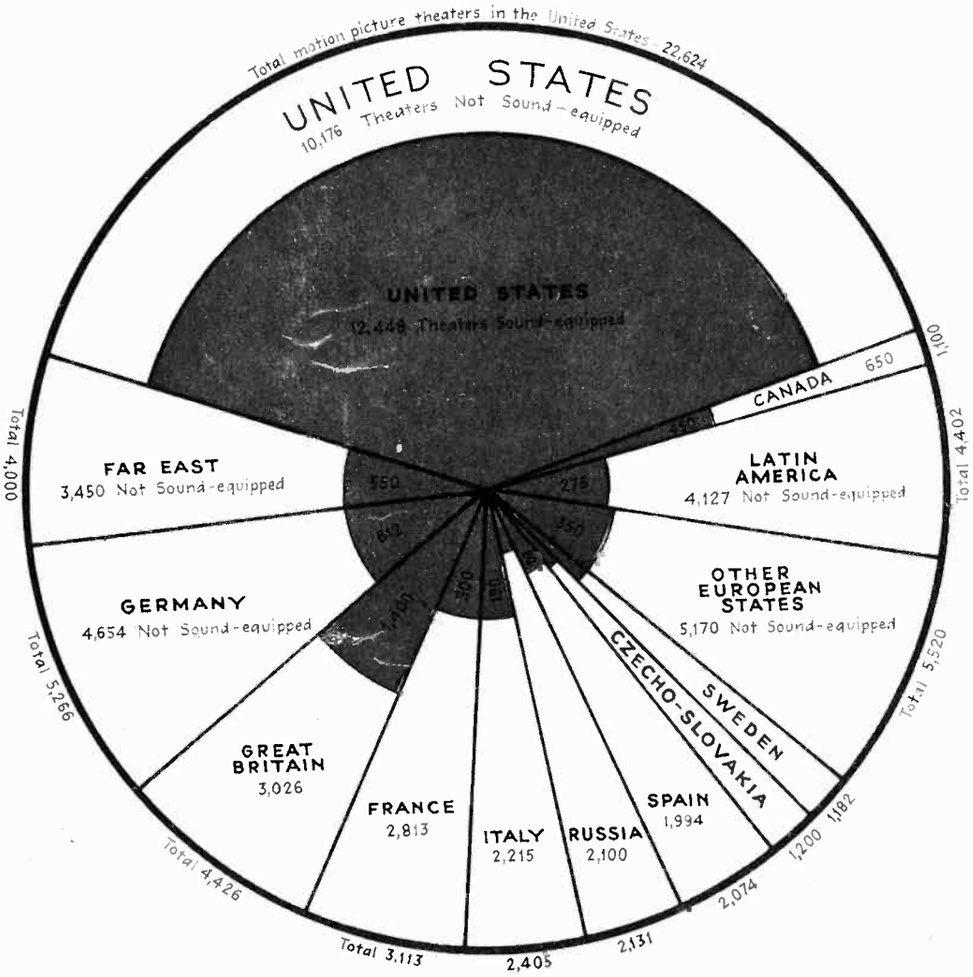
electronics

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

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



The sound-picture industry of the world

Advances in thermionic tubes and uses

Electronic music — The home "talkie"

A McGRAW-HILL PUBLICATION

SEPTEMBER 1930

electronics

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Contents for September, 1930

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he march of the electronic arts

n-language sound production

nt studio at Joinville, France, completed 80 features and short during the past six months. heule of 110 features in twelve gs has been drawn up for production. About 300 em- are working day and night on the remaining pictures. e being turned out in French, Spanish, Italian, Swedish, Dutch, Russian, Hungarian, ovakian, Portuguese and Croat. y as five and six versions are on the same set so that each is made in the language of the where it is likely to appeal.

✦

er Brothers expanding lio field

arner Brothers are entrenching ves independently, not only in ing picture field, but in the radio nograph industries, in television, the production of recorded pro- officially known as "electrical ptions" for home and broadcast- poses.

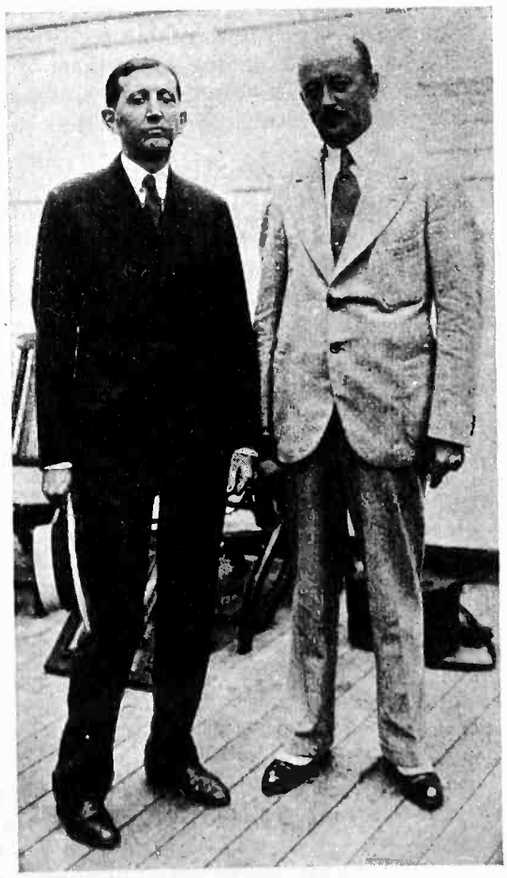
reported that they are keeping er eye open for an opportunity r the broadcasting field by the tion of existing stations, if not ngths. It has been rumored that arners have laid plans for a home tus to sell under $200, which ombine a radio-receiver, pho- h machine, facsimile television ucer, and a talking motion picture tor.

rner Brothers recently acquired the and phonograph business of the wick-Balke-Collender Company at e reputed to be $10,000,000. They also purchased the Fultograph, a system for transmitting photographs by either radio or telephone. An important feature of this device is its compactness, which makes it easily portable and convenient for incorporation in a radio phonograph combination. This device is already in use in Europe. It is simple and almost fool-proof, and can be produced and sold for less than $100.

If plans materialize, it is proposed to transmit to the home receivers, pictures of current news events, news pictures of radio performers as they appear, possibly even a tabloid newspaper in facsimile.

Another acquisition of Warner's is a controlling interest in the National Radio Advertisers of Chicago, which employs the Soatone Recording System for full length continuities, containing feature programs for use by broadcasting stations.

✦



WILL HAYS AND C. J. ROSS

Two of the American delegates who attended Paris Sound Picture Conference, snapped aboard ship on their return to New York

United states and Soviets in radio entente

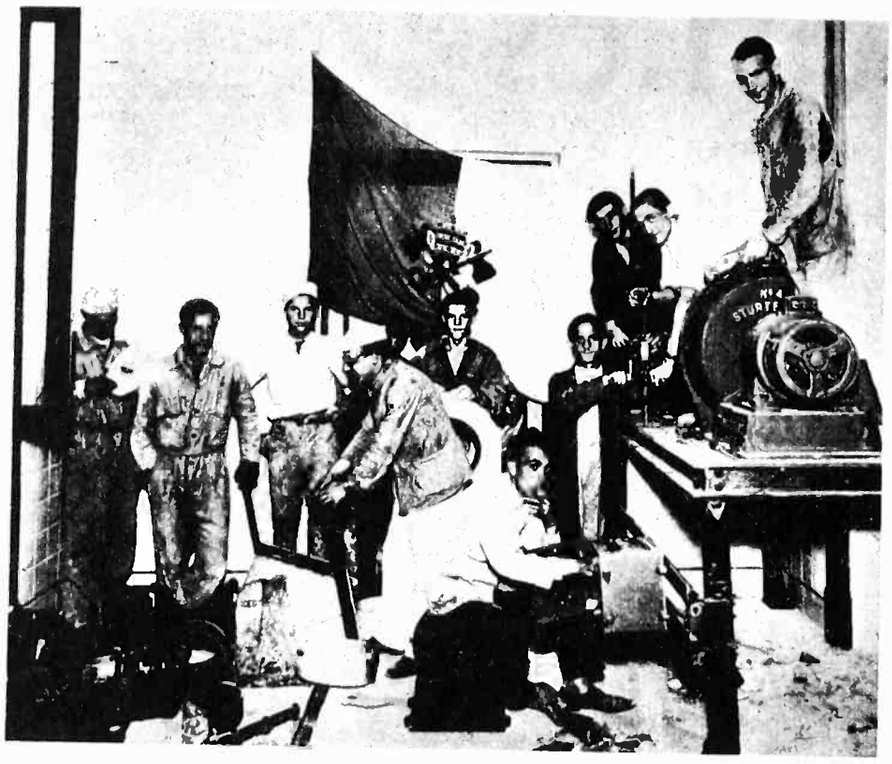
The forthcoming international conference on radio to be held in Copenhagen in 1931 and in Madrid in 1932 will present the interesting spectacle of American and Russian technical and diplomatic delegates working side by side, despite the absence of official relations between the United States and Russia.

On two committees which the United States will head at the International Radio Consultative Conference at Copenhagen next year, the Russians have been placed as collaborators. On two other committees headed by other countries, the Americans and Russians will find themselves joint collaborators.

The Americans have organized with Dr. C. B. Jolliffe, chief engineer of the Federal Radio Commission, as executive chairman, and Gerald C. Gross, engineer of the Commission, as secretary. Four committees have been named, each with a chairman, a vice chairman and a secretary. They will meet together again on September 4.

Capt. S. C. Hooper, director of naval communications, has been named chairman of the committee considering the problem of stability of transmitters. Haradan Pratt, chief engineer of Mackay Radio & Telegraph Co., is vice chairman and Lieut. Comdr. Redman, U. S. N., is secretary. William D.

RADIOPHONE INSTALLED IN VATICAN



Workmen installing a trans-Atlantic telephone service in the Vatican City which enables the Pope to communicate with the outside world

✦ ✦ ✦

Terrell is chairman of the committee to study methods for the reduction of short wave interference, with Lloyd A. Briggs of the Radio Corporation of America as vice chairman and Laurens E. Whittemore of the American Telephone & Telegraph Company as secretary.

✦

Electrochemists to hold session on electronics

Plans have already well progressed for the spring meeting of the American Electrochemical Society, to be held at Birmingham, Ala., April 23-25, 1931. One technical session will be devoted to electronics, a topic of world-wide interest. Special stress will be laid on the electro-chemistry of the vacuum tube and photo-electric cell.

✦

Proposed broadcast law considers states' rights and areas

A PLAN has been submitted to Congress, which would revise the present proportional allotment of facilities by state populations under the Davis Amendment of 1928.

The proposed revision is now before the Senate Interstate Commerce Committee. Senator C. C. Dill, Democrat, of Washington, is writing it into a bill that would set up a Federal commission to regulate all forms of communication.

Under the new formula, one-fourth of all facilities would be divided equally, each state and the District of Columbia receiving one of forty-nine equal parts. Another fourth of the available facilities would be divided among the states in proportion to their areas, and the other half would be allotted in proportion to population.

The total of privileges allotted each state, under the proposed formula, would be the sum of its share from each division of the facilities available.

The bill would supersede the Radio Act and all policies now obtaining under it.

✦

KDKA to use new 200 kw. tubes

Success of the new transmitting station of KDKA, which is being built near Saxemburg, Pa., will depend largely upon innovations in broadcast set design which have been developed by the radio engineering and research departments of the Westinghouse Electric and Manufacturing Company.

The new tube, called the AW-220, is 72 inches in height, has a diameter of eight inches and weighs 60 pounds.

In its design engineers found one of their greatest problems to be that of cooling the grid. This difficulty has been overcome by I. E. Mourmomtseff, Westinghouse research engineer, who has produced a tube of mechanical strength and sturdiness through a double end construction. Approximately five tons of cooling water must be [illegible] through the water jacket of the [illegible] each hour it is in operation.

✦

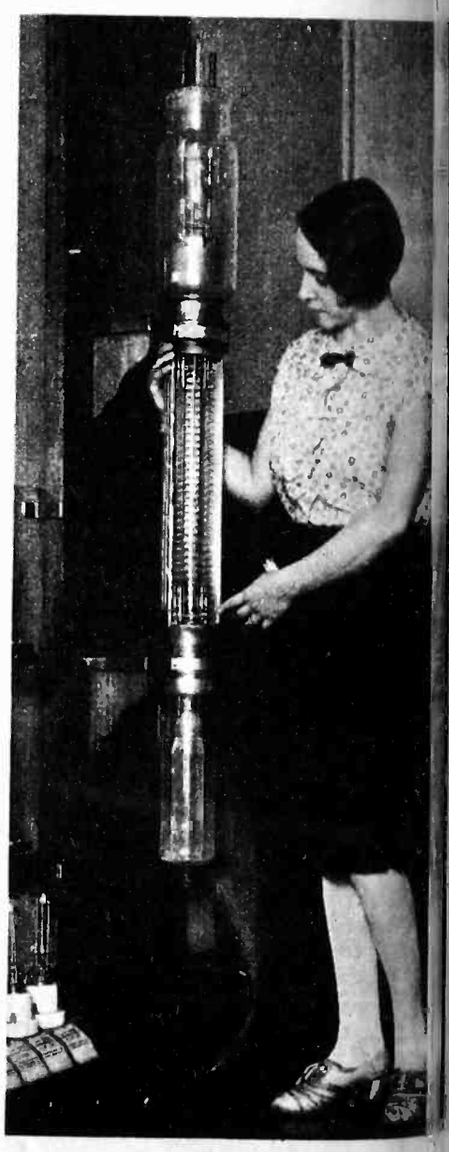
Electronic displays of Museums of Peaceful Arts

During September the Museums o[illegible] Peaceful Arts will occupy their new [illegible] hibit quarters in the News Buildin[illegible] 220 East 42nd St., New York City [illegible] number of operating electronic exh[illegible] are included in the displays. Am[illegible] these are: Photo-cell visitor's reg[illegible] ultra-violet demonstrations, alpha[illegible] tracks, Geiger electron counter, day[illegible] recorder, grid-glow tube, nitrogen [illegible] charge tube, photo-voltaic cell, ph[illegible] electric cells, visible radio waves, in[illegible] ferometer, etc. Other exhibits are b[illegible] added, with the purpose of building [illegible] an important electronic department.

The Museums were founded b[illegible] $3,000,000 bequest of Henry R. To[illegible] Dr. F. C. Brown, formerly of [illegible] U. S. Bureau of Standards, is ac[illegible] director.

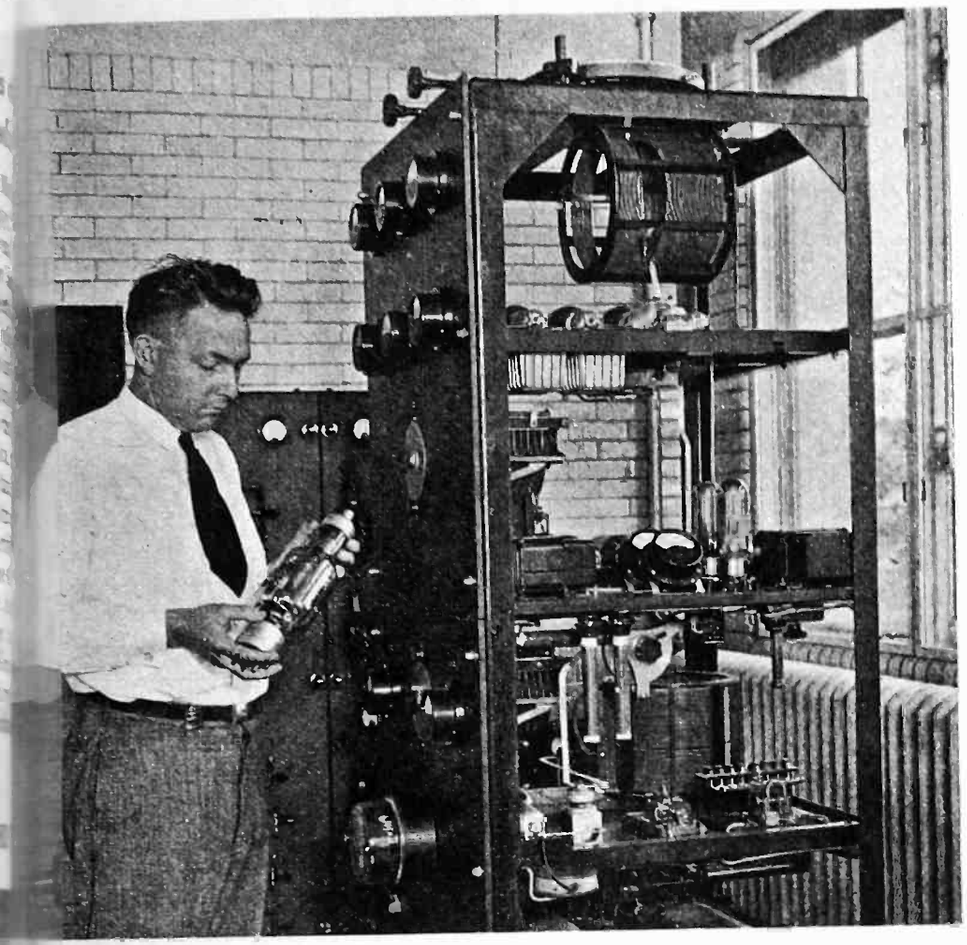
✦

GIANT RADIO TUBE



One of the 200-kw. tubes install[illegible] in the new KDKA station, ne[illegible] Saxenburg, Pa.

TRANSMITTER AT FORD AIRPORT



transmitter which broadcasts half-hourly weather reports from Station 'QDW, for the guidance of traffic on the airways radiating from Detroit. he operator is holding one of the ten 250-watt tubes with which the transmitter is equipped

✦ ✦ ✦

ein pays tribute ndio

Albert Einstein admonishes the se of radio addicts to listen with becoming respect when crooners, bands, symphony orchestras or spellbinders are holding forth he air. The author of relativity st climbed down from the Olympic gts of incomprehensibility, which dinarily adorns, to talk in words e or two syllables on the magic oadcasting. Addressing the seventh an radio exhibition at Berlin, riday, August 22, Professor Ein- said:

ne ought to be ashamed to make f the wonders of science that are odied in a radio set, the while apating them as little as a cow eciates the botanic marvels in the ts she munches. Honored listeners professor was himself broadcast- at the moment) forget not when listen how humanity came into session of this wonderful means of munication. The source of all scien- advancement is the source of the l-given curiosity of the toiling eximenter and the constructive phan- of the technical inventor."

RMA to establish central patent bureau

An important step toward solution of the patent troubles in the radio industry has been taken by the Radio Manufacturers Association. Establishment of a central patent bureau to collect and disseminate complete information on radio patents was ordered by the RMA board of directors at their mid-summer meeting July 30, at Niagara Falls, Ont. The new patent department will be in the New York offices in charge of a competent radio patent attorney.

An extensive library on radio patents, foreign as well as domestic, will be developed in the RMA patent department. It will collect, digest and index all radio patents and publications and all information regarding patent litigation. Files of many important manufacturers who are members of the RMA will be centralized in the RMA patent department which will advise manufacturing members of radio suits and decisions, applications for and issuance of radio patents.

The new patent department will not participate in any patent litigation, but its patent data will be available to all RMA members.

In addition to the new patent department, the RMA directors, also made organization plans for development of other industry services. The following chairmen of the various manufacturing groups were appointed: receivers—Captain William Sparks of Jackson, Michigan; tubes—B. G. Erskine of Emporium, Pa.; speakers—Henry C. Forster of Chicago, Ill.; cabinets—N. P. Bloom of Louisville, Ky.; amplifiers—A. C. Kleckner of Racine, Wis.; raw material—R. T. Pierson of New York; miscellaneous parts—Lloyd Hammerlund of New York.

✦

Federal monitor station at Grand Island, opens

The huge monitoring receiving station being erected by the Department of Commerce under the direction of the radio division for maintaining a careful check on radio transmitting stations throughout the country, opens at Grand Island, Nebraska, in September.

The station will not only police the air but will serve as a standard and give calibrations to broadcasters who desire to have their frequency determined. The main building is of brick and concrete construction, eighty-five feet long and seventy-five feet wide, and two stories high. The building provides space for receivers, generators, batteries and living quarters for the executive force as well as thirty electrical engineers serving as radio inspectors.

Telephone and telegraph lines run into the station underground to prevent interference.

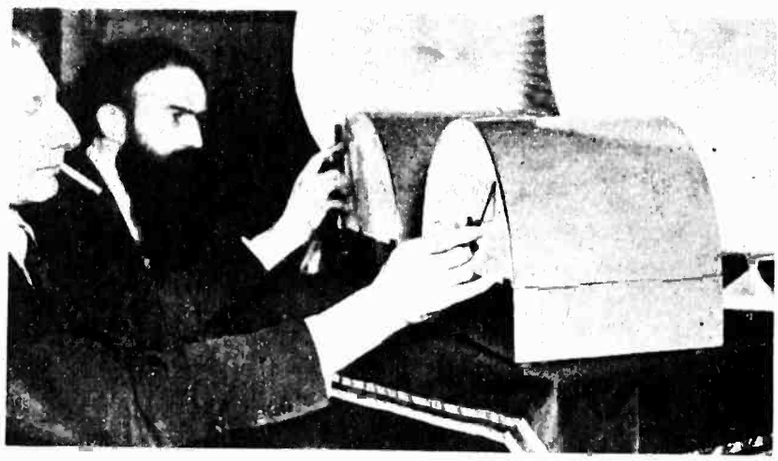
✦

LOUDSPEAKER ON BUS

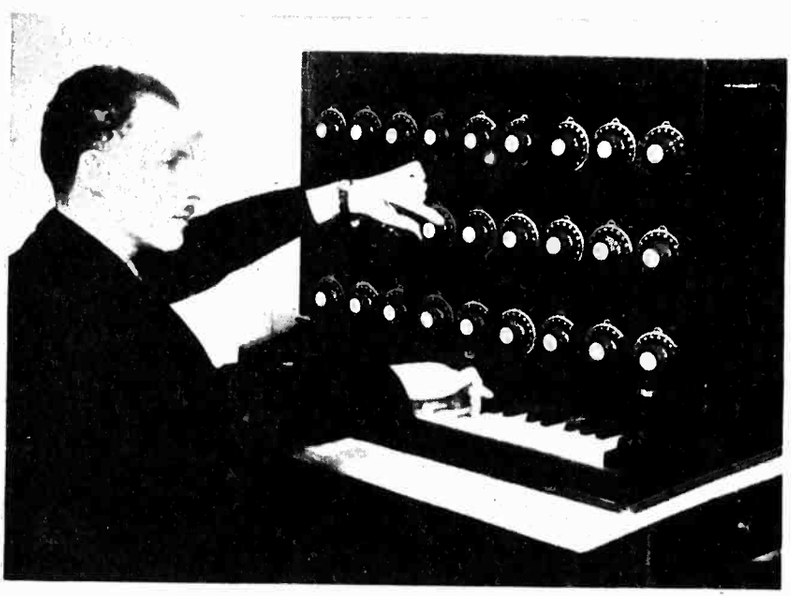
In Chicago some of the buses have been equipped with loudspeakers for special advertising purposes

The MUSIC of the ELECTRO

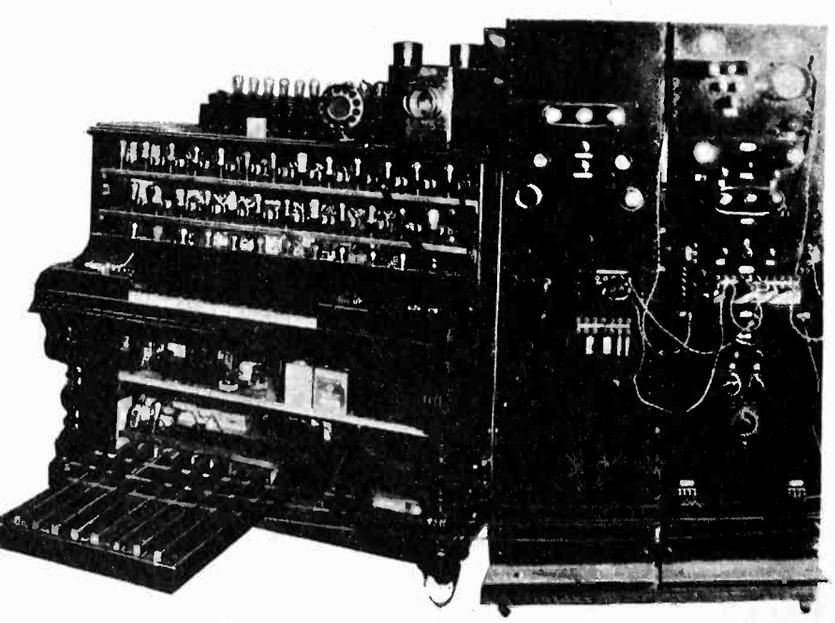
New electrical instruments open up new depths and richness of musical interpretation



Early instrument with condenser-dial control



Condenser-dial tuning; keyboard operation



Dr. Miller's "voice-chord"; one tube-circuit per note

By Dr. ALFRED N. GOLDSMI*

THE past of music has been tied up with m and ponderous things. To produce music have been used hammers, strings, bows, reeds, and other things,—to pound, to hammer, to to rub, or through which to blow. The musicia used his hands and his feet, and sometimes ev elbows and knees to produce musical effects. Tl of mechanisms naturally brought forth music by m ical means. It is perhaps a novel viewpoint to musicians, but actually their art is a mechanical the sense that physical mechanisms are the only ag through which they produce music. (Even the s voice of the artist is produced by mechanical m very broadly similar to those utilized in a pipe o The musical achievements of the past, in the way performances, have been amazingly good, consi the limitations of the devices which have been u produce music.

Now, however, we are entering the age of the el and consequently electrical music is attracting incr attention. What is electrical music? It is music ob through the human control of electric currer appropriate form, which currents, actuating loud ers, produce the desired music.

Gives artist freer scope

The next and obvious question is: Why is ele music necessary? The answer is simple—viewed the future, mechanically produced music will be s be extraordinarily limited in its scope and possib both artistically and as an entertainment means, a pared to electrically produced music. It is to be that electrical music in nowise displaces the arti the contrary, it makes the artist more importan ever and gives him freer scope.

Electrical music is obtained by personal perfor on an electrical musical instrument—not by reprod from a record or from a radio wave which car musical program.

In the following general and necessarily inco survey of electrical music, it is not proposed to a the various methods which have been suggested o out. Individual experts will presumably prepare d tions of such methods for this publication. The of Messrs. Cahill, De Forest, Frank E. Miller, mond, Ranger, C. J. Young, Goldthwaite and Hard Theremin—are among those who have worked i field and have accomplished results of interest.

The first task in every electrical musical instrun

*Vice-President and General Engineer, Radio Corpora America.

