electronics

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Fairchild Aerial Surveys, Inc

McGRAW-HILL PUBLISHING COMPANY, INC.

Price 35 Cents

JANUARY 1932

Electronics, January, 1932. Vol. 4, No. 1. Published monthly. McGraw-Hill Publishing Company, Inc., 330 West 42d Street, New York, N. Y. $3.00 per year, 35 cents a copy. Foreign Postage, $4. U. S. Currency, or 20 shillings. Canada (including Canadian duty), $3.50. Entered as second-class matter April 4, 1930, at the Post Office at New York, N. Y., under the Act of March 3, 1879.

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McGRAW-HILL PUBLISHING COMPANY, INC.

New York, January, 1932

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

The balance sheet

On the pages that follow, the editors of *Electronics* have sketched the picture of the electronic and radio arts as they exist today. The outlook we find encouraging. In fact, if an accountant were to summarize the situation, he might, somewhat as follows, draw up "the electronic balance sheet" as of January, 1932:

Liabilities: Radio overproduction, engineer unemployment, financing delays, idle factory capacity

Assets: New inventions, lower manufacturing costs, new tube uses for 200,000 plants, a million places for "electric eyes," increasing public-address demand, a 300,000-car auto-radio market, and new opportunities for radio, home-talkies, television, etc., in 19,000,000 homes

COMPLETING TELEVISION ANTENNA ON EMPIRE STATE TOWER, 1,250 FT. ABOVE SIDEWALK

Early in 1932, television signals on a 4-meter wavelength will be broadcast over the densely populated New York City area (see cover) from the tip of the airship mooring mast of the world's tallest structure, the Empire State Building. It is expected to serve only an area within 15 to 25 miles of the tower, as the waves are limited to visible distances, but even so, a ready-made audience of ten millions will be reached.

Great secrecy has been maintained concerning the new television transmitter, but it is understood that the 2.5-kw. television unit will be of the arc-scanning type, covering 120 lines and 24 frames per second. From the glass-enclosed studio a "stove-pipe" shielded transmission line carries the short-wave impulses 300 ft. aloft to the antenna at the peak.

RADIO—BROADCASTING—

IN BROADCASTING, 1931 was marked by extraordinary prosperity among the stations, and great increases in station valuations. A 500-watt station sold for $900,000 during the year, and 5-kw. stations were held as high as $7,000,000. Increasing expenditures for programs reflect this "boom" condition. In 1931, $35,000,000 was spent for talent alone; in 1932 this sum will be increased to $40,000,000.

Synchronizing of 50-kw. stations operating on the same channel as close together as WEAF, New York and WTIC, Hartford, Conn.,—also WJZ, Bound Brook, N. J., and WBAL, Baltimore, offered the most promising technical possibilities for future extension of broadcasting by eventually grouping chain transmitters on a limited number of channels. Great credit belongs to Charles W. Horn, general engineer, National Broadcasting Company, for carrying out this work. Some public criticism has followed these experiments culminating in a public hearing before the Radio Commission next month, claim being made that the service of existing stations is injured by synchronized operation.

Much public misunderstanding of synchronizing results has been caused by the extraordinary "selective fading" experienced everywhere in the nation throughout 1931 and the present winter, at short distances from broadcasting stations. This fading and "mutilation" has been suffered within 25 miles of important stations. It is due to the excessive reflection of the sky-wave, which pours down in such strength as sometimes to destroy the direct wave completely during night broadcasting. Since this condition of the Heaviside reflecting layer is attributable to the present small number of sunspots, and since the present sunspot minimum will continue another year, no improvement in this regard can be looked for during 1932.

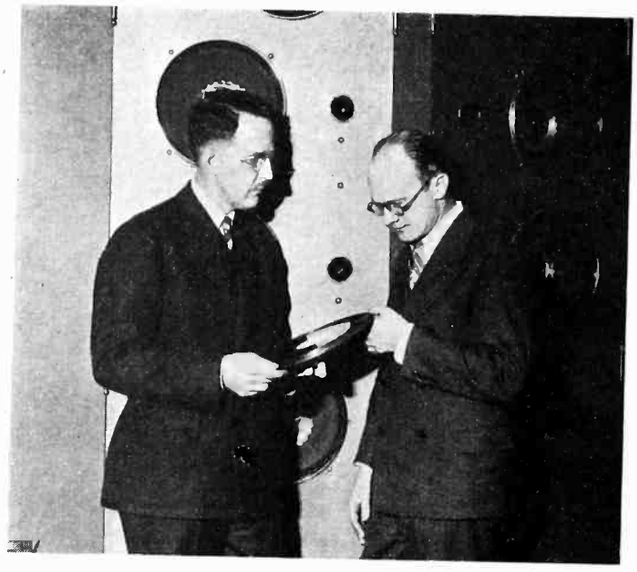
High modulation of broadcast transmitters required by the Commission has proven not an unmixed blessing. Stations having high modulation are being found to cause serious receiver trouble. Despite the widened interference range that will result, it is likely that lower modulation percentages may shortly be called for, opening the way to higher station powers on clear channels.

In microphones, two marked advances were the electrodynamic pickup with which the Philadelphia Philharmonic Orchestra has been broadcast, and the "beam microphone" or parabolic reflector device, adapted from the Hollywood "talkies," and used in the Metropolitan Opera broadcasts, and in the experiments on the floor of the United States Senate.

After revolutionizing Hollywood's talkies, the parabolic-reflector microphone picks-up opera, is tested out against senatorial oratory

The first "0.6-wave" or half-wave antenna tower is now functioning successfully at the New York transmitter of WABC, key station of the Columbia Broadcasting System, erected under direction of E. K. Cohan, technical director.

Greater clearness of transmission and increased number of international broadcasts has also added new interest for the listening audience.



Dr. H. A. Fredericks demonstrates for Deems Taylor new long-playing, high-quality records developed by the Bell Telephone Laboratories for use in electrical transcriptions

✦

Radio and television advance

TELEVISION does anything but stand still. Interest centers around what is happening in the Empire State Building in New York, in the RCA-Victor laboratories in Camden, in the Philco Laboratories, in Chicago where Majestic engineers are reported to be burning midnight oil, and in California where Dr. deForest is said to have a new system too expensive for home reception but of importance to theaters.

Dealers or radio manufacturers who look to television to pull them out of the red in 1932 had better look elsewhere for their profits according to those close to what is actually going on. The Federal Radio Commission, admitting that progress has been made in 1931, does not seem inclined to open the television bands to

TELEVISION IN 1932

paid broadcasting until still more progress has been made. Television in 1932 will remain in the realm of experiment. But early in that year demonstrations will be made in a wave-length region utterly unknown to the American public by means of a tube (cathode ray) unheard of by 99 per cent of the lay listeners and using a circuit so little known that it will be called new. At last the super-regenerator, the master invention of Major Armstrong, seems to be coming into its own.

In the Empire State building, reports have it that tons of equipment have been assembled into two transmitters, one for voice and one for television. The latter will use, temporarily at least, mechanical scanning 120 lines, 24 frames (later in 1932 180 and then 240 lines). These transmitters are in the 4–5 meter band.

Engineers who claim to have seen reception from this station are pleased with the apparent brightness of the image, with the apparent detail (two or three figures) and are surprised at the interest-holding ability of synchronized sight and sound (it is said they saw a musical comedy). Within six months a two-foot picture is expected with a million-cycle sideband required. The output of these transmitters is about 2.5 kilowatts, sufficient to get good signals out some 15 miles from the transmitter.

The year will undoubtedly see demonstrations of this television system given to prominent set manufacturers, perhaps to the press. Several hundred sets may be built receiving simultaneously on two channels and having cathode-ray scanning and viewing, and put into operation around New York City. It is extremely doubtful if any large scale sales can be possible before 1933.

Those close to the industry do not view the approaching television demonstrations with unanimous approval. Some believe that increasing public interest in television, stimulated by demonstrations of new systems will act as a deterrent to sales of radio receivers. Others feel that so long as engineers work in laboratories new things must be expected and prepared for.

Television is distinctly on the way, it does not look so hopeless, so costly as it did a year or so ago. Combined research by chemists, tube men, circuit engineers, and others is bringing results. "There is no fundamental obstacle to television" is the statement coming from an engineer close to the art.

New tubes

Going on the assumption that no year is a success without one or more new tubes it is interesting to speculate on what may happen in 1932. Undoubtedly the pentode type of r.f. tube will come into general use. Possibly some revamping of the 224 or 227 as to make them perform their detector-oscillator functions better will come about. The 235 will continue to be the r.f. tube. But the 280 in its large bulb, and with its high resistance seems doomed—if the present difficulties with mercury vapor tubes can be ironed out. Experimental tubes seen are in an S12 envelope, deliver 150 milliamperes, have a 2-volt, 3-ampere filament. The advantages of this type of rectifier are well known. Good regulation, low voltage drop, comparative freedom from line fluctuations, are cited. The smaller size would be welcome to midget manufacturers. Better regulation is desirable in a.v.c. sets and those using Class B amplifiers.

Other new tubes will be a complete line for ultra-short wave reception, a bigger and better pentode (although considerable power can be got out of the present pentodes, it is poor stuff, so engineers say, so full of harmonics, that the total output of undistorted music is actually less than obtainable from 245's.) A double-tube (see *Electronics,* December, 1931, page 216) is clamoring for attention. Its fate is still undecided.

Incidentally, tube prices to manufacturers after the most recent cut averaged less than 40 cents. If the annual sales of tubes amount to 40 million, the annual business is about $16 million. One company is reported to need at least 25 million output to break even and naturally wants to make and sell about 35 million. And there you are.

Improvements in fidelity

The use of permanent magnet speakers may be another step toward cheaper filter-rectifier systems. For a 1000-ohm speaker field one can substitute a 200-ohm choke with equivalent filtering but with less loss of voltage and regulation. On the other hand, no manufacturer has seen fit to substitute a 40-cent choke for the present speaker field in his filter to get the better regulation. After all, some argue, there would be a saving of only a few turns of wire on the transformer and what is that, with the present price of copper?

There will be some increase in the use of two speakers,

Television will benefit by Senator Marconi's research into ultra-short waves. Thirty years after his epoch-making transatlantic experiment, he experiments in an unknown region of the ether

ADVANCES IN SOUND RECORDING—

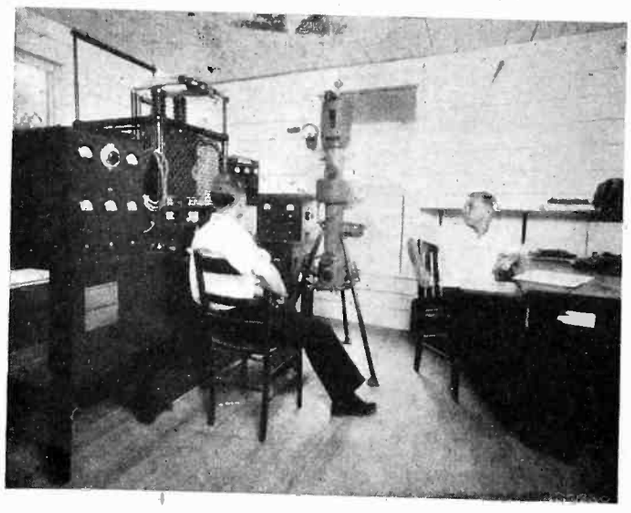
although it may be largely from the sales standpoint. The advantages of using the alliterative expression "double dynamic" in advertising will weigh heavily. With present receivers being down about 25 db. at 5,000 cycles (and nearly everybody turning the tone control so that all music sounds like a mid-African tribal dance) there seems little use in handing the public any 6,000-7,000 cycle notes. On the other hand, some engineers, who have heard the Bell Telephone Laboratories vertical cut records, claim the public has never heard good high frequency response and that a taste of really good music might change the clamor for bass. The local distance switch, made unnecessary by variable-mu tubes, may become a local-good quality, distance-bad quality switch.

There are certain advantages to two-speaker operation even if the speakers have nearly identical characteristics. To secure these advantages (better overload characteristic, apparent of pseudo binaural effect, etc.) more than a mere installation of two speakers is necessary. Engineering and design play their inevitable part.

Without a doubt there will be an honest attempt on the part of many manufacturers to produce at least one high quality model. Reports are that a $150 set with a three-foot baffle and everything else engineers have produced to date for high quality, is to appear under a very well known name. Time may prove that vast quantities of junk thrown upon people, overstimulated with low price bait, may not be a good investment.

Tuning aids, "push-push," diode detection

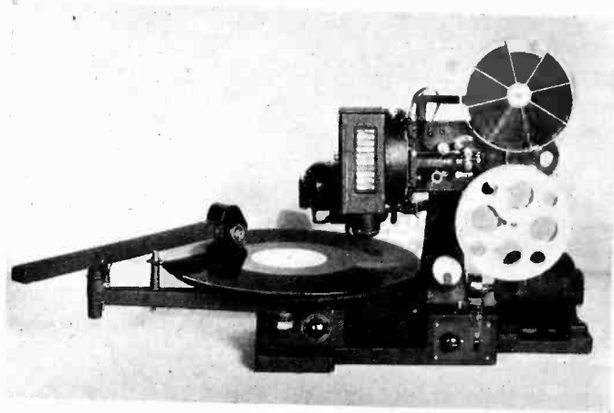
Increased use of tuning aids, gaseous and meter-type, will be in evidence. This will come about with the gradual spread of a.v.c. to cheaper sets made possible by engineering economies. There will be four tube sets, five tube sets at about $50 maximum price, seven tube sets and ten tube sets with a top price of about $100 (or less!) Combinations using the long playing records will cost the listener about $150. The chances are he will have to turn over his records manually. All sets will be supers. Class B amplifiers will become more common. Now used in battery sets to save battery power (electric power from batteries costs $12 per k.w.h.) the "push-push" system may become common in a.c. sets, although the benefit here is not so evident.



Electron tubes used in high-speed oscillograph permit recording of the most transient phenomena, even lightning flashes

Sound equipment developments, 1931-32

CONTINUED improvement in sound recording was noted during the past year with better technique employed in the operation of noiseless recording equipment. This improvement has extended to the better class of theaters where sound reproducing equipment has been properly adjusted to present the new film. The public's appreciation of sound-picture improvement durin the year as reflected in box-office receipts has unfortunately not been fully realized, due to the general economic situation.



Portable projector and sound reproducer for 16 mm. film developed by Western Electric

New developments of meters for measuring sound and noise intensities have contributed to the proper acoustical treatment of stages and theaters. Several companies, including Western-Electric, RCA Victor, and Burgess Laboratories, have developed reverberation meters for acoustical analysis work. This equipment has been a great boon to engineers in bettering auditorium acoustics.

Two new types of microphones were introduced in 1931: the ribbon microphone, as developed by RCA Photophone, and the dynamic microphone developed by the Bell Laboratories. The former, because of its directional characteristics, has found particular application in sound-picture work. The dynamic microphone represents a decided improvement over the condenser microphone heretofore used for broadcasting and sound picture recording.

The condenser microphone has an acoustical resonance in the cavity in front of the diaphragm, which causes a peak in frequency characteristic of approximately 6 db. around 3,000 cycles. The effect of this rise in output has been to accentuate certain frequencies in recording which gave an unnatural reproduction of this frequency. The better quality obtained with the moving coil loudspeakers, led to the design of the dynamic type of microphone using the same principle of construction. The

diaphragm in this microphone has a rigidly attached coil, in which the generated voltage is proportional to the velocity and acoustic impedance of the diaphragm. The sensitivity of this microphone is given as approximately 10 db. higher than the condenser type.

The parabolic microphone receivers introduced in the early part of 1931 in Hollywood, have met with continued success in the sound-picture and broadcasting field. Application of these parabolic reflectors to outdoor broadcasting pick-up, especially for football games, etc., has been very successful.

16 mm. sound equipment

The year 1931 started off with ten or more manufacturers having a line of 16 mm. film projectors with sound on accompanying disk. The problem of film distribution and cost to the ultimate consumer has not, however, been satisfactorily worked out, such as to create a large market for this equipment. Some progress in the establishment of film libraries is being made with better coordination promised among the various manufacturers. Sound-on-16 mm. film has not yet been commercially launched, although several public demonstrations of this apparatus have been made. The industry has been awaiting the 16 mm. equipment developed by RCA Victor, which is expected to be placed on the market early in 1932. Initial efforts in marketing RCA's equipment will probably be concentrated in the advertising and educational fields with introduction into the home looked into later. One other large manufacturer of radio equipment is expected to announce a new combination 16 mm. sound-on-film projector incorporated with a radio set in the early part of 1932. Just what progress may be expected during the year in the sub-standard film field will depend on the solution of the distribution problem, and the cost of film rental to the public.

Two new long-playing records were introduced in 1931. The 10- and 12-inch lateral cut record developed by RCA Victor have increased the usual playing time of records to 15 minutes. The new record is made of a new material called Vitrolac which is much lighter and stronger than the material previously used. The number of grooves cut per inch has been extended to 107, while the recording and reproducing speed of 33 1/3 r.p.m. is used instead of the usual 78 r.p.m.

Fundamental improvements in the method of recording, using an acetate base have been made by the Bell Laboratories in reverting to the first method used by Edison. The principal improvement in these records comes from a marked increase in the volume and frequency range. A high volume level can be recorded for the same groove spacing and speed. The number of grooves cut per inch has been practically doubled.

Improvements made in the methods of processing the stampers and in the record material, give a large reduction in ground noise and hence a corresponding increase in the volume range. The frequency range has been extended to 10,000 cycles and the volume range increased to 50 decibels. The acetate base used for this record is transparent and possesses an almost unlimited life.

The recording and reproducing speed is retained at 33 1/3 r.p.m. as used in present sound-picture practice. At present the new "hill and dale" or vertical cut record is being adapted to electrical transcription work in the broadcasting field. It is not known to what extent commercial promotion of these records will be attempted in the home phonograph field. It is understood that the original licensees of Western Electric in the phonograph field have licenses to make records under the new process.

[*Please turn to page 38*]

Thermionic tubes in industry

In the application of thermionic tubes to control purposes, the past year has recorded gratifying progress. Steel mills, sheet plants, wire mills, rubber factories, paper machines, chemical processes, and many other industrial operations are making wider use of tubes.

Elevators are leveled by three-element tubes, railroad signals are tube operated, and automatic "train-stop" apparatus is actuated by thermionic apparatus that also shows distant signal settings directly in the locomotive cab. During the year a large number of corner traffic lights using tube-and-condenser timing elements have been installed to speed up travel at intersections.

Light control by thermionic devices on an increasingly grander and grander scale, was applied in theaters, auditoriums, ball-rooms, flood lighting, swimming pools, ornamental fountains, waterfalls, etc. Such apparatus sells for from $5,000 to $30,000 per theater, or large installation. The 3,000-seat Chicago Civic Opera House

[*Please turn to page 38*]

Through thyratron tubes, the fifty lighting circuits in the new Earl Carroll Theater, New York City, are controlled from this keyboard

Photoelectric cells in precision inspection work

By W. J. TIETZ and C. PAULSON
Western Electric Company
Hawthorne Works

Fig. 1—Photoelectric-optical apparatus for capacity measurements

IN the manufacture of a product such as the telephone and its associated equipment, it is absolutely essential that the various component parts meet certain requirements in order to insure satisfactory operation and uniformity. These requirements often specify such close limits that precision methods must be employed in the inspection processes.

Early consideration was given to the possible application of the photoelectric cell for this type of work. It was soon apparent that the most advantageous use of light-sensitive devices for inspection purposes would be in their application to the task of reading deflection-type measuring instruments. It was evident also, from the very first, that such applications would readily lend themselves to automatic testing and inspecting operations.

From the electrical standpoint, a condenser to be satisfactory must have, among other qualities, the correct capacity within certain prescribed maximum and minimum limits, and possess a high insulation resistance. Both capacity and insulation resistance tests lend themselves to application of photoelectric-cell methods as hereinafter illustrated.

Figure 1 shows the assembly of an optical system to a standard make of capacity meter arranged to check condensers to determine whether they are within their specified tolerances. In this construction the usual scale has been replaced by a metallic plate which is provided with a narrow slit at a position corresponding to half scale deflection. The photoelectric cell is mounted directly below the slit.

The optical system referred to above consists of a group of lenses and an aperature arranged so as to focus a sharp outline of the filament of the associated electrical lamp through the meter slit, when it is not covered by the meter pointer, onto the photoelectric cell mounted below. The use of a prism allows the optical system to be made compact.

In the design of the meter for use in checking condensers for their maximum capacity requirement, a stop is arranged so that the movement of the indicator hand is restricted to the lower half of the scale. Under this condition the indicator hand is free to move between zero as a minimum and the stop as a maximum. In the latter position the slit is covered by the pointer.

In practice, with the beam of light from the optical system directed on the slit and with the proper alternating current potential applied to the meter, the condenser to be tested is connected, through a contact making jig, to the test terminals of the meter. Should the capacity of the condenser under test exceed the maximum permissible the indicator will move upward until it reaches the stop at which position it covers the slit, thus intercepting the light falling upon the photoelectric cell. Through the action of the photoelectric cell and its associated cold-cathode grid-glow amplifier, the eject mechanism of the testing machine causes this condenser to be rejected. However, should the capacity of this condenser be below the maximum permissible, the indicator will not move upward a sufficient distance to cover the slit and therefore the eject mechanism is not called into action and condenser is accepted as having passed this requirement.

In the case of the minimum capacity test a separate but similar arrangement is utilized to assure that no condenser below the specified value is allowed to pass inspection as being satisfactory.

In order that a given position of the meter indicator suffice for all values of capacity within the range of the meter, an effect equivalent to shifting the scale relative to the indicating pointer must be obtained. This is accomplished by shunting the moving element of the meter with a variable resistance which is calibrated so as

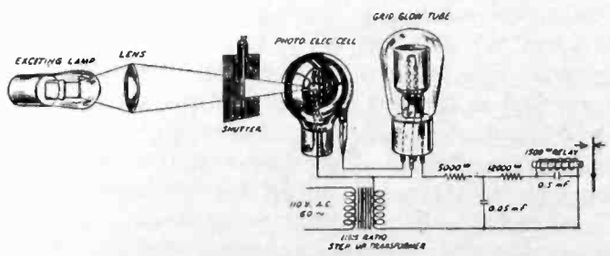


Fig. 2—Grid-glow tube amplifier for automatically rejecting condensers

to give a definite step for each of the capacity values which the machine is designed to handle.

The amplifier used to step up the photoelectric currents to a sufficient magnitude to operate a relay is of the a.c. operated grid-glow tube type. The circuit of this amplifier is shown schematically in Fig. 2, together with its associated light source, shutter and photoelectric cell.

