# electronics

radio, sound, communications and industrial applications of electron tubes ✦ ✦ ✦ design, engineering, manufacture

Mid-season radio trends

✦

Receiving tube manufacturing costs

✦

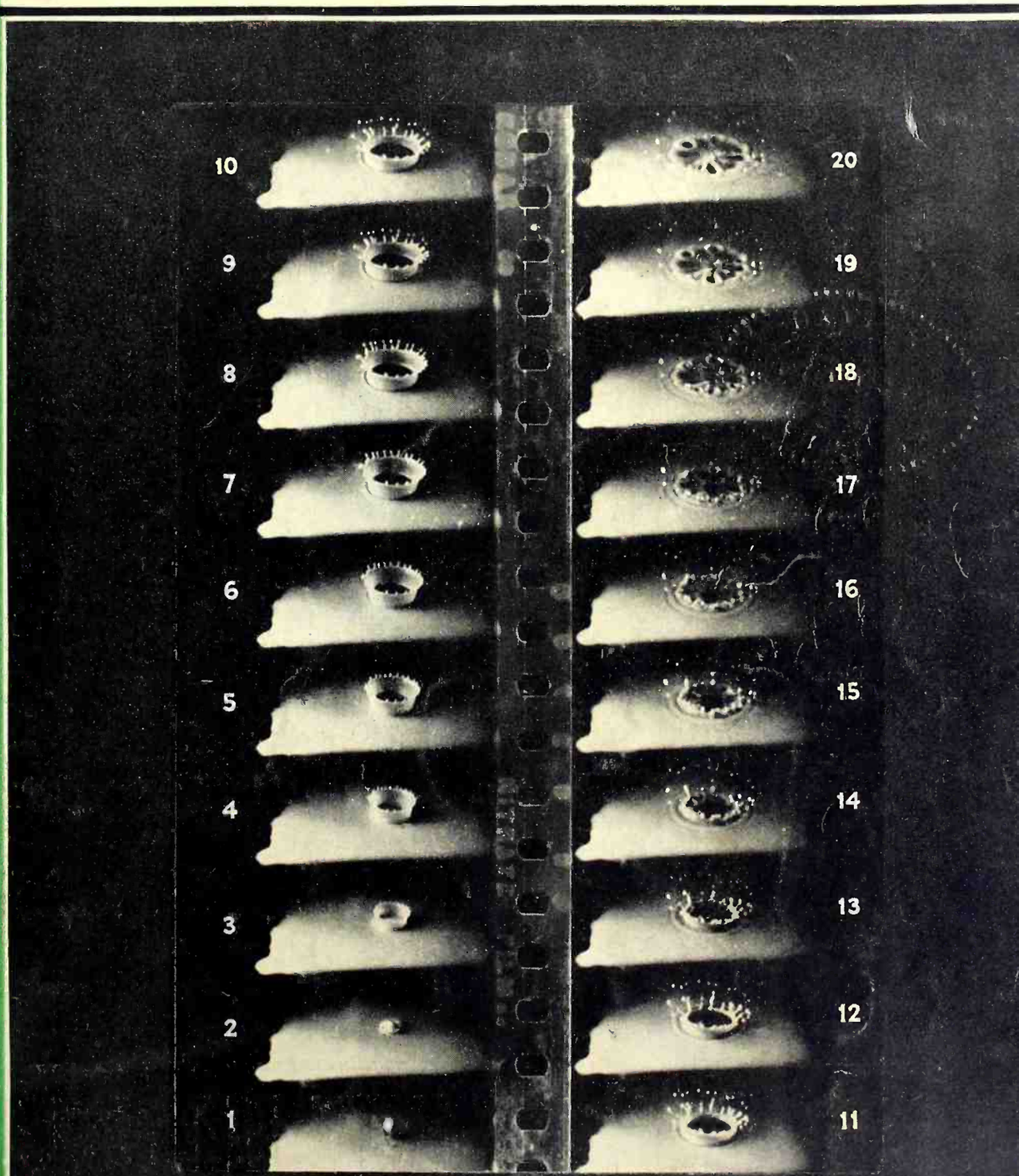
The menace to broadcasting

✦

Stroboscope takes 4200 photos per sec.

✦

Economics of theater maintenance




Tube-timed photos of a drop of milk falling on a plate (Page 220)

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# electronics

McGRAW-HILL PUBLISHING COMPANY, INC.

New York, July, 1932



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*Associate Editor*


## Opportunities for

# UNEMPLOYED RADIO ENGINEERS

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

DOZENS of industries and hundreds of small factories and shops are today waiting to be made more efficient or more productive, by some application of electronic tubes, photocells or other devices familiar to the reader of *Electronics*. The difficulty in getting such special applications installed has lain in the cost of the special engineering involved, which usually cannot be borne by the maker of the tube equipment alone.

BUT scattered all over the country today are unemployed radio engineers, familiar with the principles of these electronic devices. These engineers can find plenty of opportunity for their own ingenuity if they will drop into local shops and factories in their vicinity (particularly "home-town people" they know), and ask to be taken through the shop or plant to suggest opportunities for saving money. Practical uses will at once suggest themselves, and the engineer can arrange to install the electronic apparatus and get it working.

IN this way the man out of a job will find agreeable occupation along his own lines doing creative work,—he will be putting his leisure to use—he will be building economic independence for himself—and he will be speeding the inevitable day of electronic control in the shops and factories of his community.

# THE MENACE TO

## "Clear channels" being destroyed under pressure of political expediency

SLOWLY but surely the "clear channels"—the very backbone of American broadcasting—are being whittled away. One by one, the exclusive wavelengths which have made it possible for radio to reach every small town, rural community and farm in the United States, are being ravaged by political pressure and commercial expediency. Steadily the structure crumbles.

Forty of these "clear channels" were set up by the Federal Radio Commission in its Reallocation of November, 1928, when the wavelengths had to be reassigned in accordance with the Davis Amendment to the Radio Law, dividing radio facilities in proportion to population.

Already five of these forty clear channels are gone as "rural service" channels because of other stations authorized to operate on the same wavelengths, making that many clear channels useless to serve the millions of small-town and farm population which have no other avenue of radio service except through such clear channels.

### Why "clear channels" are needed

Every radio engineer, every radio manufacturer, every man in the radio industry or trade is vitally concerned in this destruction of the great radio arteries by which, only, can broadcasting be carried to the vast areas outside of the immediate vicinity of large cities.

A channel on which only a single high-power broadcast station is operating is a channel which serves listeners throughout the nation, as far as its faintest signal can be picked up. But once permit a second station to operate on the same channel in the U. S., no matter how remote, and immediately the service range of the original station is hemmed in by heterodynes and squeals to within a radius of a few miles. The solution of the problem of reaching the American public with a reasonable diversity of radio programs, depends upon the maintenance of clear channels, pending the advent of synchronization. With synchronizing, that fond dream of many broadcast transmitters exactly controlled from a common frequency source and operating on the same wavelength, still ahead in the dim future, clear channels remain as the only way of efficiently serving the public, and particularly the small-town and rural population.

The breakdown of the clear-channel structure started when the owners of Station WGY at Schenectady carried to the Supreme Court their case demanding the unrestricted full-time operation of Stations WGY and KGO at San Francisco on the same wavelength,—without synchronized frequency control between the two stations, as proposed by the Radio Commission.

With this entering wedge for the destruction of sound radio principles authorized by the highest court in the land, and on motion of an organization believed to be concerned with the protection of good engineering, the subsequent crumbling of the clear-channel structure has been rapid.

### The Commission authorizes "doubling up"

KSL at Salt Lake City, Utah, now has its clear channel destroyed by the Commission's authorization of Station WJJD at Chicago to operate until 9 p.m. Chicago time.

The frequency assigned as a clear channel to Station KJR at Seattle, Wash., is now authorized for destruction by a 5-kw. transmitter which the Commission has granted permit for the Chicago Federation of Labor station, WCFL, to build at Chicago.

The National Broadcasting Company operates KJR at Seattle, which will have its service area hemmed in to within a few miles of Seattle when the new WCFL transmitter gets operating, depriving millions of small towns, remote mountain cabins, and ranch owners in the Pacific Coast and Rocky Mountain states of radio reception from this station. The matter was referred to the operators of station KJR, but with the labor group demanding the use of the wavelength, engineering principles were waived and forgotten, and the simultaneous use of the channel conceded. Here was an instance in which the majority of the members of the Federal Radio Commission, sworn to protect the radio rights of the listeners, gave no heed to the loss of radio facilities by remote millions in the mountain area which needs broadcasting service most, and yielded to the importunities of the Senators who control the confirmation of the Radio Commissioners.

The Radio Commission had previously refused many other applications for facilities to be used in Illinois,

▼

**Here are the "clear channels" no longer clear:**

**KGO, San Francisco, shared with WGY.**

**KSL, Salt Lake City, shared with WJJD.**

**KJR, Seattle, shared with WCFL.**

**KNX, Los Angeles, shared with Canadians.**

**WPG-WLWL, New Jersey, shared with Canadians.**

▲

## Five out of forty of these "rural service" frequencies soon limited to local use

because that state was over-quotaed under the Davis Amendment. In fact the Commission recently granted an applicant from Indiana the facilities previously assigned to Station WIBO in Chicago, in order to bring about equalization. This case is now pending in the Court of Appeals, but regardless of all this, the Radio Commission last month granted additional facilities to Illinois, in the WCFL case, inconsistent with the Commission's own quota rules and regulation,—inconsistent with the mileage separation which the Commission's engineers say is necessary between two five-kilowatt stations,—and also inconsistent with General Order No. 40 setting up clear channels. A powerful bloc—and politics —did the trick.

### The State Department dispatches Nos. 4 and 5

Clear Channel No. 4 had its doom sealed when the State Department, also charged with the protection of American interests, assented to the simultaneous operation of a 5-kw. station in Nova Scotia, on the same wavelength as station KNX at Los Angeles. In periods of good radio reception, the inevitable heterodyne beating in on this channel from the Canadian border, will convert KNX from a great clear-channel station designed to serve the vast Rocky Mountain territory, into an impotent regional, barely getting out to the San Francisco Bay country without an annoying whistle riding on its carrier.

The fifth clear channel to go into the ether trash-heap is 1100 kilocycles, now occupied under a time-sharing arrangement between Station WPG, the Columbia Broadcasting System's outlet at Atlantic City, and Station WLWL at New York, the station of the Paulist Fathers, one of the teaching orders of the Catholic Church. Destruction of this clear channel was also arranged by the U. S. State Department in completing its recent radio agreement with Canada. Our good friends of the north, numbering in population about the same as California or New York City, *already had three times* as many wavelengths per capita as have citizens of the United States, but the latest adjustment dictated by the State Department grants them *four times the radio service per capita,* besides ruining two American clear channels in the bargain.

What protest and effective action against this cancellation of American rights, will be set up by the present tenants of the 1100-kilocycle channel, both influential and powerful at Washington, remains to be seen.

The sorry spectacle thus taking place in the collapse of the clear channels is known to radio engineers and to all who follow the Washington wave-length assignments, but while all privately lament the progress of the destruction, few can be found to raise their voices in protest. Unhappily those informed seem too busy or concerned with their own individual situations, to protect the general commonwealth of radio. And the majority of the Federal Radio Commission, continuously pounded by political pressure, find that they must grant concessions to properly accoutred applicants, while radio principle and the rights of farm and rural listeners go into the discard.

### What favorite stations will be next to go?

What clear channels will go next, is a matter for conjecture. WEAF, WABC, WLW, KDKA, WGN, WMAQ—call-letters all sacred in the minds and memories of American listeners,—may within the next twelve months follow the others over the plank to oblivion, and become merely high-powered locals, each serving a few counties, but lost to rural listeners outside a few miles range.

"It seems that there is little or no use fighting for clear channels," comments one Washington observer. "Perhaps by the time the U. S. State Department concludes its negotiations with Mexico there won't be any clear channels left!"

The majority of the members of the Radio Commission, the U. S. State Department, the radio leaders in Congress, and the large broadcasters, have all shown their failure to defend radio principles in the interest of American listeners. Are there no red-blooded fighters among radio engineers and industry leaders who will get up on their hind legs and battle for the future of good radio reception and good listening conditions in every home on the American Continent, whether in city, town, cross-roads settlement, farms, ranches, mountain cabins or island dwellings?

Only clear channels can bring radio broadcasting to every American fireside. Clear channels must be saved.

▼

## CLEAR CHANNELS

**A "clear channel" on which only a single high-power station operates, is a channel which serves rural listeners so far as its faintest signal can be picked up.**

**Only clear channels can bring radio broadcasting to every American home, —town, village and farm.**

▲

# NEW RADIO RECEIVERS SHOW

## A mid-season survey of 1932 sets shows results of new tubes and circuits

AS THE radio season advances, trends seen earlier become more evident; the feeling that manufacturers have more to offer than in any previous year assumes an aspect of certainty. Circuit features are not only of considerable interest to engineers but now are seen to be of great practical value to the owner of the new set.

Although some set makers feel the trend to two speakers is not necessary and that one speaker (*if* good) will give as good results, there is this "if"—and it is about as costly to make one good speaker as to use two fairly good ones. In other ways the fidelity has been improved, or at least it is now possible to get better fidelity, and sooner or later the public will demand it.

The exact extent to which manufacturers have utilized the new features may be seen from the actual count of the number of models using this, that, or the other advance. It is interesting and important to note the number of all-wave receivers (24 per cent of the total models displayed at the Trade Show), the encouraging use of class B amplifiers so soon after special tubes for this purpose were made available, the number of models (70-odd) using two or more speakers, and the extent to which the automatic muting circuits have come into vogue.

With respect to the number of lines which use the new features in one or more models a survey of the Trade Show indicates that 95 per cent of all manufacturers use the new tubes in nearly all their models, twin speakers are found in at least one set of 72 per cent of the lines, automatic muting systems in 68 per cent of the catalogs and push-push amplifiers are adopted by 48 per cent of the factories.

A favorable trend is the introduction of more higher priced sets than lower priced radios, thus raising slightly the average list price. An unfavorable angle is the increase in number of models, one manufacturer offering nearly 30 models. The importance of clocks in radios seems to have been overrated, some small models now including timepieces but the number of grandfather clock models of double-purpose furniture having lost ground.

### STATISTICAL SURVEY OF NEW MODELS AT RADIO SHOW

*Total models shown 215*

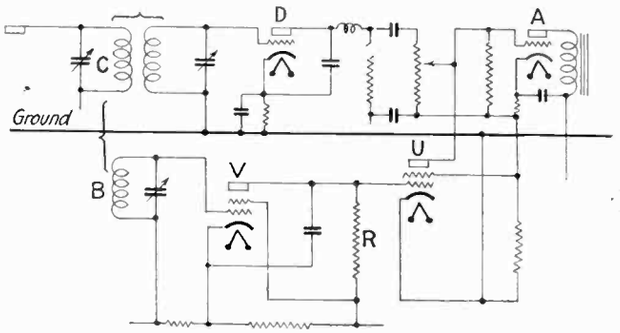
| | |
|---|---|
| Consoles | 62% |
| Table models | 23% |
| Double-purpose | 5% |
| Shortwave combination | 5% |
| Auto radio | 5% |

*Total consoles . . . . 133*

| | |
|---|---|
| Phonograph combination | 7% |
| Automatic phonograph | 5% |
| 2-volt battery sets | 9% |
| All wave receivers | 24% |

*Circuit features*

| | |
|---|---|
| R.f. pentodes | 96% |
| A.f. pentodes | 75% |
| Class B. amplifiers | 13% |
| Manual tone control | 90% |
| Automatic volume control | 74% |
| Automatic noise control | 31% |
| Remote control | 2% |
| Two speakers or more | 30% |




**Method by which Wurlitzer engineers compel owners of Lyric receivers to tune correctly**

It seems that radios are something to kill time at, not to tell time by. And at any rate the frequency with which announcers shout the time (paid for, of course) is sufficient to keep all commuters on time for the 8-o'clock train for town.

The averages shown below give an idea of the way the wind is blowing and how much.

| | 1931 Show | 1932 Show |
|---|---|---|
| Average price range, low | $39 | $43 |
| Average price range, high | $148 | $162 |
| Average number of models per line | 6 | 9 |
| Average number of consoles | 4 | 6 |
| Average number of table models | 2 | 2 |
| Average number of tubes | 7 | 9 |

### Automatic tone control

Just how valuable will be the systems in which tone fidelity is automatically bettered when tuning into a strong carrier, as from a local station, remains to be seen. Increasing the load upon the primary of an intermediate frequency transformer, already loaded with the tube resistance will probably not broaden the tuning a great deal and thereby let more high frequencies through. The secondary of the transformer, although changed somewhat by this extra loading, still remains very selective and whacks sidebands like nobody's business.

Whether the change is useful or not it provides a good talking point, and with additional work may be of considerable value.

If an i.f. transformer is overcoupled to provide a band-pass or flat-top effect, it may become less than overcoupled when the primary is loaded by a lower tube resistance, and thus the set may conceivably become more selective and result in further decrease in high frequencies.

Measurements on a typical receiver, having one r.f. stage, a first detector, and two i.f. stages one of which is fidelity controlled shown in a bulletin from the RCA Radiotron laboratories indicate an improvement of 6 db.

# IMPROVED TECHNICAL DESIGN

## Slight increase in price and betterment of fidelity are favorable signs

at 5,000 cycles and 3 db. at 3,000 cycles. The receiver, however, was still down 12 db. at 5,000 and 5 db. at 2,000 cycles which is pretty bad fidelity at that.

### Automatic muting systems

Undoubtedly much will be made of the circuits which cut down a.v.c. noise between carrier waves when tuning. These are really automatic muting circuits performing in a much more elegant manner the same function as the muting button which made most listeners ambidextrous, one hand for tuning, one for muting. Although there is no reason for advising the public of the fact, it is true that such circuits were available as long ago as 1927 but the cost of performing the stunt and presence of other novelties to advertise delayed the introduction until the present time.

There are at least a baker's dozen methods by which the loudspeaker is dead between carrier waves but they all have the same useful characteristic of keeping out static, natural and man-made, and the hash of tube noise, unshielded super squealing, etc., etc. Some of the circuits are entirely automatic, others have some manual adjustments and others seem to be entirely manual. The idea of the more or less manually operated schemes is for the dealer who installs the set to adjust the circuit so that noise of a certain level and peculiar to a certain locality is automatically kept out of the loudspeaker. Some in addition keep out carriers of this field strength and so nothing is heard unless a carrier can stick its head above the noise. Then it comes through. In the other cases carriers down in the noise will come to the speaker, but of course will be passed by since they cannot be heard satisfactorily through the accompanying noise.

A good example of the *modus operandi* of these newly applied methods of quietly tuning between stations is the Fada system which affects the audio amplifier as shown in the accompanying diagram. The first audio tube is biased beyond plate current cut-off. This bias voltage is supplied by a separate tube whose input is connected to a portion of the a.v.c. circuit. The voltage developed in the a.v.c. system, when a carrier is applied, reduces the plate current of the separate muting tube and thereby releases the cut-off bias on the first a.f. tube.

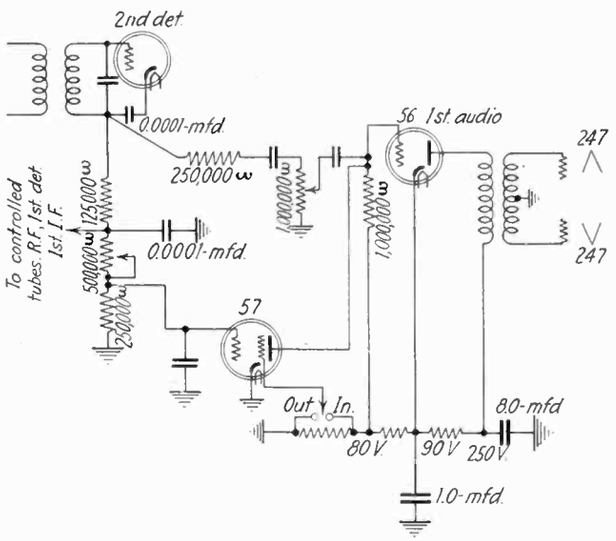
It is said that methods using thyratrons as electrical relays, and even mechanical relays to short the loud speaker or the a.f. system have been tried.

### Lock-in systems

A more complicated but withal more interesting circuit is that shown here from Wurlitzer which is probably similar to that developed by circuit engineers of National Union Tube Company. This employs another tube, in addition to the a.v.c. tube, whose purpose is to automatically prevent any signal coming through the receiver until the listener has tuned almost exactly to the carrier. This extra tube, in the Wurlitzer circuit at least and probably in the others, gets an r.f. input through a very selective input but refuses to release hold of the following tubes, over which it has control, until this r.f. input is within 2 kc. of the exact center of the carrier.