A orchestra of ten theremins which, in conjunction with one keyboard-operated instrument, gave a recital at Carnegie Hall, New York, in April, 1930

uce an alternating current. Alternating currents uired because only such currents carry musical pitch within themselves since they have a definite cy. These need not be pure sinusoidal currents. ac in general they should not be such. They may any desired proportion of a fundamental tone ch of its harmonic, or even unharmonic, over- s. These alternating currents may be controlled to e desired notes and sequences of notes.

e alternating currents are of high frequency, the notes of the treble register will be produced; if rnating currents are of low frequency, the deep notes will result. If the alternating currents inusoidal wave form, but thin note will the addition of har- to the wave form ake the tone richer re interesting. Alter- currents of small ude correspond to nes, and the larger udes give rise to loud

nt form and tone produced

corresponding al tones will thus re- he form of the alter- current which pro- them. Furthermore, olume of the musical which is produced is ourse dependent only the power available in electrical generating ment and bears no re-

The photo-electric organ developed by Prof. A. C. Hardy of Cambridge, Mass., using tone-wheels on which vibration curves are photographed

lation whatever to the physical strength of the performer. A child could fill the largest auditorium in the world, or even a group of auditoria, with music produced by electrical means.

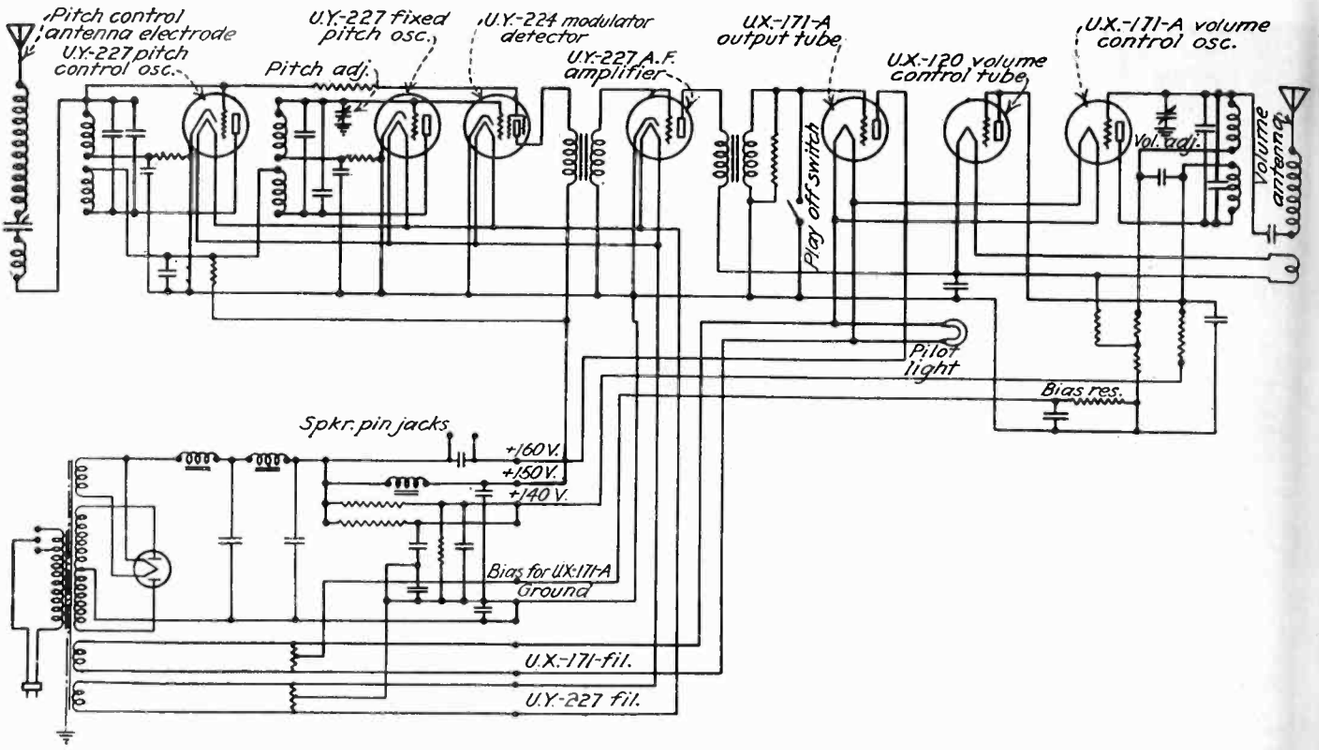
There are thus two steps in connection with electrical music; the production of an alternating current of any desired form, and its modulation or systematic control.

An interesting feature of electrical musical instruments is that the mode of control can be practically anything which one desires. One can control any sort of tone either from a keyboard or from a device like a string, or from a fret-board, or even by merely waving one's hand around in the air. Rather amazing things can be done; for example, one can play an instrument which, from appearances, should produce a well-known tone quality whereas the tone quality actually produced is very different from that expected. The difference may be controlled at the will of the operator.

Advantages over mechanical methods in music

More specifically, then, electrical musical instruments will, when developed, surpass mechanical musical instruments in the following basic respects:

1. Any tone quality, at present known or unknown, which is capable of perception by the ear, will be obtainable. Not only can any known instruments be closely imitated, but *new*



Circuits of the antenna-operated theremin. One antenna-rod controls pitch, the other volume. The artist plays by waving his hands at the proper spacings from these two antenna rods, and thus varying the capacities in the circuits.

tone qualities, corresponding to any existing instrument and some of them of exquisite character, are producible. A musician in the future need not play according to the limit set by previous instruments—he can literally invent new sorts of tones to please himself, and will astonish and thrill his audiences.

2. Any desired pitch of tone can be produced. The limitations of mechanical musical instruments become rather severe in the extremely low and in the extremely high registers. Such limitations do not exist for electrical musical instruments which can be made to give low notes even to the limit of audibility and high notes of any desired shrillness, or piercing quality, or alternatively, of sweeter quality. The tonal pitch range of electrical musical instruments far transcends the capabilities of the ear, and will bring satisfaction to musicians in the future.

3. Any desired volume or loudness of sound can be produced. Practically without effort, the musician can change from music which is the softest of whispers to a thunderous volume which would make the very walls of an auditorium tremble. Dynamic and dramatic effects, quite beyond the reach of mechanically-operated musical instruments thus become available.

4. Any desired form of control can be adopted at the musician's own choice. If the musician happens to have a particular aptitude for the piano, he can use the piano keyboard form of control. If he prefers to bow a string or to play any other form of control such as push-buttons, or moving his hands in space, he can utilize these forms of control as well and produce similar effects.

Electricity is so versatile an agency and so flexible in its control under the new mastery which man is imposing upon it, that the electrical musical instruments of the future will undoubtedly be a glorious source of entertainment to the fortunate audiences of that time.

New musical dimensions are introduced

A word of caution is necessary, however. The development of electrical music will be a long and difficult task. The matter of producing musical scores which will adequately indicate the greater number of available "musical dimensions" which are at the disposal of future artists constitutes a real problem. Symbols for delicate shades of quality, and more accurate indicators of loudness, are obviously called for.

There is a serious element of delay involved in the development and general acceptance of the new methods of writing music which are thus required. W tremendously enhanced range of tone quality, vo pitch, and mode of attack of musical tones, it is clear that the new musical shorthand which is c of describing these effects for a solo performance be something distinctly unlike the musical score present. When orchestral and symphonic effects into consideration, the necessary elaborations of m scoring are even greater because electronic music the controlling musicians a chance of coupling, as de any instruments or groups of instruments, either exact correspondence or with any desired lag or more complicated relationship. One is rather stag at the possibilities, from the musical viewpoint, of these combinations and permutations. They the analyst into the belief that music is destined to into a new phase, which will be as much more subtl refined and of value to mankind as is, for exa modern chemistry as related to medieval alchemy

And, long after the perfected musical instrumen its scoring methods are available, their full capab will not be recognized by mankind because of the l the necessary specially written music and trained a The electrical musical instrument of the future require great composers just as the piano needed M and Beethoven before its capabilities were re Somewhere in the future, probably as yet unbor the great composers who will write the masterwor these new electrical instruments.

And, after they have produced their masterpie music, there must also be born and trained, great who will have the technique adequately to perfor music which has been written. All of this is a of many generations—"art is long and time is fleeti

But that electrical music is revolutionary and opens up new vistas of the utmost importance to posers, musicians, and the music-loving public is a obvious; and all this is made possible through the of that obiquitous servant of mankind—the electr

ound noise in

ınd pictures

A study of noise

due to disc recording

mer G. Tasker*

E success or failure of any sound picture de-
ads on whether or not the person who pays to
e and hear this picture is sufficiently entertained
tisfied with his investment. If so, he and others
ind will continue to provide the income with
ch pictures are made.

oduce successful sound pictures, three important
ents must be fulfilled by the recording and re-
ig system:

system must show very little frequency discrimination
nd sufficiently wide to include those frequencies impor-
peech and music; that is, it must have a nearly flat
characteristic;

ust also show a minimum change in the relative loud-
ounds of large or small amplitude, whether or not the
loudness has been changed; that is, it must have a
ly linear amplitude characteristic;

ust not introduce to an objectionable degree sounds
the screen being depicted.

unwanted sounds are ordinarily of moderate
such that they seem to form a background for the
sounds and for this reason have come to be
as ground noise.

noises measured are in all cases typical examples
s normally occurring in talking picture work. In
instance the results may depart appreciably from
rage which would be obtained by measuring a
umber of similar noises but for the purpose of
ion they will serve admirably.

Sources of ground noise

sources of ground noise are very numerous and
y cases difficult to control. Certain of them are
t to the recording and reproducing processes,
r the recording be done on disc or on film. These
clude inherent characteristics of the materials used
cording and of the apparatus required for record-
d reproducing and such items as mechanical vibra-
f recording or reproducing mechanisms. Many of

istant Chief Equipment Engineer, Warner Brothers Pic-
Inc., Hollywood, California.

these factors may be readily controlled and others may be circumvented by the adoption of special measures either in recording or reproducing.

A second group of noises originate in the electrical systems which energize the recorder in the studio and the reproducer in the theatre. Most of these electrical noises can be eliminated but many of them are recurrent and have occasioned considerable expense for improvements and maintenance.

A third group of noises are the acoustic noises appearing on the stage itself. Important among such sounds are those caused by the cameras. Since the microphone cannot discriminate between these sounds and the ones wanted, both will be recorded and reproduced in the regular way. Consequently the only recourse is to reduce the noise itself or insulate it with sound-proofing materials. The silencing of cameras was one of the first, and has remained to be one of the most important problems in the making of sound pictures.

In reproducing sound from disc, certain ground noises appear in the final output which are primarily due to

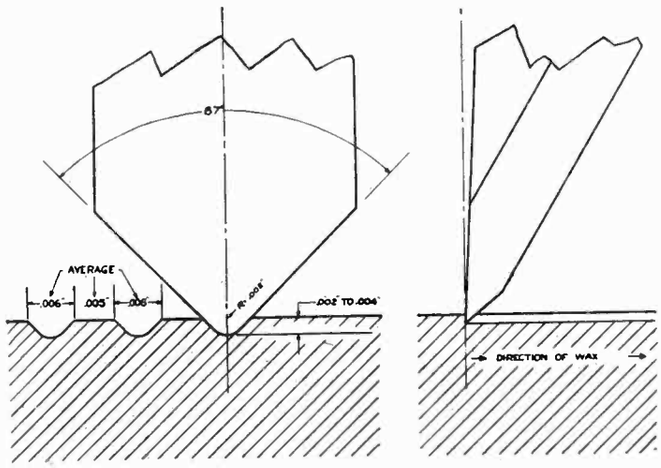


Fig. 1—Details of the stylus point of a wax cutter

surface roughness of the record. Much of this roughness originates in the granular structure of the material used for the final record, while other irregularities are introduced in the recording and processing of the original wax. While the physical dimensions of these irregularities of the surface are very small indeed, some idea of their importance may be gained from a discussion of the dimensions involved in the actual reproduction of speech or music from a disc record.

The grooves of a disc record are ordinarily spaced

▼

IN the accompanying article, Mr. Tasker has made an interesting study of noise due to disc recording. In a following issue of *Electronics* a discussion of the noise due to film recording, the electrical system and acoustic noise will be given.

—The Editors

▲

about 92 per inch. This means that about .011 inch is available from center to center of the grooves of which about .006 inch is required for the groove itself. This makes possible a maximum lateral motion of the stylus of about .0025 inch to either side. For safety, .002 should not be exceeded. The disc recording cutter, of which the stylus is a part, is known as a constant velocity device. That is, if the same electrical level of a number of different single frequencies is applied successively to the cutter, the resulting amplitude at 400 cycles will be only half the amplitude at 200 cycles; the amplitude at 1,000 cycles will be one-fifth of that at 200 cycles, etc. It happens that the cutters ordinarily used for disc recording have this characteristic above 200 cycles only. Below this point, the amplitude is independent of frequency. Assuming that a 200 cycle wave has been cut at the maximum amplitude of .002 inch to either side of the mean, then a 1,000 cycle amplitude for the same electrical level would be .0004 inch and the corresponding amplitude for 4,000 cycles would be .0001 inch. Now suppose that the level drops about 20 db., a not uncommon range in talking picture work, and the 4,000 cycle amplitude becomes .00001 inch or about ten millionths of an inch. This very minute amplitude is comparable to the dimensions of the granular structure of the material of which

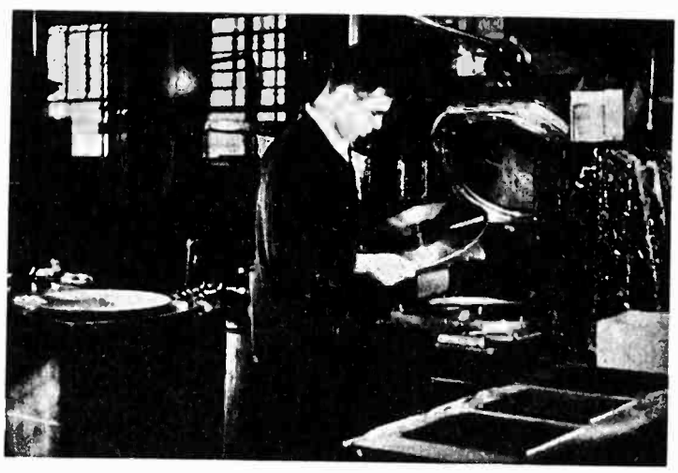


Fig. 2—Record press, showing finished record just removed from the dies, and record stock heating on the steam table

the disc record is composed and we may expect surface noise of frequencies in the range from 2,000 to 5,000 cycles to originate from this structure when the record is played in the theatre.

Experience shows that the amount of surface noise in a record is not entirely due to the record stock and an attempt to reduce this annoyance to a minimum leads to an investigation of many other sources of surface roughness in disc recording. For example, the soft wax blank on which the record was initially cut may be the cause of considerable surface noise. This material must have such a homogeneous structure that it is capable of being cut very smoothly. The temperature at which the recording is done must be controlled within reasonable limits. If it falls too low, the wax will become brittle and will chip along the edges of the groove. This will obviously introduce surface noise into the finished record. On the other hand, if the temperature rises too high, the wax will tear instead of cutting clean, again resulting in an uneven surface in the groove. In practice, very little difficulty has been encountered with this upper limit. Waxes have been successfully recorded on desert locations with tem-

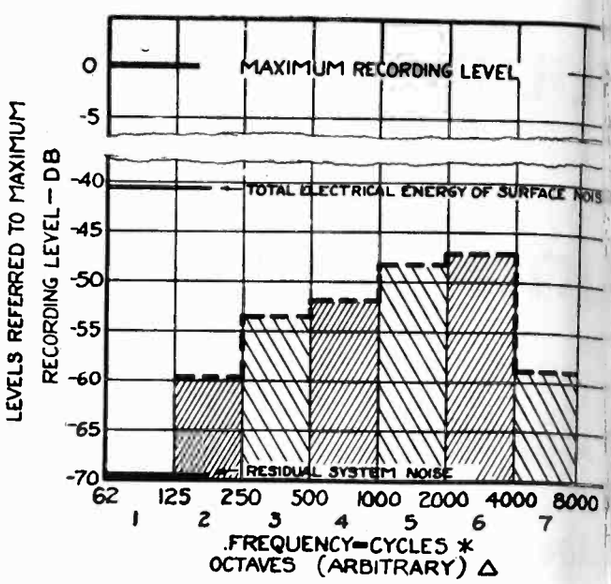


Fig. 3—Electrical energy analysis of disc surface noise

peratures of over 100° F. in the recording truck. lower limit, on the other hand is much more likely encountered in practice. For certain types of wax temperature must not fall below 80° F., but with th cutting waxes now commonly used, the lower li about 60° F.

The accumulation of dust on the surface of before or after recording will introduce surface and considerable care is taken to provide dust-free the recording rooms. The accumulation of dust finished record in the theatre is of negligible impo since the needle plows this dust out of the groov progresses.

The condition of the cutting stylus will also affe smoothness of the original groove. It is importa this device present keen but uniform edges to th so that no scratches or other irregularities will be duced into the groove. This stylus cuts a groov .006 inch wide and about .003 inch deep; the the preparation of such a stylus becomes a matt great skill and care. Two enlarged views of a styl shown in Fig. 1. The material used is selected sa which retains its shape and keen edge for a long of time.

Record processing

When a soft wax on which sounds have been re is removed from the recording machine, several pro must intervene before suitable records can be made able. The soft wax is first coated with some cond material, usually graphite. An electrical connect then made to this coating and the wax is immer an electroplating bath. After a suitable period of a layer of copper will have been deposited on the s of the wax which is about .02 inch thick. This shell constitutes an exact copy of the original wax that it bears ridges instead of grooves.

In this procedure, two opportunities for intro surface noise occur. If the graphite is not app the wax in a very uniform, thin layer, there irregularities in the metal negative. Moreover when the greatest of care has been employed, the gr structure of the graphite itself will introduce an ciable amount of surface noise. For this reas metal negative is carefully polished before bein

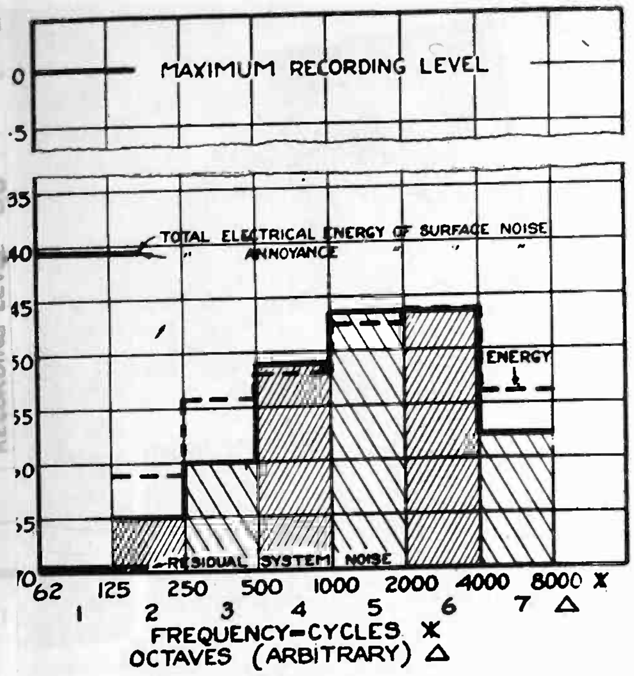


Fig. 4—Electrical energy and annoyance analysis of disc surface noise

…additional processes. This polishing must be …refully done since it would be quite possible to …away many of the high frequencies having such …mplitudes as those described above. Improved …ds of making electrical contact with the soft wax …en developed, which avoid the use of graphite and …an appreciable lessening of surface noise. It is …at also that the current strength during electro… …hould be properly regulated since too rapid plat… …sults in coarseness of the deposited metal, and …ent surface noise.

…mplete the records for theatres, it will be neces… …o pass the negative just obtained through two …nal electro-plating processes, in the first of which …r more master metal records (positives) are de… …om the negative and in the second, a number of …egatives called "stampers" are obtained from the …asters before the actual pressing of records can …ertaken. These steps are taken primarily as a …f insurance for it would be possible to use the …master negative in the record press as a stamper, …chance of losing an entire recording because of …ccident to this master, warrants the additional …ecessary to obtain a number of stampers as de… …d. Each of these additional plating processes in… …ce the possibility of further surface roughness but …aphiting is not involved, the successful avoidance …tional noise is only a matter of careful control …rocesses.

…metal stamper is backed up with a heavy copper …preserve its shape and then placed on the bed of …ulic press as illustrated in Fig. 2. Record stock …d on the steam table in the foreground until it …s quite plastic. It is then rolled into a ball by the …perator and placed on the stamper which has been …by steam in the hollow dies to the approximate …ature of the steam table. The press is then closed …pressure of more than a ton per square inch which …the record stock into the minute grooves of the …record. Cold water is then turned into the dies … of steam and after a few seconds the press may …ned and the finished record removed.

…riety of record stocks are in general use, some of …produce somewhat less surface noise than others, … general these quieter stocks are shorter in life. The resulting poor quality as the record becomes old often more than outweighs the advantage of reduced surface noise. Such record stocks, however, are quite desirable for studio use in connection with original recordings, especially for the re-recording of these records into theatre releases. For these original records, life and unit cost are of relatively small importance while the reduction of surface noise is of great value.

When sounds recorded on disc are being reproduced in the theatre there is no inherent characteristic of the reproducing means which will cause additional noise, as is the case with film recording. There are, however, such items as defective needles or needles loosely clamped in the reproducer which, in addition to causing bad quality, will cause increased noise.

Analysis of typical disc surface noise

Figure 3 is a graphic representation of the noise produced by a disc record made with a cutter which was not connected to any electrical circuit. It contains, therefore, blank grooves only. The turntable on which it was played during these measurements was almost entirely free of mechanical vibration. Consequently the data reported in this chart applies only to noises introduced by the recording, processing and pressing of the record.

In order to obtain a rough analysis of this noise, it was measured through band-pass filters, each passing approximately one octave of the audible range. For convenience these bands are assigned arbitrary numbers from 1 to 7. The shaded areas, therefore, represent the amount of electrical energy expressed in decibels below maximum recording level of all the noise frequencies within any one octave. This maximum recording level is taken to be 10 db. below the highest peak level for a single frequency, thus allowing for the combination of frequencies in speech. It may happen that the noise energy is largely concentrated in one or two frequencies or that it is quite generally spread over the entire octave, but the measuring apparatus is unable to discriminate between such conditions.

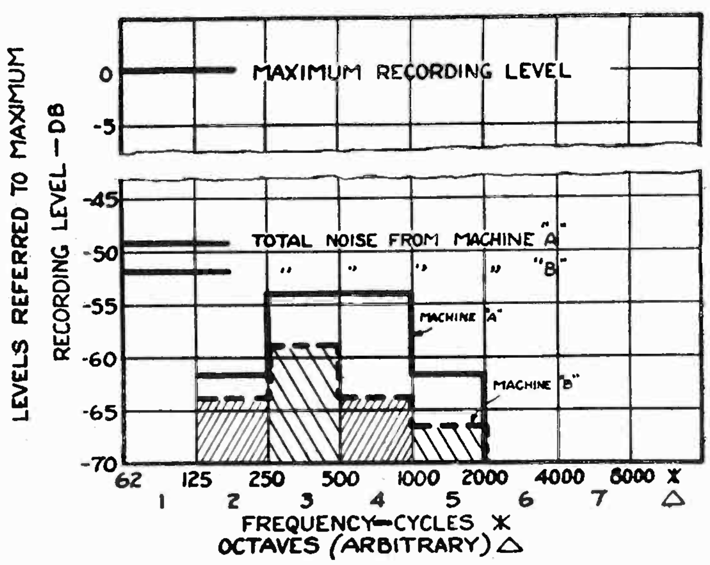


Fig. 5—Annoyance analysis of disc turntable mechanical vibration

The bulk of this electrical energy appears in the higher frequencies although a surprisingly large amount is present in the third octave. The amount of energy per band increases with frequency up to the sixth octave, but in

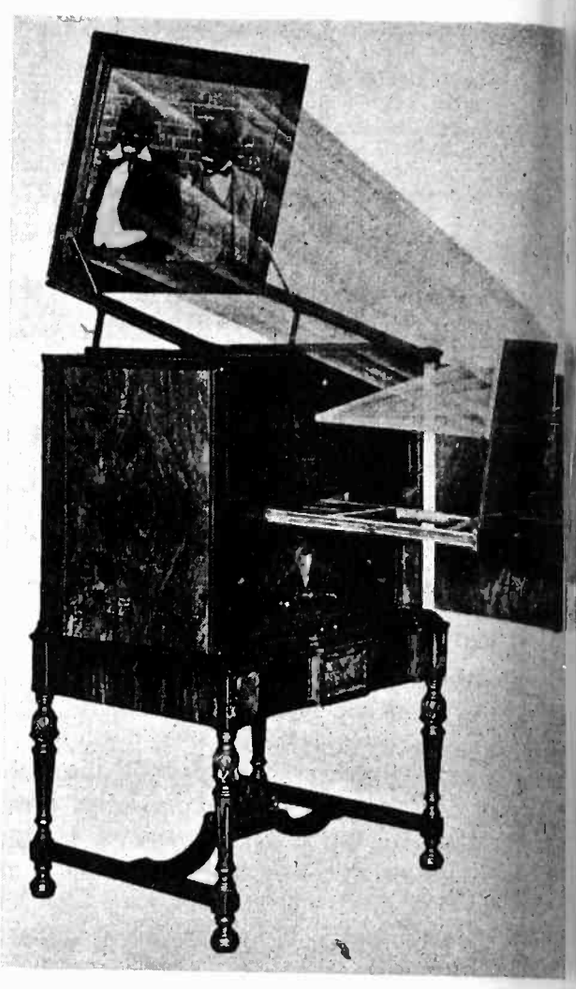
[*Continued on page 312*]

Home talking movies

Technical design of present 16 mm. sound-picture equipment

By FRANKLIN S. IRBY

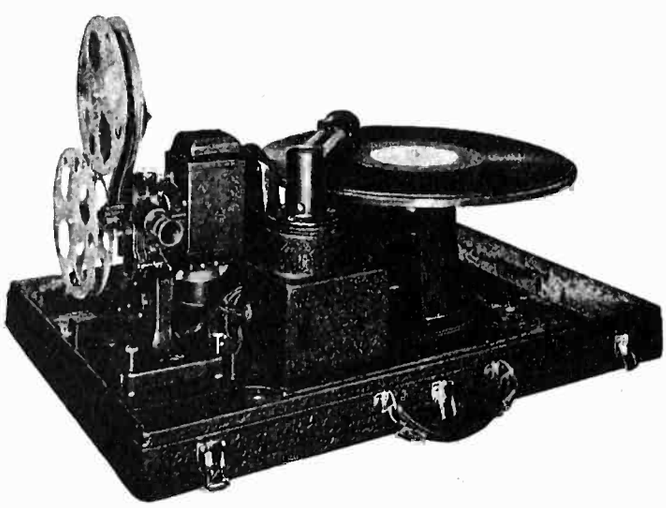
Associate Editor, Electronics



A 16-mm. projector, radio receiver, turntable an screen, with a reflecting mirror, are combined i one cabinet as manufactured by the Visionol Company, New York City

WITH the addition of sound to standard 35 mm. film for theaters, a new impetus has been given to advancing the market for home sound movies. The use of 16 mm. film for home entertainment is not new. Standard projectors using this size film have been on the market for years. It has been estimated that 200,000 of these projectors in one form or another have been sold. The development of low priced amateur moving picture cameras has recently been a great stimulus to this market. These cameras have permitted "all the family" to appear on the screen, which seems to be the goal of everyone at least once.

