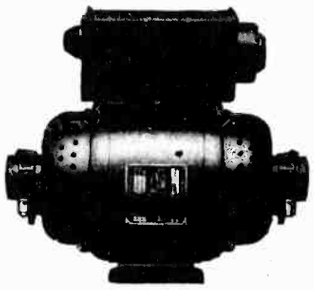
COMMERCIAL PRODUCTION of a slide resistor is announced by Hardwick, Hindle, Inc., 215 Emmet St., Newark, N. J. The resistor combines the ruggedness and high wattage of the vitreous-enamelled resistor with the convenience of being continually adjustable. Along the surface of a refractory tube is space-wound a resistance wire having a low temperature coefficient of resistivity,



with suitable terminals at both ends. This assembly is then enamelled with a vitreous coating by a special process, which leaves a small arc of the upper surface of the turns exposed along a straight narrow track. A suitable adjustment band and shoe are employed to furnish contact with the coil at any desired point. — *Electronics, October, 1930.*

Dynamotors for a.c. radio receivers

THE ELECTRIC SPECIALTY COMPANY, Stamford, Conn., announces a new line of ESCO dynamotors and motor-generators for operating alternating current radio receivers or other apparatus from direct current. They are equipped with standard attachment plugs—providing "plug in" connection between alternating current apparatus and direct current. A new type filter is provided, which in addition to silencing the noises of the machines, smooths out stray noises brought in by the direct current lines. All units are equipped with wool pack bearings which are long lived, quiet in operation and require a minimum of



attention. Totally enclosed wiring improves appearances and safety. The new line of machines and filters is made in both high and low speed. New and lower prices are being quoted.—*Electronics, October, 1930.*

✦

Small dynamic speakers

TWO ELECTRO-DYNAMIC speaker units are announced by the Jensen Radio Mfg. Co., Chicago, Ill. Designated as the Jensen Midget and Jensen Concert, Jr., these new models have been designed for use with automobile and the so-called mantle or midget type radio receiver and for similar purposes requiring a speaker of extreme compactness permitting of its installation where only limited space is available.

The Midget unit is suitable for operation with amplifiers using type 171 or 245 tubes, connected either singly, in parallel or in push-pull.

The Concert, Jr., unit is being offered as an electro-dynamic speaker of small size yet having a degree of brilliance, sensitivity and uniformity of response at all frequencies comparable with units of much larger size.

List prices are $15.00 and $18.50 respectively, for the Midget and Concert, Jr.—*Electronics, October, 1930.*

✦

Thin insulating material

KEEPING IN STEP with the advance in the electrical industry, the Spaulding Fibre Company of Tonawanda, N. Y. has developed a fish paper that meets the many requirements of the trade. This material is called Spaulding Armite. It has an average dielectric strength of approximately 500 volts per mil thickness. It is claimed to have high dielectric quality, uniform throughout the sheet. In addition to using this material for armature and stator slot insulation it is used for other parts of electrical equipment, such as linings for metal boxes, base and stiffener for duplex cloth, coil and transformer insulation.—*Electronics, October, 1930.*

✦

Portable multi-range volt-ammeters

DIRECT-CURRENT VOLT-AMMETERS of pocket size have recently been announced by the Roller-Smith Company, manufacturers of electrical measuring and protective apparatus, 233 Broadway, New York City. These Type PD portable instruments are made in a number of range combinations, from 1.5 to 150 volts and from 0.03 to 30 amperes, some with two voltage and two current ranges, and others with three voltage and three current ranges. All models may be obtained with or without either selector switch or fuses. These volt-ammeters are 4½ in. wide, 5 in. long, and 1⅝ in. deep. The scale length is 3⅛ in., hand calibrated into 60 scale divisions. The cover is drawn metal and the base is

moulded Bakelite. All instruments are magnetically shielded. Accuracy is within one per cent of full scale value. The prices range from $40.25 to $53.25. —*Electronics, October, 1930.*

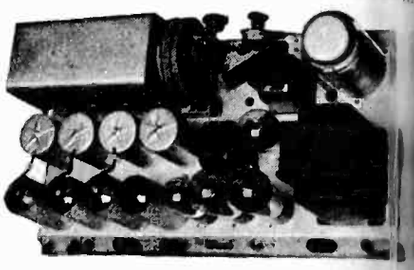
✦

Asbestos in paint form

TECHNICAL PRODUCTS COMPANY, 2308 Main St., Pittsburgh, Pa., manufacturers of Insa-lute cement (liquid porcelain) announces a new product "Color-Bestos" (asbestos in paint form) to the industry requiring a fireproof insulating paint. This material may be had in a number of attractive colors, as well as white. One of the features is that it may be sprayed or brushed on. Color-Bestos can be scrubbed or washed, thus making it sanitary as well as fireproof, oil proof, acid proof, and a good insulator. This material may be used on furnaces in the same way as asbestos is now used.—*Electronics, October, 1930.*