In the Lyric "channel control" circuit shown herewith, tube *V* is coupled loosely to the intermediate frequency input to the second detector *D*. Tube *V* is biased beyond cut-off until signal is applied to its input, through careful tuning (this circuit has 2-kc. selectivity). Then current flows through *V* which increases the bias on *U* which reduces the bias on the audio tube *A* and permits signals to arrive at the loud-speaker.

Although on paper this sounds and looks like a Rube Goldberg cartoon, in practice it works beautifully according to impartial reports and is one of the season's most interesting circuit tricks.




**The Fada circuit for muting the audio amplifier between carriers thereby shutting out noise and static**

Sour quality secured in the average superheterodyne unless the set is tuned most carefully to the desired carrier is prevented by this scheme, and the apparent selectivity is vastly increased without the sideband decimation that would result by any other method. Without a doubt this circuit development is most interesting technically and has the greatest apparent possibilities for the future. Operation of such receivers will tend more than any other single thing to point out how obsolete is a receiver of several years ago.

Such circuits will tend to eliminate the necessity of tuning meters or gaseous indicators, since the listeners will get nothing until and unless correctly tuned to the carrier. Manufacturers reputed to be working with National Union are Zenith, U. S. Radio and Television, Colonial and Echophone.

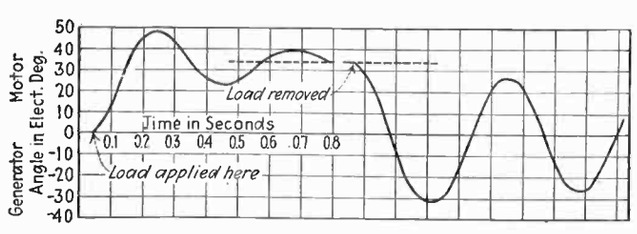
# Stroboscopic photography

By H. E. EDGERTON
and K. J. GERMESHAUSEN

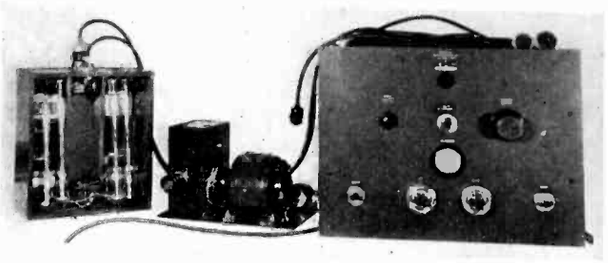
STROBOSCOPES of the flashing-light variety have proved their worth in many fields of industry and research. They are useful for examining the vibration of rotating or pulsating machinery, for measuring the oscillations of synchronous machines, for accurately determining the speed of parts which are inaccessible to tachometers, for balancing rotating masses, and for many other problems which have been described in numerous articles.

The usual procedure is to adjust the frequency of the light flashes so that it is slightly less than the frequency of rotation of the object under observation. The appearance of the object to the eye is an optical illusion which shows it in a stationary or slowly-moving condition. Good quality of appearance depends mainly upon three things. First, the light flash must be of short enough duration to stop the object; in other words, during the time the light is on, the object must not move an appreciable distance. Secondly, the motion of the object must be absolutely periodic; that is, in a steady state of oscillation, vibration, or rotation, or it will appear blurred to the eye. Thirdly, the frequency of the light flashes must be under accurate control. The first and third requirements are easily met by practically all gaseous-discharge types of stroboscopes. The second requirement depends upon the motions of the object under observation.

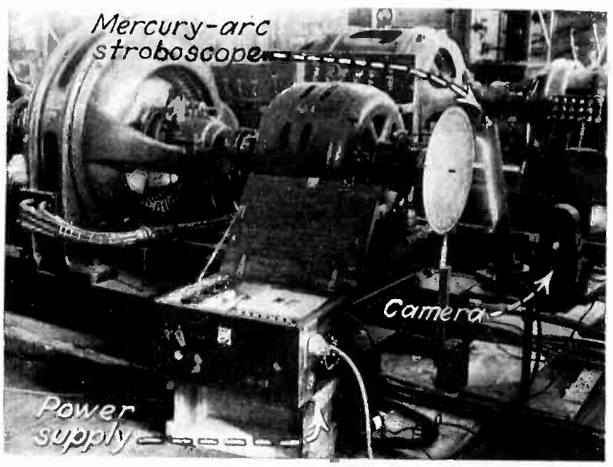
As an example, consider the case of a synchronous motor when load is suddenly applied. Synchronous stroboscopic light shows the rotor in a stationary position. After the extra load is put on the shaft, the rotor is again in a stationary position, but it has shifted back in phase. During the transition between these two steady operating conditions there is an oscillation which can be observed by the eye but it occurs so quickly that no quantitative relations can be taken. In such cases as this it is important to have sufficient light from a stroboscope to obtain a photographic record on a motion-picture film of the transitory phenomena from which quantitative records may be read and plotted.




**Curve showing the variation of the angular displacement when a sudden load is applied and then removed from a synchronous motor**



**A 480-picture-per-second stroboscopic motion-picture camera**




**Sixty-cycle stroboscope and camera for photographing the angular transients of synchronous machines in the Electrical Laboratory M.I.T.**

Even in the case of the stroboscopic effect, where the motion is periodic, it is important to have sufficient light to obtain photographs so that the phenomena may be studied at leisure. In a great many cases important aspects are overlooked visually but are easily noted when studied individually.

There is also another very important use of stroboscopic light for photography. By the use of stroboscopic light it is possible to take motion pictures on continuously-moving film. The quick flash of the light, besides "stopping" the object being photographed, likewise "stops" the film upon which the picture is being recorded. The upper limit of speed is not determined at present, but no difficulties have been experienced in obtaining good clear photographs at a rate of 480 pictures a second. (Editor's note—The authors report successful photographs taken at 4,200 exposures per second.)

A mercury tube is used for producing the light. An electrical circuit is arranged so that a considerable amount of energy is instantaneously discharged into the tube, forming an arc which allows a very rapid intense discharge. The time of flash is usually less than 10 microseconds.

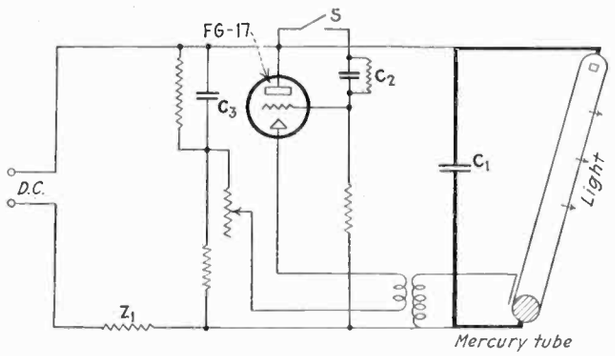
The diagram shows one arrangement to produce stroboscopic light. The condenser $C_1$ is charged through the impedance $Z_1$ from a source of d.c. The voltage of the d.c. source and the size of the condenser $C_1$ are made sufficiently large to produce enough light energy to give the desired photographic effect.

The tube is started in the following manner. When the switch $S$ is closed, the grid of the thyratron is made plus with respect to its cathode. The thyratron then becomes conducting and allows the energy in the small condenser $C_3$ to discharge into the primary of a step-up transformer. The resulting high voltage in the secondary is applied to an external connection on the light-pulse tube, and it causes the formation of a cathode spot or electron source. The condenser $C_1$ now discharges through the tube and because of the volt-ampere characteristic of the mercury lamp the discharge time is short and the current surge high, resulting in a quick intense pulse of light.

A stroboscopic motion-picture apparatus for taking pictures at 480 per second is shown. The camera was designed for use with string and cathode-ray oscillographs by the General Radio Company. It has a continuously-moving film and has no shutter nor intermittent motion. The pictures are taken while the film is on the sprocket, and they are one-half of the normal height of standard 35 mm. frames. A 1,800-r.p.m. synchronous motor drives the sprocket (32-tooth), which gives a film speed of 15 ft. per second.

The lamp house on the left contains four one-foot stroboscopic lamps with four discharge condensers. Photographs are made by aiming the camera through a hole in the lamp house. A flexible cable attaches the lamp house to the power supply. Three kilowatts of power are needed to run the outfit when taking motion pictures at 480 per second.

A photograph is shown of a 16 mm. motion-picture camera driven by a small synchronous motor and arranged to take stroboscopic motion pictures of the transient oscillations of a synchronous motor. The camera is driven at exactly 60 frames a second and thus 60 readings of the angular displacement may be read for each second. Both the shutter and the intermittent motion have been removed from the camera. Sixty readings of the angle are sufficient to plot the variations, since the period of oscillation is about one per second.




**A circuit which produces stroboscopic light for photographic work**

This 60-cycle stroboscope produces sufficient light so that ordinary Eastman 16 mm. positive film is adequately exposed. A curve showing the variation of the angle when load is suddenly applied and then removed is shown. The motor was running at 1,200 r.p.m. when this picture was taken, and the picture shows part of an oscillation.

The cover photograph shows a drop of milk falling on a ferro-type tin covered with a thin layer of milk resulting from previous drops. The pictures were taken at a rate of 480 per second.

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## EXTENSIVELY USED PATENTS RELATING TO AMPLIFYING CIRCUITS

In May *Electronics* was given a summary of the amplifier patent situation, i.e., who holds the important patents and the manner in which rights under those patents are administered and controlled. In response to many inquiries as to what the important amplifier patents are, the following list is given. Many of these twenty-odd patents are owned by the A.T.&T. Company, others by the General Electric Company or by R.C.A. Rights to use them for specific purposes must be discussed in the manner outlined in the May article.

| | | |
|---|---|---|
| 1,173,079 | Alexanderson | Tuned radio frequency amplifier |
| 1,195,632 | White | A.C. filament heating, center tap |
| 1,231,764 | Lowenstein | Negative grid bias |
| 1,251,377 | Hull | Power supply |
| 1,273,627 | Langmuir | Plate current for grid bias |
| 1,297,188 | Langmuir | Resistance coupled amplifiers |
| 1,313,094 | Langmuir | Energy amplification, power tube |
| 1,329,283 | Arnold | Matched impedance of tube and output circuit |
| 1,349,252 | Arnold | Straight line amplification |
| 1,375,447 | De Forest | Multi-stage amplifier |
| 1,377,405 | De Forest | Grid leak |
| 1,398,665 | Arnold | Matched impedance with voltage amplification |
| 1,403,475 | Arnold | Impedance coupled amplifiers |
| 1,403,932 | Wilson | Uniform plate current for grid bias |
| 1,426,754 | Mathes | Grid biasing resistor |
| 1,432,022 | Heising | A.C. filament heating, center tap to path in shunt to transformer secondary |
| 1,448,550 | Arnold | Resistance across input coil |
| 1,459,412 | Nicolson | Uni-potential cathode tube and circuit |
| 1,465,332 | Arnold | Plate by-pass condensers |
| 1,477,898 | Rice | Condenser coupled TRF amplifier |
| 1,483,273 | Blattner | Push-pull A.C. filament heating |
| 1,493,595 | Blattner | Push-pull preceded by another tube; common space current supply; a.c. filament heating |
| 1,504,537 | Arnold | Multi-stage amplifier including a final push-pull stage |
| 1,520,994 | Arnold | Amplifier volume control |
| 1,537,708 | Schottky | Screen-grid vacuum tube amplifier |
| 1,544,921 | Mathes | Push-pull stages in impedance or resistance coupling |
| 1,558,437 | Langmuir | Screen-grid vacuum tube amplifier |
| 1,622,170 | Aceves | Plate-current biasing in voltage divider |
| 1,728,879 | Rice | Speaker field acting as filter choke in power supply for amplifier |
| 1,834,414 | Miessner | Proportionate plate filtering |

# Costs in radio tube manufacture

By THOMAS E. CONWAY

IT IS generally conceded that current prices of radio tubes preclude the possibility of the legitimate manufacturer deriving a fair profit, therefore his immediate problem is, how much he can afford or desire to sacrifice in order to remain in business.

The cardinal factor in this situation is absolute knowledge of costs. Average or theoretical costs are of little value, with varying inventory requirements and consequent constant change of manufacturing schedules. Further, in view of frequent requests for price concessions from sales departments in order to secure particularly desirable accounts, it is ruinous to proceed without positive facts based on given standards, predetermined and proven.

In charge of manufacture at a fairly large tube factory, the writer who had had wide experience in large basic industries and is familiar with the tried and accepted methods of procedure in production scheduling and control, found the lack of established standard costs a serious handicap in the operation of this plant. This absence of accurate costs was due in part to the rapid development of the industry generally, many and radical changes of product and prices, but principally because through the early stages of radio tube manufacture on a production basis, profits were generous in a market where the only requirements were for unlimited volume.

The radio tube is now an element of every day merchandise. As such the manufacture necessitates careful planning and control of every phase and constant effort to effect the most minute economy.

The surviving tube factories are operating under varied conditions. As in most industries, the small plant has many advantages over the large one under present circumstances. The heavy fixed burden of the large plant more than discounts its advantage in superior equipment and specialized operation.

Every plant, however, has its own peculiar conditions and it is his particular plant that concerns each manufacturer. With this in view, the writer made a detailed analysis of every element involved in manufacture, at a given plant. It might be mentioned here, that this was not done toward the end of completing a scientific, orthodox job of accounting, but as a definite guide in plant operation and a means of deriving a profit from manufacture.

The first problem was to determine the smallest volume that could be manufactured, considering the uncontrollable fixed expense. At this particular plant this was far above average, due to excess space, greatly increasing heating and maintenance expense, electric service charges, taxes, insurance, etc. It was found that in order to justify the cost of operating the large capacity equipment it would be necessary to produce 6,500 tubes per day of seven and one half hours, and a minimum of four days a week, with an additional day for a small force, with limited use of auxiliary power equipment, to test, salvage, classify returns, etc. Such a schedule, considering the above mentioned fixed expense must not be construed as being profitable, but simply to operate without loss in manufacture without consilering sales and administrative expense.

**TUBE prices to radio set manufacturers and to the trade have declined to such an extent that, as Mr. Conway's cost figures show, little or no profit is to be made in their manufacture if high quality is to be maintained. What is to be sacrificed remains an open and vastly important question.**

## Determination of costs

The next step was to analyze sales for the preceding three months to set up a schedule embracing all types, provide for a finished goods inventory not exceeding two weeks production and maintain a work in process inventory not exceeding two days' production.

All direct labor operations were checked, piecework and day rates adjusted (December 1931), indirect labor occupations analyzed, personnel selected for versatility and satisfactory performance and the work of retained engineers and supervisors defined in detail.

The minimum production schedule was divided into two groups, to be produced in two thirty-hour periods, each period constituting a work week. The arrangement by type was made to utilize the services of trained operators to the best advantage and keep them continuously employed, and also to avoid having similar types in production at the same time.

The program being outlined, a standard sheet was prepared in detail for each element of manufacturing cost in the following order: 1, Direct labor; 2, Indirect labor; 3, Mechanical and building maintenance expense; 4, Supervision, engineering and manufacturing office expense; 5, Material sheets for each type; 6, Fixed service charges, manufacturing supplies, taxes, insurance and expense of recovery from defects and returns.

These sheets indicated the number of people to be employed on each and every operation, time allowed to complete specified quantity and cost on either day work or piecework basis.

Space will not permit the presentation of the layout in detail or the explanation of the provision made to take care of changes in the prescribed quantity of any type, due to sales requirements, all of which was considered and provided for, however.

The composite sheet accompanying this article, shows the production schedule by type and quantity, arranged in the two groups, the types arranged in numerical order across the sheet and the standard cost of every item of manufacturing expense for each type. The items of depreciation, sales and administrative expense are not shown. Expense of salaries of factory management and all others engaged in manufacture are included in total labor costs.

It might be mentioned that in the sub-division "Units" included in Direct Labor and Indirect Labor, embraces mounting, sealing, exhausting, basing, seasoning and testing.

## COMPOSITE COST SHEET

*Based on quantities produced in two 30-hour periods in two weeks, January, 1932*

| Basic Schedule | | Items of Mfg. Cost | 224 | 226 | 227 | 235 | 245 | 247 | 280 | Total | Average Unit Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Type | Quan. | Quantity | 4800 | 6400 | 4800 | 4800 | 4800 | 3300 | 5120 | 52890 | |
| Group 1 | | Direct labor small parts | 125.13 | 24.78 | 52.29 | 125.21 | 24.46 | 67.12 | 29.92 | 587.46 | .011 |
| 112A | 3200 | Stem dept | 33.14 | 29.92 | 21.45 | 33.14 | 33.04 | 21.23 | 31.27 | 319.75 | .006 |
| 280 | 5120 | Units | 181.05 | 106.35 | 113.24 | 181.17 | 95.59 | 138.31 | 107.56 | 1443.12 | .0273 |
| 245 | 4800 | W'house-pack'g Shipping | 12.87 | 17.47* | 12.87 | 12.87 | 10.31 | 10.00 | 15.47 | 148.07 | .0028 |
| 226 | 6400 | | | | | | | | | | |
| 235 | 4800 | Total direct labor | 352.19 | 178.52 | 206.85 | 352.39 | 163.40 | 236.66 | 184.22 | 2498.40 | |
| 199B | 400 | Unit cost direct labor | .0734 | .0279 | .0431 | .0734 | .034 | .0717 | .036 | | .04714 |
| 199X | 800 | | | | | | | | | | |
| 210 | 100 | Indirect labor small parts | 6.526 | 11.487 | 6.524 | 6.526 | 8.616 | 5.849 | 9.122 | 91.60 | .00173 |
| 250 | 250 | Stem dept | .889 | 1.186 | .889 | .889 | .889 | .602 | .931 | 9.79 | .00018 |
| 281 | 150 | Units | 15.864 | 21.134 | 15.864 | 15.864 | 15.864 | 10.733 | 16.763 | 174.66 | .0033 |
| 866 | 200 | Recovery | 3.621 | 4.825 | 3.621 | 3.621 | 3.621 | 2.451 | 3.818 | 39.86 | .00075 |
| | | W'house-Shipping | 11.571 | 15.406 | 11.571 | 11.571 | 11.571 | 7.836 | 12.224 | 127.38 | .0024 |
| Group 2 | | Engineering | 5.243 | 6.972 | 5.243 | 5.243 | 5.243 | 3.551 | 5.544 | 57.72 | .00109 |
| 171A | 4800 | | | | | | | | | | |
| 201A | 6000 | Total indirect labor | 43.714 | 61.01 | 43.714 | 43.714 | 45.804 | 31.022 | 48.402 | 501.01 | |
| 227 | 4800 | Unit cost indirect labor | .0091 | .0095 | .0091 | .0091 | .0095 | .0094 | .0094 | | .00947 |
| 224 | 4800 | | | | | | | | | | |
| 247 | 3300 | Expense, mech. bldg. gen'l main | | | | | | | | | |
| 222 | 250 | Equipment, watching, cleaning | | | | | | | | | |
| 233 | 400 | Electrical dept | 10.812 | 14.409 | 10.812 | 10.812 | 10.812 | 7.323 | 11.431 | 119.084 | .00225 |
| 236 | 1200 | Bldg. and gen'l main | 10.834 | 14.438 | 10.834 | 10.834 | 10.834 | 7.388 | 11.455 | 119.314 | .00225 |
| 237 | 606 | Machine shop | 14.709 | 19.602 | 14.709 | 14.709 | 14.709 | 9.963 | 15.552 | 161.99 | .00306 |
| 238 | 520 | Engineering, equipt. construction | 5.798 | 7.726 | 5.798 | 5.798 | 5.798 | 3.926 | 6.130 | 63.87 | .00121 |
| | | Night watchman, matron-cleaner | 12.696 | 16.799 | 12.606 | 12.606 | 12.606 | 8.539 | 13.328 | 138.84 | .00262 |
| | | (Day watchman, mat'l and mech. stores) | | | | | | | | | |
| Total | 52,890 | | | | | | | | | | |
| | | Total mech. and bldg. main and equip't. | 54.759 | 72.974 | 54.759 | 54.759 | 54.759 | 37.089 | 57.896 | 603.098 | |
| | | Unit cost and bldg. main. and equip't. | .0114 | .0114 | .0114 | .0114 | .0114 | .0113 | .0113 | | .0114 |
| | | Expense, supervision engineering | | | | | | | | | |
| | | Manufacturing office | | | | | | | | | |
| | | Engineering | 34.757 | 46.318 | 34.757 | 34.757 | 34.757 | 23.541 | 36.749 | 382.79 | .0072 |
| | | Production | 39.182 | 52.218 | 39.182 | 39.182 | 39.182 | 26.538 | 41.425 | 431.50 | .0081 |
| | | W'house-Shipping | 5.902 | 7.865 | 5.902 | 5.902 | 5.902 | 3.997 | 6.24 | 65.00 | .0012 |
| | | General | 20.604 | 27.457 | 20.604 | 20.604 | 20.604 | 13.955 | 21.784 | 226.88 | .0042 |
| | | Mfg. office clerical-payroll | 6.131 | 8.17 | 6.131 | 6.131 | 6.131 | 4.152 | 6.481 | 67.52 | .0012 |
| | | Total super. Engineering Mfg. office | 106.576 | 142.028 | 106.576 | 106.576 | 106.576 | 72.183 | 112.679 | 1173.69 | |
| | | Unit cost super-Engineering Mfg. office | .0222 | .02219 | .0222 | .0222 | .0222 | .02187 | .022 | | .02279 |
| | | Grand total all labor (mfg.) | 557.239 | 454.532 | 411.899 | 557.439 | 370.539 | 376.954 | 403.197 | 4776.198 | |
| | | Unit cost all labor | .11609 | .07102 | .08581 | .11613 | .07719 | .1423 | .07875 | | .09034 |
| | | Total all material in tubes | 698.543 | 497.840 | 539.5465* | 698.763 | 466.0713 | 478.76 | 564.679 | 5986.9476 | |
| | | Unit cost all material | .14572 | .07778 | .11240 | .14557 | .09709 | .14507 | .11028 | | .113196 |
| | | Total labor and material | 1256.002 | 952.372 | 951.4455 | 1256.202 | 836.610 | 855.704 | 967.876 | 10763.11 | |
| | | Unit cost, labor and material | .26166 | .1468 | .19822 | .26166 | .17428 | .2593 | .18904 | | .203499 |
| | | Gen. mfg. expense | 42.213 | 56.253 | 42.213 | 42.213 | 42.213 | 28.591 | 44.630 | 464.87 | .00879 |
| | | Fixed charges; insurance | 14.668 | 19.546 | 14.668 | 14.668 | 14.668 | 9.935 | 15.508 | 161.54 | .00306 |
| | | Fixed charges, taxes, city corporate | 48.166 | 64.186 | 41.166 | 48.166 | 48.166 | 32.623 | 50.924 | 530.46 | .01003 |
| | | Recovery | 11.014 | 14.677 | 11.014 | 11.014 | 11.014 | 7.458 | 11.634 | 121.28 | .00229 |
| | | Total gen'l mfg. exp. fixed ch'gs., ins., etc. | 116.061 | 154.662 | 116.061 | 116.061 | 116.061 | 78.807 | 122.696 | 1278.15 | |
| | | Unit cost, gen'l mfg. exp. fixed ch'gs, ins. etc. | .02418 | .02416 | .02418 | .02418 | .02417 | .02382 | .02396 | | .02416 |
| | | Grand total all mfg. costs | 1372.06 | 1107.034 | 1067.5065 | 1372.263 | 952.671 | 934.311 | 1090.572 | 12041.26 | |
| | | Unit cost all mfg. costs (Exclusive of depreciation) | .2858 | .172918 | .22239 | .28588 | .1984 | .2931 | .213 | | .227666 |