This general development, while building up a fairly successful market has not met with as widespread larity as the equipment deserves. There are few today who would not place an inestimable valu moving picture record of their youth which woul in action some of the "stirring events" of their lives. The adoption of home movies has not recei popularity that the home radio has received. easily understood; for once the radio receiver h purchased, the owner's entertainment is free exc the nominal cost of tube replacement, while in the home projectors, the renting of films represents preciable amount when compared to the radio. Th when once installed, requires no further persona and return of the entertainment as is the custom handling of films. This then may explain broad one form of home entertainment has so far outs the other.



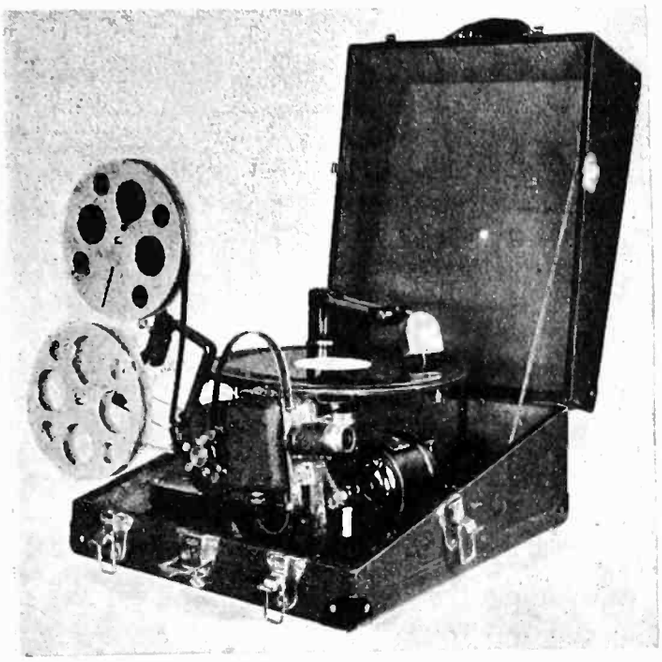
The turntable and 16 mm. projector unit are integral in this portable unit manufactured by the QRS-DeVry Corporation, Chicago

Another reason perhaps is the lack of conve located film libraries except a few placed in the cities. The number of silent film features avail such libraries may be adequate considering this d ment up to the present. The rental of an average six reel feature silent picture from one of the stores catering to this trade in New York, is $2 day. No figures are available at present on wha features will rent for with the addition of sound. companies have, however, complete sound film accompanying disc records which may be purchas right and it is understood that a few libraries ha films on a rental basis. One of the larger produ 16 mm. films for this market has announced future releases will only be with sound.

lefinite statistical data it is well known that the of sound to moving pictures has tremendously theater attendance. This great popularity is ved for there is no doubt that sound has added ie entertainment value of pictures than all other ents combined. For this reason, it is felt that on of sound to home movies will widen the r this type of entertainment. Just how far this ill go can only be a guess at present. If only sound projector were sold for every twenty eivers now in use, it would mean the sale of 500,000 projectors in the United States alone. ment such as this would mean a great stimulus raries and additional demand for tubes, ampli- ther electronic equipment.

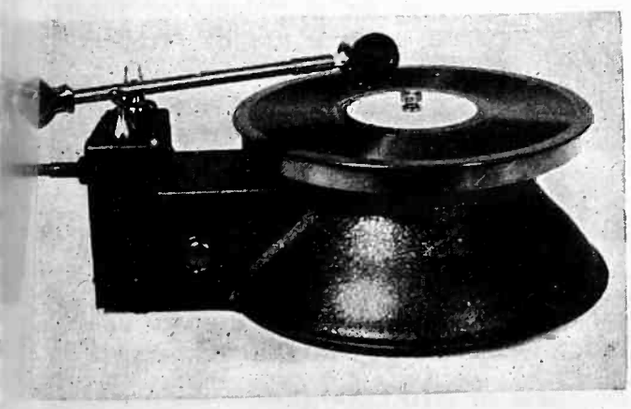
re a number of home movie machines already arket. This equipment varies from a simple with a flexible cable for attaching to present jectors, to elaborate combining a radio, projector, turntable in one cabinet. All rsent equipment, how- lesigned for sound- hich is run in syn- with 16 mm. film.

ndard speed for run- m. sound film is 90 minute or 24 frames d. This corresponds 5 feet per minute or s per second for 16 m Present home sound ing the professional $33\frac{1}{3}$ r.p.m. disc thus projectors geared to rames per second to synchronism. This erence in linear speed te is a serious draw- dding a sound track m. film, assuming that ficulties can be over-



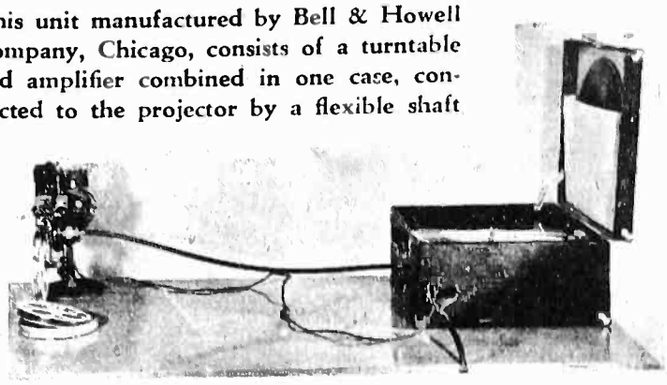
The North American Sound Picture Corporation, New York City, is the manufacturer of the combined projector and turntable above

oduce the same fre- nge it would require a slit width of .4 of a mil 6 mm. projector sound head as compared to the one mil slit for 35 mm. film. This also requires d reduction of the 35 mm. sound track to 16 mm. me ratio to allow for the difference in linear the two films.



This turntable, manufactured by the Hollywood Film Enterprises, is designed to connect to standard 16 mm. silent projectors by means of a flexible shaft

This unit manufactured by Bell & Howell Company, Chicago, consists of a turntable and amplifier combined in one case, connected to the projector by a flexible shaft

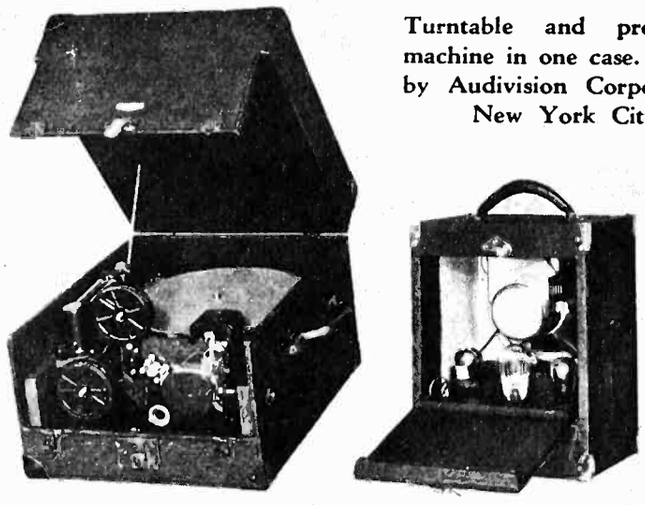


The reduction in picture area with the addition of a sound track to 16 mm. also offers some objection to sound-on-film. It has been proposed to eliminate the sprocket holes from one side of the present film which would allow the sound track to be added in this space. This has been done in some experimental tests. The majority of home projectors now on the market have only one claw for operating the film past the intermittent so elimination of sprocket holes on one side might prove practical by making slight changes in the projector design.

Other schemes have been proposed to allow for the sound track on the present 16 mm. film. One of these methods calls for an optical unit having a tiny spherical lens with an extremely short focal length, the resulting light beam projected on the film being very thin and requiring a sound track only $\frac{1}{16}$ inch wide. It is claimed, however, that the high cost of such equipment would add greatly to the cost of home apparatus.

The sound-on-film head for a home projector will require a photo-cell as well as a two or three stage PEC amplifier. The cost of this equipment is appreciably greater than the pick-up arm serving the same purpose used for disc reproduction. Both methods of course require an additional amplifier which may be a special unit for this purpose or the home radio receiver may be used. The vibration in home projectors caused by the movement of the intermittent and other mechanism is more difficult to contend with in a sound head than the present disc turntable. Some type of flywheel to insure constant speed of the film past the sound gate without flutter is also required.

Some of the drawbacks to the development of sound-on-film for home use have been pointed out, but it is felt that such problems will be successfully worked out in the future. There seems to be no doubt that the successful exploitation of home sound movies will depend largely on developing the sound-on-film method for reproduction. The latter will do away with transportation of discs and much trouble of the exchanges in keeping damaged films and discs in synchronism. This also eliminates one unit required for inspection on return to the exchanges.



Turntable and projection machine in one case. Made by Audivision Corporation, New York City

Present home sound movie equipment is designed for the professional 16 inch 33⅓ r.p.m. disc, while in some cases, the turntable can be used for commercial 78 r.p.m. records. The complete sound unit is designed to operate off 110-volt 60-cycle a.c. with no additional batteries required. Specifications for the projector lamp are similar, usually requiring one 20-volt 250-watt lamp. A special transformer is supplied to furnish this voltage from the 110-volt circuit.

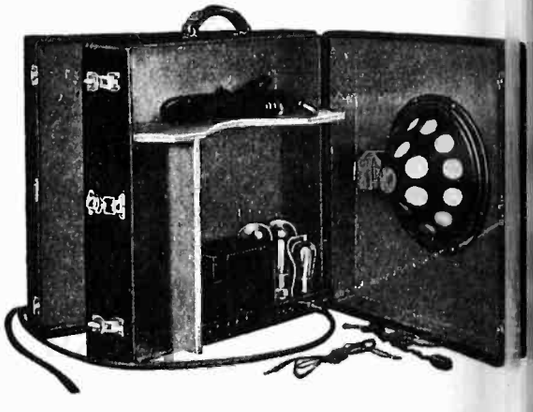
The amplifiers supplied with these units vary somewhat in details and hookup. Usually three tubes only are required, one 224, one 250 and one 281 tube. Some of the equipments use magnetic speakers while others are equipped with dynamic reproducers. When the turntable and projector are supplied for home equipment without a special amplifier, plug-in cords are provided for operating the unit from standard radio receivers.

Only one motor is generally used to drive the projector and turntable, thus securing direct synchronization of these units. In at least one equipment on the market two motors are used, one to drive the projector and the other for the turntable, the two motors, however, are connected by a flexible shaft to maintain synchronization. A synchronous motor of 1/20 to 1/30 hp. is generally used for the turntable and projector drive. Recently an ingenious synchronous motor for this use has been brought out. The rotor is a simple laminated ring having 92 teeth in its inner periphery. It is secured to the underside of the turntable concentrically around a bearing shaft which is pressed into the turntable. The stator assembly is free to turn through an arc of 50 degrees but is held against rotation by light tension springs secured to a radial arm. This spring tension plus the friction couple in the stator support bearing gives a very uniform and highly damped control to the turntable itself.

A new material for disc records has recently been placed on the market which has many advantages for home as well as professional use. These new one-third the weight of present records, are f not subject to breakage as the standard 16 in are now. They may be packed easily and se the mail with little chance of damage.

Film libraries

The future adoption of home sound movies scale will depend upon the growth of film libr felt that an improved class of subjects and charges will be necessary to promote the w home sound pictures. The sale of sound proj the development of libraries will have to g hand. In 1929 there were some 856 featur made in the professional studios in this countr ing for an attendance of one person to the th week, it will only mean that 52 feature picture seen in a year. What happens to the remainin pictures? It has been stated that only 10 to 25 the pictures released have a theatrical market of one year. Of the remaining 75 per cent o many that are excellent might be made av



Amplifier unit designed by QRS-DeVr Corporation, Chicago. One 224, one 25 and one 281 tube are used. The speake section may be removed from the case

home use on a reasonably profitable basis. Pict over a year old when released for home proj their appeal to public demand.

Up to the present, the larger producers hav enthusiastic about the development of the h field, but whether such a development would present theater attendance is problematical. the free entertainment value offered by radio i rise during the last few years has not been det such attendance. In fact, the latter has provide through radio broadcasting of special movi features to increase the attendance of theat such development or free use of "trailers" similarly used in home movies.

DR. F. S. IRBY

▼ ▼ ▼

THE "HOME TALKIE" MARKET

If only one home sound projector were sold for every 20 radio re ceivers now in use, it would mean the sale of 500,000 projectors i the U. S. alone, or a total business of $100,000,000.

This would create a great additional demand for tubes, amplifie and other electronic equipment.

n improved e-selector cuit for dio receivers

DWIN A. UEHLING

QUATE separation of radio-frequency signals the receiver constitutes one of the most impor- nt problems before radio engineers. This prob- f electivity cannot be solved simply by increasing uber of tuned circuits in the receiver, nor by any vment that can be made in these circuits indi- Selectivity under present conditions of broad- is not dependent entirely on the amount of l selectivity of the receiver, but under conditions countered it may be determined largely by the ance of the very first circuit.

i-frequency signals of all wave-lengths are im- on the grid of the first amplifier tube. Attenua- c frequencies to which the receiver is not tuned st, but the attenuation is not infinite, and may be n sufficient to reduce to negligible values the of undesired signals. Should the receiver be or example, to a rather weak carrier, sufficient rom a strong carrier 50 or more kilocycles away ch the grid of the first amplifier tube, and cause ion of the desired carrier by the rectified audio- cy of the undesired wave. As a consequence both may be heard, and no amount of selectivity fol- the first stage of amplification can eliminate the ed signal.

Cause of cross-talk

Interference of this kind, "cross-talk," is due primarily to the non-linear characteristic of the first tube. With small signals the characteristic may approximate linearity, and cross-talk may not be noticeable. However, it is not feasible to maintain the signals in the first tuned circuit below that value for which modulation becomes important, since it is not practical to control the volume entirely in the antenna circuit. The remedy for "interference" of this kind rests with the circuit preceding the first amplifier tube. It is this circuit which will receive our consideration now.

The conventional tuned radio-frequency receiver has one tuned circuit preceding the first tube. A natural remedy for cross-talk is the use of two tuned circuits instead of one. This is the method of coupled circuits, which under certain conditions gives a double resonant effect in transmission, and may approximate the ideal in the transmission as well as in the attenuation regions. Such circuits, however, have not met with whole hearted favor. While their characteristics at certain frequencies may be desirable, uniformity at all frequencies might be lacking. To understand the operation of these circuits and the newer ones in which uniformity of transmission has been partly attained we shall review certain fundamental principles.

Coupled-circuit theory

Two coupled circuits may have any coupling impedance whatever. Let us designate this coupling impedance by the symbol B. If the two circuits are identical two resonant points occur when the reactances of the two circuits take on the negative and positive values of the quantity $\sqrt{B^2 - R^2}$. Since the circuits are identical the resistance R is the same for both, and the reactances of both circuits take the positive and negative value of the quantity $\sqrt{B^2 - R^2}$ together. The frequency separation of the two resonant points determines the band that will be transmitted, which is dependent, therefore, on the values of B and R. We are free to choose these quantities as we desire, B being any coupling impedance and R being the radio-frequency resistance of the circuits which is certainly susceptible to alteration. Unfortunately the value of R increases with frequency in a rather definite manner. Also B changes with frequency, increasing if the coupling impedance is purely inductive, and decreasing if it is purely capacitative. The rate at which B increases with frequency if the coupling is purely inductive is much greater than the rate at which R increases with frequency. For uniformity of transmission the difference between the squares of B and R must remain constant.

Consider the circuits of Fig. 1 where a common impedance B that is capacitative is shown in Fig. 1(a). This impedance decreases with increase in frequency. Since the radio-frequency resistance of the circuits in-

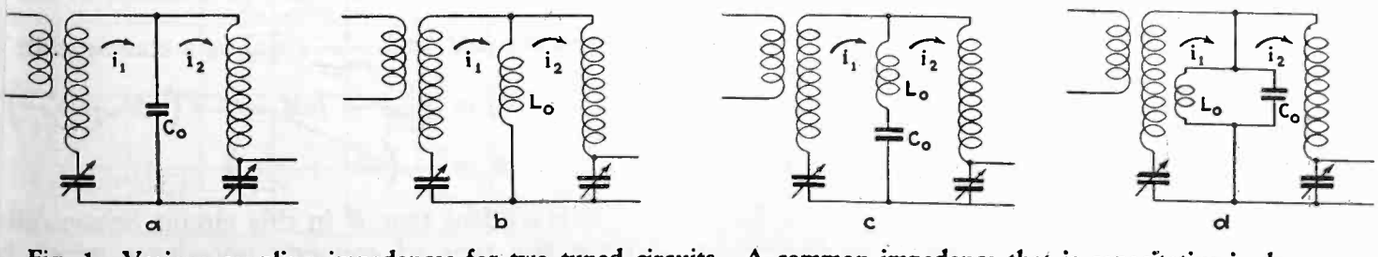


Fig. 1—Various coupling impedances for two tuned circuits. A common impedance that is capacitative is shown in (a). Circuit (b) will produce separations depending on R and its change with frequency. Circuits (c) and (d) combine inductive and capacitive coupling

creases with increasing frequency the quantity $\sqrt{B^2 - R^2}$ does not remain constant. A circuit of this kind, the constants of which have been adjusted to give 10 kilocycle separation between the two resonant points of the transmission characteristic at 550 kilocycles, will have progressively less frequency separation with increasing frequency; no separation at a certain frequency in about the middle of the broadcast range; and for the remainder of the broadcast range actual attenuation. On the other hand a circuit of the type shown in Fig. 1 (b) if adjusted for 10 kilocycle separation at 550 kilocycles may have 20 or 30 kilocycle separation between resonant points of the transmission characteristic at 1,500 kilocycles, the actual value of the separation depending on the value of R at any one frequency and the rate of change of R with frequency.

Complex coupling impedance

A possible solution of this lack of uniformity in the transmission characteristic is the use of a combination of inductive and capacitative coupling. Such combinations as shown in Fig. 1(c) and (d) are, however, of no avail. Regardless of the adjustment of constants the rate of variation of the width of the band with change of frequency is greater than for either purely inductive

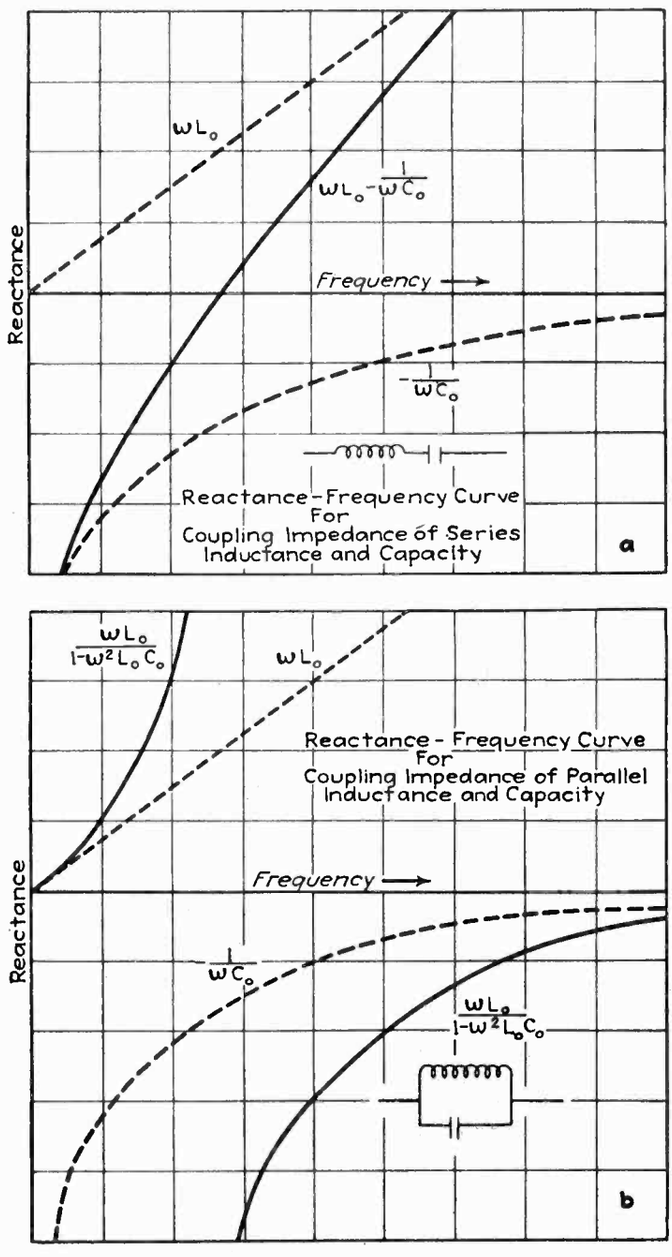


Fig. 2—Reactance-frequency curves for series- and parallel-tuned circuits

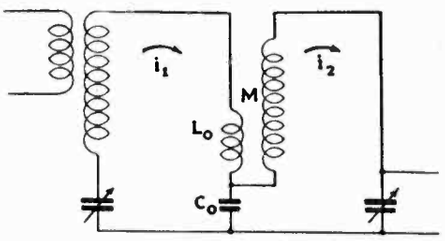


Fig. 3—A ne
led circuit i
band-width
stant

or purely capacitative coupling, since the rate of of B in (c) and (d) is greater than in either (a) The rate of variation in impedance with change quency of a series combination of inductance and ity is shown in Fig. 2(a). This variation is prop to the slope of the solid line which is greater t slopes of either of the dotted lines representing pedance variation of pure inductive and pure coupling. Similarly in Fig. 2(b) we learn tha parallel combination of the component elements of variation of B with frequency is greater than either of its parts, regardless of whether we combination above or below the resonant frequenc parallel circuit.

All possibilities, however, have not been exh Suppose we write down the differential equati the circuit of Fig. 1(c).

$$R_1 i_1 + L_1 \frac{di_1}{dt} + \frac{1}{C_1}\int i_1 dt - L_o \frac{di_2}{dt} - \frac{1}{C_o}\int i_2 dt =$$

$$R_2 i_2 + L_2 \frac{di_2}{dt} + \frac{1}{C_2}\int i_2 dt - L_o \frac{di_1}{dt} - \frac{1}{C_o}\int i_1 dt =$$

The positive direction of the currents is in th tion of the arrows, and the e.m.f., $Ee^{j\omega t}$, is in circuit one.

Assuming solutions for the currents i_1 and i_2

$$i_1 = I_1 e^{j\omega t} \text{ and } i_2 = I_2 e^{j\omega t}$$

and substituting these solutions in the differenti tions, we get

$$Z_1 I_1 - Z_o I_2 = E$$
$$Z_2 I_2 - Z_o I_1 = O$$

where

$$Z_o = j\omega L + \frac{1}{j\omega C_o}$$

$$B = \omega L - \frac{1}{\omega C_o}$$

A new coupling circuit

Note that both terms of Z_o are of the same s consequently the terms of B are of opposite sign rent flowing in the positive direction in circuit duces e.m.f.s. in L_o and C_o of opposite signs wi ence to circuit two). If the mutual impedance ca signed so that the e.m.f. induced in circuit two a current in circuit one is of the same sign for itative element and an inductive element, the Z_o will be of opposite sign. A circuit having th erty is shown in Fig. 3. If L_o is properly conn e.m.f. induced in either circuit by the current in is of the same sign for the two elements of the

impedance $j\omega M$, and $\frac{1}{j\omega C_o}$, and as a consequence

$$Z_o = \frac{1}{j\omega C_o} - j\omega M = -j\left(\omega M + \frac{1}{\omega C_o}\right)$$

$$B = -\left(\omega M + \frac{1}{\omega C_o}\right)$$

It is evident that B in this circuit behaves d from any type of coupling impedance which studied hitherto. A plot of B as a function of is shown in Fig. 4 and is represented by the

ne information for the components of B are given dotted line curves.

the resistance of radio-frequency circuits in- with frequency, the most desirable portion of re representing B will lie between the short ver- ies on the solid line curve having the abscissae, 1,500 kilocycles. The determination of M and n rather narrow limits depends on the value of tance, the rate of change of this resistance with cy, and the desired band width. This determi- must be such that the curve between the short lines corresponding to the abscissae 550 and locycles has a nearly constant first derivative, difference of the squares of B and R is constant quency, and that the value of the square root of erence gives the proper determination of the ed band width.

equency separation of the two resonant points is proximately by the equation

$$f_s = \frac{\sqrt{B^2 - R^2}}{2\pi L}$$

is the total inductance of either of the coupled which are assumed to be identical. A reference 5 will demonstrate the truth of this statement. ve shown in this figure is the reactance—fre- urve of the tuned circuit. Choose the ordinates ring the positive and negative values of R^2. At these values of reactance the currents upled circuits are at a maximum. The frequency n of these points is then given by the difference bscissae corresponding to these values of re- . The slope of the reactance curve at O; i.e., the line of zero reactance, is $4\pi L$, since

$$L - \frac{1}{\omega C}\Big) = 2\pi L + \frac{1}{2\pi f^2 C} = 2\pi L + \frac{4\pi^2 LC}{2\pi C} = 4\pi L$$

lope changes very little in the interval f_s. Then

$$\sqrt{B^2 - R^2} = 4\pi L \frac{f_s}{2}$$

$$f_s = \frac{\sqrt{B^2 - R^2}}{2\pi L}$$

ircuit of Fig. 3 has certain unique properties nentioned. The terms of the coupling imped- are of opposite sign, as the differential equation circuit shows, and therefore the terms of the value of the coupling impedance B are of the gn. In a practical receiver the value of the B can be made to vary with frequency very R varies with frequency, giving nearly uniform

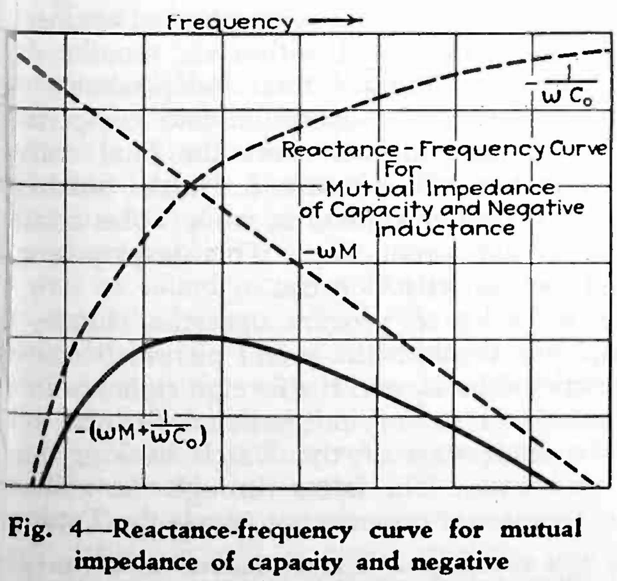


Fig. 4—Reactance-frequency curve for mutual impedance of capacity and negative inductance

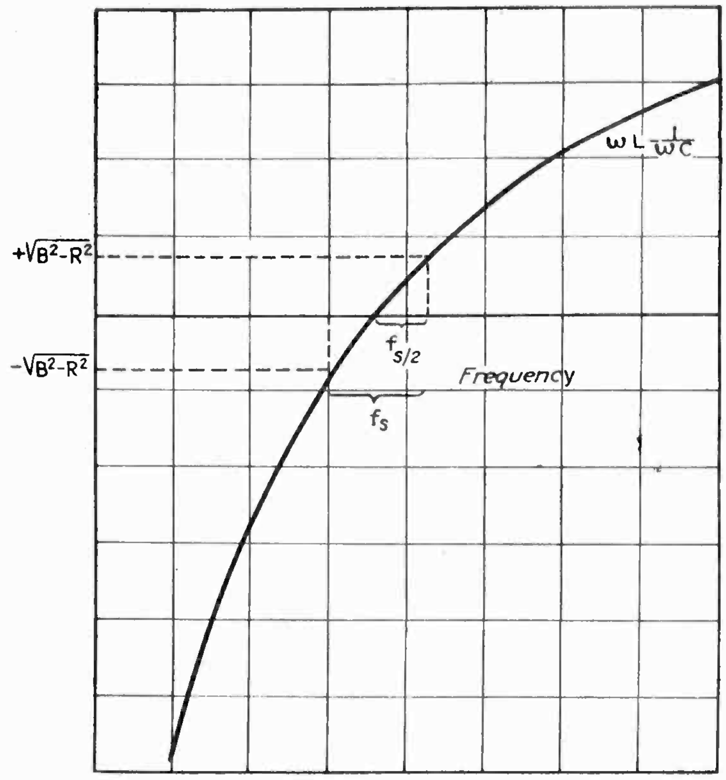


Fig. 5—Reactance-frequency curve of tuned circuit

selectivity in this circuit over the range. To accomplish this result M and C_o must be carefully chosen.