Radio chassis kit

AN EIGHT-TUBE, screen grid r chassis kit, for the use of radio t cians, custom set builders, and facturers, has been announced Acme Electric & Manufacturing pany, 1453 Hamilton Ave., Cle Ohio. This set, Model 98, cove

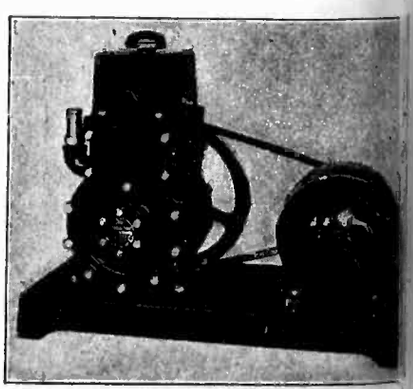


entire broadcast frequency band has been particularly designed fo quality reproduction with single four-circuit tuning. Radio freq gain 50 per cent greater than the age commercial radio is claimed fo receiver. It operates from 60-cyc ternating current, containing a b rectifier utilizing a 280 rectifier tu a 24 mfd. electrolytic condenser. C dimensions are 21 in. long, 11 in and 7½ in. high. It can be asse and wired in a few hours. Weig lbs. List price, $65.—*Electronics, ber, 1930.*

✦

High vacuum pumps

A VACUUM OF 0.00005 mm. of me in a gas-tight system is guarante the Central Scientific Company, 4 Ohio St., Chicago, Ill., for their Cenco Hypervac rotary, oil-sealed, vacuum pump. Design features, ac ing to the manufacturer, include rapid evacuation, provision for rapid heat dissipation and the cooler operation, oil requiremen only one pint, automatic vacuum ment of all oil entering the fini stage, and low power requiren The over-all dimensions of the pump are 15¼ in. high, by 11 in.



in. At a speed of 425 r.p.m. it reac pressure of one micron in one-fif the time required by the Cenco Me Pump. The unmounted Hypervac sells at $250, and mounted with a volt a.c., ⅓ hp. motor, at $350, f.o.b. cago.—*Electronics, October, 1930.*

PATENTS

IN THE FIELD OF ELECTRONICS

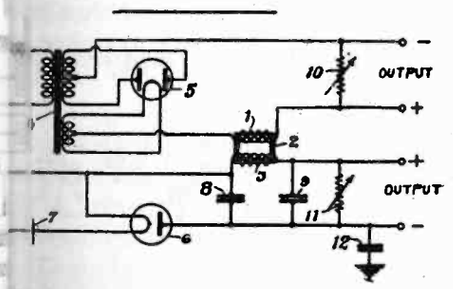
A list of patents (up to Sept. 23) granted by the United States Patent Office, chosen by the editors of *Electronics* for their interest to workers in the fields of the radio, visio, audio and industrial applications of the vacuum tube

ration, Rectification, Control

llation generator. A stressed thin ctifier disc is fastened at one ex-, with the other extremity vi- by an electromagnet, thus vary- e stress and the rectifier's im- e in the circuit. W. H. Edwards, ed to A. T. & T. Co. No. 52.

llation generator. Crystal os- r with a screen grid tube. R. B. assigned to G. E. Co. No. 49.

per-oxide rectifier. Process of g dry surface-contact rectifying consisting of treating a copper o form an electrolytic oxide film, perimposing a second oxide film first. W. D. Dooley, Wheeling, . No. 1,776,217.



ifier-filter circuit. Combination of and double wave rectifiers to pre- aturation of the core of a filter Humphrey Andrews, London, d. No. 1,774,822.

cury arc rectifier. Several cathode t the upper edge of the mercury aintain the arc at the center of the rface. Christian Krämer, Berlin, ny, assigned to G. E. Co. No. 57.

cury-arc rectifier protection. Re- current flow causes a grid within tifier to be charged to a potential ch the reverse arc is suppressed. dmer, Baden, Switzerland, as- to Brown, Boveri & Co. No. 34.

trolytic rectifier. The active elec- s composed of a siliconferro alloy. P. Bensing, one-half assigned to Koelliker, Cleveland. No. 1,775,417.

hronizing and controlling re- and generators. A receiving sys- omprising a vacuum tube genera- hose frequency is controlled in ance with the changes in fre- of the received oscillations. R. Hartley, assigned to W. E. Co. 774,003.

er supply. In series with the in- a rectifier-filter system is a ca- so related to the operating ial of the plate circuits of a re- that proper value of current is d and excessive current is pre- . A. P. J. Boesen, Richmond Hill, No. 1,773,939.

