electronics

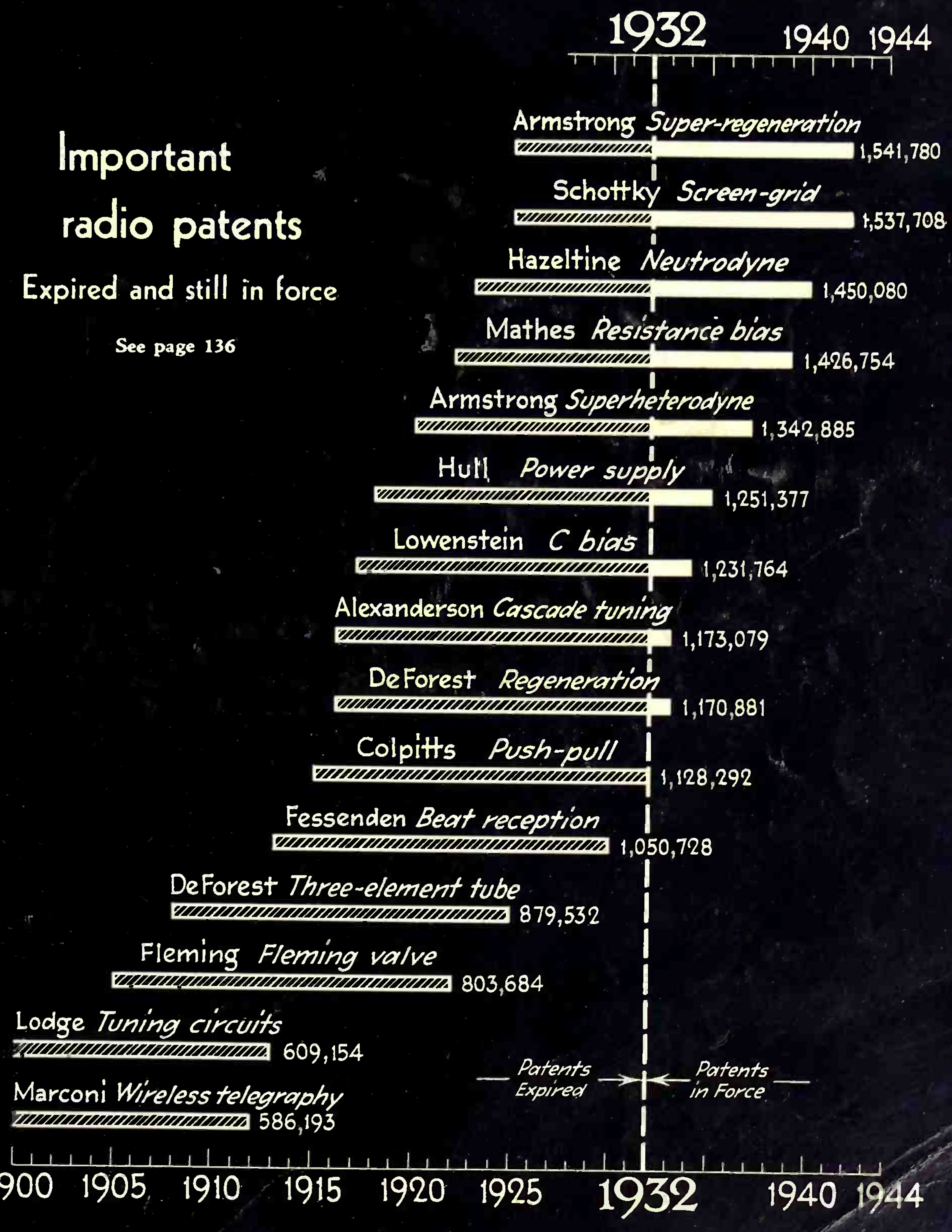
radio, sound, industrial applications of electron tubes • • • design, engineering, manufacture

Changes in
Patent Law
✦
Data on new
radio tubes
✦
Pentodes
as detectors
✦
D.C. receiver
output circuits
✦
Thyratron
voltage
regulator

Important radio patents

Expired and still in force

See page 136



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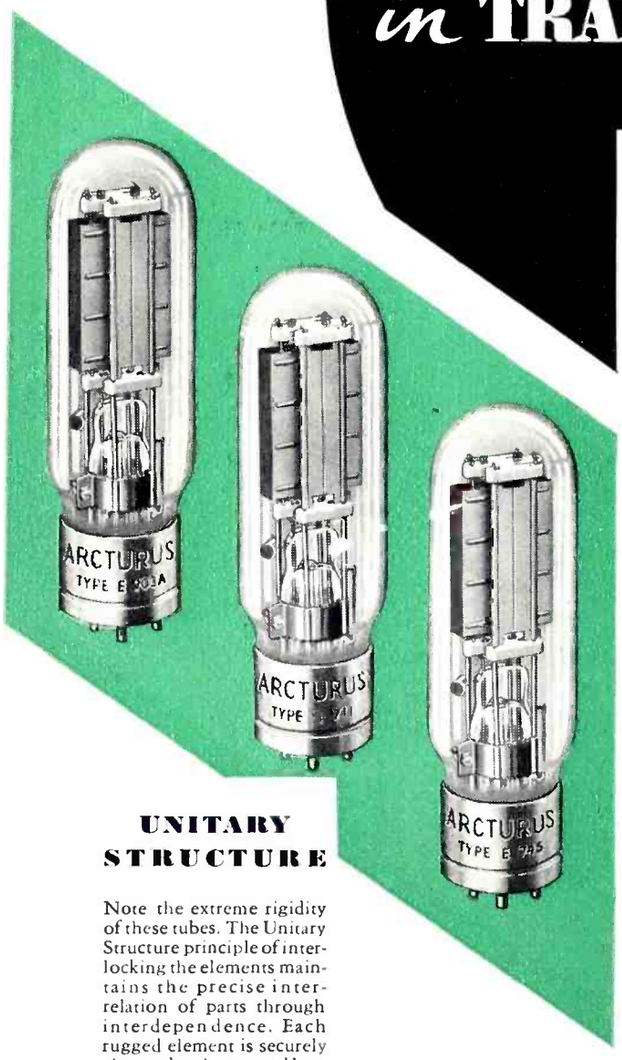
APRIL 1932

'Unitary Structure' in TRANSMITTING TUBES

assures matched tubes . . . enduring uniformity . . . long-lived performance



UNITARY STRUCTURE

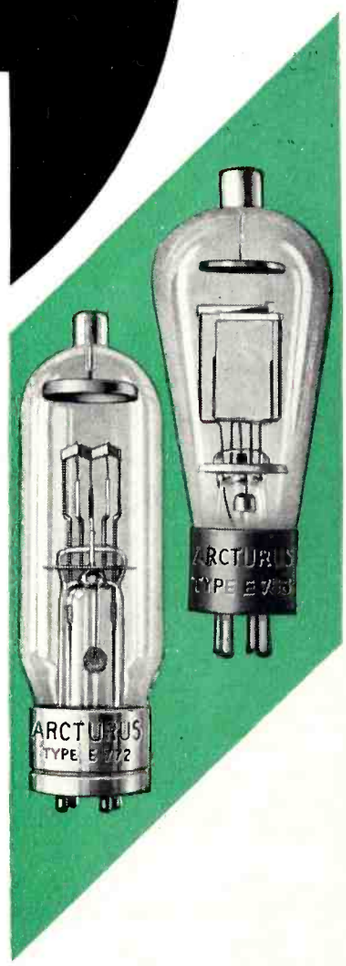
Note the extreme rigidity of these tubes. The Unitary Structure principle of interlocking the elements maintains the precise interrelation of parts through interdependence. Each rugged element is securely clamped at the top and bottom and the complete assembly is a sturdy unit—insuring constant uniformity.

Seldom have new products offered such a decided improvement over existing devices. The uniformity, performance and unique construction of Arcturus transmitting tubes establish a new basis for considering operation cost per hour.

The exclusive "*unitary structure*" principle employed in these tubes—the same as used in the well-known Arcturus *Blue* receiving tubes—assures unvarying uniformity even under most rigorous conditions. "Unitary structure" also insures matched tubes, so necessary for critical operation. These tubes are interchangeable with other makes whose last two digits are similar.

Write for technical data bulletins on the Arcturus Types E703-A, E711, E711-E, E745 (50-watt tubes) and E766 and E772 (mercury vapor rectifiers).

Arcturus Radio Tube Co., Newark, N. J.



ARCTURUS

Quality Tubes for Transmitting, Receiving and Industrial Uses

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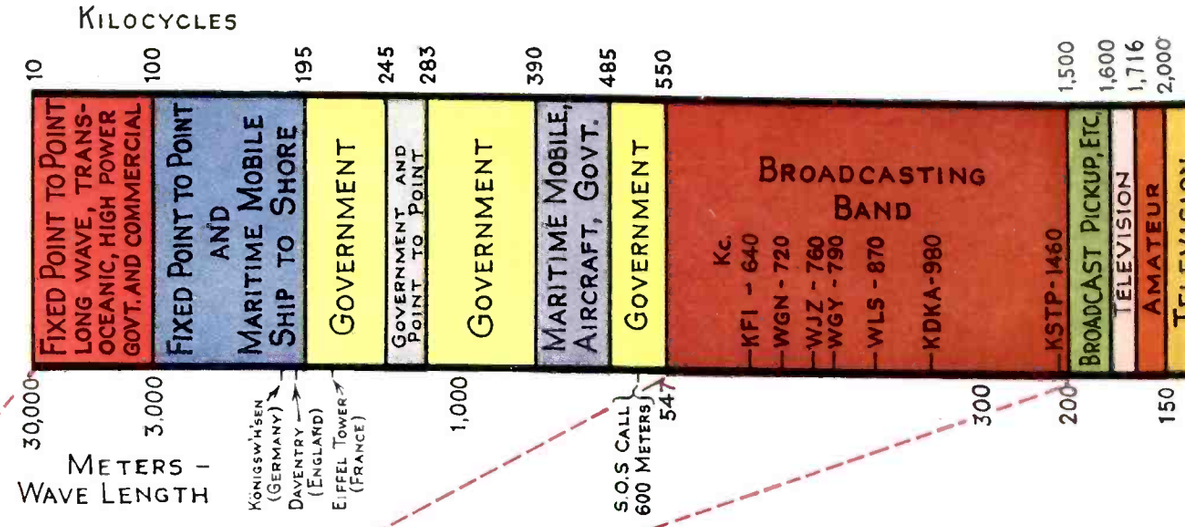
THE RADIO SPECTRUM



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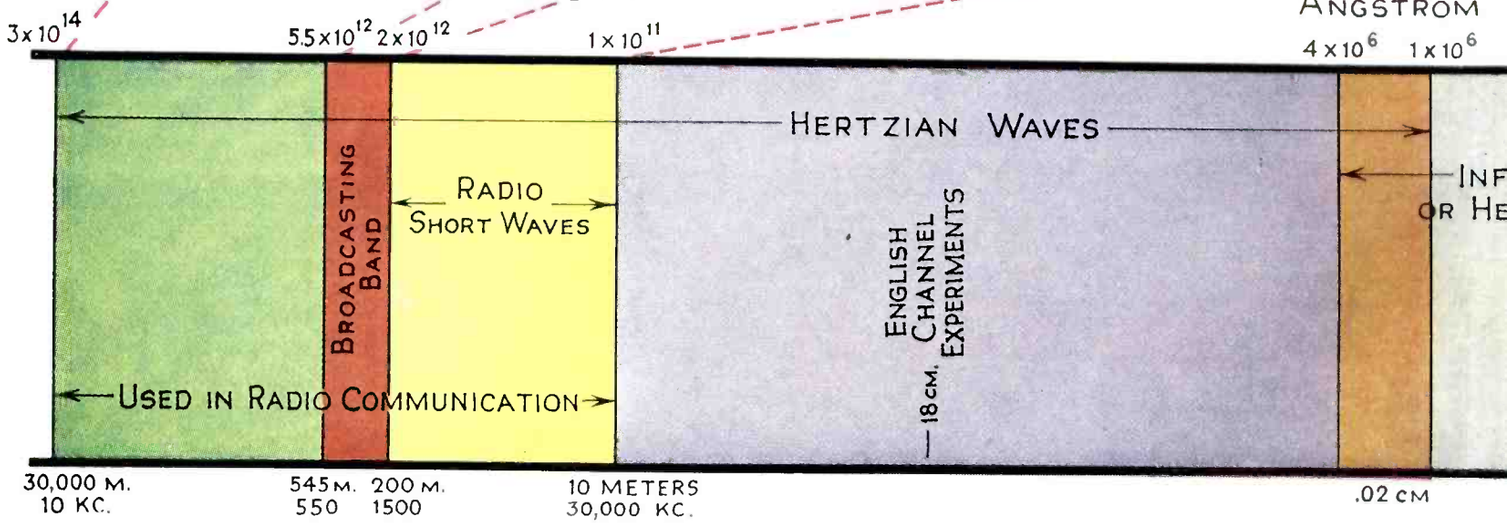
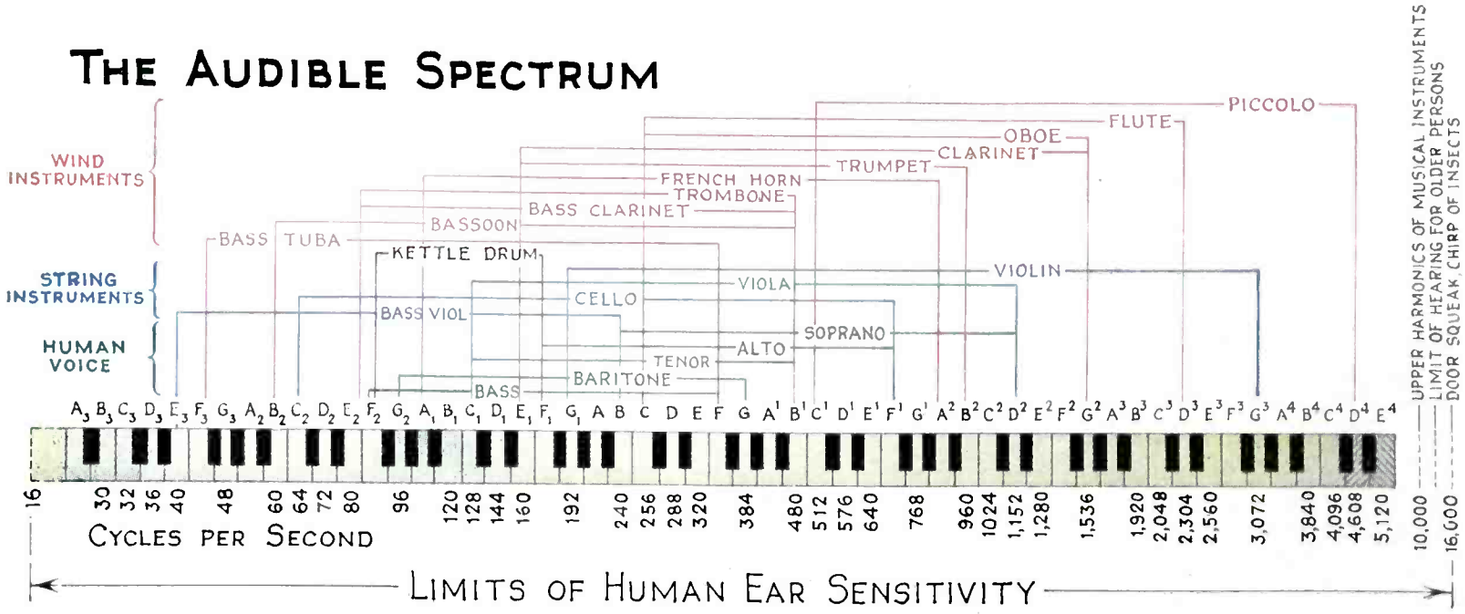


THE AUDIBLE SPECTRUM



Supplement to the April, 1932 issue of
ELECTRONICS

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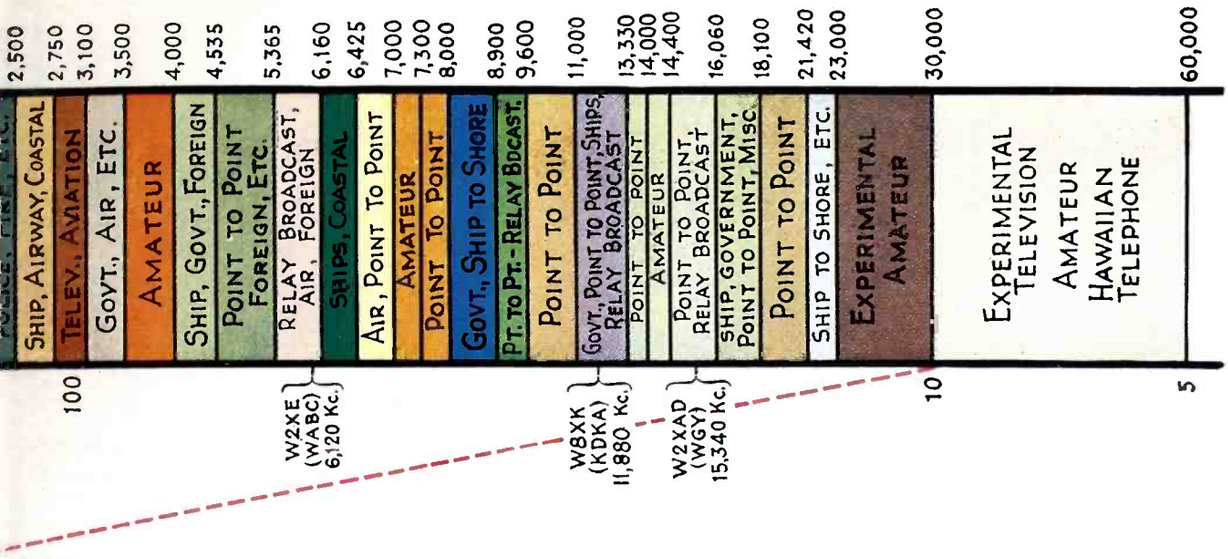