This circuit utilizes the property of the grid glow tube to rectify alternating currents. Obviously the photoelectric cell used in a circuit of this type must be capable of withstanding the rather high potential to which it is subjected. This arrangement is highly sensitive, positive, very rapid in action and quite inexpensive to construct. Figure 3 shows a photograph of a completed amplifier of the type just described.

The automatic machine designed to completely test condensers incorporates three applications of the photoelectric cell and is capable of testing this product at the rate of 1,600 per hour. This output as well as the automatic testing itself is made possible only through the use of light sensitive devices and their associated amplifiers.

Many kinds of equipment used in the telephone system, as for example cable terminals and drop wire, are required to have an insulation resistance so high that it can be measured conveniently only with a reflecting type galvanometer.

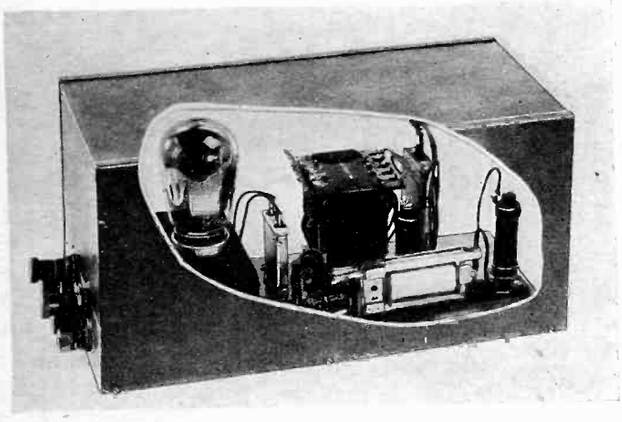


Fig. 3—Assembly of photoelectric cell, grid-glow tube and amplifier

In order to adapt this type of inspection equipment to automatic inspecting, nothing short of a light sensitive device can be used. Figure 5 shows the galvanometer, lamp, scale and photoelectric cell assembly employed for such work. Figure 6 shows more specifically in schematic form the details of the optical system used.

With this system of measurement the deflection of the galvanometer is inversely proportional to the resistance being measured. In view of this, in setting up the equipment for testing, it is merely necessary to determine what deflection of the galvanometer is the maximum which can be tolerated and still guarantee an insulation resistance above the minimum limit and then provide a means of either permitting light to fall upon a photoelectric cell, if this deflection is exceeded, or arrange to interrupt the light should the maximum permissible deflection be exceeded. The latter method was adopted and is shown incorporated in the design illustrated in Figs. 5 and 6.

It will be noted in the above figures that the reflecting mirror is composed of a straight portion and curved portion. The purpose of this arrangement is to provide

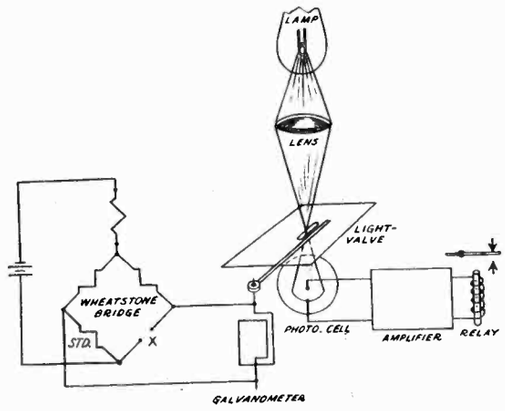


Fig. 4—Schematic of bridge, galvanometer and light valve

a means through the curved portion of the mirror of keeping the beam of light focused on the photoelectric cell at all times that the deflection is below the maximum permissible value and to provide a means through the straight portion of the mirror of allowing readings to be taken in the normal way or to check the calibration of the photoelectric cell set-up.

The combination of the straight and curved mirrors permits the use of a large deflection which may be made very sensitive over a selected, limited part of the range.

The inspection of drop wire for insulation resistance is illustrative of the condition where the limits of measurement are variable, being a function of temperature and the length of wire being tested, therefore provisions are made for readily changing the calibration of the photoelectric cell set-up as required. This is accomplished by providing a means for moving the photoelectric cell and its associated slot to the right or left thus shifting the location of the position at which the light focused on the photoelectric cell is cut off.

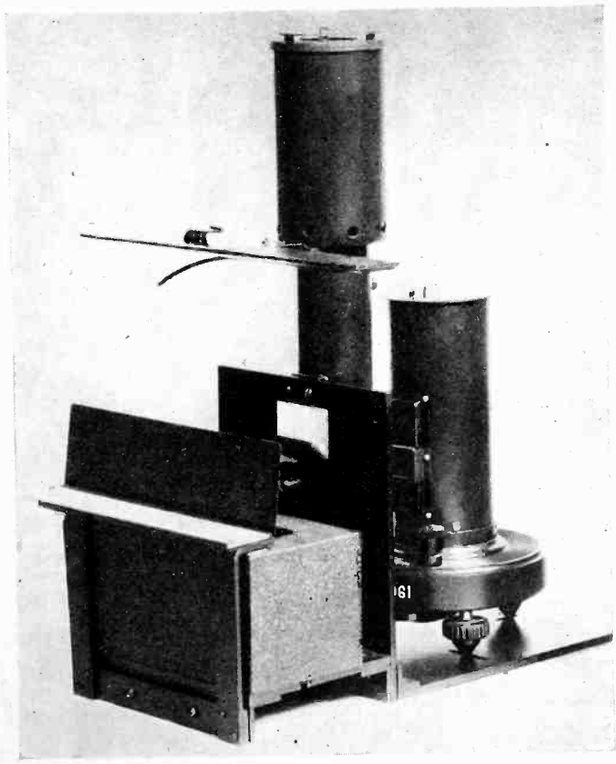


Fig. 5—Light-sensitive equipment assembled for automatic insulation testing

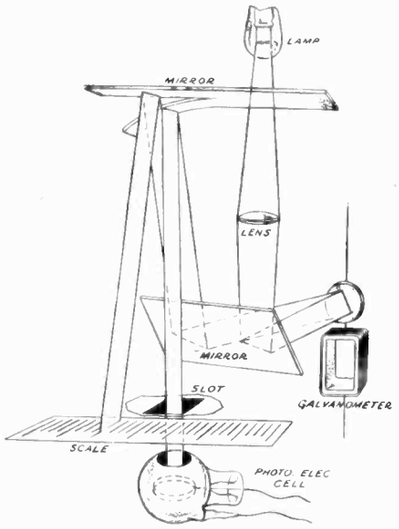


Fig. 6—Optical system for reflecting galvanometer and photocell

The methods employed for automatic or machine testing where resistances, which fall in the range of the ordinary wheatstone bridge, are encountered, is best illustrated by the design of the resistance units constructed for the inspection of heat coils. The heat coil is employed in telephone offices as a means of protecting delicate equipment from the effects of stray currents of considerable duration but of insufficient magnitude to blow the fuse ordinarily also found in the circuit. In order to insure that the heat coils will function properly in service they must be capable of passing a rigid inspection, one requirement of which calls for the resistance to be within given limits. Two separate tests are made, one to determine that the resistance does not exceed the maximum requirement and the second to determine that the resistance is not less than the minimum requirement.

Figure 7 shows a galvanometer, with its cover and optical system removed, arranged for photoelectric cell testing of the product for the high resistance limit. In practice the light from the lamp is focused through a suitable optical system upon the photoelectric cell mounted below a slit in the plate which replaces the scale of the galvanometer. The galvanometer and the associated wheatstone bridge are calibrated so that the insertion of a coil in the bridge circuit above the maximum permissable resistance will cause the pointer of the zero center galvanometer to deflect to the right thereby covering the slit and cutting off the beam of light focused on the photoelectric cell. This, through the medium of the grid glow tube amplifier, causes the necessary eject mechanism to function.

The automatic heat-coil testing machine which applies a number of mechanical tests in addition to the electrical tests described, is capable of testing the product at the rate of 3,600 coils per hour.

Broad uses for photocell

From the preceding discussion it has been shown that photoelectric cells can be applied to precision testing equipment and methods have been described whereby such cells can be utilized for automatically inspecting for such properties as capacity, insulation resistance, conductor resistance, etc. While the discussion has been limited to these items, it should not be thought that the use of the photoelectric cell in the manufacture of telephone apparatus and equipment is limited to the particular items mentioned or that the methods described are the only ones in use on a practical working basis.

The field of application for the electrical eye is fast increasing. Specific instances where this device can be

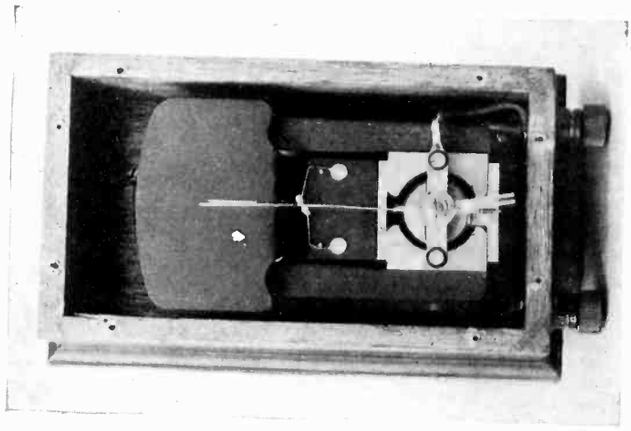


Fig. 7—Galvanometer arranged to be used with phototube in resistance tests

applied advantageously and profitably are constantly coming to attention.

Not only can it be applied in many instances instead of the human eye but this can often be done with a marked increase in speed and dependability.

Surely there can be no excuse now for continuing to subject the human eye to difficult, exacting and fatiguing tasks.

▼ ▼ ▼

THE "ELECTRIC EYE" NEITHER SLEEPS NOR WINKS

The phototube has great advantages in the meaner services of seeing. We need to sleep and we repeatedly wink, and thus miss something. But the phototube neither sleeps nor winks. Moreover, it may be made much more accurate and sensitive than the eye of man. And it measures light too feeble to be visible to us. Moreover, it "sees" in ranges or what we call "color" entirely outside our human range.

DR. WILLIS R. WHITNEY,
Director of Research Laboratory
General Electric Company

Effects on reception of over-modulation

By C. E. KILGOUR
Chief Research Engineer
Crosley Radio Corporation

THE recently initiated move to consider broadcast transmission and reception as two units of a single system so that the best overall results may be obtained is to be greatly commended. However, it is hard to see how receiver designers can do anything worth while to correct one very frequent and serious transmission defect, that of over-modulation.

We all know that broadcast engineers, realizing the importance of deep modulation as an aid to effective transmission, have designed or redesigned their apparatus in the past few years so that 100 per cent modulation may be attained. In some cases it is suspected that the increased power has been provided without taking precautions to insure that this deep modulation can be obtained without distortion. In addition, trouble arises due to the fact that when an average heavy modulation is maintained, peaks of the audio signal over-modulate the carrier. Considering the extremely erratic nature of the microphone current, it is difficult to see how this can be avoided as long as the operator maintains a high level of modulation on the average and the required power is available in the modulators.

From the listener's point of view, over-modulation produces two undesired results; audio distortion and interference on nearby channels, both of which may be attributed to the same cause. We will assume that the modulation characteristic is a straight line as shown in Fig. 1, although even an approximate approach to such an ideal condition is difficult to obtain. If the ordinate at point *a* represents the carrier strength without modulation, it is evident that the peak swing of the modulation may extend from *b* to *b'* producing a 100 per cent effect without distortion. In the case of harmonic modulation one cycle of the upper half of the carrier envelope would then appear as curve B in Fig. 2. However, with the same type of modulation, it is evident that should the voltage swing from *c'* to *c''* (Fig. 1) that the carrier envelope is no longer sinusoidal in form but has a flat bottom portion somewhat as shown in curve C, Fig. 2.

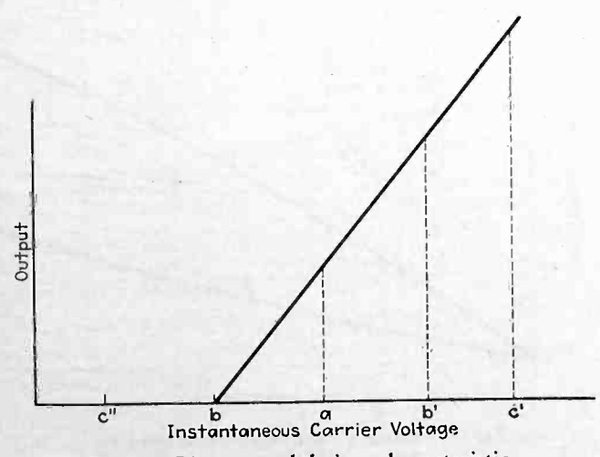


Fig. 1—Linear modulation characteristic

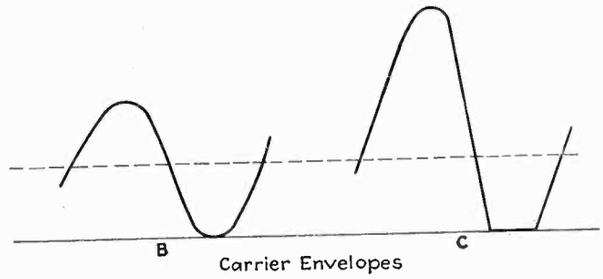


Fig. 2—Effect on carrier envelope of over-modulation

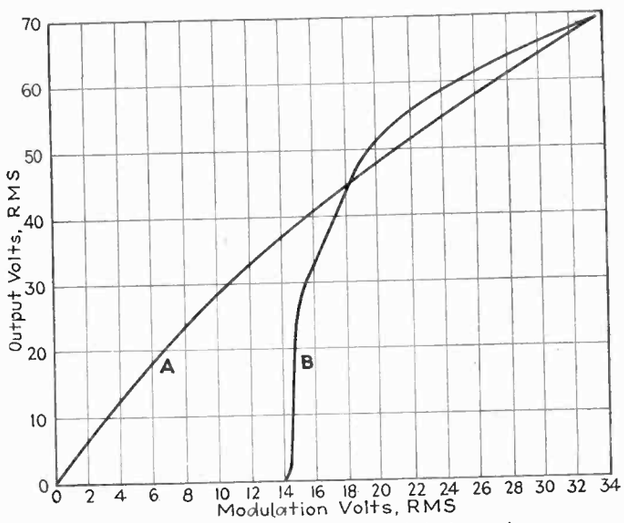


Fig. 3—Output versus modulation of modern superheterodyne

A voltage represented by such a trace may be considered as composed of the fundamental modulation frequency plus a series of even harmonics, and, considered from any angle, modulation of this type must mean interference over a band width much wider than that required to transmit undistorted modulation.

With superheterodyne receivers with very high selectivity a peculiar effect is noticed. Normally it might be possible to receive a distant station without interference from a local one, although the two were operating on nearby channels, except when occasional distorted bursts of the local station would break through the distant program. Listening tests pointed to the fact that this interference occurred only on the modulation peaks of transmitters known to employ so called 100 per cent modulation. In one instance, a certain station joined the offender's ranks on the same day that a considerably advertised boost in modulation was made effective.

[*Please turn to page 36*]

Automobile radio problems face solution in 1932

DESPITE a number of discouraging factors, sales of automobile radios in 1931 will total over 100,000, a small figure compared to the total set sales for the year—approximately 3,000,000—but which nevertheless is a significant number. Added to general business uncertainty was the opinion often and publicly expressed that automobiles were no places for radio sets, that the driver should suffer no further attention diversion, etc., etc. There were technical difficulties, costs and troubles of installation were considerable, battery upkeep nothing to be taken lightly. Radio dealers did not have the requisite knowledge of automobile mechanics and electrical equipment. Automobile dealers knew too little about radio apparatus. All in all the year will go down as a year of experiment in which neither manufacturer nor distributor made much money but in which everyone concerned learned a great deal.

What will happen in 1932 will be another story. The experimental stage is largely over. Increasing public interest in automobile radio is forcing automobile and radio people to get together to solve their problems jointly. *Electronics* has interviewed the major automobile manufacturers within the past month, often sitting in on conferences while automotive engineers and executives discussed their plans and problems. As a result it is in position to report what the picture looks like at the beginning of the new year.

Automotive industry still uncertain

Prominent automobile manufacturers mentioned as considering installation of radios as initial equipment either openly refuse to admit the truth of such reports or are non-committal. The truth is the automotive people do not know what they are going to do. It is certain they will make some play to the radio business, even if only to the extent of equipping cars with antennas or providing space under the cowl for the set. Up to January 1 no large-scale producer of automobiles had announced a model in which radios would be part of the initial equipment.

Radio manufacturers hope, individually, to line up some well known automobile maker to use their particular radio as initial equipment and failing that to make a profit in automobile radio in any other way possible. Dealers of both cars and sets wonder where they fit into the 1932 picture having performed their share of experiment in the past year, usually without any profit.

The requirements for a compact, rugged, extremely sensitive and inexpensive receiver will be met in 1932 by a number of manufacturers. At the same time the problem of keeping spark plug noise out of the receiver will be solved, largely through careful shielding to prevent direct pickup from the ignition system. Automotive practice of running high potential leads wherever expedience dictated is due for some change when radios are widely installed. At the same time television engineers, working in the ultra-short wave region, view with considerable hope the widening use of the automobile radio. One of the chief obstacles to successful exploitation of television is the amount of automobile interference in the very high-frequency bands. Widespread use of auto radios will help clean up this trouble.

The interference problem is not always so simple as installing resistances in the spark plug leads. One manufacturer found that radio frequency racket persisted until he had soldered the oil pressure and water lines to the frame of the car. Radio amateurs have often cleaned up noises on their short-wave receivers only by binding solidly together water pipes in the basement of their homes. Apparently the changing position of such pipes so they touch sets up changing fields or actual static discharges which radiate in the very short wave region.

B battery eliminators

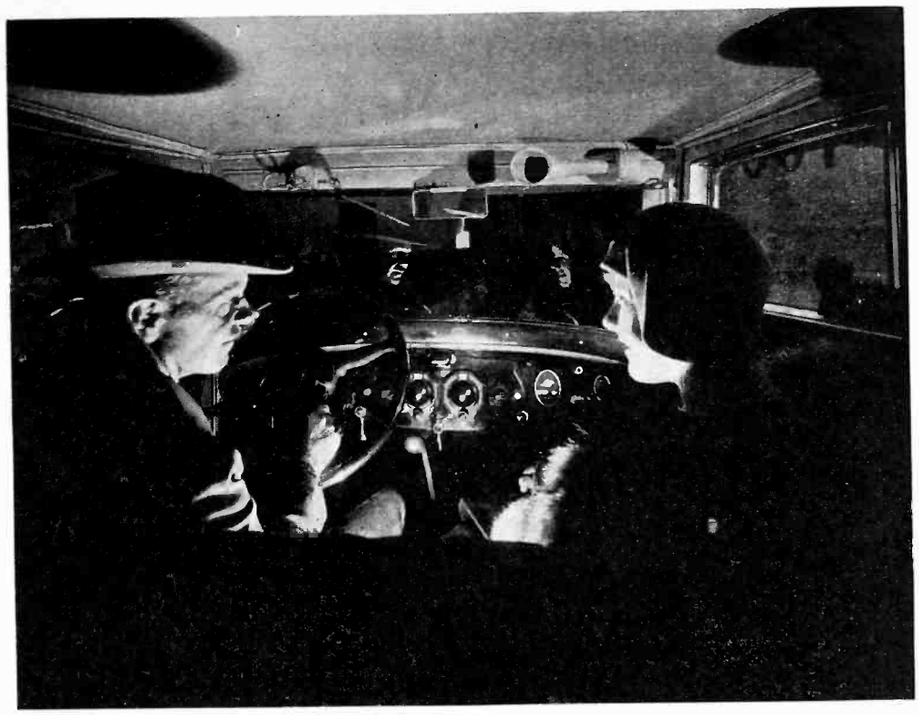
To supply the radio receiver, perhaps an eight-tube superheterodyne with plate power, has taxed the ingenuity of many engineers. Up to the present time the common and almost only source of power has been the familiar B battery. But when one watt of output power is required the drain becomes excessive, considering that space for heavy duty batteries is not present. For this reason there has been a determined effort to find some source of power that will eliminate the B battery.

Eliminators which have been offered the radio and automotive people are in various forms, few of which

The Dynatrope, Hutch-Gard, San Francisco, installed in a Pontiac Six. This is a non-rotating type of converter changing six volts d.c. to a.c. 110 volts

are really ready for the market. Among the most promising is the permanent-magnet field dynamotor operating from the storage battery. One is reported to be 50 per cent efficient, supplying 40 miliamperes at 180 volts. There are engine-driven double-current generators supplying all the needs of the set, dynamotors with filters, rotary or chopper switches with transformers and commutation devices to switch the current back to d.c. There are vibrators with transformers and rectifiers either with the contacts in vacuum or the entire device in vacuum.

The storage battery which drives these devices, already is well loaded. It must start the car, operate its lights, run various accessories. The average battery eliminator has an efficiency of about 35 per cent, the average automobile radio takes about 12–15 watts and so the battery has an additional 5-ampere drain. If, as some think, two watts of output is needed to overcome the sound absorption in heavily upholstered cars, still more power must come from somewhere.



Installation of a radio in the cowl of a car. Recent loud speakers are of the dynamic type

The battery already overloaded and having an average life of perhaps two years would have this life halved if much more drain is taken from it. The charging rate must go up according to the increase in discharge rate or charging must start at lower car speeds, say 8–10 miles per hour. Free wheeling is but another problem facing the battery end of automotive engineering. Increasing the charging rate ought to bring with it a battery with more plates which means more expense, more costly replacements.

General feeling indicates that rotating types of supply have the best chance of going into service in any large number. This feeling is undoubtedly dictated by the fact that the vibrator or non-rotating types are new and hence fairly untried in comparison to the older art of dynamotors, motor generators, etc. One manufacturer has a motor-driven commutating device which converts 6-volt d.c. into a.c., which is stepped up by a transformer and by synchronous commutation converted back to d.c. The list price is about $35, it delivers 155 volts at 35 milliamperes taking 5.3 amperes from the car battery.

A maker of motor generators has a dynamotor which furnishes 180 volts 30 milliamperes drawing 2.8 amperes from the battery and selling at $18. Both the units noted above require less space than the equivalent voltage of B batteries and weigh less.

In addition to such devices there are several invertors, using tubes; other substitutes for B batteries are standard motor generators supplying 110 volts a.c. which can be used on a.c. recievers of conventional type.

Obstacles to be hurdled

Sale of automobile sets is hindered by two factors, worry on the part of automotive people about how to handle the service problem, and on the part of the public regarding the high cost of auto receivers. The latter look at the vast sales of cheap sets ($70 and below) and wonder why they must pay much over this figure for a car radio, one that will be in service perhaps 2,000 hours before the car is turned in or pushed over a cliff. They do not feel the radio should cost over 10 per cent of the cost of the car.