High-frequency control. A method of controlling high-frequency circuits by means of an impedance consisting of a conductor surrounded by thin magnetic discs for reducing hysteresis and eddy current losses, and a circuit which controls the effect of the impedance by varying the degree of coupling between the control circuit and the high frequency circuit. M. Osnos, Berlin, assigned to Gesellschaft für Drahtlose Telegraphie m.b.H., Berlin. No. 1,775,210.

Power supply system. Familiar circuit supplying rectified and filtered current to the anodes of several tubes, and the cathode current of several series tubes filtered by the field coil of a dynamic type loud speaker. F. C. Barton, assigned to G. E. Co. No. 1,774,467.

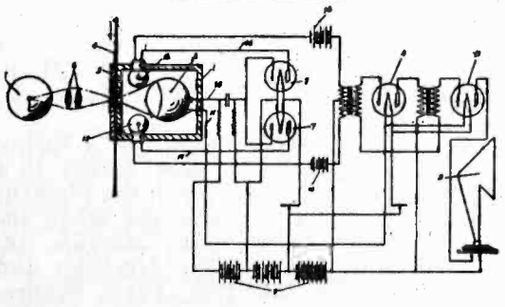
Modulating high-frequency circuits. A microphone shunted across a condenser in series with an inductance forms one branch of a parallel circuit, the other branch consisting of a resistance and an inductance, with the oscillating current applied to the parallel circuits, and the amplifier coupled to the inductances. W. Runge, Berlin, assigned to Gesellschaft für Drahtlose Telegraphie, m.b.H., Berlin. No. 1,775,213.

Harmonic suppressor. A method of eliminating from a power line the harmonics of the fundamental frequency by super-imposing harmonics of equal magnitude. and opposite phase position. Oscar H. Berthold, assigned to A. T. & T. Co. No. 1,773,772.

Sound Recording and Reproducing

Electro-magnetic pick-up. A unit for recording or reproducing sound. M. Trouton, assigned to Wireless Music, Ltd., London, England. No. 1,774,681.

Loud speaker. Two parallel plates and a flange form a resonance chamber, with an opening in the base for the speaker unit. G. A. Fude, San Francisco. No. 1,774,706.



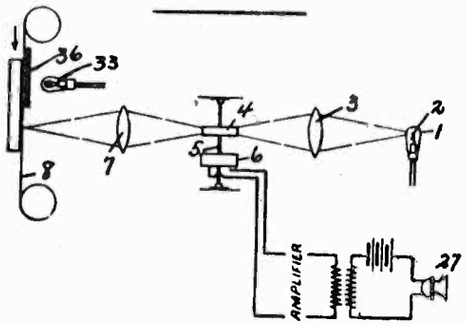
Reflexed photo-electric circuit. In sound-on-film reproduction the output from the photo-electric push-pull amplifier is reflexed through a pair of lamps in position to increase the illumination on the photo cell. F. H. Owens, assigned to Owens Development Corp. No. 1,774,759.

Condenser loud-speaker. Stretched dielectric diaphragm with an electrode coating on one surface, and several flexible electrode strips mounted adjacent to the diaphragm. P. E. Edelman, assigned to Ephraim Banning, Chicago. No. 1,776,112.

Spliced sound record film. Film having an opening through the sound record which gradually decreases in width in both directions from the splice. E. I. Sponable, assigned to Fox Case Corp. No. 1,776,049.

Sound film. A narrow helical sound record on a light-sensitive film. J. C. Kroesen, Belleville, N. J. No. 1,776,123.

Calibration of speaker units. A method of calibrating the flux of polarized push-pull electro-magnetic units by mechanically oscillating the armature and measuring the e.m.f. induced in the coil of the unit. M. R. Hutchison, assigned to Echodon, Inc. No. 1,774,920.