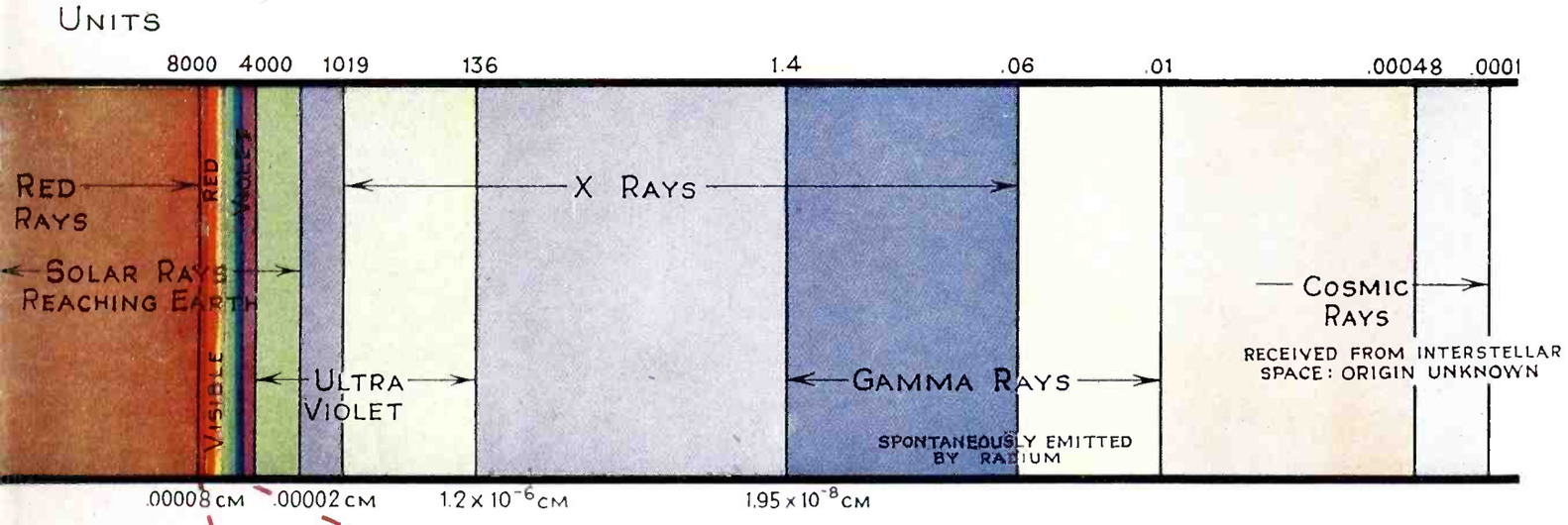

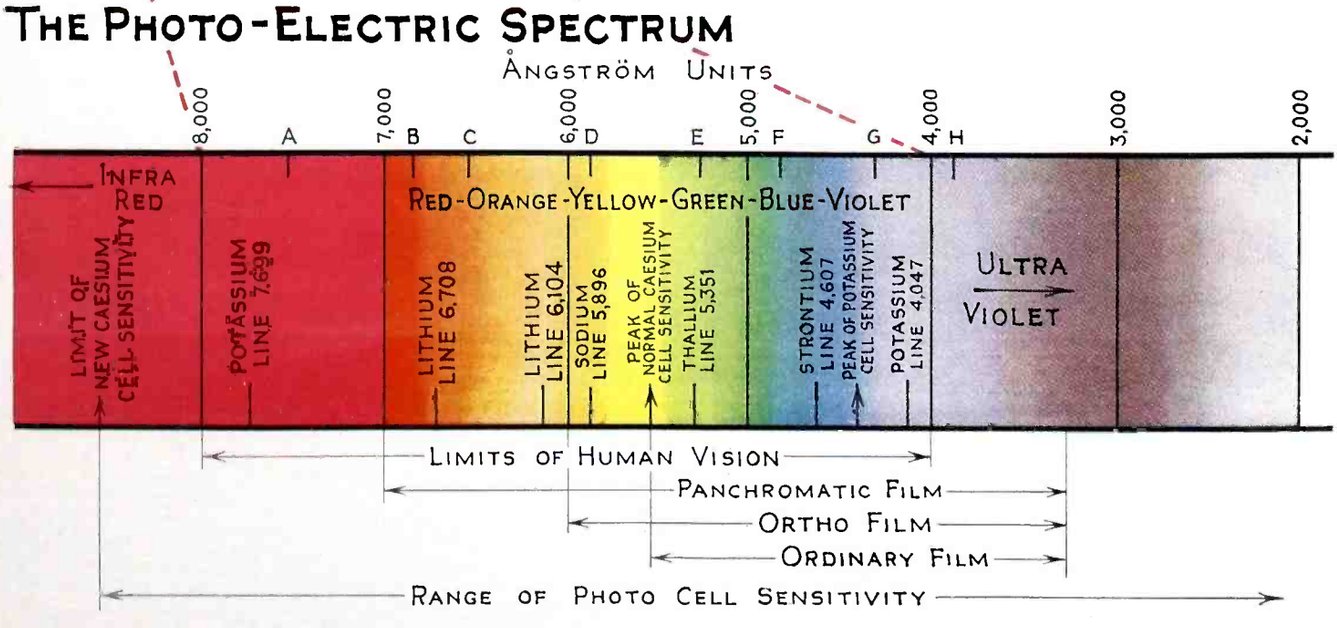

electronics

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New York, April, 1932

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radio
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Bury the chisel!

WITH the adoption of the chisel as its national emblem, the radio industry has surrounded and honeycombed itself with dangers of the gravest sort.

Excessive demand on the part of set manufacturers for components at prices representing manufacturing costs or below, will ultimately force old-line companies with reputations at stake out of the radio business. A new crop of parts makers will spring up able to satisfy the "chiselers" by the dangerous expedient of cutting the corners of long life and performance.

THE greatest danger in this price war carried on by radio-set makers is the tendency to cheapen the product in the eyes of the public. Already the process has got a good start. An automobile dealer at the New York Show said, "Well, a radio is just something to cut the price on, you know." A radio dealer on Long Island has discovered the best way to make a profit is to sell cheap sets at a loss and to make his money in servicing them. Within six months many sets in the lower price brackets need new condensers, resistors, or transformers. Often a half year has seen a greater expenditure for parts and service than the original cost of the set.

THE public is still mightily interested in radio. New models continue to attract eager throngs. But with the present tactics, how long can the public retain its pride of ownership in a radio set made up of a conglomeration of 10-cent store parts that daily threatens the owner with severe service costs?

PROPOSED PATENT

Modifications designed to simplify patent procedure and limit term abuses

By R. S. McBRIDE

FUNDAMENTAL changes of far-reaching importance are being proposed to the Patents Committee of the House of Representatives which has been holding a series of hearings under plans formulated by its new chairman, William I. Sirovich of New York.

The changes which have been proposed fall in three general classes—those which relate to securing of patents, those which would affect patent litigation in the courts, and those which have to do with the ownership of that intellectual property which results from invention. All three of these groups are of large importance to radio engineers and to professional men of all classes.

Expediting patent procedure

Patent Office procedure should be expedited. This has been the unanimous sentiment of all those appearing before the committee. Several specific proposals to this end have been made.

1. Provision of a "Classification Division" adequately manned to furnish reliable and complete records for use within the Patent Office and for the consultation of attorneys and patent applicants outside the Office, is one of the proposals most likely to be carried into effect in this Congress. A bill providing that about thirty experienced examiners shall be assigned to such division, and incidentally providing adequate funds for this enlargement, is being drafted and undoubtedly will secure committee approval. Even in a period of drastic economy this measure is likely to be passed by Congress, because of the fact that the Patent Office is an almost self-sustaining body, as the fees charged nearly equal the cost of operation.

2. A highly controversial provision intended to prevent applications for patent from being unduly delayed in the Patent Office has been proposed by the American Bar Association. As originally drafted this measure would have thrown open to public inspection any application after it had been three years in the Patent Office. As revised, the bill gives the Commissioner of Patents authority at the end of such three-year period to require a patent applicant at once to put his case in such shape that final action by the Office may be taken within thirty or ninety days, resulting in either rejection or granting of the claims or the advancing of the patent to the stage of appeal.

3. Because of the controversy over measures proposing the limitation of time in the Patent Office before issue of patents, an alternative idea has been proposed. Under this newer scheme the life of a patent would terminate either 17 years from the date of issue or 20 years from the date of filing, whichever date was the earlier. One exception would, however, extend such terminal date, but not more than 17 years after the date of issue, in the event that through no fault of the inventor interference or appeal proceedings resulted in a delay in granting of the patent to a time more than three years after the date of filing.

4. It is proposed to empower the individual or company to whom a patent application has been assigned the right to file without aid of the inventor either a divisional, continuation, renewal, of reissue application. By this means it is hoped that an assignee will secure *full* control and ownership of the invention in a patent application which he has bought and thus be able to prosecute it as may be most effective, even though the inventor be unavailable or unwilling to afford needed cooperation.

Simplifying Patent Office practices

Simplification of patent procedure, independent of any effort of expediting it, is sought in another group of measures. Among these is one which is proposed by the American Bar Association intended to prevent the difficulty now sometimes experienced in determining which one of several individuals of a group is the real inventor. This proposal would permit the joining of any number of persons who had had a part in the invention as members of the applicant group, even though there was a single invention involved. This would prevent the complication which now results under the law in invalidation of a patent because more persons appear than were actually inventors.

A second simplification step proposes that an inventor should lose all right for demonstrating priority of invention beyond a period of two years prior to his application. It is argued that this requirement would speed up the application for patents and prevent the retention as secret processes of inventions which should not thus be withheld. The nominal objective sought is the speeding up of the time when a patent will be applied for, granted, and hence ultimately expired and available for public use. It is argued that this change would be in harmony with the basic purpose of a patent. This purpose is stated clearly both in the Constitution and in frequent subsequent court decisions as being an effort to secure revelation of an invention for free public usage by granting to the inventor exclusive use of his invention for a limited period.

Reissues and renewals

Highly controversial modifications regarding the rights of disclaimer and re-issue of patents have been proposed by the patent bar. Vigorous controversy has arisen among attorneys and among representatives of industrial groups who have appeared before the committee. Unquestionably certain members of the committee are in favor of requiring disclaimers to relate to whole claims and of limiting, and perhaps even preventing, re-issue of patents. There is likelihood that the privilege of "renewal" of patents will be done away with by early legislation. This privilege, apparently in the judgment of the committee, is now abused and utilized mainly as a means for delay, not to protect worthy inventors.

OFFICE REFORMS

Changes would expedite litigation and clarify status of intellectual property

Litigation involving patents should be speeded up, quite as much as should securing of patents. It is not surprising that this sentiment should appear to have unanimous support among those appearing before the committee. Just how to accomplish this desirable objective is, however, not evident from the testimony. There is clear evidence that most of those appearing would welcome a clarification of the rights of industry to pool patents or to grant reciprocal license rights.

Patenting of "discoveries"

Patent of mere discovery, as distinct from invention, has been seriously proposed by a number of groups. An inquiry made by a special committee of the patent section of the American Bar Association led to the conclusion that such recognition of discovery was desirable. How this could be accomplished was, however, a question for which no satisfactory answer has yet been offered. The most telling argument thus far afforded has been that if a biologist who produces a new variety of plant by asexual reproduction is to be given protection for his improvement, then it is equally logical that a man who discovers a useful property of nature, even though no invention be involved, should be likewise rewarded. In this connection, it should be recognized that a man who not only discovers the property but invents or devises a useful application thereof can even now secure a patent with its attendant advantage for personal exploitation. Only in the case of such general discoveries as correspond to phenomena or properties of matter not having specific or individual application does the present law prevent patenting.

Another matter affecting the ownership privileges accorded to a patentee relates to compulsory working requirements or compulsory licensing of patents not worked by their owners. Apparently the sentiment before the committee is almost unanimous against the adoption in the United States of such requirement regarding licensing or working. The judgment expressed on the part of the patent bar is clearly to the effect that the owner of the patent should be given the privilege of deciding without outside intervention as to whether he will work, will license, or will simply hold unused the patent which he has obtained.

Patents by Government employees

The ownership of patents obtained by Government workers is involved in serious uncertainty at the present time. An amendment to the law adopted in 1928 undertook to give certain privileges of private ownership and exploitation to individual Government workers who had accomplished invention. The law then phrased is, however, of such conspicuously ambiguous nature that no agreement as to interpretation appears to be obtainable among outstanding patent attorneys who have given the matter thought. Some say the measure is clearly unconstitutional. Others, taking the opposite extreme, say that the rights of the individual Government employee are complete and not subject to question. All sorts of intermediate interpretations on the general subject and on details appear.

The practices of the various departments during years past have differed widely in respect to such matters. Some have required their employees to take patents and dedicate them to the public. Other bureaus, however, insisted that patents be taken for which they demanded only shop rights for their department or the Government.

Another related matter not yet brought before the House committee relates to the ownership status and the most desirable methods for handling patents obtained wholly or in part with funds of quasi-public or state or municipal institutions. The tendency of state universities to demand that their staff men assign to the university or some designated representative any patents which they obtain has been highly unsatisfactory in some cases. Certain faculty men have regarded this as an improper intrusion into their personal rights. Others have welcomed the development. It is urged that the law with respect to such matters may require amplification. Certainly it is demonstrated that the practice in such matters must be clearly defined not only in order that the inventor and the general public may know their rights, but also that potentially interested industry may not find itself unable to use an invention because of the cloud on the title or the uncertainty as to the extent of the authority of those who claim jurisdiction in the administration.

▼

SOME FUNDAMENTAL CHANGES RECOMMENDED

Patent Office work should be speeded

Applications remaining three years opened to public

Assignee given full right to file reissue

Group permitted to file as co-inventors

Priority of invention limited to two years before filing

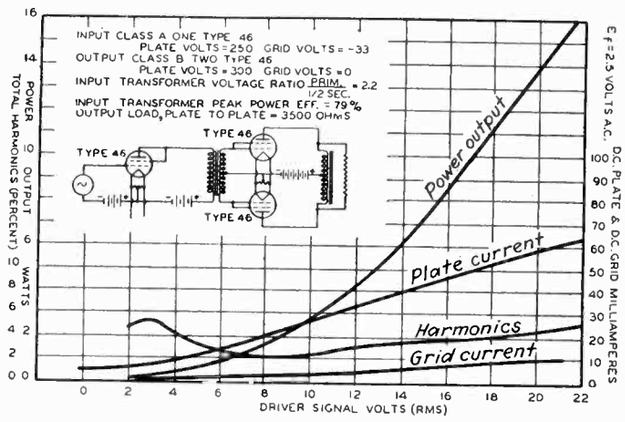
Speeding up of patent litigation in courts

Definition of status of government employees as patentees

NEW TUBES—DETECTORS,

LIKE the poor, new tubes seem to be always with the radio industry. The approaching season is to be no exception for a number of new tubes is not only promised, or threatened, but some of them are on dealers' shevles—and as for the poor, the chances seem as good as ever.

Class B amplification talk has crystallized suddenly with the announcement and introduction of a new tube (the 46) designed primarily for this purpose. It will deliver upwards of 10 watts, more or less undistorted, if anyone wants that much power. The attendant difficulties of poor regulation seem to be partially solved by the development and introduction of a new rectifier, a double-wave mercury vapor tube (the 82) with low internal voltage drop.



Class B amplifier circuit and characteristics

These tubes are not all. The Triple-Twin tube seems to be gathering momentum, and in the minds of many may be utilized instead of Class B amplification which at the moment looms very large indeed. Some claim the Triple-Twin tube in push-pull will be used as a counter-irritant to push-push, indicating that the industry is not completely sold on the over-biased amplifier at this time.

There are still other tubes. The Wunderlich tube has advantages which capable engineers are investigating. Construction details have not been available for publication but it is understood the tube has two co-planar grids, about which much was heard several years ago after a paper before the IRE by Bell Laboratories engineers.

Triple-Twins in push-pull

The following data on the Speed Triple-Twin tube are supplied through the courtesy of A. E. Lyle, chief engineer Cable Radio Tube Company. The high power output and high sensitivity of this tube are due to the ability to use the positive part of a characteristic instead of being restricted to the negative part only. In effect the tube is a two-stage amplifier in which the second tube, directly coupled to the first, can be driven into the positive region of its grid characteristic with resultant increase in power over a normal triode which cannot go positive without severe flattening of the output waves.

Signal must be applied to the first or input section between cathode and grid and not between grid and ground. This means that the cathode is above ground potential. This causes no difficulties when using transformer coupling and entails some slight circuit changes when resistance-coupled to a previous tube. An output of $4\frac{1}{2}$ watts is obtainable with an applied signal of 5 volts r.m.s. at 250 volts plate potential. The tubes can be used in push-pull delivering 14 watts with an applied voltage of $7\frac{1}{2}$ and 250 plate volts. With an input of $5\frac{1}{2}$ volts r.m.s. the output is 10 watts and the distortion is less than $2\frac{1}{2}$ per cent.

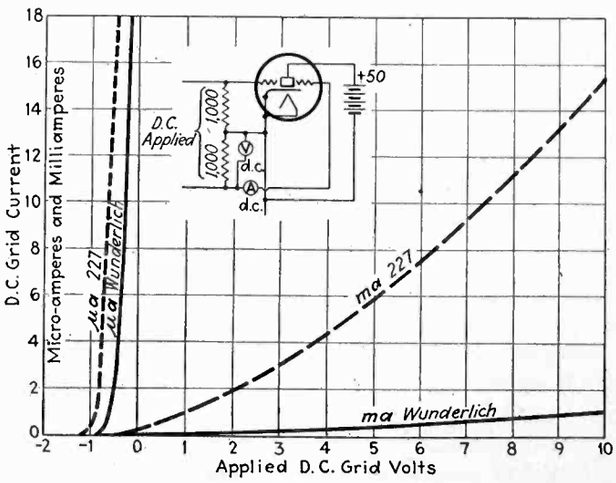
When used in push-pull a split secondary transformer is necessary together with proper coupling resistors to maintain the cathodes above ground potential. The push-pull circuit is shown.

A single tube gives least distortion and maximum power when worked into 4,000 ohms. The second harmonic is the chief offender against perfect fidelity and increases with load becoming about $2\frac{1}{2}$ per cent at 8,000 ohms. On the basis of Ballantine's definition of power sensitivity as the ratio between the square root of the power output and the voltage input, the new tube has a rating of 0.42, the 247 a rating of 0.15 and the 245 of 0.046.

The difficulties of introducing the tube into a million or so 1932 receivers seem to be not technical but economic. There seems to be a double-edged payment system which to the set manufacturers seems high (amounting to about 8 cents per tube plus a circuit royalty, according to reports) but to the sponsors and patent application holders this seems little enough considering the lavish manner in which the industry has paid royalties in the past.

The Wunderlich tube

The new detector tube known as the Wunderlich tube has definite advantages. The input so far as r.f. is concerned is push-pull; the a.f. output is normal. The tube



Grid characteristics of 227 and new detector tubes compared

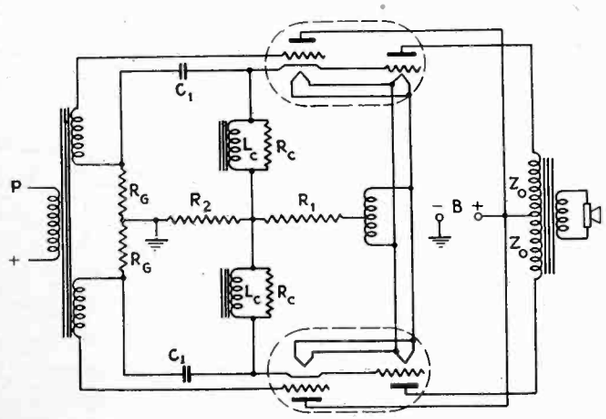
itself has two grids, of course, arranged in a co-cylindrical fashion about the cathode. At the time of writing, it is made solely by Arcturus.

Circuit details are not available for publication but imagine a center-tapped input coil tuned to the incoming signal, either at r.f. or i.f. Between the center tap and the common cathode is a resistance. The plate circuit is normal in that it can be coupled to a following tube by conventional means. Incoming signals cause first one grid to take current and then the other with result that a rectifying action takes place. The current flowing to the positive grid, when the other is negative, is less than would normally be expected, or which would be measured in a pair of 227's in a similar arrangement.