Calculation of circuit constants

Let us assume that R is equal to 10 ohms at 550 kilocycles and 30 ohms at 1,500 kilocycles. Assuming a transmission band width of 10 kilocycles the value required for B at each of the extreme frequencies of the broadcast range may be calculated from the equation

$$B = \pm \sqrt{R^2 + 4\pi^2 L^2 f_s^2}$$

where R is the radio-frequency resistance of the circuit at a particular frequency, L is its total effective inductance, which will be taken as 200 microhenries, and f_s is the desired transmitted band width. In this way B will be determined for both the 550 and the 1,500 kilocycle points using the proper values of R in each case. Using the subscript $_1$ for quantities at 550 kilocycles, and the subscript $_2$ for the values at 1,500 kilocycles; then

$$B_1 = -\left(\omega_1 M + \frac{1}{\omega_1 C_o}\right)$$

and the second

$$B_2 = -\left(\omega_2 M + \frac{1}{\omega_2 C_o}\right)$$

These equations may be solved simultaneously for the quantities M and C_o. In the specific problem given, B_1 is found to be equal to 16.1 ohms, and B_2, 32.5 ohms. Then M is 3.2 microhenries, and C_o is 0.06 microfarads. These values of M and C_o will give the correct slope to the B-frequency curve. Selectivity is therefore almost constant over the broadcast range. The position of the point on the B-frequency curve of zero slope is also worth noting. This point occurs where

$$\frac{d}{df}\left(\omega M + \frac{1}{\omega C_o}\right) = 2\pi M - \frac{1}{2\pi f^2 C_o} = 0$$

This derivative is zero when

$$f = \frac{1}{2\pi}\sqrt{\frac{1}{MC_o}}$$

Substituting in this equation the value of M and C_o determined by the method given above

$$f = 363{,}000$$

[Continued on page 309]

The European sound-picture industry

Relationships due to capital and patent pools; technical advances

THE production of sound films in Europe required the unification of hundreds of patents, which represented the developments of a large number of different systems. Some of the German patentees have reached an agreement among themselves, but others are still engaged in litigation. A significant lull in the international sound-picture battle between the German electrical interests and the American interests has been reached as a result of the Paris Sound Picture Conference at which the German and American representatives reached an agreement on July 22, 1930.

The sound recording systems can be divided into two general groups: recording on film by means of light and recording on phonograph disk. The Tri-Ergon method belongs to the first group, as do the Kuechenmeister method; the Petersen-Poulsen method, controlled by the Deutschen Tonfilm A.-G.; the Klangfilm method and others. The Tri-Ergon method, controlled by Tobis, is the result of the research of three Germans, Englund, Vogt and Massoelle.

▼

Supplement to this issue

"ELECTRONICS CHART OF THE SOUND-PICTURE INDUSTRY OF THE WORLD"

IN attempting to present a composite view of the European sound-picture industry, it is seen that a very complex structure has been built, because of interlocking patent agreements and associated capital tie-ups.

▲

Various methods have been developed to effect chronization between the sound and the picture. T class of recording belongs the synchronizing meth Messter and the Kinoton method of C. Lorenz, In this connection, the special patent rights of gramophone concerns play an important part, on the of which the production and importation of all elect disk recordings in Germany are licensed by the o of these patents, (Telegraphon A.-G.). Among t are the Breuning method (Lignose-Hoerfilm) of recording, and the Vorbeck patents for electric disk cording. The relation of Lignose-Hoerfilm to Klang and Telegraphon A.-G., to Tobis and Kuechenmei is shown in the accompanying chart. This explains the strong interest between the sound-picture gramophone industries. Reference to this chart facilitate following the description which is given of complex development of the European sound-pict industry.

Organization of Tobis and Klangfilm

In 1928, due to the initiative of General Co Brueckmann, came the organization of Tonbild-Sy cate A.-G. (hereafter referred to as Tobis) wit capitalization of 12,000,000 marks.* Besides Ger and Swiss capital, considerable Dutch capital participa in this organization. Through the joining of m smaller companies and the collection of more than sound-picture patents, patent litigation and competit was to be eliminated. Tobis, besides building rep ducing apparatus for theaters, represented especially sound-picture production interests, and contracted w the Deutschen Lichtspiel-Syndikat (German Talk Picture Syndicate) the well-known organization of so 800 unaffiliated moving-picture theater owners, for sale of German domestic films and sound-film apparat

At this time (October, 1928) the German electr concerns, Siemens & Halske, and A.E.G., who have b carrying on research in the realm of sound films, step forward with the founding of Klangfilm G.m.b (capital 3,000,000 marks), in which the Polyphon-We A.-G., holders of important gramophone patents, par ipated. The organization of Klangfilm was thus rep sented: Siemens & Halske, 45 per cent, A.E.G., 45 cent, and Polyphon 10 per cent.

This organization, because of the technical produc ity of the electrical firms, their capital, their resea and development and also because of their internatio patent affiliations with the American General Elec Company, constituted a threat to the Tobis organizati

Patent litigation, which Tobis instituted against Kla film, was, however, ended within six months due t settlement which provided total independence of b companies, continual co-operation and complete pat exchange. Klangfilm took over the final delivery apparatus to theaters, Siemens & Halske undertook production of theater apparatus, while Tobis retained monopoly of film production. This development, up this point, was strictly German.

Tobis, in order to procure operating funds, and the same time to place the sound picture business u an international basis, sold the foreign rights in its sou picture methods to an international finance syndi under the leadership of the Dutch banking house Oyens and Sons. The latter through the affiliation the Kuechenmeister organization, made the Tobis pat

*From "Die Europäische Tonfilmindustrie," by Dr. Bruno K wetter, in Wirtschaftsdienst, Heft 21, 1930.

ens & Halske, of Germany, have constructed a rful loudspeaker which can be heard 15 miles away. retically, it has the sound output of a 2,000-man orchestra

s of a comprehensive international organization quisition of other methods of electro-acoustics. the settlement of conflicting interests between nd Klangfilm, N. V. Kuechenmeister Interna- Mij. voor Sprekende Films was formed with a ation of ten million florins, in which the meister group concentrated its film interests and h Tobis placed about one-third of its capital

taneous with the founding of Klangfilm, Oyens ns, in October, 1928, organized the N. V. meister Internationale Ultraphon Mij. (see ght-hand corner of chart). The numerous inter- these concerns, which are represented in the fields o, phonographs, and phonograph disk manufac- well as sound pictures, embracing all the fields ro-acoustics, were finally, in March, 1929, brought r under the N. V. Kuechenmeister Internationale oor Accoustiek, with a capitalization of thirty florins, thus creating the nucleus of the Kuechen- group, which, as holding company, has the final n international transactions. The building up of npany is shown in the chart, which indicates that und-picture branch is more strongly centralized e the talking machine and phonograph disk manufacturing groups, while radio production is still in its infancy.

The strength of the Kuechenmeister group, whose financial center is in Holland, while the manufacture takes place in Germany, lies in the realm of sound films. The Dutch banking interests were also successful in acquiring about 26 per cent of the Tobis capital for the account of the Kuechenmeister Accoustiek, so that this organization, together with its Dutch financial allies, holds about 68 per cent of the Tobis capital. Tobis, therefore, must be regarded as a daughter company of a foreign concern. About 30 per cent of the Tobis capital is held by a German banking syndicate under the direction of the Commerz and Privatbank.

Closer co-ordination within the industry

This internationalization of the sound apparatus industry led on the one hand to patent litigation against the American electrical concerns, which were fighting the European leadership of the Dutch-German group. But on the other hand, it led to a closer co-ordination with the film industry for the production of sound pictures, because film production and the manufacture of sound apparatus go hand in hand. The position of the Klangfilm-Tobis-Kuechenmeister group thus assumed a definite alliance for future co-ordination and expansion.

Prior to the consolidation of the European sound-picture apparatus interests into the German-Dutch Tobis-Kuechenmeister concern, attempts had been made to get in touch with England, since co-operation with the English film industry had always been the basis for the international film business of the Germans. The goals toward which the German and English were striving conflicted, since the English film industry is under strong American influence. This was due to the position already obtained by Western Electric as a manufacturer of sound film apparatus, who had acquired a good foothold in the leasing of sound equipment, together with the control of the Gaumont chain of 300 theaters by the Fox Film Corporation.

Shortly after its organization the Klangfilm company had obtained a majority holding in the Lignose-Hoerfilm, Ltd., which owned the patents on the Breuning system of disk recording and also controlled the British Phototone Company. The British Phototone Company belonged to an Italian Count, H. H. de Bosdari, who also owned a sister company, the French Phototone, Ltd. The British Phototone Company itself, within the Bosdari group, was comparable to the second largest talking machine and phonograph disk company in the United States, the Brunswick-Balke-Collender Company (now owned by Warner Bros.) whose system was employed by another organization of Bosdari. This group also held valuable contract agreements with certain English film companies.

Klangfilm, Ltd. (Great Britain) was founded in London in May, 1929, to absorb and make use of the English Klangfilm interests. This new company was to take over the production of Klangfilm apparatus in England to avoid payment of high English import duties. The co-operation with the British Phototone does not appear to have had the anticipated results, at least not in the manufacture of apparatus. The film production interests which had heretofore been concentrated in the British International Films, became First International Sound Pictures, Ltd., through re-organization of the former company, with a capitalization of one million pounds. The latter organization undertook the production of

British talking pictures, employing the Tobis-Klangfilm system, and was expanded through the acquisition of the Tobis-Klangfilm licenses for Great Britain.

Further foreign affiliations made

The consolidation of the Tobis-Klangfilm-Kuechenmeister group with the British Talking Pictures Corporation was of great significance. British Talking Pictures is owned by a group headed by I. Schlesinger, and whose brother, M. A. Schlesinger, is in control of the General Talking Pictures Corporation in America. These companies control the Lee de Forest sound-picture patents. The Schlesinger group thus holds a significant position through control of the British and American companies, and also control of the South African film and theater market by the Schlesinger-owned African Consolidated Investments Corp., to which several African theater and film enterprises belong.

British Talking Pictures later organized the S. A. Films Sonori in Rome (organizing capital 15 million lire), with the support of the Italian government, and by purchasing 40 per cent of the capital of the new company. British Talking transferred to S. A. Films Sonori the monopoly of its sound-film patent rights in Italy. The latter is a manufacturing concern for sound-reproducing apparatus. Several large film concerns such as the Ente Nazionale per la Cinematografia, Luce and several music publishing houses are affiliated with Films Sonori.

The Associated Sound Film Industries, Ltd. (Asfi), with an authorized capital of one million pounds, was organized in November, 1929, as a holding company for the Kuechenmeister group and General Talking Pictures Corporation. The acquisition of the de Forest patents, already controlled by British Talking Pictures, by this complex organization, resulted in a concentration of practically all sound-film patents in the European market, which ranked with that of the United States. Asfi entered into an agreement with Klangfilm on August 13, 1929, whereby it took over the studios of British Talking at Wembley, and thus entered film production. This contract stipulated the geographical divisions for the various subsidiaries.

European expansion of Tobis group

The entrance of the Tobis-Klangfilm-Kuechenmeister group in France took place in February, 1929, when Tobis organized the Soc. des Films Sonores Tobis as its French producer. In the realm of films, France does not rank in importance with England. The French film market which at first had the leading place in supplying the international film industry, is today under strong foreign influence. The Compagnie Generale de Telegraphie (capital 100 million francs) is a national producer of apparatus. It organized the Radio Cinema with a capitalization of 10 million francs for the development of its system of sound recording. Radio Cinema's manufacturing is centered about recording apparatus, while the Etablissement Continsousa is engaged in making reproducing apparatus. The latter organization is affiliated with the powerful Gaumont concern. The Klangfilm-Tobis-Kuechenmeister group has closed an agreement with the Gaumont organization in regard to the sale of sound film apparatus and mutual co-operation in the supply and distribution of film.

Since the advent of sound pictures there is to be observed a development towards concentration within the film industry with still stronger international c

In spite of the strong position of Western apparatus in England, the Klangfilm-Tobis gro been enabled to gain a foothold there. One of the English theater chain companies, the Gaumont Pictures Corporation, is now owned by the Fo Corporation. The English film industry has mac ous attempts at consolidation to counteract foreig ence. A new attempt in this direction is the organ of the Argosy Filmcraft, Ltd., which embraces the national Talking Screen Productions, Ltd., w subsidiaries (British Screen Productions, Ltd., Filmcraft, Ltd., and Automatic Filmprinter, Ltd.

The counteraction of the French consisted fusion of two large film undertakings, Etablis Aubert, a theater company with about 50 theate the Societe Franco Film, one of the largest fil ducers, which also has an exchange agreement w German film syndicate, into the Aubert Franc (capital stock 55 million francs). This mo towards consolidation gained impetus in March, the Etablissement Gaumont, the largest theater co by increasing its capital from 18 to 85 million took over the new Aubert Franco Film and a manufacturing works of Etablissements Conti Thus was formed in France the largest vertic trust, with whom Klangfilm entered into special ments as mentioned previously. Gaumont, moreov exchange agreements with Ufa, a large producer German film industry.

International Patent agreements

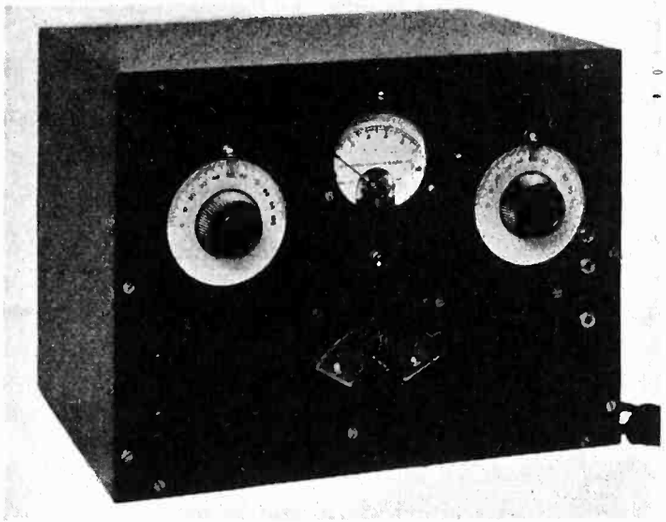
Because of the patent litigation between the (and American electrical industries, the Western Company was prevented by court injunction from ing their sound picture apparatus in Germany. American films were prohibited from showing o man apparatus, all of which caused considerable in this market.

This led up to the Paris Sound Picture Con in July between the German and American repr tives of the film and electrical industries. The companies involved in these negotiations were: the Siemens & Halske Company and the Tobis American concerns were the Electrical Research ucts, Inc., and RCA-Photophone, Inc. Prel negotiations were concluded July 22, 1930, as a r which a memorandum was signed providing interchangeability of motion pictures in all c upon all makes of licensed apparatus of the si parties. This memorandum also divides world te into three sections, for the manufacture and sound picture apparatus. The section which supplied solely by American manufacturers incl following countries: United States, Canada Foundland, Australia, New Zealand, the Straits ments, India and Russia.

The countries reserved for German-manu apparatus include: Germany, Danzig, the Saa Memel, Austria, Hungary, Switzerland, Czecho Holland, the Dutch East Indies, Denmark, Norway, Finland, Jugoslavia, Rumania and Bulg

The countries not included in either of the ab groups, and open to products from either Ger the United States include several European among which are France, Great Britain, Spain a Other parts of the world not specified are open German and American sound-picture apparatus.

ne design of a ortable signal nerator

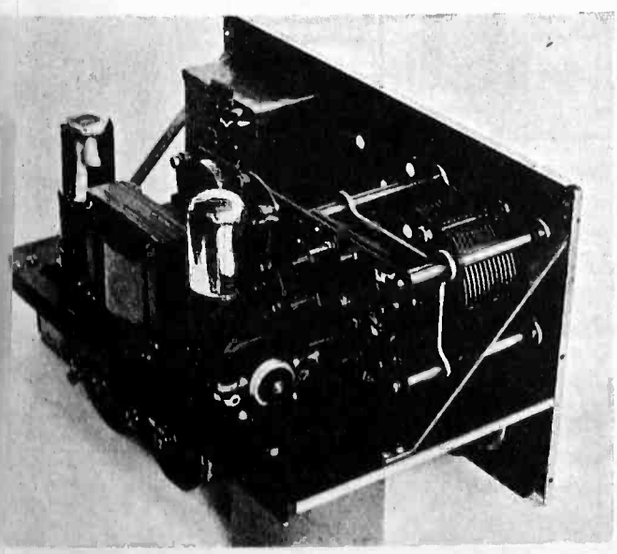


Signal generator made and used at American Bosch Magneto Corporation

OBERT S. KRUSE

HE manufacture of radio receivers it is essential ave available a known radio frequency voltage vhh may be fed to each receiver as it "comes off din" for the purpose of making a rapid and reason- curate determination of its performance. In such con measurements extreme precision is not re- d. The apparatus must, however, be exceedingly r to the effects of continuous use, capable of anipulation and capable of retaining its cali- to insure that production standards are being ained.

requisite artificial signal is commonly produced acuum tube oscillator, operating under crystal for the sake of frequency stability and modulated ycles, usually to about 30 per cent. Since it is considered advisable to test each receiver at three n its tuning scale this equipment must appear cate. As the output of all three oscillators must venience, arrive at a common coupling coil at position it is necessary to interpose buffer amplifiers. Each buffer amplifier necessarily involves another tuned circuit and thus the final equipment becomes both bulky and complex. It must therefore be located in some convenient fixed position and the output led to the various test positions through shielded feeders. Such a system is unsatisfactory in that the standard has to be taken to the factory whereas flexibility and ease of maintenance would suggest leaving the standard in the laboratory and employing a portable transfer instrument at each test position.



Interior of generator, using switching scheme of Fig. 3

The design of such a portable transfer instrument was undertaken at the Radio Frequency Laboratories by Malcolm Ferris and G. Edgar Stone. One form of the device is indicated by the diagram of Fig. 1. In this form the instrument is entirely self contained, the WX-12 vacuum tubes being used to permit the enclosure of both A and B batteries. The tube at the left is a 400 cycle oscillator which imposes plate modulation upon the other tube, a radio frequency oscillator. Circuit constants are chosen so that the output consists of a modulated r.f. voltage which is sufficiently constant to permit calibration of the instrument for portable work by service men, provided only that the filament voltage is set to the proper point and the batteries renewed at reasonable intervals. An accuracy of 25 per cent or better can be maintained by this simple procedure. Where production measurements are involved this variation is too large; therefore the instrument is at intervals (usually each day) taken into the laboratory and checked against a stationary standard.

Voltage output

Whichever procedure is used, there results an r.f. output exact enough for the purpose and it is only necessary to add to the instrument an attenuator network permitting readings at fractional values of the full output voltage. If the network be as shown in Fig. 2 the various switch positions will make available four different voltage ranges as follows:

(1) 50—5000 microvolts.
(2) 10—1000 microvolts.
(3) 2— 200 microvolts.
(4) ½— 50 microvolts.

The range of the "baby-microvolter" is seen to be adequate for sensitivity tests of any receiver as well as providing signals suited to overload tests and for the alignment of tuned circuits. The ranges are maintained

with considerable constancy throughout the entire frequency range as is shown in the upper curve of Fig. 2. This is due to the choice of constants in the circuit, the resistor in series with the grid coil and the inductive output potentiometer. This last is necessary because the voltage across the tuned plate circuit is constant and therefore the current in it varies inversely with frequency. This same variation continues through the attenuator and the inductive potentiometer. The voltage across the latter is therefore independent of frequency. Since this potentiometer consists of a single two-inch turn of brass strip the variation in the voltage appearing at the output terminals is closely linear as shown by the lower curves of Fig. 2.

Construction of the generator

The oscillator circuits are so designed that changing tubes will not cause great change in the output level. Tests with a variety of tubes of the same type but different ages indicated a maximum variation of only plus or minus 6 per cent from the nominal or indicated voltage output. Coil dimensions are given in Fig. 1.

The attenuator is wound non-inductively with No. 38 Advance wire and is mounted on the back of the rectangular copper can which surrounds the inductive output potentiometer.

The constants for the audio oscillator inductance need not be given since any convenient reactor core may be used winding on enough No. 38 or No. 40 wire to give the desired frequency when the grid coil has about $\frac{9}{10}$ as many turns as the plate coil.

For production use it is obviously convenient to mark passing limits on the output dial and to alter the construction so that rotation of the tuning condenser to different test frequencies will automatically switch in a voltage such as to cause standard output to appear at the loud speaker terminals. Since few receivers have equal sensitivity at all points this is done by an arrangement indicated in Fig. 3. The switch *S* is driven by the tuning condenser shaft and the proper output level for each frequency is pre-set by use of the clips 1,2,3,4 the adjustable resistors a,b,c,d.

The Bosch "Microvolter"

Special requirements have brought forth various of portable standard signal generators in the fac of R.F.L. licensees. The portable "microvolter" s herewith is a special modification of the type 4 s generator developed at the plant of the American E Magneto Corporation by C. L. Walker, radio inspe equipment engineer. It does not carry its own fila supply but uses the type 227 tube supplied by a down transformer from the a.c. line in the usual ma An r.f. filter insures that the oscillator output doe wander out along the a.c. line which could easily i in the arrival of unknown r.f. voltages at the rec which is under test. There is thus made possibl elimination of the filament battery and the use o 227 tubes whose merits are extreme ruggedness comparative immunity to filament voltage changes

Reference has been made indirectly to the use output meter which indicates when the receiver is ducing "standard output". This "standard output" be taken as 200 milliwatts or some other conv figure.

The output measurement device must evidently the same impedance as the load (loudspeaker) into the set normally works. It can conveniently consist resistor and a voltmeter adapted to operation at cycles, at which frequency the output voltage ap It need have but one calibration point since the in adjustable. Extreme ruggedness of this meter i perative, while convenience dictates that it shall permanent portion of the "microvolter". For thes sons the Bosch device employs a copper oxide re and a d.c. moving-coil instrument. This combi was discussed in some detail in an article by Franks in the July issue of *Electronics*.