Sound-record film and apparatus. Variations on a film corresponding to sound wave variations, with opaque, straight edge borders upon opposite sides of the sound record. J. R. Balsley, assigned to Fox Case Corp. No. 1,776,058.

Electric pick-up. Electro-magnetic pick-up with adjustable damper. R. Hillner, assigned to G. E. Co. No. 1,774,975.

Sound reproducer. Loud speaker with cone-shaped diaphragm. R. L. Brown, assigned to Brandes Laboratories. No. 1,775,064.

Pick-up device. A double phonographic pick-up with two separate tone arms, the two needles running in tandem in the same groove of the record to reproduce the same sound in the same place at time intervals indistinguishable to the normal ear. H. Küchenmeister, Berlin, Germany. No. 1,775,248.

Loud speaker. The air chamber behind the diaphragm may be opened to the atmosphere or completely closed from it. E. H. Foley, 99 per cent assigned to International Acoustigraph Co. No. 1,775,453.

Electric pick-up. H. W. Rogers, New York, N. Y. No. 1,776,045.

Piezo-electric transmitter. Transformation of mechanical vibrations into electrical impulses by means of a piezo-electric crystal. F. Rieber, San Francisco. No. 1,776,009.

Electric pick-up. An acoustic device consisting of a spherical non-metallic wall, vibrating means connected to one pole, and the armature of an electro-magnet attached to the opposite pole. J. V. L. Hogan, assigned to Radio Inventions, Inc. No. 1,776,223.

Recording and reproducing system. In a telegraphone, a reproducing element partially magnetically saturated. S. N. Baruch, New York. No. 1,774,821.

Synchronizing reproducing apparatus. A method of reproducing without interruption a sound record continued from one film to another. E. D. Cook, assigned to G. E. Co. No. 1,775,019.

PATENTS—

Radio Circuits and Apparatus

Radio transmitting system. A complicated circuit, apparently push-pull, with provision for parallel modulation. F. G. Simpson, assigned to Pacific Radio Co. No. 1,775,327.

Radio antenna. S. P. Nixdorff, assigned to G. E. Co. No. 1,775,826.

Radio signalling system. Waves of different frequencies emitted by two r.f. generators are simultaneously modulated in opposite phase. E. L. Chaffee, assigned to John Hays Hammond, Jr., Gloucester, Mass. No. 1,776,065.

Screen antenna. An insulating screen having the property of intercepting Hertzian waves. G. M. Ferguson and P. E. Harth, assigned to National Pigments & Chemical Co., St. Louis. No. 1,775,276.

Radio receiving circuit. A system of r.f. amplification in which each tube feeds into an impedance of the order of magnitude of its own capacitive impedance. G. von Arco, Berlin, assigned to Gesellschaft für Drahtlose Telegraphie m.b. H., Berlin. No. 1,775,181.

Radio volume control. Control coil and contact shunted across antenna and ground, the resistance change per turn being uniform and the inductance change per turn being of different magnitudes, so that equal increments of movement of the contact produce different impedance changes. A. Atwater Kent, Ardmore, Pa. No. 1,775,399.

Tuned r.f. amplifier. A method for the stabilization of tuned r.f. amplifiers. E. F. W. Alexanderson, assigned to G. E. Co. No. 1,775,544.

Radio compass. Two compasses, Patents Nos. 1,774,458 and 1,774,459, one for indicating the angular position of a body with respect to a magnetic field fixed in space, the other for indicating the direction of an axis of a body with relation to a component of a magnetic field. J. D. Tear, assigned to G. E. Co.

Double demodulation receiver. Tuned radio frequency amplifiers feeding into a periodic detector input circuit whose frequency is varied by means of a variable inductor to a value high in comparison to audio frequencies; this frequency is amplified and fed into a second detector circuit where the frequency is made audible. Bowden Washington, one-half assigned to H. L. Hoyt, Jr., New York, N. Y. No. 1,774,493.

Receiving circuit. A radio receiving circuit in which audio frequency signals are reflexed through the untuned amplifying stages. W. T. Lewis, Racine, Wis. No. 1,774,834.

Telephone-operated radio control. A contact on the receiver hook opens the loudspeaker circuit when the telephone is in use. J. G. Lewis, Scranton, Pa. No. 1,775,567.

Audio frequency transformer. A third winding on a transformer core is short-circuited through a variable inductance for adjusting the time constant of the transformer to effect energy transfer without distortion. F. Carbenay, Paris, France. No. 1,775,190.