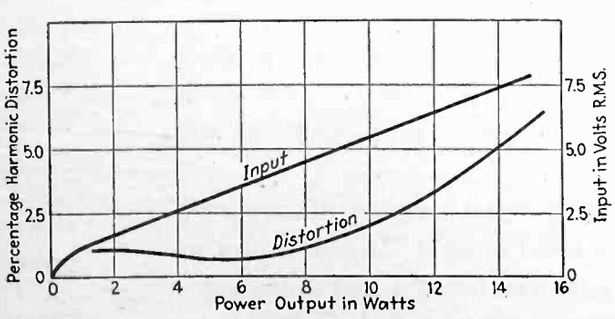
This rectification produces a pulsating d.c. across the center tap resistance and at the end of this resistor near the grids will be a negative potential of amplitude depending upon the incoming signal. This negative potential can be applied to the automatic volume control system of the receiver and used to govern the sensitivity.

After detection the tube acts as an audio-frequency amplifier with the two grids in parallel. The tube will behave much as a 227 so far as audio amplification is concerned except that a slightly less abrupt cut-off will be experienced.

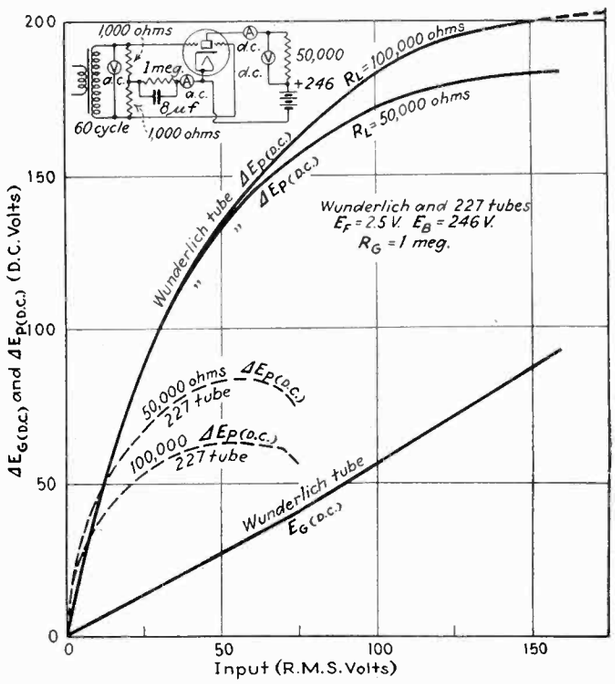
It is reported that as much as 20 volts can be available for volume control without severe distortion on heavy modulation. Stronger carrier voltages will produce stronger bias for the r.f. amplifier tubes, with the result that a fairly constant level is maintained at the input to the detector so that overloading is avoided.



Circuit for push-pull Triple-Twin tubes



Output and distortion of push-pull Triple-Twin tubes



Comparative sensitivity and linearity of Wunderlich tube and 227 as detectors

The tube offers advantages from the standpoint of greater sensitivity and greater fidelity—the demodulation process will be accompanied with less distortion. In addition there are certain manufacturing advantages according to the tube's sponsors which will make it possible with 6 or 7 tubes to duplicate the present performance of a 9-tube set. A 5-tube automatic volume control automobile receiver is suggested.

One interesting feature is the fact that ordinary tube noise and hiss will provide the initial bias for the tubes and that the time constant can be so fixed that the set can be tuned from one local station to another before the set returns to full sensitivity to bring up the noise level between stations.

Class B tubes

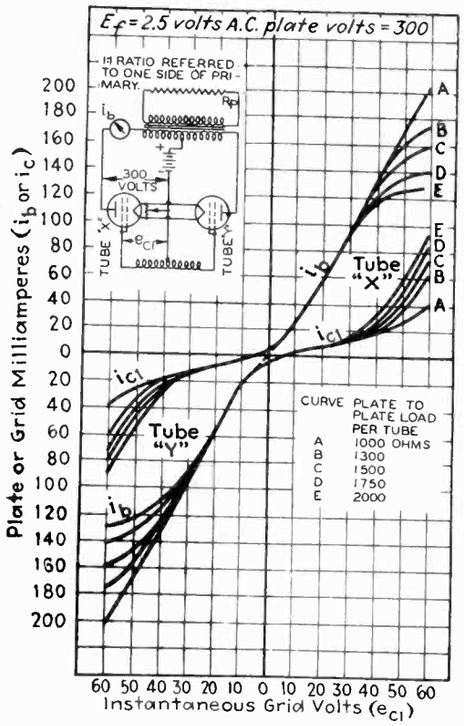
Class B amplifiers for audio amplification have attracted attention since the paper by Barton at the Chicago IRE convention meetings nearly a year ago. The theory (see *Electronics,* March, 1932) is well known. A tube is so biased that little plate current flows during the negative half cycle but considerable during the positive half cycle. This produces considerable second and other even harmonics, but a push-pull connection eliminates these and leaves an essentially undistorted power output. The two tubes must be driven from an amplifier capable of supplying considerable power, because the grids of the class B tubes are driven positive.

The new tube designed for this purpose (RCA 46) is a double-grid dual-purpose amplifier. With the two grids tied together the amplification factor is so high little plate current flows at zero bias. Hence it is unnecessary to supply a bias voltage and the entire voltage

output of the rectifier filter system is available. If the grid near the plate is tied to the plate a low-mu tube results. This can be used effectively as the driver. A step-down transformer connects the two tubes together.

Since the tubes operate at zero bias, no resistors are necessary to supply this bias from plate or other currents, and degeneration effects due to such resistors are not present. The distinguishing characteristics of the system lies in the fact that a very high output of good quality may be obtained with fairly small tubes; that unusual overall economy of power consumption is possible because the plate current is very low when no signal is applied to the grid. The requirements are that the driver must furnish plenty of power, that the voltage supply system must have good regulation, that a properly designed inter-stage transformer be employed and that slightly higher distortion at average volume be tolerated. It looks as though class B amplifiers, or the Triple-Twin may provide the way out of the pentode situation. Receivers using pentodes have not been noted for exceptional quality. Without adequate design considerable distortion results from the use of pentodes, their great advantage being their superior power sensitivity. A few manufacturers have not seen fit to use pentodes in high-priced, high-quality sets. Others have equalized to some extent the circuit conditions which produce distortion with pentodes. Whether the industry as a whole will go to push-push is a question that is hidden not only in technical problems but economic ones as well.

It is a fact that high quality receivers can well have available greater power output for peak modulations. It is noticed that with the use of better circuits for symphony and opera broadcasts, the volume range has increased appreciably. If the average radio volume control is fixed so that the lowest modulations are always audible in the average room, the peaks will overload the set, or will be leveled off. On the other hand, if the control is set so that the loudest passages are let through, the weakest passages will be lost in room noise.



Dynamic characteristics class B amplifier using C-46 tubes

Thus if the average receiver has 5 watts available, the push-push amplifier using 46's will enable twice this power to be put into the speaker on instantaneous peaks.

This will undoubtedly entail some changes in loudspeaker design, change the power supply system to some extent, and in general will contribute to burning midnight oil by technicians. At the same time the sales people may have something to shout about aside from low prices.

The mercury vapor tube (82) is a full-wave rectifier recommended for supplying d.c. power of uniform voltage in cases where the current goes through considerable variation. The voltage drop in the tube is about 15 volts. Because of the abrupt manner in which current builds up r.f. disturbances are set up which must be prevented from getting into the power supply system. Small chokes, one mh. or more, placed near the tube and preferably within a shield about the tube will reduce the slope of the current wave sufficiently to eliminate r.f. noise.

The maximum peak plate current of the tube is about 0.4 ampere making it necessary that the receivers be properly fused. Experience has shown that terrific currents will be drawn through the primary of the power transformer before the rectifier tube burns up if anything goes wrong. To realize to the utmost the good regulation of this tube the filter and transformer must have low resistance making it possible for a large current to flow under abnormal conditions. The chances are that class B will appear only in the more expensive sets for some time. [*Please turn to page 148*]

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With this issue—

ETHER SPECTRUM CHART SHOWING RECENT RADIO REALLOCATION

RECENT changes by the Federal Radio Commission in the allocation of radio channels, particularly in the short-wave region, have made it desirable to present to our radio readers a 1932 revised chart of the radio spectrum. Such a chart, in full colors, is sent as a supplement to this issue of *Electronics*.

The chart shows the latest assignment of radio services by channels, as arranged under the Radio Commission's 1932 orders. It also brings up to date the latest scientific determinations of wavelengths and frequencies in the fields of sound, Hertzian waves, heat rays, infra red, visible light, ultra violet, X-rays, Gamma rays and cosmic rays.

Some overlooked opportunities for electrical phonographs

ON March 13 Professor Vladimir Karapetoff of the School of Electrical Engineering of Cornell University demonstrated before a University audience some new uses of the electric phonograph. He showed how a phonograph may be tuned to a piano and used to play duets with it, using either of the two instruments as a solo instrument.

He played a Rachmaninoff prelude in which the phonograph took the place of the second piano, and also used a real piano in accompanying some vocal records. Some of the solos used were recorded on aluminum disks unaccompanied and specially made either by Professor Karapetoff or under his direction for use with a real piano. He also demonstrated a distant control by means of which he can regulate the pitch and the volume of a phonograph record while sitting at the piano.

The use of the phonograph in accompanying any other solo instrument was also shown, the accompaniment records having been made by Professor Karapetoff himself. Having such accompaniment records, it becomes possible to sing a song or to play the violin without having a skilled accompanist on hand. Moreover, the pitch of the accompaniment is readily changed by a turn of a screw, and it becomes possible to sing in any desired key to suit one's voice.

Phrasing the phonograph

In conclusion Professor Karapetoff demonstrated how one may take part in the performance of an ordinary standard phonograph record, and thus derive added pleasure, as well as a more intimate knowledge of the piece performed. He participated with his five-stringed cello in a record played by the London String Quartet, and then supplemented on the piano the orchestra part in a scene from the opera "Aïda."

Speaking of his endeavors and experiments in this direction, Professor Karapetoff said:

"Solo playing on musical instruments, and solo singing, have been steadily going down in smaller communities since the war. At the same time, general interest in and understanding of good music have been noticeably on the increase. It is generally agreed among experts that unless a considerable number of persons in a country care to perform or to sing, however imperfectly, music as an art can not advance.

"A nation of 'listeners only' is condemned to lag behind others in music. A return to the pre-war interest in solo performance does not seem to be practicable at present, and so for a number of years I have been trying to devise various means of producing good music with less technical skill required. The use of an electric phonograph in combination with other musical instruments or with human voice is one of these ideas; I hope that my demonstration will stimulate new interest in performing on musical instruments and in singing, especially among the younger generation."

"Manufacturers of phonographs and of records should take advantage of this idea, to promote their sales, at the same time performing a valuable service to the cause of good music. Here are a few things which they could do:

(1) Make records of accompaniments of some well-known vocal and instrumental pieces, so that a person who has a phonograph could sing or play a musical instrument to the accompaniment of a record, thus dispensing with an accompanist.

(2) Make records of some well-known vocal and instrumental solos unaccompanied, so that a pianist could accompanying them on his own piano.

(3) Provide an electric attachment whereby the speed and the volume of an electric phonograph could be regulated from a distance. This would make it much more convenient to adjust the pitch while sitting at the piano and to control the volume at will while playing or singing with a record.

(4) Improve the phonograph attachments for home recording, put on the market separate recorders for aluminum disks, and provide studios where a person could have records made for his personal needs."

"With a judicial development of such a program, the phonograph will cease to be merely a machine which always grinds out the same pieces in the same mechanical way. It will become a musical friend and partner with which one may play duets and which will serve either as soloist or accompanist, playing correctly and stimulating the performer himself to higher achievements in music."

▼

VLADIMIR KARAPETOFF is internationally famous both as an electrical engineer and as an accomplished musician and performer on several instruments. In this article he points out that the person who plays a phonograph should be able to take a creative part in the phrasing and emphasis of the music. Proper electrical controls, he demonstrates, would make it possible to restore some of the old-time individualism in music.

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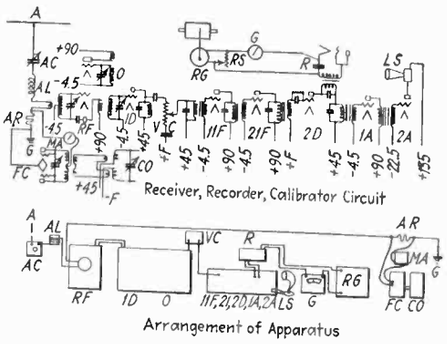


Radio recording apparatus at Perkins Observatory, Delaware, Ohio, with circuit employed

Radio reception and sunspots

By H. T. STETSON

Director of Perkins Observatory

RECORDS of the last six years appear to have established beyond much doubt marked changes in the intensity of radio reception accompanying the outbreak of disturbances on the sun. As has long been known, the sun passes through a cycle of changing activity which attains a maximum about once every eleven years. We are now passing one such cycle which culminated in 1928-1929. During periods of great solar activity curious spots appear on the sun's surface which may be seen in a telescope of even moderate power. These dark spots are in reality centers of terrific magnetic disturbances that sweep the sun's surface, often covering billions of square miles.

The electro-magnetic character of sunspots was first demonstrated by Dr. Hale, of the Mount Wilson Observatory, in 1908. By means of the spectro-heliograph photographs may be taken of the entire sun in the light of the Hα line which reveal vast clouds of hydrogen gas whirling about in vortices similar to the atmospheric whirls near the center of cyclonic storms. That these particles of hydrogen gas carry charges of electricity generating powerful currents was demonstrated through observation of the so-called Zeeman effect in the lines of the solar spectrum overlying sunspot areas. That these electro-magnetic fields in the sun should produce magnetic changes in the earth appears reasonable in the light of observational evidence.

For more than a century and a half records of the numbers of sunspots have been kept making possible a study of their periodicity over about fifteen solar cycles. For more than a century records of the earth's magnetism, both as regards intensity and direction, have been made and show a remarkable correlation with changes in solar activity as exhibited by sunspots. While for many years scientists have recognized a recurrent cycle in the magnetic changes of the earth accompanying changes in the sun, never before the present period of sunspot activity has it been possible to study so thoroughly the changing degree of ionization of the earth's atmosphere with the coming and going of spots across the sun's disk. All this has come about by the development of radio. It now becomes apparent that the same electronic disturbances which alter the earth's magnetic field and produce remarkable displays of the aurorae also change the state of the Kennelly-Heaviside layer so that radio waves are effected to a very marked degree by the occurrence of solar cyclones.

The quantitative measurement of radio reception in the broadcast zone was systematically begun by G. W. Pickard in his private laboratory in Newton Centre in 1926, and great credit is due him for his pioneer work and his preëminent contributions in this field. In February, 1928, a duplicate set of apparatus was installed at the Astronomical Laboratory at Harvard, and measurements carried on there under the direction of the author for about two years. A curve showing the varying intensity of radio reception in microvolts per meter as received in the vicinity of Boston from WBBM Chicago for this period is shown in Fig. 1. The graph also carries an inverted curve of the numbers of sunspots observed during the same interval.

In starting a research program at the Perkins Observatory in the fall of 1929, plans were made for continuing the same investigation over the 300-mile path between Chicago and Delaware, Ohio. The apparatus employed, shown in Fig. 2, is a superheterodyne receiver to which is connected a Leeds and Northrup single-point recorder. To standardize the receiving apparatus a local oscillator forms a part of the equipment and broadcasts within the laboratory a 770 kc. frequency with known current input. The correspondiing observed deflection of the recording galvanometer, tuned to this frequency when WBBM is off the air, serves therefore to give the neces-

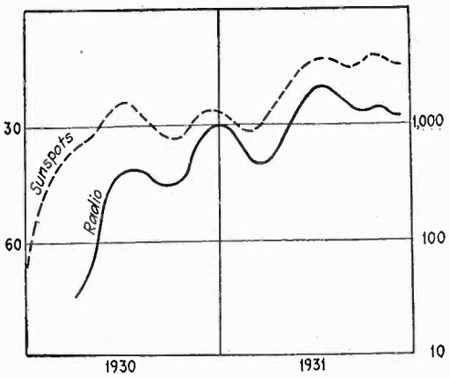
sary reduction constant for the evening. Copies of the log of WBBM are received daily which give a check on the current input at the broadcasting station. Measurements of the intensity of the carrier wave from Chicago systematically began in March, 1930, and the accumulation to date of nearly two years records have served to corroborate the Boston-Chicago series of findings.

At the outset observations of signal strengths were confined to the 9:00 to 10:00 hour in the evening (E.S.T.), but have since been extended to cover the entire broadcast program of WBBM until it is off the air at 2:00 a.m. (E.S.T.). This extended series of observations has made it possible for us to determine corrections to the observations which depend upon the great circle distance of the sun below the horizon of the receiving station.

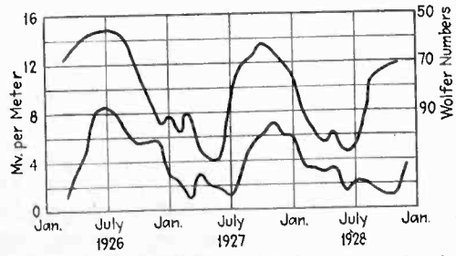
In Fig. 3 is shown a curve of measured intensities of WBBM at Delaware over this two-year interval, the unit being microvolts in the antennae laid out on a logarithmic scale. The graph of sunspot numbers is also charted with increasing values downward. The close parallelism of the two curves thereby becomes obvious and suggests that the relation is an exponential one. It is noted that while during this interval sunspot numbers have decreased by 50 per cent, the received intensity of the carrier wave from WBBM has increased by 400 per cent. The fact that the same sort of correlation seems to hold over the 300-mile path that was found over the 900-mile path between Chicago and Boston leads us to suppose that the solar effect is indeed quite general.

Mechanism of wave transmission

Opinions may differ as to just what happens when a broadcast wave travels over the earth. Whether we regard the ether wave as reflected or refracted by the ionized layer of the earth's upper atmosphere may be of little consequence. In either event it would appear that the Kennelly-Heaviside layer is effectively lowered as a result of an outbreak of solar activity. We are led to infer that the decreasing intensity of the radio signals at the outbreak of sunspots is due to an increased ionization of the earth's atmosphere with the resultant lowering of the Kennelly-Heaviside layer. Opinions differ as to whether the increased ionization is due to an ultra-violet light radiation from the sun, or is produced by an increased bombardment of the upper atmosphere by electrified particles emitted from the sun. The fact that the radio reception appears to be more seriously impaired when the spots are near the center of the solor disk suggests that the electro-magnetic whirls in the sunspots themselves may be responsible for concentrating electron fire in the vicinity of the earth, much as the fleeing electrons in a Coolidge tube may be directed into a pencil stream by an imposed electromagnetic field. An examination of the secondary fluctuations in the sunspot curve during the last maximum reveals a short period of approximately fifteen months between the successive sunspot peaks of the secondary maxima. On the basis of this fifteen-month cycle a peak in the sunspot curve, occurring at the end of 1929, was predicted a year in advance. A corresponding diminution in radio signal strengths was likewise predicted which as the graph shows was remarkably fulfilled.