The problem of service

The service problem is a big one. It is reported that General Motors will sell the sets through its dealers but install the receiver in the automobile plant. The dealer will be charged a flat sum for the installation, say $10, and will be sold the set 40 off list. Out of this 40 per cent he must pay the installation cost. It is said that General Motors will not push sales of radios until service stations have been set up widely to handle any difficulties that may appear. Floating service stations will be made available so a man who owns a General Motors radio will have the same service as the owner of a General Motors car.

Installations in Hudson and Essex cars will be made while the car is in process of construction. The number of cars so equipped will depend upon dealer orders. The set to be used as such equipment has not been decided. From sources other than Hudson it is indicated that Transitone will be used, the receiver which is used by Chrysler.

Chicken or other wire in the roof of the car is the antenna preferred. Chrysler closed cors, Buick, LaSalle and Cadillac closed cars, Lincoln closed cars, all Pierce-Arrow cars from 1929 to 1932 inclusive have, or will have, antennas built in. Peerless installed antennas in 1930 and 1931 and will do so in 1932.

The technical problems of designing and building a receiver to be operated under widely varying conditions of field strength, often changing rapidly, have been severe.

Automobile radios seem to be selling faster in the medium price cars than in the lowest or the highest. Certainly the price of receivers will have to come down. Introduction of new tubes designed specially for this market, development of B battery substitutes, simplification of the installation, freedom from service troubles brought about by rugged construction and careful selection of tubes will aid the rapid sale of receivers.

Modern treatment of broadcasting acoustics

By S. K. WOLF
Manager, Acoustic Consulting Department
Electrical Research Products, Inc.

IT is well known that the development of the broadcasting and talking picture industries has had a stimulating effect on the progress of architectural acoustics. Little had been done, before the advent of these industries, in the attempt to raise room acoustics to a scientific basis. Public buildings were planned and erected with no apparent regard for acoustic requirements although heroic attempts were often made to correct the acoustics when they were found to be intolerable. Some of the earlier and more spectacular methods of attempted correction were the use of stretched wires, plane and parabolic reflectors, and resonance urns. There were no definite acoustic criteria which could guide the efforts of investigators; instruments and technique were lacking so that little could have been done to have fulfilled the demands of adequate criteria had such existed. In general, this was the status of architectural acoustics when W. C. Sabine began his reverberation studies in the Fogg Art Museum in 1895. Though he was handicapped by a lack of modern measuring instruments, these investigations mark the beginning of the scientific era in the study of architectural acoustics.

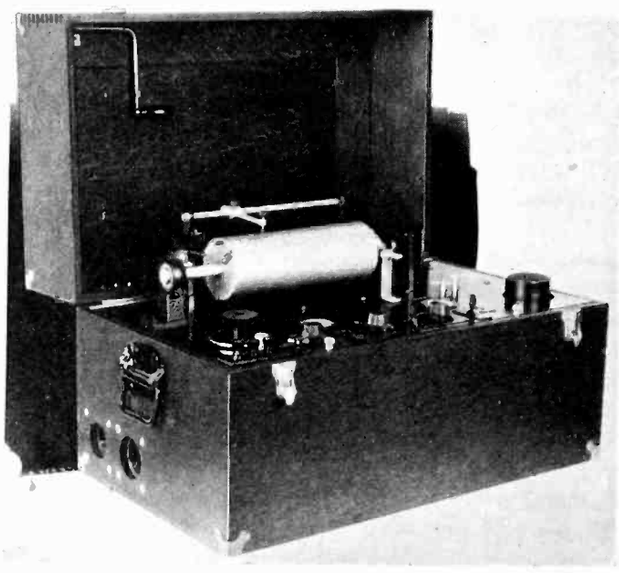


Fig. 1—Chronograph reverberation meter designed for acoustical analysis work

One of the important factors in the acoustic adjustment of an enclosure, is the control of reverberation time which is the time required for sound to decay to one millionth of its original value. Reverberation is always a factor in room acoustics and affects all sound produced in enclosed spaces and progress in architectural acoustics has been marked by a relatively great emphasis on reverberation control.

The chief limitation in earlier methods of reverberaiton measurement was the subjective element. It is exceedingly difficult for the human ear to detect the exact instant when the decaying sound reaches the threshold value, particularly where the reverberation time is short. Not only may background noise be mistaken for the decaying tone but the fatigue of the observer as well as other personal characteristics, are likely to vitiate the measurements. Add to this the labor and inconvenience associated wtih the earlier methods and the need of a better method is appreciated.

Measurement by reverberation meter

These considerations have led to the development by the Bell Telephone Laboratories of an instrument known as the Spark Chronograph Reverberation Meter[1] (Fig. 1). This instrument is an electro-acoustic ear with an adjustable threshold sensitivity. It consists in part of a variable gain amplifier, a full-wave rectifier, and a biased relay shown schematically in Fig. 2. When the current from the rectifier falls below a predetermined value it releases the relay which permits a condenser to discharge through an induction coil, the spark from which plots the decay curve pattern on special recording paper. This paper is clamped on a drum which revolves at a known constant speed. The decay pattern is obtained by successively varying the gain of the amplifier by constant intervals and by automatically interrupting the source of sound at the same point in the rotation of the drum. An electrical source capable of transmitting any desired frequency is used; usually a dynamic cone speaker is satisfactory. The use of a frequency varying regularly over a band instead of a single frequency eliminates difficulties due to standing waves. This kind of tone is known as a warble frequency. Acoustic resonators and electrical filters insure that only the intended frequency is measured. In this manner the reverberation meter plots the rate of decay of any given tone, a typical curve being shown in Fig. 3; from this the reverberation time is readily obtained.

During the past few years experience has been obtained in the analysis of reverberation difficulties. In connection with the installation of talking picture apparatus, over 5,000 theaters have been acoustically analyzed. As a result of this activity a large amount of practical data has been collected. Due to earlier but similar activities in recording and broadcasting, much data has been collected in these fields. It is apparent that data collected in any one of these three categories might find application in another; this is especially true when recording and broadcasting are considered since it very frequently happens that knowledge gained in recording finds direct application in the improvement of broadcasting technique.

Problems in the acoustics of broadcasting studios usually have their origin in studio plans, which were incomplete or lacking in vision. When compromises must be made more planning rather than less, is usually

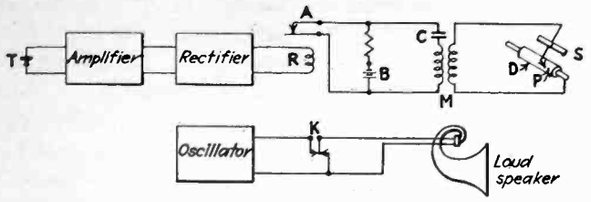


Fig. 2—Schematic of reverberation meter circuits

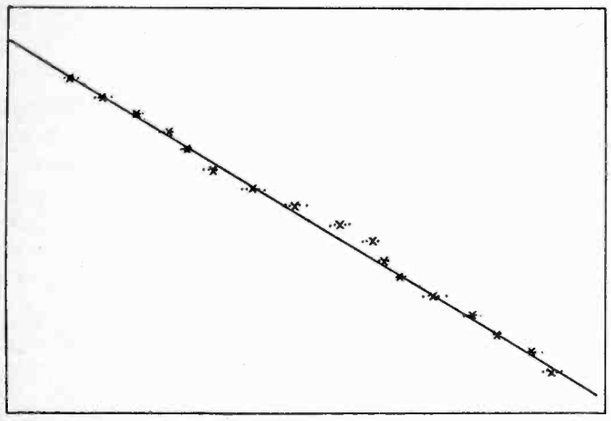


Fig. 3—Typical curve obtained with meter showing rate of decay of any given tone

necessary. Often the extra planning completely eliminates expected difficulties due to acoustic interference. Some of the features to be considered in studio planning are: size and its relation to the number of artists, shape, noise control, reverberation requirements, type of absorbing material, and location of absorbing and reflecting surfaces.

Relation of volume to room acoustics

It has been known for some time that the size of studios used for broadcasting musical selections are, in general, too small for the size of orchestras employed. There is not only an optimum or best reverberation time for every room size but also a relation between the size of room and size of orchestra for the best acoustic effect. Where too many instruments are used in a room of given size the clarity or definition of the various instruments will very quickly be lost; this will noticeably decrease the quality.

In concert work it is customary to build the hall large in order to provide space for a large paying attendance. The orchestra is as small as is consistent with the type of music being played. Results are good, however, providing the proper loudness level is maintained. There is a definite relation between the size of hall and the size of orchestra which is clearly shown by a tabulation of the sizes of world famous orchestras and their home concert halls.

Broadcasting studios contend with the reverse of this problem since they present a large orchestra in the smallest possible room, for obvious economic reasons. A relation suitable for studio use has been established providing both an optimum or ideal size for orchestras, as well as a maximum recommended limit which permits a slight loss of quality for maximum economy.

In design, the shape of the studio is associated with its size. While not an exacting factor, it contributes largely to the ease and economy of acoustic adjustment; the square studio presents many difficulties not found in those having greater depth than width.

Measurements of broadcasting studios sometimes show that the reverberation times have been corrected to approximately their optimum value at 512 cycles by the installation of acoustic treatment, but that the period over the balance of the frequency range is far from ideal. Many studios are far too reverberant at the lower frequencies and far too dead at the higher. This is clearly shown in Fig. 4 where the full line represents the measured reverberation time and the shaded area, the optimum band. If a properly balanced orchestra is used, this results in a predominance or prolongation of bass notes and a lack of highs, giving what is generally known as a "tubby" or "drummy" effect.

Obtaining optimum reverberation time

The correct reverberation characteristic will contribute to ease of performance by the artist, enhance naturalness and contribute to a pleasing effect of spatial perspective; the improper characteristic will jumble and distort the sounds as well as distract and impede the artists.

Some time ago J. P. Maxfield made a comprehensive study to determine the correct acoustic conditions for sound recording studios[2]; in this investigation a relation was established between optimum reverberation time at 512 cycles and volume of studio. By reference to Fig. 5 this relation is found to be a band instead of a line. The reasons for this method of indication are that judgments of musical observers will specify good conditions over such a range and that more reverberation is required for some musical selections than is necessary for others.

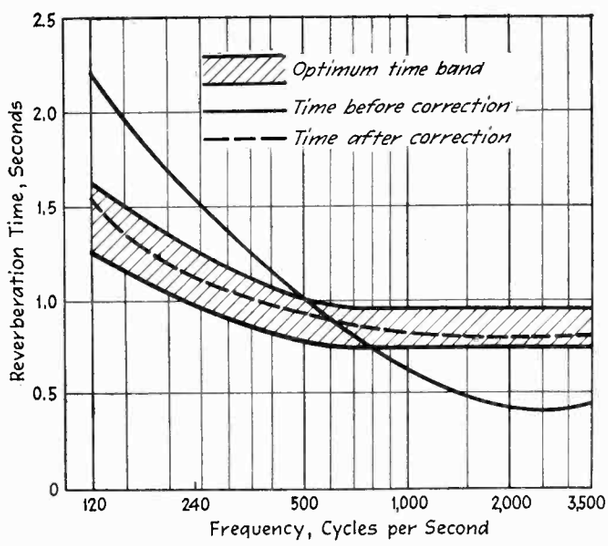


Fig. 4—Characteristic reverberation curve of studio before and after treatment

The use of a band for representing optimum time therefore insures that one element will not be emphasized at the expense of another and allows the conductor considerable leeway in arranging the orchestration to suit his personal musical taste. It has been found that this optimum band is well adapted to the requirements of broadcasting studios since the acoustic problems are similar. This band should be adjusted over the frequency range for equal rates of loudness decay since such a characteristic has been found both theoretically[3] and practically to give the best results. A typical optimum band adjusted over the spectrum is indicated by the shaded area in Fig. 4.

As a preliminary check in studio adjustment it is well to measure its reverberation times at various fre-

quencies. Distribution, intensity and noise measurements should also be made if the need is indicated. Prior to construction these data may be obtained by computation from the architect's plans and other available sources of information. Computations of reverberation time should be made by Eyring's formula for the reverberation time in dead rooms[4].

Arrangement of absorbing material

One of the elements which required much attention is the sound absorbing material, its location and its absorbing power in relation to frequency. If a badly distorted characteristic is indicated, it is obvious that either some or all of the existing material must be removed. A commercial material must then be selected which will give the desired characteristic, or a new one must be developed.

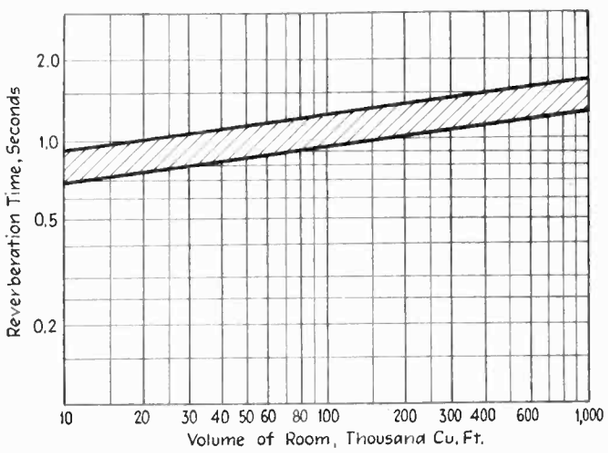


Fig. 5—Optimum reverberation time at 512 cycles vs. volume of room

In selecting a suitable material either from measurements or theoretical considerations, resort should be had again to Eyring's formula[4].

The general tendency in installing acoustic treatment in studios is to distribute it equally on the four side walls and ceiling. With the musicians and artists placed in one end of the room, such an arrangement provides a high degree of damping at the production end of the studio and a somewhat more reverberant condition at the pickup end. This is directly opposed to what has been found to give best results.

The absorbing material should be distributed so that the microphone end of the room is more highly damped than the other end when the orchestra is in the live end[5]. This live end—dead end relationship is similar to that found in good auditoriums and to that used in recording work and has been found to give very satisfactory results. Such an arrangement removes all necessity of crowding about the microphone, makes it easier and more pleasant for the artists to perform and greatly improves the quality of the broadcast program due to the absence of interference at the microphone.

The acoustics of monitor rooms deserve careful consideration because of the critical control functions exercised in this room. If it has some definite acoustic bias the effect will be comparable with that of judging paintings with colored glasses. Defects inherent in the monitor room will be interpreted by the mixer as due to the performance of the artists. The acoustic condition should therefore be adjusted in such a manner as to give the mixer the impression that he is located in the same room with the orchestra or speaker. If he gets the sense of space and acousitic perspective, then the condition is good.

Unbalanced orchestras are used sometimes in radio broadcasting, the unbalance consisting of a predominance of bass instruments and a lack of treble instruments, all crowded much closer to the microphone than is desirable. Singers and speakers also stand very close to the microphone. The use of several microphones is frequent practice. The poor acoustic characteristic of the usual studio very probably accounts for this undesirable arrangement as close pickup tends to eliminate studio effects.

The proper location of performers is in the live end of the room, arranged as for a concert both in regard to the number of each kind of instrument and their general disposal about the room. Under these circumstances, all instruments will receive their normal emphasis. If it is desired to give any instrument or group of instruments, greater emphasis, as for solo purposes, it is only necessary to move them slightly closer to the microphone. This will not then disturb the clarity or general balance of the rest of the orchestra. This is of special advantage where the orchestra is used as an accompaniment to vocal numbers; the nearness of the singer to the microphone determines the amount by which he is brought into the apparent foreground.

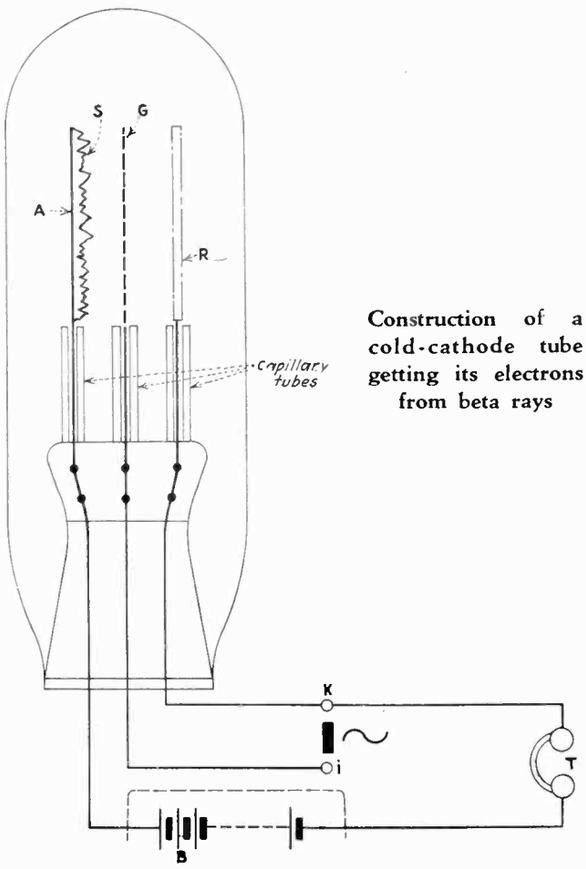
The microphone should be placed in the dead end of the room in approximately the location of an imaginary listener. This general arrangement, of performers in the live end and microphone in the dead end, will give results superior to those obtained under the former method. The exact position of the microphone in this general area is fortunately not very critical so that the method is easy of application and rapid in the matter of setting up after the basic principles have been mastered. With correct studio acoustic conditions and proper microphone placement, it should never be necessary to employ more than a single microphone at one time. Only in this way is it possible to avoid distortion due to sound reaching one microphone out of phase with that which reaches the other[6].

The commercial and artistic importance of favorable acoustic conditions in the broadcasting studio can hardly be over-estimated. It is a well known fact that reverberation reacts on the artists and affects their performance. It has been said that the room is a part of the source of sound, and that this is true can be seen from the effects obtained from the same artist or instrument under various acoustic conditions. The commercial success of broadcasting is dependent on many elements, some of which tend to remain buried in the mass impression, but which nevertheless may exert a decisive force on the results obtained. Such a matter as crowding too many artists into a room may produce a jumbled effect that will not be directly detected or diagnosed by one listener in a thousand. Yet the effect tends to be expressed in vague dislike, undoubtedly influencing the fingers at the tuning dial.

1. See a Chronographic Method of Measuring Reverberation Time, E. C. Wente and E. H. Bedell, *Journal of the Acoustical Society of America*. Volume 1, No. 3, Part 1, April, 1930.
2. Acoustic Control of Recording for Talking Motion Pictures, J. P. Maxfield, *Journal of the SMPE*, Volume XIV, No. 1, 1930.
3. The theoretical treatment of this phase can be found in the paper Optimum Reverberation Time for Auditoriums, W. A. MacNair, *Journal of the Acoustical Society of America*. Volume 1, No. 2, Part 1, January, 1930.
4. Reverberation Time in "Dead" Rooms, Carl F. Eyring, Journal of the *Acoustical Society of America*, Volume 1, No. 2, Part 1, January, 1930.
5. Optimum Conditions for Music in Rooms, F. R. Watson, *Science*, August 27, 1928.
6. For a further discussion of the distortion obtained see, One Type of Acoustic Distortion in Sound Picture Sets, by R. L. Hanson, *Journal of the SMPE*, October, 1930.

Status of cold-cathode tubes abroad

By DR. IRVING J. SAXL
Consulting Physicist



Construction of a cold-cathode tube getting its electrons from beta rays

ATTEMPTS to replace the filament in a vacuum tube with some other source of electrons have been made for a number of years. In Europe, particularly, considerable research on the part of a number of scientists has resulted in some practical advance. The writer has just returned from Europe and has been in touch with the centers of activity in this direction; it is his privilege to report the present status of the cold-cathode tube in *Electronics*.

There are two ways of attacking the problem of doing away with A batteries, transformers and other sources of heating energy which have sufficient technical merit to be discussed. They are the photoelectric-cathode and the glow-cathode.

There are other schemes but the above two are much farther along the road to final use, or discard, than the others. The glow-cathode tube of Dr. Georg Seibt, for example, has a good chance of practical use. The photo-electric-cathode, the goal of many inventors and designers, has reached its best development in the hands of Manfred von Ardenne.

There is nothing new about a glow-discharge tube. At the beginning of our modern high-vacuum electronic tube, the two-electrode tube of J. A. Fleming and the three-electrode tubes of R. Von Lieben and Lee Deforest worked primarily with the glow-discharge, arising through the ionization which was created in the gas of the tubes, which, at that early time, had not been exhausted sufficiently. The efficiency of these tubes, because of low ionization was not very great.

The modern era of tube development started by the design of the highly emittent filament and of the sufficiently high vacuum. This type of tubes needs several sources of current, that supplying the cathode usually requiring considerable output. Considering the tube as a whole, it operates at low efficiency; i.e. the amount of useful power handled is low compared to the total power used up. This is due to the wastage of power in heating the emitter which supplies the electron stream.

A very natural solution of the problem is to use the radio activity of certain substances. Radio-active materials, as for instance uranium-oxide, are constantly emitting electrons. These can be accelerated by a plate voltage, but also without it. Such an emission of electronic matter takes place along practically straight lines.

Such a cold-cathode radio tube is in practice constructed as shown in Fig. 1. In an evacuated container, is a surface R which is covered with an electron emitting material. The larger the surface the greater the emission. Opposite it is the grid G consisting, for instance, of a metal mesh. At a certain distance is a plate A which is usually built with points S as to increase its effects. The plate R emits continuously beta rays which, for our purposes, are the most important although the alpha and gamma rays are of influence upon the physical properties. These electrons pass through the control grid G and are deposited upon the plate A. From there the circuit can be closed, for instance over a headphone back to the cathode, with or without the aid of a battery.

If an alternating voltage is put between K and G the current of electrons is controlled similar to a usual electron tube. This construction did not come into any practical application until recently. This might be due partly to the small electronic current which is emitted by the radio-active substances and, furthermore, to the influence of the alpha and gamma rays which as yet has not been fully controlled. From ionization currents in incompletely evacuated bulbs and by secondary radiation from other parts of the tube than the cathode, complications arise which disturb the general usefulness of this design.

Glow-discharge tubes

The glow discharge, however, can be used with a good chance of success as a source of electrons for amplifier tubes. If a tube is evacuated to a certain degree or filled with a gas under a certain pressure (especially the rare gases neon, argon, helium) and if between two or more electrodes there is a sufficient voltage a glow dis-

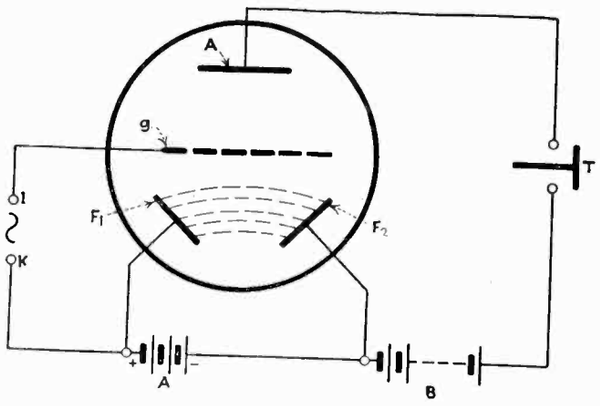


Fig. 2—Glow-discharge tube circuit

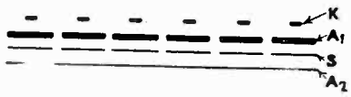


Fig. 3—Construction of Seibt's cathode structure

charge is created. By this discharge the neutral atoms of the gas are split into positive ions and negative electrons, often paralleled by the emission of certain frequencies usually in the visible spectrum.