EDITOR'S NOTE—Depreciation on buildings, machinery, trucks, etc., bring the average unit cost from $0.227666 as shown on the chart to $0.317935. These costs were for an average production in January, 1932. At that time the average price to jobbers (roughly 70 per cent off list) was $0.414. In May, 1932, however the prices paid by large set manufacturers for the tubes most often used, (226, 227, 224, 235, 247, 280) were about $0.302—and therefore below the manufacturing cost of the plant whose figures are given by Mr. Conway. (Sales and administrative cost not included.)

In the chart only those tubes in most active use were included although the average unit cost was determined by using the cost figures on all types of tubes made, shown in the column marked "basic schedule" and totalling 52,890 tubes.

# "Cheater circuits"

## for synthetic testing of mercury-vapor power tubes

By J. L. ZEHNER

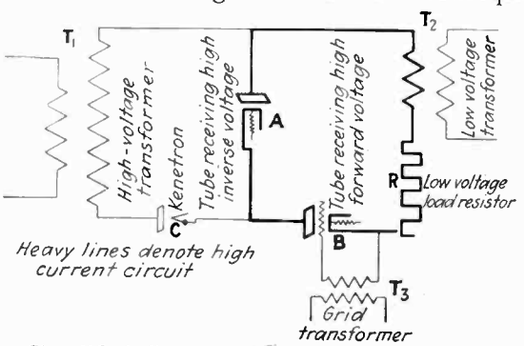
*Vacuum Tube Engineering Dept., General Electric Company*

WITH the development of mercury-vapor rectifiers and power tubes, it became necessary to use much higher power and hence larger and much more expensive apparatus in order to exhaust and test tubes properly.

For example, the General Electric FG-41, an intermediate size Thyratron, is about the size of the usual 250-watt transmitting tube. However, it has a voltage rating of 15,000 volts and a peak current rating of 75 amperes. Since it is necessary to test tubes up to at least twice their voltage and current rating in order to insure a high quality of product, it is readily seen that the cost of installed apparatus in the usual type of testing set and of the power consumed by it may become a large percentage of manufacturing cost of tube.

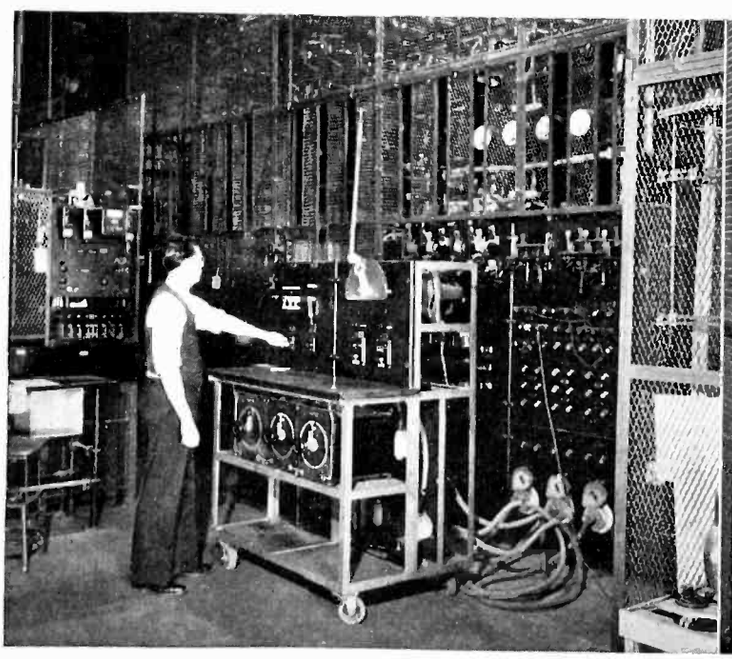
The power consumption of testing equipment may be reduced by the familiar "pump-back" scheme in which power is actually fed back into the supply lines and the only power used is that necessary to supply the losses of the tubes and apparatus. The disadvantage of this method is that the already high cost of apparatus is still further increased.

In order to reduce to a minimum the power consumption and at the same time the cost of installed apparatus, the vacuum-tube engineering department of the General Electric Company is developing a synthetic testing circuit or, as it is more commonly called, a "cheater circuit." In this unique circuit, the current is passed through the tube from a low-voltage source during one-half of the cycle, and a high voltage from a low-current source is applied across the tube during the other half cycle. It depends for its operation upon a Thyratron tube whose grid potential is varied in step with the potential of the high-voltage transformer. The power consumed by any device is the summation of the products of instantaneous values of current by the corresponding instantaneous values of voltage supplying the current. It is seen readily, therefore, that, as the current and voltage do not occur simultaneously, and the voltage transformer furnishes only small leakage and clean-up current, the power and apparatus requirements may be made very small as compared with the usual testing equipment. Thus, a 20-kva. high-voltage transformer with its corresponding low power apparatus can give results in tube testing which would require 3,000-kva. apparatus in the usual circuit with consequent saving of course.

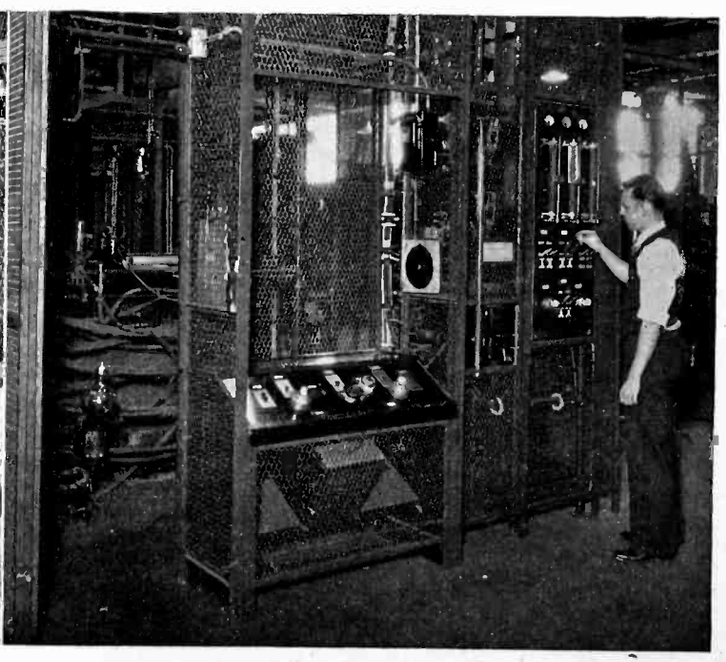



**Simplified diagram of "cheater circuit" for testing power tubes**

The "cheater circuit" was started primarily as a test circuit for mercury-vapor rectifier tubes but it also provides a Thyratron test which, although not an exact reproduction of inverter operation, may be made a reliable test as more experience is gained. At the present time comparisons are being made with the regular test circuits to see to what extent the synthetic results are equivalent to the standard.



**A 1,000-kva. test set. Transformers, voltage regulator and oil circuit-breakers are in other rooms**



**Synthetic test set, complete, in which only 30 kva. of apparatus replaces 3,000 kva. of equipment**

# Economics of theater maintenance

By W. W. WALTZ
*Manhattan Playhouses, Inc.*

THAT the present trend towards economy is exerting its influence in the theatrical field is best shown by the discovery of the fact that sound equipment, long the pampered pet of every exhibitor, is coming in for its full share of attention when costs, past, present and future, are considered and checked against receipts. Tremendous pressure is being brought to bear against the licensing companies for reductions in the so-called service charges but these efforts have been but partially successful; further relief from that direction does not appear to be imminent. Additional reductions in the cost of maintaining theater sound equipment must originate within the individual theater or theater chain. These reductions are generally accomplished, in the case of the chain theaters, by employing an engineer trained in the maintenance of the equipment who works with and acts as a constant check upon the activities of the service engineers of the licensing companies. Unfortunately, individual theaters are unable to maintain an engineer as a permanent part of the staff, but this may be rectified in the future by the growth of several companies that can supply this extra service at a very low cost. Apparently, the only thing in the way of the individual theater obtaining this "watch dog" service is lack of active demand.

### A typical economy program

What can be realized from an economy program directed at the sound equipment is best illustrated by a typical case, that of a chain of about 20 houses. Sound maintenance costs had been mounting until an engineer took over the responsibility of curbing them. Prior to that time, the average cost per theater per month for replacement parts (vacuum tubes, photoelectric cells, mechanical parts, etc.) had been approximately $75. Six months later a cost analysis showed a reduction to $35 per theater per month and the latest figures from this circuit shows a maintenance cost of only $18 per theater per month. As a matter of interest the result of the economy program at a few typical houses is shown. In the table, Column I gives the cost per month before an engineer was assigned to the task of cutting expenses; Column II is the cost at the end of six months under the economy program; Column III shows the costs for the six months ending April 1, 1932; Column IV, which gives the seating capacity of the houses, is included to show how the maintenance costs depend upon the relative intricacy of the equipment.

In the case of house *C*, after the costs had reached a reasonably low level ($16.94, Column II) they tended to flatten out at or near this point. This seems to indicate that it is impossible, or unwise, to cut further and experience substantiates this.

House *A* was the worst offender on the circuit. The inordinately high cost was due chiefly to the necessity of replacing the power tubes in the amplifier about every ten days. This was occasioned by poor voltage regulation along with the fact that the tubes, even with normal line voltage conditions, were being worked right up to their rated output. The trouble was entirely eliminated by substituting a power tube identical with the unsatisfactory ones except for a filament current some 10 per cent greater. This meant that an increase of as much as 10 volts on the line could be tolerated without exceeding the maximum current for which the filaments of these tubes were rated. This, of course, accomplished the desired effect without the expense and uncertainty of a voltage regulator. It is of interest to note that tube life in excess of 6,000 hours is being attained regularly.

It will be noticed that for theater *D* there is a very slight difference between the amounts shown in columns I and II. This is largely due to the fact that some experimenting was being done at this theater with various types of photoelectric cells which were being offered in competition with those supplied by the licensing company. In some cases it was necessary to purchase a cell in order to get it for test purposes. This expense was charged (improperly) to the theater where the tests were conducted. However, regardless of how the expense was charged, the tests provided information which is still the basis for the purchase of all photoelectric cells by this circuit.

### Disadvantage of cut price photocells

It was found that there was no advantage in using photoelectric cells that were sold entirely on a price basis. On the contrary, to maintain quality standards in the reproduced sound, it was necessary to use the cells supplied by the licensing company. The difference in price between the licensed and non-licensed cells was approximately $4 which did not represent sufficient saving to warrant the invariably poor quality and unsatisfactory life usually given by the cheaper product.

The same argument applies to some of the other items, notably the smaller type of tubes. Generally, the saving possible through the use of a cut-price tube was more than vitiated by an increase in noise level and unstable operation. There was a certain point below which costs could not be cut without seriously impairing the sound quality. There is always the risk of losing a certain percentage of a theater's patronage on account of poor quality of sound. This applies particularly to the house serving a so-called "better class" locality. The speech of an accomplished player can be so marred by intermittent clicks and frying noises, most of which originate in the photocell and the tubes of its associated amplifier that patrons show their objection by staying at home. Theaters have discovered that news about "sour" quality travels fast in a given community.

Considerable economy is effected in many houses by postponing the acceptance of improved equipment as it

is offered by the licensing companies. No one will deny the advantages of having equipment responding faithfully to frequencies as high as seven or eight thousand cycles providing that film can be obtained on which such frequencies are recorded. At the present time such films are few and far between and, by the time that the smaller houses get the prints, they are so badly scratched and so oily and dirty that these higher frequencies, being recorded at low levels, are entirely masked by the noise caused by the dirt and scratches. Even assuming a satisfactory print, the average back-stage speaker has such a decided cut-off at about 6,000 cycles it is problematical if the frequencies above that point will be noticeable outside of the direct beam of sound from the speaker. Add to this the fact that the average ear, trained to listening to the limited frequency range of even the best of radio sets, does not generally notice a difference in quality if the range of frequencies from about 150 to 4,000 cycles is covered. Thus it becomes readily apparent that there is a real chance for economy in turning a deaf ear to the salesman who wants to spend several hundred dollars of the theater's money to "bring out the highs."

**COST PER THEATER PER MONTH BEFORE AND AFTER ECONOMY PROGRAM**

| THEATER | I | II | III | IV |
|---|---|---|---|---|
| A | $116.08 | $69.46 | $13.69 | 1,200 |
| B | 111.73 | 46.63 | 19.07 | 1,460 |
| C | 65.50 | 16.94 | 13.42 | 605 |
| D | 45.50 | 44.55 | 4.17 | 587 |

An excellent illustration of a way to put a theater in the red is provided by a case the facts of which come from an unquestionable source. After the installation of an up-to-date reproducing set in a theater of some 900 seats it was found that an expenditure of $2,000 was necessary to correct the acoustic conditions. The house catered to a better-than-average class and it was the aim of the management to hold this clientele if humanly possible. The acoustic correction was of the best—recommended by the company that sold the equipment and by numerous "experts." The results were deplorable. In the first place, the licensing company had not provided amplifiers of sufficient output capacity to permit increasing the level to a point where the house could be covered, when more than half filled, at satisfactory volume. With the acoustic treatment the absorption was so great, with more than half the normal audience, that the patrons had difficulty hearing. The licensing company installed, at the expense of the theater, equipment to overcome this difficulty. Following this, it was found that there was a noticeable lack of intelligibility in the reproduced speech. Next came the recommendation for the purchase of new type sound-unit optical assemblies as a sure cure for the lack of what few high frequencies were being recorded. At present writing, this house is deeply in the red, with no signs of any relief. The point is that with all of the so-called expert and un-biased advice which was so freely donated the theater from the start has been a liability to the owner. True enough, this is an isolated case but it is illustrative of what is happening, fortunately on a smaller scale, to many houses where the service engineer goes on an orgy of ordering material in a mistaken effort to improve the sound. Today's audiences are not "sound conscious" to the point where they will notice, let alone demand, that theater sound is not much more than 60 per cent of what it some day will be.

### Economies in power supply equipment

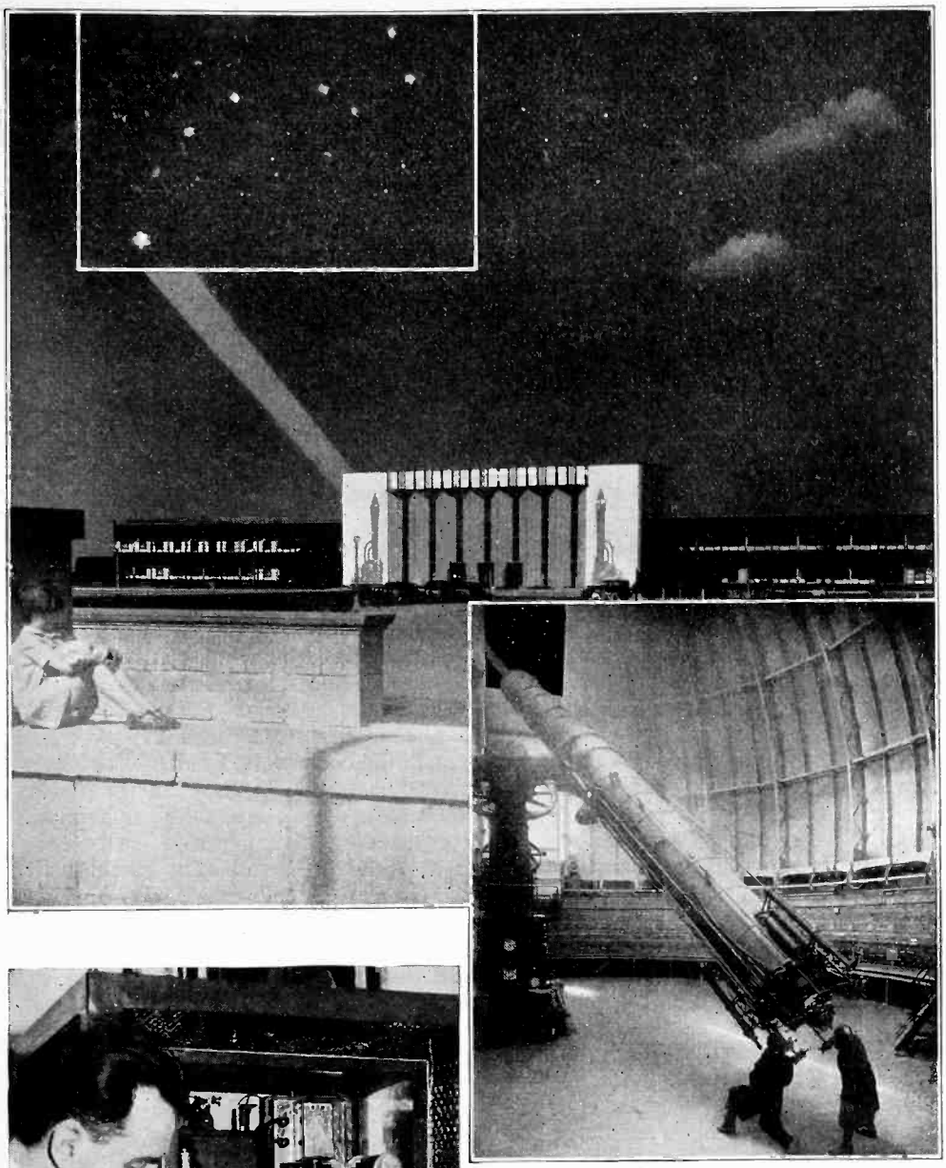
Additional economies are practicable in less spectacular parts of the sound equipment. The storage battery, long since relegated to obscurity as something best kept out of a theater, can be replaced economically by small motor generators or by rectifiers. Prejudices exist regarding both of these battery eliminators. Both are satisfactory. Prices, disregarding the product offered by the licensing companies as invariably unreasonable, distinctly favor the motor generator but this may be, and usually is, offset by the necessity of maintaining the motor-generator set and the desirability of keeping as much machinery as possible away from the operators. However, neither the rectifier nor the motor generator requires more than a fractional part of the time formerly devoted to the care of batteries and hence either is apt to be a popular as well as useful addition to the equipment. Of course, the initial cost is much greater than a replacement of the batteries but for a long-term write-off there is not much to be shown in favor of the batteries.