Correlation between inverted sun-spot numbers (upper curves) and radio intensity (lower curve)



Intensity of WBBM, 770 kc, as received at Delaware, Ohio, and 1930-31 sunspot numbers

Long-distance reception improves—Local listeners suffer

It must be borne in mind, however, that while long-distance reception appears to markedly improve with a decrease in the numbers of sunspots and the concomitant rising of the Heaviside layer, trouble may be brewing for radio fans who operate sufficiently near a broadcasting station to receive both the sky and the ground wave. While during the period of marked solar activity, 1927-1929, the sky wave was nil at a radius of 30 to 50 miles from the sending station, present conditions favoring increased transmission of the sky wave have made possible interference between the sky and the ground wave thus raising havoc with what was previously supposed to be the skip distance of the broadcast region. Undoubtedly the destructive interference of these waves has been responsible for much of the mushiness of reception noted during the last year or more at points within this critical distance from the broadcast station. We can, perhaps, hardly expect such conditions to improve unless a marked change in the present altitude of the Kennelly-Heaviside layer should result as we progress in the solar cycle. On the other hand, it appears entirely possible that a certain turmoil is for the moment present in the upper atmosphere due to the rapid change in ionization conditions which have taken place with precipitant fall in sunspots during the last two years. It appears evident, however, that cosmic researches are likely to become of increasing importance in radio engineering from the point of view of the radio market and very practical commercial considerations.

The result of these investigations may suggest that during years of sunspot maximum when long-distance reception is relatively poor, sales pressure should be brought to bear upon the placing of receiving sets for successful reception within a 30- to 50-mile radius, whereas during periods of depressed solar activity such as we are approaching at present long-distance reception be one of the selling features for the radio market. The coming two years should see a continued recession in the numbers of sunspots with a continuance of favorable conditions for long-distance reception. After 1934 we shall begin to enter upon the next period of solar activity with a rise in the number of sunspots, gradual at first and becoming more and more apparent by 1935-1936. The next maximum in the solar cycle should be reached about 1938-1940 when again we may anticipate a marked lowering in the Kennelly-Heaviside layer with the resultant deterioration of long-distance reception.

Improvements in frequency multipliers for aircraft radio

By E. G. WATTS

Formerly, N. Y., Rio & Buenos Aires Line, Inc.

PIEZO-CONTROLLED transmitters have not been widely used in aircraft, ostensibly because of their complication and inflexibility in comparison with tuned-circuit controlled types. On the other hand the unique advantages of piezo-control are especially desirable under the conditions encountered in aircraft operation. For long range daylight operation, however, higher frequencies are necessary than are obtainable directly from a quartz controlled oscillator at the level of power required, and frequency multiplication must be used. Two stages following the piezo-oscillator —one multiplier and one amplifier—are ordinarily required, as the power available from the multiplier is small, owing to its low efficiency. If the multiplier efficiency could be made to approach that of the amplifier, it would be possible to dispense with the amplifier. If at the same time facility in harmonic frequency-shifting can be provided, the design of a more reasonably efficient and flexible piezo-controlled transmitter becomes practicable.

Improved efficiency in a multiplier may be obtained by introducing into the grid circuit in proper phase relation a component of the frequency to which the output circuit is tuned; i.e., by causing an approach toward straight amplifier operation. One method of accomplishing this is by partial self-excitation, by feedback from the output circuit. It should be noted that the harmonic component already in the excitation from a piezo-oscillator is in phase opposition to the component generated in the multiplier. A considerable increase in efficiency is obtainable if precautions are taken to keep the harmonic content of the excitation at a minimum (by the use of a low reactance oscillator tank circuit, a suitable type of tube and adjustment of grid bias).

Any feedback system employed in a multiplier must discriminate against the predominating fundamental frequency component of the plate current, so that the feedback will take place largely at the harmonic frequency. Systems utilizing the tube inter-electrode capacitance as the coupling medium provide this discrimination inherently, by virtue of the low impedance of the plate circuit at the fundamental frequency. An inductively coupled system such as the tickler, on the other hand, is not suitable, since it operates on the plate current instead of the plate voltage. Circuit arrangements employing the tube capacitance coupling have been described by previous investigators.[1,2]

It is the purpose here to show that the commonly used amplifier neutralization systems become regenerative at the output frequency when employed in a frequency multiplier. In both the Hazeltine and Rice systems, the change from the neutralized to the regenerative state takes place by virtue of a reversal in sign of the reactance of a part of the circuit, with the change in output frequency from fundamental to a harmonic. The feedback is derived from the plate tank circuit, which contains a small fundamental component.

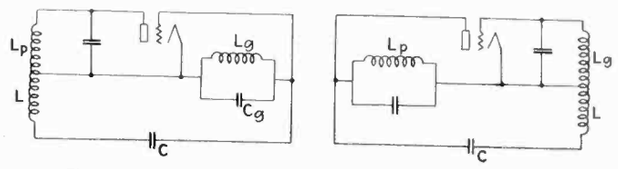


Fig. 1—Hazeltine (a) and Rice (b) circuits in which improved frequency doubling can be attained

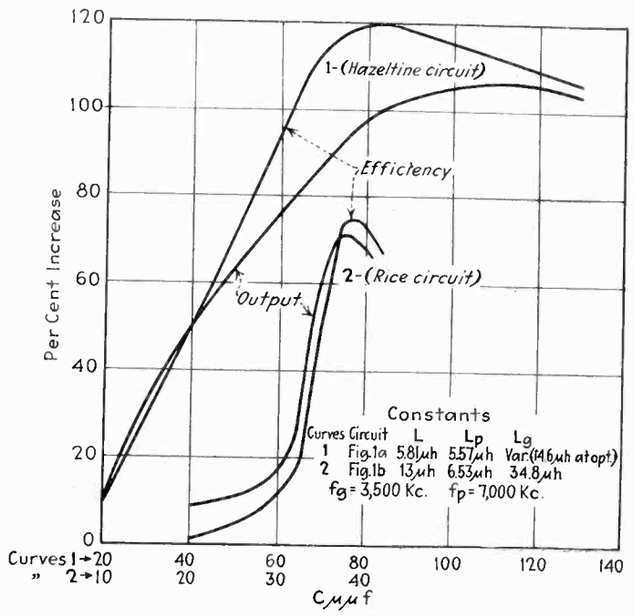


Fig. 2—Improvement attained in output and efficiency by proper circuit operation

In the Hazeltine type circuit of Fig. 1_a in order that the grid voltage set up by the neutralizing branch L-C be in phase opposition to that set up by the tube capacitance coupling, the reactance of the circuit L-C-L_g, C_g must be capacitive. If made inductive (by increasing C), the feedback obviously reverses in phase and aids the tube capacitance feedback, as in the Hartley circuit. With the plate circuit operating at a harmonic of the input frequency, it is possible to have the reactance inductive at the harmonic and capacitive at the fundamental. The feedback at the fundamental therefore remains negative, but on account of the low impedance of the plate circuit the reduction of the external excita-

[1]Page, R. M., *Proc. IRE.*, 17, 1649. Sept. 1929.
[2]Howden, Maxwell, *QST*, Experimenters' Section, Nov. 1929.

tion is negligible. At the harmonic frequency, regeneration will take place, but in an appreciable amount only if the impedance of the circuit L_g, C_g is made sufficiently high. This automatically becomes possible, since with the adjustment for optimum inductive reactance at the harmonic, the branch L-C constitutes the major part of the capacitance of the grid circuit. L_g may be anti-resonated at the fundamental with this capacitance alone, C_g being then the tube, coil and circuit capacitance. L_g and C_g are hence anti-resonant in the vicinity of the harmonics, and may be made to have a high impedance at the desired harmonic by suitable adjustment of L_g. The feedback is more dependent on this adjustment than on the setting of C, which is then made for the fundamental anti-resonance. Under these conditions the impedance of the grid circuit is fairly low to the external excitation harmonic component, while high to the internal regenerative component.

Better efficiency and output of frequency doubler

The improvement in efficiency and output of a frequency doubler, obtained with this system, is plotted in Fig. 2, curves 1, in terms of per cent increase over the efficiency aud output of the same circuit without the branch L-C. The efficiency is somewhat more than doubled at the maximum. Output is not far below that obtained with complete self-excitation (self-oscillation) (130 per cent) with the grid circuit tuned to the output frequency and the tube capacitance supplying the feedback. The efficiency under the latter condition is considerably better (174 per cent), however, owing to the absence of the fundamental excitation. With the circuit constants given, there is no detectable departure from the stability of the controlling excitation unless the latter is reduced. When removed entirely, or with the plate circuit detuned, however, the feedback is sufficient to sustain self-oscillation. It is not usually practicable to operate the stage following a piezo-oscillator in a saturated condition, and this is not a requisite for stability with this system. A UX 210 tube could be operated with a plate input of 40 watts (600 volts) under the optimum condition, with negligible heating of the plate.

The improvement obtained with the Rice type circuit of Fig. 1b is shown in Fig. 2, curves 2. The regeneration is limited by the relatively low impedance of the grid circuit at the harmonic frequency. The use of a high L/C ratio to make this impedance high accentuates the out-of-phase excitation harmonic, so the improvement is somewhat less than in the Hazeltine type.

Triode as neutralized amplifier

With these systems, a triode (or pentode) may be operated as either a neutralized amplifier, or regenerative multiplier, by changing plate coils. In the Hazeltine type it is necessary to add a condenser across the grid circuit for fundamental operation, since it is not practicable to neutralize and tune the grid circuit simultaneously with the feedback branch. The various coils may be adjusted so that no resetting of condensers is necessary when shifting. With a screen-grid tube, the feedback portion of the fundamental coil may be omitted from the usual circuit.

The improvement noted when a neutralizing circuit is used in a frequency multiplier has sometimes led to the erroneous conclusion that the benefit derives in some way from the elimination of all feedback. Multipliers adjusted for regeneration by feedback through the plate-grid capacitance of triodes have shown reduced efficiency when operated with screen-grid tubes.[1] Furthermore, a consideration of the following points should make it evident that no actual state of neutralization is possible in a frequency multiplier: (1) The reactance of the grid circuit to harmonic frequency feedback through the tube capacitance is negative, and the grid voltage set up is in opposition. (2) The neutralizing circuit causes regeneration at the harmonic frequency over a wide range of adjustment, obscuring the neutralized point for the fundamental. Although the tube capacitance feedback in a frequency doubler may be sufficient to sustain self-oscillation at approximately the grid circuit frequency (since the plate circuit presents sufficient impedance when tuned to twice the frequency) with the external excitation removed, the effect of the feedback is negligible in the presence of the excitation.

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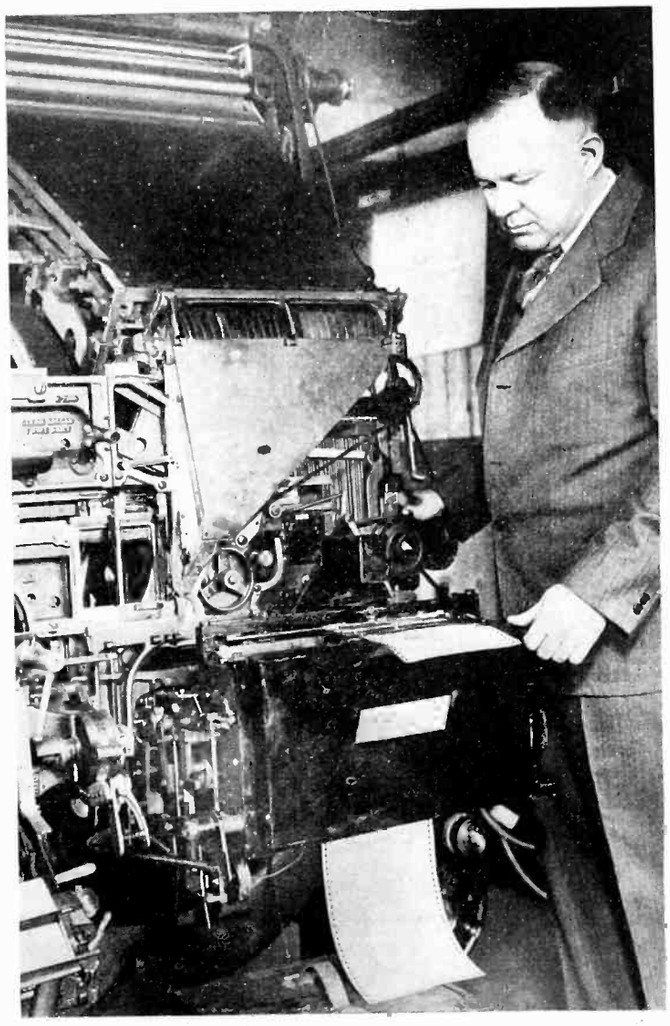

The "Semagraph," a new form of photoelectric control which makes it possible to operate a linotype directly from "copy" prepared on a special typewriter, is the invention of Buford L. Green of the Charlotte (N. C.) Observer. Beneath the regular letters, this typewriter prints corresponding control symbols made up of combinations of dots. These grouping of dots, scanned by the photo-cell, actuate the matrix-releasing mechanism

Power detection characteristics of pentode tubes

By H. A. BROWN and C. T. KNIPP
University of Illinois

FOR some years the writers have been interested in the quality and efficiency of the detection phenomena in various types of thermionic tubes being especially interested in detector tubes which function to the best advantage at very low input potentials.[1] The writers have been particularly interested in the problem of obtaining as much audio-frequency power output without objectionable distortion as possible, as well as obtaining as much signal voltage output as possible from the detector device. Commercial forms of detector tubes in use today do not meet both of these requirements to a satisfactory degree, although the screen-grid type of tube gives a very high value of voltage detection. With the advent of power detection[2] it was possible to obtain considerably more power output from the three-electrode detector tube, but with a quite unsatisfactory value of signal voltage output. Power detection is the process of exciting the detector tube with modulated radio-frequency potentials of one and a half or two volts or higher, r.m.s. value, obtaining signal frequency output voltages in which the total harmonic residue amplitude is roughly below the limit of 5 or 7 per cent of the signal frequency amplitude component of the signal output potential. In other words, the "distortion" is kept below a limit which is generally believed to have a noticeable effect on the audible quality of the signal or modulating potential originating at the transmitter microphone.

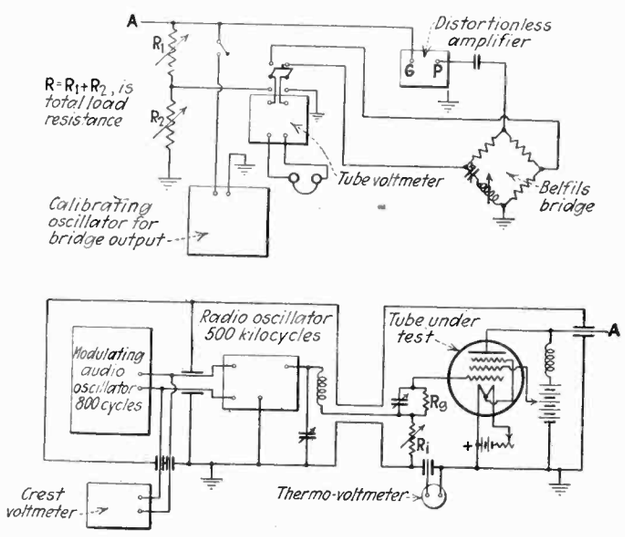

Fig. 1—Output and distortion test circuit

Considerable investigation and development work has been done to obtain practically distortionless detection with three-electrode heater-type detector tubes, and with the screen-grid type of tube with a separate heater for the cathode. Apparently very little if any investigation work has been done on the problem of obtaining more effective power detection with the pentode tubes, now so commonly used as power amplifiers in radio receiving sets. Static characteristics of pentode tubes indicate that they will give considerably more voltage and power output when used as detectors with relatively high input voltages than do the screen-grid and heater-type three-electrode tubes. The writers have from time to time obtained some quantitative data on the performance of pentodes as detectors, and wish to present the results to date in this paper.

Distortion measurement apparatus

The measurement of the comparative harmonic residue and fundamental components of the output voltage was accomplished with the aid of a continuously calibrated Belfils' bridge, testing apparatus being so provided that readings of the effective values of both the fundamental and the harmonic residue components can be obtained. A high-grade audio oscillator in Fig. 1 induces the required modulating potential at a frequency of 800 cycles in a pick-up coil magnetically coupled to the oscillator inductance. A crest voltmeter indicates the amplitude of the practically sinusoidal modulating voltage, which is adjusted in value to obtain 50 per cent modulation of the plate supply voltage of the radio-frequency oscillator. The modulated output current of this oscillator flows through a resistance, R_1, to produce a modulated radio-frequency potential to excite the grid of the

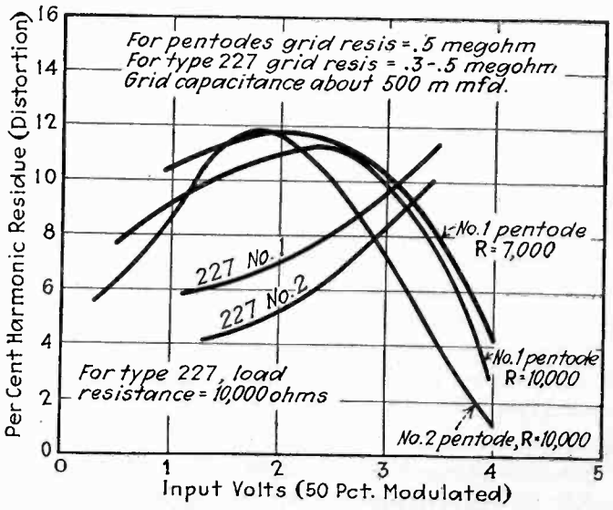

Fig. 2—Distortion characteristics for grid-circuit detection

[1] "Alkali Vapor Detector" Tubes, Bulletin No. 138, Univ. of Ill. Eng. Exp. Sta. *Radio Engineering*, January, 1932, p. 21.
[2] See paper by Stuart Ballantine; *Proc.* IRE., Vol. 17, July, 1929, p. 1153.
Also, paper by Termin and Morgan; *Proc.* IRE., Vol. 18, Dec., 1930, p. 2160.

tube under test. This modulated frequency input voltage is measured with a thermo voltmeter. The audio-frequency output potential is impressed upon the load resistance, $R_1 + R_2$, and the total output voltage is obtained from the output vacuum tube voltmeter and values of R_1 and R_2. The load resistance also connects to the grid of a special distortionless amplifier whose output feeds the Belfils bridge, the grid circuit of this amplifier adds no appreciable shunt admittance to the load resistance of the detector tube. After obtaining the total output voltage reading with the tube voltmeter the Belfils' bridge is balanced until the fundamental frequency of the output is completely balanced out, and there remains only the harmonic residue across the output terminals of the bridge. The calibrating oscillator operating at the frequency of the harmonics present across the bridge provides a means of quantitatively determining the effective value of the harmonic residue by comparison measurements. It is not within the scope of this paper to go into the methods of making measurements in detail. The process of obtaining total input and output voltages is fairly simple, but the process of determining the harmonic residue component entails more work.