Between these electrodes a medium of electric conductivity is created. For producing an electric current going out from such a medium, a device has been designed which, in its important characteristics, is reproduced schematically in Fig. 2 where F_1 and F_2 are the electrodes between which a glow discharge takes place if a voltage is applied to them. This glow discharge current takes the place of the heated filament of the radio tube. It has the advantage over the radio tube of delivering, with the same amount of energy, more electrically-charged bodies (ions and electrons) than the filament or coated filament. This ionization current can be increased, if the cold metallic electrodes are covered with materials (like the alkaline metals or the rare earths). If a very extensive discharge is to take place between the electrodes, the surface of the electrodes and the inter-electrode distance have to be chosen in a special way to reduce the interior resistance of the space between the electrodes. One way of doing this is to build the electrodes in the form of tubes of sufficient diameter, one other way is to use a heated cathode instead of the cold cathode. But the minute a heated filament is introduced the advantage of the cold cathode is non-existent. On the other hand, the production of electrically charged bodies bodies to be transported through the tube to the plate and to be controlled by a grid, does not take place primarily on the heater spiral. The hot cathode mainly results in a stronger current flowing between the two cathodes and it is this current (and not the heater current as such) which creates the ionized atmosphere which acts as the true cathode. The advantage of this method is that with the same amount of energy a much more conductive space is created than with any other cathode, thus making possible an unusually large plate current with a relatively small amount of battery energy and relatively inexpensive equipment.

The device is Fig. 2 works in such a way that electons are sucked from the glow discharge current between the electrodes F_1 and F_2 towards the plate, under the influence of a voltage B put thereon. This discharge has to pass through the opening in the grid G and is biased by electric differences between K and I.

In the glow discharge current F_1-F_2 there are many positive and negative charges. Between grid and plate, however, there are relatively only a few positive ions but still sufficient negative electrons. Such a device has the disadvantage, that a clean and reproductive amplification occurs only seldom and almost at no time can be performed at a constant value. This is natural, as the glow discharge not only exists between the two electrodes F_1 and F_2 but penetrates also in the field between grid and plate. It is therefore possible that the grid gets covered with a cloud of positive ions which influences unfavorably the effect of control and amplification.

Dr. Georg Seibt in Berlin therefore introduced a new method for the production of reliable amplifier tubes with a (cold) glow discharge cathode. He succeeded in developing the device in such a way that the electrons can be liberated out of a glow discharge whereby the tube is fed exclusively by the plate current. Although it was necessary at the beginning of the experiments to use a higher plate voltage to make the voltage drop along the glow discharge distance greater than that of the usual radio tube, he succeeded in reducing these voltages recently. The special advantage of this tube is that a separate filament current is now unnecessary.

With Seibt's glow tube the system of electrodes is designed in such a way that the glow discharge takes place generally only between two electrodes. The amplification current which goes towards the second anode does not come directly from the glow discharge. This is performed by making the plate very large. The sides of this plate reach over the connecting line between the discharge cathode and the amplifier electrodes. By a special form of the different electrodes he succeeded in increasing the plate current considerably.

The cathode is made in the form of a wire net. The size of its openings must not be more than a few millimeters. The plate can be designed in the form of a net. The openings in this plate, however, have to be *smaller* than those used in the cathode.

In Fig. 3, the discharge electrode A_1 is mounted about 5 millimeters from the cathode. The cathode K and the plate A_1 can be designed in the form of cylinders of iron, nickel or molybdenum in which holes are stamped. Those holes in the cathode cylinder have about half the size of those in the plate cylinder. The sides of the discharge-electrode A_1 reach over the outer limits of K. The centers of the holes in the cathode and in the plate are in one line. The control grid S is designed either

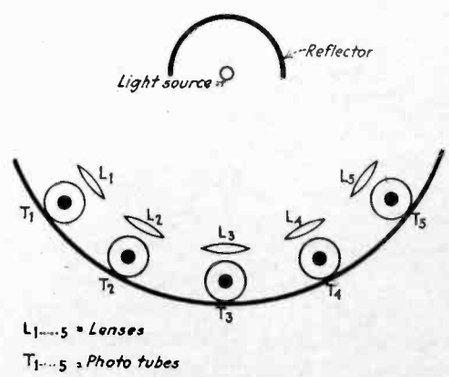


Fig. 4—Use of reflectors in a photoelectric cathode tube

in the form of a spiral or of a net with large openings. The amplifier electrode A_2 has the form of a cylinder without holes.

All four electrodes are attached to the stem with lead-in wires which are covered with isolating covers so that no discharge may take place directly between them. The entire system of electrodes is sealed into a bulb which is filled with a purified rare gas or a mixture of gases. At present, helium of a few millimeters pressure is used for this purpose. The ionization potential therefore is rather high.

By such an arrangement a great number of sources for the glow discharge is given, without creating disturbing grid currents. The cathode K is covered with compounds which reduce the emitting potential. The emitter-cathode A_1 has not this cover. A direct emission from A_1 is therefore not likely to take place at the special voltages and distances. At the same time A_1 acts as a filter which grants passage mainly to the electrons. Positive charged ions meanwhile stay behind and thus cannot make the disturbing cloud around the grid S. This type of tube works in a fairly reliable manner. It gives a relatively high plate current and great amplification factor with simple constructional means.

Photoelectric cathodes

Tubes with photoelectric and radioactive electrodes are still in a state of development. Those which include radioactive substances only without the additional aid of a battery voltage do not give enough emission at present.

The photoelectron emitter is being studied by many inventors of whom Manfred von Ardenne at least has shown experimentally a possibility for practical application.

As shown in Fig. 4 the electronic current is released by a source of light. For applying several steps of amplification and more tubes, the separate cells are put in a half-circle around a light source, with or without a half-circular mirror behind the tubes.

It is well known that the emission of photoactive surfaces increases with the increasing light, and depends upon its color. The plate current of this photo tube will be a small one and the interior resistance of the tube rather high. Such tubes with photocathodes are therefore especially to be used as resistance-coupled amplifiers for the high-frequency part of the receiver. The plate load resistance has to be very high.

In the type of phototube used in the early experiments, a photocurrent of not much more than about 10 to 12 microamperes resulted from a layer of potassium even under very intensive radiation.

In the newer photocathode tubes of von Ardenne a control grid is provided between the photocathode and the plate whereby plate and cathode have about the same size of surface. The photocathode is made of a layer of potassium activated with hydrogen. With monatomic caesium layers particularly good results have been obtained. It is possible to use other photolayers, as for instance calcium, the maximum sensitivity of which is in a part of the spectrum in which ordinary light sources emit with special energy. Especially the caesium variants of this cell make it possible to use part of the infra-red energy of the light sources.

The cell is filled with rare gases which influence the amplification less than the grid bias. This new photocathode cell is supposed to give amplication of from 20 to 30 times if daylight (diffuse, overcast sky) or an incandescent lamp of 40 candlepower is applied together

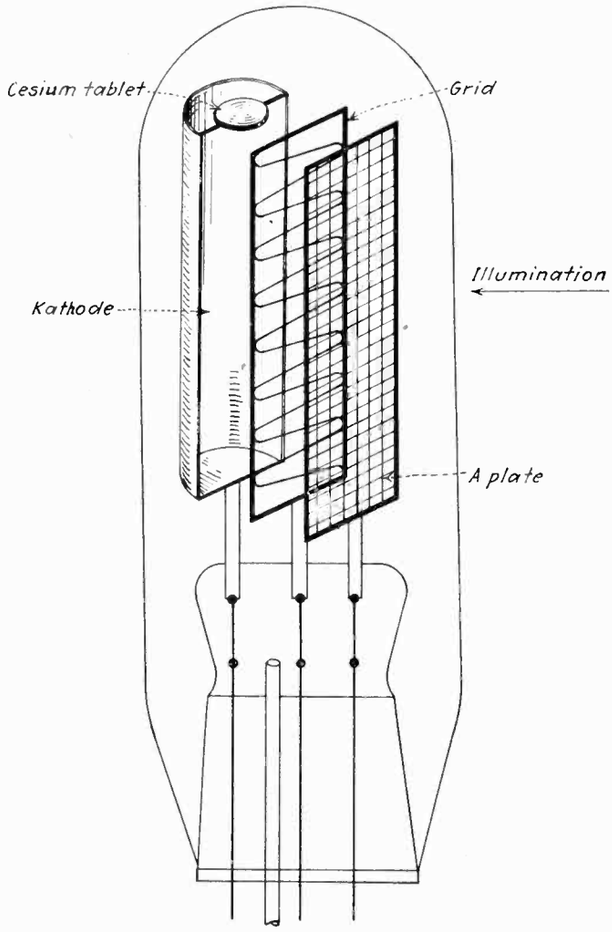


Fig. 5—Photoelectric tube with control grid

with a plate resistance of about 10 megohms. Ardenne states that with daylight or direct current illumination the amplification is free from tube noise. With an incandescent lamp which is fed by alternating current disturbances are likely to occur as the temperature inertia of the filament is not sufficiently high.

Photoglow tubes

In connection with cold cathodes it is also necessary to mention the photoglow tube. Here a gas-filled tube is put into the electric circuit in such a way that the initiating discharge voltage is not reached completely. A minute photocurrent which can be as low as one-tenth of a microampere is then sufficient to start the glow discharge. This latter can be easily of the order of about 50 milliamperes.

The cold-cathode tube, of the phototube type, gives in a resistance-coupled amplifier, a considerable audio amplification if the resistances are designed correctly. They might, in a later state of development, become important for high-frequency amplification. As a gas-filled tube gives no results at such frequencies, a vacuum type phototube has to be used. So the necessary condition arises to develop a photoemissive surface which, even in vacuum, gives satisfactory emission. A method has been developed for increasing the photoemission of caesium by depositing it upon layers of mixed oxides. In single tubes emissions up to 65 microampere per lumen have been found already in tubes of such form.

HIGH LIGHTS ON ELECTRONIC

To open doors for hand truckers

C. S. STOUFFER, works engineer of Stanley G. Flagg & Company, foundrymen, Stowe, Penna., suggests the desirability of photocells for opening doors in shops, warehouses, etc., for hand truckers.

Such use of a photocell, so arranged that the door will swing open at the shadow of the trucker, would save many bruised knuckles and incessant noise and banging as doors are crashed against by the trucks.

✦

Radio rangefinder traces birth and path of storms

METHODS FOR DETECTING the birth of a thunderstorm 2,000 miles away and six or seven miles above the earth's surface and for following the path of such a storm across the country mile by mile as it approaches a city or an air route which it is desired to safeguard or to warn, have been perfected in England by scientists of the Radio Research Board.

The method is to record the waves of radio "static" sent out by the storm, in much the same way used by soldiers on a battle front to locate concealed batteries by means of sound waves. Every lightning flash sends out waves of static which may be detected hundreds of miles away. The British experts have set up at two places 400 miles apart delicate apparatus to pick up each such flash of thunderstorm static and to record its direction on strips of motion picture film which run continually through the recorders. Time records are printed on these same film strips so that simultaneous records of the same flash can be identified. By then plotting on a map the directions from the two stations of such flashes recorded at both, the engineers are able to mark the exact location, perhaps hundreds of miles away, of the storm which is gathering and has begun to broadcast. As the storm moves across the earth's surface the changing locations of the flashes let the engineers follow its progress.

✦

Printing telegraph gets crime news to Pennsylvania police

USE OF LEASED telephone lines to broadcast typewritten messages between the 96 offices and field posts of the Pennsylvania State Police, even when no one is present at a field office to receive the message, is the latest electronic contribution to thief-catching.

The device used is the telephone typewriter, an instrument by which the keys of an ordinary keyboard operate an automatic electric system which sends special signals over the telephone wire, one signal for each typewritten character. At the receiving end another electric apparatus sorts out these signals and uses them to operate the keys of an automatic typewriter, so that the message is written out just as it is being typed by the sender. The offices of the Pennsylvania State Police are divided into four divisions with their headquarters at Pittsburgh, Wyoming, Philadelphia and Harrisburg. By the new system each of the four headquarters offices can broadcast any typed message simultaneously to all field posts in its district, or General Headquarters at Harrisburg can broadcast the same message to the whole state at once. If desired, messages may be sent to only one field post or to selected posts. If no one is present in a field office when a message is to be sent the operator at Headquarters can start the receiving mechanism by a special signal over the wire, so that the message is written out automatically ready for the field trooper when he returns.

✦

Ultra-sonic vibrations effect chemical changes

DURING A RECENT DEMONSTRATION of electronic experiments held in the General Motors Research Building at Detroit, Mich., H. R. Wolf showed some of the possibilities of accomplishing chemical changes by high-frequency vibrations.

A long-wave sending set of 270 kilocycles was demonstrated. In a quartz crystal ultra-sonic vibration was produced which shook the iodine from potassium iodide solution. Emulsions of mercury in benzine were also produced.

Bulbs with no connections were made to glow brilliantly when held in the hand over a condenser. Sparks were made to come from water in a beaker and a wire held in the hand was welded to another placed in the beaker of water.

✦

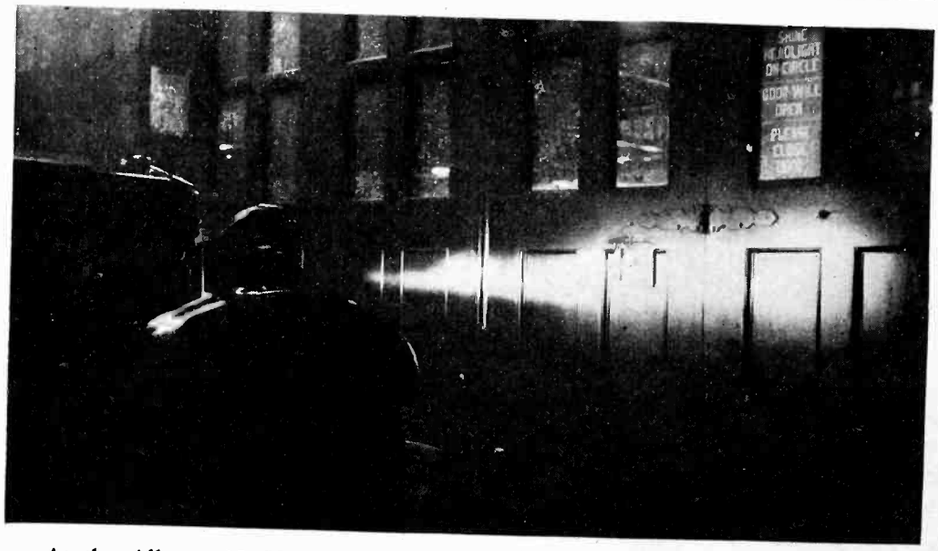
He throttles announcers by photocell

BY WILLIAM SHAW

YOUR READERS MAY BE interested in knowing of a selenium cell gadget a Chicago radio fan has rigged up. When the announcer's blurb threatens to be long and tiresome this Chicagoan takes out a vestpocket flashlight, aims it at a little "window" he has made in his radio cabinet, and so throttles down the voice until such time as he feels the entertainment has been resumed.

✦ ✦ ✦

GARAGE DOORS OPENED BY AUTOMOBILE HEADLIGHT



At the Albany, N. Y., service building of the New York Power and Light Corporation, a hole, about an inch and a half in diameter, has been drilled in the automobile door, protected by a glass covering. On the inside is a metal tube containing a General Electric photoelectric tube, controlling the door-opening motor. The door remains open until the "closing button" is pushed

DEVICES IN INDUSTRY + +

Distant-reading galvanometer, employing photocells

To make a laboratory galvanometer indicate at a distance, without in any way loading the galvanometer or impairing its freedom, Mr. Norman McKinney of the Struthers-Dunn Company, Philadelphia, suggests the use of a row of small photocells over which the reflected light-beam of the galvanometer can swing.

Each compact small light-sensitive unit is connected through a tube and relay to a distant lamp bank. Thus as the galvanometer beam swings over the arc of photocells, the corresponding light in the series at the remote reading point will light up, thus giving a distant reproduction of the movement of the galvanometer, following it through comparatively rapid movements.

✦

Rubber conveyors are synchronized by tubes

By B. S. Havens

A considerable reduction in wastage has resulted from the application of Thyratron tubes to the synchronizing of rubber conveyors by the B. F. Goodrich Company. Conveyors are used in much of the processing work in a rubber factory, and it is important that the speeds of the various conveyors in a chain are synchronized.

The speed of the synchronized group is usually determined by the speed of the material entering one conveyor. The speeds have heretofore been controlled manually, but the results were unsatisfactory as a very slight disagreement in speeds could be the cause of a high percentage of waste material.

The first conveyor, or the one receiving the original supply of material, is driven at a fixed rate of speed, depending on the material in question, and the other conveyors are synchronized with this key conveyor. The material, as it passes along, dips slightly between any two conveyors. In each of these dips rides a wheel attached to a balanced lever mechanism. The lever mechanism, at its other end, governs the movement of the core in a reactor. Variations in the reactance of the reactor (governed by the position of the core) control the output voltage of a pair of Thyratrons in the circuit of the motor driving the conveyor whose speed it is desired to govern.

By this arrangement, when a conveyor is running too fast for the preceding one, the slack material between them tightens, the rider wheel rises, the position of the core in the reactor is changed, the tubes pass more current and to the motor field the motor slows down. Conversely, when the conveyor is running too slow, the reactor core moves the other way causing the tubes to pass more current and the motor speeds up. As a result, the tension between conveyors keeps the speeds in synchronism.

✦

Measuring vs. "judging" loudness of noise

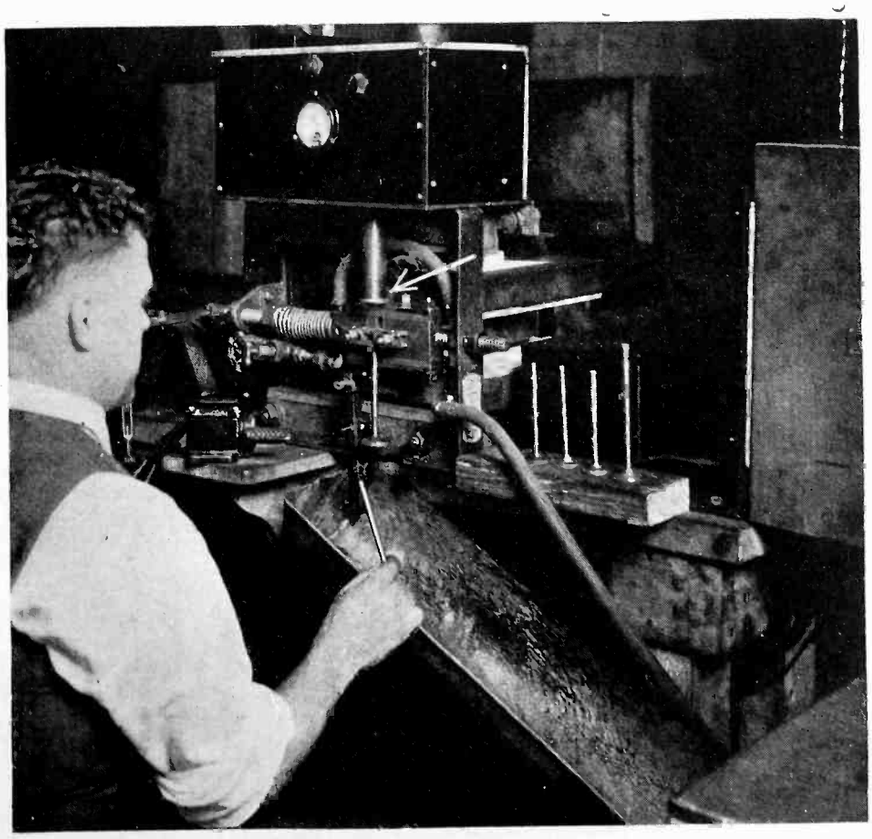
By Dr. E. E. Free

If an average person listens to two noises one after the other and decides that one of them is twice as intense as the other one, he is reasonably sure to be about 800 per cent wrong. One noise must be, apparently, just eight times stronger than another noise in order to seem twice as loud, or one thousand times stronger to seem ten times as loud. For some mysterious reason which no one yet understands, the human ear seems not to hear noises in proportion to their actual intensities, but in proportion to the cube roots of these intensities; a law discovered recently by J. S. Parkinson of the Johns Manville Corporation, in New York City, and Professor L. B. Ham of New York University, and reported at the recent meeting of the Acoustical Society of America in Cleveland, Ohio.

Professor Ham and Mr. Parkinson produced in a room noises having measured amounts of energy, like watts of electricity. More than a hundred normal persons then listened to these measured noises and indicated which noises seemed to them louder or less loud than others and how much. When these judgments of loudness were compared with the measured noise intensities the unsuspected cube-root law appeared. Whatever may be the machinery in the ear or ear nerves which makes things work in this way, the fact undoubtedly is valuable to mankind. Were it not for this ability of the ear greatly to increase its sensitivity and accuracy for faint noises and to hear louder ones less accurately, loud noises like those of modern cities probably would paralyze the ear altogether while faint sounds like those of whispers would be entirely inaudible.

✦ ✦ ✦

ELECTRIC EYE GIVES VALVES RIGHT HEAT



Thompson Products Company, Cleveland, Ohio, uses the electric eye in heat-treating valves. Tips are heated electrically. At the right heat according to color, the eye shuts off current and releases valve into an oil quench

Economics of police radio reception

By G. F. LAMPKIN
Consulting Engineer

RECEIVERS for mobile use in a police radio system must meet demands which are relatively unimportant to receivers intended for broadcast reception. Reliability of apparatus in police work is paramount, not only because of the nature of the work, but also because twenty-four hour service is as a rule demanded. A minimum of filament and plate battery drain is essential both to low operating cost and to uninterrupted service.

The maximum sensitivity of a police receiver must be greater than can ordinarily be used. Assuming the transmitter has been so located as to insure an equitable distribution of signal about the city, the success of the system depends on the receivers. They must have sensitivity not only to operate on a comparatively poor antenna in the often numerous 'dead' spots, but must have a reserve to do so in spite of battery ageing, tube ageing, set detuning, and the like.