It must be remembered that the licensing companies are inclined to frown heavily on this use of what they are pleased to call "boot-leg" equipment and for that reason it is well to give the matter careful thought, especially in the case of the theater that is at some distance from a source of reliable, intelligent repair service. For even the best of equipment fails occasionally. In this unhappy event, with non-licensed equipment in use, complications may ensue and it will then be necessary for the exhibitor to adopt, and stick to, a spirit or independence. The service engineers shake their heads and frown deeply when confronted with anything that does not carry the distinguishing marks of their companies and dire predictions are freely made. But many thousands of dollars worth of non-licensed equipment is in use and is operating satisfactorily in a great majority of cases.

### Service costs versus economy

It may be well to point out, in fairness to the service engineers who visit theaters, that their jobs are in no way dependent upon the amount of material that they can sell. However, it is to the engineer's advantage to have the sound-reproducing equipment in top-notch shape at all times—fewer failures and resultant emergency calls in his territory mean a cleaner record at the main office. As a result, the engineer is painstaking about reporting and replacing parts that show the slighest trace of wear. Excepting such parts as actually require immediate replacement in the event of even slight trouble, it is true that most items can be neglected for periods of time that vary from one to six weeks or more. In the long run, it is by carefully checking all items requested for replacement that the greatest economy results. At present writing, this appears to be a job for a trained engineer although there is no good reason why the average theater manager, with the co-operation of the operators, cannot learn to recognize the various parts and get to know reasonably well when one part or another needs replacement. Obviously, there are many items on which the engineer's word must be accepted but generally when the service engineers come to realize that someone is taking an active interest in the projection room, their ordering activities decline immediately.

# New jobs for electrons

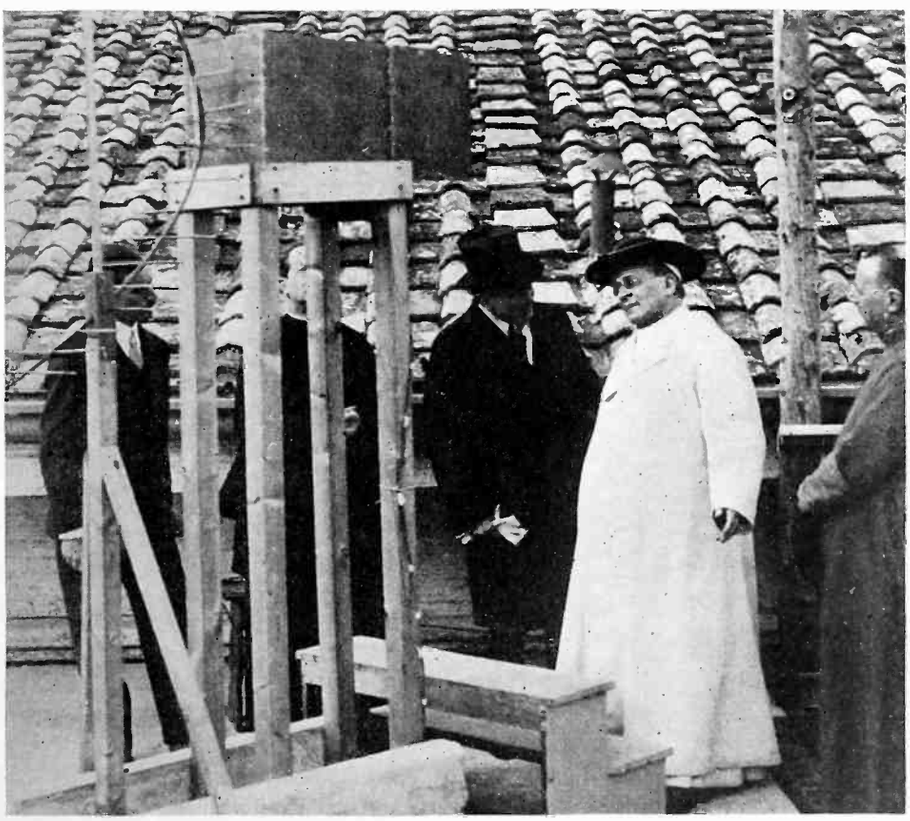


When the Chicago World's Fair of 1933 opens next June, its lighting circuits will be switched on by light from the star Arcturus, gathered in the great Yerkes telescope, focussed on a photocell, and amplified for transmission to relay switches at Chicago. The light used left Arcturus 40 years before, at the time of the Chicago World's Fair of 1893

A Chicago inventor employs thermionic tubes as a fire-alarm apparatus, arranging thermo-electric couples to detect the presence of undue heat. An amplifier then sends in the alarm

BELOW—

Senator Marconi demonstrates to the Pope at Rome, the new ultra short-wave equipment which has just been installed on the roof of the Vatican



# HIGH LIGHTS ON ELECTRONIC

## Fluorescence stimulated by ultra-violet at Chicago Fair

MANY NOVEL LIGHTING EFFECTS are being worked out for the Chicago "Century of Progress" exposition which will open in June, 1933.

An innovation will be the use of fluorescence. Many objects such as flowers, foliage, statuary, etc., will be treated with fluorescent materials and under so-called invisible light (ultra-violet radiation) will appear in contrast with the surrounding foliage.

The possibility of fluorescent fountains has not been overlooked. There are several organic substances that may be added to water to produce fluorescence, such as eosine, fluorescene, and aesculin. Very small quantities of these substances added to water in a circulating fountain are sufficient to impart a mysterious glow to the water under ultra-violet stimulation.

✦

## Automatic egg-candling machine uses photocell

IF YOU EAT EGGS, they are often served to you cooked in the shell, but seldom are you served with an egg unfit for food. That is because all eggs, in compliance with the laws of most states, are "candled" before they can be sold to the consumer.

Probably ever since eggs were used for human food, they have been tested for their edibility by allowing a strong light to shine through the egg. If the egg has started to deteriorate a dark shadow is cast, which the expert recognizes as an indication that the egg is not fit for food. Hundreds of professional egg-candlers are employed by large commission houses and every egg must be individually handled and tested before it is sold to the retail dealer. Since eggs may spoil in a short time under unfavorable conditions of climate and temperature, it often happens that it is necessary to candle the eggs several times between the hen and the consumer.

For two hundred years, no improvement had been made in the method of candling eggs. Now Wheaton C. Ferris of St. Louis, Mo., has invented an automatic machine which will handle more eggs than ten professional egg candlers, and, with the use of a photo-electric cell to measure the amount of light passing through the egg, will separate the eggs into good and bad.

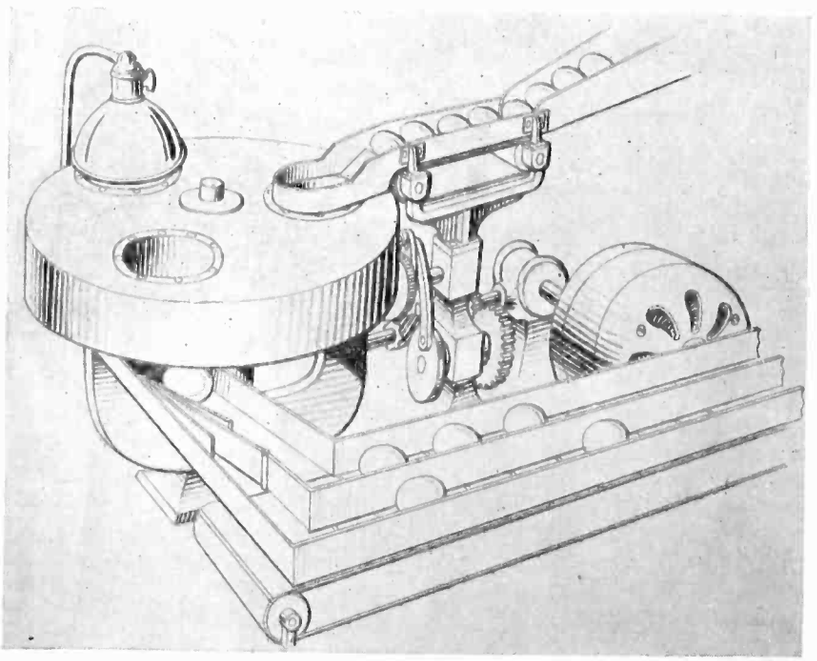
It has been found by laboratory experiment that instead of separating eggs into good, medium and bad—the usual commercial procedure—eggs may be separated by selenium cells or photo-electric cells into as many as a hundred different classifications, or as many as may be desired. It has also been shown in these experiments that the light-sensitive cell is many times more accurate than the human eye. Numerous experiments, such as the following, have been tried:

Mr. Ferris secured the services of one of the most expert professional egg candlers in the city of St. Louis, who candled several dozen eggs and threw out several of the eggs as bad eggs. The eggs were then passed through the laboratory model of the automatic egg-candling machine, and three of the eggs which the professional egg candler had discarded as bad were shown by the candling machine to be good eggs. These eggs were then broken, and the egg candler himself admitted that he was wrong and that the machine was right.

The inventor, a real estate man, was formerly in the general merchandise business in a small town, where he bought eggs from farmers and peddlers. The tedious work of testing eggs remained in his memory years afterward, and caused him to wonder if there could not be developed a better way of testing eggs.

One of the problems which gave him much difficulty was a method of handling the fragile products of the hen by automatic machinery, without breaking them. Also the method of handling must provide that all light reaching the light-sensitive cell must pass through the egg. This problem was finally solved by the use of a rubber ring in the inside of a steel ring. When the egg is in this ring, compressed air at low pressure is passed between the rubber ring and the steel ring. Thus the egg is supported wholly by an air cushion, the rubber ring fitting snugly round the egg so all light reaching the cell must pass through the egg itself.

Supported in its air cushion, it is practically impossible to handle the egg roughly enough, by machinery or by hand, to break it.



**As the eggs reach the photocell, they are supported on a compressed-air cushion which is formed between a steel ring and a rubber ring**

✦

## Signalling to rubber-tired cars at 200 miles per hour

PLANS ARE NOW UNDER WAY for the operation of high-speed trains at 200 miles per hour, on a roadway of special construction to be built between Camden and Atlantic City, N. J., and operated by the Aeroland Transportation System, Inc. The traffic will be handled by single cars which run over the roadway on rubber-tired wheels. Since it will not be possible to use an ordinary track circuit, it is required to control the trains entirely by inductive means. This will be accomplished by placing a large coil of wire on the cars and a single loop of No. 0000 conductor on the roadway. These loops are arranged in sections one-half mile in length and the system will be operated with alternating current of 500 to 750 cycles per second.

# DEVICES IN INDUSTRY

## Dispatches river barges by short-wave radio

ON-TIME PERFORMANCE of tows of the privately-owned Mississippi Valley Barge Line Company, operating between Cincinnati and New Orleans, is facilitated by the system of radio reports recently installed by the company.

Every three hours the company's four towboats report their positions to the central station in Cincinnati, and communication is established between the various boats.

"Since installation of the radio equipment, percentage of on-time performance has increased steadily," said L. Wade Childress, president of the company. "Long before a towboat arrives at Vicksburg, Miss., its captain has received last-minute instructions as to the number of barges to be picked up there, and the operation is completed with minimum loss of time. Towboats requiring supplies or replacements need lose no time now, as radio orders may be placed far in advance of arrival."

✦

## Ultra-violet puts red on apples

SOME CAREFUL EXPERIMENTAL WORK by Dr. Arthur of the Boyce Thomson Institute for Plant Research, Yonkers, N. Y., has established that apple coloration is most active in the extreme part of the ultra-violet light which is received from the sun (3,120 to 2,900 A.u.). This he confirmed by exposing uncolored ripe apples to light and heat of various frequencies, and found that artificial ultra-violet light of the right frequency could duplicate the solar coloring action in every detail. With the light sources available he was able to color an apple completely in 48 hours of exposure. Rhode Island Greenings and other apples which do not color in sunshine do not color in ultra-violet light.

✦

## Photo-cell piles bags in factory

THE CHASE BAG COMPANY, Milwaukee, Wis., uses the photoelectric relay in piling its product. After the bags are stitched, they travel on a moving belt to a stacking table. A suitable light source projects a beam of light across their path at such a place that the photoelectric relay is actuated and metal fingers come up under each bag and toss it on the pile.

## Testing tires for noise

NOISINESS IN TIRES has long been a problem of the rubber industry, but only recently has it been attacked scientifically with view to producing tires that will have maximum silence, and still retain the fundamental requisites of safety and good traction.

With this objective, The B. F. Goodrich Company of Akron, Ohio, started experiments making hundreds of tests to compare the noise produced by six types run under exactly similar conditions. Tests were first made on new tires and then on the same tires after they had been run 1,000, 2,000 and 3,000 miles.

The noises, it was found, came from three main causes, impact on the tire on the pavement, clatter of design on the pavement, and pavement roughness.

Noise-measuring equipment consisted of a Jenkins & Adair condenser microphone, a Burgess accoustimeter and a 1,000-cycle low-pass filter. The filter served to reduce wind noises without materially affecting tire noises. Carried in an iron box, the microphone was carefully padded with felt to shield it from any mechanical vibrations of the car. This iron box was bolted to the car floor in the position normally occupied by the left end of the rear seat cushion. A 4½-inch fiber tube, fitted closely about the diaphragm of the microphone, extended flush through a hole in the car floor. This hole was over the rear axle and 12 inches to the right of the left rear wheel.

Accoustimeter and battery cases rested on a rack on the right side of the car in the position normally occupied by the right end of the rear seat cushion.

Two men were required to conduct each test, one to drive the car and observe the speedometer, the other to operate the accoustimeter and record its readings.

✦

## Artificial light needed 30 per cent of time in school room

A NUMBER OF experiments have been conducted in schools recently with photoelectric light-control relays which regulate automatically the turning on and off of artificial lighting as the intensity of daylight decreases or increases. During the year such control was applied to the lighting of one school room where children in a special "sight-saving" class receive their instruction. Tests conducted in this room indicated that in order to maintain an intensity of 15 foot-candles, it is necessary to use the artificial lights at least 30 per cent of the time the room is in use.

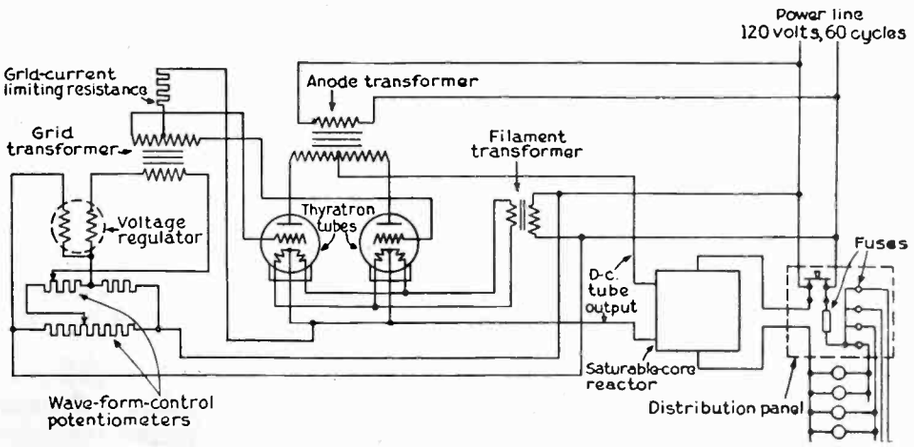
✦

## Mine uses electronic door-opener

A WESTERN PENNSYLVANIA MINE has installed a system of automatic door control using "the electric eye" as the controlling relay. The mine doors are caused to open and close in proper sequence for either direction of movement of the trip.

✦ ✦ ✦

## CONTROL OF WINDOW LIGHTING BY TUBE CIRCUITS




**The diagram shows method of arranging Thyratron reactor control circuits for mobile color lighting of a show-window, fountain or other application of color flood-lighting. No moving parts carry load currents, and the dimming is smooth and without energy loss**

# A standard microvolter

## using 2nd harmonic principle

By W. F. DIEHL
*RCA Victor Company*
*Camden, New Jersey*

AT LEAST one variable radio frequency test oscillator, the output voltage of which is controllable but not definitely known, is found in practically all laboratories. Such an oscillator is useful in analyzing and aligning circuits and making comparative measurements where accuracy is not important. If the oscillator incorporates a source of variable and accurately indicated modulation, if means for accurately determining the output voltage magnitude is provided and if the device is relatively free from frequency modulation and leakage, then it becomes a standard signal generator.

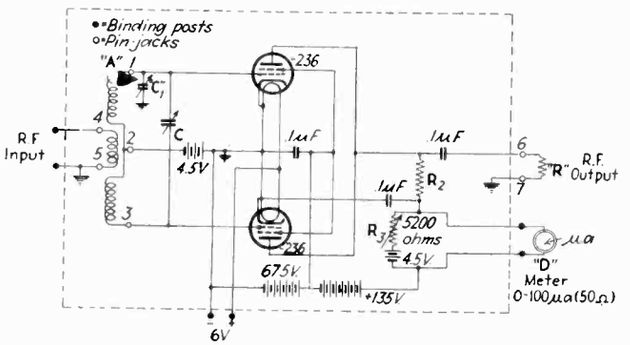



**Fig. 1—Balanced circuit in which second harmonic is produced**

The standard signal generator meets the demand for a single portable instrument for obtaining the essential performance characteristics of receivers as standardized by the I.R.E.

In one type of signal generator, the voltage output is determined from the combined reading of a tapped multiplier and a slide-wire attenuator. The current entering the attenuator is held constant and the voltage across the first section, or input, is attenuated by a ladder type attenuator and a slide-wire connected across the output. Due to the capacity across the current indicating device and because of inductance or other reactive effects in the resistor net-work, it is not possible to rely on the voltage as calculated from the current and resistance, especially at the higher radio frequencies. Some of these defects have been overcome by resorting to a special thermocouple voltmeter to indicate the input voltage across the attenuator. The thermocouple is constructed so that the shunt reactance effects are made negligible up to approximately 30 mc., at which frequency the voltmeter has been checked by fundamental methods. The resistor attenuator used with this voltmeter is constructed so that the impedance ratio on the different attenuator steps is independent of frequency and the reactance shunting the meter then only affects the load on the oscillator but does not affect the calibration. While it is possible to design an attenuator resistor net-work, in which the resistance ratio is correct at low frequencies, it is necessary to check the attenuator at high frequency in order to insure the independence of impedance ratio with frequency.

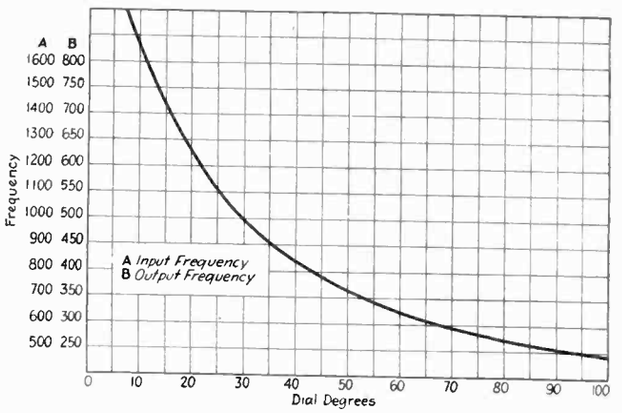



**Fig. 2—Calibration of generator showing frequency doubling characteristic**

### Purpose of microvolter

The standard microvolter is an instrument for generating and measuring very weak radio frequency voltages. The device is particularly useful for calibrating signal generators and obtaining performance data on receivers. The principle of operation is based on a method[1] first described by Dr. Walter Van B. Roberts and later adapted to production test equipment by the Technical and Test Department of RCA.[2] The present design of microvolter known as Type TMV-47-A, however, incorporates certain refinements and improvements over earlier equipment, which makes it universally applicable to either factory or laboratory use.

### Theory of the frequency doubler

If a signal $S = A \sin \omega t$, is superimposed on the control grid bias (B) of a thermionic vacuum tube, the plate current ($I_p$) may be expressed in terms of $(B + S)$ by the series: $I_p = f(B) + f'(B)\,S + \frac{f''(B)\,S^2}{2!} + \frac{f'''(B)\,S^3}{3!} + \frac{f''''(B)\,S^4}{4!} + \ldots$ when $S$ = Zero, $I_p = f(B)$ and this current may be balanced out of the plate circuit microammeter (D) by means of the resistor $R_3$ and the 4.5 volt battery. After this adjustment is made, the plate current change due to an applied signal is determined by all terms containing (S). The first power term shows plate current at the fundamental frequency of the signal (S), while the second power

term shows a d.c. component which is exactly equal to the peak magnitude of the a.c. component of twice the frequency (second harmonic) of the fundamental;

$$\frac{f''(B)\,S^2}{2} = \frac{f''(B)\,A^2 \sin^2\omega t}{2} = \frac{f''(B)\,A^2}{2}\left(\tfrac{1}{2} - \tfrac{1}{2}\cos 2\omega t\right)$$

$$= \underbrace{\frac{f''(B)\,A^2}{4}}_{d.c.} - \underbrace{\frac{f''(B)\,A^2 \cos 2\omega t}{4}}_{a.c.}$$

When conditions are so chosen that the fourth and higher order effects are negligible in comparison with those of the squared term, measurement of the d.c. change in plate current is equivalent to measurement of the peak magnitude of the second harmonic which the tube generates. The conditions for this d.c.-a.c. equality are obtained by so choosing the grid bias (B) that the change in plate current is proportional to the square of the applied e.m.f. This proportionality is obtained with the 236 type tube, using $4\frac{1}{2}$ volts bias and the screen and plate voltages as indicated on the diagram. Derivatives, plotted up to and including the fourth show the d.c.-a.c. equality to be less than 1 per cent in error.