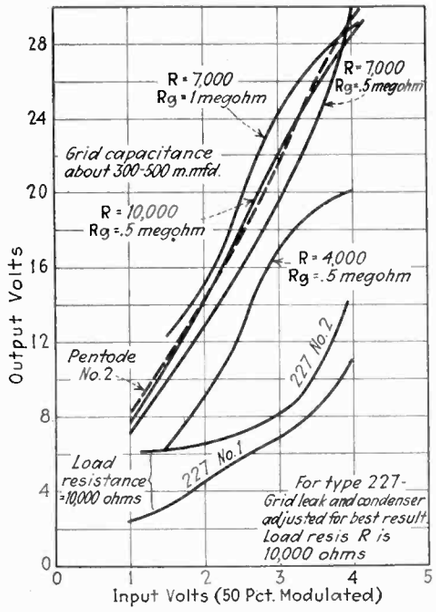

Fig. 3—Grid circuit voltage detection characteristic

With this apparatus the per cent of harmonic residue was determined for several pentode tubes, and for a few type 227 tubes for comparison. Figure 2 is a plot of the quantitative measurements. It will be noted that the pentode tubes seem to give a little more than allowable distortion for an effective value of the modulated frequency input potential of from two to two and a half volts. For three and a half volts the distortion is again lower, and at four volts input it seems to be remarkably low. A considerable amount of time was devoted to adjustments for best results, and it was found that the following factors are of importance:

1. Grid circuit detection, using the grid leak and condenser gave the best output and less distortion than did anode detection with a control grid bias.
2. The grid leak resistance became lower as the input voltage increased for lowest distortion, but this also reduced the detector output.
3. The supply potentials of the pentode plate and screen could be varied from the rated value of 250 volts down to about 180 volts without noticeable changes. Lowering the screen potential below 100 volts produced excessive distortion.

Figure 2 shows that a somewhat lower distortion is obtained by using a load resistance of some 10,000 ohms instead of 7,000, with the values of grid resistance and capacitance indicated on the graph sheet. The trend of the curves indicates that still lower values of distortion (percentage of harmonic residues) would be obtained if the detector input were raised above four volts. However, measured values of distortion above 4 volts input do not seem to be consistent, varying between 4 and 10 per cent. A technical paper on some problem such as the fidelity of tone or signal in a receiver device requires quantitative results to be convincing. However, many investigators are themselves not satisfied until they carry out the old-time procedure in obtaining the "proof of the pudding." Accordingly the authors provided a high-grade dynamic speaker with which they could listen alternately to the modulating potential tone and to the detector output tone and volume for comparison. This test gave assurance that excellent tone fidelity and good loudspeaker volume can be obtained from pentode detectors at one or two volts input as well as at three and a half or four volts. The subject of detector power and loudspeaker volume will be treated presently.

The voltage and power output values are of special interest. In Fig. 3 data are plotted to show how the output voltage of pentode detectors varies with the load resistance and grid resistance. These data were obtained for plate and screen potentials of 220 volts. Type 227 three-electrode detectors give output voltages which are between one-half and one-third as great as for pentodes. These curves would indicate that pentode detectors provided with about three and a half volts input would directly excite pentodes or the best high efficiency low-amplification high-power amplifiers in push-pull for the greatest possible degree of effective high-power undistorted power amplification.

Figure 4 indicates what pentode detectors will do as regards audio power output. While the values indicated are roughly 5 or 10 per cent of the output of a pentode power amplifier, these values really produce fair loudspeaker volume for small rooms. It is interesting

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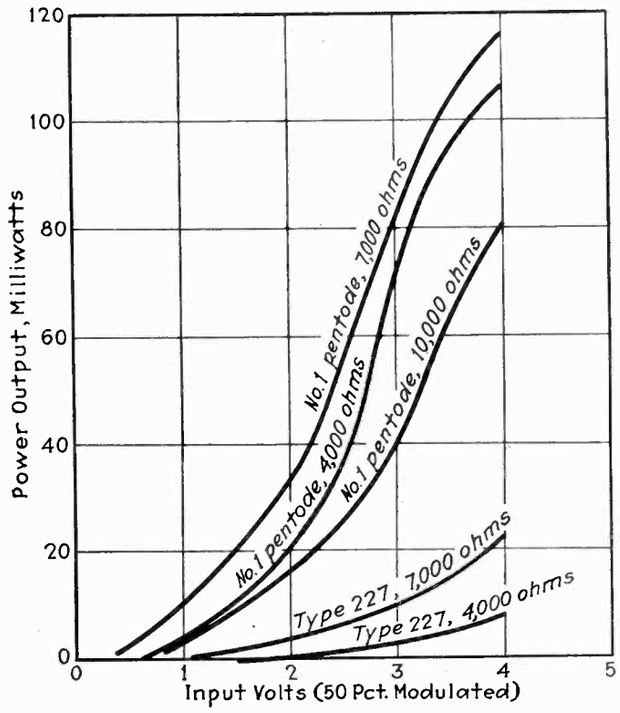


Fig. 4—Audio power output characteristics

Output amplifiers for 110-volt d.c. receivers

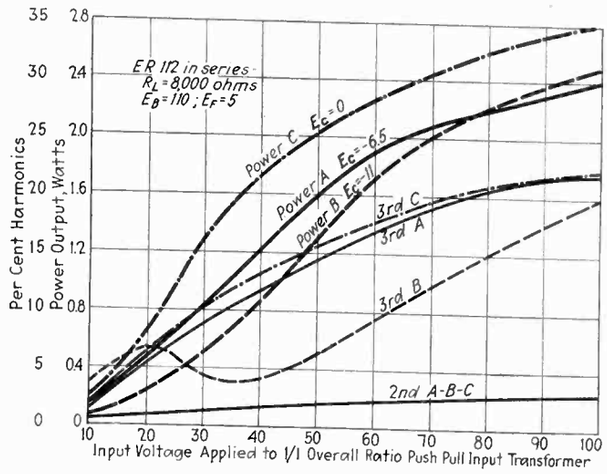


Fig. 1—Power output and distortion of 112-A tubes with various biases

By J. R. NELSON

Raytheon Production Corporation

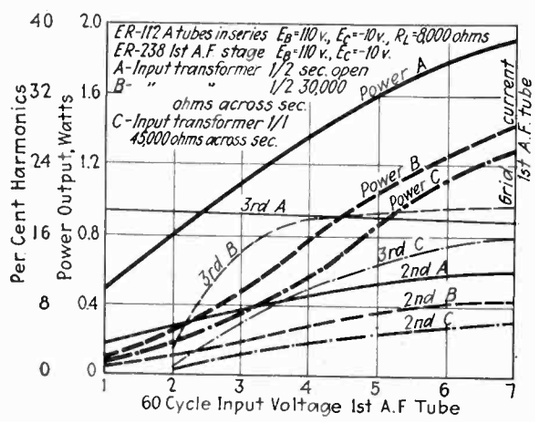
THE power output of d.c. receivers with a reasonable amount of distortion using about 110 volts supply has been somewhat limited, in comparison with a.c. receivers. Pentodes introduced comparatively recently have considerably greater efficiency at low voltages than triodes, but have considerable distortion in the output, usually. Recently a combination of power tube and driver in one envelope has been suggested as a means of getting greater power out of low plate voltages.

This paper will give the results of an experimental study of the output and distortion obtained using various tubes and combinations. The combination tested is approximately equivalent to that recommended for the new combination tube.

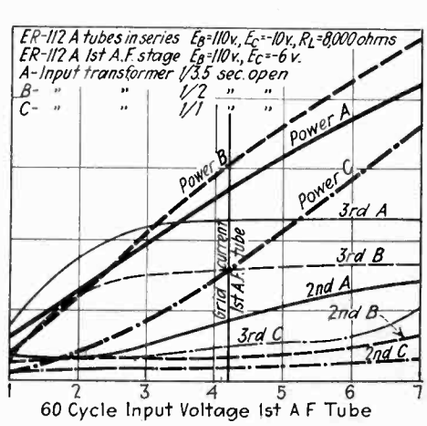
In Fig. 1 the grids of the 112-A tubes were fed from a generator through a push-pull input transformer having 1 to 1 overall turn ratio and 2500 ohms d.c. resistance in each half. Sufficient power was available at either 60 or 500 cycles to operate the tubes when drawing grid current so conditions are somewhat ideal. The value of 2500 ohms for half of the secondary although lower than most secondary resistances should be obtainable in a low ratio transformer. The results then indicate what should be obtained if sufficient power were available to operate the tubes when drawing appreciable grid current.

The curves of Fig. 1 marked A show the results obtained using two 112-A type tubes with approximately the normal push-pull or class A amplifier bias voltage. Curves C show the results when the bias voltage is reduced to zero while B shows the results when an 11-volt bias is used which is the push-push or class B amplifier bias. The distortion is rather high for any appreciable power output for the A or C conditions but much lower for the B conditions. The rise in third at lower power levels for curve B is caused by a slight over bias and a slight reduction of this bias voltage would cause the hump in the third to be reduced and the power output curve to rise so that the B conditions are apparently the best for the 112-A tube. Results obtained using two 171-A tubes in the same circuit show the hump in the curve for the third harmonic in the C curves caused by over-bias.

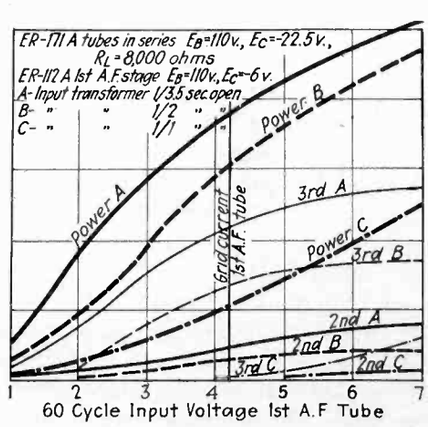
The next step was to obtain the curves through an intermediate audio stage. It was thought the 238-type of tube would be suitable for the intermediate stage with 110 volts B and —10 volts C as it would deliver the required power. Figure 2 shows the results obtained with 112-A output tubes using the 238 tube with a 60-cycle input voltage. Curves A show the results using a 1 to 2 (primary to total secondary ratio) transformer with the secondary open. The 238 should work into a definite impedance so that the secondary was shunted with 30,000 ohms total of 15,000 ohms per side (curve B). This resulted in some improvement but not enough. The distortion of the waveform was caused partially by the



(Fig. 2)

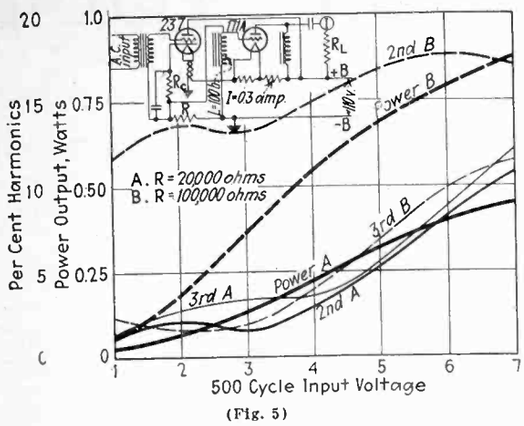


(Fig. 3)

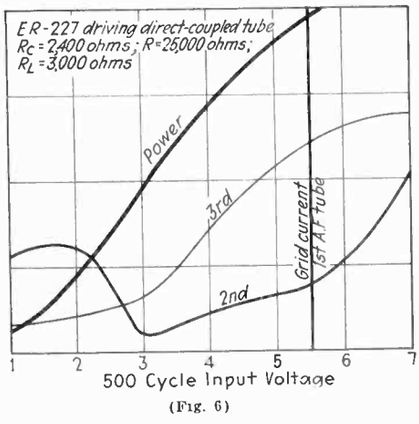


(Fig. 4)

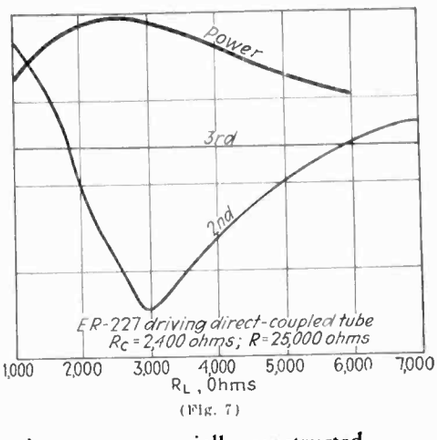
Effect of driving 112-A and 171-A tubes in push-pull by several first-stage amplifier tubes



(Fig. 5)



(Fig. 6)



(Fig. 7)

Direct-coupled circuits; in the first case standard tubes are used and in the two following cases a specially constructed direct-coupled tube was used

grid impedance when drawing current becoming comparable to the 15,000 ohm resistor. A 1 to 1 ratio overall was next tried with 7500 ohms from each grid to ground (curve C). This reduced the power output but improved the waveform considerably.

Results varied considerably with frequency due to the impedance transferred to the plate of the pentode varying with frequency. Using a 500-cycle source measurements show considerable variation from the 60-cycle run. When 171-A tubes with —10 volts bias were used with the two transformers shunted by 15,000 and 30,000 ohms total, variations between 60-cycle and 500-cycle curves were much less.

The results obtained with the 238 tube were not very satisfactory. Part of the distortion is caused by the 238 tube. As is well known, the distortion of the pentode varies considerably with load impedance and it is not practical in this case to keep the transferred load resistance constant as the frequency is varied. To obtain large output from triode output tubes, it is necessary to work the pentode first a.f. stage near maximum output and as a result considerable distortion will be introduced by the pentode stage.

Figure 3 shows the results obtained with 112-A tubes in series and a 112-A tube in the first stage. Power curves for conditions A and B are satisfactory but the distortion was rather high. The power curve for condition C is not as high as for A or B but the distortion is much less. It is to be noted that a reduction in turn ratio results in a large reduction in distortion as would be expected. A turn ratio between those shown for A and B or about 1 to $1\frac{1}{2}$ should result in fairly satisfactory output and distortion curves. This turn ratio would raise power curve C considerably and would give us about one watt of output with a reasonable amount of distortion. The curves using 500 cycles checked reasonably close to those given for 60 cycles so that they are not shown.

Using a 60-cycle input voltage on the 112-A first stage with 171-A tubes in series in the output give the same characteristics as 112-A tubes in both stages. The plate voltage on the 171-A tubes was 110 volts and the bias voltage was —10 volts.

Figure 4 shows effect of using a 112-A to drive a 171-A. The distortion for condition C is the most satisfactory obtained so far. It appears as if 171-A tubes in series using 110 volts B and —22.5 volts C coupled to the 112-A first audio stage by means of a 1 to $1\frac{1}{2}$ (primary to overall secondary) ratio transformer will give the best results of any combination studied so far. Somewhat improved results could possibly be obtained by the use of tubes having a somewhat higher amplification factor and mutual conductance than the 171-A type of tube and designed to have as low as grid voltage curve as possible.

Better results would probably be obtained under the conditions studied so far by the use of push-pull or push-push intermediate audio stage than with the single stage used in this experimental study. It requires power to operate the output stage and the power which the single first stage can deliver is limited using 110 volts B supply.

Direct-coupled circuits

Figure 5 shows a direct coupling similar to the one that has recently been proposed for use with a combination direct-coupled tube. This circuit differs somewhat from that employed in the combination tube as the bias on the tube in the input part of the combination may be made independent of the output part in the circuit as shown thus making it more flexible. The bias on the tube in the output part of the combination depends upon the plate current of the first tube, the d.c. resistance between B minus and the cathode of the first tube, and the voltage drop across the heater of the tube in the input of the combination. The cathode of the input tube is above ground by the audio frequency potential impressed on the output tube which is not a very desirable operating condition.

Several features of this combination circuit should be noted at this point. For example, it should be possible to balance out the even harmonics by having the harmonics introduced by the output tube balance out those introduced by the input tube. A study of tube characteristics with bias ranging from negative to positive values will show the theoretical possibilities of doing so, as the load resistance R_L is varied. It is beyond the scope of this paper to study this effect in detail but experimental proof of the balancing-out will be given later. Very little second is introduced by the output stage until an appreciable power is delivered. This means that the impedance of L and R in the input of the output tube should be adjusted so that the first tube causes very little second to be introduced. The load R_L should be chosen so that second harmonic caused by the output stage will about balance that introduced by the input stage. This makes the whole combination rather critical with respect to the load

[*Please turn to page 148*]

✦ ✦ ✦ ELECTRONIC TUBES

Sensitizing the wavemeter for intermediate frequencies

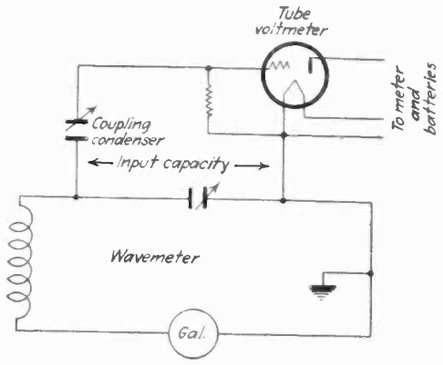
By Avery G. Richardson

Commercial wavemeters using thermo-galvanometer resonance indicators become decidely insensitive as the frequency to be measured drops below 100 kc. If closer coupling is resorted to, especially with low power oscillators, annoying frequency variations occur.

The use of a vacuum tube voltmeter as a resonance indicator permits very loose coupling and does not impair the wave meter accuracy if certain precautions are observed. The schematic circuit shows a grid leak type of voltmeter connected across the wavemeter condenser through a small coupling condenser.

The added capacity introduced by the tube voltmeter may be measured across its input terminals on a capacity bridge and set by means of the coupling condenser to a value corresponding to two or three scale divisions on the wavemeter. For example, if the wavemeter condenser constant is 0.6 $\mu\mu$f per scale division, the voltmeter input capacity would be adjusted to 1.8 $\mu\mu$f. Then, when the wavemeter is read, a correction of three scale divisions should be added to the reading before consulting the wavemeter calibration chart.

For easy use, and avoidance of stray



capacities, the voltmeter tube socket may be mounted on a twelve inch bakelite strip arranged to clamp on the wavemeter and make the proper contacts. The leads from the socket will thus be kept away from the wavemeter.

With the apparatus described it is possible to obtain wavemeter readings five to ten times farther from the oscillator than would otherwise be possible.

✦

Coal and Iron

Several articles of importance discussing the properties and preparation of coal and iron for use in the electronics industry have appeared recently. Notable are those in the *Bell Laboratories Record*, January and February 1932, by P. P. Cioffi and W. E. Orvis and that by T. D. Yensen of the Westinghouse Research Laboratories in *The Physical Review*, January, 1932.

As in other industries, coal and iron are indispensable in the radio field, a material better in many respects than permalloy (see *Electronics*, February 1932, for picture) is obtained by heating iron rods up to one-sixth inch thick, at 1,500 deg. C. in a stream of hydrogen, annealing it afterwards for 12 hours at 880 deg. C., and cooling it slowly to room temperature. The maximum permeability for such a rod is 180,000 against 10,000 for ordinary annealed iron, 167,000 for hypernik. The coercive force is 0.025 gauss and the hysteresis loss at 14,000 lines per sq.cm. is 190 ergs. per c.c. per cycle, one-third that of permalloy. The iron is nearly as soft as annealed copper once carbon, sulphur, phosphorous, oxygen and nitrogen have been removed. A few thousandths of a per cent of these impurities may have an enormous effect on the permeability, coercive force and hysteresis.

Carbon transmitters of a new type have been developed for operators' use and for coat-lapel microphones. The electrodes are the inner surfaces of two gold-plated brass cylinders immersed in the carbon. As the thin aluminum diaphragm is varnished and does not conduct, no frying noise is produced, because the voltage drop is not concentrated at the vibrating electrode in the case of strong motions.

The anthracite of which the greatest quantity is used in communication circuits is that for the handset transmitter.