A high output level is very desirable at times when an officer is not in the car but nearby—directing traffic, for instance. The receiver must have selectivity to discriminate against the intense fields encountered under the antennas of local broadcasting stations; and against present and future occupants of nearby police, television, and aviation channels.

The data to follow are based on 103 mobile receivers built and installed in the early part of 1931 for the Cincinnati Police Department.

The receiver is a six-tube tuned radio-frequency type of circuit, using three UX-222 tubes as radio-frequency amplifiers, a UX-201-A grid-leak detector, a UX-201-A audio amplifier, and a UX-171-A output tube. Particular attention was paid to complete shielding between the stages, while at the same time preserving accessibility of all parts. All component parts were mounted on a single vertical panel. Stage shields consisted of soldered copper boxes which completely enclosed individual stages, being clamped to the panel from behind. By-pass condensers and chokes completed the isolation of each stage, so that the maximum possible gain was had. The Clough-system audio transformers made for a lessened B-battery drain, because of the series plate resistors which they incorporated. The 171-A output tube was biased to approximately 2 milliamperes plate current. It operated nearly as a Class B amplifier without appreciable loss in quality, but with increased plate efficiency and peak output.

The receiver chassis was made to slide into vertical runners in an aluminum set box of dimensions 15 in. by 7 in. by 5½ in. The tuning controls were accessible only when the box was open.

The receiver required 1.1 amperes from the car storage battery. It required only 90 volts of B battery, on which the drain was 10 milliamperes. The output level was such that speech could be understood 50 to 200 feet from the car. The sensitivity was such that in daylight satisfactory signals from a 500-watt transmitter were had at distances averaging 50 miles.

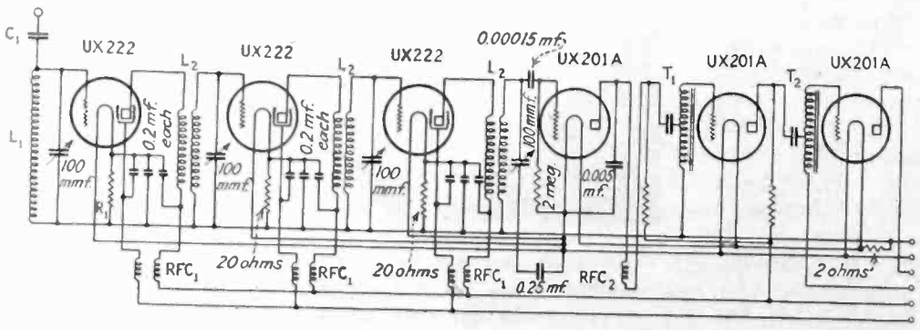
Installation in police cars

Most installations were made in coupes, in which the set was mounted behind the seat, the battery box in the turtleback, screen antenna in the roof, and switch and volume control on the dash. All wiring save that to the speaker was run in armored BX cable and anchored. For the speaker live-rubber garage cord was used. The battery box was 12 ga. japanned iron, and included space for the C battery and junction and terminal connections.

Both A and B circuits were fused. The receiver circuit was such that only tne 90-volt tap on the B battery was used, with the result that both B blocks were equally drained. A speaker unit and horn was used in preference to other types of speakers because of the greater ruggedness and increased sound output efficiency. The horn was made to specifications of heavy papier-maché; the one end was offset to clear the speaker unit, the air column was made long to give reasonable loading on the unit, and the entire horn was made flat so that it would be unobjectionable in the roof of the car. All cars were equipped with spark plug suppressors.

Servicing of the radio installations is done at a central point by a radiotrician. The time required to put a defective reception unit back in shape averages from five to ten minutes. A test board with four meters is arranged to plug into the battery cable in place of the set. At a glance the condition of the batteries and installation wiring can be told. If these check satisfactorily, a spare

[*Please turn to page 40*]



Police radio receiver on which repair cost studies were made

Use of special heater-type tubes reduced service costs appreciably

Ultra-short wave receivers

By R. RAVEN-HART
Electronics European Correspondent

CONSIDERABLE data are now available as to the types of receivers which have proved suitable in the German experiments, both as regards the commercial firms and laboratories carrying out these tests and by amateurs who have interested themselves.

Generally speaking, only two types have so far shown themselves practical for the direct reception of programs put out on these waves, and both are very simple—the regenerative and leaky detector, and the superregenerator.

As regards the former of these, the only feature of interest is the antenna coupling (Fig. 1) used in the majority of amateur sets and by Telefunken, the values are not at all critical, ranging from 100 to 1,000 ohms for each of the three resistances, and 5 to 10 micro-microfarads for the condenser. This coupling has the great advantage of reducing the radiation from oscillating receivers, and, as these must usually be worked on the edge of oscillation on account of the low field-strengths, this is a very important feature. In the receiver used at Jena (e.g. on March 26, this year when an ultra-short wave receiver was successfully used to feed a broadcast transmitter in lieu of the normal land-line link) a screen-grid tube was used as antenna-coupling in place of this resistance-T, but the simpler method seems to suffice. The only satisfactory control of regeneration is by a variable resistance (shunted by a block condenser) in the +B lead.

One of the superregenerative receivers used at the Heinrich Hertz Institute, where this type of receiver is specially favored, is shown in Fig. 2; no comments appear necessary. A photograph of an ultra-short wave receiver of the type used in Germany will be found in the Digest of Foreign Literature in the November issue of *Electronics*, page 205.

Double demodulators

If, however, it is not a question of direct ultra-short wave programs, but of the reception of such waves modulated by a broadcast frequency carrying a program (double modulation) the "first detector," to be connected to a normal broadcast receiver, takes the form of Fig. 3, "A" being tuned to the ultra-short and "X" to the broadcast wave. If grid detection is preferred, the usual grid resistance must be replaced by a circuit tuned to the broadcast wavelength and possibly with regeneration applied (Fig. 4). Alternatively a circuit such as that of Fig. 5 can be used, where A_2 controls the regeneration and also serves as a stopper for the ultra-short waves.

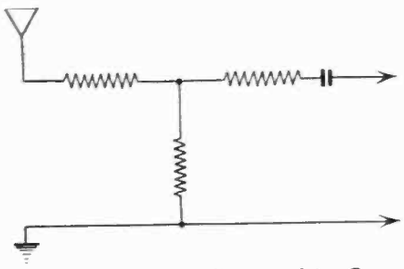


Fig. 1—Antenna coupling used in Germany

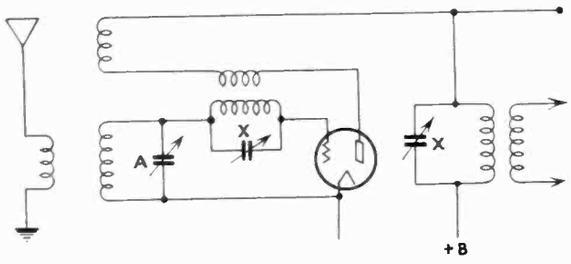


Fig. 2—Super-regenerative circuit (Heinrich Hertz Institute)

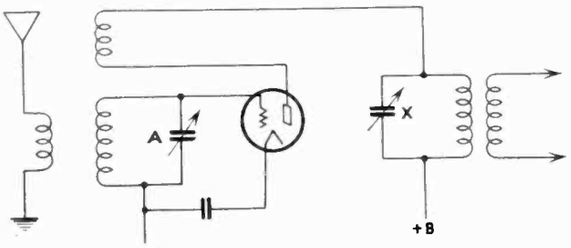


Fig. 3—First detector for ultra short-wave superheterodyne

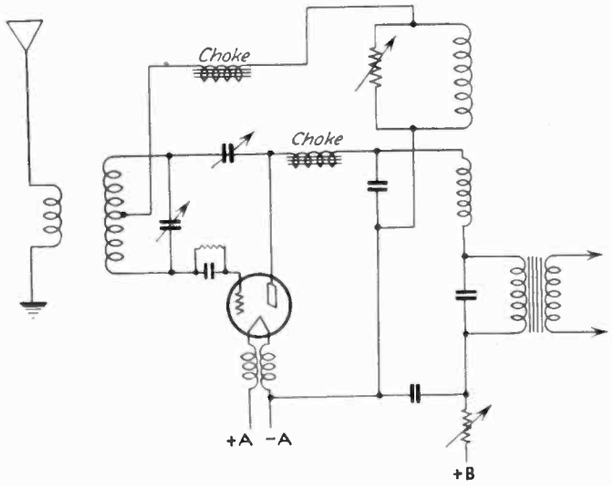


Fig. 4—Regenerative grid-circuit detector

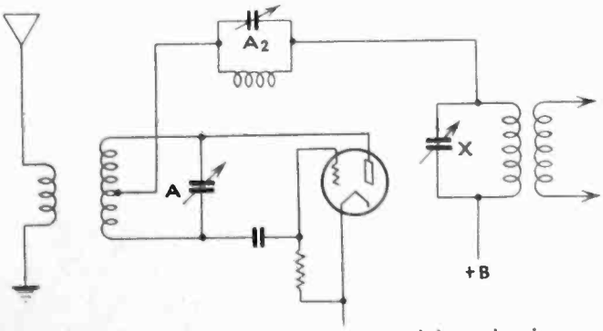


Fig. 5—Rejector-regenerator receiving circuit

electronics

McGraw-Hill Publishing Company, Inc.
330 West 42d Street
New York City

O. H. CALDWELL, *Editor*

Volume IV — JANUARY, 1932 — Number 1

Electronics, Volume IV

WITH this issue, *Electronics* enters upon its fourth volume.

First appearing in April, 1930, the number now in the reader's hands is the twenty-second monthly issue.

The present editorial organization includes the same names with which the first issue was launched. Following the usual McGraw-Hill plan of retracing the publication's history and bringing it down to date in each first-of-the-year number, we list the present editorial set-up: Orestes H. Caldwell, editor; Keith Henney, associate editor; Dr. Franklin S. Irby, contributing editor.

Oscillograms as a logical form of written speech

SPEAKING at a New York session of the Motion Picture Engineers, Leopold Stokowski, famous director of the Philadelphia Orchestra, pointed out the difficulties which the musician, who undertakes to reproduce a master's composition, finds in interpreting from the crude hieroglyphics of written music, just what effects were in the composer's mind. Dr. Stokowski confessed that he felt his own renditions sometimes fell far short of the original conception of the creative artist.

To replace the gross markings on paper of the musical score, Dr. Stokowski suggested that some of the new improvements in musical recording, utilizing the full range of frequencies up to 9000 cycles, might be used by future composers, to put down their thoughts directly in a more responsive medium,—one capable of conveying the most delicate shades of emphasis and color.

But has not Dr. Stokowski's suggestion wider applications to our written language as well? The printed speech on this page consists of a succession of conventionalized ideographs, which we have learned to recognize quickly only through training and practice. Would a child starting fresh have any more difficulty in learning the actual oscillograph wave-forms themselves?

There we would have a rational, natural medium for communicating ideas—complete with all the finest shadings of intonation and meaning,—something no mere string of adjectives or words could picture. Indeed such an oscillogram script would be as much richer in conveying impressions and sense of reality, as a photograph is superior to a crude mechanical drawing.

With the inevitable wider use of sound recordings, it may be that "reading the sound-track" will some day become as much the ordinary thing, as reading the totally unrelated and empirical ideographs which make up our cumbersome written language.

Fifty-fifty between radio "replacements" and new homes

A GREAT deal of curiosity has been expressed in the radio industry as to what proportion of the radio sets now being sold each year, find their way into homes hitherto without radios, and what proportion are sold as "replacements" to homes wanting a better or newer set.

To get definite figures on this point, the publishers of *Electronics* recently circularized a thousand radio dealers in different parts of the country. On the basis of the replies so far received, the ratio stands as follows:

Fifty-two per cent of the sets sold by these dealers went into homes that had previously had no radio sets. The remaining 48 per cent went into homes already equipped with radios.

Metropolitan Opera "on the air" in 1931—and 1910!

IN THE minds of many, the greatest radio event of 1931 was the broadcasting of the Metropolitan Opera—"Hansel and Gretel"—on Christmas Day. After holding out against radio for many years, the Metropolitan Opera management finally acknowledged the adequacy of radio and permitted installation of the new parabolic-reflector microphones to pick up the music.

Although the Metropolitan has long been a holdout against radio, this was not the first time it had gone on the air. To Metropolitan belongs the credit for supplying the talent for one of the earliest broadcasts. On the evening of Jan. 13, 1910, Dr. Lee de Forest arranged a broadcast of a performance starring Enrico Caruso, directly from the stage for the benefit of a group of wireless men and passengers listening-in aboard a ship docked in New York harbor and for reception by amateurs around New York City with whom he had been cooperating in experiments. The broadcast was carried out with success despite the crude apparatus then available.

Light-controlled schoolroom produced better grades

THE test carried out at Tuscumbia, Ala., where a photo-cell control was installed in a fourth-grade schoolroom to provide uniform intensity of illumination, will be of wide interest to educators, and should have great influence in extending the use of light-control apparatus in schools and other places where close application of the eyes is required.

This school-room unit automatically turns on the electric lights whenever the natural outdoor illumination falls below the required intensity. Again when clouds have passed off and the natural light brightens, the photo-cell switches the lights off.

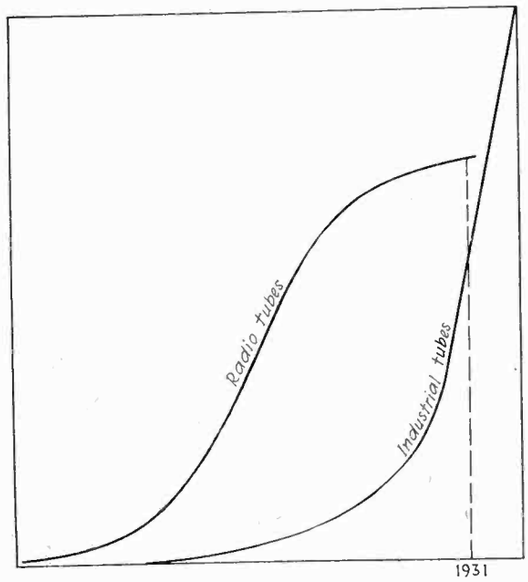
After a three months' test it was found that artificial light was used about one-third of the time, and that the average grades of the students in the test room were considerably higher than those in the other half of the same class in another room. As a double check, the two sections of the class were then switched, and again the new class in the test room showed marked improvement over those relegated to natural lighting and manual control.

A survey of American school buildings shows that there are at least 400,000 schoolrooms in electrically lighted buildings which might be equipped with such illumination-control units.

Industrial tubes on the up and up!

IN the production of radio tubes, the rapid ascent of the curve of a few years ago, is now showing signs of slowing down. The "knee" of the graph is being reached, as saturation takes a hand in braking the early rush of demand.

Contrasted with the present slow rise of radio-tube output, is the rapid and steep ascent of the



increase in industrial-tube sales. While production is still small in relative numbers, the rate of increase here in the industrial field has been utterly phenomenal and has outrun all predictions of those who had studied this field in advance.

Industrial-tube production is on the up-and-up. It offers "green fields" for those who look over the fence from the now closely-cropped meadows of radio land!

The march of the electronic arts

"Open Patent Pool" in sight

INQUIRY AT THE Department of Justice at Washington indicated that with the coming of 1932, steps were being concluded for setting up an open patent pool in radio, to be administered by three trustees, one representing the Department, one the Radio Corporation of America, and the third to be selected by these two.

Meanwhile the original suit against the Radio Corporation filed by the Government months ago, will be prosecuted on greatly narrowed issues, it is understood. This suit will be carried before the Courts to the point of getting adjudication on several questions, but with the matter of the patent pool definitely removed from the case.

Complaint has been filed by some of the independents that the proposed pool may be "too wide open" for the good of the established independent radio industry, permitting and encouraging radio newcomers or any one to take out licenses. This prospect of twenty or thirty additional radio manufacturers is guarded against, it is explained, by the provision for wide discretionary powers given the trustees who can use their own judgment as to granting additional licenses.

1932 census of radio manufacture

THE U. S. CENSUS BUREAU soon will submit forms to all radio manufacturers for the bi-annual manufactures census. This is the first year that radio has been considered as a distinct industry by the Census Bureau. The 1932 census will be based on f.o.b. factory prices of radio products, following the general federal practice, and will cover receiving sets in groups of various price ranges. Television, tubes, phonographs and other completed radio products, not including component parts, will be included in this manufactures census.

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Canada's radio production

CANADA'S 1930 PRODUCTION of radio receiving sets totaled 223,228, valued at $22,776,000, while exports of radio equipment from the United States continue high. This would indicate that the Dominion government figures showing around 500,000 Canadian set owners paying the $1 per year license fee do not provide a true index to the size of the Canadian radio audience.

✦ ✦ ✦

DIAL TO GET LATEST STOCK PRICES

With this new wire service offered by the Western Union Company, the subscriber, by dialing number of stock desired, will receive opening, high, low and closing prices

To teach schools how to select radio equipment

AN AGREEMENT HAS BEEN reached between the RMA and the U. S. Office of Education, Department of the Interior, for cooperation in preparing a booklet to promote radio in education and the equipment of schools with radio and sound apparatus. Plans for the proposed booklet were made at a meeting between Dr. C. M. Koon, chief of the radio activities of the U. S. Office of Education, and A. C. Kleckner of Racine, Wisconsin, chairman of the special committee.

Orrin E. Dunlap, Jr., who for many years has been radio editor of the *New York Times*, has been engaged as editorial director of the school booklet. Mr. Dunlap is the author of several books on radio subjects.

✦

Finds 50 per cent fewer sunspots, better DX radio

Addressing the American Astronomical Society at Washington, D. C., Dec. 28, Dr. Harlan T. Stetson, director of the Perkins Observatory of Ohio Wesleyan University, announced his most recent studies of the relation between sun spots and radio reception. At his observatory in Delaware, Ohio, he makes nightly records of the reception of radio signals from Station WBBH in Chicago, 300 miles away.

During the past year, Dr. Stetson stated, the sunspots decreased about 50 per cent, and this was accompanied by an improvement of about 400 per cent in the intensity of the signal from WBBW.

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Radio Engineers at Pittsburgh April 7 to 9

THE SEVENTH ANNUAL CONVENTION and parts exhibition of the Institute of Radio Engineers will be known as the Twentieth Anniversary Convention in commemoration of the founding of the Institute in 1912. It will be held at the Hotel William Penn, Pittsburgh, Pa., on April 7, 8, and 9. Plans are being prepared for an excellent program of technical papers by prominent engineers, as well as trips of high educational interest to those who will attend.

The date is particularly well suited to the receiving-set design engineer who will be enabled through the parts exhibition to make a final survey of all that the parts manufacturer has to offer, before completing receivers to be displayed at the RMA show in Chicago, scheduled for May 23 to 26.

Soviet Union expanding all its radio services

SOVIET RUSSIA IS TO HAVE its own Radio City in Moscow by 1933, according to advices reaching the Soviet Information Bureau in this country. It will be known as Radio Center and, besides being a center of scientific and experimental work, it will be the focal point for the Soviet Union's expanding broadcasting and short-wave systems.

The Supreme Council of National Economy, says the report, is to build three more 100,000-watt stations during the next year at Kiev, Minsk and Sverdlovsk and 14 stations at various points of 10,000 watts power each. These will supplement and in some instances replace existing services that are regarded as inadequate. Moscow already has its Komintern station rated at 100,000 watts, which with the 100,000-watt station in Rome and the 160,000-watt station in Warsaw, represents the highest powered broadcasting being done on a regular schedule in the world.

✦

Ultra-short wave in Hawaii telephone service

WHAT CONSTITUTES THE first practical employment of ultra-short radio waves, which for many years have remained one of the curiosities of radiotelegraph experimental work, has been accomplished with the establishment of the new, inter-island radio telephone system of Hawaii.

The development is regarded as an important milestone of radio, as it taps an altogether new reservoir of wavelengths for commercial utilization. Such an ultra-short wave communications system lends itself to duplication in other archipelago, and particularly in those of the tropical regions. For this and similar short distance communication purposes the ultra-short waves provide definite advantages in reliable, continuous communication although the efficiency of frequencies now employed for long range communication remains unchallenged.

Ultra-short waves have many of the properties of light waves, which do not tend to follow the curvature of the earth. In the Hawaiian system they are transmitted from point to point on the same plane, without intervening mountains or other intervening obstacles. This condition was met by locating the Hawaiian stations on top of the mountains and in a direct air line with stations on the mountain peaks of other islands. Mathematically exact surveys were conducted so as to permit a perfect alignment of sending and receiving antennae at the different stations.

Although ultra-short waves provided, in this instance, the solution to transmission through the ether without static or interference, the apparatus which generated the waves was extremely critical of adjustment. A transmitter on so short a wavelength is subject to "frequency drift" or shifting of wavelength, from very slight causes.

The usual engineering method of maintaining a transmitter on its assigned wave by the use of crystal control was not used in this installation, but instead, a new development known as the "Long Line Frequency Control," designed by RCA engineers has been installed. This is an electrical circuit, with no tubes and no moving parts, connected to the five-meter transmitting circuit. Its action is to correct automatically and entirely by electrical means any tendency of the transmitter to stray from its proper wavelength.

✦

WCAU constructing special workshop for Dr. Stokowski

WCAU, PHILADELPHIA, recently authorized by the Radio Commission to increase power to 50 kw., soon will have a new home, at 1618-20-22 Chestnut St. An important feature in the new studios will be the construction of a special workshop for Dr. Leopold Stokowski, conductor of the Philadelphia Orchestra. Dr. Stokowski has become intensely interested in radio broadcasting from the reception viewpoint, and many experiments will be carried on in his special workshop.

Chicago Section I. R. E. elects Hoag chairman

AT THE DECEMBER MEETING of the Chicago Section of the Institute of Radio Engineers, the following officers for 1932 were elected: Chairman, Dr. J. Barton Hoag, Ph.D., assistant professor of physics, University of Chicago; vice-chairman, Robert M. Arnold, formerly chief engineer radio division Grigsby-Grunow Company; secretary-treasurer, Donald H. Miller, Western manager, *Electronics* and *Radio Retailing*.

E. W. Ritter, head of tube development work, for RCA-Radiatron Co., Harrison, N. J., delivered a valuable paper on "The Use of Suppressor Grids in Pentodes."