The peak a.c. developed in the plate circuit, due to the second harmonic, flows through the output resistor (R) back to cathode (ground) and produces across the output terminals, 6 and 7, a peak r.f. voltage equal to $IR$; where $I$ is the direct current ($I_p$) indicated by the meter (D). If the resistance of (R) is made equal to

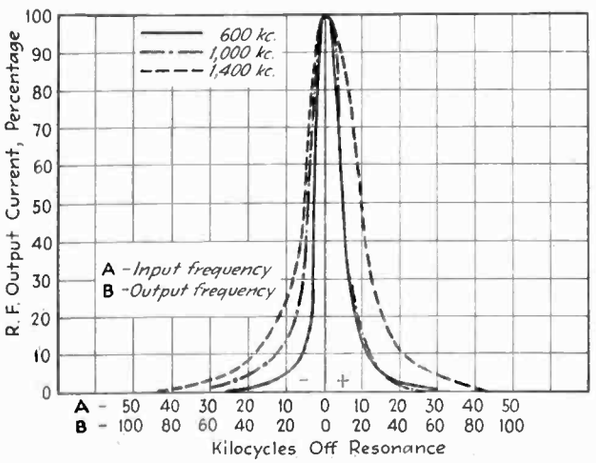



**Fig. 3—Microvolter selectivity characteristic**

the square root of 2 ohms, or some even multiple thereof, then the meter (D) will read r.m.s. microvolts output directly. To cover a satisfactory range and for simplicity of operation, two values of (R) 1.414 and 14.141 ohms are generally used. Using two such values of resistors and a microammeter, with variable shunts, to obtain ranges of 100 μa. to 1 ma. outputs of from 1 to 10,000 μv. can be obtained from an input not exceeding 400 mv.

The presence of the fundamental frequency across the resistor (R) will cause no trouble when testing modern receivers. Nevertheless, there are occasions when an accurately known high frequency magnitude is desired in circuit combinations with insufficient selectivity to properly discriminate between the undesired fundamental that "leaks through" and the second

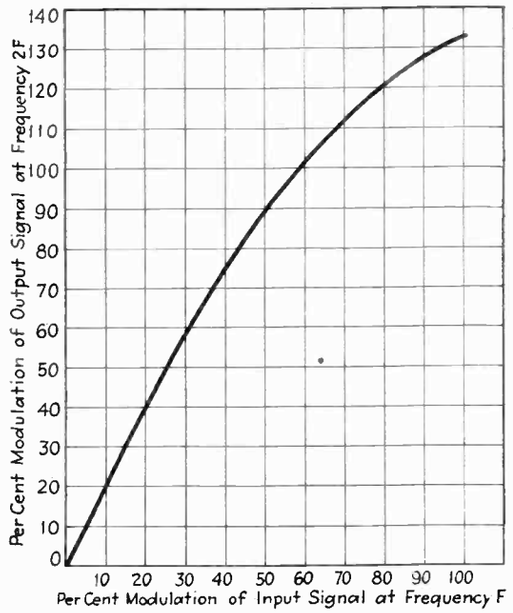



**Fig. 4—Curve showing relation between input and output modulation**

harmonic generated in the device. By employing a symmetrical tube arrangement, a balanced r.f. input transformer A, a small variable air condenser $C_1$ (adjusted to balance stray capacity fields) and taking precautions in grounding, as shown in Fig. 1, the strength of the fundamental existing in the plate circuits of the two tubes is practically zero.

In view of the wide frequency range which this instrument will satisfactorily cover with interchangeable coils, the input transformer A is of the plug-in type and the r.f. filter in the d.c. plate circuit consists of a resistor $R_2$ of 10,000 ohms instead of an r.f. choke. As the value of this resistance is small compared with the d.c. impedance of the tubes, it has no detrimental effect on the d.c. increment reading.

## Microvolter precision

The precision of the microvolter depends almost entirely on the accuracy of the output resistor (R) and the accuracy of the microammeter (D). If the value of the balancing resistor $R_3$ is at least 100 times greater than the meter resistance, there is less than 1 per cent error. Low resistance microammeters will increase the electrical accuracy but will increase observational errors if the sensitivity and scale reading have been proportionally reduced. For high accuracy, where low radio frequency output voltage is desired, the meter should be especially calibrated at low scale readings, or a lower range instrument used. The standard output resistors consist of extremely fine resistance wire, wound in a non-inductive manner to reduce the error which measurements show to be small, except at the ultra high frequency. By analyzing the equivalent plate circuit and noting the various capacities which shunt the output resistor, including the plate capacities of the tubes, it can be seen that errors due to shunt reactance are negligible at all ordinary radio frequencies and cause little more than 2 per cent error at 30 mc.

When a modulated signal is applied to the microvolter the output carrier at $2F$ acquires approximately twice the percentage modulation of the frequency $F$ applied to the input. Assuming that the development of the

[*Please turn to page 246*]

# + + + ELECTRONIC NOTES

## Measuring acidity and alkalinity by photocell

ELECTROCHEMISTS ARE USING electron tubes for the measurement of acidity or alkalinity of solutions. In the case of acidity measurements, there are in addition to potentiometric methods those involving the change in color of a class of organic substances known as indicators, according to James A. Lee, of *Chemical & Metallurgical Engineering* in a recent address.

Indicators are of two general types—one-color indicators, which involve a change in transmission of light of one spectral band or color and two-color indicator, which involve a similar change in two colors with change in acidity. The indicator methyl orange, for instance, in acid solution transmits red light preferentially and in alkaline solution shows a preference for yellow light. Varying degrees of acidity between these two colors gives the eye a sensation of different shades of orange. This is not due to the orange of the spectrum but to the additive effect of the red and yellow intensities on the human eye. These color transmission bands vary definitely for a given indicator. Although varying for different conditions it may be generally stated that photoelectric cell methods using one stage of vacuum-tube amplification and a milliammeter as the indicating instrument exceed visual precision by about ten times. For indicators which give different shades of blue and violet where the sensitivity of the eye is poor, much greater improvement is noted.

Metals whose salts are colored may be analyzed rapidly and accurately by colorimetric methods using the photoelectric cell. Nickel, cobalt, iron, copper and manganese are among the metals that can be analyzed by this method. Nitration, chlorination and bromination processes may be followed and controlled, and the hardness of water or its chlorine content may be checked by using a similar device.

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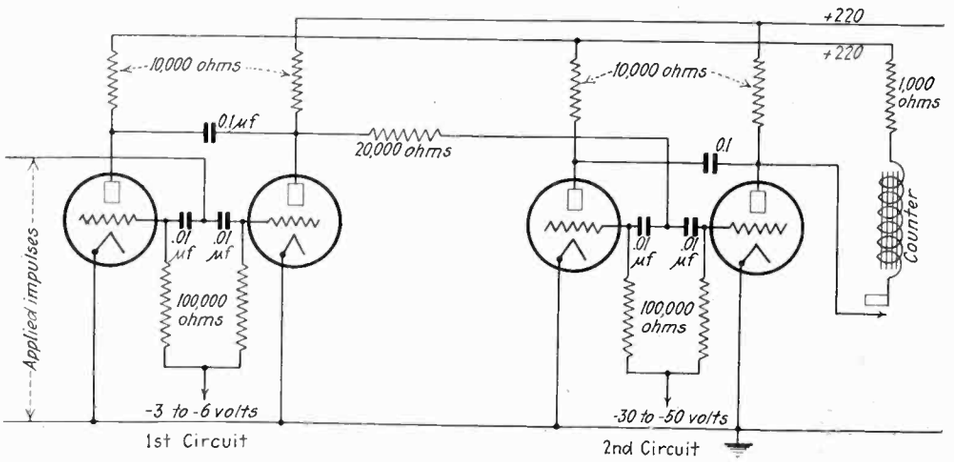
## High speed thyratron automatic counting

THE CIRCUIT DEVELOPED by C. E. Wynn Williams of the Cavendish Laboratory and described in the *Proceedings Royal Society*, London, May, 1932, allows of recording or counting the passage of 1,250 objects per second (over 4 million per hour). The principle of the method employed is that of arranging several units of two thyratrons in cascade so as to reduce the rate of counting by a factor of two per unit, until the final counting rate is sufficiently slow for a mechanical meter. In each unit the steady bias potential applied to both grids by the grid bias battery through the grid resistances is slightly more negative than the critical negative potential required to prevent arcs from striking. Suppose that by some means an arc has been started in one thyratron; the striking of the arc in the other thyratron consequent upon the arrival of an impulse at the grids results in a sudden drop of its anode potential and the resulting negative potential surge, transmitted through a condenser to the anode of the other thyratron causes the arc in that thyratron to be extinguished. Each thyratron responds to one-half the total number of applied impulses. Only one of the thyratrons in each stage is coupled to the preceding unit of two by connecting the input side of the grid condensers to the anodes of one of the thyratrons through high resistances.




**High-speed counting circuit developed by Williams of the Cavendish Laboratory**

## Heat tempering of valves controlled by photocells

THE USE OF photo-electric tubes for controlling operations in the production of automobile valves is an outstanding feature of a Cleveland plant, according to F. L. Prentiss, writing in *Iron Age*. A photo-electric tube is provided for controlling the temperature to which tips of valves are heat-treated electrically in the hardening operation. Electronic control is used also on gathering machines in the forge shop. With this control the machine does not perform its function of gathering the metal that forms the head, the first forging operation, until the end of the piece that is to be gathered is at the proper heat.

Various grades of alloy steel are used, the most common being nickel-chromium and chromium steel for intake valves and chromium-nickel-silicon steel having high heat-resisting qualities for the exhaust valves.

✦

## X-rayed seeds may simplify industrial processes

EXPERIMENTS WITH X-rayed seeds are being carried out in the new greenhouse of the Research Laboratories at Schenectady, N. Y. The General Electric scientists have already used the Coolidge tube to produce new and curious varieties of tomatoes, sunflowers, and cosmos, by X-raying the seeds, seedlings, and bulbs, of the various plants before planting them, applying the Coolidge tube for this purpose.

Goodspeed and Olson at the University of California have already produced new tobaccos; Stadler, at the University of Missouri, new grains; and Sprague has increased the production of potatoes by irradiating the seed tubers.

A variety of cotton has already been grown from X-rayed seed in which the seed is free from lint. Another type of cotton gives monstrous seeds. Both of these variations, if successfully carried out, would work remarkable changes in the ginning process and in obtaining more than the usual amount of cottonseed meal.

The mechanism of these changes, according to laboratory workers, is only poorly understood at present, but it is evidently tied up with modifications in the chromosomes—the determiners of heredity which lie at the centers of the cell nuclei—under the ionizing force of the X-ray beam.

The Schenectady laboratory greenhouse is trying the effect of X-rays on

# FROM THE LABORATORY + + +

some new plants of economic importance, under carefully-controlled conditions, so that the scientific as well as the commercial possibilities may be understood. The seeds of certain tropical fruits and plants have been or are being planted at present, after being exposed to the X-rays. Common garden fruits and vegetables now growing in the greenhouse will later be transplanted outside.

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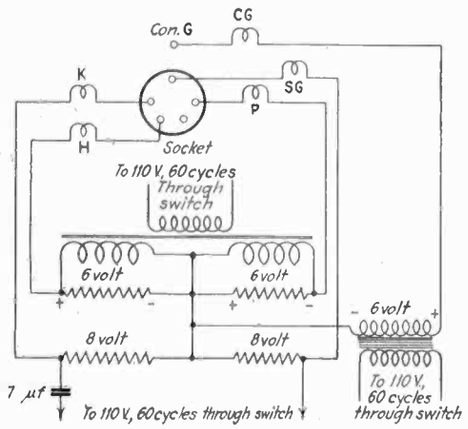
## Direct reading short circuit test for vacuum tubes

By Avery G. Richardson

The ideal short circuit test should require only the insertion of the tube into the socket and should not demand manipulation of switches. It should




also indicate clearly the exact type of short circuit and not depend on reference to a key chart.

The exterior of a useful test set has two sockets and five lights, marked for the tube elements. Two lights burn for any short and indicate the elements involved, as P-G or K-H.

Standard 6-volt pilot lights are used. A small transformer with three 6-volt secondaries furnishes the associated resistance units with voltage of the instantaneous polarity shown. A 7 μf condenser is in series with the two lower resistance units, which are given values so that there is approximately 8 volts across each. This voltage is nearly 90 degrees out of phase with that furnished by the transformer secondaries.

A short circuit between any two elements completes the circuit through the lights associated with them, so the device is direct reading. It will be noted that there are always two sources of voltage in series in each short circuit and that these two sources are always additive because of the out of phase current furnished by the condenser.

## Electronic oscillograph lightning studies

Measurements of lightning involve time in microseconds (millionths of seconds), volts in millions, amperes in hundreds of thousands, and horsepower in millions. So rapidly does the flash come and go, that its rise and fall can be indicated only by a cathode-ray stream of electrons.

It is not necessary for lightning to strike to cause damage. Voltages may be "produced" in transmission lines by lightning strokes a considerable distance away. These voltages travel over a line as electric waves, at the rate of about 1,000 feet in a microsecond and may flash-over an insulator, permitting the power current to follow, or may destroy apparatus. Electric waves act much like water waves, and "splash up" to double value on reaching an open end of a line—an electric sea wall.

With the recently developed cathode-ray oscillograph, which records extremely brief phenomena by a pencil of electrons, it has been possible to secure records of natural lightning waves on lines, and to reproduce these in the laboratory. This equipment was used on a short antenna to determine the rate of collapse of the electrostatic field of a cloud. This would indicate the rate of lightning discharge.

Clouds sometimes discharge in one to two microseconds. By means of the laboratory cathode-ray oscillograph and the 5,000,000-volt lightning generator it has been possible to send waves, duplicating those found in practice, along a short transmission line and to record their effects. These waves speed at the rate of one foot in a billionth of a second.

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## Freezing point of platinum

It is well known that the freezing of a pure material takes place at a constant temperature, the most familiar instance being the freezing of water at 0° C. Pure metals also have definite freezing points, which are useful in accurate temperature measurements. One of the more important freezing points is that of platinum, somewhat above 1,770° C. In spite of the importance of the platinum freezing point, various determinations of its temperature, even those made in recent years have differed by nearly 10° C. The Bureau of Standards has recently made another determination of this freezing point and found it to be 1,773.5° C. (3,224° F.), which is believed to be correct within about 1° C.

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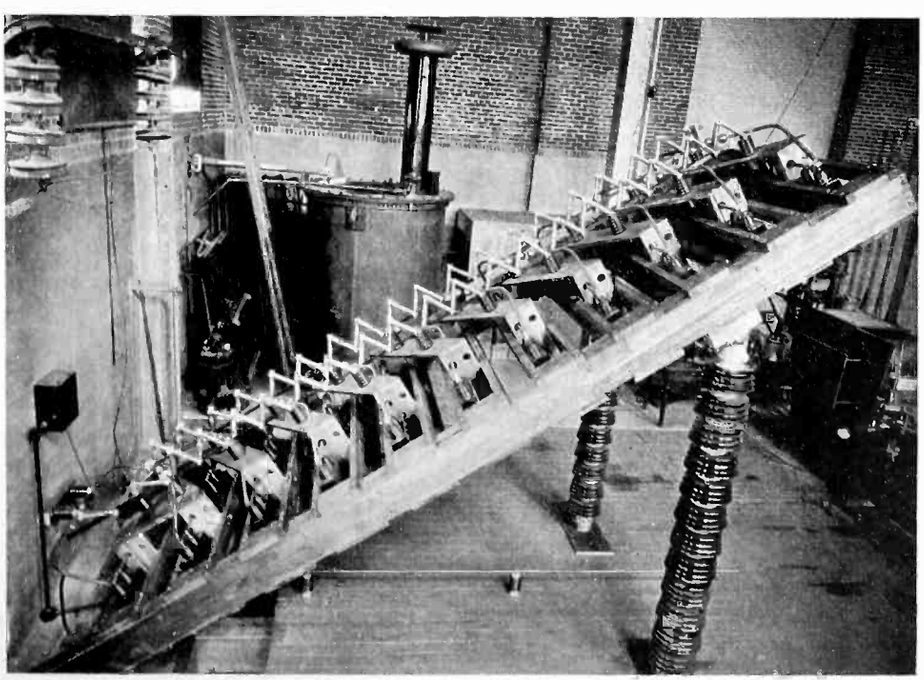
## PURDUE'S MILLION-VOLT GENERATOR



**Kenetron chargers feed these condensers, in parallel; they can be discharged in series, while a cathode-ray oscillograph records the discharge**

# electronics

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New York City

O. H. CALDWELL, *Editor*

Volume V — JULY, 1932 — Number 1

## "Plant modernization" — by inexpensive electronic control

THIS is a time when every effort is being made to stimulate modernization of equipment in manufacturing plants. Yet, despite the pressure that is being brought to bear, it seems likely that under present business conditions there will be little major rehabilitation and replacement of main machinery.

But the very situation opens an opportunity for electronic control, by means of which a small outlay and minor changes can effect perfectly prodigious improvements in efficiency and economy.

The thermionic tube, the photo-cell, the three-element gaseous tube—all can work industrial miracles when applied to the control of existing equipment. The electronic engineer holds the key to industrial improvement and modernization on a scale all out of proportion to the modest expense of the equipment by which his wonders are wrought.

## Electronic advances and unemployment

EVERY man interested in electronics repeatedly finds himself faced with the question: "If your electric eyes and vacuum tubes are replacing human labor and throwing men out of work, what real advantage are they to society as now constituted? Are not your inventions a menace rather than a boon to mankind?"

This puts a puzzling query up to all invention and all scientific progress.

But one thing is certain. Invention is bound to go on. And a way must be found so that society as a whole benefits rather than suffers from labor-saving devices.

Electrical inventions that substitute an electrical eye or electrical brain for human effort, must contribute the leisure and advantage thus obtained to the general good.

In the ultimate, electronic devices must be used to make the world a happier place for all—they must not be allowed to grow into a spectre of unemployment and distress.

## Electricity direct from sunlight

NEARLY everyone in the electronic art knows of the extensive use of the copper-oxide rectifier, but few realize that the discs used in this valuable device are a strong contender for the honors now held by the photoelectric cell.

In 1924 Dr. Grondahl discovered that the dry copper-oxide rectifiers he had invented were light-sensitive. Subsequent investigation by his associates disclosed currents of the order of micro-amperes flowing in an external circuit when the rectifier discs were irradiated with sunlight.

In 1930 the world's newspapers carried headlines dealing with the work of Bruno Lange in Germany who had made a motor run from energy derived from sunlight. In his technical disclosures it was discovered that he had secured currents of the order of 500 microamperes per lumen. Later Duhme and Schottky secured 5 milliamperes per lumen.

Dr. Earl D. Wilson of the Westinghouse Research Laboratories soon will describe in *Electronics* his work in this field. One of his best cells delivered 3 milliamperes through 100 ohms or a power output of about 1 watt per square yard.

This is the closest man has approached to the dream of using, directly, energy from the sun. When it is realized that in full sunlight 200 watts per sq.ft. of energy fall on the surface of the earth

from the sun, it is seen that man's best efforts so far are rather puny.

But Dr. Wilson says of his work "when the power output has been increased 100 times, cuprous-oxide cells will afford other types of light-sensitive devices very uncomfortable competition."

## Enlisting city police against radio offenders

AN interesting principle concerning radio interference has been introduced into the new ordinance at Los Angeles.

If the installation of the complainant complies with the official requirements, or is made to comply, and providing also that there is the specified broadcasting signal strength (500 microvolts per meter) within 50 ft. of the receiver, then the complainant may seek redress from the person causing the interference and also has the aid of the police powers of the city to back up his demand that the offender eliminate the source of the interference without delay.

The ordinance gives specific requirements for installation. The lead-in must be shielded, and the aerial must be at least 40 ft. in length and not less than 20 ft. above the ground. This last requirement is designed to reduce pick-up of interference from appliances.

The Los Angeles ordinance appears to be paternalistic in the extreme, but if it can thereby put radio offenders to the test, the experiment may be worth while, after all.