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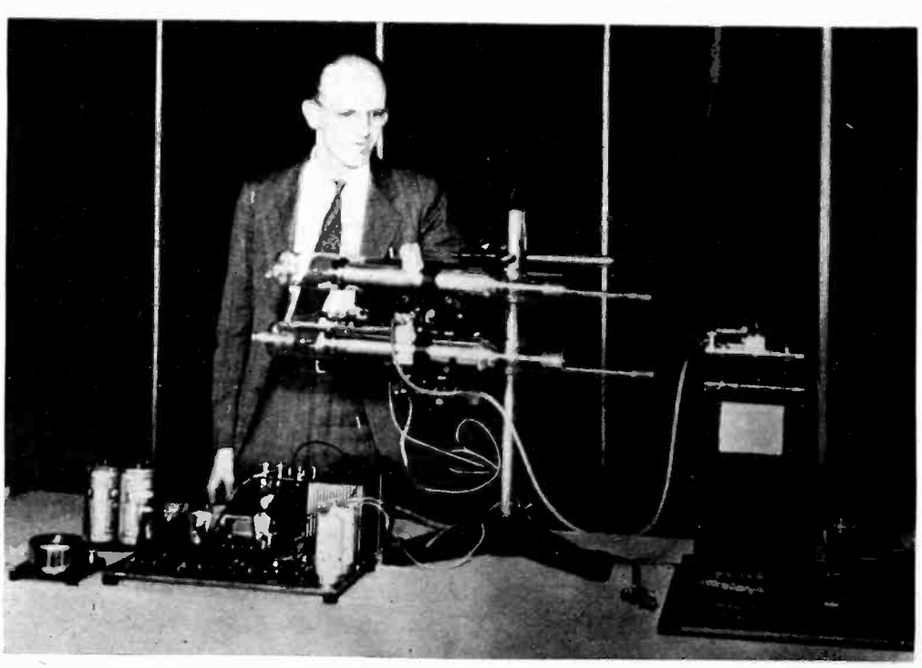
MAKES COSMIC RAYS TICK



Dr. G. L. Locher with his apparatus which makes audible the flow of cosmic rays from interstellar space

Existence of cosmic rays demonstrated

Scientists heard cosmic rays, silent messengers from the interstellar spaces, tick, during the annual meeting of the American Association for the Advancement of Science in New Orleans.

The cosmic rays bombard the earth from every direction, but the heaviest shower comes from directly overhead. With his apparatus, Dr. Locher of the Rice Institute captured the cosmic rays in an electrified gas compartment. As the rays plunged through the gas, they set in motion electrical impulses which were translated into clicks by means of a loudspeaker. Each individual ray makes its own click, and the succession came like the ticking of a clock. Scientists claim that the cosmic ray, although known to be more powerful than the ray coming from radium, passes through the human body day and night, but nobody knows to just what effect.

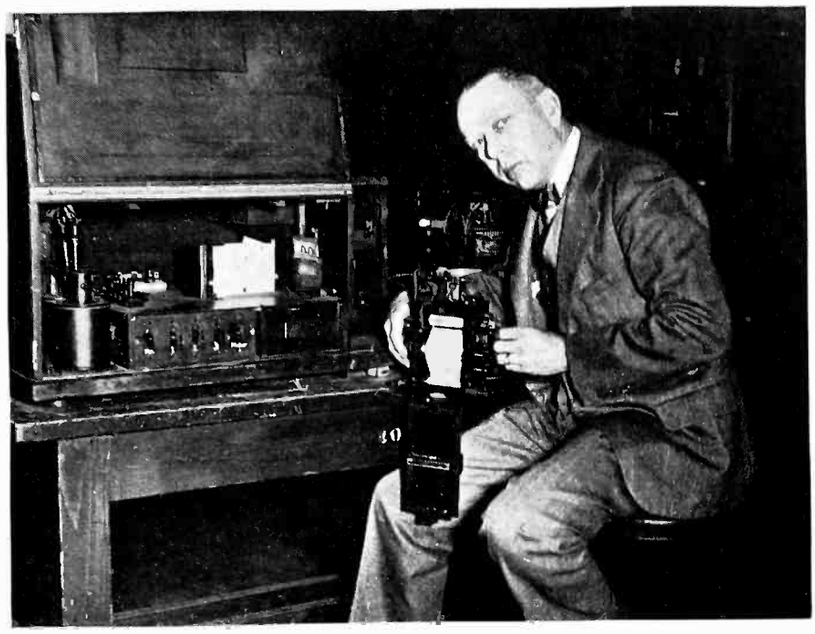
Dr. Locher's equipment furnishes audible evidence of the presence of cosmic rays.

IN THE LABORATORY

New camera operating mechanism

A NEW MECHANISM intended primarily to photograph the rapidly moving electric waves in high voltage, high power transmission lines has been patented by Professor H. C. Dyche, head of the Electrical Engineering Department of the University of Pittsburgh.

This camera, attached to an oscillograph, has automatic means for opening and closing the shutter, and starting and stopping a continuous film. These special devices make it possible to obtain a positive exposure of the phenomenon under consideration, which could not be done heretofore. An interesting feature of this patent is the automatic control of continuous film which adapts it to the moving picture camera. With this device, a moving picture camera may be set up in the wilds to expose automatically, a predetermined length of film in the study of wild animals, birds, etc., without the presence of an operator.



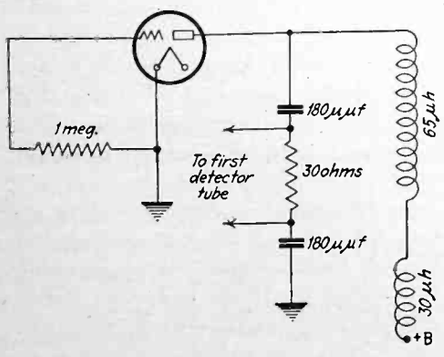
Professor Dyche with the oscillograph attached to the electrical wave camera for use on high voltage transmission circuits

✦

Polydoroff cores for superheterodynes

REPORTS INDICATE THAT considerable progress has been made toward the adaptation of iron cores (developed by Polydoroff) to radio receiver circuits. One of the most useful places where such coils could be applied, according to several radio set engineers, would be either in a pre-selector stage for a superheterodyne or as an oscillator. Because of the characteristics of the coils, whose inductance is varied by moving in or out the cores of "polyiron," an oscillator of constant output is possible, and a selector of constant gain over the broadcast band could easily be made.

The circuit gives constants of an oscillator and is furnished through the courtesy of Ralph Langley. Using the constants given the output would vary not more than about 15 per cent over the desired band. The value of 65 μh. is the inductance of the plate coil without the iron core. This value increases, of course, with introduction of the core, and thus tunes the oscillator over the broadcast, or other spectrum.



At a recent meeting of the Radio Club of America data were given on the constants of coils using Polyiron. The best "Q" at 500 kc. is about 200 making possible a very selective circuit. Such an inductance would require about 16 times smaller cubic space than an equivalent air-core coil.

✦

Notes on constant temperature work

IN AN ATTRACTIVE bulletin describing the American Instrument Company mercury relay which operates on 4 milliamperes at 3 volts and controls 1,000 watts is found the following statement regarding constant temperature work.

"One of the most prolific sources of error is the custom of using much more heat than is needed and attempting to compensate this condition by reducing the time during which the heat is applied. Thus if 200 watts steady input are required to maintain a given temperature, the same total energy input may be obtained by using 400 watts half the time or 800 watts one quarter of the time. Any one of these arrangements will maintain *approximately* constant temperature but the variation of the temperature will be greater in the last case than in the first."

A better arrangement would be one that applies less heat but over longer periods approaching that condition in which heat is applied at the same rate that it is lost.

✦

Wet versus dry electrolytic condensers

IN RESPONSE TO A letter inquiring his opinion on the relative merits of dry and wet electrolytic condensers, an engineer who has much experience with these types of concentrated capacity has the following to say:

"I have seen condensers on test in manufacturers' inspection departments that had been on test over two years. These condensers were of the dry type and were operating at a temperature of 20 or 30 degrees F. in excess of the temperature normally encountered in radio sets and in an atmosphere in which the relative humidity was very low. The power factors of these condensers had changed slightly, but the capacities had not changed to a great extent. Leakage current had decreased in each case.

"I believe that in a well constructed dry condenser in which too great an effort is not made to conserve space at the expense of absorbed electrolyte, the probable life would be well over two years.

"The above presupposes that the condenser is of satisfactory design and does not follow the general practice of two or three years ago in connection with semi-dry condensers."

A thyratron voltage regulator

By CLARENCE E. WEINLAND
Physicist, J. M. Research Laboratories

THE thyratron has opened up many new fields of engineering development, but there is at least one old field to which it has brought possibilities previously undreamed of. The field referred to is that of voltage regulation, and is of course closely associated with the regulation of many other quantities. The enormously high power control ratio and power output of the thyratron as compared with previous devices have rendered possible the performance of this function with a delicate, yet forceful touch, coupled with speed and economy of operation.

In the present application, a thyratron voltage regulator has been successfully applied to a 12.5 kva. 60 cycle 220-volt alternator, supplying power to a laboratory for precise thermal conductivity testing. The requirements were twofold: the action of the regulator had to be fast enough that voltmeters and wattmeters could be easily read to ½ per cent without the operator having to judge the mean point of wide fluctuations of the needle, and at the same time the voltage had to be stable over periods of 48 hours or longer in order that tests might attain complete thermal equilibrium.

In one of the early papers describing the thyratron, Hull[1] outlined a method of voltage control, and showed voltage curves for two experimental circuits. The regulator to be described is built along similar lines, though with several modifications. A more extended description has recently been published elsewhere.[2]

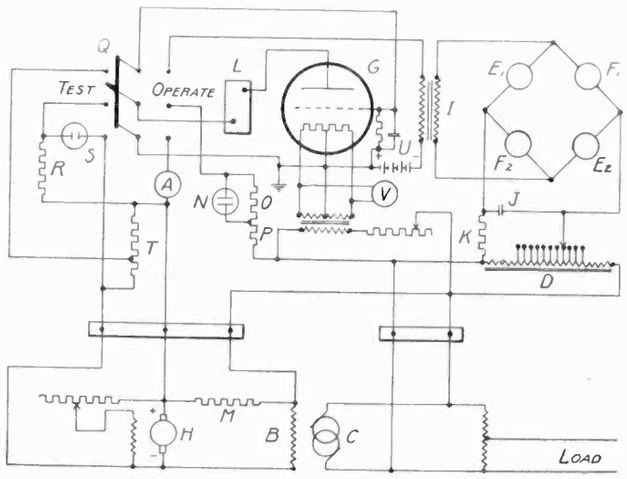


Fig. 1—Circuit diagram for regulator and alternator

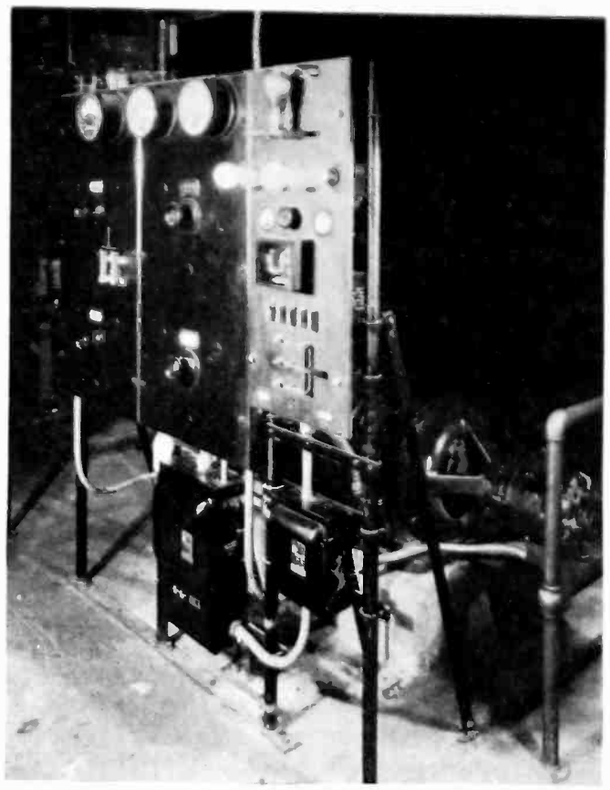


Fig. 2—Motor generator set with regulator panel in actual service

The circuit was designed around the General Electric Company's FG-27 thyratron. This tube is of the hot cathode, mercury vapor type, and is capable of delivering 2.5 average amperes of rectified plate current. Connected as a half wave rectifier, no current is delivered during negative half cycles of plate voltage. During positive half cycles when operation of the tube is required in order to correct the alternator voltage, an alternating potential of the same frequency and phase as the plate voltage is applied to the grid through the biasing battery. The peaks of the grid voltage curve are thereby made to intersect the operating curve causing the thyratron to pass current for the remaining quarter of any such cycle. There results an intermittent type of operation, the tube passing current during groups of cycles, each group consisting of one or more cycles, and such groups occurring as often as required. When, however, the lengths of the groups has increased and intervals between the groups has shortened to such a point that operation takes place every cycle, further increase in output is still possible, due to the fact that further increases in height of the grid voltage peaks results in the initiation of operation earlier in each cycle. This is of course a variation of the "magnitude" method of controlling the thyratron, but does not seem to have been clearly recognized before as a definite mode of operation of the tube.

Figure 1 is a circuit diagram for the regulator and alternator. The voltage developed in the armature of the generator *C* is desired to be controlled, so it is im-

[1]Hull, General Electric Review, Vol. 32, p. 390-99; 1929.
[2]Weinland, Review of Scientific Instruments, Vol. 3, p. 9-19; 1932.

pressed through the autotransformer D and the phase correcting resistance and condenser K and J upon the voltage sensitive bridge circuit E-F. E_1 and E_2 are carbon filament lamps having a negative temperature coefficient of resistance and consequently a negative non-ohmic resistance characteristic with changing voltage, while the behavior of the opposite arms of the bridge, which consist of ordinary Mazda lamps is just the opposite. Consequently for any given set of lamps there is only one value of voltage at which the bridge will be balanced, while at any value above or below this point the unbalance of the bridge will be a function of the direction and magnitude of the deviation of the voltage from normal. The output of the bridge is put through an ordinary audio transformer I in order to insulate the voltage sensitive bridge from the grid circuit, and is then impressed upon the grid of the tube, a 0.1 megohm leak and a grid condenser being provided for stability. Grid return is through the biasing battery U. Plate voltage is applied through the resistors O and P and the time delay relay L to the thyratron G, and the circuit through the filament is completed through the ammeter A and the fixed resistance M back to the 220 volt supply. The resistor M is likewise in the field circuit of the generator, H being the exciter armature and B the generator field winding. The current from the thyratron during periods of operation passes through the resistor M in the same direction as the field current of the generator and in so doing builds up the voltage drop across the resistor, reducing the field current through the generator and consequently reducing the voltage developed in C. Since the field rheostat of the exciter H is so set that if the thyratron did not operate the voltage developed would be too high, intermittent operation of the thyratron is required in order to keep the voltage bucked down to the proper point.

Since in some cases the failure of a thyratron can be predicted from a knowledge of the voltage drop across it, a testing circuit was incorporated into the regulator. When the switch Q is thrown to the "test" position, the plate of the thyratron is disconnected from the 220-volt a.c. and connected instead to plus 125 volts d.c. through the resistor R, while the grid of the tube is made positive by connection to the tapped resistor T. A voltmeter plugged into the receptacle S will then read the voltage drop from plate to filament of the tube, and when this voltage is found to be rising rapidly at successive readings the indication is that the end of the life of the tube is near.

A voltmeter V has been provided for the filament of the tube, but is really unnecessary, for after completion of adjustments of the circuit the regulated voltage applied to the primary of the filament transformer has required almost no adjustment of the filament rheostat.

The FG-27 thyratron is limited to a peak current output of 10 amperes. The calculation of the necessary series resistance for the plate circuit seemed quite hopeless in view of the lack of exact knowledge of the wave form of the pulsating current involved. An indicator was developed, however, consisting of a neon lamp N shunted around the resistor O. The ignition voltage of the neon lamp was found to be very close to 75 volts, so with a resistance of 7.5 ohms at O any flashing of the neon lamp would immediately indicate that the 10 ampere limit on peak of plate current was being exceeded. With the help of this indicator the resistance P was adjusted until the neon lamp was found to be dark under all conditions of operation of the generator and regulator.

The output of the generator may be held at any desired point within wide limits by merely varying the connection to the taps of the autotransformer D. With 120-watt carbon lamps at E_1 and E_2 and 75-watt Mazdas at F_1 and F_2 the bridge balances at about 98 volts, so the taps were provided on the autotransformer one volt apart in the neighborhood of 100 volts.

The rate of operation and the output current of the regulator may be varied by changing the variable resistance in the field circuit of the exciter H. By thus decreasing the voltage of the exciter the regulator is gradually relieved of the necessity of bucking the voltage down to the desired level, while increasing the exciter voltage requires the regulator to increase its output. The output of the regulator may thus be adjusted whenever desired, a value somewhere between 0 and 1.2 amperes being the range of intermittent operation of the tube, and being the range in which the greatest voltage stability has been found.

The regulator output ammeter A should be of the moving coil type, giving true average d.c. readings. For if, for instance, a dynamometer type of instrument be employed, its readings will be greatly in error, as may be seen from consideration of the form factor of the current impulses which endure only about one fourth cycle each.

In many applications of thyratrons it is necessary to use a full wave circuit. In the present case, however, the output of the thyratron is shunted by a pure resistance, so no difficulties were encountered from reactive effects. The decreased cost of maintenance and the elimination of difficulties due to unsymmetrical operation of unmatched tubes were considered quite advantageous.

By simply reversing the connections the regulator might be used as a "booster" with the exciter set to maintain too low a voltage. The principal advantage of the

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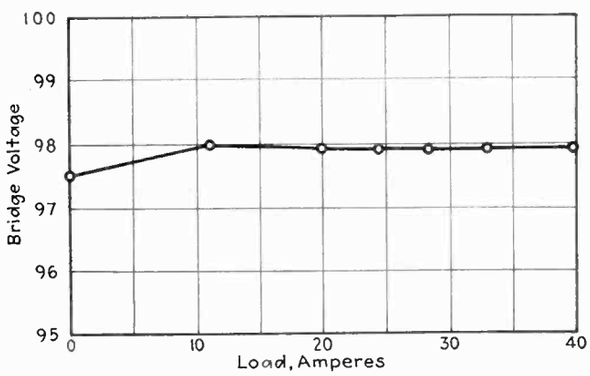


Fig. 3—Variation of output voltage with load

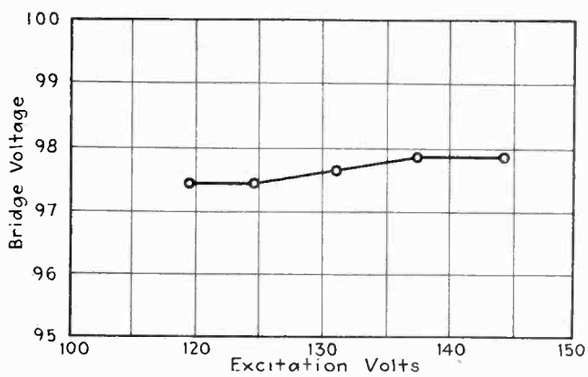


Fig. 4—Variation of output voltage with excitation

HIGH LIGHTS ON ELECTRONIC

Photocell camera guards laboratory

W. L. ENFIELD, manager of the Nela Park lamp development laboratory, Cleveland, Ohio, desired to discover the identity of some visitors who insisted on intruding into one of his laboratories, despite a "No Admittance" sign.