The radio frequency circuit as a whole is enclose rectangular copper shield, the coil shield, of c

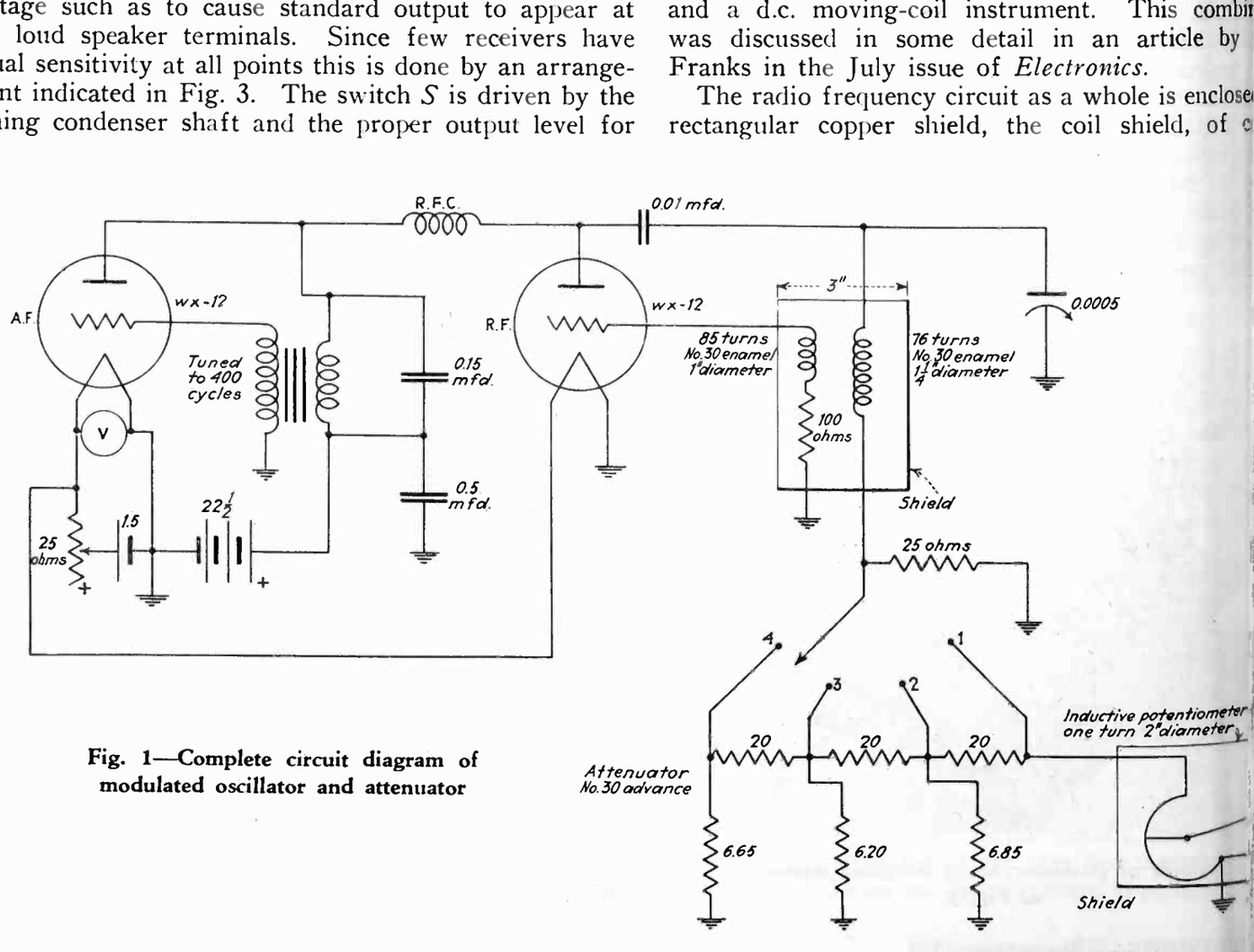


Fig. 1—Complete circuit diagram of modulated oscillator and attenuator

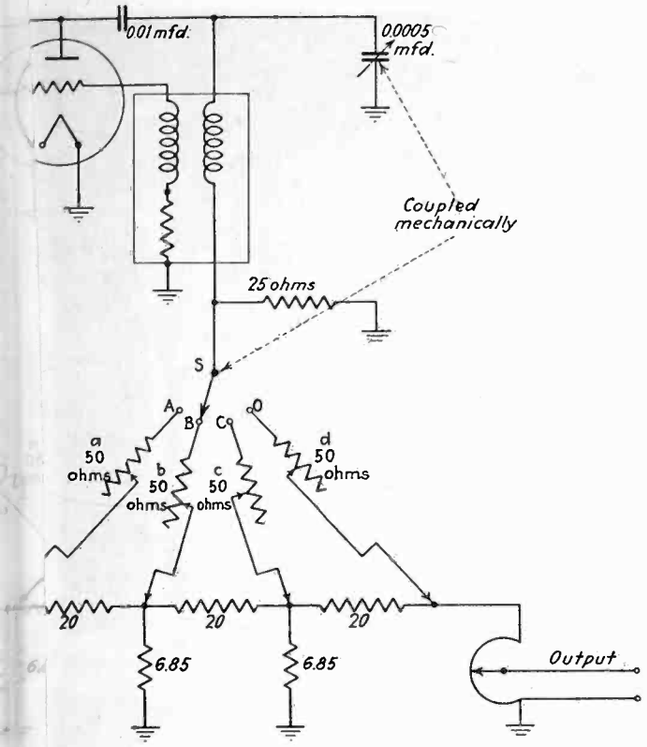


Fig. 2—Output characteristics of signal generator (right)

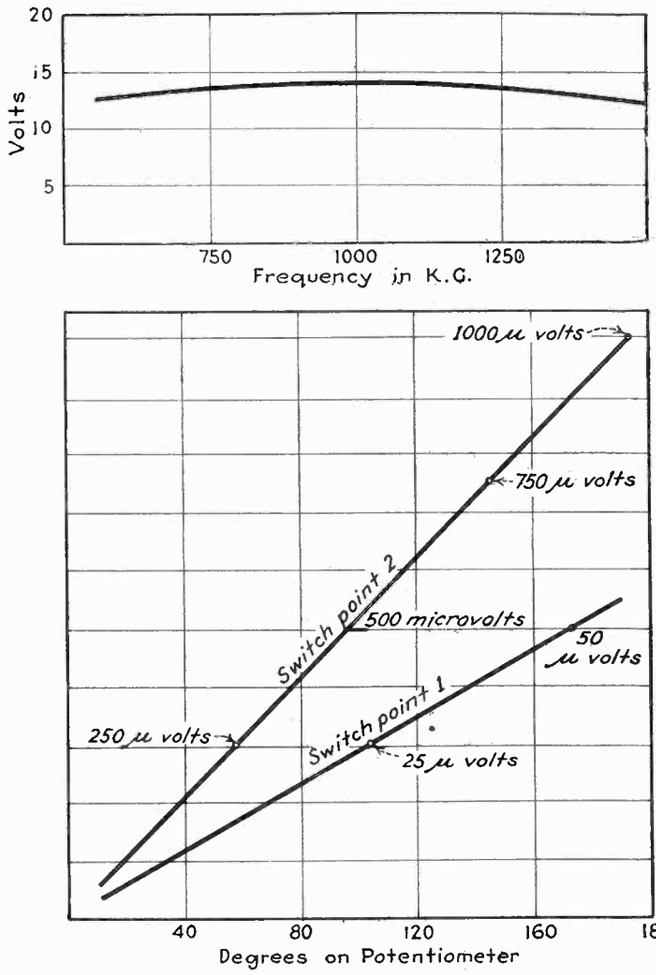


Fig. 3—System of coupling together tuning and attenuator (above)

tained. The attenuator has been sectionalized d pper baffle interposed to prevent the transfer of m r.f. voltages from the input (high voltage) to the output (low voltage) portion through the s between the two.

dherwise the attenuator and output potentiometer am emains the same as in the self-contained device. ner. system has been modified slightly as it was d at the desired constancy of output voltage could, th 227 tube be obtained more easily by the use of esistance grid leak and a low-capacity grid con- r han by means of the resistor in series with the cc.

The late-circuit supply of the service is self-contained ce. Two 22½ volt "B" blocks are used in parallel. l plate circuit drain is 1.3 milliamperes and the life of these batteries is long, even with continuous use.

The factory uses of the instruments are clear from the foregoing. Production tests of sensitivity may be made with commercial accuracy. The instrument also serves as a very convenient source for an alignment signal and for overload tests. For these latter purposes it is, as was pointed out by Franks in the paper previously mentioned, convenient to combine sight and sound; for which purpose a phone jack and switch are provided.

For service work these same tests may be exceedingly useful. There has, in fact, existed no means whatever by which the service man could obtain any quantitative information as to set sensitivity. Increasingly high standards of performance cause such tests to assume increasing importance.

▼ ▼ ▼

THE ASTONISHING RANGE OF MAN'S OBSERVATIONS

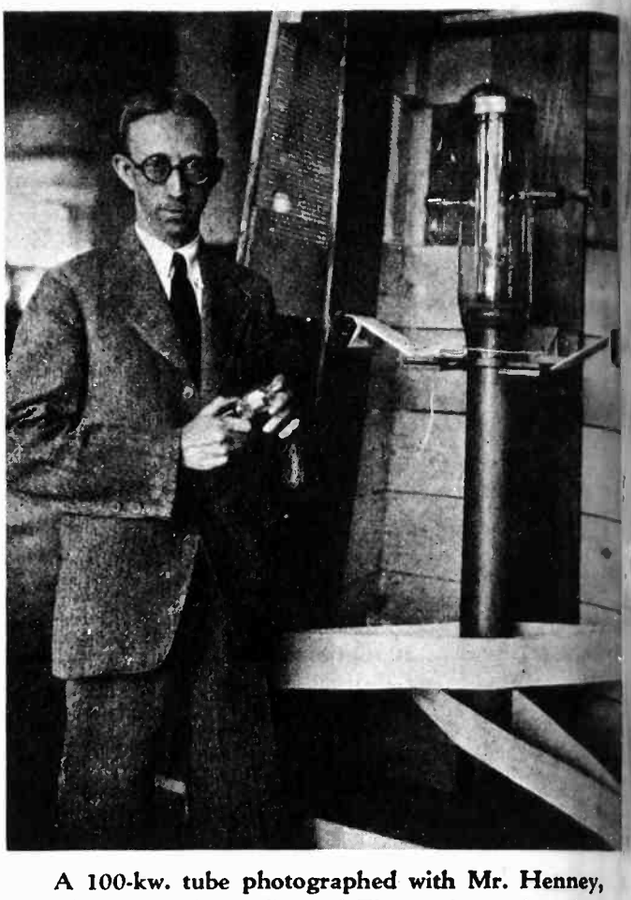
ass of each item in the accom- g list is about one millionth the item preceding it.

The known material universe
A large spiral nebula
A very large star
A good-sized planet
An ocean
A mountain peak
A forest
MAN
A butterfly
A paramecium
A bacterium
The largest organic molecules
A few score electrons
A quantum of ultraviolet light.

List compiled by
PROF. JOHN Q. STEWART,
Princeton University

Coming industrial markets

for applications of the thermionic tube and the photo-electric cell*



A 100-kw. tube photographed with Mr. Henney, who is associate editor of Electronics and author of "Principles of Radio"

By KEITH HENNEY

Associate Editor, Electronics

RADIO engineers have known for years that the electron tube would perform many tasks silently and efficiently, but it has been only recently that engineers in other fields have discovered the remarkable capabilities of electronic devices. Engineers are now finding out that the little tube which made a $500,000,000 industry out of a vacuum can also be applied to problems in mining, manufacturing, chemistry, transportation, or other industries. Industrial engineers have made the discovery that the electronic tubes (the photo-cell and the thermonic tube) not only make new processes possible, but create new economies in old processes. In fact, the year 1930 may become known as the year in which the electronic tube took hold of the wheels of industry; it is the year when the tube's emancipation from the art of communication is being proclaimed.

No one questions that the thermionic tube made broadcasting possible; radio has become a half-billion-dollar industry by its aid. This has taken place in seven years. The sound-picture business, in the short space of three years, has doubled the movie box office receipts and brought them to a point where they represent a weekly income of 30 million dollars, an annual equipment business of 150 million dollars.

Both of these industries are but aspects of communication,—the one in which the listener hears the message simultaneously with the event, and the other in which he sees as well as hears but with a lag in time. These "amusement" businesses in dollars and cents at present far overshadow the uses of electronic tubes in industry; the difference however is that we can see the top o radio market, barring some new development like vision, and the sound-picture market cannot contin grow at its present rate. But the industrial sale an of tubes are scarcely begun.

Tube uses spread to other industries

Radio engineers' noses are so close to the grindst communication that they are prone not to see or be ested in what is going on in other industries. example, not many appreciate the fact that th electronic tubes are already found in transpor where they control the speed and security of e trains as well as operate traffic lights on important ways, and in the case of the Detroit-Windsor actually count the traffic and instantly turn the r into the superintendent's office some distance away vacuum tube also starts, stops, levels, fast passeng vators; the photo-cell has gone into forestry wh measures the amount of sunlight reaching the gro an index of how closely to replant; in additi vacuum tube will measure and record the rate of of cut timber. Similarly the vacuum tube is find way into mining, into the textile industry, into cer into automobile plants and into other industries. A surface is only scratched. The estimate has beer within five years radio will buy but a small part output of vacuum tube plants.

Radio men know the characteristics

There are two ways in which the approaching trial development of the vacuum tube and ph touches radio engineers. In the first place there is else who knows as much about the tube and how t Already equipped with a complete knowledge vacuum tube the radio engineer is in a particular

*From a paper "The Functional Evolution of the Vacuum Tube" presented before the *Institute of Radio Engineers*. Toronto convention, August 19, 1930.

n to pioneer ahead in this new field of electronics. ie second place radio manufacturers are finding it ingly difficult to stay in the game. Some of them, is includes tube manufacturers, have equipped ves with factories and equipments so extensive nay be difficult to operate them economically pro- nothing but radio equipment. The inference is u; radio and tube manufacturers already equipped nle tube circuits and apparatus may find a ready for vacuum tube and photo-cell applications in an the communication field.

engineers and manufacturers must be alert that ers" short on fundamental knowledge and equip- t long on vision do not take the rapidly increasing al market away from them. The tendency among en seems to be to consider adaptation of a tube o an application outside communication as some- a stunt and not worthy of commercial considera-

rom radio to paper-calipering machine

v of many examples of what the tube is doing trate its possibilities. A young man in the Maine uilt a radio with which he played when he was ng timber for pulp mills. He noticed that when of paper was put between the condenser plates scillating detector the pitch of the squeal varied different thicknesses of paper produced different Now the squealing detector became a device that measures and records the moisture of paper and s of rubber sheets as they are made but it exer- ch a control over the machinery that paper and n much greater uniformity of manufacture can uced. The annual saving to the manufacturer is mes the cost of the machine.

Broadway there is the new Warner Brothers od theater. On top of this theater is a new outdoor sign. It uses several thousand red, blue, ow theatrical lighting bulbs. The blue ones and nes come through the factory in fairly uniform But the red ones vary so that though individually k alike, when used in the large sign they give it arance of having the measles. These bulbs were y girls who looked at them and rejected those which looked too dark or too light. But the girls' eyes soon tired; they had to rest frequently. Not only was the process costly and slow, but because of varying psychological factors the bulbs still were non-uniform.

The answer was to shine the bulbs into a photo-cell which does not tire, nor is affected by moods or physical states. An amplifier followed the photo-cell and finally a vacuum tube voltmeter working into a milliammeter gave an indication of how accurate in color the bulbs were. It was only a step further to use a relay which automatically rejected the bulbs which were not satisfactory. The new process is simple, costs very little, is speedy, and above all is satisfactory. The results are positive. A photo-cell and a vacuum tube did the trick.

Putting an old friend to work

Some of the most interesting and ingenious industrial tools have been made of the photo-cell. For years this device (which translates light waves into electricity) lay idle and misrepresented. It was used experimentally by physicists, biologists, and scientists. It suffered from fatigue, it did not deliver much current, it was hand-made. But more recently engineers found how to employ modern vacuum-tube technique to its manufacture, how to increase the current, how to make cells in quantity.

And other engineers discovered that light was no longer a wave motion to be used only for illumination; but that it was a weightless, inertialess, untiring tool, and could be made to count objects, sort them, grade them, control the operation of machinery, or protect the operator of that machinery from bodily harm. The expression "swift as light" may yet have a practical meaning in industry.

A list of the places where the tube is working is already rather impressive. Engineers in other fields than communication are realizing that the tube has no moving parts, that it will measure thickness, pressure, degrees of titration, noise and vibration, that it will control the operation of and even replace machinery hundreds of times as heavy and as expensive, that it will do all of these things in a quiet and efficient manner. It seems but a question of time before we find that the radio and other communication purposes are after all but a small part of our electronics industry.

▼ ▼ ▼

SOME NEW USES OF VACUUM TUBES

IN REFORESTATION

Tubes measure the amount of sunlight reaching the ground as an index of how closely to replant.

IN LUMBERING

The rate of drying of cut timber is now measured by a thermionic device.

IN ELECTRIC SIGNS

In classifying sign-lamp colors, photo-cells give dependable fatigueless inspection.

IN PAPER MANUFACTURE

For calipering the thickness and moisture of paper during manufacture, the principle of the squealing radio oscillator is used.

IN INDUSTRY PROCESSES

Electronic tubes not only make possible new processes in industry; they also produce new economies in old processes.

Measuring

1 / 100,000,000,000,000,000

of an ampere

A tube that will indicate minute currents down to 63 electrons per second

By B. J. THOMPSON*

THOUGH the grid of a tube is normally thought of as taking no current, it is well known that, with the usual types of tubes, under normal operating conditions, currents of from 10^{-6} to 10^{-8} ampere flow to the grid. Under even the best conditions, it is rare to find a tube which shows a current of less than 10^{-10} ampere. Since these currents are variable within about 1 per cent or more of their value, a current of less than 10^{-12} ampere could not be indicated by such a tube.

AMONG the myriad uses of vacuum tubes, that of indicating small currents has long been recognized. However, the minimum magnitude of the current to be measured can not be reduced by any means below the unpredictable variation in the grid current, since this current must flow through the same circuit as that to be measured. This article describes the development of a new vacuum tube in which the grid current is reduced to a very low value, for measurements as small as 10^{-17} amp.

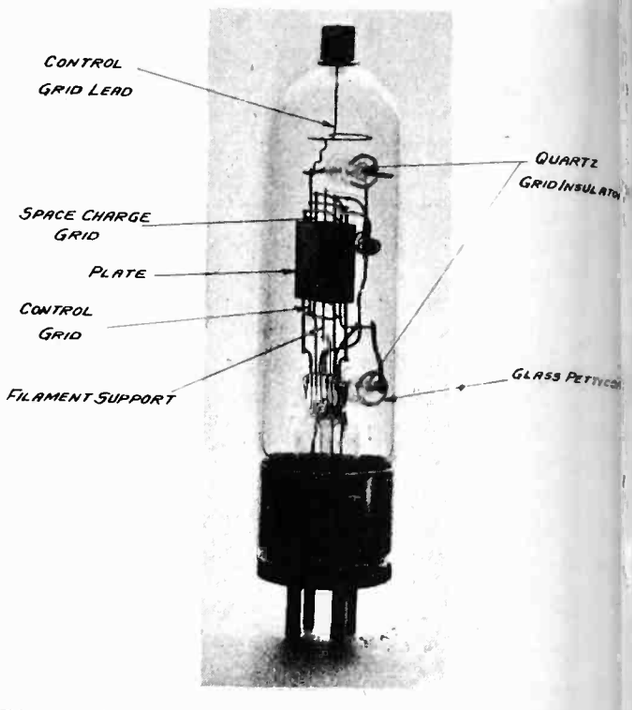


Plate voltage	**6.0 volts**
Space-charge grid voltage	**4.0 volts**
Control grid voltage	**—4.0 volts**
Filament voltage	**2.5 volts**
Filament current	**110 milliamperes**
Plate current	**40 microamperes**
Mutual conductance	**25 microamperes per v**
Plate resistance	**40,000 ohms**
Amplification factor	**1.0**

A thorough analysis was made of the sources of current to determine by what means it might be redu These sources are:

1. Electrons from the filament.
2. Positive ions formed by collision between the trons constituting the plate current and the molecules in the space.
3. Electrons emitted by the grid due to its tempera
4. Leakage.
5. Positive ions emitted by the filament.
6. Electrons emitted from the grid under the influ of light from the filament.
7. Electrons emitted from the grid under the influ of the soft X-rays given off by the plate due bombardment by the plate current.

This is a considerably more imposing list of so than had been expected. It was only when the cur due to the first four had been very greatly reduced the last three were observed.

The first source, electrons from the filament, i most obvious and may be eliminated by the usual m of operating the grid with a negative bias. It was f that this bias must exceed 3.0 volts before this cu became negligible.

An attempt was made to eliminate the current d positive ions formed from the gas in the tube by exh ing the tube very thoroughly. Partial success wa tained, but this current always remained above 10^{-1} a pere. How low a pressure this corresponded to m estimated as follows:

Assume that each collision between an electr and a gas molecule produces an ion having a po tive charge corresponding to the loss of one ele tron. Assume that one-tenth of these ions rea the grid. Thus, all of the positive ions wo constitute a current of 10^{-12} ampere, and if t

*Vacuum-tube Engineering Department, General Electric pany, Schenectady, N. Y.

ate current were 10^{-4} ampere, there must be one ollision for each hundred million electrons which ss across the space. Then the mean free path, the distance the average electron could travel thout striking a molecule, would approximate ty miles! The mean free path in air at atmos-eric pressure is of the order of 10^{-5} cm., so that pressure in the tube was about 10^{-12} atmos-ere, or of the order of 10^{-6} micron.

as concluded that the best means of reducing this t further was to operate the tube with all voltages the ionization potentials of any gases present. Such ion reduced the "gas" current to a negligible value. this meant using a plate voltage below ten volts, reasons were found for operating even lower.

ctron emission from the grid due to its temperature, ed grid emission, while a serious factor in many of tubes, was eliminated completely by using low-ed filaments.

kage was a source of very considerable currents, ese were greatly reduced by careful insulation of id. It was found especially desirable to mount the n quartz beads shielded by a skirt of glass to prevent ce contamination.

eated filament will emit positive ions, in addition ctrons. These ions are drawn to the negative grid nstitute an appreciable current. By placing a space-e grid, operated at a positive potential, between the l grid and the filament, these ions may be driven o the filament. Such a grid, of course, also serves rease the mutual conductance of the tube. This as was found to reduce the current from this source inappreciable value.

photo-electric effect, or emission of electrons from al under the influence of light, is well known. It ot expected that this effect would be of importance, a surface must be very carefully prepared to give l emission with visible light. However, the com-on of considerable light intensity and the practically idable contamination of the surface of the grid re was found to give currents of undesirably high gitude. It was found most satisfactory to reduce the sity of the light by using a thoriated tungsten fila-operated at low temperature. This measure greatly ed the current from this source.

X-ray tube is merely a tube in which an anode mbarded by electrons at high voltage. The wave length, or hardness, of the X-rays depends on the anode voltage used. A vacuum tube has all the essential features of an X-ray tube, except that the voltage is low and hence the X-rays are very soft. The photo-electric effect is readily obtained from metals under the influence of X-rays, so that it is not startling that such effects were discovered. It was found that the currents due to this cause varied greatly with anode voltage and surface contamination of the grid. They became negligible when the anode potential was less than 6 volts.

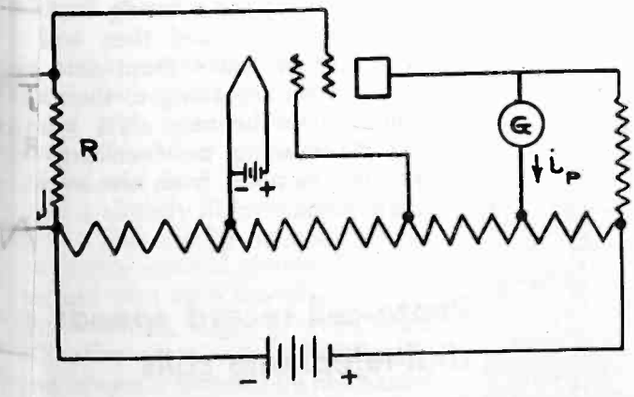
The final design of tube arrived at was one in which all of the above means of reducing grid current were incorporated. The result was a tube having a grid current of the order of 10^{-15} ampere and an input resistance of the order of 10^{16} ohms. Typical plate and grid current curves plotted against grid voltage are shown. The tube obviously is not useful as a voltage amplifier, but the current amplification may be tremendous.

If the current to be measured is passed through a high resistance and the drop across this resistance applied to the grid, the current is indicated by the change in the plate current. A circuit for accomplishing this is shown. Assuming that the resistance in parallel with the galvanometer is large compared to the galvanometer resistance, and that the latter is low compared to the plate resistance of the tube—both reasonable assumptions—the current, i, flowing through the grid resistance, R, may be expressed as follows:

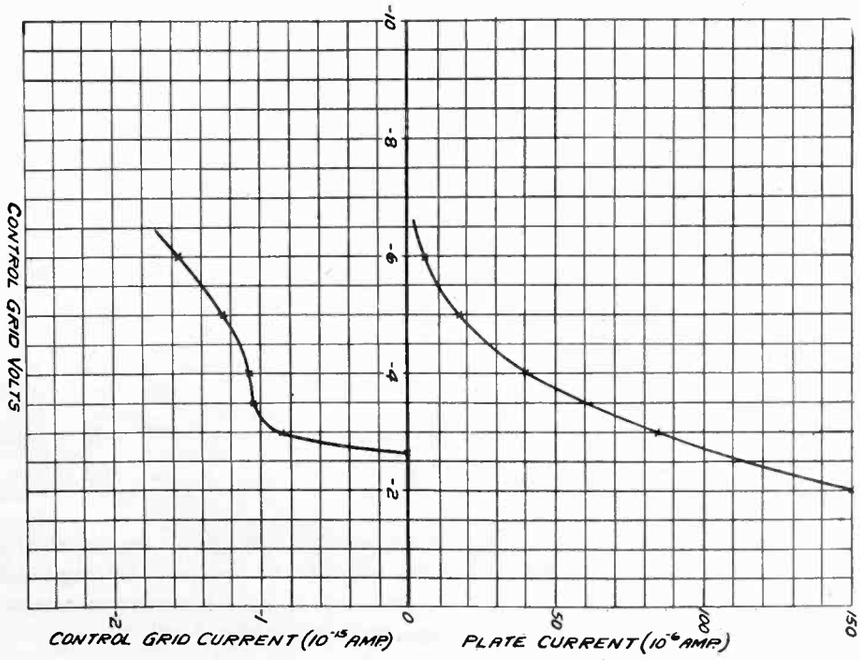
$$i = \frac{i_p}{Rg_m}$$

where i_p is the change in the plate current flowing through the galvanometer. If it is desired to measure a current of 10^{-17} ampere, which value may be taken as near the lower limit of the usefulness of the tube, and a galvanometer sensitive to 10^{-10} ampere is used, it follows that the value of R must be 4×10^{11} ohms if the mutual conductance be taken as 25×10^{-6} mho. Such values of resistance may be obtained in several ways.

The normal method of indicating currents of the order of 10^{-10} to 10^{-15} ampere is some form of electrometer. The sensitivity of an electrometer is expressed as the m.m. deflection of the beam per volt applied. For such instruments, 2,500 m.m. per volt is a high value of sensitivity; for the circuit described above, the sensitivity is 250,000 m.m. per volt. In addition to the increased sensitivity, it is felt that the vacuum tube electrometer offers a considerable advantage, in convenience.



Above: Circuit for measuring extremely minute currents



Right: Characteristics of the low-grid current tube

HIGHLIGHTS ON ELECTRON

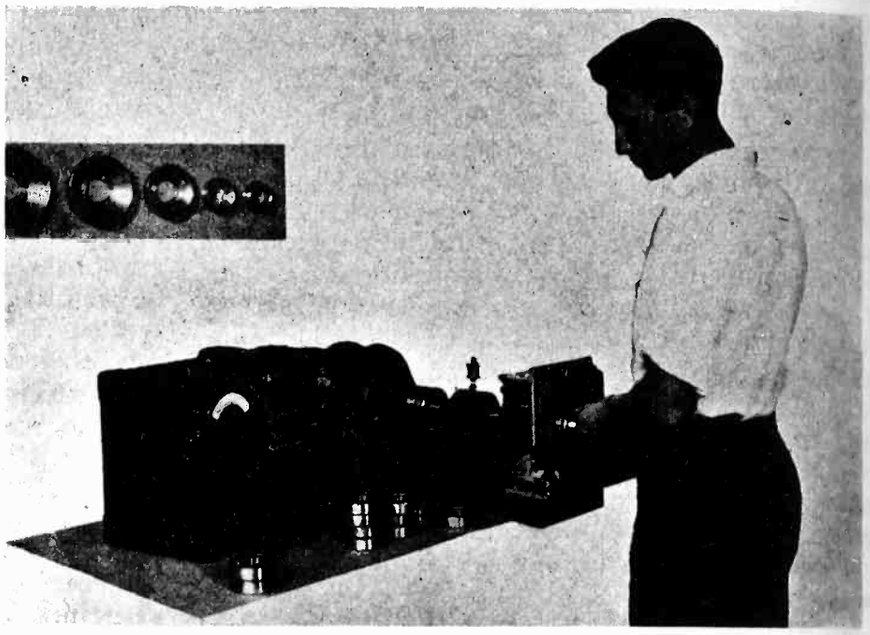
Electronic amplifier tests bearings for vibration

By Hallett H. Germond

Smoothness and quietness in the operation of an automobile or other machines depends in a great part upon the degree of perfection of the bearings. It has long been the practice to test the ball bearing assemblies (consisting of inner and outer races, balls, and ball retainers) for noisiness. In these tests the inspector thrusts the assembled ball bearing on a rapidly spinning shaft, holding the outer race stationary with his hands. Listening to the bearing and also judging its condition partly from the feel, he decides whether the bearing is satisfactory or not. This requires a quiet room and it requires an experienced inspector. Even so, no two inspectors are likely to sort a given group of ball bearings in the same fashion, nor for that matter is any one inspector sure of being able to arrive at the same sorting if by any mischance the bearings are mixed after the original sorting. This method which will allow some attempt at separation into good, fair, poor, and rejects is by no means sure.