Static eliminator. Electro-magnetic devices in the antenna circuit. W. A. Seller, Argentine, Mo. No. 1,774,068.

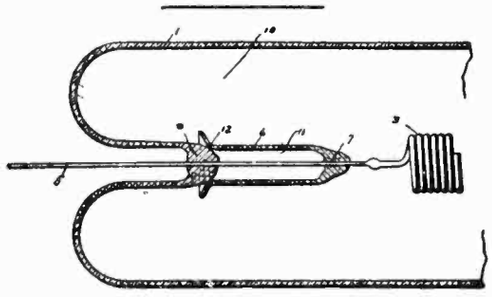
Radio station indicator. By means of light reflected from a lamp which is lit when the set is tuned, the transmitting station is indicated. A. Lesti, Los Angeles, Cal. No. 1,774,146.

Radio antenna. E. F. W. Alexanderson, assigned to G. E. Co. No. 1,775,801.

Receiving circuit. "Tickler" feed-back coil, shunted by a resistor and condenser in series, in the plate circuit of a detector tube, of such proportions that the amount of energy fed back is substantially independent of the frequency. H. I. Becker, assigned to G. E. Co. No. 1,774,958.

Electron Tubes, Manufacture, Etc.

Gaseous conduction lamp. A discharge tube containing nitrogen, a pair of main electrodes, one of which is cup-shaped, with its open end toward the path of the discharge, within which is a cone-shaped container holding a nitrogen-evolving compound. F. Skaupy, H. Ewest, H. Pulfrich and W. Schallreutter, assigned to G. E. Co. No. 1,774,407.



Method of fixing electrodes in glass tubes. A separate heat-conducting member sealed to the stem of an electrode. F. B. Hale, one-half assigned to W. C. Brumfield, San Francisco. No. 1,775,198.

Thermionic valve. An element consisting of radially disposed plates interconnected by laterally projecting arms. J. S. Van Horne, assigned to R.C.A. No. 1,775,219.

Electron valve. The cathode, having resistance sufficient to generate heat solely by means of the normal space current flow, maintains itself at an electron-emitting temperature independently of any auxiliary heating means. H. Cohn, Charlottenburg, Germany, assigned to the firm Dr. Erich F. Huth Ges., m.b.H., Berlin. No. 1,775,588.

Electron discharge tube. A three-element gas-filled tube with a negative resistance characteristic. R. E. H. Carpenter, Purley, England. No. 1,775,886.

Filament support. Clamp for filament leads and auxiliary supporting member. R. B. Prindle, assigned to G. E. Co. No. 1,776,133.

Filament support. In the manufacture of vacuum tubes with carbon filaments, the end of the filament is plated and welded to the support. C. H. Braselton, assigned to Arcturus Radio Tube Co. No. 1,774,698.

Adapter for radio tubes. In a casing which fits a standard tube socket is a thermo-electric pile to which the filament of a radio tube is connected when inserted in the adapter. C. Mieville, assigned to Etablissements Herbelot and Vorms Société Anonyme, Paris, France. No. 1,774,720.

Television, Etc., Systems

Television apparatus. Television transmission and reception in natural colors. A. L. Barnes, Oak Park, Ill. No. 1,774,348.

Electro-optical system. Record reproducing system for moving J. W. Horton, assigned to Be phone Labs. No. 1,775,241.

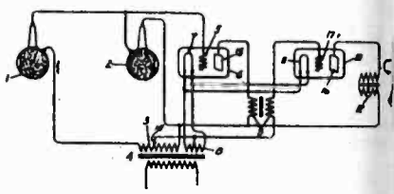
Television. Method of scann image at high speed, so that su signals balance out each other i terval less than that required to a sound wave, permitting the sir ous transmission of sight and s a common channel. P. L. Clark, lyn, N. Y. No. 1,776,148.

Television system. Perforate ning device with several light-s cells and provision for block unwanted images. R. W. Melbourne, Victoria, Australia 1,776,298.

Television system. A method vision in which an electrical i traversed by an electric shutter. ceiving system which includes tr the field of view in one directio modulated wave, and travers field in another direction with tected components of the wave. Farnsworth, assigned to T Laboratories, Inc. Nos. 1,773,9 1,773,981.

Electro-optical system. Ligh from scanning an object are tran into sound waves and recorde taneously with the accompanyi or sound wave from the obje single record. J. L. Baird, assi Television Ltd., London, Engla 1,776,097.