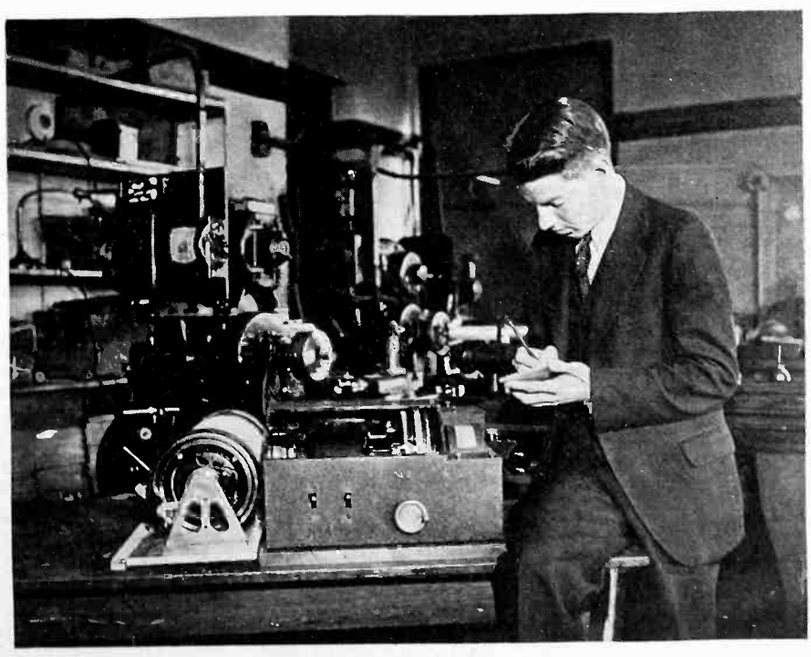
✦

Radio-controlled warships

WITH ITS DECISION to equip the U.S.S. Utah, so that it can be completely operated by remote control radio for handling its course and speed in bombing and gunfire tests, the U.S. Navy will have two radio-controlled ships. The destroyer Stoddert, based at San Diego, is already being used for that purpose. The Utah will be refitted at Hampton Roads for operations on the Atlantic. The Navy also plans to equip two other destroyers, the Kilty and the Boggs, as radio-controlled targets. The radio control of crewless vessels was first tried off Panama in 1923 when the old battleship Iowa was used as a target.

✦ ✦ ✦

HEIGHT OF LAYER KEY TO FADING



The Bureau of Standards has devised this machine for recording ever-changing height of Kennelly-Heaviside Layer. By transmitter combinations, fading might be continuously avoided

REVIEW OF ELECTRONICS LITERATURE

HERE AND ABROAD

Measurement of modulation

[KAMMERLOHER] Simple method of measuring the degree of modulation by the use of photographs of the oscillations recorded by a Braun tube, giving a maximum error of about 7 per cent and useable between 10 and 5,000 cycles.—*E.N.T., Berlin, October, 1931.*

✦

150 kw. tube for submarine radio

[BRACHET] Holweck and Chevalier have developed a tube of this type, especially for communication with submarines when below the surface, on 10,000 meters wavelength. Diagrams and photographs of the tube itself and of the sender in which it acts as amplifier to a 40 kw. master-oscillator are given. The filament, composed of eight parallel tungsten wires, takes 200 amperes at 40 volts, the plate 7,500 volts from dynamo or mercury rectifier.—*Science et la Vie, Paris, December, 1931.*

✦

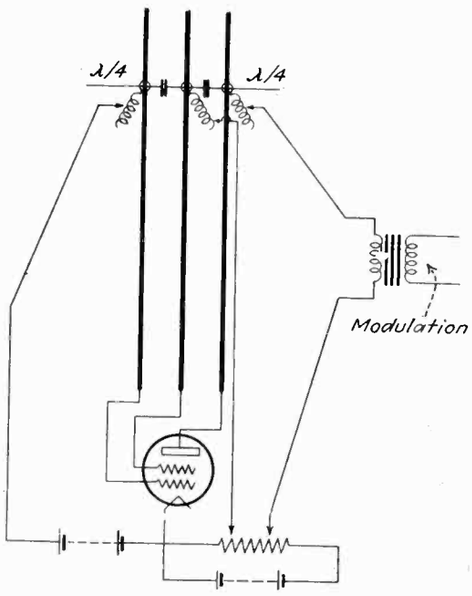
Influence of nodes in loudspeaker diaphragms

[M. J. O. STRUTT, Philips' Fabrieken, Eindhoven, and N. W. MCLACHLAN] Recent experiments (these Digests July, 1931), have shown that the diaphragm of a cone loudspeaker does not vibrate as a whole like a solid piston, but possesses circular and radial nodes at frequencies as low as 500 periods per sec. (wavelength 66 cm. in air). A well centered cone will only show circular nodes; these reduce the strength of the low notes in any case. If the natural frequency of the membrane corresponds to a wavelength in air which is much larger than the diameter of the diaphragm the response at all frequencies is much smaller than that of a solid piston. But if the lowest natural frequency corresponds to a wavelength in air which is of the same order as, or smaller than, the diameter of the cone, the sound radiation at all the higher frequencies is stronger than that given by a solid piston.

Strutt's theoretical conclusions receive support from experiments made with 5-inch cone loudspeakers, which show a resonant frequency at 900 cycles (one circle of least motion) and a second at 2,000 cycles.—*Annalen der Physik, September, 1931, Wireless World, August, 1931, Wireless Engineer, October, 1931.*

"Decimeter" waves

[RINDFLEISCH AND ROHDE] Chiefly relates to the Barkhausen methods, magnetron circuits being dealt with only in passing. A table of usable European tubes is given, with wavelengths obtainable and voltages to be applied. The most suitable has proved to be the French "Metal TMC" [in which the straight filament, spiral grid, and tubular anode may be represented in cross-section as a dot surrounded by two concentric circles]. The Telefunken RE 074 d, with two grids, is also suitable, with the circuit shown.



A similar arrangement but with two wires in lieu of three is used with triods and a photograph of such a transmitter is given. The Lecher-wire feed is used to stabilize the frequency, the doublet and the attached condensers and chokes sliding along these wires. The question of range is dealt with, also the use of a crystal receiver for checking modulation, degree of directivity, etc. Receivers of the same type as the sender but without Lecher-wire systems are described, with photographs; also two types of super-regenerative receivers.—*Funk, Berlin, November 20, 1931.*

✦

The latest

[H. G.] Swiss land-line radio: by paying twice the normal radio fee (30 francs, say $6 per year, instead of 15) telephone subscribers may attach a loudspeaker with one stage of audio-frequency amplification, costing about $30 (only approved types may be used) to their telephone line and thus receive the local program. No choice of program is given. In the case of a telephone call, the reception is interrupted. The distribution is over land-lines throughout, no radio transmission being involved, although the program is that of the radio sender.—*Radio B.F.f.A., Stuttgart, November, 1931.*

✦

"De amplificatoribus"

A NEW Siemens pamphlet with this title and written entirely in Latin strikes a new note in radio literature. It deals with the use of loudspeakers in churches, more especially with the installation recently made in Speyer Cathedral. The opening is "Qua de causa amplificatores in aedibus sacris adhibendos censemos" and a phrase later in the booklet is also worth quoting, if only for its reminiscence of the first lines of Caesar: "Apparatus omnes dividuntur in partes tres, quarum una microphonum appelatur, altera, quae vocatur amplificator, tertia illa, quam liceat appellare pronunciatorem."

Incidentally, "pronouncer" or "clear-speaker" is a welcome variation of "loudspeaker," and one which, thank Heaven, most modern apparatus fully deserves.—*Electronics, European Correspondent.*

✦

Time signal apparatus

[H. S.] Paris Observatory. The system consists essentially of an invar pendulum of high inertia, adjusted to swing in 60/61 seconds; and a potassium photocell with associated amplifier. The pendulum carries a permanent magnet, one arm of which enters a solenoid at each oscillation. It is normally driven by a current sent through this solenoid every minute by a standard clock, but before the commencement of the rhythmic signals this is disconnected and the pendulum is left entirely free for the five minutes of emission. A mirror mounted on the pendulum causes a ray of light to traverse the opening of a photo-cell at each oscillation. An auxiliary pendulum, driven normally by the standard clock but during the emissions by the main pendulum, serves to suppress alternate impulses from the photocell, to lengthen the remaining ones slightly and those corresponding to the "minutes" considerably, and to switch the signals over to the transmitter (the complicated system of relays is described).—*La T.S.F. Moderne, Paris, September, 1931.*

Acoustic "relaxation oscillations"

[HOLLMANN AND SCHULTES] It is possible to replace the condenser in a normal (neon tube or kallirotron) circuit in which relaxation oscillations are produced by the energy-storage in acoustic form in a room, wherein loudspeaker and microphone convert this energy from and into an electrical form respectively. The application of this phenomenon to acoustic measurements (more especially relating to damping and echoes) is discussed.—*E.N.T. Berlin, 1931.*

✦

DeBroglie electronic wavelengths

[A. RUPP] German El. Research Lab. Berlin and O. Eisenhut and E. Kaupp, Research Lab. I. G. Farben Oppau. In its action upon gases or metal layers the electron behaves somewhat like an electromagnetic wave of short wavelength. Its associated wavelength in cm. is given by the fraction $7.28/v$ where v is the velocity of the electron. Electrons which have fallen through a potential difference of 20,000 to 70,000 volts act like extremely short X-rays of wavelength 0.09 to 0.045 A (where $1A = 10^{-8}$ cm.) passing through a given material. They are rapidly absorbed, or reflected, however, in the first few hundred layers of a metal, so that they can only penetrate thin layers and give evidence as to the structure of thin solid films or surface layers, in contrast with ordinary X-rays which penetrate many thousand layers. A thin pencil of electrons was sent through thin films of platinum, gold, copper deposited on mica, and then allowed to act upon a photographic plate. The electrons appeared along a system of sharp rings after having passed through metal films prepared by evaporation at normal speed; from rolled films in which big crystals exist they emerge as separate pencils forming sharp spots along the rings.

The rings lose their sharpness when very small crystals only (20A.) are present in the film such as may be expected when the evaporation leading to formation of the film is extremely slow. The diameter of the ring is related to the distance between the layers of atoms as in the case of X-rays. When a film of copper is deposited upon a film of gold a separate ring system corresponding to gold and another corresponding to copper are formed. But on heating the films to 300° C. the gold rings become broader and broader and finally a single new ring system appears indicating that mixed gold-copper crystals have formed. There is no other way of following up these delicate changes except by studying the behavior of a bundle of electrons of the same speed. The same is true for the transparent surface films which protect aluminum and stainless steel from corrosion.

Owing to the frequent use which his laboratory makes of equivalent wavelengths of electrons, a convenient table has been prepared by Rupp who studied electrons of speeds as high as 100,000 to 250,000 volts.

Potential Difference (Volt)	Wave-Length in A, 10^{-8} Cm.
+0.1 volt	38.67 A
0.2	27.35
0.3	22.33
0.4	19.34
0.5	17.29
0.6	15.79
0.7	14.62
0.8	13.67
0.9	12.89
1.0	12.23
2	8.647
3	7.061
4	6.115
5	5.469
6	4.993
7	4.622
8	4.324
9	4.076
10	3.867

These wave-lengths belong to the X-ray range, a hundred to thousand times shorter than ultra-violet waves. A one hundred times larger potential difference corresponds to a ten times shorter wavelength. — *Annalen der Physik, August 1931; Zeitschrift f. Elektrochemie, August, September 1931.*

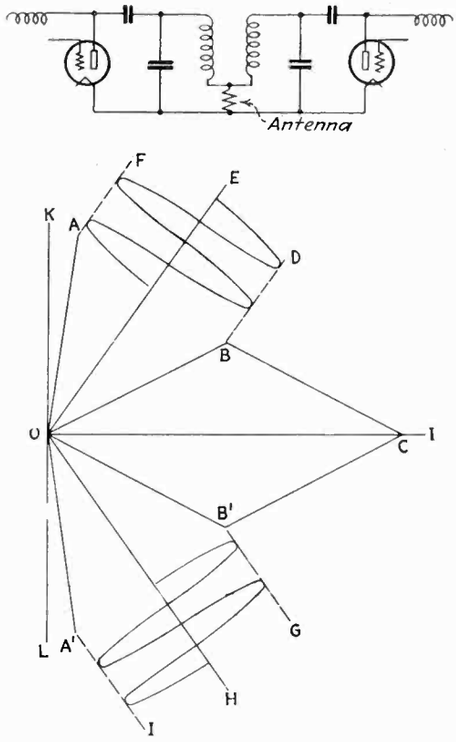
✦

Measurements of ultra-short-wave field strengths

[SOHNEMANN] (Communication from the Heinrich Hertz Institute). An instrument is described, consisting of a detector with regeneration set well into oscillations (and not on the edge as in the case of similar instruments for longer waves) to which a super-regenerative tube is added. Measurement is by the decrease in plate current with the received signal (as in the case of normal longer-wave measurements) or by the strength of the typical super-regeneration noise, this being measured by a tube voltmeter after audio-frequency amplification. The constants of the instrument are obtained by measurements in the known field of a small sender. Examples of results are given, more especially of the changes in field strength that result when the receiving antenna is rotated in a vertical plane normal to the line joining sender and receiver, the curious result appearing that not only is maximum reception not obtained with vertical antenna, but that the inclination of the antenna from the vertical for maximum strength varies from day to night and according to the state of the sky, being greater both by day and night with a cloudless sky. It was found that, for a city area, the ratio of actual field strength to that calculated (i.e. inversely to the distance) was e^{-aR} where R is the distance and a was from 0.3 to 0.5—*E.N.T., Berlin, October, 1931.*

Chireix system of plate modulation

IN THE DIAGRAM, the resistance corresponds to the antenna, the two circuits are in phase-opposition so that normally no current flows therein. If now the phases of the grid-excitation are deplaced, current flows in the antenna, the currents in the two opposed circuits varying between OA and OB



and that in the antenna between OC and a value approaching zero. As a result, practically 100 per cent modulation is obtained with high exciting currents in each circuit, hence with good efficiency, about 60 per cent being claimed whereas plate modulation gives about 33 per cent only. An overall saving of some 130 kw. for an 85 kw. station is claimed, this being the power of the new "Radio Paris" sender at which this system is used.—*L'Antenne, Paris, November 22, 1931.*

✦

"Physikertag" at Bad Elster

[SCHÖNWALD] Brief description of the subjects dealt with at this meeting, more especially: Theory and applications of semi-conductors (Lange photocell, etc.); Grützmacher sound analysis by the production of beats between the components and a continuously varying heterodyne, the beat frequencies being automatically recorded by an oscillograph; electrostatic light relay, a thin reflecting plate being made to move under the influence of the speech currents and thus alter the intensity of the light.—*Funk Magazin, Berlin, December, 1931.*

New Telefunken director

MEYER, who has replaced Arco in this post, speaking on future developments: some of his remarks may be of interest in America, especially "the Americans build a cheap but relatively bad tube of short life only. We prefer on the contrary a stable tube at a distinctly higher price, but having the advantage of being long lived." He considers the German receivers better than British or American makes, as well as cheaper. As regards television, "in some years" something usable will probably arrive. Cable communication will last "for a few decades longer, just as horse transport has done despite the automobile." *Funk Magazin, Berlin, December, 1931.*

✦

Measurement of frequency and base modulation

[HEILMANN] A new method of measuring these undesired modulations in an amplitude-modulated transmitter is described, in which the modulated signals are heterodyned to an intermediate frequency and this fed to the control plates of a Braun tube so that a circular patch is formed on the fluorescent screen. By means of an auxiliary oscillator, with exactly the same frequency as this intermediate frequency or a multiple thereof, very short impulses are fed to one of the pairs of control-plates of the Broun tube. As a result, standing figures in the form of dark curves on the circular patch are produced, and from the form of these the existence and nature of the unwanted modulations can be deduced. Possible sources of errors and their avoidance are discussed.—*E.N.T., Berlin, November, 1931.*

✦

Fourier analysis of modulated radio frequencies

[GRÜTZMACHER] A simple method is described in which the transmission to be analyzed is heterodyned by an auxiliary frequency, the resultant rectified, and the difference-frequency filtered out and recorded. Some elementary cases are discussed vectorially and a simple formula developed to enable the degree of frequency-modulation to be obtained from the curves traced by the recording galvanometer.—*E.N.T., Berlin, November, 1931.*

✦

The recording and reproducing of sound

[A. G. D. WEST] Gramophone Company, His Master's Voice. The Cantor Lecture. On nearly 100 pages a valuable review of the subject is given dealing with sound characteristics and measurements, the acoustics of studios, the disk recording system, recording on wax, on film, the processing of film and disk records, mechanical and electric reproducers. Mention is made of a recently designed audio interstage transformer giving level amplification within ± 3 db. from 25 cycles to 30,000 cycles per sec.—*Journal Royal Society of Arts, October-November, 1931.*

✦

New high-efficiency photocell

MENTION, WITHOUT TECHNICAL DETAILS, of a new cell developed by the Lorenz Company, which gives an a.c. of the order of that obtained from a pick-up, thus greatly reducing the amplification required. The cell is usable with from 20 to 1,000 volts, and volume can readily be controlled by varying this voltage. Distortionless reproduction up to 25,000 cycles is claimed.—*Funk, Berlin, November 20, 1931.* See also report in *Funk Magazin, Berlin, December, 1931,* of a public film demonstration with these cells, where mention is also made that the capacity is only about ½ micromicrofarad, the internal resistance some hundred thousand ohms, and the operation very silent.

✦

The cathode-ray oscillograph

[J. B. JOHNSON] Bell Telephone Laboratories. Forty or fifty years ago, when the properties of electron streams were analyzed, three-electrode tubes in which one electrode influenced the current electrostatically were constructed. The first to put these tubes to practical use was Braun in 1897; the first tubes had cold electrodes, but in 1905 Wehnelt constructed a hot filament tube which he could operate on the 220 volt power circuit. One of the most recent types of these oxide-coated filament tubes is the W. E. No. 224 cathode ray oscillograph. The anode, placed a short distance from the cathode, is a metal tube through which the electrons pass before entering the space between the deflecting electrodes. Filament and plate are enclosed in a narrow glass tube to reduce the space in which ionization may take place in the gas, (0.01 mm. argon). In addition, a disk with a hole in its center is placed between the two electrodes; it prevents heavy positive ions formed near the plate from bombarding the coated filament. The gas present reduces wall charges and helps getting a narrow beam at 20 m.a. In the plants of the Bell system alone more than 100 electronic oscillographs are in constant use for research, the supervision of speech transmission channels and for the control and calibration of manufactured products.—*See these digests December, May, March, 1931, Electronics November 1931.*

Plate detection of radio signals

[J. P. WOODS] Bureau of Engineering Research, University of Texas. The entire static characteristic of the three electrode vacuum tube, using the axis of grid bias as the zero axis

$$i = a_0 + a_1 e + a_2 e^2 + a_3 e^3 + a_4 e^4 + a_5 e^5 + \ldots$$

is considered and the rectified current in a pure resistance load calculated when a singly modulated signal of voltage e is applied to the grid, where as usual $e = E(1 + m \sin pt) \sin Pt$, E being the amplitude of the carrier wave of frequency $P/6.28$ modulated "m" per cent at the frequency $p/6.28$. The resulting plate current becomes simply $i = c_0 + b_1 \sin pt + c_2 \cos p_2 t + b_3 \sin p_3 t$ where c_0 is the direct current, b_1 the amplitude of the fundamental audio frequency, c_2 the amplitude of the second harmonic, b_3 that of the third, etc. For complete modulation ($m = 1$)

$$C_0 = A_0 + 0.75\, a_2 E^2 + 1.641\, a_4 E^4 + 4.51\, a_6 E^6 + 13.75\, a_8 E^8 + \ldots$$

$$b_1 = a_2 E^2 + 2.625\, a_4 D^4 + 7.734\, a_6 E^6 + 24.44\, a_8 E^8 + \ldots$$

$$c_2 = -0.25\, a_2 E^2 - 1.312\, a_4 E^4 - 4.834\, a_6 E^6 - 17.11\, a_8 E^8 + \ldots$$

$$b_3 = -0.375\, a_1 E - 2.15\, a_6 E^6 - 9.34\, a_8 E^8 + \ldots$$

This means that as the signal strength increases the strength of the higher harmonics increases, but evidently much more slowly than the strength of the fundamental, unless overloaded so that the view that as the input voltage increases the working characteristic approaches a straight line is not unjustified (ideal detector). (Thus when E increases, the amplitude of the fundamental increases at the rate of $2\,a_2 E + 10.5\, a_4 E^3$, that of the second harmonic by $0.5\, E + 5.25\, a_4 E^3$.) Similar conclusions are valid for "m" smaller than unity. If as is customary the grid voltage e' is reckoned from zero grid bias

$$i = A_0 + A_1 e' + A_2 e'^2 + A_3 e'^3$$

so that

$$a_0 = A_0 + A_1 B + A_2 B^2 + A_3 B^3$$

$$a_1 = A_1 + 2A_2 B + 3A_3 B^2 + 4A_4 B^3$$

where B grid bias

$$a_2 = A_2 + 3A_3 B + 6A_4 B^2 + 10A_5 B^3$$

$$a_3 = A_3 + 4A_4 B + 10A_5 B^2 + 20A_6 B^3$$

$$a_4 = A_4 + 5A_5 B + 15A_6 B^2 + 35A_7 B^3$$

The ideal detector (see *Electronics*, March, 1931), produces no harmonics. but the rectified wave contains high frequency components of frequency $P/6.28$ and amplitude $E/2r$, of frequency $(P + p)/6.28$ and amplitude $Em/2r$, of frequency $(2P + p)/6.28$ and amplitude $Em/9.42$, etc.