The C. F. Burgess Laboratories, Inc., of Madison, Wis., has developed an instrument which enables the bearings to be sorted with certainty. This instrument eliminates the human factor in that a meter indication tells at once the degree of roughness in the bearing makeup.

An especially designed pick-up device contacts with the outer race of the bearing. Any vibration present in the ball-bearing assembly is thus transmitted to an electromagnetic arrangement which generates an alternating e.m.f. corresponding in both amplitu and frequency to the vibration. T minute alternating current is supplied an acoustimeter. This acoustimeter so designed that it will sort out t vibrations that tell most about the c dition of the bearing and reject th which are not truly indicative. It a rejects such vibrations as may ar from the driving motor. The altern ing e.m.f's. of the retained frequenc are then amplified until enough pov is available to operate a meter. T more intense the original vibration larger the meter reading. The t amplification is adjustable so that la and small bearings may be tested w equal facility. The operator, hav determined a suitable standard, thru each bearing on the rotating shaft f with one face out and then with other and then sorts them into th various grades according to their me reading. Thus he may class beari giving no reading as excellent, fr zero to one as good, from one to two fair, and so on.



Any vibration present in the bearing generated an alternating current of corresponding amplitude and frequency

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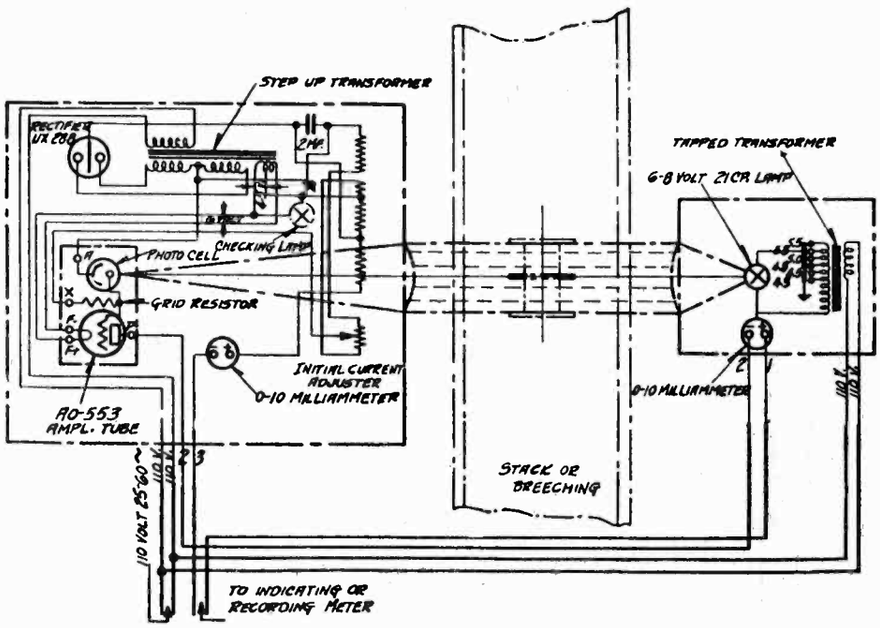
CIRCUITS OF PHOTO-ELECTRIC SMOKE RECORDER



This sketch shows the operating parts of a standard electric smoke indicator as installed in a number of plant smoke-stacks by engineers of the Westinghouse company. A beam of light is projected across the smoke passage, and onto a photo-cell

✦

Photo-cell record speeds u dial-telephone calls

One of the latest developments in a matic telephone operation is what Bell Laboratories call the "opt phonograph call announcer." I viously, the practice in handling c originating from a dial-telephone change to a manually-operated excha included a visual indicator on

l switchboard. On this indicator ed the number which the sub- dialed, thus informing the opera- the manual board the number hich to make a connection.

n the installation of the optical- graph call-announcer the number by the subscriber is translated into figures. The operator is thus re- of the necessity of glancing from shing numbers to the keyboard in f her. Under the new system, he is free to take a call, by merely g a button the called number is directly into her ear. This is considered faster and easier ne visual method, as it permits erator always to keep her eye on nual board. At the present time stem is being installed in three exchanges in New York City, is expected that its use will be ed to other exchanges.

spoken numbers are produced by films which were made by a girl d because of her clear voice. are ten of these films, one for f the nine numbers and the zero. films are wound on drums which nde to revolve automatically upon ling of the number.

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"electric eye" lood analysis

ccuracy of blood and other phys- gal analyses, which often depends the accuracy of color observation e part of the analyst, has been ced by the development of the t-electric cell as an "artificial eye" ic can be carefully calibrated in nce to sensitivity to different , according to George Lewis, vice- lent of the Arcturus Radio Tube pany.

e human eye almost invariably s to some extent from color-blind- says Mr. Lewis. Some persons nore color-blind than others, and of us will find that one eye sees ts at a slightly different shade than ther. This can be noticed by look- t a highly colored picture first with eye and then with the other.

lor blindness, slight or even acute, ittle effect upon our success in life, e are lawyers, automobile mechanics, ngaged in any of about 75 per cent ll possible trades and professions. when it comes to blood and other siological analyses, where color is n a determining factor, an electric such as the photo-electric cell, ch never suffers from color blind- s, or even retinal fatigue (which may effect even the normal eye) is a considerable contribution to the accuracy of results.

The photo-electric eye can detect color differences beyond the sensitivity of the best human eye, and can relay its decision to amplifying apparatus that will indicate the color or variation from a standard color on a printed card for a permanent and accurate record.

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Tubes maintain tension as wire is reeled

Wire produced in the wire-drawing shops of the General Electric Company at Schenectady, N. Y., must be kept at proper tension as it is reeled, and this tension is now maintained by the use of vacuum-tube equipment.

The wire passes from a large reel through the wire-drawing machine, where it is reduced to the desired size, thence to a small spool where it is re-reeled. As the wire is drawn at a constant rate, the speed of the re-reel spool must be constantly decreased as the effective diameter of the surface on which the wire is wound, increases.

The re-reel spool is driven by a small direct-current motor, power being supplied to the motor armature by Thyratron tubes. A small reactor controls the power supply by the tubes. This control is determined by the position of the core in the reactor, and the position of the core is governed by the re-reeling operation itself. The wire runs over a rider pulley mechanically connected to the reactor core. As the loop on which the rider pulley rides decreases when the re-reel motor is running too fast, the core is drawn into the reactor, increasing its reactance and causing the tubes to pass less current and so causing the motor to slow down. Conversely, if the loop increases in length the reactor core is withdrawn, causing the tubes to pass more current and so increase the motor speed.

Very little work is done by the rider pulley. The reactor core weighs but a few ounces, while the current controlled by the tubes can be sufficient to control the speed of a motor of several horsepower. In the present installation the tubes control the armature current to a $\frac{3}{4}$-horsepower motor with the field excited from a separate source of direct current, but a similar control unit could be used to control a motor many times as large by supplying and regulating the field current instead.

Safety provision is made so that a failure of either the alternating or direct current, or breaking of the wire, causes a shut-down not only of the re-wind motor but also of the main motor driving the wire-drawing machine.

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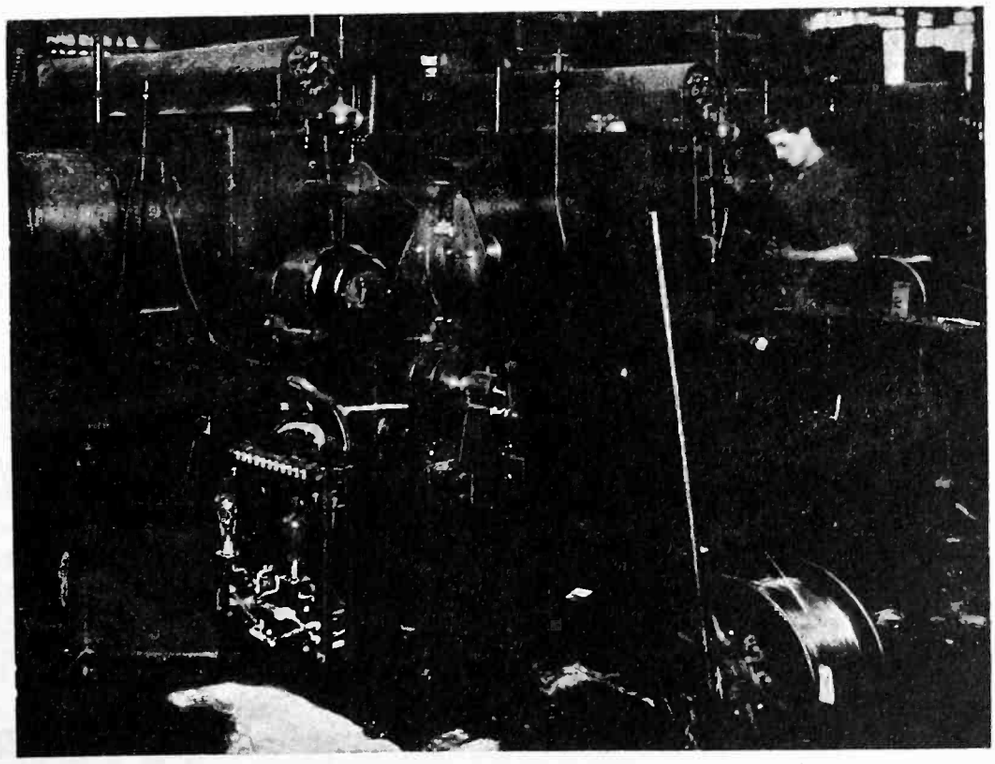

Electronic tubes keep uniform the tension on this wire as it is reeled onto spools in layers of constantly increasing diameter

Delivering electrons outside the tube

Effects of high-speed bombardment on familiar materials in air, under rays from Lenard-tube window

By A. R. DENNINGTON*

A GREAT improvement was made in cathode-ray tubes in 1894 when Lenard [1] used a thin metal-foil window, through which the electron stream could emerge into the air. A single hole less than two millimeters in diameter was covered by the metal foil. In 1921 Eisenhut [2] used a tube made up with a hot cathode, thus increasing the available electrons, reducing the cathode drop, and making the tube much more efficient.

Further improvements in cathode-ray tubes were made by Dr. Coolidge [3] who used a metal-foil window supported by a honeycomb structure cemented or sealed to the end of the tube. He also used a tubular metallic shield connected to the window and through which the electron stream passed. The shield very largely prevents electrons from reaching the walls of the tube and building up charges on the glass which are liable to result in destructive discharges. As a result of these improvements the Coolidge cathode-ray tube can be operated at very high potentials, thus greatly increasing the speed and range of the electrons emerging from the window. Cathode-ray tubes of this type made up of two or more single sections connected in series so that voltages of one half million to one million volts may be applied have also been constructed and used in experimental work.

All of the tubes thus far described make use of small orifices or thin metal-foil windows for the emergence of the cathode rays. The nature of the metals used and the construction is such that the tube cannot be heated very high during manufacture to drive out gases from the container and the electrodes and also there may be leakage through the thin metal foil. It is usually necessary, therefore, to have the tube connected, during operation, to a vacuum system or use a charc
densing chamber immersed in liquid air.

A cathode-ray tube which overcomes these di
has been developed by Dr. C. M Slack[4] of the V
house Lamp Company who made a tube havin
glass window substituted for the metal foil pr
used. The window is merely a reentrant spheri
ble of glass formed at the end of the tube and
made about .005 mm. in thickness for a dian
2.5 cm. Larger windows may be made but
correspondingly thicker to withstand the pres
the atmosphere over the concave surface. The
under tension which must be maintained con
avoid breakage. Even the slightest pressure on
vex side of the window results in its rupture
thin glass window must be protected from me
pressure but because of its shape there is little
of accidental contact being made. The electro
the hot cathode (a) are drawn toward and thro

hollow anode (b) and through the thin s
window (c).

Materials placed at the mouth of the tube rec
impact of the electrons at a distance of about o
from the window. The field is smooth and nea
form from center to edge. This tube may be ex
to such a high vacuum that no condensing cha
necessary and the tube is sealed off from the pur
becomes a self-contained unit which may be usec
place where a suitable power supply, such as ar
machine, is available. Being easily portable, th
brings to the experimenter a convenient source
speed electrons which may be controlled in inten
time of application as readily as are X-rays.

To prevent the possible accumulation of static
on the glass near the anode and on the window a
film covers the tube adjacent to the anode and
contact with the anode terminal. The window it
been most effectively protected by floating a
extremely thin aluminum foil on the concave
Coating the window with a solution of gold w
but had to be abandoned because the solution a
the glass surface enough to cause its destruction.
have also been operated for considerable perio
no foil or other conducting coating on the windo
out serious accumulation of static charges.

Operation and circuit apparatus

When it is considered that the window of a c
ray tube, whether made of thin metal foil or a th
bubble, is bombarded with electrons moving
velocities, it is evident that if this bombardment
cessive, the window may fail. Electrons havin
paratively low speed, that is, under the force o
potential of about 20 kilovolts cannot pass thro
window but disturb the molecular equilibrium a
the film of metal or glass. Those electrons strik
window with high velocity, equivalent to 100 kilo
more pass through with very little loss of spee

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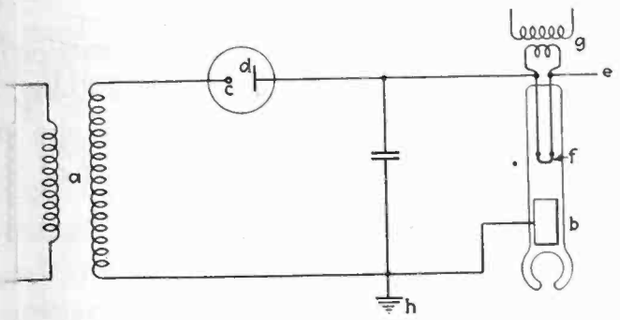
*Westinghouse Lamp Company, Bloomfield, N. J.

not go through they strike with such an impact
er electrons on the outside of the glass are pro-
om the outer surface of the window with almost
ished speed in much the same way that a ball
im head will be knocked away by the impact of
ball on the opposite side.

athode rays external to the tube are the same
cter to those within the evacuated envelope but
n called Lenard rays in recognition of the work
Lenard in studying the effects of the rays in air.
tion of a glass-window type of Lenard-ray tube
ccomplished by means of a transformer, rectifier
denser or an X-ray machine capable of supplying
current at a potential of 100 kv. or more. A



a of the general arrangement herewith, discloses
former (a) capable of supplying a maximum
ry voltage of 150 kv. connected to the anode (b)
enard tube and to cathode (c) of a high voltage
, the anode (d) of which is connected to the
of the Lenard ray tube. The filament (f) is
by means of a low-voltage transformer (g) or
ge battery. This part of the equipment must be
ly insulated as it is desirable to ground the anode
oint (h) near the tube. Many well-equipped
ories have all the apparatus necessary to use this
lied form of Lenard-ray tube and as this field is
le explored we may look for considerable activity
the next few years.

action of Lenard rays on drying oils was in-
ted by Long and Moore who reported a decided
ng action on linseed and prilla oils which become
crystal clear after exposure. The tube was
ed at 250 kv. maximum and the time of exposure
ree to ten minutes.

lidge and Moore experimented with cathode rays
monds and reported no change in color and no
horescence but all but two showed fluorescence
in the electron stream.

olished sample of fused quartz from Brazil rayed
wo minutes showed a non-homogeneous structure
rple tints. This color disappears if the material
ll heated in a Bunsen flame but reappears if re-
d with the Lenard rays. The pattern appears to be that of the distorted outlines of the crystals which were fused into the specimen tested. Most of the quartz crystals rayed showed no changes in appearance but some samples turned brown.

Sodium chloride changes to yellow, potassium chloride to a purple, caesium chloride to a blue on exposure to Lenard rays. These colors are approximately those of the flame spectra and fade away slowly; caesium first, potassium second and sodium third. If sodium chloride is over-exposed the discoloration becomes permanent. A fluorescent effect and also scintillation was noted on calcite crystals under the effects of the rays. Sheet celluloid after being rayed showed branching lines from numerous spots. The impact of the electrons apparently broke down the surface structure of sheet glue as was evidenced by the formation of minute bubbles when the material was slightly warmed after raying. Milk and butter after being rayed soon become rancid and give out a strong odor.

Water solutions of cane sugar, starch and glycerine give an acid reaction to litmus paper, after raying.

The effect of the electron stream upon selenium is similar to that of light but the action is more rapid.

Destruction of living cells

Lenard rays have a decidedly destructive effect upon living cells as is evidenced by the killing of bacteria and a breaking down of vegetable and animal matter. A leaf of a rubber plant exposed for as short a period as ten seconds exuded white latex. Some effect of this kind may be expected when it is considered that the electrons making up the discharge are moving along the path of the ray at speeds of approximately 125,000 miles per second. While the penetrative power of the rays appears to be slight, this effect is increased by lengthening the time of exposure, the electrons beating deeper and deeper into the cellular structure as the surface layers are destroyed.

Animal tissues are broken down and if the exposure is continued for more than a few seconds the cells may not be fully replaced by the healing process. Small insects such as fruit flies may be killed by exposure to the rays. If the cathode rays strike any part of the hollow anode of the tube X-rays are produced and should be guarded against by proper shielding of the tube by means of sheet lead.

It has been found that Lenard rays have an effect upon insulating oils and varnishes similar to the effect produced by high voltage stresses continued over a long period of time. These rays have therefore been used for testing cable insulation to determine its probable life. With further experimentation additional applications of Lenard rays may be made and the field of use broadened.

▼ ▼ ▼

ELECTRONS TRAVELING AT 125,000 MILES PER SECOND

Bleach linseed and prilla oils crystal clear.
Change color of common salt, potassium chloride, etc.
Break down surface structure of sheet glue.
Cause milk and butter to become rancid.
Kill living cells, and small insects, fruit flies, etc.
Within ten seconds caused leaf of rubber plant to exude white latex.
Produce fluorescence in diamonds while held in electron stream.

electronics

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O. H. CALDWELL, *Editor*

Volume 1 — SEPTEMBER, 1930 — Number 6

Home talking movies

A GREAT market for electronic devices will be opened if, and when home talking movies arrive. Solutions for present difficulties may be in the offing.

The problem of reduction photography of a sound track from 35 mm. to 16 mm. film may be solved by re-recording if other difficulties with sound on 16 mm. film can be overcome. If the 16 mm. film is run at the standard speed of 24 frames per second, its linear speed will be 36 ft. per minute, corresponding to 90 ft. per minute of 35 mm. film. It is obvious that to obtain the same high frequency response under these conditions it will be necessary to have the reproducing slit width four tenths of that used with 35 mm. film. To utilize the present home silent projectors already in the field, the use of sound on disks offers a less expensive equipment and may be the key for opening up this market.

The tube's range widens tremendously

WITHIN the covers of the issue of *Electronics* now in the reader's hands, two remarkable developments are chronicled, extending the working range of the electronic tube in two directions of magnitude—on the one hand, the infinitesimal, and on the other, the use of still greater powers.

A hundredth of a millionth of a billionth of an ampere can be measured by means of the new vacuum tube described in detail on a pr page. Here the electron flow is such that rent expressed as 0.00,000,000,000,000,0 10^{-17}) ampere, compares with the electr through the usual 50-watt incandescent la do two drops of water with the enormous of water spilled over Niagara Falls in Something like three quintillion electrons p ond (3,000,000,000,000,000,000) flow t the ordinary 50-watt incandescent lamp; t vacuum tube is able to measure accurately of about 63 electrons per second.

And on the other hand, our news section the commercial production of a 200-kw. casting tube, extending the tube's range 1 cent upwards, over the former limit of 1

And the end is not yet in sight!

American versus British practic

IN England an unscientific practice of rati uum tubes is used. Instead of giving th fundamental constants of the tube—pla sistance, amplification factor, and mutua ductance—under working conditions, th makers give values for these factors under tions at which the tube is never operated, n zero grid bias. Without negative grid b mutual conductance of a tube may be severa its value with the proper bias—which may why so many American experimenters wond we do not have tubes with mutual conducta high as several thousnd.

In a recent issue of *Wireless World* (L the characteristics of a new Mullard scre (S4VA) are discussed. At zero grid bias is the standard measuring condition, the t a resistance of 430,000 ohms, an ampli constant of 1500 and a mutual conducta 3500. The writer laments the fact that actual operating conditions the tube's resis over ten times the quoted value. The ab of so rating tubes is evident. No engineer sign a circuit for a tube unless he knows i acteristics—and if the manufacturer quot under conditions not approached in prac might as well not have them at all.

In America, it is standard practice to tube at the conditions under which it wil

he searchlight
engineering scrutiny

M time to time "discoveries" or "inven-
s" appear which, in spite of their promul-
faith in their virtues, seem to fail to find
g place in their particular industry. Occa-
these devices attract some measure of
n, but invariably sooner or later a bit of
atics (and what is so heartless as mathe-
)—or a neat experiment,—discloses that
much of novelty or perhaps even of merit
developed.

al years ago there were several schemes
which in a mechanical manner changed
equency the coupling between windings of
stage transformer. Engineers were not
ed by the announcements; they noted the
experimental data. The idea never took
One or two devices are still in search of a
still lacking laboratory confirmation of
entor's hopes.

he Toronto meeting of the Institute of
Engineers, August 18 to 21, a simple—but
legant—bit of mathematics on selectivity
that staggered tuning in multi-stage ampli-
oes not improve selectivity as has been
d.

e again it can be emphasized that engineers
ot impressed by unsupported claims; they
ck to note the lack of experimental proofs.

Measuring screen intensities

PARATUS for accurately measuring the
light intensity on moving picture screens
practical conditions has been under investi-
for some months. One such device which
hoto-electric cells in connection with absorb-
ters has been fairly successful for this pur-
A drawback, however, has been the type
oto cell available to meet existing require-
s.

Equipment which will be portable, reliable
ccurate for field use is much needed at this
With the development of wide-films using
screens and involving many new problems,
equipment for accurate analysis will be of
t assistance to engineers in this field.

Short waves carry the load

BECAUSE engineers once thought radio waves below 200 meters were worthless for communication, amateurs were given them to play with. Yet today the bulk of the world's transoceanic radio traffic is carried by short-wave stations. The number of long-wave stations that, a few years ago, cramped into a scant 15 kilocycles, carried this traffic, has not increased in five or more years. Meanwhile the number of short-wave stations has increased enormously.

Today the Mutual Telephone Company of Hawaii has 16 licenses to work below 10 meters; communication companies have had a number of licenses granted for experimental purposes below this figure. It looks as though the thousands of channels in this region—once thought worthless—would be opened up and filled.

It is a pity there are no lower waves for amateurs to explore.

A Chicago museum of industrial electronics

IN the new Chicago Museum of Science and Industry, founded by Julius Rosenwald, and now being organized by Dr. Waldemar Kaempffert as director, opportunity has been opened for a great department of electronics in which the practical application of the electron in industry and engineering can be shown in operating models.

There is a special reason why a museum located in Chicago should have such a department of electronics.

The key invention in the electronics field, that of the grid-control by Dr. Lee deForest, was made in Chicago in 1906, and the work leading up to it was done at Armour Institute in the preceding years, while Dr. deForest was technical editor of the old Chicago *Western Electrician.*

Certainly Director Kaempffert's plan to develop an electronics museum in Chicago should be received with interest and cooperation on the part of the electronics industry. For his purpose he wants historical apparatus, and working models illustrating electron applications. Undoubtedly these contributions will be forthcoming as the plan of exhibit grows.

REVIEW OF ELECTRONIC LITERATU

HERE AND ABROAD

Electrical music

[SCHULTZE] Descriptions of the Theremin (change in capacity by the position of the player's hand), Mager (moving lever changing capacities), Gernsback (keyboard with fixed inductances and capacities), Martenot (variable condenser, actuated by unrolling more or less of a metal ribbon), Hugoniot (multi-oscillator, pitch-control by the position of the iron core within an inductance), Givelet (fixed condensers, key-operated).—*Funk, Berlin, June 27, 1930.*

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Radio-electric musical instruments

[J. REYVAL] As a variation of the well known etherophone of M. Theremin, M. Martenot has developed a new musical instrument, operating on the same principle, but offering better control over the volume and a more mechanical control of the operation. In one model an ordinary keyboard is used to operate the instrument. *Revue Generale de Electricité, Paris, May 24, 1930.*

✦

Electrical music

[TRAUTWEIN] From a theoretical point of view the outstanding feature is the statement of a new theory of tone-quality, replacing that generally accepted (of overtones, multiples of the fundamental frequency) at any rate as far as the majority of instruments are concerned. This theory is: "The physiological effect of musical quality is in the main produced by the presence of one or more 'Hallformanten' which are heard simultaneously with the fundamental. These are damped oscillations of a definite frequency which is invariably higher than that of the fundamental and which may be in any relation to this, not necessarily a multiple. The 'Hallformant' invariably dies out during each period of the fundamental, or is suppressed by the beginning of the next. The frequency of a 'Hallformant' may remain unchanged for a considerable range of frequency of the fundamental. Should the fundamental reach a higher frequency than that of a 'Hallformant,' the latter disappears. 'Hallformanten' are in general caused by variations in strength occurring during each period of the fundamental." (Should the theory receive general support, a suitable English term for "Hallformant" will no doubt be developed: for the moment it seems preferable to retain the German word.) It should be added that certain instruments (especially the flute) have no "Hallformanten."

The first figure shows a circuit designed to illustrate this theory. *S* is an oscillating circuit, having a frequency between 400 and 4,000 cycles per second, excited by the glow-lamp circuit (glow-lamp 1, resistance 2 of the order of one megohm, condenser 3 of about 0.003 microfarads: this can be placed in parallel either to the lamp or to the resistance) through the triode 4. Regeneration is applied by the condenser 5. The resistance 6 (about one megohm) reduces the coupling between *S* and the lamp. The resistance 7 (together with the condenser 5) controls the damping in *S*.

If now the frequency of the glow-lamp circuit be brought within the range of audible frequencies, changes in the value of the "Hallformant" circuit *S* will give different tone-colors: for example, a "Hallformant" of low frequency suggests a bassoon, of medium frequency a clarinet, of higher frequency a trumpet. Weakly damped "Hallformanten" give shrill and acid quality: heavily damped ones a more tone. One curious effect is tha slowly altered, the ear can fo "Hallformant" frequency and tone-color effect; but as soon left fixed, the tone-color reapp on the other hand 3 is jerkily the effect is that of several ins playing in turn. A point str favor of the new theory is that of the "Hallformant" by one tones only entirely changes t color: were the usual theory tones true, this would argue an sensitivity of the ear to very hi tones, which is not the case.