Miscellaneous Applicati



Illumination control. Two lig tive cells, normally balanced an ranged that when substantially amounts of light fall upon the series of lamps is lit. H. C. S assigned to G. E. Co. No. 1,77

Photo-cell protection of elect paratus. Gases of decomposi veloped in the insulation of elec paratus pass between the ligh and lens system of a selenium Buchholz, Kassel, Germany 1,774,961.

Vacuum tube circuit. A sy indicating the reception of wav in which the grid of the tube f the detector becomes strongly upon the receipt of an electric E. E. Turner, Jr., assigned to S Signal Co. No. 1,775,073.

Variable light-producing a Apparatus for producing light v in accordance with variations i trolling current by means of a lamp with several arcs in par variations in controlling curre ing the relative distribution of current to the arcs. E. W. Kel signed to G. E. Co. No. 1,774,3

Grade-crossing alarm. The s an approaching train are picked microphone near the tracks, a and reproduced at the cross Gherassimoff, assigned to d'Avertisseur Ferrovoie, Paris, No. 1,775,675.

[*Continued on page 360*

acting vacuum tube relay

[*Continued from page 343*]

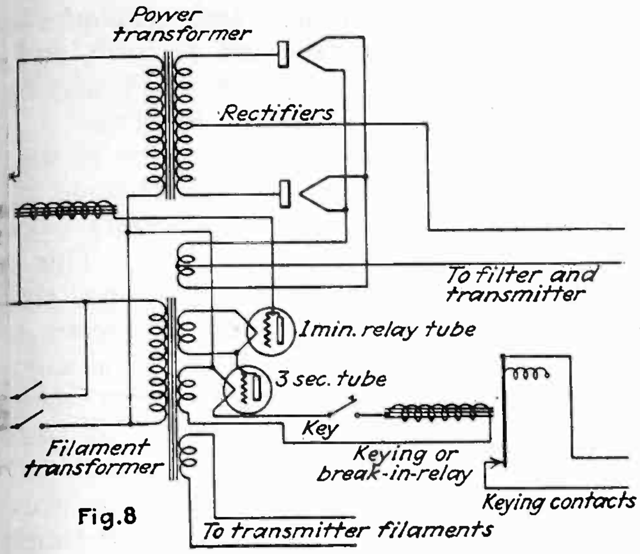


Fig.8

Transmitter power supply with time delay protection using two tubes

a in large broadcast transmitters, it is desired on the various tubes in a predetermined order, tarting with the radio frequency oscillator and succession through the intermediate amplifiers, llators and the final amplifiers. A sequence of ube relays as described here, properly adjusted, suited for the purpose.

uum tube code transmitters no other keying d be used other than the slow acting relay used t the power tubes. The transmitting key may ged as in Fig. 6 to place a positive bias on the he relay tube when the key is depressed. The *C* should be connected in the negative high lead or in the "center-tap" lead as is usually Then if the transmitter is keyed the relay will until after the tube filaments have become comated and no high voltage will be permitted to reach the power tubes. The relay may of course be equipped with "break-in" contacts.

The diagram, Fig. 8, shows a complete transmitter power supply, which with the proper choice of constants may be used to supply current to any set. The relay equipment consists of two slow acting relays and a low resistance keying or "break-in" relay. Once the power switch is closed, no other switch other then the telegraph key need be touched until the station closes down, for the key controls a slow acting relay which connects the high voltage and maintains it as long as the key is not left up for longer than the normal spacing between words. The tube filaments remain lighted continuously. If a break-in relay is utilized, the key controls the entire operation. Such an installation will be found of much value wherever a large amount of traffic is handled.

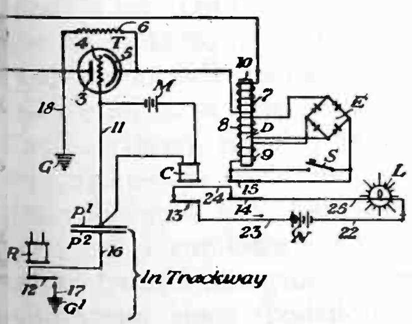
Color definition (*Cont'd from page 322*)

mission or reflection factors at suitable wave lengths, so that the contour of its curve is approximately defined. For precision work, beyond the range of ordinary color matching, the same method may be employed by using a greater number of these factors, all of which have been measured with a high degree of precision.