Accordingly he fitted up a phototube unit to operate a camera and a flash-light circuit, in this way automatically taking photographs of any unexpected visitor. Developing these and showing the likenesses to their self-identified originals, has effectively stopped the intrusions. By adding a special chemical to the material inside the bulb, the lamps were made to explode with a deafening roar when flashed, thus adding to the terrors of the electric-eye burglar alarm.

✦

Electronic soundings give ship's location despite fog

ELECTRONIC ECHO DEVICES now make it possible for ships' captains to make continuous soundings of the depth of water beneath their vessels. This new application thus permits the ocean floor itself to be used to enable the navigator to identify his position at any moment.

The ocean bottom will be used first in this way over Georges Bank, which lies off the New England coast, with the issuing by the U. S. Coast and Geodetic Survey of a new chart describing the floor of the ocean in this region.

Instead of "shooting the stars" to keep their ships on a true course, captains of transatlantic liners during the most dangerous parts of their voyage will compare readings of their echo depth-finder with a map of the bottom of the sea. So well does the map describe the hills and valleys beneath the water and so accurately can the depth-finder report their size that the navigator will be able to determine his position by speedy soundings and so keep on the right course.

With this method of navigating, the frequent fogs over Georges Bank will no longer make dangerous the many hills on the ocean bottom that rise close enough to the surface to ground ships.

The new chart is the result of surveys of the past two summers which have covered two-thirds of the 30,000-square-mile submerged continental shelf. Work on the chart was speeded up following insistent requests from shipping men. The Coast and Geodetic Survey expects to complete the survey next year.

A large submarine valley, longer and deeper than Corsair Gorge discovered during 1930, was found by surveys of the past summer and is shown on the chart. The new valley, which has not been named, cuts back into the southern edge of the Bank about eleven miles and is roughly two and a half miles wide and 2,000 feet deep. The tops of its ridges are only 600 feet below the surface of the ocean, while at its mouth on the edge of the shelf the depth drops abruptly to 6,000 feet.

The oscillator sounds, as they are echoed back from ocean bottom to microphone on ship's hull

✦

Ultraviolet stimulates egg production

A 70 PER CENT INCREASE in egg production by a flock of 180 chickens treated two hours daily with ultraviolet rays, is reported following a test on the Case and Elling Farm, at Concordia, Missouri.

A flock of pullets was divided into groups of 180 each and housed in a two-section Jamesway hen house, insulated but unheated. Each group received the same food and ventilation. Egg production was checked from November 1 to January 1 and was found the same for each flock. Beginning January 1, Group A was treated with ultraviolet radiation by means of two standard sunlamps suspended four feet above the feeder. These were automatically turned on at 5:30 a.m. and off at 7:30 a.m. Sufficient illumination was provided Group B so that each flock would be off the roosts at the same time.

After a month's test, the untreated group had gained 13 per cent over normal production and the treated flock gained 92 per cent. The increase for the former group and 13 per cent for the treated group was ascribed to extreme mild weather conditions. With full allowance for the unseasonable conditions, the treated group showed a 70 per cent increase as a result of ultraviolet treatment. Group A showed an egg production of 2150, while the untreated class gave 1263 eggs for the month.

✦

"Silent House" conquers city noise

BY DR. E. E. FREE

A "SILENT HOUSE," almost noiseless to its inhabitants even amid the city din of London, is one of the exhibits, erected by A. Trystan Edwards, at the recent Building Trades Exhibition held in the British metropolis. The walls of this model house were built of various sound-proof materials now available. Floors and ceilings were deadened similarly.

Floor coverings are of rubber, designed to soften the noise of footfalls inside the house. Windows have been so constructed that they cannot rattle, and the glass panes, window frames and other parts of the structure have been stiffened and otherwise designed to keep outside noise from entering, (noise experts having discovered that most of the noise that gets into the ordinary house comes in through the windows even when these are closed). Ventilation is provided through ducts which also have been noise-proofed, so that sounds cannot enter although there is free passage for the air. Doors of the "silent house" are provided with anti-slam devices so that little or no noise is produced even when a door is closed violently. Creaking floor boards, noisy stair treads and even chairs, beds or other furniture that squeaks or creaks when used, all are banished. Such a "silent house" now may be built anywhere, acoustic engineers maintain, at a cost no greater than for ordinary good construction.

DEVICES IN INDUSTRY ✦ ✦

Automatic control of airport lighting on runways

By Robert A. Holmes

Many airports of small size have rotary beacons and floodlighting installations, but because of the great expense in operating these, the management does not provide an attendant to be on watch at all hours to operate the necessary equipment.

With the aid of electronic devices, however the operation of flood-lighting and boundary lighting becomes automatic.

By placing a specially designed cell at an advantageous point, such as the top of the rotary beacon tower to provide height, an approaching plane equipped with landing lights of approximately one million candle power, will cast a beam of light upon the photocell, automatically causing a relay to operate a switch which closes the feeder supply line to the flood-lighting and other equipment necessary for landing.

The photolytic cell used for this service is designed to admit light from almost any angle of approach. It is weather-proof and shock-proof. The intensity required to operate such a cell is about ten-foot candles at the lens of the cell.

Of course the cost of operation of such a system is very small and it eliminates running the equipment for long periods of time when there is no aircraft in the vicinity.

A patent for this service has been applied for by the author in the name of the Arcturus Radio Tube Company, Newark, N. J.

✦

Photocell watches for earthquakes, gives alarm

To the "electric eye" has now been assigned the new task of watching for earthquakes according to *Science News Letter*. At the Canisius College Seismic Observatory in Buffalo, N. Y., Rev. John P. Delaney, professor of physics has attached a photocell to the recording mechanism of his Galitzin seismograph. The function of the cell is to keep continual watch on the galvanometer light beam, and to send a warning signal to the observatory office whenever the light beam moves under the influence of an earthquake that is being recorded.

Ordinarily the seismologist discovers his earthquakes only after the development of the seismograph record. The record is usually brought from the underground instrument vault only once in 24 hours, a fact which explains the paradox that even serious quakes often escape the notice of the vigilant seismologist for many hours, and even a day, after their occurrence. The new photocell attachment brings to the seismologist the assurance of immediate warning whenever a serious quake is recorded.

A similar photocell attachment could serve in earthquake regions to set in motion any number of auxiliary instruments, such as accelerometers, and also to set in motion any available safety devices or alarm signals.

✦

Scales weigh automatically with help of the electric eye

N. Ryan Company, Inc., of Brooklyn, N. Y., manufacturers of ready-mixed concrete, use the scales shown in the accompanying photograph for automatically weighing the proper amount of sand and cement before this material goes into the mixer.

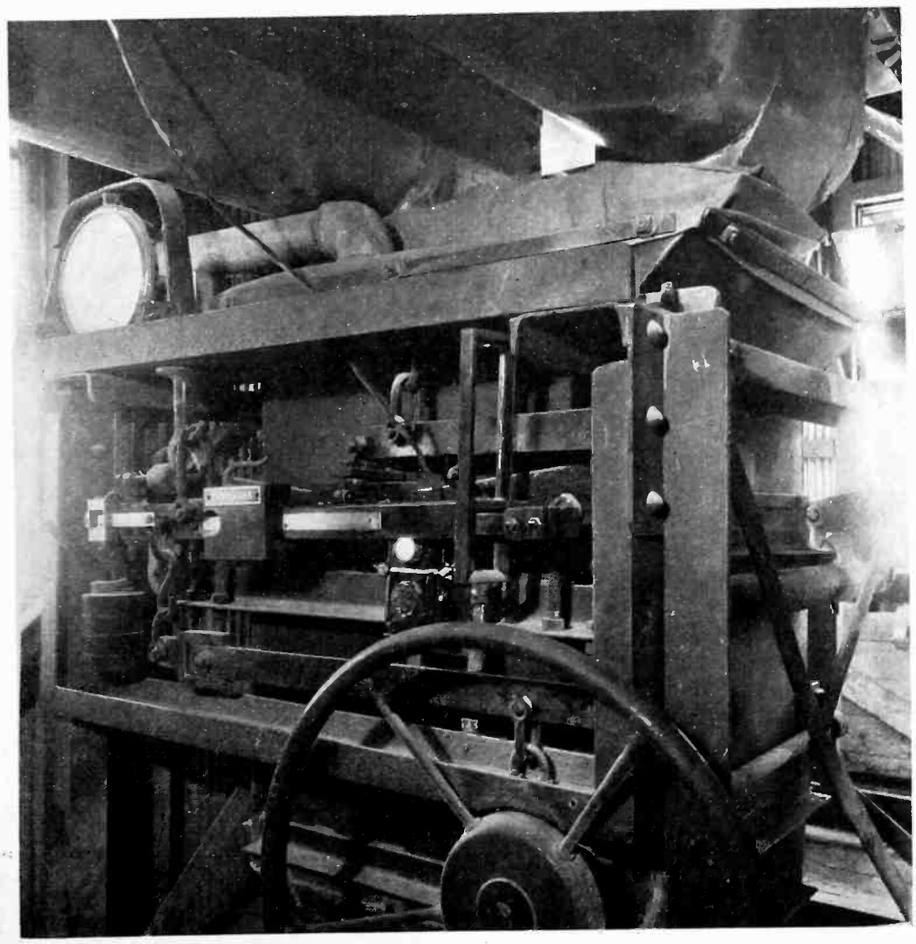
The scale beam is set for the weight desired by means of a poise. A light source is set directly back of the beam and the photoelectric relay is mounted six feet in front of it. Cement is fed into the hopper and, when the proper weight is reached, the beam rises, exposing the light source and energizing the photoelectric relay. This causes the opening of a control circuit to the cement feed motor and automatically shuts off the supply.

✦

Electric eye to detect counterfeits

An electronic device in the Westinghouse Research Laboratories can be used to show whether a "doubtful" stock certificate is printed on the same grade of paper as a certificate which is known to be good, and indicates therefore it is probably not counterfeit.

The method is based on a scientific analysis of the thinness of paper. The stock in this case is the same as that used in a certificate which is known to be good. Almost invariably imitations are printed on a slightly different stock and thus they are quickly branded as false by the photocell meter.



Behind the scale beam is a General Electric photocell unit which signals when the scale is deflected, and shuts off supply of cement

electronics

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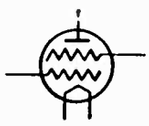


Patents, past and present

ON THE COVER of this issue of *Electronics* will be found a chart giving, in seventeen-year periods, the status of a few patents of importance to the radio industry. Of the thousands which have been applied for and issued applicable to the radio receiving circuits, these, among others, have stood the test of time as having contributed definite advances to the art. Some of them have gone through the additional ordeal of review by legal tribunals. A few have been weighed by the Supreme Court.

The chart gives the patentee, a brief title, the number as assigned by the Patent Office, and the period of time during which the patent was, or has been, in force. Some of the patents on inventions on which the art is built have expired; others have a number of years of life left. All are important.

"Every radio listener is entitled to good reception"

REALIZING that millions of radio sets now in use *badly need* overhauling, re-installation, tube renewals, and even replacement with modern receivers in many cases,—the editors of *Electronics* and its associated trade organ *Radio Retailing* have secured the cooperation of the broadcasters in a nationwide campaign to get the public

(1) to demand high standards of radio reception, and
(2) to call in the nearest radio dealer to put sets in first-class operating condition this Spring, in preparation for the coming political conventions.

From the broadcasters' point of view this rehabilitation work will add many thousands of "circulation" for the broadcasting programs.

For the radio industry, it will mean:

a. Employment of service men, increase of profitable "servicing" business, increase of dealers' volume, and new contacts for set sales.
b. Sale of tubes, condensers, resistors, rheostats, coils, antennas, etc. as well as sales of many new sets.
c. Appreciation of tone quality in radio, and recognition of the value of the new sets with their improved tone fidelity.

During April, broadcasting stations all over the nation will cooperate with short 20-word announcements, several times daily: "If your radio set is giving trouble, see your nearest radio dealer."

Every man anywhere in the radio industry can benefit from this campaign to better the radio reception of the individual radio listener. Every reader of *Electronics* should be interested in pushing this effort, which will result in greater popularity of radio with the public, and increased sales of sets, parts, and tubes, for the industry.

Should radio receivers be fused?

ECONOMIC reasons rather than technical have dictated to many radio manufacturers against their better judgment that home receivers shall not be fused. At the same time price competition has forced the use of components with low factors of safety.

Thus for the price of a few cents the public—and who supports the radio industry, anyway?—purchases a potential fire hazard, or at least a box of parts costly (to the consumer!) to replace.

Introduction of mercury vapor rectifiers to the home receiver market will bring into the open, the question if sets shall be fused or not. Terrific currents will be drawn by the power transformer if something in the secondary circuit shorts because of the high current capacity of this rectifier. Even today replacements of the transformer seems all too prevalent. A survey by *Radio Retailing* shows that roughly a half million power transformers and a quarter million filter chokes were replaced by service men in the year 1930.

Fuses would have saved the owners of these sets much money, not to mention the inestimable asset of good will.

Engineering versus "Ballyhoo"

RADIO engineering is a profession and its future greatness is dependent on every individual radio engineer. Each one owes to himself and his fellow engineers the duty of making this a highly respected profession by holding to high standards and technically sound principles in his own work.

Unfortunately, the radio industry is beset by "ballyhoo"; that is, the use of designs, circuits, etc., which will make "talking points" and "startling announcements," regardless of the technical soundness and fundamental engineering value of the device or principle in question. Naturally, the engineer must design the sort of product that his sales department wants, but, at the same time, he can exert his influence toward good engineering when there is a choice between that and "something new" which may be technically undesirable.

It seems unfortunate that many recent circuits and devices have been literally "ballyhoo-ed" into existence, whereas if the engineer had been able to follow his own judgment they would not have come into use.

Wills, contracts and electronic legal records

WHEN Eddie Cantor signed the contract covering his present trip to Hollywood, the record of this agreement was made in the form of a sound-track recording, on standard film, of the voices of the contracting parties. Lawyers on both sides agreed that such a sound-track document would have all the authority of an ordinary written legal document.

Sound-film wills and last-testaments have also been proposed. They would certainly have the advantage that the testator might read his will in person, with the witnesses pictured standing in the background, and the testator's own inflections might later assist the court in interpreting questions of intent.

With home talkies, talking books, and other electronic records being rapidly developed both here and abroad, it is possible that every lawyer's office of the future may be equipped with a sound-picture camera, just as every modern doctor's and dentist's office has an X-ray machine.

Another step in television technique

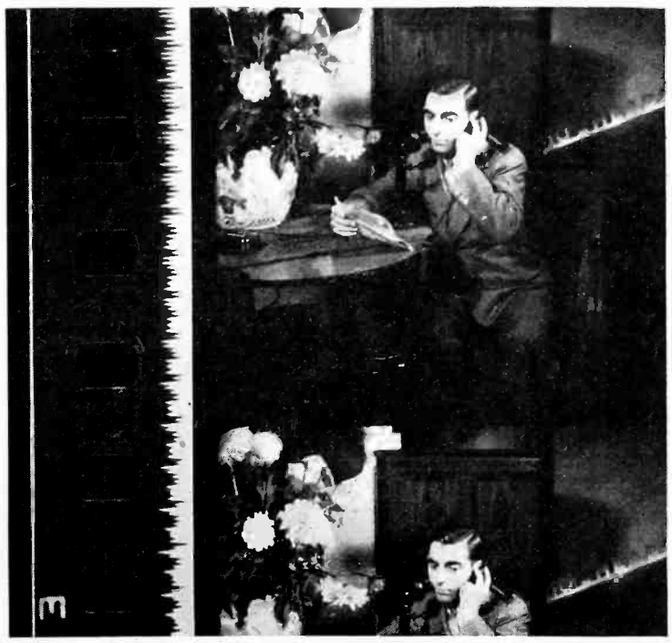
SO few have been the recent radical developments in television, despite the enormous number of inventors working on the problem, that special interest attaches to the announcement by the motion-picture and television pioneer, C. Francis Jenkins, of Washington, D. C., of a new type of television projector.

In Mr. Jenkins' new laboratory device the transparent scanning disk, instead of being vertical, lies flat, and immediately beneath its wire spokes, which end where the usual metal disk would have pinholes, there is a glass plate containing a thin film of an acid. The wires and acid are subject to voltage controlled by in-coming television signals.

A high voltage will cause sparks to jump from the ends of the wires to the acid. At low voltages there will be no spark. Each spark decomposes the acid and forms an air bubble in it. The bubble causes a dark spot to appear on the screen, but it quickly rises to the surface and breaks before another and slightly different image is formed in about one fifteenth of a second.

"The projected picture on the screen is, therefore," Mr. Jenkins explains, "exactly like the usual lantern-slide picture except that it has motion; or like a motion picture except that it is made up of changing picture elements instead of changing picture frames on a film."

THE "DOTTED LINE" — 1932 STYLE



Enlarged section of the "signature" of Eddie Cantor on his sound-film contract with Hollywood studios

The march of the electronic arts

N B C and others made defendants in U. S. suit

On March 7, the Attorney-General filed with the District Court at Wilmington, Delaware, a supplemental petition in the case brought against the Radio Corporation of America and its associates.

The new pleading alleges additional facts relating to certain activities of the defendants in foreign trade and international communications, charging them with attempts to restrain commerce between the United States and foreign countries, as well as domestic commerce. Three new defendants are added because of these allegations, viz:—International General Electric Company, Westinghouse Electric International Company and RCA Communications, Inc. The National Broadcasting Company is also added as a party defendant. It is owned by the other defendants.

The RCA reply

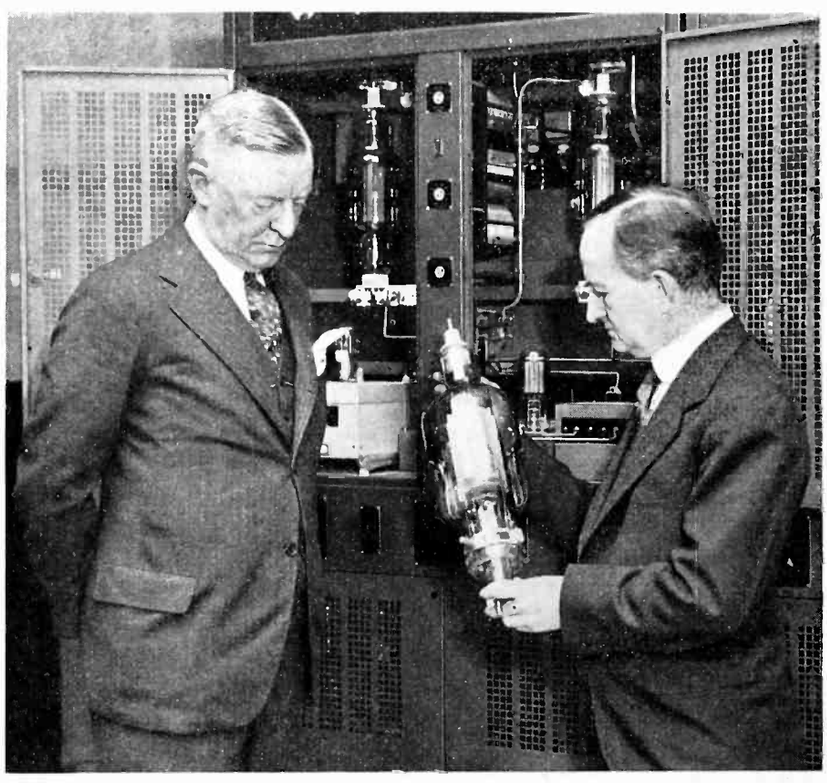
In a statement reviewing the steps already taken to accede to the government's demands, the Radio Corporation comments:

"In view of all these circumstances we are unable to understand the action of the department in persisting in doing unnecessary things and making unnecessary charges, particularly in times of great business depression and even when there is and long has been great competition—more than adequate from every point of view—in the radio industry. The department's demand for additional competition came when there were so many competitors in the field that overproduction and cut-throat competition threatened the entire industry. This is even more true today, when surveys show that there now exist in the country radio plants with a capacity of approximately 25,000,000 radio sets per year, while the market is estimated at approximately 3,000,000 sets per year; when prices for merchandise are lowest in the history of the industry, and when few, if any, companies engaged in the manufacture and sale of radio devices are able to earn a profit on their business.