## Harnessing starlight 40 years old

FROM Chicago comes the announcement that a photo-cell and electronic amplifier is to turn on the lights for the coming Century of Progress Exposition of 1933, using light from the star Arcturus. In fact, the luminous energy which the photo-cell will detect, will be light which actually started on its way from the great sun Arcturus 40 years before, during the Chicago Columbian Exposition of 1893, and has been in transit ever since, at 186,000 miles per second.

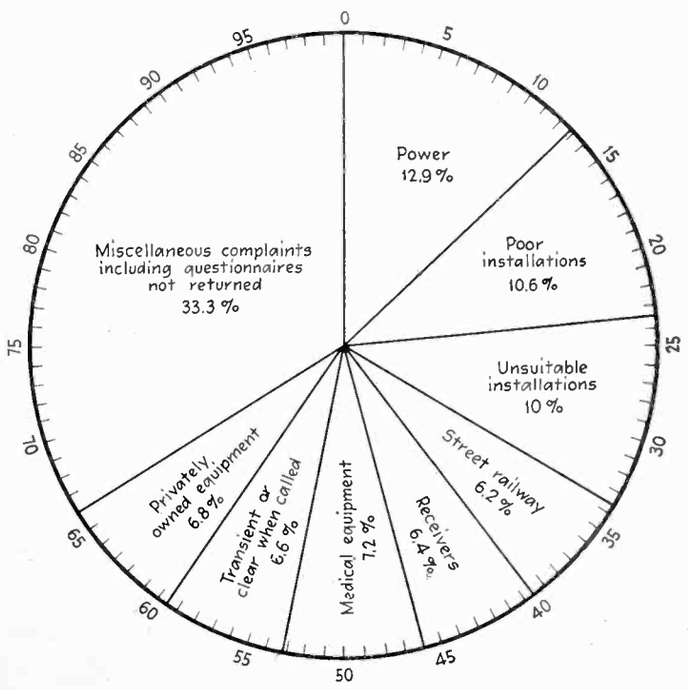
This Chicago experiment gives credence to our suggestion that electronic devices may yet provide science with the super-telescope of the future, exceeding in penetrating power anything ever attempted by astronomers along present lines of simply increasing the diameter of telescope object glasses.

No basic improvement has taken place in telescopes since Galileo.

Instead of expending the 12 million dollars estimated as necessary to complete and mount the projected great 200-inch telescope, it might pay to devote part of this sum to research along radical new lines of electronic amplification. Expressed in radio terms, our present great telescopes are merely huge crystal receiving sets which collect and gather up impulses of very short wavelengths, as a crystal set with a very long antenna gathers up broadcasting impulses. But modern radio receivers do not gather impulses; instead they utilize amplifying systems, which amplify faint ether impulses through series of radio tubes. When by some system of light choppers, etc., this principle of amplification can be applied to amplifying faint short-wave ether impulses (light rays) it should be immediately possible to extend greatly the usefulness of the modern big glass, for spectrograph studies, measurements, etc.

✦

CAUSES OF RADIO COMPLAINTS




Analysis of 3,245 radio interference complaints investigated by the Radio and Music Trades Association of Los Angeles. The cost of investigating these complaints averaged $4.38 each

# REVIEW OF ELECTRONIC LITERATURE

## HERE AND ABROAD

### *The distortion factor*

[KLEEBINDER] Description of the new Siemens and Halske "Klirrfaktormeter" (percentage of false overtones introduced by non-linear amplification etc. as compared with the basic pure frequency) and of its use. This instrument measures each overtone separately and not the sum jointly. Five per cent is said to be the permissible limit in German practice. The theory for triode and screen-grid amplifiers is discussed, as also that for push-pull amplification. —*Radio Amateur, Vienna, May, 1932.*

✦

### *Short-wave reception and solar activity*

[H. M. MOEGEL] Telefunken Laboratory. Since the beginning of 1930 Telefunken has been obliged to use at all times of the day slightly lower frequencies for best results with long distance reception of short waves, particularly when the path traverses the neighborhood of the magnetic poles. At the end of the year 1931, the increase in wavelength amounted to from 50 to 90 per cent on the North Atlantic route and only about 10 per cent on the lines to South America and Africa. The shift is less during the day than at night, so that more wavelengths are now required for a reliable 24-hour service than were necessary a few years ago when the activity of the sun was higher; on some paths four or even eight in place of two. A drop in the emission of electrons by the sun seems to account for the change. —*Telefunken Zeitung, March, 1932.*

✦

### *Television on ultra-short waves*

[UNSIGNED] It is hoped that the u.s.w. broadcasting will commence in Berlin as a regular feature by June next, using directed waves [probably as regards limiting radiations near the vertical]. Television is to be specially pushed, with 10,000 elements and 5:6 dimension of frame, corresponding to the normal film image: i.e. with 90 lines.—*Funk, Berlin, March 11, 1932.*

✦

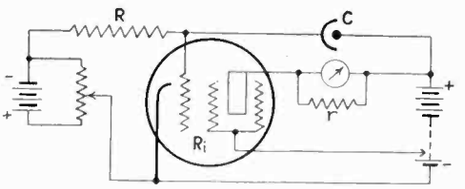
### *Relays in vacuum tube circuits*

[H. STROHMEYER] Brunswick Institute of Technology. Experiments are made with a number of relays inserted in the plate circuit of vacuum tubes. In d.c. operation the tube does not simply act as a resistance, but influences the speed with which the electromagnet works. For reaching a given value of current in the shortest time a tube with high internal resistance is to be recommended. When in addition the mu of the tube is small the necessary grid potentials can be kept low.—*Hochfrequenztechnik and Elektro Akustik, April, 1932.*

✦

### *A photoelectric cell circuit*

[G. A. WOONTON AND R. A. ELSON] A mathematical analysis is given of the vacuum tube circuit having resistance $R$ between filament and grid and a photocell between grid and plate, the resistance $C$ of the cell being defined as the reciprocal of the conductivity of the cell at constant anode voltage but with




varying light flux. If $C$ is kept very much larger than $R$ and sufficient negative grid bias applied, the plate current is equal to $R_i\ R\ (E_p + E_g/C$, where $R_i$ is the internal resistance of the vacuum tube, $E_p$ and $E_g$ the plate and grid potentials.—*Canadian Journal of Research, April, 1932.*

✦

### *Barkhausen-Kurz oscillators*

[LITTMANN] Useful summary, largely mathematical, of the Barkhausen-Kurz, Gill-Morell, Hollmann, Möller, Potapenko studies of ultra-short-wave production, and of the present situation as regards the theories of these.—*Funk, Berlin, April 29, 1932.*

✦

### *Results of television tests on seven-meter waves*

[G. KRAWINKEL and K. ZIEBIG German Post Office Lab.] The first tests were made with pictures of 60 lines containing 80 elements per line and repeated 25 times per sec. The upper frequency of modulation was therefore 60,000 cycles, the lowest frequency was taken as 25 cycles and in one receiver as zero cycle. Three types of receivers were used all at a distance of four miles as well as close to the 300 watt sender. The simple regenerative detector followed by three audio stages was found to feedback too much and thus to give considerable distortion. The super-regenerative detector is suitable for pictures having not over 3,000 elements and 25 repetitions, because the frequency of the controlling oscillation could not be pushed much over 100,000 cycles without causing distortion or lowering the amplification. Superheterodynes were found satisfactory. They had a first stage of r.f. amplification with a tuned plate circuit. Resistance coupled stages amplify the intermediate frequency. In the last few weeks the Fernsch Ltd. has completed a transmitter for pictures with 19,200 elements and 25 frames, so that the tests can be extended.—*Fernsehen und Tonfilm, April, 1932.*

✦

### *Electric receiving set without filament transformers*

[EDITORIAL] In the rectifier tubes developed in the vacuum tube plant of Gustav Ganz, Vienna, the filament is directly heated by the 220-volt a.c. Under normal conditions, that is in a four-tube receiver with 25 ma. plate current and an input condenser of 4 $\mu$ these tubes furnish 208 to 212 volts d.c. The same firm has put receiving tubes on the market with filaments heated in the same way and which tests at Berlin showed to work to "full satisfaction" after 2,000 hours service, giving still the same plate current of 18 ma. as at the start. It is hoped that in the future power transformers will be required only for furnishing plate voltages.—*Sieben Tage, Berlin.*

✦

### *Absorption coefficients for frequencies up to 8000 cycles*

[F. L. HOPPER] Electrical Research Products Lab. Naturalness and intelligibility are increased by the addition of frequencies above 5000 cycles, and the paper is concerned with the determination of absorption coefficients for frequencies up to 8000 cycles by a chamber reverberation method. Some materials, like pre-cast plaster tile show an increase in absorption from 4000 cycles to 8000 cycles while others exhibit a marked decrease in absorption (rockwool filled studding, for instance). Heavy carpets and hairfelt pads have high absorption, above 1000 cycles.—*Journal Acoustical Society, January, 1932, —(issued March, 1932.)*

## *The latest*

[H.G.] Some details of the Philips scheme for wired broadcasting over supply mains. Vicious attack on the Bureau of Standards fading-prevention studies on the grounds that due acknowledgment of the previous work of Zenneck and Goubau is not made and details of their system of echo-study in which the light-spot on the screen of a cathode-ray tube is made to describe a circle in synchronism with the wave-groups transmitted by the distant station, these (and such echoes as may occur) being fed to the tube through a normal receiver and causing momentary distortions of the circle. Direct observation and photographic records are thus possible and give the average echoes. "The Americans have transformed the method developed by Zenneck and Goubau for the study of fading into a method for its prevention. This is a very valuable and original idea practically, but due acknowledgment of the previous work in Germany should be made. The American communication, following notorious precedents (nach berühmtem Muster), makes no mention of this." — *Radio B.F.f.A., Stuttgart, April, 1932.*

✦

## *Ultra-short waves*

[G. POTAPENKO] California Institute of Technology. Beginning with waves of the order of 3 metres, the period of generated oscillations becomes comparable to the time necessary for an electron to move from one electrode to the other in a non-uniform field. Vacuum-tubes having their grids strongly positive with respect to the plate, generate two kinds of ultra-short waves. Those of the first kind have a wave-length given by Barkhausen's formula (square of wave-length by grid voltage equal to $10^6$ times the square of the distance filament to anode), and much shorter or dwarf waves form the second kind. The shortest of these waves measured 9.4 cm. It is claimed that they are excited in such a manner that during the time the electrons pass from filament to plate and back, the circuits associated with the tube perform 2, 3, 4, etc., complete oscillations, so that the waves produced become 2, 3, 4, etc., times shorter than the Barkhausen waves.—*Physical Review, February, 1932.*

✦

## *Selectivity and audio-frequency range*

[C. L. FORTESCUE, P. K. TURNER, E. V. APPLETON and D. BOOHARIWALLA.] A discussion on Feb. 24, before a very large gathering of the wireless section of the Institution of Electrical Engineers showed that the upper audio frequency considered to be necessary for good reproduction was 8,000 or 10,000 cycles per sec., and that the present spacing of allocated frequencies should on no account be reduced, but if possible increased.

There was agreement that stations for which the sidebands overlapped with carrier waves could not be separated by any set, but the discussion as to whether stations for which part of the sidebands overlapped could be received free from interference gave no results. This question has, however, been treated in articles dealing with the demodulation of weak stations by a stronger one separated from it by several kc. The extent of the interference as measured by the a.f. response of the receiver is much less than would be expected from the ratio of the carrier wave potential differences produced by the wanted and unwanted stations.

Assuming an ideal detector acted upon by a strong signal $S \cos pt$ and a weaker signal $W \cos gt$., the rectifier output will be proportional to the total amplitude of the resultant wave, which amplitude, however, is not simply the sum of the two separate amplitudes. The output will not, therefore, be proportional to $S$ and still less to $W$. If strong and weak signals of carrier-frequency amplitude $S$ and $W$ are received with an ideal linear detector, the modulation of the weak signal is reduced to a fraction $W/2S$ of its original value, that of the strong signal to $1 - W^2/4S^2$. A square law detector gives no effect, a cube law detector gives increased modulation of the weaker signal. This seems to explain the performance of the Stenode receiver.—*The Wireless Engineer, March, 1932, April, 1932.*

## *Cathode-ray tubes*

[KONTRUS or KRUTUS, both forms of the name appear.] Short historical summary of the work of Hess, Braun, Wehnelt, Zenek, Samson, Roschansky, Rogowsky, Rudolf in the development of these tubes and their applications. [SLISKOCIC.] Discussion of the practical use of these tubes in television, résumé of an experimental lecture not lending itself to further condensation but very full and documented.—*Radio Amateur, Vienna, May, 1932.*

✦

## *Directly-connected rectifiers and amplifiers*

CHARACTERISTICS OF A series of heater tubes, both amplifiers and rectifiers sold in Europe by Ostar, Vienna, have been sent to *Electronics* by its European correspondent. These tubes will operate directly from a.c. or d.c. lines with voltages up to 220 volts. The amplifiers are recommended for d.c. lines only because of hum. There are two rectifiers, one delivering 50 ma. and the other 125 ma. Each takes about 6 watts for heater power.

✦

## *Supports for short-wave apparatus*

[LG.] German patent 532551 in which conducting supports having high resistance to oscillatory currents (e.g. in the form of spirals) are used to support the components of a short-wave transmitter, where necessary in series with insulators.—*Funk, Berlin, May 6, 1932.*

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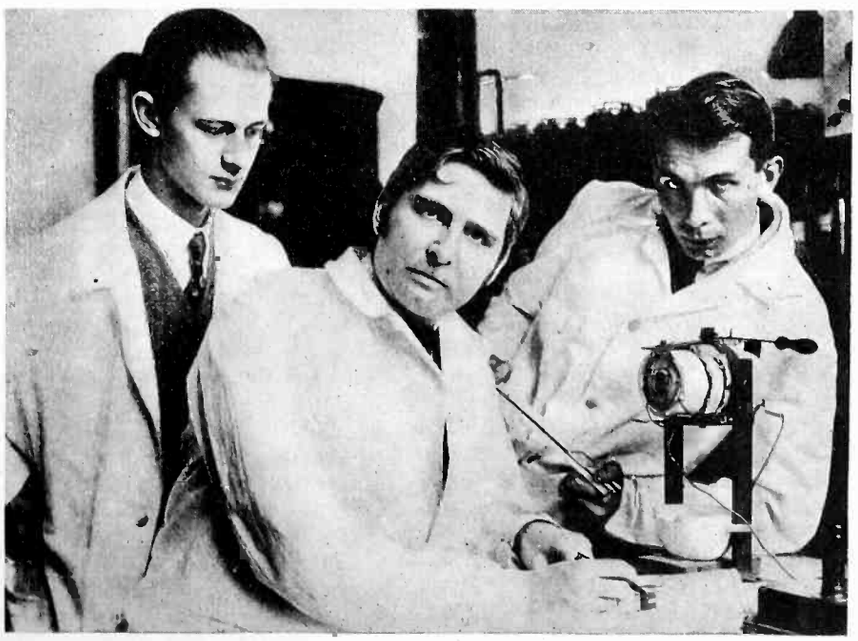
## INVENTOR OF "SUNMOTOR"



**Bruno Lange, center, whose photoelectric research has resulted in cells of high sensitivity and large current output**

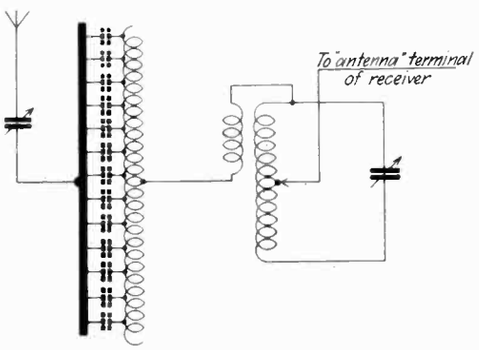
## *Tuned rectangular loop aerials on short waves*

[L. S. PALMER] University College, Hull, Board of Scientific and Industrial Research. Experiments on 7.54, 8.65 and 8.80 meter waves were carried out with a tuned loop capable of expanding and contracting in either or both dimensions. The resonant current which may be obtained by tuning is not necessarily the maximum current that can be produced in the frame by the incident wave. By a proper adjustment of the height and width of the frame, additional to tuning, the current may be increased to a very much larger value. When the angle of incidence of the wave is 0 or 90 degrees, the area of the shaped and tuned frame ought to be about one-fourth or three-fourths times the square of the wavelength.—*Proceedings Royal Society, May, 1932.*

✦

## *Klangfilter*

DESCRIPTION OF SAIC'S ARRANGEMENT, a sort of band filter to precede any receiver, in which the first part consists of an insulated core of heavily silvered litzendraht (the heavy straight line of the diagram) over which many turns




of fine wire are wound, so that close inductive and (distributed) capacitative couplings exist. It is claimed to produce very good band-filter effects and to possess many other advantages, the Editor confirms some of these. — *Radio B.F.f.A., Stuttgart, May, 1932.*

✦

## *Distortion in low-voltage cathode-ray tubes*

[J. T. MCGREGOR-MORRIS AND H. WRIGHT M. VON ARDENNE] The likelihood of obtaining a commercial tube with deflecting plates which are not parallel is now quite small, although plates may distort after some time has elapsed. Owing to the fact that a trace of gas is always present in the tube and that this gas becomes ionized when the electron beam is in action, there is a conducting path of resistance R between the deflecting plates which may cause distortion when the amount of energy for producing a deflection is extremely small, and also when a resistance R′ is placed in series with one of the deflecting plates; in this latter case the actual voltage across the plates is only the fraction R over R + R′ of the total. The resistance R is not constant at voltages below 8 or 12 volts. This "threshold effect" may become quite marked when gas is introduced in order to concentrate the beam; the trace is more brilliant near the zero position on account of the smaller deflection for small voltages. Ardenne recommends using light gases, hydrogen and helium, and applying a strong negative bias to the deflecting plates. The internal resistance of the a.c. source applied to these plates should not exceed $10^6$ ohms.—*Preprint, Journal Inst. El. Engineers, February, 1932. Hochfreguen Technik, January, 1932.*

✦

## *Smaller and better condensers*

[K. F. RODGERS] Bell Telephone Company. The reduction in size has been made possible by creating an assured and adequate source of paper of 0.4 mil thickness and by developing a better impregnating compound, chlorinated naphthalene, known commercially as halowax. The use of aluminum in place of tinfoil reduces the cost. After rolling two sheets of metal foil and four of paper, the unit is pressed into shape, dried in vacuum ovens and impregnated with the halowax.—*Bell Laboratories Record, April, 1932.*

✦

## *Device for measuring the height of the ionized layers*

[H. RUKOP AND P. WOLF. University of Cologne] In view of ill-founded statements on the altitude of the Kennelly-Heaviside layers, as affected by the sunspot cycle, it is fortunate that the measuring equipment is gradually being simplified so that work in this field becomes accessible to the ordinary laboratory. In the set-up described a neon crater lamp as used for television reception is mounted in front of a photographic objective, on the shaft of a steel rod making 25 revolutions per sec. The upper portion of the path of the lamp is photographed on a sliding piece of paper. The same a.c. supply which is used for turning the motor holding the shaft causes signals of 0.0001 sec. duration to be emitted by a horizontal dipole antenna a short distance away. The received signal is fed into the neon lamp, and the transmission by the ground wave is recorded as a close succession of points lying in a straight line. Signals returned from the high layers will appear later along the circumference so that apart from the slight curvature the record represents an actual cross section of the higher atmosphere, 100 km. corresponding to one cm. A record taken in the morning of Oct. 25, 1931, with 84-m. waves shows the appearance and gradual lowering of Appleton's F and the presence, about two hours after sunrise of the E layer. — *Zeitschrift techn. Physik, March, 1932.*

✦

## *New calibration method for the condenser microphone*

[W. LANGE] The amplitude of the displacement of the membrane is measured, and the pressure is calculated from the dimensions of the microphone and the mass of the membrane and the air set in motion. For a given microphone the r.m.s. pressure is proportional to the amplitude; the ratio of pressure to amplitude is equal to the elastic force divided by 1.41 times the area of the membrane. The amplitude is determined by compensating for the capacity changes of the system in a high frequency circuit.—*Hochfrequenztechnik and Elektro-akustik, April, 1932.*

✦

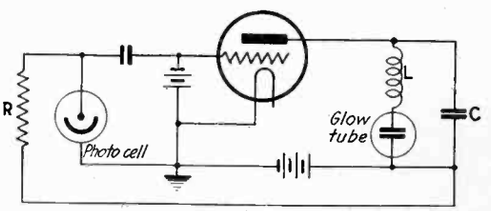
## *Growth of radio in England*

POST OFFICE FIGURES show that 900,000 new licenses were issued during 1931, and a statistical survey reveals that a total of 1,250,000 radio sets were sold during this period, 600,000 to new listeners, 650,000 as replacements. It is anticipated that 1,800,000 new sets will be sold in 1932. Of the 11 million homes 4.3 million were equipped with radio at the end of 1931.—*Electrician, March, 1932.*

✦

## *Optical feed-back circuit*

[RUDOLF LEMIG] Osram Vacuum Tube Laboratory. The plate current flows through a discharge tube or another source of light, and light from this source produces a current in a photoelectric cell placed between grid and filament. When inductance is placed in series with the discharge tube and a condenser in parallel with these two ele-



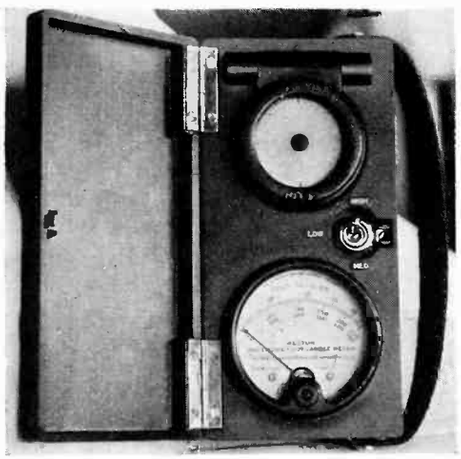

ments, the light produces sufficient feedback to maintain steady oscillations. their strength can be varied by screening part of the light. By using a sector disk or another variable diaphragm the oscillations can be modulated in many ways. A disadvantage of the device is the high resistance of the discharge tube and the distortion at frequencies above 10,000 cycles. — *Zeitschrift techn. Physik, April, 1932.*

# ✦ NEW PRODUCTS

## THE MANUFACTURERS OFFER

### Foot-candle meter

THE PERMANENT CHARACTERISTICS OF the "photronic" photoelectric cell, made by the Weston Electrical Instrument Corporation, Newark, N. J., have made possible many simplified photocell applications with relays and indicating instruments.