For the accurate measurement of the factors that determine the inherent color of a material, we are no longer dependent upon human eye sensitivity, with its errors and weaknesses, for with the perfection of that electronic device, the photoelectric tube, *the measurement of color is being transferred from the physiological to a physical basis,* and we now employ this tool to secure precision measurements of differences not detectable visually. Although spectrophotometric curves of considerable accuracy can be derived from data secured by the slow and laborious method of visual observation, the fact nevertheless remains that greater precision is assured by physical measurements.

PATENTS—

(*Continued from page 358*)



ay traffic control. Condenser ne in the trackway, the other on , control the grid potential of a tube. P. N. Bossart, assigned n Switch & Signal Co. No.

e control circuit. A rotating supplies intermittent energy to a circuit, where an electric dislamp rotating in synchronism rotating contact is energized en the first circuit is interrupted. Iethlin, assigned to Schneider & is, France. No. 1,775,368.

l-reproducing apparatus. Means ying a number of sound disc supported coaxially within the as. N. J. Carputo, Hollis, N. Y. 5,510.

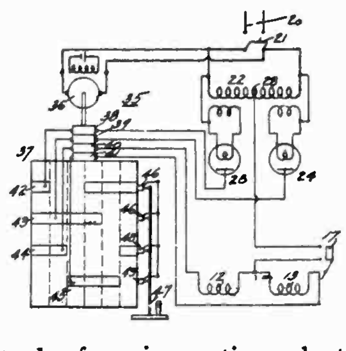
Generator frequency stabilization. A portion of the alternator output is connected to a harmonic generator whose output is fed back to the field of the driving motor in two parallel circuits, one tuned slightly above the normal harmonic frequency, and the other slightly below. One of the two circuits is increasingly energized by a frequency variation in the alternator and serves to correct the effect by a corresponding speed variation in the motor. W. A. MacDonald, assigned to Hazeltine Corp. No. 1,776,592.

Short-wave transmitter. An oscillating circuit utilizing inter-electrode capacity and three closely coupled inductances, with plate circuit modulation. Henri Chireix, Paris, France. No. 1,776,381.

Electro-optical system. A method of rendering an electro-optical image unintelligible by means of an interfering image wave for secret transmission. Harry Nyquist, assigned to A. T. & T. Co. No. 1,773,785.

Locomotive control. High frequency signals vary the grid bias on a pair of detector tubes, which energize relays through amplifiers. T. E. and J. E. Clark, assigned to Continuous Train Control Corp. No. 1,774,227.

Loudspeaker. One face of the fabric covering the frame is cotton, and the other silk. F. L. Stine, assigned to Belding Heminway Co. No. 1,776,709.



Control of reciprocating electric motors. Controlling the energization of a double-field motor by electric valves, the valves being alternately connected in succession to each winding by a synchronous switch, to supply a pre-determined number of overlapping current wave impulses. S. Katz, assigned to Syntron Co. No. 1,774,751.

Railway traffic control. Control current is passed through a section of railway track, and picked up by coils located on the train, causing the potential of a vacuum tube grid to vary. P. H. Geiger, assigned to Union Switch & Signal Co. No. 1,775,025.

Signal-relay system. In the plate circuit of two vacuum tube relays are the two windings of a polarized relay for automatic telegraph operation. W. G. Fluharty, assigned to Western Union Telegraph Co. No. 1,776,219.

The "radio Knife"

(*Continued from page 319*)

From these simple circuits it will be noted that radio design generally is followed. Input currents preferably are regulated by tapped reactors and suitable switches, while the patient or output connections are made across the main resonator or from taps thereon; from across the main oscillating-circuit condenser, or from taps between a number of condensers connected in series to form the main condenser; through a variometer in the patient circuit, and so forth. Pilot lamps generally indicate when the machine is in operation.

While many surgeons still prefer the scalpel for cutting, the pronounced advantages of electrocoagulation in conjunction with electrical cutting are apparent, for bleeding can be prevented or immediately stopped in many cases without the time and bother of tying severed ends of blood vessels with ligatures.

Technique of cutting

Consider the case of opening the abdomen. An incision is made with the needle, thus severing two blood vessels that require the application of four clamps. Further clamps are required in the operations on the organs, but the two severed blood vessels will serve as examples for all. When these clamps are about to be removed, the surgeon calls for coagulating current and then quickly touches each clamp with the needle, in rapid succession, which causes the ends of the blood vessels to be so thoroughly cooked that the clamps can be immediately removed. When the scalpel alone is used, four ligatures must be applied. Some surgeons simply grasp the ends of severed blood vessels with tweezers and touch them with the needle, thus avoiding the use of clamps, but many surgeons who use the "radio knife" still use clamps, as a rule, because they cannot change technique very quickly after long habit.