One among the many interes gestions made is that reson quencies in amplifiers, loud speal are in reality not dangerous so cause of the tendency to exagg particular note as because of th this note forming a "Hallform thus giving a false color: much of the good effect often by a condenser in parallel t speaker is due to the absorptio "Hallformanten." There is als curious suggestion on the dev of speech from animal noises b crease of the power of holding nant "Hallformant" steady.

The second diagram is that c cal instrument based on this Mention is made of the difficult ing suitable glow-lamps, those lightning protection having i proved most suitable. The var denser shown serves merely t range of pitch, the actual pi tion being carried out by va resistance: this takes the forn a screen-gride tube, with var bias. This is done in order t straight-line relationship bet tances on the "keyboard" (wire pressed into contact wit stat, for example) and the m

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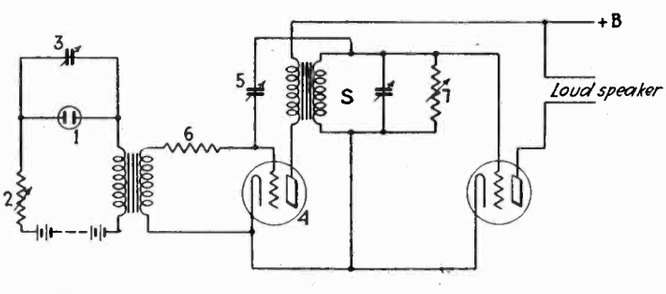


Fig. 1—Circuit to illustrate theory of producing damped oscillations or "Hallformanten"

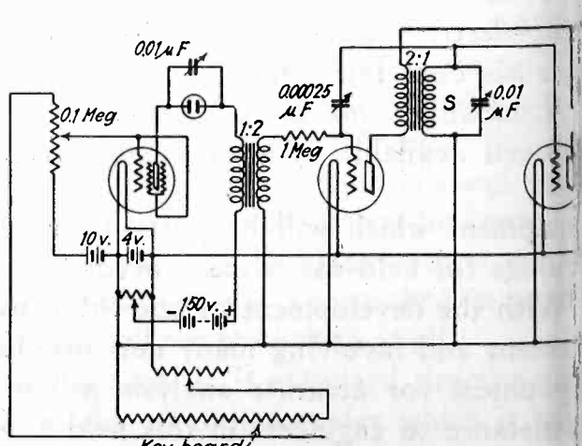


Fig. 2—At right: Diagram of electrical musical instrument designed to employ principle of "Hallformanten"

since were an ordinary resist- be used the fingering at one end cale would be very crowded. It ws of complete silence when the lifted from the "keyboard," the y blocking the grid completely. of the transformers are given. an one "Hallformant" can be eously added to the fundamental g tubes and oscillating circuits the first transformer. Volume- s of any normal type, in the of the tubes following those it can be operated by foot, r hand, and valuable practical ons are made.

stions for a similar instrument, g a different circuit (these for August) are also given.— *ions of the Radio Research the Staatl.akad.Hochschue für Vo. 1, Berlin, 1930.*

✦

ion variation method asuring resistance

MOULLIN] The two best known od of measuring radio-frequency ue of a circuit depend on the vion of the alteration of current ter to a change in resistance or nge in reactance. The author s the latter of these and points following sources of error:

mpurity of circuit elements, ductance of condenser leads.

E.M.F. induced in measuring ts assumed constant.

Changes in generator frequency circuit adjustments.

E.M.F. induced directly into the ng circuit from the generator. ods of recognizing and eliminat- e errors are discussed.—*Experi- Wireless and Wireless Engineer, 30.*

✦

ric impulses in ear-nerve loud speaker

table experiments on the nerve ring, indicating that this nerve s in a way quite different from rve of the eye and presumably r nerves in the body, have been d by Ernest Glen Wever and s W. Bray of the Department of logy of Princeton University. ing surgically on anesthetized hese experimenters connected the of the ear electrically to an ampli- e those used in radio. Electric es coming over this nerve, instead aching the animal's brain, then sidetracked into the amplifier, fied millions of times and could corded on electric meters or fed loudspeakers so that sounds cor- nding to these nerve impulses were heard by the human observers. Previous similar experiments on eye nerves and other nerves, chiefly by the late Dr. E. I. Adrian in England, had disclosed electric nerve impulses differing greatly in character from the impulses of light or other impulses received. Contrary to this Mr. Wever and Mr. Bray find that the electric impulses in the ear nerve are precisely like the sounds entering the ear. The ear of the anesthetized cat even could be used, the experimenters found, as a kind of living microphone like the microphone of a broadcasting station, sounds which entered the ear being picked up faithfully, amplified by the electric apparatus and emitted, still in faithful reproduction, from the loudspeaker.—*Bulletin National Academy of Sciences.*

✦

Explanation of selective photo-electric effect

[R. H. FOWLER] It has already been conclusively shown that a clean metallic surface does not show a selective photo-electric effect. One exception to this statement is that of thin clean layers of an alkali metal on less positive supports, which agrees with other clean surfaces in showing no selective effect but does show a strong preferential action when the electric vector of the incident light is normal to the surface.

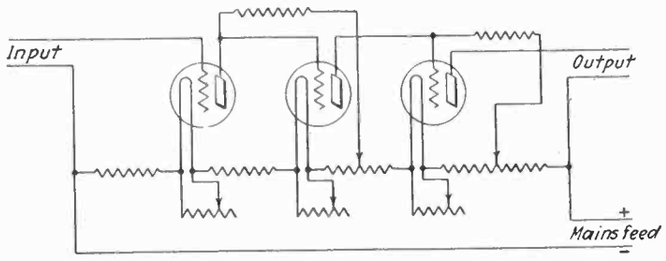
Taking his key from the known fact that the ejection of a photo-electron from an atom is closely correlated to the direction of the electric vector, the author asks if it is not possible that the extra momentum picked up by an electron in a metal is similarly related to the electric vector. He arrives at the conclusion that the most favorable direction of projection is along the electric vector and with this perpendicular to the reflecting surface the photo-electrons have their greatest probability of escaping from the metal. This agrees with the published results of experiments.

Since the selective effect depends essentially on a surface condition the assumption is made that on the surface of the clean metal there are deposited in turn an electro-negative layer, an electro-positive layer and, finally, a monomolecular electro-negative layer. Considering the work functions which would be associated with such an arrangement of layers is it possible to predicate a frequency-selective effect such as shown by the alkali metals? Using the wave equations which represent a stream of electrons ejected from such a surface and being partly reflected by and partly transmitted through the various layers the author shows that such a selective effect will exist. Moreover, the required work-functions and the resultant resonant frequencies assume reasonable values.—*Proceedings of the Royal Society, July, 1930.*

✦

Amplification independent of frequency

[SCHRAMM] A summary of methods suitable for the amplification of all frequencies, including zero (direct current). The well-known systems are given, together with modern methods suitable for screen-grid tubes, for mains-feed, etc. The diagram shows one of the most interesting.—*Funk, Berlin, August 1, 1930.*



✦

Cathode-ray oscillograph without glass parts

Under continued use, the properties of glass defeat perfect operation of the ordinary tube, in that gases are liberated, which affect the vacuum, the cathode gradually evaporates and the arc does not burn as steadily as sharp focus demands. In addition, great inconveniences and limitations are introduced by having the photographic plate or film within the vacuum. In a new cathode-ray tube, glass is entirely eliminated and a window (Lenard window) has been provided, which allows free passage of the recording beam to a photographic plate or film, located outside the vacuum. The new tube is suitable for potentials up to 80 kv. and currents of as much as 2 milliamp. and can be left in operation all day without attention.

The emission window, size 4x6 cm., consists of a Cellon sheet, 0.016 mm. thick, which withstands external pressure due to a reinforcing supporting structure of a fine mesh metal screen and a grillwork of small edgewise steel bars. It is claimed that such a window passes 60 per cent of the electrons with undiminished speed. More than 200 records were made through such a foil without damage of any kind. Investigations on traveling waves made with such oscillcgraphs gave very clear-cut records in spite of the tremendous writing speed of 3,000 miles per second, which allows readings of 10^{-9} seconds. The new oscillograph is much smaller and therefore much more portable than the former glass type.—*Elektrotechnische Zeitschrift, July 3.*

The new "flat tube"

[SCHW] The Telefunken Company is putting on the market new indirectly-heated a.c. tubes using electrostatic control (Weagant-Round), a metallic coating on the outside of the glass replacing the usual grid. The height is approximately the same as that of a normal tube, but the tube is flat, about an inch wide by hardly a quarter-inch thick, the reduction in size having of course been made to bring the metallic exterior coating as near as possible to the internal electrodes. The price is to be considerably lower than that of the normal a.c. tube. A peculiarity is that the lower frequencies are practically suppressed, the amplification factor being, for example, 1 at 50 cycles and 100 at 1,000 cycles: as a result, a.c. hum disappears, but special treatment of the low notes will no doubt be necessary.—*Funk, Berlin, July 18, 1930.*

✦

Piezo-electric crystal as frequency standard

[H. J. LUCAS] The paper opens with a review of certain relevant points in the modern theory of coupled circuits as applied to systems consisting of a low-decrement circuit tightly coupled to a source of free oscillations. The following deductions are made:

(1) All mechanical vibrator-valve combinations which obey the laws of coupled circuits produce frequency stabilized oscillations.

(2) Such combinations have two possible modes of oscillation.

(3) The combination cannot oscillate at the resonant free period of the mechanical vibrator.

The first application of the crystal was as a resonator, i.e., used non-regeneratively, in which case it was found that in addition to temperature, the type of mounting, air-gap, amount of humidity and air pressure influenced the frequency and decrement of resonance. The advantages of this system are:

(1) The resonator is not doing any work—it is fed with just enough energy to enable a determination to be made and the load applied by the indicating device (valve-voltmeter) is practically one of potential.

(2) Provided the "Cady crevasse" closed circuit is accurately tuned, the true period of the crystal assemblage is obtained.

(3) Any variation in the electrical circuit is immediately made manifest and is under complete control.

The principal disadvantage of this system is a slight uncertainty in the true value of the resonant frequency due to the large radius of curvature at the bottom of the crevasse. (In the discussion which followed the presentation of the paper D. W. Dye showed how this defect could be eliminated.)

The second part of the paper deals with the crystal used as an oscillator, i.e., regeneratively and serving as a control. The frequency stability of such a system is investigated and improvements indicated so that the frequency variation over long periods of time is less than three parts in a million.—*Journal Institute of Electrical Engineers, July, 1930.*

✦

Sinusoidal and "relaxation" oscillations

[VAN DER POL] The author's summary is as follows: "An electrical system composed of a constant inductance and a constant capacity is considered, whose resistance is a function of the potential V, the equation

$$L\frac{d^2v}{dt^2} + R\,(v)\frac{dv}{dt} + \frac{v}{C} = \frac{E\,(t)}{C}$$

thus holding good. If the resistance $R\,(v)$ is negative when the absolute value of v is less than a certain value, and positive for greater values, it may be considered that in the absence of the applied voltage $E\,(t)$ the system will be capable of self-oscillation with fixed frequence and amplitude, the energy received during that part of the cycle when R is negative compensating exactly for that dissipated when R is positive.

"The author chooses as the normal form of oscillations of this type those given by the equation

$$y'' - e\,(i - y^2)\,y' + y = O$$

He shows that when e is very small, the final state, reached after a great number of oscillations, closely approximates to a sine form. On the other hand, when e is very large, the final state, reached very rapidly, differs greatly from a sine form. The extreme cases are practically reached when e is $\frac{1}{10}$ and 10 respectively.

"The case where e is very large is particularly interesting in that it includes a great number of natural periodic phenomena, in which the approximation to a sinusoidal form is evidently impossible. Oscillations of this type present, apart from their particular form, three striking physical characteristics: (1) their period is determined by a product of the type CR or of the type L/R (relaxation time) instead of by the square root of a product of the type LC as in the case of sinusoidal oscillations; (2) they fall readily into synchronism with a sinusoidal force of a frequence considerably different from their own, but, though their frequency is thus readily varied within wide limits, their amplitude remains practically unchanged; (3) under the influence of a periodic force of a frequency greatly superior to their own, they take up a frequency which is an exact sub-multiple of that of the applied sinusoidal oscillation, thus effecting a demultip of frequency.

"The author considers in large number of examples of tion' oscillations taken from me acoustics, electricity, biology, eco etc."

This is the first article. An of the stimulating suggestions associated with the works of this is the demonstration of the sir between the curves for the build of the oscillations of a triode, development of a colony of fru and for the growth of a sun- with the suggestion that comp problems of the growth of pop may be studied in the laborat the building up of electrical ne more readily than by analytic m —*L'Onde Electrique, Paris, June published July 17.*

✦

Flat-piston moving-coil loudspeakers

[ROBERT W. PAUL and B. S. C Owing to the high ratio of elasti density, which is a property o wood, pistons of correct design from this material do not "break the same extent as do paper hence the resonances are simpl less pronounced. With this as a postulate the authors describe a of tests of balsa-wood pistons, of sizes and designs, in view of whi feel that a real advance has been in respect of uniformity of respon reliability, in moving-coil loudsp of the hornless type.—*Experi Wireless and Wireless En August, 1930.*

✦

Mercury-arc rectifiers for radio transmitters

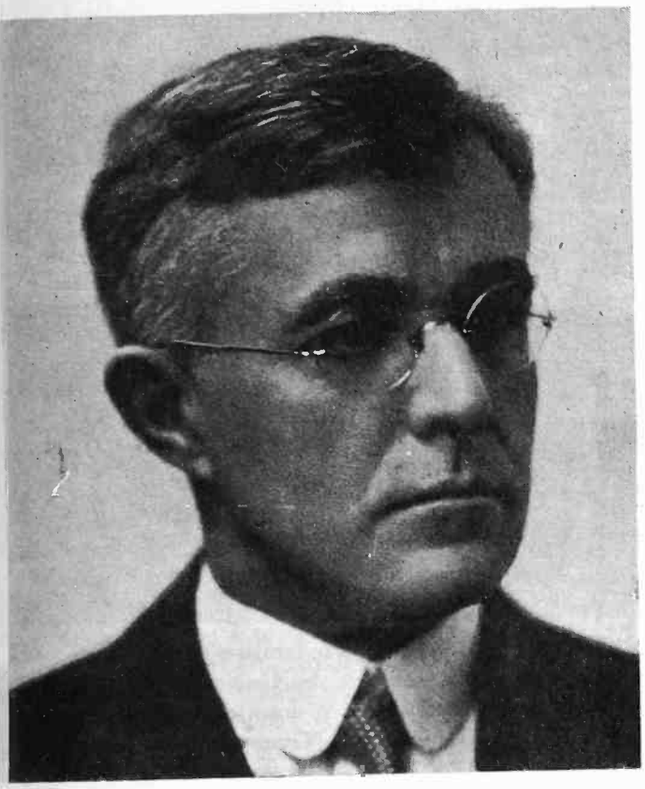
[H. C. BECK] The paper open a comparison of motor-generato mionic and mercury-arc power re for wireless transmitters. It g to describe the installation in th coni Research Laboratories at C ford, England. This unit is d to furnish an output of 400 kw. pressures of 9,000, 10,000 and volts. Mention is made of the fa the new broadcasting station at W Russia is to be equipped with m arc rectifiers.—*Brown Boveri July, 1930.*

✦

Thoriated cathodes

[RICQ] Details of manufacturi testing processes in France for ated filaments, the second artic series (see these Digests, July) Director of one of the principal tube-manufacturing companies.— *électricité, Paris, August, 1930.*

Builders of the electronic arts



IRVING LANGMUIR

Chemist, research engineer and inventor. Developer of gas-filled tungsten lamps, thermionic devices, and electron discharge apparatus. Research Laboratories, General Electric Company, Schenectady, N. Y.

CHARLES M. SALTZMAN

Chairman Federal Radio Commission, Washington, D. C. Major-General, U. S. A. Cited for gallantry, Spanish-American War and World War. Chief Signal Officer, Army, 1925-'28, in charge of radio.

JOHN H. MORECROFT

Teacher, author and consulting engineer. Specialist in radio and vacuum-tube applications. Author, "Principles of Radio Communication." Professor of electrical engineering and radio, Columbia University, New York City

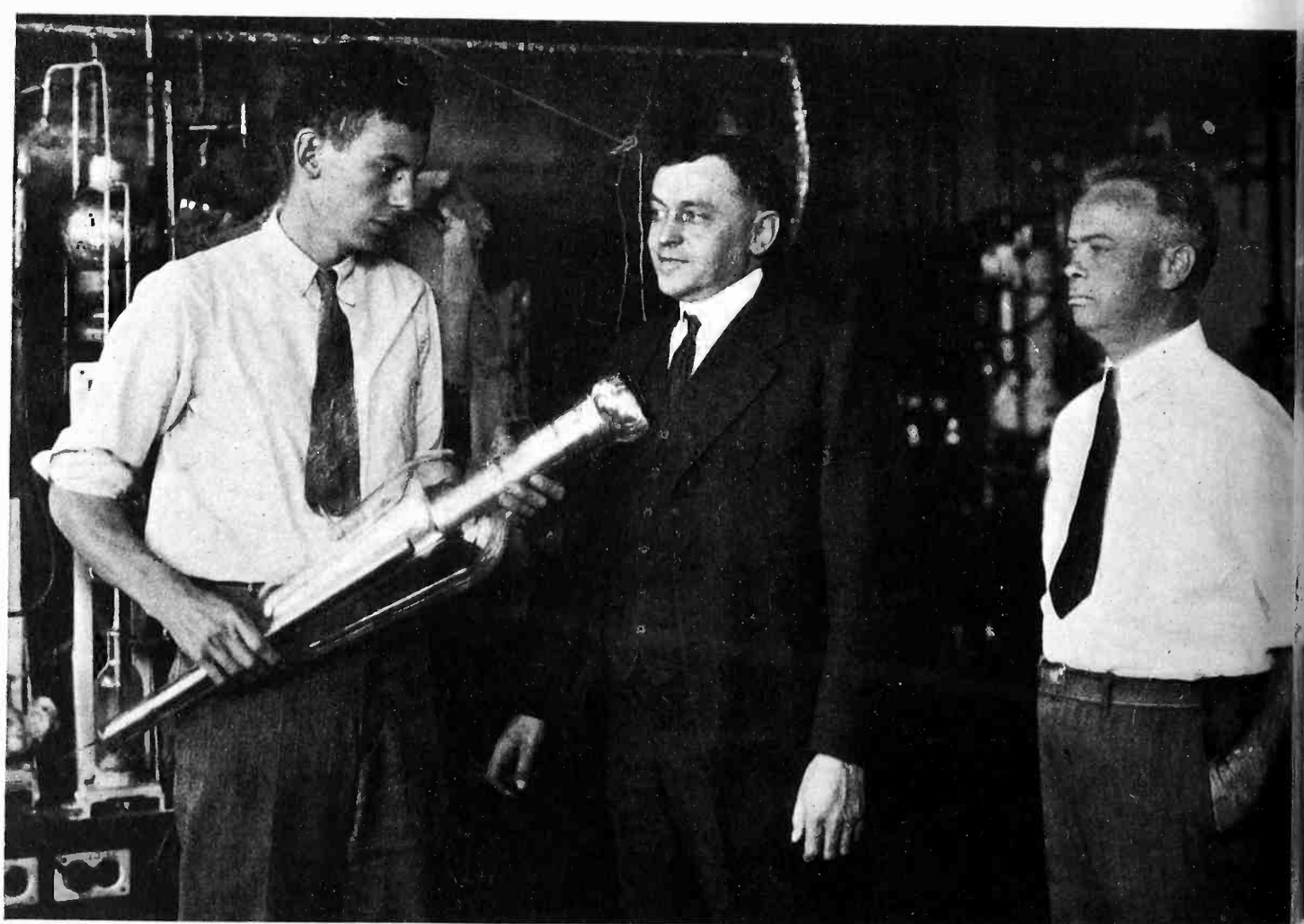
JOHN E. OTTERSON

President Electrical Research Products, Inc., New York City, licensors Western Electric sound-picture patents. U. S. Naval Academy, 1904. Naval constructor, 1914; Executive, Winchester Company, 1915-24; Western Electric Company, 1924-'26

ELECTRONICS' CAMERA

P. T. Russell, who has been awarded $1,000 for the best U. S. Navy invention of the year, an under-water loudspeaker for disabled submarines

Popularizing the electron in Chicago. To familiarize the Loop public with the marvels of electronic phenomena, the University of Chicago has been conducting, with the help of coeds, a downtown demonstration of Millikan's oil-drop experiment, the Compton effect, etc.



A 300,000-volt Lenard-ray tube the electrons from which are projected clear through a thin glass window and out into the open air where they may be used to bombard familiar substances, producing changes in structure and chemical combination (see pages 294 and 295). The tube is being held by Dr. Slack, inventor of its improved construction. Dr. Harvey Rentschler and Dr. Ulrey, both of Westinghouse research forces, are seen looking on

NEWS

THE ELECTRON INDUSTRIES

trade developed

A group

efforts to develop export trade products have been planned by io Manufacturers Association its Foreign Trade Committee is just been reorganized. Ex- American radio products are y expanding, particularly to and the Latin-American coun- e exports to Canada having during the last fiscal year.

Moss of Electrad, Inc., New ity, has been appointed by t Metcalf of the Radio Manu- Association as chairman of ciation's Foreign Trade Com- Other members are: J. M. , RCA-Victor Co.; Charles son, General Motors Radio S. J. Spector, Insuline Corp. ica; K. Nielsen, Belden Mfg. J. Barkley, De Forest Radio Howard Haley, Colin B. Ken- rp.; and C. J. Hopkins, Crosley orp.

export trade manual of the iving detailed information re- foreign trade outlets, broad- facilities, customs regulations, gencies, etc., will be developed committee in co-operation with artment of Commerce and other

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Manufacturing Company in- production facilities. Manufac- f radio sets throughout the Mid- t and in New England have been lly apprised of the large increase luction facilities of the Lynch cturing Company, by A. E. , sales manager, who has just ed a round of calls in these two of the country. Heretofore the s of the Lynch Manufacturing ny have been confined to the field.

Tracey to West Coast to discuss National Union plant. At the behest of California business and aders, Gene (E. A.) Tracey, first esident of National Union Radio ation, 400 Madison Ave., New City, has left for the West Coast estigate possibilities of National plant and sales development out National Union Radio's position independent tube manufacturing it was said, prompted the Cali- ns to urge the erection of a model actory which will supply the west- arket.

Brunswick Radio Corporation continues promotional activity in the Jersey territory due to the driving activity of Sidney Rogovin, head of the Northern Distributing Company. First it was a tie-up with the Warner Brothers jubilee. Then it was a monster Warner Brothers-Brunswick radio parade, and now it is a "guess who" contest. The "guess who" contest is predicated upon the fact that most movie enthusiasts know more about their favorite stars than a motion picture editor. It is being starred in twelve Warner-Stanley theatres and featured by twelve great New Jersey newspapers. There will be presented a number of noted Warner Brothers and Brunswick artists who shall be nameless except for their biography. The Jerseyites who participate in this state-wide contest will be asked to judge the names of the stars from facts presented to them in a biographical manner.

Milton Alden and Elinor Johnson formerly of the Alden Manufacturing Company has formed a new company to be known as the Alden Products Company. They will occupy a daylight factory with seven thousand feet of floor space located at 715 Center St., Brockton, Mass. They are manufacturing speaker plugs for connecting dynamic speakers, adaptors, sockets, binding posts and phone top jacks and special assemblies. In addition to parts for the radio industry they will manufacture material going to the chain stores and electric appliance manufacturers.

▼

GEORGE THROCKMORTON

just elected a director of the Radio Manufacturers Association, is executive vice-president of E. T. Cunningham Company, New York

The Louis Allis Company, manufacturers of direct and alternating current motors, of Milwaukee, Wis., has announced the recent opening of three new sales offices, with the following men in charge: C. O. Sargent, 1715 Union Bank Bldg., Pittsburgh, Pa.; W. Woobank, 215B East Archer St., Tulsa, Oklahoma; A. R. Thomas, 4441 Santa Fe Ave., Los Angeles, Calif. These men, all of whom are well known in their respective territories, will handle the entire line of Louis Allis "custom-built" electric motors, which include "standard," "multi-speed," "explosion-proof," and many other types specially developed to meet ordinary and unusual industrial conditions. With the opening of these three new offices, there is now a Louis Allis sales office in each of the following principal cities: Buffalo, Cincinnati, Chicago, Cleveland, Detroit, Minneapolis, New York, Rochester, Atlanta, Boston, Dallas, Grand Rapids, Greensboro, Houston, Los Angeles, Philadelphia, Pittsburgh, St. Louis, San Antonio, San Francisco, Toledo, Tulsa, Toronto, Winnipeg, and Regina, Canada.

RCA-Radiotron announces new filament rating for 231 tube. Since the new two-volt RCA Radiotron 231 was announced, it has been found advisable to change the filament rating from 0.150 ampere to 0.130 ampere. More economical operation of battery receivers, designed for this new RCA Radiotron, in combination with RCA Radiotrons 230 and 232, will result from this change in filament drain.

R. L. Davis, engineer in charge of radio development at the East Pittsburgh plant of the Westinghouse Electric and Manufacturing Company, has been named manager of the radio engineering department of the Westinghouse, Chicopee Falls, Mass., plant.

V. E. Trouant has been appointed to the radio engineering position at East Pittsburgh made vacant by the transfer of Mr. Davis. As manager of the radio engineering department at Chicopee Falls, Mr. Davis will succeed H. J. Nichols who has resigned. In his new position Mr. Davis will report to the director of engineering at East Pittsburgh. D. G. Little will continue as chief engineer of the radio engineering department. Announcement of the changes was made by R. S. Feicht, director of engineering.

RCA-Victor Company has announced the appointment of E. A. Nicholas of Chicago, as Radiola distributor in northern Illinois, including Chicago, northern Indiana, and Berrier and Cass Counties in Michigan. Mr. Nicholas, president of the organization bearing his name is widely known throughout the radio industry through his long association with Radio Corporation of America and the RCA-Victor Company. He has been in radio since its infancy when radio meant wireless communication. He first began his radio career as a messenger boy for the United Wireless Company in 1909.

Mr. Nicholas has surrounded himself with the following staff executives: Charles P. Hindringer, sales manager, formerly sales manager of the Lyon and Healy wholesale department; Elmer Forsell, secretary and credit manager, formerly credit manager of the Westinghouse Electric and Supply Corp.; H. C. Stewart, service manager, formerly with Beckley-Ralston. Louis Sarnoff is branch manager of the company at South Bend where a display room and warehouse have been established.

✦ NEW PRODUCTS

THE MANUFACTURERS O

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.