The latest of these is a pocket size photronic foot candle meter, built especially for salesmen's use, calibrated to read directly on three ranges—50, 250 or 500-foot candles.

One cell is used as an adjustable light collector with readings appearing on a scale 2.36 in. in length. The cell and instrument are housed in a neat black bakelite case measuring approximately $3\frac{3}{8}$ in. by 7 in. by $2\frac{1}{4}$ in. A hinged cover and convenient carrying handle finish it in attractive form.—*Electronics, July, 1932.*

✦

### Caesium-argon photocells

THE TELEPHOTO & TELEVISION CORPORATION, 133 W. 19th St., New York City, is now manufacturing a complete line of photoelectric cells of the caesium-argon type, and is also developing crater tubes of the hot and cold cathode types.

Telephoto photoelectric cells are designed to operate at an anode voltage of 90 volts and at this voltage give an output suitable for use in the particular apparatus for which the cells were designed. Although the cell is not injured by ionization or glow from short periods where a suitable series resistance is in the circuit, no higher anode potential should be used than 90 volts, as the positive ion bombardment of the sensitive surface by higher potentials will eventually destroy the sensitivity of the cell and greatly shorten its life.—*Electronics, July, 1932.*

### B supply for auto-receivers

ELECTRIC SPECIALTY COMPANY, Stamford, Conn., has developed a new dynamotor with filter and voltage divider for B supply to automobile receivers.

This complete unit consists of a dynamotor, a filter, and a voltage divider mounted in a totally enclosed, non-corrodible metal box. An insulated shielded cable is also supplied to prevent the possibility of noise pick-up from the leads, and a control switch is mounted in the box for operating the dynamotor.

The dynamotor is of special design. All parts are proportioned for maximum efficiency, and the construction is exceptionally rugged. The design is carefully worked out, so that there is very little voltage fluctuation or ripple, and with the filter perfect results are obtained with the popular auto receivers.

The shielded cable is furnished with insulation outside the shielding to prevent interference caused by possible rubbing of the metal shielding against metal parts of the car.—*Electronics, July, 1932.*

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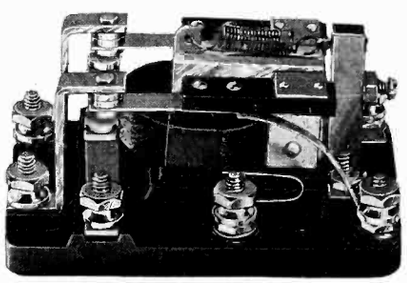
### Alternating-current relays

RELAYS FOR A wide variety of purposes, including remote-controlled radio transmitters, traffic signals, burglar and fire-alarm systems, carrier systems, lighting devices, railway control, etc., have been developed by the Leach Relay



Company, 693 Mission Street, San Francisco, Calif. Armature and core are fully laminated, and the armature is cast into a bakelite base, with surface ground to fit, thus eliminating hum or chatter. All parts of the moving element are cadmium plated, other parts being nickeled. Contacts are of pure silver, designed to give long wiping effect and to close under pressure. Voltage limits range from 6 to 115 volts. The No. X-20 relay shown in the illustration measures 2 in. by 3 in., and is 1 11/16 in. high. Seven different contact arrangements are available.—*Electronics, July, 1932.*

### Bell-less electric carillon

A LINE OF remarkable new carillons, utilizing no tubes or bells, but producing beautiful bell-like tones in a bell-less belfry, electrically, has been developed by the RCA Victor Company, at Camden, N. J.

The console consists of a 49-note keyboard beginning with C below middle C. As the keys are depressed, tiny hammers strike small tuned metal reeds. The musical vibrations from these reeds are electrically amplified by a 1,000-watt audio amplifier and sent out as bell-like tones through a sound-projector in the distant tower. Special effects can be obtained with a special foot "swell" pedal, especially when tolling the chimes. The volume is turned down as the notes are struck and then swelled to full volume, giving a pleasing and unusual effect, which cannot be obtained with bells. Special clock arrangements on the console strike the hour and fractional hours with a Westminster peal, and turn the peal off automatically during the early hours of the morning. Another clock can be set to operate special roll playing mechanism for the carillon at any specified hour. An automatic electric phonograph provides appropriate recorded religious music when required.

The development of this new equipment is expected to make it possible for a large number of churches, memorial parks, schools, and public buildings to have chime music at reduced cost.—*Electronics, July, 1932.*

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### Dual-range airplane receiver

TRANSPORT PLANES customarily carry two complete radio receivers, one for weather and radio-range service covered by the band 235 to 350 kilocycles, and the second for reception of signals from ground stations operating in the range 3,000 to 6,000 kilocycles. Receivers developed by the Aircraft Radio Corporation, Boonton, N. J., are capable of covering either band by use of gang plug-in coil sets. The development of the "dual set" means that one receiver will have attached to it a "dual set" capable of covering either band by the snap of a switch.

No internal changes in receivers already in service are necessary. The original plug-in coil set is merely replaced by the dual coil set.

Reduction of weight and space requirements for radio make this development of interest for the one-pilot type of ship.—*Electronics, July, 1932.*

## Magnetic inspector

THE MAGNETIC INSPECTOR developed by N. A. Kurman, 43-23 Fortieth St., Long Island City, N. Y., is a vacuum-tube Wheatstone bridge, so arranged that balance can be obtained at any point on the meter scale. The device is designed to provide a comparative check for magnetic materials of all sizes, in all condition of work, and is so sensitive that single laminations can be checked for their overall characteristics, which include permeability, initial and differ-

ential, hysteresis, eddy current losses, and thermal history. It can be put in the hands of any operator who can read a meter.

Other practical uses are: checking magnetic material for uniformity, analysis, heat treatment, etc., and inspection of incoming shipments.

One single short-circuited turn can be checked in any coil. Turns can be counted, coils checked for distributed capacity, with or without cores. Assembly of electromagnetic apparatus, such as relay switches, can be checked for adjustment and overall qualities.—*Electronics, July, 1932.*

✦

## Stroboscope

THE DAVEY VIBROSCOPE made by the Electrocon Corporation, 6 Varick St., New York City, is a simple portable instrument for studying the behavior of rapidly moving machine parts, while actually in motion. It is applicable to the study of rotary, reciprocating, or any type of cyclic motion, at any speed. Moving parts can be made to appear perfectly stationary at any desired position in the cycle of operations, by illumination with a powerful neon lamp, which flashes in synchronism with the motion.

The flashing lamp is controlled either by a breaker-head which is driven directly from the mechanism under observation, or by a governed motor unit. By adjustments the movements can also be observed at greatly reduced speed, as in a slow-motion picture. The instrument weighs 24 lbs., complete with batteries.—*Electronics, July, 1932.*

✦

## Two-stage vacuum pump

THE W. M. WELCH MANUFACTURING COMPANY, 1516 Sedgwick St., Chicago, Ill., offers a two-stage rotary oil vacuum pump of special design which is extremely rapid and capable of very low vacua.

In a vessel of ½ liter capacity, the pump will produce in 15 minutes a vacuum of .00001 mm. of mercury, and in a vessel of 5 liter capacity, a vacuum of .000018 mm. in 30 minutes. The action in the early stages is particularly rapid, and if an X-ray tube be connected directly to the intake of the pump, X-rays can be produced in considerably less than 1 minute. The calculated free air capacity is 225 liters per minute. No backing pump is necessary. In the design, a new positive oil seal has been developed which is partly responsible for the vacua produced. The pump is also capable of developing pressures through the exhaust nozzle, a maximum of 30 lbs. per square in. being possible.—*Electronics, July, 1932.*

✦

## Light-sensitive relay

A NEW PHOTOELECTRIC RELAY has been brought out by the G-M Laboratories, Inc., 1735 Belmont Ave., Chicago, embodying a feature permitting all wiring to be concentrated at one point. This single unit combines the amplifier, photoelectric cell and light source within a single case, greatly simplifying the work of installation.

Another advantage of this type of unit lies in the fact that no separate and bulky light source is required. The rays from the lamp behind the lens are focussed on a special mirror, and reflected to the lens in front of the photoelectric cell. This mirror can often be mounted in a space too small to accommodate a separate light source, or in a location where it would be difficult to bring in special wiring to supply lighting current.

Removal of a small front plate permits ready adjustment. All wiring and interior parts are attached to a central


section of the relay entirely independent of front and back covers. The case is of cast aluminum and so designed that the entire unit may readily be weatherproofed for outdoor use. The unit is capable of operating at speeds as high as 600 light interruptions per minute.—*Electronics, July, 1932.*

## Volt-ohmmeter

TO ROUND OUT ITS LINE of radio service instruments, the Franklin Radio Corporation, Dayton, Ohio, announces its new Model 1 voltmeter-ohmmeter, combining various ranges and testing facilities required for radio service work. This consists of a bakelite-case Jewell meter, with flush mounting on a laminated bakelite panel, and housed in a hardwood case finished in oak. The pin jacks and push buttons are all mounted on the bakelite front panel. A 4½-volt battery is enclosed in the case. An outside voltage supply is unnecessary.

The meter has a double scale; the upper scale reading 0-100,000 ohms; the lower scale 0-300 volts. The resistance range can be reduced to one-tenth its value and the voltage range can be reduced to 3 or 30 volts and increased to 600 volts. When used as a voltmeter, the Model 1 has a resistance of 1,000 ohms per volt in each of its ranges, thereby measuring plate voltage without distortion.—*Electronics, July, 1932.*

✦

## Rubber substitute unaffected by solvents

A NEW CHEMICAL PRODUCT which has practically all the charactertics of rubber but which is not affected by solvents is an olefin polysulfide reaction product made by the Thiokol Corporation, Yardville, N. J.

Because of its unusual resistance to the deteriorating action of most gases and liquids, particularly gasoline and oils, it is already now in wide use in a number of industries.

Electrical manufacturers are testing Thiokol for use as follows: Protective covering for underground low-voltage cable, connections for oil-filled cables in place of cement, submarine cables, ignition cables to protect against oils and corona conditions, for protecting drop-cords against oil in machine shops, wiring for plants having corrosive fumes such as those in powder and dye factories, transformer gaskets, high voltage cable covering in place of lead for protection against soil and corona conditions.—*Electronics, July, 1932.*

✦

## Aerial to eliminate noise

THE AKAFORMER, put on the market by Amy, Aceves & King, Inc., 11 W. 42d St., New York City, is used in conjunction with a shielded lead-in wire, and provides maximum radio pickup to the set with minimum loss and at the same time, with a shielded down lead wire, eliminates the pickup of extraneous noise.

The unit consists of a matching impedance transformer which compensates for the loss in the shielded wire.—*Electronics, July, 1932.*

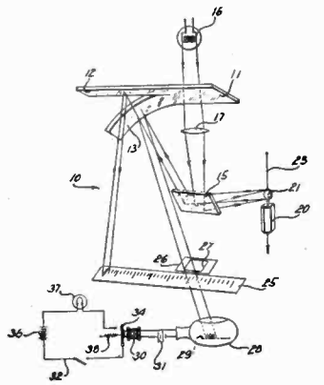
# U. S. PATENTS

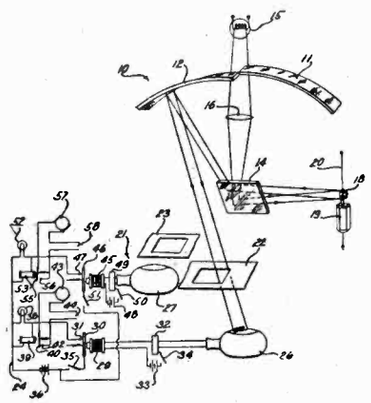
## IN THE FIELD OF ELECTRONICS

### Electronic Applications

**Dynamo regulation.** A method of using electronic valves in the field circuit of a dynamo electric device to regulate its field excitation. F. W. Meyer, assigned to Cutler-Hammer, Inc. No. 1,862,233.

**Control and measuring apparatus.** Methods using photocells and amplifiers for the control of measurements of apparatus in manufacture. No. 1,859,047 and No. 1,859,020, to Christian Paulson and L. H. Brown, respectively, assigned to Western Electric Co.





**Motor-generator regulator system.** A speed regulator system using vacuum tubes. W. T. Rea, assigned to A. T. & T. Co. No. 1,861,550.

**Gaseous discharge device.** Electrodes in a container, a main source of current connected to the electrodes and the starting circuit, comprising a high-frequency generator connected across the terminals of the main source. M. Pirano, Carl Becker and Mark Reger, assigned to G. E. Co. No. 1,861,581.

**Discharge device.** In an inductive vapor discharge device, a closed path comprising a vaporizable, electrically-conductive liquid which is present in such an amount that under normal operating conditions there will have become evaporated an amount sufficient to open the path. L. J. Buttolph, assigned to G. E. Vapor Lamp Co. No. 1,861,620.

**Automatic direction finder.** A loop system and means for driving a controlled current from the received signal. Donald G. Little, assigned to Westinghouse E. & M. Co. No. 1,862,119.

**Train control system.** A system involving vacuum tube amplifier relay circuits. A. G. Williamson, assigned to Union Switch & Signal Co. No. 1,856,822.

**Railway signal system.** A method of putting signals on railway system, by a vacuum tube. W. H. Reichard, assigned to General Railway Signal Co. No. 1,852,377.

**Tuned circuit system.** A rotating mirror is synchronized with the turning of a variable condenser across a tuned circuit, for measurement purposes. H. I. Becker, assigned to G. E. Co. No. 1,853,953.

**Electric regulating system.** A combination of a synchronous dynamo electric machine and three-element tubes with means for controlling the phase relation between the potentials of the grid and anode, and responsive to the armature current of the machine. Myron Zucker, assigned to G. E. Co. No. 1,857,174.

**Arc welding system.** G. J. Holslag, assigned to Electric Arc Cutting & Welding Co. No. 1,857,306.

**Stroboscope.** Constant frequency oscillator circuit, a variable frequency oscillator circuit, means for combining for producing a beat frequency, a glow discharge tube and means for subjecting the glow discharge tube to a flashing potential at each recurring beat. R. H. Worrall, Washington, D. C. No. 1,857,422.

**Curve plotting system.** A method of synchronizing a curve plotting element and the apparatus for varying the characteristic of the apparatus to be tested. Samuel Isler, assigned to Wired Radio, Inc. No. 1,857,959.

**Thermionic measuring instrument.** Two tubes with grids arranged in parallel and the plates in push-pull, have a deflection meter across the output load. B. W. St. Clair, assigned to G. E. Co. No. 1,857,216.

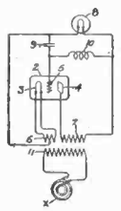
**Electric regulator.** A method of controlling a dynamo electric machine by means of thermionic tubes. Myron Zucker, assigned to G. E. Co. No. 1,851,692.

**Spark-plug and engine indicator.** A method of using an oscillograph for determining sparking conditions in a cylinder. E. J. Martin, assigned to General Motors Research Corp. No. 1,861,021.

**Power conversion system.** A method of using 3-element tubes for the conversion of power. Alan Howard, assigned to G. E. Co. No. 1,860,182.

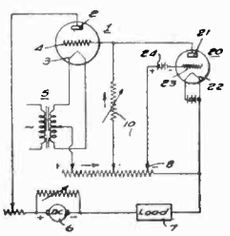
**A method for sounding.** Apparatus using ultra-audible waves for sounding and locating submarine obstacles. Paul Langvin and T. L. Florisson, Paris, France. No. 1,858,931.

**Circuit interrupter.** Apparatus for generating a periodic current by interrupting a circuit periodically, comprising a source of current, a tube, a capacity, a circuit for charging the capacity, and a resistance and means for maintaining the tube non-conducting during the discharge of the capacitor. A. S. FitzGerald and H. L. Palmer, assigned to G. E. Co. No. 1,859,082.



**Air-conditioning control.** Apparatus for controlling the amount of moisture in the air within a room, using an amplifier relay system. S. M. Anderson, assigned to B. F. Sturtevant Co. No. 1,860,377.

**Regulator.** Direct-coupled circuit, involving a d.c. source in series with the load, and two tubes. L. R. Harness and F. A. Bokovoy, assigned to Westinghouse E. & M. Co. No. 1,858,271.



### Generation, Detection, Etc.

**Constant current system.** A method of operating a 3-element tube in which secondary emission from the grid is used to maintain the current in the external circuit approximately constant over a range of voltage variations between grid and cathode. Marcus A. Acheson, assigned to G. E. Co. No. 1,857,128.

**Constant current amplifier.** A pair of devices, impedances of which can be varied in accordance with the signalling impulses, and means for varying the impedance of one in such a manner that the impedance of the other device varies in a sense opposite to the impedance of the first device. P. J. Walsh, San Francisco, Cal. No. 1,857,901.

**Piezo electric oscillator.** A method of connecting an oscillator to an amplifier by a circuit tuned to a frequency at least twice that determined by the Piezo electric element in the grid circuit of the oscillator. A. W. Hull, assigned to G. E. Co. No. 1,857,194.

**Push-pull amplifier.** Filament winding for each tube and individually adjustable bias resistors. J. O. McNally, assigned to B.T.L. No. 1,848,187.

**Polyphase radio-frequency system.** Single phase source of high frequency power, accessory apparatus, including triodes and means for controlling the phase relation of electromotive forces in the primary windings of several transformers. W. R. G. Baker, assigned to G. E. Co. No. 1,848,866.

**Distribution system** A polyphase load, a source of single-phase high frequency current, and tuned circuit for supplying polyphase current to the load. E. F. Carter, assigned to G. E. Co. No. 1,848,824.

**Piezo crystals.** Metallic film is deposited on the surface of a crystal, adhering intimately to the crystal and having a thickness proportionate to the natural frequency of the unloaded crystal, and the desired frequency of the loaded crystal for electrically fixing the frequency of operation. E. O. Hulbert, Washington, D. C. No. 1,848,630.

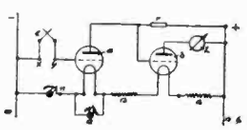
**Multiple-frequency generator.** Push-pull input plate circuits in parallel, and a number of tuned circuits in the plate circuit. M. Vos and H. K. A. Sterky, assigned to Ericsson. No. 1,848,507.

**Vacuum tube circuit.** Circuit for translating electrical energy in which a number of groups of electron tubes are provided in push-pull, the successive groups being separated one from the other by an electrical distance equal to one-half wavelength for an integral multiple thereof. C. E. Strong, assigned to W. E. Co. No. 1,848,209.

**Oscillator circuit.** A Hartley oscillator in which the filament is separated from ground by a choke-coil, to maintain a high r-f potential on the filament. R. H. Worrall, assigned to Federal Tel. Co. No. 1,848,594.

**Synchronizing system.** Patent Nos. 1,848,180 and 1,848,181, to Wm. A. Knoop, assigned to B.T.L., Inc.

**D.C. amplifier.** A direct-coupled cascade system. Eric Asch, assigned to Radio Patents Corp. No. 1,862,394 and 1,862,393.