The radio knife, or electrical cutting tool, generally consists of an applicator or holding device into which is clamped the needle, or some special form of electrode, to which the current is switched or discontinued by means of a finger-switch on the applicator, or a foot-switch on the floor. The needle cuts without requiring any pressure. Only slight traces of any sparking are generally noticeable, yet some kind of sparking is necess cutting, since the tiny sparks produce the heat tha the bursting asunder of the tissue.

There are a great many uses and techniques kr the surgeons, dermatologists, and so forth, and a fairly large amount of literature which may be through the "Medical Review of Reviews."

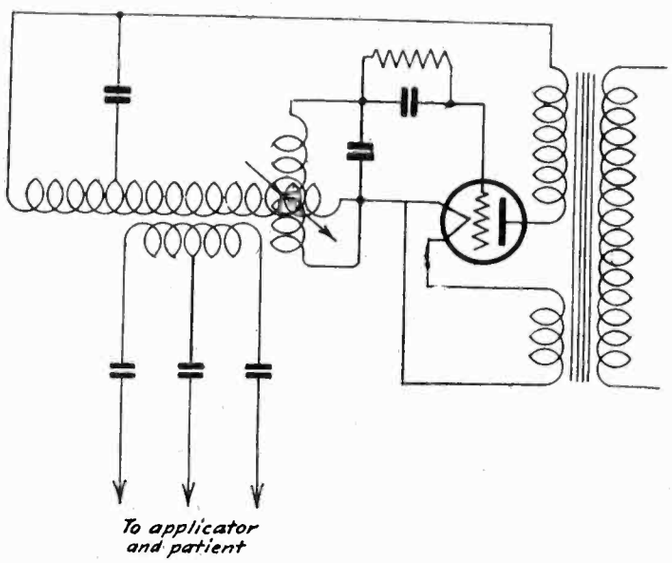
Among other uses, electrical surgery is succ employed in the resection of the prostate gla application where it has reduced mortality from cent to 5 per cent, according to claim. This el operation is very simple as it is performed thro irrigating catheter device of very ingenious co tion, being equipped with a telescope, a lamp, cutting loop which necessarily cuts under water. operation also is performed by means of speci trodes and a different technique. In both tech the only cutting done is on the prostate gland Only a local anesthetic is applied and the patient little inconvenienced. Electrical surgery also is s fully employed in the removal of tonsils and hemor partly through electrocoagulation and partly t electrical cutting. Snares also are used for cuttin varying degrees of simultaneous electrocoagu according to the patient's blood pressure.

In one of the standard surgical cutting, coag and dessicating machines illustrated, the upper contains the electronic-tube cutting apparatus, whi may be used for certain forms of electrocoagu A voltmeter shows the filament voltage. A neo indicates when resonance has been obtained. The portion contains the spark-gap operated apparat electrocoagulation and dessication. Milliammeter cate the current strength to the patient. Full c for spark gap, variocoupler and so forth, as we switch for changing to any desired modality changing the cords, are provided. The lower co ment is for a rotary converter, when required. P spark-gap surgical cutting, coagulating and dess machines are also available.

The electronic tube is serving humanity in the s field as it is increasingly serving in other fields. I the contraction previously mentioned, operatio regularly being performed with electrical apparatu the contraction is not of much importance in many where it is scarcely noticeable. But one object article is to point out what still is to be overcom powerful tube at a lower price is greatly to be d

According to recent published statements, one manufacturer has presented 240 surgical machi hospitals, and not one of the machines is for sale.

J. W. Schereschewsky, Surgeon, United States Health Service, has published[1] some interesting in the treatment of implanted tumors in mice pla electrostatic fields with frequencies ranging from to 150,000 kilocycles per second, produced with receiving tubes. Although no free electrons could or leave the mice in the technique employed, results favorable in many cases, with the exception of the ding of hair, so that it would appear that tech eventually will be developed for use in the general ment of tumors as the art progresses. Certain it the surface has hardly been scratched and that the co-operation of trained radio men with surgeon physicians will yield many beneficial results.



Electronic tube employed as both rectifier and oscillator

[1]Public Health Reports, Sept. 10, 1926, pp. 1939-1963, an 20, 1928, pp. 927-945 (the latter in collaboration with Andervont).