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Steel coil for dynamic speakers

FIELD coils, especially designed for dynamic speakers, have been placed on the market by the Inca Manufacturing Corporation, Fort Wayne, Indiana. The coil can be furnished with or without external leads. By means of an ingenious terminal arrangement, the terminals may be made available, but eliminating the necessity of long external leads when not desired. The insulating sheath, completely concealing the coil, creates a moisture and water-proof condition, and affords mechanical and electrical protection for the winding. This coil supplies an enamel wire in coil form without the spool. The coil is bound by two circumferential bands, which contribute to its neatness and strength.—*Electronics, Sept., 1930.*

✦

Radio condenser tester

ESPECIALLY constructed for radio work is a condenser tester manufactured by the Electric Heat Control Company, Cleveland, Ohio. It measures capacities from $\frac{1}{10}$ to 8 microfarads and quickly shows up poorly insulated and defective condensers. It can be used as an ohmmeter to measure resistances from 150 to 30,000 ohms, also as a tester for radio transformers and as a continuity tester.

Capacity of transformer, 250 milliamperes at 500 volts. It has a tube socket for a type 281 tube which permits the use of 500 volts of direct current as well as 500 volts of alternating current. List price, $17.50. This company also manufactures various types of transformers to meet special requirements. Type A step-down transformers, from 220 to 110 volts, are made in capacities of 60 to 250 watts.—*Electronics, Sept., 1930.*

Transformer of unique design

A TRANSFORMER recently brought out by the American Transformer Company, 178 Emmet St., Newark, N. J., is moisture-proof and adaptable for either top of panel or sub-panel mounting. In the former case, the terminals come out from the top, and in the latter, they protrude from the bottom. The terminal board is a part of and is fastened to the other parts of the transformer having no connection with the case. This allows the transformer to be inspected and serviced with little

trouble after assembly. To remove the transformer from the case, it is only necessary to remove two short screws from the top and the base. By subjecting the transformer to a little heat, it readily comes out of the case. This case is also designed so as not to limit the core build in cross-section.—*Electronics, Sept., 1930.*

✦

Theater dynamic speaker

DESIGNED especially to handle the extreme power range of large power amplifiers with an output of 20 watts is claimed for the Best theater dynamic speaker built by the Best Manufacturing Company, 1200 Grove St., Irvington, N. J. The field power i in the 60-cycle a.c. model by rectifier tubes and in the 1(model by a dry rectifier. Th can be supplied with a push-p transformer for direct opera push-pull tubes. The univer is furnished with the necessa ance, rectifier, and connectio that the speaker can be operat volts a.c. or d.c. or 220 volts out alteration of the speaker proper choice of elements List price, $95.—*Electronics, S*

✦

Midget resistor unit

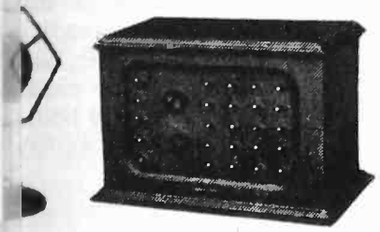
IN AN accompanying view, a midget resistor manufactur International Resistance Comp Chestnut St., Philadelphia, P is particularly adapted for ai ceivers and for the mantel type

These resistors are manufa ranges from 30 ohms. up t ohms and are of a one-third

pacity rating. Resistor unit half watt, one watt and two the same type, are also availa letins on various subjects per the application of resistors, resistance coupled amplifiers, be obtained free of charge b to the service department of pany.—*Electronics, Sept., 193*

e control unit ralized radio

ti-Trol is to a broadcast sys- a switchboard is to a tele- em. Complete room control by adjustment of switches el, the director may send his nograph music or radio music all rooms in the building d-speakers are installed and to the Multi-Trol unit. Vol- be adjusted suitable for any

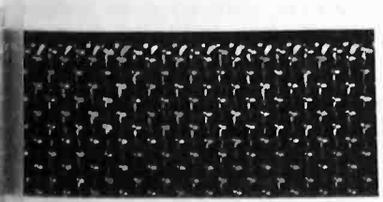


e Multi-Trol contains: Remote radio set; control switches g on or off radio, phonograph hone; master volume control for all speakers, etc. This nanufactured by the Multi- Phonograph Company, Inc., iroe Avenue, N. W., Grand ich.—*Electronics, Sept., 1930.*

✦

wire mesh cloth screens

vark Wire Cloth Co., 351-365 ve., Newark, N. J., announces, have perfected their "Seal- their new 85 x 70 mesh nickel h as used on the 227 tubes. cipal difficulty with radio grid neretofore has been the un- of the edges of these plates r tendency to unravel. Un- is not possible with this mesh. ates have a smooth and even



over. All wire ends are in- y bent over. The use of this in tubes prevents wires drop- from the cloth, thus overcom- eat many rejects of the finished to short circuits.

niformity of the cloth is an e in forming the plates as the in width, straightness elimi- mming in the guides. The turers are making this wire a number of meshes and are to make it in any width —*Electronics, Sept., 1930.*

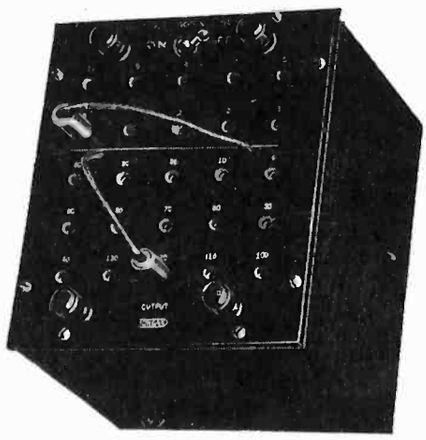
Condensers for high-frequency furnaces

TO MEET the demand of a condenser able to withstand the transient overloading conditions in tube bombarders, the Allen D. Cardwell Manufacturing Co., 81 Prospect St., Brooklyn, N. Y., has developed the Cardwell S-2244, an oil dielectric fixed condenser, affording high capacity and having self-heating characteristics. It can be supplied as an oil condenser for small capacities and also as an air dielectric condenser. The breakdown voltage is 4,000 in air and 30,000 volts when immersed in pure castor oil. List price $120.—*Electronics, Sept., 1930.*

✦

Variable voltage testing transformer

FOR furnishing any desired voltages and designed especially for electrical laboratories and manufacturers is the No. 4612 Dongan transformer, manufactured by the Dongan Electric Manufacturing Company, 2987 Franklin Street, Detroit, Mich. This unit has



a bakelite panel with 25 individually marked outlets. With an input of 115 volts, any voltage within a range of 1 to 150 volts in 1 volt graduations may be obtained. The current capacity is 5 amperes at any voltage. List price, No. 4612 for 60 cycle input, $32.50 and for 25 cycle input $42.50.—*Electronics, Sept., 1930.*

✦

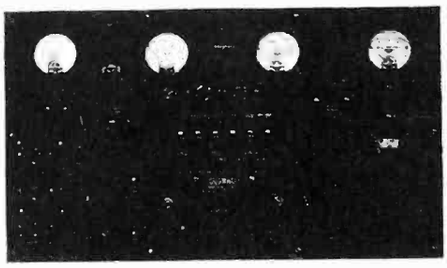
Booklet on photolytic cells

PHOTO-ELECTRIC division of Arcturus Radio Tube Company, 260 Sherman Avenue, Newark, N. J., has available an excellent booklet on the photolytic cell. It is written by H. L. Haltermann, S. B., gives a general résumé of the history behind the cells that make sound talking pictures possible, discusses the characteristics of photo cells in general and of the Arcturus cell in particular, and winds up with circuits commonly used with the "electric eye for every industry." — *Electronics, Sept., 1930.*

Test panel for tubes and receivers

MEANS for testing all types of tubes, radio receiver sets, power supply devices, etc., are provided for in the Day Rad type HB test panel brought out by the Radio Products Company, Fifth and Norwood St., Dayton, Ohio.

Set analysis connections are made by placing cable plug in radio set tube socket and the tube in the test panel socket. Simultaneous analysis readings are obtained by operation of a series of clearly marked cam key switches.



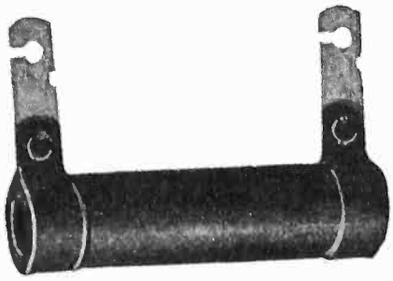
By utilizing the test oscillator and output meter of the panel, it is possible to transmit a weak signal to the radio set under test for determining first, alignment; second, neutralization; and third, overall response in comparison with standards. List price, $179.—*Electronics, Sept., 1930.*

✦

Layer-wound high resistance

THIS recent addition to the Electrad line of radio resistances and voltage controls is recommended by the manufacturers, Electrad, Inc., 175 Varick St., New York City, particularly for use as plate resistors, multipliers for voltmeters and general laboratory work.

Nichrome resistance wire is wound in insulated layers around a selected refractory tube. The entire unit is covered with a heavy coating of mois-



ture-proof enamel. Contact bands and soldering lugs are of Monel metal. The lugs are solder-dipped for easy connection. All parts expand equally under load. The overall length of the unit is 2 inches, with a maximum outside diameter of $\frac{5}{8}$ inches. It is made with resistance ratings from 10,000 to 250,000 ohms.—*Electronics, Sept., 1930.*

Waterproof speaker head felts

THE American Felt Company, 315 Fourth Ave., New York City, announces a special waterproof felt for speaker head insulation. This felt is unaffected by climatic conditions. It is made accoustically correct and dampens all disagreeable vibrations before they reach the baffle board. The American Felt Company has manufactured damper felts for fine pianos for over 70 years. Speaker head damping felts are made to your specifications and are cut to any size or shape.—*Electronics, Sept., 1930.*

✦

Microphone equipment

MILES REPRODUCING COMPANY, 45 West Seventh St., New York City, are manufacturers of microphone and microphone stands. Their type M-1000 consists of a two-button type of 100 ohms resistance on each side. The diaphragm is made of a special composition of metal, the center of which is gold plated. It is claimed the frequency response curve is uniformly flat from 30 cycles to 7,000 cycles. Ten milliamperes can be safely used on each button without damage to the microphone. — *Electronics, Sept., 1930.*

✦

Constant speed motors

MOTORS designed especially for constant low shaft speed which eliminates intermediate gears or belts are manufactured by the Bodine Electric Company, 2250 West Ohio Street, Chicago, Ill. The type SAR and SDR are available in 1/30, 1/20 and 1/12 hp. and are suitable for turntable drive, projection machines, etc. The motors are equipped with bronze bearings and all end thrust strain is absorbed by ball thrust bearings at each end of the motor shaft. The worm gear speed reducer is mounted in a carefully machined grease-tight housing. — *Electronics, Sept., 1930.*

✦

Condensers of high capacity

AMONG the several new types of condensers introduced by A. M. Flechtheim and Co., Inc., of 136 Liberty St., New York City, is type HS. This new condenser is noted for its small physical size and high working voltage, the condenser having a rating of 1,000 volt d.c., or 660 rms. rectified a.c.

Features of this new condenser are such that it fulfills a need in aircraft receivers and transmitters and in portable radio outfits. The Flechtheim Company also announces a new 5,000 volt d.c. (3,300 rms. RAC) transmitting condenser. The 1930-1931 Flechtheim fall catalog is now available and will be gladly furnished on request.—*Electronics, Sept., 1930.*

Type 210 tube

THE Triad Manufacturing Co of Pawtucket, R. I., manufactu Triad radio tubes, announces type 210 power amplifier and os having unique and improved f It has heretofore been the practice among most tube m turers to make the 210 tube witl coated filament and nickel plate new Triad 210 power tube thoriated tungsten filament in c tion with molybdenum plates presents an ideal combination cially when the tube is used oscillator. Life tests already co with the new Triad 210 tube steady maintenance of charac beyond a period of 1,500 hours oscillating load of 60 milliam *Electronics, Sept., 1930.*

✦

Applications of synthetic ceramics

TO THE extrusion method of any desired cross-sectional form tinuous lengths, there is now a exceedingly accurate cutting or technique for the production thetic ceramic or crolite piece cording to Henry L. Crowley, P of Henry L. Crowley & Co. Orange, N. J., it is now possibl very thin pieces, thereby making sible to apply crolite economi many new purposes. The comb trusion and cutting process m low cost. Pieces as thin as 1/(inch may be cut. Among the im applications of the new cutting te is the making of crolite spacers and -24 a.c. tubes, providing a and satisfactory insulator.—*Ele Sept., 1930.*

An improved pre-selector circuit for radio receivers

[*Continued from Page 281*]

The essential features of this preselector are shown in Fig. 6. The difference of the quantities B^2 and R^2 is nearly constant over the broadcast range: the band width is nearly constant, and has the chosen value of 10 kilocycles. This circuit has greater attenuation for signals, more than 5 kilocycles from the desired carrier wave than two tuned circuits separated by one amplifier tube, and has the additional advantage that all the selection occurs before any amplification has been performed on the signal. The principal advantages of this circuit then are that the transmission characteristic is rectangular in form; the selectivity characteristic is very nearly uniform throughout the broadcast range; and interference of the kind described at the beginning of this article is almost completely eliminated, even when the receiver is used under the worst of existing broadcast conditions.

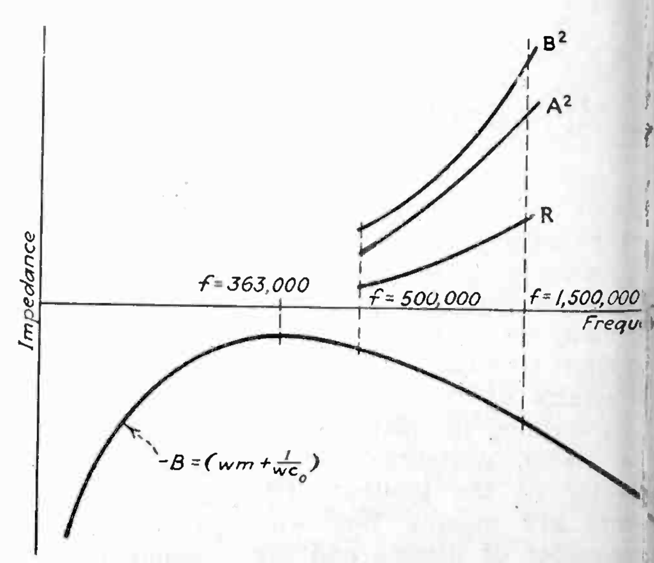


Fig. 6—Characteristics of the new pre-selector circuit

PATENTS

N THE FIELD OF ELECTRONICS

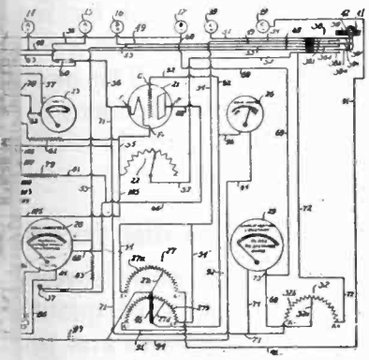
A list of patents (up to Aug. 26) granted by the United States Patent Office, chosen by the editors of *Electronics* for their interest to workers in the fields of the radio, visio, audio and industrial applications of the vacuum tube

n Tube Manufacture and Testing

vapor tube. A tube having , a grid and two cathodes, h consists of liquid mercury cond of which comprises a on emissive material extend- h and above the primary Ernst Lubcke, assigned to Halske, Berlin, Germany. 17.

coating process. A process a body with tungsten. A ine tungstate is electrolized t density which is lower than peres per square centimeter surface, the body to be coated athode, and the temperature 900 deg. C. J. A. M. Van ssigned to N. V. Philips, n Fabrieken, Eindhoven, s. No. 1,771,974.

ype tube. A hollow cathode, everal filaments to be ener- a polyphase source of cur- Bethenode, Paris, France. 04.

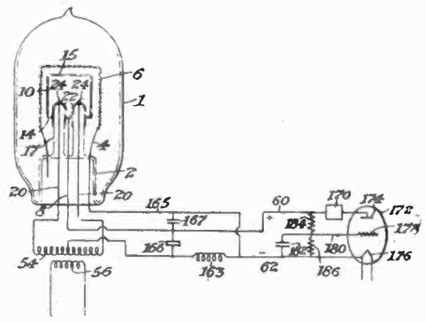


sting equipment. A patent aims, involving the testing of means of apparatus arranged ne grid potential and thereby e mutual conductance and a varying plate potential to in- e resistance, etc., all contained binet. J. H. Miller, assigned Electric Instrument Company, No. 1,771,504.

eneration, detection, rectification, etc.

ng system. Converting elec- es into audible signals by am- he waves sufficiently to pro- nonics, filtering the harmonics converting the amplified waves nd vibrations. Julius Wein- ssigned to RCA. No. 1,772,374.

ting current rectifier. A sys- hunting across a rectifier tube y of the order of one micro- store in it inductive impulses lace in the secondary winding ansformer, so that the voltage ne cathode does not increase so much that a discharge in the wrong direction can take place. P. W. Dobben, assigned to N. V. Philips, Eindhoven, Holland. No. 1,772,133.



Rectifier and voltage regulator. Two patents granted to T. E. Foulke and assigned to General Electric Vapor Lamp Company, Hoboken, N. J., dealing with a combination of a gaseous rectifier and a voltage regulator in a single envelope. Nos. 1,772,562 and 1,772,603.

Oscillation generator. An oscillation circuit tuned to a high frequency and the anode-cathode circuit of a three-element electron discharge device, to which is coupled a source of sharply-peaked relatively slowly alternating energy. The oscillation circuit is periodically charged, causing it to oscillate at its natural rate. Georg Von Arco, assigned to Gesellschaft für Drahtlose Telegraphie, Berlin, Germany. No. 1,773,556.

Condenser plate. Each plate is provided with an integral peripheral spacing flange, perpendicular to the plate, and abutting the adjacent plate, while a flat bar attached to the flanges maintains the plates in fixed relations. W. F. Dester. No. 1,773,574.

Radio Circuits

Multiplex signalling. Waves of different frequencies adapted to radio transmission, are modulated at different points on the earth's surface. These several modulated waves are received at a point different from that of ultimate reception, but at a short distance from it, and are used to modulate another frequency, which is finally received at the ultimate reception point. Here the several messages are translated. E. F. W. Alexanderson, assigned to R.C.A. No. 1,771,700.

Screen grid amplifier. Inter-stage transformer between screen grid tubes has as many turns on the primary as on the secondary, so that the combined capacity and magnetic coupling between the two windings gives a uniform voltage amplification over the desired frequency range. Burke Bradbury, assigned to G. E. Company. No. 1,771,913.

Radio frequency amplifier. One transformer between tubes has a primary winding, the resonant frequency of which is below the lowest frequency to be received, and the primary winding of another transformer has a frequency which is higher than the highest frequency to be received. Burke Bradbury and H. E. Roys, assigned to the G. E. Company. No. 1,771,914.

Multiplex broadcast system. A series of patents granted to E. R. Taylor and O. B. Hanson, assigned to A. T. & T. Company, involving inter-connecting several studios with several transmitters, etc. No. 1,772,165 to No. 1,772,168, inclusive.

Radio receiver. A regenerative circuit for receiving radio signals filed in 1923. Samuel Seaman Jones, assigned to Kellogg Switchboard & Supply Co. No. 1,772,607.

Selective radio receiver. A system for using a quartz crystal in a radio circuit and a means of controlling the bias voltage on the grid of a detector in response to, and to offset, variations of the carrier intensity. Russell F. Ohl, assigned to A. T. & T. Co. No. 1,772,517.

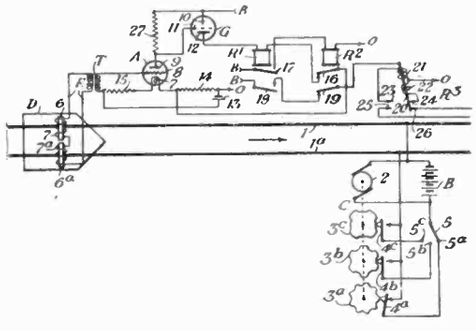
Radio transmitter. An oscillating and modulating system, H. C. Forbes, assigned to Zenith Radio Corpn. No. 1,772,077.

Antenna system. A plurality of antenna sections and couplings, the couplings serving also to intercept electro-magnetic impulses. Samuel W. Dean, assigned to A. T. & T. Co. No. 1,773,097.

Radio amplification. Independent transformer systems are created, each responsive to different frequencies. The output circuit of the final tubes is responsive to the integral effects of all of preceding tubes. L. C. F. Horle. No. 1,773,185.

Radio receiver. Two or more radio-goniometers are combined with a pair of frame aerials, and supply a receiving circuit. C. S. Franklin and B. J. Witt, assigned to Radio Corporation of America. No. 1,773,354.

Electronic Tube Applications



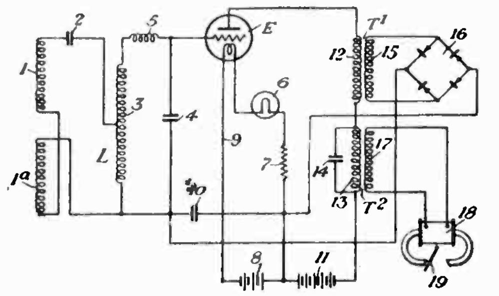
Railway traffic control. Direct current is periodically supplied to a track-rail, the train carries a vacuum tube receiving circuit system in which an amplifier tube is coupled by resistance to a following tube which operates a relay controlling the train. L. L. Nettleton, assigned to the Union Switch & Signal Company. No. 1,772,781.

Atomizing device. Using a two-element rectifier tube in combination with an internal combustion engine to produce desired ionization. E. H. Hamilton, assigned to E. T. Wagner and Wm. M. Malisoff, New York, N. Y. No. 1,771,626.

Photo-electric lamp tester. Determining the rating of electric lamps by exposing each lamp to a pair of photo-electric cells of different frequency sensi-

tivity characteristics. N. R. Campbell and C. G. Eden, Watford, England. Assigned to G. E. Co. No. 1,771,915.

Recording and reproducing pictures. Recording by means of a magnetic member, photo-electric cells, amplifiers, etc. Boris Ritcheouloff, London, England. No. 1,771,820.



Train control apparatus. Vacuum tube circuit to be carried by a train capable of picking up electrical energy from the trackway and thereby controlling the train. G. W. Baughman, assigned to the Union Switch & Signal Co. No. 1,772,796.

Modulation arrangement. A system of conductors which are in series with respect to the controlling terms, and in parallel with the set to be controlled, and a means for preventing a flow of controlling current in the path of the controlled current. Mendel Osnos, Berlin, Germany. Assigned to Gesellschaft für Drahtlose Telegraphie. No. 1,772,841.

High current filter. A combination of a large capacity source of invariable potential and a small capacity source of variable potential, to protect the large capacity source from destructive current in a high current filter. E. G. Gage, assigned to Radio Patents Corp., New York, N. Y. No. 1,772,541.

Vacuum-tube circuits. By means of series resistance, the inductance effective in the control circuit can be varied, together with the voltage impressed upon the electrical discharge device. E. R. Stoeckle. No. 1,773,503.

Miscellaneous Applications

Electro-optical transmission. A method of producing an image of a picture or object at a distance by the usual scanning devices, vacuum tube amplifiers, etc. A minimum carrier current represents an intermediate light value at the transmitter, and shifting the phase of the current takes place when the light passes through the intermediate value. R. K. Potter, assigned to A. T. & T. Co. No. 1,772,519.

Echo suppressor. A series of patents, Nos. 1,772,550 to 1,772,552, inclusive, granted to Doren Mitchell, H. C. Silent and Joseph Herman, and assigned to the A. T. & T. Co. The purpose of these circuits is to suppress echoes occurring in a two-way transmission circuit.

Telephone transmission. comprising selecting a porti by predominating frequencies, this to shift the message band termined position. H. A. Af to A. T. & T. Co. No. 1,773,

Television scanner. An o with a helical series of apert tated about the lamp, in fron jection window. J. F. ar Ballard. No. 1,773,161.

Loud speaker. Diaphragm two concentric connected members formed of differer and having portions which d lap. Wilfred and Penningt No. 1,773,605.

High-frequency communic tem. The various stations a to operate at frequencies cor to the calling frequency in r a non-selective operation of party. Stanley A. Clark, a General Electric Company. N

Resistance paint. Finel graphite and a binder of met phate in phosphoric acid, usabl thin coating. Lester L. J Schmidt, and Joseph Jones, Technidyne Corporation. No.

Carrier telegraph. Includes in receiving channel responsi frequency impulses, for disabl ing apparatus. Robert H. signed to A. T. & T. Co. No

Electro-optical system. An generator, light-source and tive element. Frederick W. assigned to A. T. & T. Co. N

Ground noise in sound pictures

[*Continued from page 275*]

the next octave there is much less energy. This is explained by the fact that the reproducers normally used for theatre operation do not reproduce frequencies above 5,000 cycles, so that actually only a small portion of the seventh octave is represented in these measurements.

It now becomes interesting to discover the relation between these energy measurements and the amount of annoyance caused by these various groups of frequencies. Figure 4 repeats the energy measurements (shown dotted) but also shows the results of measurements made with the same record and measuring through the same band-pass filters, using a noise measuring set instead of a volume indicator. It will be observed that the low frequencies are relatively less important than the higher frequencies up to the seventh octave but that for the next octave higher, the condition is reversed. This is undoubtedly explained by the fact that the sensitivity of the human ear reaches a maximum in the neighborhood of two to four thousand cycles and begins to fall off above this range.

In the theatre, exactly similar mechanical problems are involved in the machinery used to reproduce the sounds from the record. The fact that there are many theatres for which to provide equipment makes cost an important factor, and consequently the machinery provided for theatre use is more subject to mechanical difficulties than that employed in the studio. Moreover, it is difficult to provide satisfactory foundations in most projection rooms, and building vibrations are often severe. As an indication of the importance of this type of noise, Fig. 5 gives the annoyance factors for mechanical vibrations from sample theatre equipments of two different makes designated A and B. The corresponding total annoyance for a typical disk recording properly installed in a studio is more than 20

These measurements were obtained by m reproducer on the turntable itself, in such a wa reproducer rotated with the record. The moti needle was then due to the radial component of cal vibration which is the only part in whic interested.

Reduction of noise level in disc recor

Most of the sources of ground noise cover recording may be reduced to negligible quant proper choice of materials and methods and pr trol of conditions.

Our attention must then be directed toward ing the remaining noises. Since Fig. 4 indi average surface noise is composed of more quencies than low, some opportunity is afford duce this noise by lowering the efficiency of t equipment in the high frequency range, prov this does not impair the quality of the desire To avoid this impairment the recording syster arranged to have an increased efficiency at the quency end by a corresponding amount, the being to lower the amount of surface noise he theatre without changing the character of th sounds.

In disk recording, there is practically no ground noise with changes in level of the sounds. For this reason, it is important that mum level of useful sounds should be maintai times, thereby keeping the ground noise at a low level. The principal limitation in this resp when too high a level is applied to the cutter, o may cut into the next and the needle will

[*To be continued in a following issue of Electr*