**Audion-amplifier circuit.** An anti-regenerative stage, arranged in the form of a Wheatstone bridge circuit, having as conjugate arms the input and output circuits of the stage. H. A. Snow and L. M. Hull, assigned to RCA. No. 1,861,587.

**Superheterodyne oscillator.** Oscillation generator of the double grid tube type. W. L. Carlson, assigned to G. E. No. 1,848,823.

**Electrical testing system.** A network for measuring reflection effects between unequal impedances, comprising a Wheatstone bridge, and vacuum tube amplifier. K. B. Lambert, assigned to B.T.L., Inc. No. 1,848,134.

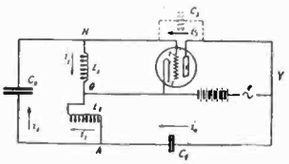
**Stabilized oscillator.** An oscillator having coupled to it a second oscillator of relatively low power and high inherent frequency stability. R. A. Heising, No. 1,848,126, assigned to W. E. Co.

**Piezo electric indicator.** A method to indicate visually the receipt of communications comprising a hermetically sealed piezo electric device. Eric Giebe and Adolph Scheibe, assigned to RCA. No. 1,860,145.

**Piezo electric oscillator.** Patent No. 1,861,862 to August Hund, Bethesda, Md., and No. 1,858,339 to Russell F. Ohl, assigned to A. T. & T. Co., dealing with piezo electric oscillators.

**Amplifier circuits.** A 4-electrode, vacuum tube circuit whereby a compensating voltage is impressed upon the control grid to neutralize the inter-electrode capacity between the two grids. L. M. Hull, assigned to RCA. No. 1,861,574.

**Neutralizing circuit.** A constant capacity in one of the arms of a bridge, and between anode and cathode of the tube, and inductances in other arms of the bridge and in the input circuit of the tube, having zero coupling between them, whereby the regenerative blocking is maintained perfect at all frequencies impressed upon the input circuit. W. V. B. Roberts, assigned to RCA. No. 1,861,585.



**Modulated oscillator.** F. J. Mead, Knoxville, Tenn. No. 1,860,897.

**4-Electrode valve circuit.** Two patents to E. W. B. Gill, assigned to RCA. No. 1,861,231, and No. 1,861,232, on circuits for 4-electrode valves.

**Power supply circuit.** Apparatus for energizing the filament and plate circuits of an amplifier, from a source of rectified current. The impedances provide two Wheatstone bridges and with the filament plate circuits are across the respective bridges as arms. G. B. Crouse, assigned to Conner Crouse Corp. No. 1,858,323.

**Oscillation generator.** A generator for producing simultaneously a plurality of carrier waves of slightly different frequencies. Nendel Osnos, assigned to Telefunken. No. 1,860,050.

## Light Sensitive Apparatus

**Electrical transmission of light.** Transmission of light by phase control. J. H. Hammond, Jr., Gloucester, Mass. No. 1,860,341.

**Light sensitive apparatus.** A means for controlling a circuit in response to light variations, comprising a gaseous discharge device, non-conductive at voltages below a pre-determined voltage but passing a discharge having arc like characteristics above the voltage. T. A. E. Belt, assigned to G. E. Co. No. 1,860,169.

**Speed and position control for television apparatus.** A method of television using a multitude of vacuum tubes for controlling speed and position. W. A. Marrison and J. W. Horton, assigned to B. T. L. No. 1,860,935.

## Patent Suits

1,173,079, E. W. F. Alexanderson, Selective tuning system; 1,251,377, A. W. Hull, Method of and means for obtaining constant direct current potentials; 1,297,188, I. Langmuir, System for amplifying variable currents; 1,618,017, F. Lowenstein, Wireless telegraph apparatus; 1,702,833, W. S. Lemmon, Electrical condenser; 1,728,879; Rice & Kellogg, Amplifying system, D. C., S. D. N. Y., Doc. E 60/174, Radio Corp. of America et al v. F. W. Lang et al. (Lang Radio Co.). Consent decree (notice Mar. 16, 1932.)

1,648,808, L. A. Hazeltine, Wave signaling system, D. C., S. D. N. Y., Doc. E 50/69 Hazeltine Corp. v. E. J. Edmond & Co., Inc. Dismissed without prejudice (notice Mar. 16, 1932). Doc. E 50/70, Hazeltine Corp. v. E. G. Latham & Co., Inc. Decree as above.

1,305,690, H. S. Coyer, Grid making machine, D. C. Del., Doc. E 787, De-Forest Radio Co. v. Duovac Radio Tube Corp. Dismissed Mar. 8, 1932.

1,231,764, F. Lowenstein, Telephone relay; 1,403,475, H. D. Arnold, Vacuum tube circuit; 1,403,932, R. H. Wilson, Electron discharge device; 1,465,932, E. H. Colpitts, Multiplex radiotelegraph system, D. C., S. D. N. Y., Doc. E 60/175, Radio Corp. of America et al. v. F. W. Lang (Lang Radio Co.). Constant decree for plaintiff (Mar. 16, 1932).

1,141,402 (a), R. D. Mershon, Electrolytic apparatus employing filmed electrodes; 1,784,674, same, Film formation and operation of electrolytic condensers, etc., filed Apr. 5, 1932, D. C., S. D. N. Y., Doc. E 66/295, R. D. Mershon et al. v. Polymet Mfg. Corp.

1,141,402 (b), R. D. Mershon, Electrolytic apparatus employing filmed electrodes, filed Apr. 6, 1932, D. C., S. D. N. Y., Doc. E 66/298, R. D. Mershon et al. v. Condenser Corp. of America.

## Electron Tubes, Etc.

The following patents control manufacturing processes, etc., dealing with electron discharge apparatus: No. 1,861,098 to C. G. Smith, assigned to Raytheon, Inc., on a gaseous conduction rectifier. No. 1,860,187, L. R. Koller, assigned to G. E. Co., on a temperature-controlling device, comprising a cathode which emits electrons when subjected to a temperature between 80 and 150 deg. C. No. 1,860,152, to E. D. MacArthur, assigned to G. E. Co., on a high-frequency magnetron device and circuit. No. 1,860,285 to Ross Gunn, Washington, D. C., on a hot cathode tube, including a multiplicity of reeds tuned to different frequencies. No. 1,858,698 to Frederick W. Zons, New York, N. Y., on a neon lamp for television. No. 1,859,029 to J. H. DeBoer and J. M. Van Gessel, assigned to RCA, on an electron discharge device in which a coherent body of zirconium of high electrical resistance is connected to the current supply lead, so that occluded gases in the envelope are permanently combined with a hot electrode in the bulb. No. 1,858,676 to F. S. McCullough, Edgewood, Pa., on a cathode support.

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# BRITISH PATENTS

## IN THE FIELD OF ELECTRONICS

**Caesium cell.** Manufacturing patent. Philips, Holland. No. 343,930.

**Selenium cell.** The inclusion of a small quantity such as tellurium, black phosphorous or thallium with selenium, to improve the stability. Radiovisor, Ltd. No. 343,939.

**Multiple cathode cell.** A photo-electric cell provided with a cathode of plain surfaces disposed at such an angle with respect to one another, that maximum photo-electric effect is produced. Thomson-Houston Co. No. 344,499.

**Secondary emission photo-electric cells.** In a photo-electric cell, grids are provided for producing and utilizing a secondary emission of electrons from the anode. T. M. G. Toulon, Paris. No. 352,388.

**Negative grid type photo-electric cell.** In a photo-electric cell containing gas a negative field is created near the anode, stronger than the field produced by the potential of the anode, to prevent the continuation of a disruptive discharge when the illumination of the cell ceases. L. V. J. A. Dunoyer, Neuilly, France. No. 351,142.

**Anode aperture.** A photo-electric cell in which the anode has an aperture, at which the light is focussed. The width of the aperture is about one half mm., the distance between anode and cathodes 1 cm. The envelope may be of quartz or Corosilicate. Kolster-Brandes, Ltd. No. 350,075.

**Tube manufacture.** High vacua are produced in thermionic valves by heating alloys of magnesium and an alkaline earth metal containing approximately 5-35 per cent of the latter, alloys of this composition being stable in air but containing sufficient alkaline earth metal to give a high absorption of gases. The alloys are brought into the form of pellets for introducing into the valve envelope by powdering and compressing. An alloy of magnesium with 28 per cent of barium may be prepared by fusing the metals together in a crucible of carbon-free iron in an atmosphere of argon-helium or other inert gas. W. W. Triggs, assigned to Kemet Labs. Co. No. 365,801.

### Electronic Applications

**Light control.** In a counting or sorting machine utilizing a light-sensitive element, a component which can pass only a.c. is interposed between the element and the relays controlled thereby, in order that gradual changes in the characteristics of the former do not affect the relays. A. W. Isenthal, London. No. 367,319.

**Tuning system.** The input to a radio receiver comprises two tuned circuits coupled by a common impedance resonant at a frequency near the lower limit to which the circuit may be tuned. The input and interstage couplings are preferably operated on two wave bands, and means may be provided for short-circuiting the loading inductances and eliminating the couplings thereto. W. D. Loughlin, Radio Frequency Labs. No. 367,409.

**Direction finder.** A magnetic direction finder, comprising a normally partially energized indicator having a number of windings whereof one portion is normally de-energized and the other normally energized, together with an electron discharge device which is stabilized in the horizontal plane and swings from a pre-set position to complete energization of the indicator. J. D. Pear, British-Thompson-Houston Co. No. 367,426.

FIG 1

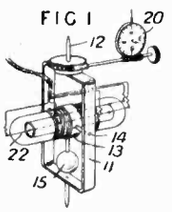
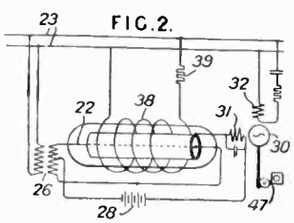



FIG.2.




**Cathode-ray apparatus.** A tube for use in the transmission of pictures. W. J. Hitchcock, British Thomson-Houston Co., Ltd. No. 363,103.

**Frequency meter.** A tuned circuit is maintained in oscillation by a tube provided with a Piezo electric control circuit which may be brought into operation for checking the accuracy of the meter. The crystal is connected between the grid of the tube and the tuned input to the tube. Kolster Radio Corp. No. 363,785.

**Television transmitter.** At the end of each line scanned, an auxiliary impulse is transmitted which is inversely proportional to the sum of the signals corresponding to the line. A. V. Bedford, British Thomson-Houston Co. No. 363,979.

**Vacuum tube protective circuit.** Overheating an electrode such as the anode of a tube is prevented by the overheated plate radiating in such a manner as to control the energizing circuit of the valve. In the patent shown, a tellurium-constantan thermo-couple with a lens is energized by the heat radiated from the anode. P. D. Andrews, assigned to British Thomson-Houston Co. No. 364,509.

**Amplifier for gyroscope.** An amplifier for amplifying the reversible phase output of a two-part controller gyroscope compass. B. A. Wittkuhns, assigned to Sperry Gyroscope Co., Inc. No. 365,855.

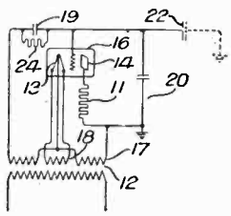
**Electrical musical instrument.** Tones are got from an oscillatory circuit. The pitch of the note is varied by introducing a core more or less into a coil, tremolo is obtained by a leaky grid condenser, timbre is varied by increasing the tremolo frequency above its audibility as a tremolo, and a mandolin effect may be obtained by a make-and-break contact. E. E. Coupleux and J. A. Givelet, Paris. No. 365,883.

**Feed-back circuit.** The grid circuit of the first tube of an amplifier, the input from which is taken from a P.E. cell, is coupled to the anode circuit of the same or succeeding tubes, by means of a circuit which enhances the feed-back of high frequencies relative to the low. Radio Rohrenfabrik Ges, Hamburg, Germany. No. 367,624.

**Constant frequency oscillator.** A two-grid tube is employed and both grid circuits are coupled to the plate circuits, the grid circuits including either bias batteries or leak resistance shunted by capacities. P. B. F. David, Paris. No. 366,094.

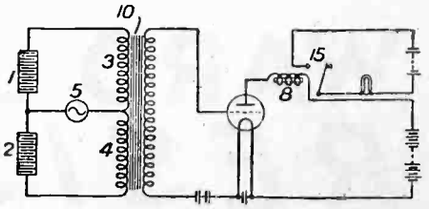
**Piezo electric crystal.** Electrodes are attached to a piezo electric crystal by a very thin adhesive film. The thickness of the film should be less than $\frac{1}{10}$th of the thickness of the crystal, multiplied by the ratio of the dielectric constant of the adhesive to that of the crystal—for example, five-hundred thousandths of an inch. The adhesive comprises a solution of dry Canada Balsam and Xylol, and is reduced to a thin film by rubbing the electrode while the parts are warm. C. B. Sawyer, Cleveland Trust Co. No. 366,252.

**Lighting circuit control.** A thermionic valve is used to control a lighting circuit or a window display device, upon the approach of an observer or a conducting body. In the diagram, condenser No. 22 represents an exposed plate which is shunted across 20. A person approaching it disturbs the balance. C. F. Whitney, British Thomson-Houston Co. No. 366,431.




**Apparatus control.** For navigational purposes, a source of infra-red rays and several receivers are provided on aircraft, so at least one of the latter receives rays from any given direction. H. Junkers, Anhalt, Germany. No. 367,283.

**Light sensitive cell circuit.** The disturbing effects of fluctuation in temperature voltage or general illumination, are compensated by connecting two light-sensitive cells, 1 and 2, to adjacent coils, 3 and 4, and a source of current, 5, so that the resulting magnetic fields are in opposition. No. 366,213, A. Cluder, Radiovisor.



# AUTO RADIO GOES ALL-ELECTRIC WITH THE MALLORY ELKONODE



## —*tried and proven the Mallory-Elkonode provides the perfect answer*

This simple *plug-in* unit which supplies the correct voltage and output for *any set* has been heralded as the *greatest single achievement* in the automobile radio field.

Used in the Mallory-Elkon "B" Eliminator, the Mallory Elkonode forms a combination that has been proven correct in principle and surprisingly superior in performance by radio engineers the country over.

The Mallory Elkonodes now in use already outnumber all other units designed to serve a similar purpose . . . proof again of the correctness of the Mallory principle.

Automobile Radio has changed from an experiment to a rapidly growing business that offers unlimited possibilities. The principles behind the Mallory Elkonode and the Mallory-Elkon "B" Eliminator are correct! So are the reasons for the design and construction of this superior unit. Few, indeed, of the set manufacturers now using the combination have found the necessity for even the slightest change in adapting it to their particular products. Those who have, recognize the value of the assistance and co-operation of Mallory engineers.

**Mallory Metallurgists have produced Elkonite . . . Elkaloy . . . Mal-Arc . . . Contact Points for automobile ignition systems, horns and industrial uses . . . Contactors for high voltage switches . . . and the latest development "HA" Contact Metal for high compression engines . . . These engineers are at the service of radio and electrical engineers in solving problems in metallurgy.**

P. R. MALLORY & CO., Incorporated, INDIANAPOLIS, INDIANA

# A standard microvolter

[Continued from page 231]

second harmonic and d.c. is due entirely to the second power term, the conventional expression for a standard modulated signal may be substituted for $S$ in that term;

$$\frac{f''(B)}{2}\left[A\sin\omega t\,(1+M\cos\omega_1 t)\right]^2 =$$

$$\frac{f''(B)}{2}\left[\left(\frac{A^2}{2}-\frac{A^2}{2}\cos 2\omega t\right)\left(1+2M\cos\omega_1 t+\frac{M^2}{2}+\frac{M^2}{2}\cos 2\omega_1 t\right)\right]$$

The output carrier at $2F$ is seen to have the peak magnitude $\frac{1}{4} f''(B) A^2 \left(1+\frac{M^2}{2}\right)$ which is equal to the d.c. showing that modulation has not affected the "d.c.-a.c." equality. The percentage modulation at $2F$ is seen to be $\frac{2M}{\left(1+\frac{M^2}{2}\right)} \times 100$, where $M$ is the original percentage modulation (of the carrier frequency $F$) expressed as a decimal. (See Fig. 4.)

## Microvolter applications

While the microvolter is particularly useful for calibrating signal generators, it has many other applications. A signal generator may be checked directly against the microvolter by employing each to measure the sensitivity of a receiver. If the signal generator has a wide frequency range, it is possible to check it without using a test oscillator to supply the input to the microvolter. When checking in this manner, the signal generator is adjusted to one-half the carrier frequency at which the calibration is desired. The receiver is then connected to the microvolter and adjusted to give a convenient deflection on an output meter with some arbitrary setting of input determined from the reading of the microammeter (D) and the output resistor.

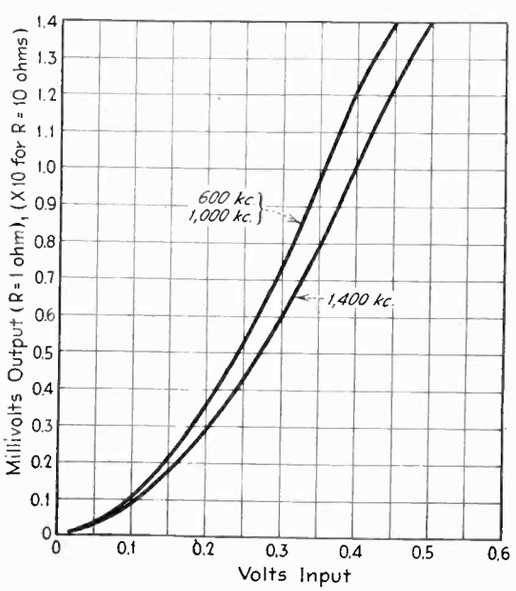



**Fig. 5—Input-output characteristic**

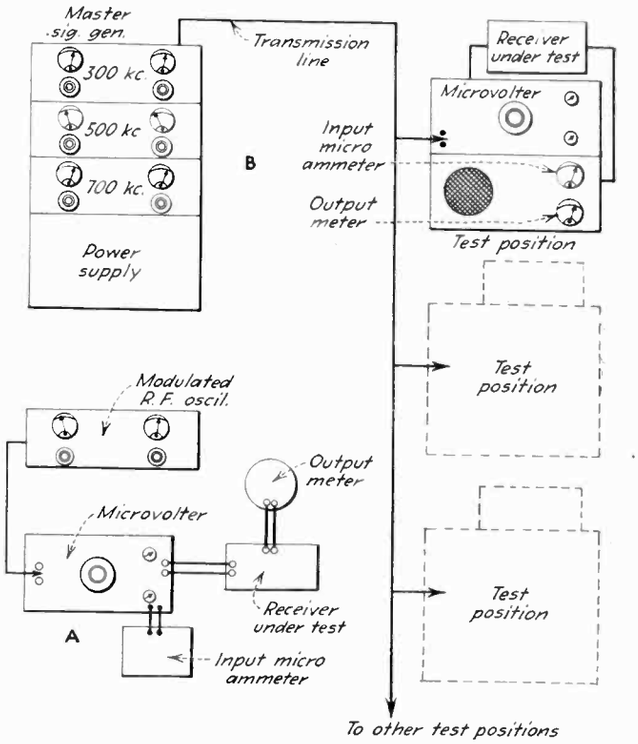



**Fig. 6—Set-up for production testing of receivers**

The output voltage in μv. as indicated on the microvolter is then recorded and the receiver switched to the signal generator directly. The signal generator is then adjusted to a frequency and voltage output (microvolts) to give the same deflection on the output meter of the receiver as was obtained when the receiver was connected directly to the microvolter.

A microvolter is directly applicable to receiver testing in production and in this respect is economical and flexible. The general scheme of using the microvolter in this manner is shown in "A" Fig. 6, the master oscillator consisting of the required number of carrier frequency channels, (modulated at approximately 15 per cent) a power suppy unit and a single transmission line. The selectivity curve Fig. 3 shows that each local test position using the microvolter can be adjusted to the desired checking frequency and no interference will be had from harmonics or undesired frequencies.

## Checking generator leakage

The standard microvolter is also very useful in checking signal generator leakage. Due to the capacity which often exists between a generator and a receiver under test, leakage from the generator causes capacity currents to flow between the signal generator and the receiver, thereby causing the sensitivity measurement to be in error, which in effect is equivalent to an error in the output calibration of the standard signal generator. The standard microvolter being operated at a low output level eliminates this effect and, therefore, introduces no leakage in itself; the difference between the reading of the microvolter and that of the signal generator can, therefore, be attributed to this leakage.

[1] "A Method for Generating and Measuring Very Weak Radio-Frequency Currents"—by Walter Van B. Roberts, published in the *Franklin Institute Journal*, March, 1926.

[2] "Quantitative Methods used in Tests of Broadcast Receiving Sets," by A. F. Van Dyck and E. T. Dickey, published in the *Proceedings* of the I.R.E., November, 1928.