Numerical values and diagrams are given applying to 201*A* tubes, and a method is indicated for expressing the static characteristic as a power series.—*The University of Texas, Bulletin No. 3113 (1931).*

+ NEW PRODUCTS

THE MANUFACTURERS OFFER

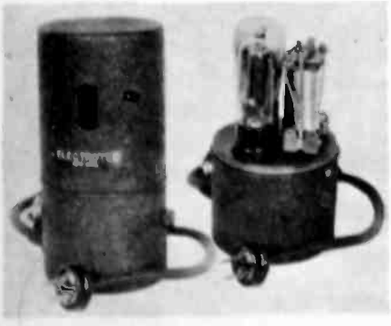
Sound equipment rectifier

RECTIFIERS ESPECIALLY DESIGNED for replacement of all storage batteries in present sound equipment installations have been announced by the Forest Electric Corporation, Newark, N. J. They are quiet in operation with complete elimination of hum claimed by the manufacturers for the largest sound systems. These rectifiers are available for 50-60 cycle, 100-120 volts or 220 volts if specified. The Forest rectifier supplies all low tension requirements of sound-on-film pickup. This includes the exciting lamp current and filament supply for the photocell amplifier. Filaments of the system amplifier relays, signal lamps, microphone and speaker fields are supplied with low voltage d.c. from the same projector rectifier by addition of a filter unit.—*Electronics, January, 1932.*

✦

Phototube relay control

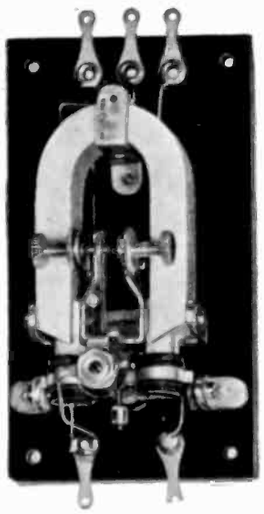
ELECTROTEC ENGINEERING CORPORATION, 180 Madison Ave., New York City, has developed a phototube light control unit that is universal in its applications. This unit has been designed so that it will meet any possible light control requirement. It has an external adjustment that may be set to



operate on a change of one-tenth of one foot-candle in illumination, from absolute dark to daylight or for impulse operation from light source. The Electrotec phototube relay is manufactured in three models, a.c., d.c. and battery, furnished with cord and plug, and terminals for open and closed circuit operation. All three models are housed in the same size case which measures 3½ in. diameter and 7 in. long. This company also manufactures a complete line of phototube light measuring, color and density matching equipment and invites inquiries on any electronic application.—*Electronics, January, 1932.*

Direct current milli-volt and micro-ampere relay

A NEW TYPE OF d.c. milli-volt and micro-ampere relay is announced by the Etna Electric Works, 410 East 15th St., New York City. This relay has two moving coils that are supported by a central hardened pivoted shaft which is held between the poles of a permanent mag-



net by bearings of sapphire jewels mounted in screws. Mounted on the central shaft are two spiral springs and the center contact bearing arm which serve to conduct the applied current to the coils and to the arm bearing the central contact point. They also serve to set the position of the arm in relation to the side adjustable contact screws.—*Electronics, January, 1932.*

✦

Three-element thermostat

TO RESPOND TO the demand of manufacturers of electrical heating devices and control systems for a compact three-element thermostat, the George Ulanet Company, 85 Columbia St., Newark, N. J., has developed its Pigmy thermostat. Its length is 1¼ in. and its cross-section triangular, ⅞ in. on a side. The sight hole in the bottom housing allows visibility of the contact and the temperature setting is adjustable by turning the contact screw which is accessible through the hole in the top housing. To prevent loosening of the contact screw, it is secured into a brass bracket by means of a tight full thread, effected by a special process.—*Electronics, January, 1932.*

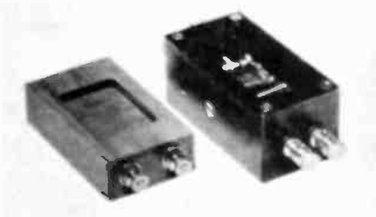
Hot cathode vapor rectifier

THE THERMIONIC LABORATORIES, 10 Liberty St., Kearney, N. J., announces a new hot cathode, indirectly heated, half-wave, high current density mercury vapor rectifier. The rectifier is rated at 35 amperes peak anode current and 500 volts inverse peak anode emf. The heater rating is 5 volts at 35 amperes. The over-all height of the tube is approximately 15 in. and the diameter is approximately 5 in. The indirectly heated cathode is so constructed as to prolong the life of the tube at least ten times over that of the usual hot-filament cathode. Instantaneous peak electron emission can therefore be had up to 145 amperes. This type of high efficiency cathode is now being embodied in the type '72, '75, and '69 hot cathode mercury vapor rectifiers.—*Electronics, January, 1932.*

✦

Light sensitive units

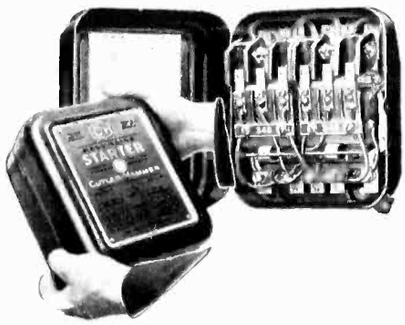
FOUR LIGHT SENSITIVE UNITS of the selenium type and a sensitive relay to operate from these units have been announced by Luxtron Devices Company, 338 Berry St., Brooklyn. These cells require the use of an auxiliary voltage and the various models are designed to operate from batteries or from 110-volt a.c. or d.c. potentials. The voltages required are as low as 1½ to 10 volts for the cell designed for direct reading photometry or sound motion



picture uses. The cell operating from a 110-volt line has an output of 2 milliamperes when placed 12 inches from a 40-watt frosted lamp. One cell, type "D," has a center tap so the effect of two cells in series or two in parallel may be obtained. The prices vary from $3.50 to $4.50. The relay closes at 1½ milliamperes minimum and the contacts will break or handle several watts. The tension of the spring on the armature can be regulated to vary the sensitivity. The resistance of the magnet can be had in several ranges, 1,000 ohms being the value usually made. List price, $4. —*Electronics, January, 1932.*

Automatic current controller

THE DEVELOPMENT OF an automatic current controller for arc projection machines, is announced by Cutler-Hammer, Inc., 243 N. 12th St., Milwaukee, Wis. This new controller is designed to replace the usual knife switches used to control the current to the carbons of



the projection machine, and offers many features for greater safety, less maintenance and better efficiency. The heavy currents required by the projection machine are handled by heavy duty magnetic contactors, of the same type as used in steel mill service. These contactors have magnetic blowouts which reduce arcing, resulting in longer life and reduced maintenance costs. Only the push-button master switch is mounted on the machine, near the operator—the controller proper can be mounted with the resistor in any out-of-the-way place.—*Electronics, January, 1932.*

✦

Photoelectric relay

THE ESSENTIAL ELEMENTS of the photoelectric relay recently brought out by the American Instrument Company, Inc., 774 Girard St., N.W., Washington, D. C., are a photoelectric cell with housing, vacuum tube amplifier, sensitive relay, lamp, and necessary connections. Due to the experimental nature of the application of this device, it has been made operable from batteries to obtain the greatest flexibility of control. The filament current is obtained by a small rectifying transformer of suitable capacity which is furnished with the instrument. The life of the batteries is practically the shelf life as they are called upon to furnish only a very small amount of current intermittently. List price of relay less batteries is $80.—*Electronics, January, 1932.*

✦

Relays for use with photocell

SEVERAL HIGHLY SENSITIVE RELAYS have been developed by the Weston Electrical Instrument Corporation, Waverly Park, Newark, N. J., especially for use with the new Weston Photronic cell. These include a miniature relay, auxiliary power relay and signal relay. The Weston miniature relay, designated as Model 634, is especially adapted for use in conjunction with an auxiliary relay. It is connected directly to the Photronic cell, without any amplifying tubes, batteries or auxiliary apparatus. The new miniature relay is a surface mounted, back-connected instrument, having a diameter of $2\frac{3}{4}$ in. It has three binding posts, the plus terminal being connected to both local and main circuits. There is a single contact which can be adjusted for any condition of light or dark operation, by a single turn of a screw mounted in the glass face.—*Electronics, January, 1932.*

✦

Condenser microphone

THE SHURE BROTHERS COMPANY, 337 West Madison St., Chicago, Ill., announces its Model 44 condenser microphone designed to meet the requirements for high quality radio broadcasting,

sound recording, and sound measurement tests. Manufacturers claim a uniform response from 40 to 10,000 cycles. High output level with tone quality is combined in the special design of this amplifier.—*Electronics, January, 1932.*

✦

Brazing alloy

THE UNIQUE BRAZING qualities of "Sil-Fos," a new low melting point alloy recently developed by Handy & Harman of 57 William St., New York City, have been recognized by the granting of U. S. Patent No. 1,829,903. "Sil-Fos" is recommended by the manufacturers for use on copper, brass, bronze, nickel, nickel-silver, extruded brass and bronze, monel metal and other non-ferrous metals and alloys fusing above 1,300° F. It contains a sufficient percentage of silver to give it easy flowing, penetrating and alloying properties. Joints are described as strong, sound, ductile and corrosion-resisting. Tests on copper lap joints are reported as showing tensile strength varying from 30,000 to 35,000 lb. per sq.in.—*Electronics, January, 1932.*

R.F. pentode

THE SYLVANIA DIVISION of the Hygrade Sylvania Corporation announces a new tube, the SY-239. This tube is an r.f. pentode, having super-control characteristics. It belongs to the automobile series, which already includes the SY-236, SY-237 and SY-238. The SY-239 is a super-control pentode for use as a radio frequency and intermediate frequency amplifier in automobile receivers or any receiver operating from 110-volt power line. The term "super-control" is used to indicate that the tube is similar in characteristics to the "variable" or "multi" mu tubes, types SY-235 and SY-551.—*Electronics, January, 1932.*

✦

Resistors

CONTINENTAL CARBON, INC., 13900 Lorain Ave., Cleveland, Ohio (in Canada, Continental Carbon of Canada, Ltd., 89 Jarvis St., Toronto), has been manufacturing the well known line of Continental resistors since 1923. This company was the first to introduce the now commonly used wire terminaled, color lacquered, radio resistor unit with terminals soldered to the resistor ends. It also manufactures suppressors, of the screw terminaled type, with the resistor element sealed in a ceramic tube. Suppressors are also furnished in two other styles of terminals.—*Electronics, January, 1932.*

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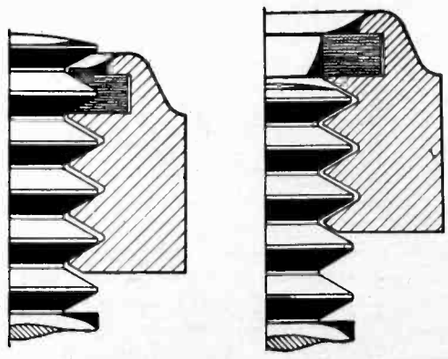
Elastic stop nut for electrical connections

THE VERY SIMPLE PRINCIPLE of elasticity has been applied to a patented lock-nut sponsored by the American Gas Accumulator Company of Elizabeth, N. J. An unthreaded fibre collar is



incorporated into a regular nut standard in all particulars. The resistance of the fibre to the entering bolt creates a permanent pressure between the load carrying side of the nut and bolt thread. Numerous applications in the radio, sound and allied fields have been made, including airplane radio, trimmers on variable condensers, etc. All standard sizes from No. 1 machine screw up are available.—*Electronics, January, 1932.*

Microphones

AFTER SIX MONTHS OF intensive development, the Electro-Voice Manufacturing Company, Inc., 338 East Jefferson Blvd., South Bend, Ind., has announced completion of its "electro voice" microphone. The damping chamber is removable and each individual microphone can be tuned separately. A variable stretched diaphragm and a screw type stretching ring that will exert pressure from every point, is used in its construction. The manufacturers claim a response of 30 to 7,000 c.p.s. with an output of 39 db. List price, $35.—*Electronics, January, 1932.*

✦

Self-starting synchronous motors

DESIGNED ESPECIALLY FOR driving the scanning disk of television cameras and receiving sets, a unique motor has been announced by the Ohio Electric Mfg. Co., 5900 Maurice Ave., Cleveland, Ohio. To provide for framing, the motor is mounted on trunnions and energized through collector rings so that it can be turned a few degrees or several revolutions. Phosphor-bronze bearings are used with oversize lubrication reservoirs capable of several thousand hours' operation on a single oiling. Normally, these motors employ a centrifugal cut-out switch to de-energize the starting winding which has been found to be most simple and rugged. For special circumstances, however, a condenser can be used with this motor, either to work in conjunction with the cut-out switch or to replace it. The motor is so designed as to bring the disk into step on potential voltages 20 per cent below normal.—*Electronics, January, 1932.*

✦

Motor radio suppressor kits

ELECTRICAL NOISES generated by the electrical system of the automobile and interfering with the automobile radio set, may now be eliminated by installing a kit of motor radio suppressors manufactured by the International Resistance Company, 2006 Chestnut St., Philadelphia, Pa. Each kit comprises the necessary suppressor units for installation in the spark plug leads and in the main distributor lead. The kits are available for four, six and eight cylinder automobiles, with the resistors packed in separate carton. Individual suppressors are available if desired. These units are moisture-proof because of impregnation with a special compound and are shock-proof, with terminals designed to withstand severe vibration. The resistor is imbedded in a high-grade ceramic tubing which is unaffected by heat and is non-combustible. The units have an exceptionally low capacity—less than ½ micro-microfarad.—*Electronics, January, 1932.*

Goggles for precision glass blowing

ASSURING MAXIMUM PROTECTION and comfort for the eyes, while at the same time offering perfect observation of the incandescent work in or out of the flame, the Burgess-Parr glass blower's goggles are an important contribution toward precision glass blowing.

The new goggles, now introduced by the Burgess-Parr Company, Inc., 202 E. 44th St., New York City, are based on the use of a special didymium glass which possesses the unique characteristic of transmitting all light except the objectionable yellow glare from incandescent glass. The pinkish lenses are mounted in a newly designed bakelite frame which provides comfort, eliminates the transmission of heat to face and ears, and is strictly non-inflammable. Also, the lenses are adequately protected against accidental breakage.—*Electronics, January, 1932.*

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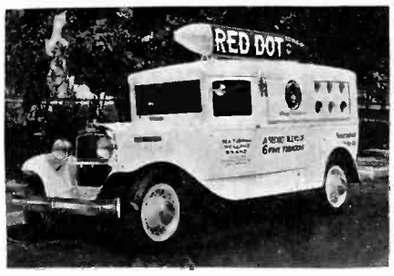
Sound-trucks for advertising purposes

ADAPTABILITY OF portable electric plants for radio sound trucks for broadcasting, advertising, and amplifying purposes is



rapidly opening up new fields of sales promotion. The RCA Victor Company, Camden, N. J., is now building portable radio units equipped with Universal Electric plants which furnish the necessary power. Either radio programs or records can be reproduced. The illustration shows one of the RCA Victor trucks used to advertise Red Dot cigars. It has outlets for 12 powerful amplifying speakers.—*Electronics, January, 1932.*

✦

Construction changes in socket design

CENTRAL RADIO CORPORATION, Beloit, Wis., has issued a chart giving complete mechanical characteristics of its series of CRC sockets. All models of these sockets are now available with the contacts attached to the base with eyelets as well as with rivets, and in the one-piece type, the combination insulator and guide plate being fastened to the base with two small eyelets. Copies of this chart will be gladly furnished on request.—*Electronics, January, 1932.*

Television tube

TWO TYPES OF television tubes have recently been announced by the Cable Radio Tube Corporation, 84-90 N. Ninth St., Brooklyn, N. Y. One of these tubes has an ignition potential of 100 volts average with an operating current of 10-20 m.a. It is designated the Wall Electrode type and may be operated directly in the plate circuit of a 71-A tube. The Crater type tube has an average ignition potential of 140 volts with a recommended operating current of 20 m.a. List prices of the two tubes are $3.50 and $7.50, respectively.—*Electronics, January, 1932.*

✦

New bulletins available

The Ohmite Manufacturing Company, 636 N. Albany Ave., Chicago, Ill., announces publication of a new stock list, Bulletin No. 10, which illustrates and describes Carbohm and Wirohm resistors. The bulletin lists 75 different values of carbon resistors in both one watt and one-half watt sizes, as well as 42 different values of wire-wound resistors.

The Jewel Company, Inc., of Waltham, Mass., is numbered among the newest of firms to invade the precision and electrical instrument field. It is the intention of the company not only to furnish jewels and jewel bearings to present users but to develop new uses for its product. An experimental staff will be maintained to assist product engineers and designers with their problems. The most modern equipment and approved methods of manufacture will be employed in this company's plant.

The Gates Radio & Supply Company, Quincy, Ill., announces publication of Bulletins Nos. 5 and 6 describing several new products added to its line, among which are the pick-up amplifier A-100, the American line of microphones and accessories, condenser microphones for broadcasting, recording and public address operation, and many other items of interest.

The Ward Leonard Electric Company, Mt. Vernon, N. Y., has recently issued Circular 514 listing its complete line of voltage dividers for the various radio sets on the market.

The Roller-Smith Company, 233 Broadway, New York City, announces a new bulletin and three new devices as follows: Bulletin No. 160 covering alternating current portable instruments, the Type T mounting base as covered by supplement No. 1 to catalog 48, the surface tension balance as covered by supplement No. 1 to bulletin No. 240 and the Type HTD-2 circuit tester as covered in supplement No. 2 to bulletin No. 300.

The Jefferson Electric Company, 1500 South Laflin St., Chicago, Ill., has recently brought out Circular 34R-3 describing its new Universal tapped output transformer, the No. 372 tapped for push-pull or straight audio-universal bracket and other new transformers.

The General Electric Company, Schenectady, N. Y., has recently brought out an illustrated booklet on plastic products, which describes in detail some of the many applications of Textolite, Fabroil, and Cetec. Various grades of these materials are described. Illustrations include Textolite Laminated in rods or tubing; laminated sheets; fabricated parts and molded products. Various forms of Fabroil are shown, including gears and gear blanks. Types of Cetec cold-molded products are given. Physical and electrical tables are included, covering Textolite laminated material.

General Radio Company, 30 State St., Cambridge, Mass., announces publication of Catalog F, Part 3. This section of the catalog lists new instruments which have been developed since April. These developments include instruments in almost every field covered by the activities of this company.

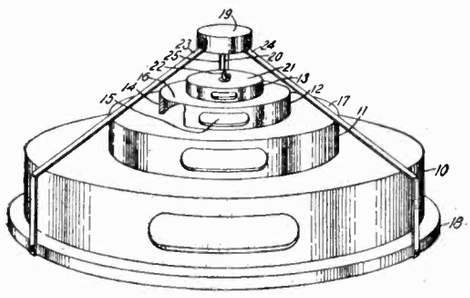
U. S. PATENTS

IN THE FIELD OF ELECTRONICS

A list of patents (up to Jan. 5) granted by the United States Patent Office, chosen by the editors of *Electronics* for their interest to workers in the fields of the radio, visio, audio and industrial applications of the vacuum tube

Acoustic Apparatus

Sound radiator. A plurality of resonators, each comprising an air chamber at a wall switch, including several diaphragms in a rigid portion, the mechanical resonant frequency of each resonator being the same as in the acoustical resonant frequency. These resonators are coupled in tandem, by means of diaphragm. R. L. Watel, assigned to B.T.L. No. 1,837,385.



Hum preventer. A method of neutralizing undesirable fluctuations produced in the moving coil of a dynamic speaker system. L. J. Bobb, assigned to Philco. No. 1,834,820.

Automatic monitor system. A light sensitive cell that responds to sound-modulated light and controls automatically the power delivered to a loud speaker. W. H. Kosken, New York, N. Y. No. 1,834,405.

Facsimile system. A method of modulating light by a plane-surface scanning system. W. M. Blower, assigned to Federal Tel. Co. No. 1,834,330.

Kerr cell recording. A method of recording by means of a Kerr cell, and of viewing the image of the line of light by a lens system. D. K. Zworykin, assigned to Westinghouse E. & M. No. 1,834,197.

Electric piano harp. Apparatus for producing damped musical sounds comprising generators of inaudible damped and undamped oscillations and means for supplying rapidly falling anode potential to an oscillator. J. Bethenod, Paris. No. 1,837,144.

Photo-electric circuit. A circuit for a light-sensitive cell, having electrodes each of which is adapted to act both as anode and as a light sensitive cathode. H. E. Ives, assigned to B.T.L. No. 1,837,364.

Oscillation generator. Tuned plate circuit oscillator with load winding divided so as to be equally disposed on opposite sides of the grid and plate winding, so that a substantially symmetrical field of distribution in the load winding is produced. Robert Goldsmith, Berlin, assigned to G. E. Co. No. 1,837,903.

D.C.-A.C. system. An electric power converting apparatus for transmitting energy between direct and alternating current circuits, containing a pair of tubes provided with non-insulated cathode heaters. C. A. Sabbah, assigned to G. E. Co. No. 1,838,001. Filed March 30, 1931.

Power conversion. Circuits relating to conversion of d.c. to a.c. by means of thermionic tubes. C. A. Sabbah, G. E. Co. Nos. 1,839,122 and 1,839,166.

Relay system. A.c. applied to grid and anode of identical frequency but out of phase. During negative half cycle of grid voltage plate voltage is high but low during positive half cycle. J. C. Warner, G. E. Co. No. 1,839,067.

Combining energies. Combining energies to obtain either sum or difference frequency. C. W. Hansell, RCA. No. 1,838,763.

High frequency generator. Rotating device for converting commercial frequencies to high frequencies. H. F. Fisher, Petroleum Rectifying Co. No. 1,838,931.

Piezo oscillator. Piezo-controlled double-grid oscillator. Alfred Crossley, Federal Tel. Co. No. 1,830,642.

Regulating device. In a conventional choke coil-condenser, filter for a rectifier system, a gas tube is connected across the circuit between the two filter chokes to ground. A. B. Asch, New York, N. Y. No. 1,829,254.

Voltage regulator. A method of using two or more glow tubes in series to maintain constant voltage. H. C. Rentschler, assigned to Westinghouse Lamp Co. No. 1,835,121.

Direction-finding apparatus. A combination of a directional and non-directional antenna, and method of rendering tuning of the directional antenna immune from adjustments of a balancing system. E. R. Fisher, assigned to Federal Tel. Co. No. 1,834,274.

Harmonic generator. Piezo-electric oscillator whose output circuit can collect and sustain several harmonics of the fundamental frequencies. R. H. Worrall, assigned to Federal Tel. Co. No. 1,834,233.

Resistance-controlling device. A method for inserting or removing resistance according to the value of resistance in a circuit comprising two electro-magnets, etc. L. Flandrin and George B. Levy, Paris, France. No. 1,834,832.

Filter system. Filter comprising a choke, consensers, output dropping resistances of conventional type. W. E. Holland, and W. H. Grimditch, assigned to Philco. No. 1,834,778.

Rectifying system. An a.c. supply circuit, two rectifiers for supplying the load with direct current, and a controlling reactor. V. L. Osgood, assigned to Ward Leonard Electric Co. No. 1,834,416.

Piezo generator. A two-tube generator in which contacts through the crystal are made for both the screen grid and the plate circuit of the tube. J. R. Harrison, Middletown, Conn. No. 1,834,155. Also 1,834,154.

Electrical meter. Variable impedance across terminals of an a.c. ammeter of rectifier-d.c. meter type such that its variations of impedance with frequency give a value of d.c. through the coil that has a fixed relation to the value of the a.c. irrespective of frequency. J. H. Morecroft, No. 1,836,934.

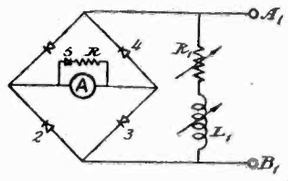


Plate circuit excitation. A parallel filter system for passing rectified current to the plate circuit of a multi-tube set. A closed winding, loosely coupled to a filter inductance is utilized to protect the shunt capacity upon opening the load circuit. G. B. Crouse, assigned to Connor Crouse Corp. No. 1,835,015.

Voltage regulator system. Variable source of high potential dissipating resistances to obtain current at low potential, and an electrical load operating at this lower potential. The use of a 3-element gas discharge tube to maintain the voltage. W. P. Koechel, assigned to Westinghouse Lamp Co. No. 1,835,061.

Re-radiation preventer. Use of a 3-element tube in a bridge system for preventing re-radiation in antenna system. R. A. Weagant, and G. A. Somersalo, assigned to DeForest Radio. No. 1,835,126.

Power supply apparatus. A method of connecting independent receiving circuits each to its own filter power supply system, and through additional filter circuits between the respective power supply apparatuses, to have them mutually connected together. E. R. Hentschel, John Olson, Wired Radio, Inc. No. 1,835,395.

Frequency multiplier. A direct current, magnetized generator of harmonics. Mendel Osnos, assigned to G.D.T. No. 1,829,419.

Rectifier. A full wave rectifier using a thermionic tube and two voltage-regulator tubes in the secondary of the power supply transformer. J. G. W. Mulder and E. Oosterhuis, assigned to Philips. No. 1,829,603.

Electronic Applications

A system for comparing light intensities. A light comparator, comprising two light-sensitive cells, amplifying tubes, plate impedances, constituting two arms of a bridge and indicating meter. H. H. Sheldon, assigned to Sheldon Electric Corp., N. Y. No. 1,834,905. Figure from British patent No. 356,017.

FIG.1.

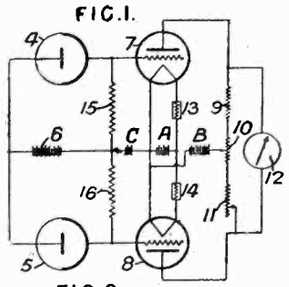
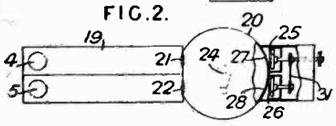
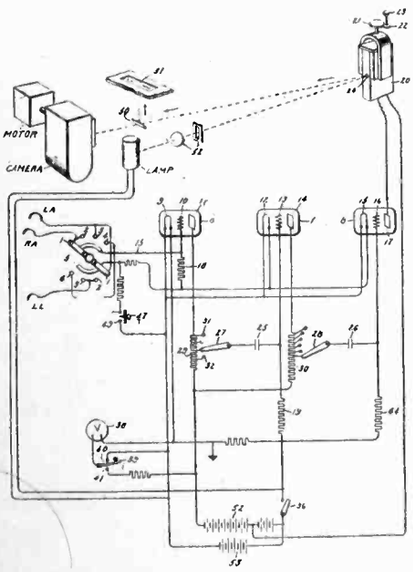


FIG.2.



Electro-cardiograph. A resistance coupled amplifier, a method of approximately calibrating the degree of amplification, a method of causing a pre-determined test voltage to be applied to one of the two. H. B. Marvin and J. K. Leiving, assigned to G. E. Co. No. 1,837,913.



Automatic steering. Use of vacuum tube to control steering of dirigible craft. E. A. Sperry. No. 1,838,965.

Statistical machine. Use of light beam and phototube for adding, sorting and other statistical operations. E. Goldberg, Dresden. No. 1,838,389.

Wave explorer. System for locating concealed objects by use of directional short waves. R. W. Deardorff, Contra Costa County, Cal. No. 1,838,371.

Follow-up system. Triodes used in follow-up circuit for gyro compasses. H. C. Drake, assigned to Sperry Gyroscope Co. No. 1,838,084.

Train control. Train-carried tube circuit is influenced by rail currents for control purposes. A. G. Williamson, Union Switch and Signal Co. No. 1,828,632.

Regulating system. A triode system for regulating the output of a dynamo electric machine. Friederich Carz, assigned to G. E. Co. No. 1,834,887.

Sound recorder. Apparatus for recording sound by means of a light-emitting crystal which is modulated by the sound to be recorded. H. J. Küchenmeister, Berlin, Germany. No. 1,835,226.

Inverter. A method for converting direct current into alternating current by electrostatically-controlled oscillations. The current is permitted to flow through the valve only for a portion of the cycle, and the valve voltage during current flow is minimized to a degree limited solely by the characteristic of the valve. L. A. Hazeltine, assigned to G. E. No. 1,835,156.

Recording system. A pair of crossed-light polarizing devices, and a means for rotating the plane of polarized light by electrical oscillation. R. V. L. Hartley, assigned to W. E. Co. Re-issue No. 18,274.

Amplification, Etc.

Series filament connection. A method of connecting a number of filaments of tubes in series with other resistors, and getting various voltages for grid and plates from the drops across these resistances. W. H. Holden, assigned to A. T. & T. No. 1,833,968.

Kerr cell control. A method of applying signal voltages to the electrode of a Kerr cell, and superimposing upon said voltages a certain high frequency voltage for preventing a collection of deposits upon the cell electrode. G. M. Wright, assigned to RCA. No. 1,834,117.

Power supply system. A method of supplying power from a rectified a.c. source, to a radio receiver. B. F. Meissner, assigned to RCA. No. 1,834,414.

Remote control. Remote control system for radio receiver. J. J. Christoffel, Chicago, Ill. No. 1,833,986.

Frequency discrimination. In an amplifier, circuits having an effective resistance variable at a pre-determined rate in accordance with changes in frequency, prevent the flow-back of undesired oscillatory current, while permitting the free transfer of signalling energy at the desired frequency characteristic. Marius Latour, assigned to Latour Corp. No. 1,834,408.

Power supply. Several sources of a.c. rectifiers individual to each source, means of connecting them as to add rectified voltages. W. E. Holland and W. H. Grimditch, Philco. No. 1,837,125.

Electric wave generator. A method of using part of the energy of an oscillating tube for supplying a constant grid bias for the tube. Felix Gerth, assigned to C. Lorenz. No. 1,835,387.

Modulating system. Between an oscillator and a high-frequency amplifier is an intermediate circuit in which modulation takes place. Felix Gerth, Berlin, Germany. No. 1,835,388.

Oscillation generator. Tuned plate circuit coupled to grid through mutual inductance and coupled to plate to resistance. System of arriving at desired frequency by consecutively varying inductance and capacity. R. E. Coram, W.E. Co. No. 1,836,839.

Radio Circuits

Remote control system. Alfred Ristow, Berlin, Germany. No. 1,837,999.

Volume control. Simultaneous control of voltage output of interstage transformer and output electrode. O. E. Marvel, General Motors Radio Corp. No. 1,839,109.

Circuit for Loewe multi-tubes. Regenerative circuit. Siegmund Loewe, RCA. No. 1,838,855.

Secret radio system. Low frequency supersonic wave is wobbled and transmitted, after modulation. J. H. Hammond. No. 1,838,762.

Facsimile, Television, Etc.

X-ray scanning. Use of narrow beam of X-Rays for exploration of subject to be transmitted. A. Dauvillier, Paris. No. 1,838,537.

Synchronizing system. Modulating galvanometer at a speed which bears a definite relation to scanning speed. W. Scheppmann, No. 1,838,709.

Vacuum Tubes, Photocells, Etc.

Photo-electric tube. A manufacturing patent granted to V. K. Zworykin, Westinghouse E. & M. Co. No. 1,837,744 and 1,837,746. Also a construction patent on a glow-discharge tube, No. 1,837,745.

"S" tube. Patent filed in 1923 for the well known "S" tube. C. G. Smith, assigned to Raytheon, Inc. No. 1,838,458.

Crystal oscillator. Method of mounting quartz crystal in evacuated envelope. E. D. Tillyer, American Optical Co. No. 1,836,735.

Patent Suits

Re. 15,278, I. Langmuir, Electron discharge apparatus D. C., S. D. N. Y., Doc. 46/307, Radio Corp. of America et al. v. Gold Seal Electrical Co., Inc. Consent and order of discontinuance (notice Sept. 28, 1931).

1,558,437, I. Langmuir, Electrical discharge apparatus; Re. 15,278, same, Electron discharge apparatus; 1,537,708, W. Schottsky, Thermionic vacuum tube; 1,696,103, G. Seibt, Electric discharge tube, D. C., S. D. N. Y., Doc. E 54/30, Radio Corp. of America et al. v. The Dale Co. Consent order of discontinuance (notice Sept 28, 1931).

1,456,528, H. D. Arnold, Electric discharge device; 1,459,412, A. M. Nicholson, Thermionic translating device, D. C., S. D. N. Y., Doc. E 54/29, Radio Corp. of America et al. v. The Dale Co. Consent and order of discontinuance (notice Sept. 28, 1931). Doc. E 46/308, Radio Corp. of America et al. v. Gold Seal Electrical Co., Inc. Decree as above.

1,757,357 (a), Cramer & Cramer, Electrical condenser; 1,800,719, S. S. Cramer, same, filed Oct. 6, 1931, D. C., S. D. N. Y., Doc. E 62/199, Radio Condenser Co. v. De Jur-Amsco Corp.

Effects on reception of over-modulation

[*Continued from page 9*]

These observations led to the following experiment. A signal generator with a fairly straight modulation characteristic having a sharp cut off was operated under conditions producing results similar to those represented in Fig. 1. A selective superheterodyne receiver was tuned to the signal generator which was set for twenty microvolts output. When the volume control on the receiver was slightly retarded to prevent overload, the relation between receiver output volts and generator modulation volts was as shown by curve A Fig. 3. With the receiver tuned 25 kilocycles off the frequency of the generator, the relation between the same two variables was as shown by curve B. In this case the signal generator produced an output of 80,000 microvolts. However, even with this level of signal, no audible or measurable interference could be noted until the modulation reached the neighborhood of 100 per cent when a sudden rise occurred as shown by the graph. In both cases a 400 cycle modulation frequency was employed. The signal levels used in the two instances were of the same order as those produced by distant and local stations respectively.

With the higher limit of modulation frequencies maintained at approximately 5000 cycles and with no distortion of the carrier envelope, interference of the type described would be eliminated. The use of "band-pass" selective circuits in the transmitter might reduce the interference even if the over-modulation occurred. However, the limiting of spectrum extension would not correct the audio distortion. All harmonics falling below 5000 cycles would still be present as well as the host of cross-product frequencies which must be produced when the exceedingly complex studio signal is impressed on a modulation characteristic which shows what practically amounts to a discontinuity.

Listening tests made with audio amplifiers indicate that distortion is not particularly noticeable even when a considerable per cent of the lower harmonics is present. However, when the amplifier is made to operate over a portion of its characteristic having a sharp break, distortion is very objectionable and easily identified and seems to consist of noises or rattles rather than a change of tone quality in the ordinary sense.

The effects enumerated may also be obtained to a certain extent even without modulation in excess of 100 per cent if the portion of the modulation characteristic in use departs sharply from linearity.

It would seem then that faulty modulation which may vitiate all efforts to obtain high selectivity and pure audio quality should receive careful consideration by those responsible for broadcast practice.

Economics of police radio reception

[*Continued from page 22*]

set chassis is slipped in the box and the defective set serviced later.

The total initial cost per installation was $78, distributed as follows: $29 for receiver chassis and tubes, $16 for batteries, installation parts and materials, and $33 for labor.

Of the installations, 60 per cent are nominally in 24-hour service as beat cars, scout cars, and cruisers. The remainder are used less than 24 hours per day. The data were computed on all cars over a four-months period.

Causes of service difficulties

By far the largest single cause for failure was the 222 screen-grid tube. It has a comparatively fragile filament and was not designed for automobile use. With the advent of the 236 heater-type automobile tube ten of the receivers were modified to use it. Over the four-months period two of these tubes failed, due to becoming noisy. While the data are not sufficient for accurate conclusions, roughly, the total tube failure of 58 per cent would be cut to 5 per cent by the use of 6-volt heater tubes. The life is not only tremendously greater, but because the 236 is a better tube, an appreciably higher gain of the receiver with less microphonic trouble results; and finally, the 236 is a lower priced tube.

The percentage of failures due to termination of B battery life is seen to be 16. The battery was used down to 68 or 70 volts before being discarded. In 24-hour service an average life of 58 days was obtained. The average life for all installations was 114 days. In other words, during the four months 98 sets of B batteries were replaced. Because the receiver was designed to give maximum sensitivity and power output on 90 volts, the battery replacement cost was cut just 50 per cent from that of a 135-volt receiver. If heater-type tubes were used throughout, battery replacement would be the major item in operating costs.

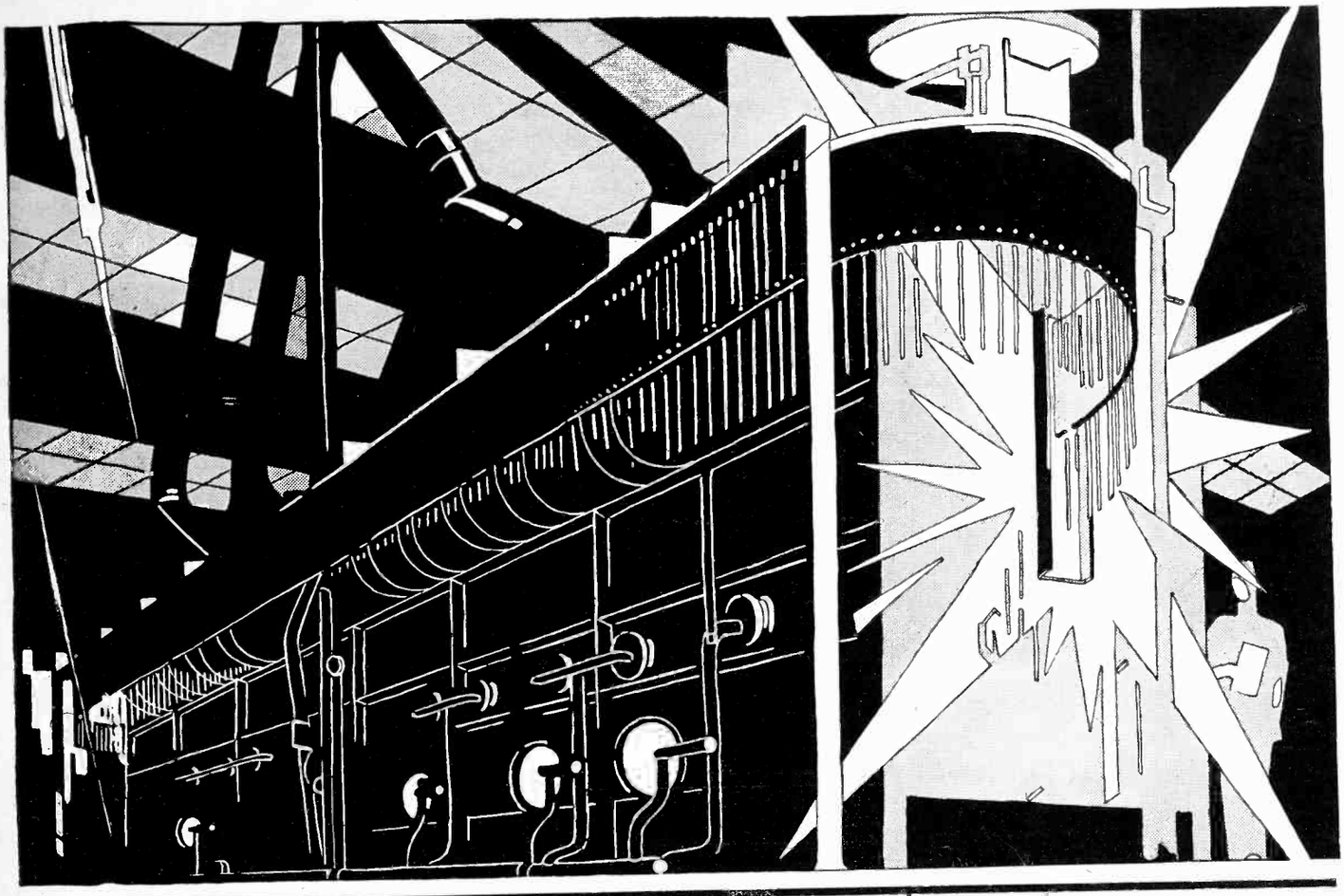
Grouped under the item of installation are 14 per cent of failures such as blown or defective fuses, fuse blocks, switches, volume controls, loose or broken wires, and so on. Open, shorted, or broken speakers contributed 3.5 per cent. In 5 per cent of the failures the set needed readjustment of the tuning condensers. In the set chassis itself defective sockets, resistors, or wiring gave rise to 3.5 per cent of the total.

The drain on the car battery due to a radio receiver may be small compared to other demands, but it is persistent. In the case of three cars whose normal duties entailed cruising at 15 or 20 miles per hour special means had to be provided on the generator to keep the battery up. On the other cars, save one, the addition of the radio receiver drain caused negligible increase in car-battery maintenance. The exception was a commercial receiver drawing 2.2 amperes, and in this installation the storage battery was replaced every two to three days.

The average length of operation per car without radio service was 22 days. The average operating cost per car per month was $2.50, of which more than half was for tube replacement.

Causes of radio reception failure:

Tubes		
UX-222	45	
Triodes	13	58 per cent
Batteries		16
Installation		14
Speaker		3.5
Tuning		5.0
Set chassis		3.5



BAKED AT 2,500°

This is one of the specially-built furnaces which bake the spaghetti-like sticks of resistance material from which CENTRALAB FIXED RESISTORS are made. This is but one of the many illustrations in the booklet just published, "A Baptism of Fire" which describes in detail the unique process of making CENTRALAB FIXED RESISTORS. It is yours for the asking. Send for it today.

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With .....

Address .....

City .....

State .....

Electronics

Industrial uses for tubes

[Continued from page 5]

controls 147 circuits by triodes and cost $100,000 Other important installations are:

Earl Carroll's, New York City, 50 circuits, 3,000 seats.
RKO Palace, Albany, N. Y., 45 circuits, 3,350 seats.
RKO Plaza, Schenectady, N. Y., 8 circuits, 2,800 seats.
RKO Orpheum, Denver, Colo., 45 circuits, 2,800 seats.
Severance Hall, Cleveland, Ohio, 110 circuits, 1,800 seats.

Increasing attention was given to handling heavy currents by tubes during the past year. Rectifier sizes have increased. Direct-current transmission over underground cables in cities is now being seriously figured by lighting companies. A tube installation will shortly supply part of Boston's three-wire Edison direct-current section directly from the alternating-current system.

Figures presented before a New York meeting of the American Institute of Electrical Engineers in December, testified that the economic distance for waterpower transmission can be multiplied nine times by using high-tension direct-current as against present alternating-current methods.

Electronic devices in surgery and therapeutics

Sudden acceptance of electronic devices by the medical and surgical professions during the past twelve months, has stimulated the manufacture and sale of high-frequency or "radio surgical knives" for all types of cutting, desiccating, etc., until it is expected that eventually such equipment will be standard in most physician's offices.

Meanwhile the new high-frequency "fever machines" are being used in some twenty different American hospitals. Artificial fevers as high as 107 degrees are being administered for five hours or so, with startling results in cures of germ diseases, arthritis, and the two great social scourges.

Modern X-ray apparatus is being given higher penetrative powers by increasing voltages and electron speeds, with improved results in therapy, X-ray diagnosis, and industrial inspection.

The cardiagraph—an amplifier oscillograph for recording the tiny emf's set up by contraction of the heart muscles—has become the standard method for studying heart pathology.

Sound-equipment development

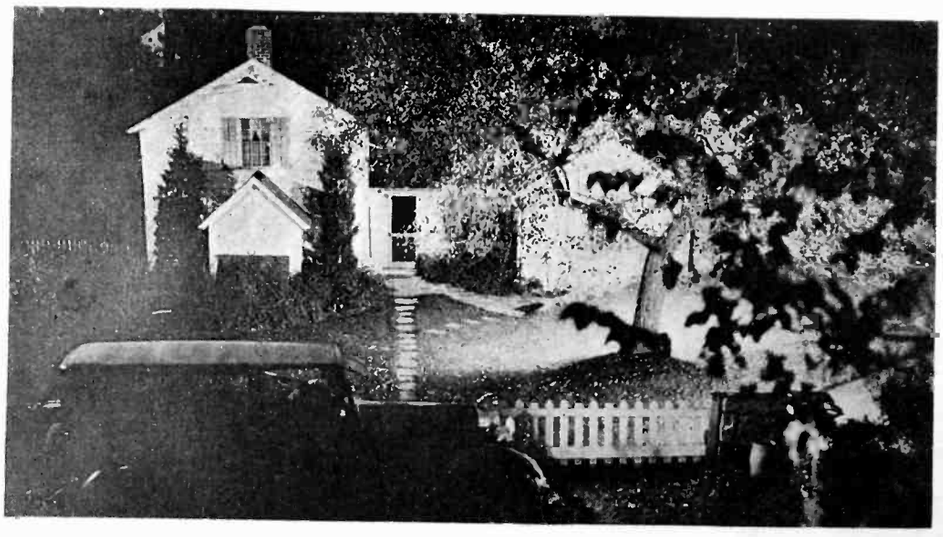
[Continued from page 5]

REPLACEMENTS of earlier sound installations will constitute the major outlet for sound reproducing equipment during the coming year. It has been estimated that there are still 2,000 theaters with disk equipment only, that will require either replacement or sound-on-film attachment added, during the coming months. The larger producers are releasing almost entirely with sound-on-film, and it has been announced that Warner Bros. expects to adopt this policy early in the year.

Improvement in all-electric sound equipment continued in 1931. Complete elimination of batteries for both portable and theater equipment has become universal. The replacement of batteries in earlier installations, with modern rectifying equipment, has proved profitable for companies specializing in this work. Theater equipment has been greatly simplified in recent months, reducing largely the cost of initial installation.

An innovation in legitimate stage productions was recently made with the opening in New York of Norman Bel Geddes' "Hamlet" at the Broadhurst Theater. Shakespeare's century-old lines are enhanced by modern equipment in the form of music and sound effects coming from multiple speakers placed backstage. A Western Electric twin turntable, similar to those used for electrical transcriptions, operating at $33\frac{1}{3}$ r.p.m., was used in this installation. They were so arranged that there was no pause in switching from one record to the next, and also, provision was made for superimposing one sound effect upon another. This superimposing facility was used to particularly marked advantage in the ghost scene, during which the weird sound of the wind at midnight continues through a brief musical selection which heralds the appearance of the ghost.

There have been other recent stage productions in which special sound equipment has been used to marked advantage. Earl Carroll's new theater, which was recently opened, has a complete public address equipment for general reinforcement of the musical selections. Continued development of sound equipment for special theater purposes may be expected during the year. With "color organs," public address and sound reproducing equipment installed, it can be said that theaters have turned completely electronic in character.



AUTO HEADLIGHTS TURN ON FLOODLIGHTS

After-dark visitors to farm home of Orestes H. Caldwell, editor *of Electronics*, at Greenwich, Conn., unconsciously turn their headlights on electric eye secreted in stone wall at right, which closes switches lighting bank of 300-watt floodlamps around house.

Similar electric-eye units are now used in many cities to turn on signs and street lights upon approach of darkness.