"The Radio Corporation of America and its associated companies, defendants in this case, together are doing less than 20 per cent of the total business in radio receiving sets and less than 40 per cent of the total business in radio tubes. It could hardly be contended that a monopoly is thereby threatened or that trade is thereby restrained."

✦ ✦ ✦

NEW YORK'S POLICE SHORT-WAVE SYSTEM



Commissioner Mulrooney, head of the New York City police department, inspecting transmitting tube for the new short-wave system, held by Thomas W. Rochester, superintendent of police telegraphs

Leon Theremin demonstrates new inventions

SEVERAL NEW musical instruments were presented by Leon Theremin, along with his Electronic Symphony Orchestra, at Carnegie Hall, New York City, April 1. Out of his space-controlled "theremin" of familiar form, he has developed a Musical Dance Stage. Not only the movement of the hands, but the movement of the body as well effects the musical output of this instrument. The sensitive electrode in this case is the platform of the dance stage, and a variety of postures can be made to produce any given pitch.

A definite relation between light and sound was established through another device which makes geometric patterns do optical tricks to the accompaniment of musical sounds. The apparatus consists of a U-shaped neon tube, excited periodically by currents arising in the space-controlled thermin, and a large rapidly rotating disk upon which the designs are painted.

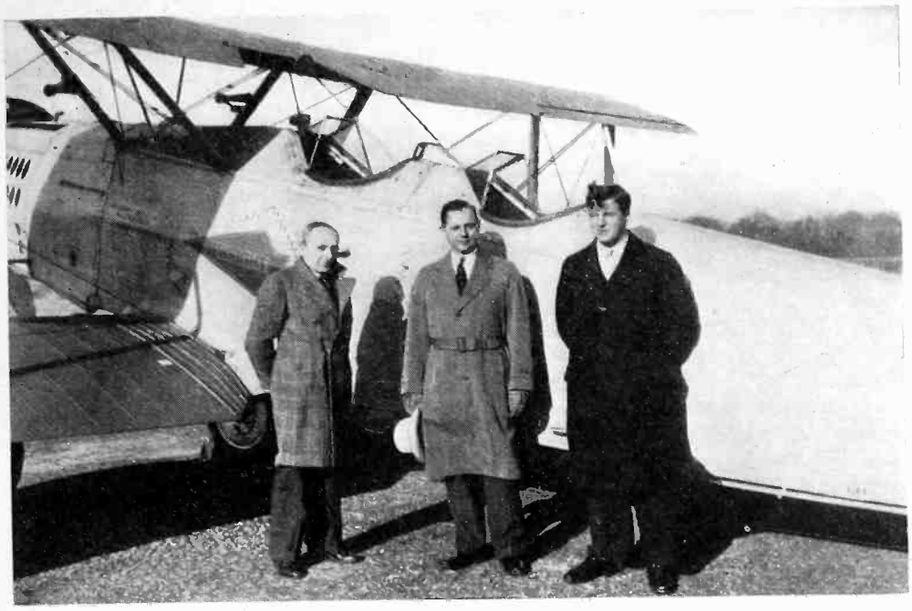
Another new development, the Rhythmicon, while not classed as a musical instrument, plays tones in any desired combination of rhythms from one to sixteen. Operating on a photo-electric principle and manipulated from a sixteen-digital keyboard, its successive notes are each assigned a tone from the harmonic series of the "chord of nature" and a repeating action corresponding in rhythmic beats to the number in the series. Thus a 5 to 4 rhythm, in addition to marking out the time, will sound a major third, a 3 to 2 relation the interval of a fifth, etc., while the metronome speed can be varied as to pitch and tempo.

✦

New uses for microphone equipment

HARDLY A DAY passes that a new and useful application of public-address equipment is not uncovered. A prominent department store recently conceived the idea of letting the managers of some of the high-priced departments "listen in" while the clerk is trying to sell merchandise to a customer. For example, the customer walks over to the jewelry counter and asks to look at some diamond rings. The manager listens in to size up how the transaction is consummated. Necessary means are provided to switch the reproducer to any microphone position. In some cases the manager has used this means to acquaint himself of the customer's wants and later to assist actively in the transaction.

"MAGNETIZED" LANDING FIELD FOR AIRPLANES



Cables laid in concentric circles underground at Patterson Field, Dayton, Ohio, set up a guiding field, enabling landings despite densest fogs

✦ ✦ ✦

"Talking night letter" system proposed

A TALKING NIGHT-LETTER SYSTEM, by which the sender telephones his message to the central office, where it will be immediately recorded and held until the wires are not busy and then transmitted to the office of destination, where it will again be recorded, and this record delivered in the same manner as the usual telegraphic night letter, is proposed by the Sound Engineering Corporation, 342 Madison Ave., New York City. Edward H. Loftin is president, Arthur W. D. Harris and S. Young White are vice-presidents, and H. R. Van Deventer is secretary-treasurer.

Another service proposed by the company relates to the automatic reception of telephone messages. A simple and cheap apparatus has been developed which will take any message coming in over the phone while the subscriber is absent from home or office. This apparatus is not attached in any way to the telephone.

✦

Ziegfeld installs sound amplification

THE ZIEGFELD THEATER, Sixth Ave. and 54th St., New York City, is the latest theater for musical plays to install a Western Electric public-address system to assure adequate sound amplification and transmission from the stage to every part of the auditorium. The necessary horns, amplifiers and microphones were installed by Electrical Research Products in time for the opening week of the new Ziegfeld revue "Hot-Cha."

R M A Trade Show, Chicago, May 26

ONE HUNDRED RADIO MANUFACTURERS will exhibit their radio and electrical products in the Eighth Annual RMA Convention and Trade Show at Chicago, May 23-26. Over 85 per cent of the available exhibit space in the Stevens Hotel already has been reserved. Exhibit space of RMA members making advance reservations was assigned at a public drawing in the Hotel Astor in New York, March 24.

A crowd of over 20,000 radio visitors is expected in Chicago during "radio week." Admission to the RMA trade show will be limited to the trade, with the public excluded. Invitations from President J. Clarke Coit and the board of directors of the RMA will be sent May 1 to the trade.

Special trains from New York and other points to Chicago are being arranged. The fare to the RMA events from all points is at the reduced rate of one and one-half fares for the round trip.

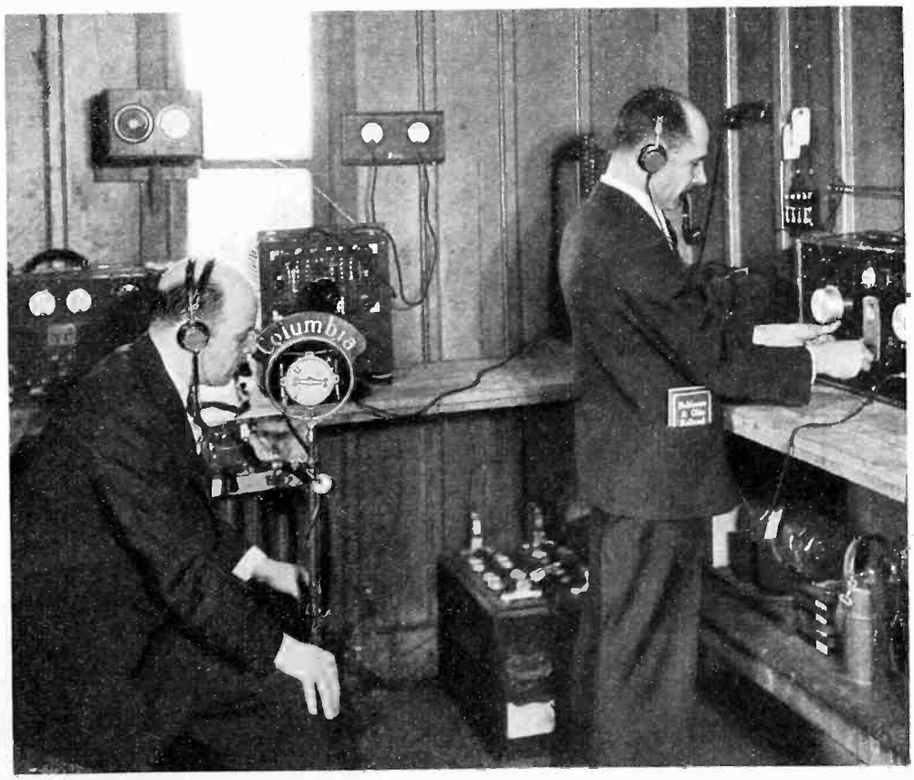
✦

Photo-cells to guard "Radio City" elevators

ELECTRIC-EYE SAFETY controls will protect passengers entering or leaving the high-speed elevators in the new Rockefeller Centre or Radio City, New York, from the swiftly-moving, power-operated doors. The Metropolitan Square Corporation, holding company for the Rockefeller interests, announces that the elevators in the buildings of the centre will be equipped with the new device.

✦ ✦ ✦

COLUMBIA BROADCASTS FROM SPEEDING TRAIN



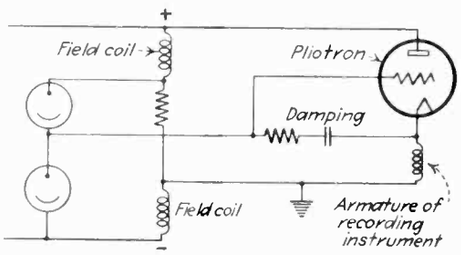
Edwin K. Cohan and A. B. Chamberlain testing out relay station which received broadcasts from mile-a-minute B. & O. train near Washington, March 27, for transmission to CBS network

REVIEW OF ELECTRONICS LITERATURE

HERE AND ABROAD

Photoelectric recorder of high sensitivity

[C. W. LaPierre] Gen. Electric Co. The filament of a lamp is focused upon the mirror of the galvanometer suspension, which throws it upon a narrow curved reflector. From there the image



is made to fall upon a mirror attached to the shaft of the recording element which in turn throws it upon a double, curved reflector dividing the light and sending it to two photocells connected in series. Power to turn the recording element is controlled by the photo current flowing through the field coils of the recording element. Any motion of the galvanometer mirror causes an unbalance and moves the shaft of the follow up element.—*Electrical Engineering, February, 1932.*

✦

Magnetic leakage of radio transformers

[R. Guertler] Telefunken Laboratory. The auto-transformer has much less magnetic leakage than a transformer with two separate windings and the same number of turns n_1 and n_2. In order to reduce the leakage in this latter case sections of the primary and secondary windings are made to alternate (interspaced winding, see *Electronics,* December, 1931). The sections may be wound as concentric tubes around the core (thickness of actual winding space $2b$, height h) or as disks piled one on top of the other. The leakage inductance may be computed with the aid of formulas developed for large transformers. When the same method is applied to the auto-transformer, the number of secondary windings to be divided up is $n_{II} = (n_2 - n_1)$ in place of n_2 and the leakage, which is proportional to the square of these numbers, is markedly reduced. This is particularly important for transmitters. The total leakage inductance when referred to the primary is for tubular windings in $(t + 1)$ sections separated by insulating material "d" cm. thick

$$S = 1.27 \times 10^{-8} n_{II}^2 \frac{l}{ht}\left(\frac{b}{3t} + \frac{2}{3}d\right) \text{henrys};$$

where l is the average length of one turn.—*Telefunken Zeitung, November-December, 1931.*

✦

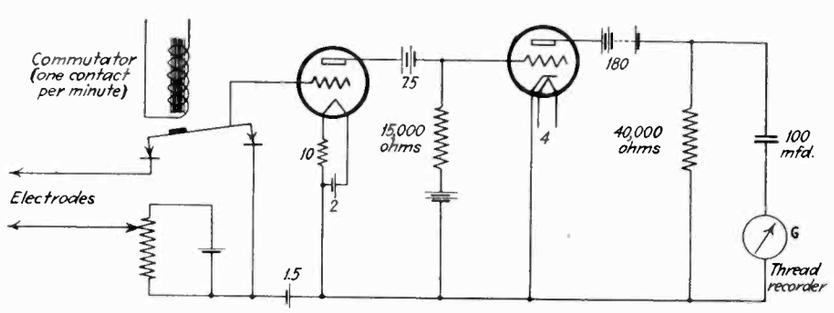
Grid-plate capacity and detector performance

[A. Van Sluiters] As the by-pass condenser in the plate circuit cannot be given a very large value, a small r.f. voltage drop is produced in the plate circuit when using plate current detection; it lowers the grid r.f. potential in any case, but particularly when the plate-grid capacity is large. In other words, capacitive reaction is not favorable for good rectification.—*Revue generale de l'Electricite, January, 1932.*

✦

Recorder for sulphur acids in flue gases

[J. J. Fox, L. G. Groves] The gases are absorbed by dilute hydrogen peroxide and the concentration measured by means of a glass electrode. A G.E. d.c. amplifier permits continuous recording.—*Chemistry and Industry, January, 1932.*



Direct current amplifier for acid recorder

Sound recording with cathode rays

[Von Hartel] Use of Braun tube for sound-on film recording. The fluorescent area is made of linear form by electrostatic screens, and either variable intensity or variable width recording can be used, although the former has been more developed. A particular advantage is that the tube is so sensitive that it can be connected directly to the microphone, thus avoiding amplifier patents.—*Radio Amateur, Vienna, February, 1932.*

✦

Currents of the human body

[Heller] Muscle and nerve currents are amplified by a resistance-coupled amplifier, and recorded by a string galvanometer, a capillary electrometer (of which details are given) or a Braun tube oscillograph. They can also be heard in headphones, this method being sensitive enough to detect the current produced when the subject merely *thinks* of a muscular action, the muscle remaining apparently at rest.—Curves of typical currents are given.—*Funk Magazin, Berlin, February, 1932.*

✦

Control of station frequencies in England

[A. S. Angwin] Chairman, Wireless Section, Institution of Electrical Engineers. During 1931, many observations have been made on long, medium and short-wave transmitters to determine the day-to-day variation of frequency and the variations which occur at short intervals. The curves representing the results obtained show that some of the tuning fork controlled long-wave stations, crystal-controlled short-wave and master oscillator controlled high-speed short-wave telegraph transmitters remain well within the limits of frequency variation recommended by the International Committee (O.C.I.R.) during the whole year. But other cases are also found where, apart from the frequency changes, the effects of excessive frequency modulation broaden the transmitted band so much that it is impossible to measure a definite carrier frequency. The frequency measuring station is at St. Albans (Colney Heath) well removed from sources of local interference.—*Journal of the Institution of El. Engineers, December, 1931.*

Radio problems

[Dr.G] Report of a lecture by Schaeffer, chief engineer of the German Broadcast Company. Points of special interest are his suggestion that it should now be possible to analyse human speech so as to record its personal characteristics (a sort of "fingerprint" system for voices); and his description of the latest German studios, built in an oblong form but with the two long walls not quite parallel, and with one short wall (that nearer the orchestra) of sound-reflecting and the other of sound-damping material and with a wavy roof in place of a flat one, all to avoid standing waves and resonance effects.—*Funk, Berlin, February 5, 1932.*

✦

Transients in musical sounds

[H. Backhaus, E. Weise] Makers of electronic musical instruments too often believe that the strength and the distribution of overtones are sufficient for defining the sound emitted by a musical instrument, whereas the transient effects, the building up and dying down of the sound are just as important. The study of these stages was not possible before the advent of electronic measuring devices, except perhaps in the case of spoken sounds. Vowels reach their steady state very quickly in a few milliseconds; the rate of growth of the different components is the same, because all the organs taking part in their production have soft walls, are highly damped and their resonance curves very broad. But sounds emitted by seven different musical instruments, reproduced by a loudspeaker, could not be correctly identified, even by trained musicians, when the building up and dying down periods were made inaudible.

Musical instruments are less strongly damped and resonances more sharply restricted. When the lower harmonics develop before the higher ones after a note has been struck, the impression will be that the sound is gradually building up, but when the higher harmonics reach full strength before the fundamental, the impression will be that the sound starts with a small explosion. The clarinet gives the fundamental before the harmonics come and the time to reach the steady state is 50 to 70 millisec. The trumpet builds up all the components at the same time, a peak being reached after about 14 millisec. When the violin is made to give 435 cycles per sec., the 4th, 8th, 9th, 11th and 12th partial prevail during the first 30 millisec., and the fundamental takes 102 millisec. to overtake the partials. But even then the changes continue, the strength of all the components goes through a low at 200 millisec., and the fundamental goes through another depression at 0.8 sec. No doubt this complicated growth gives character and charm to the sound, and electronic instruments have little chance of success so long as they neglect this factor. It is also clear that loudspeakers must be able to follow changes very quickly, within 3 millisec. This is only possible when their natural frequency is low.—*Zeitschrift techn. Physik, January, 1932.*

✦

Broadcasting statistics

[FF.] Among other points regarding Germany and Austria it is of interest that the reasons for not renewing the listener's license are 46 per cent death, change of residence, sickness, etc., 42 per cent financial, 8 per cent bad reception conditions, 2 per cent interference and 2 per cent dissatisfaction with the programs; that music represents 56 per cent of the total hours in Germany, with disks 19 per cent, literature, children's hours and the like 12 per cent, science 14 per cent, news 13 per cent, and direct reporting of events 5 per cent (in Austria there is rather more music and less talk); that the average hours per day of programs in Germany is 13 to 16, elsewhere in Europe 10 to 15.—*Radio Amateur, Vienna, February, 1932.*

✦

New tone-film patents

[Teucke.] Some of special interest are: German 520812 in which the source of light for recording is the glow of an oscillating crystal. German 525020 in which a mercury-vapour tube is provided with one cathode and two anodes, these being situated at the ends of two capillary tubes. The steady current is applied betwen the cathode and these two anodes in parallel, but the speech current is applied from one of these latter to the other, and the resultant variations in the glow within the capillary tube of one of them is used to record the sound. German 532004 in which ultrasonic frequencies are also registered on the film, these (after filtration from the sound frequencies) being used to actuate relays in the reproduction apparatus, e.g. for the purpose of switching in or out extra loudspeakers or altering the degree of amplification.—*Funk, Berlin, March 4, 1932.*

Baird Television

Mr. Baird announces that he has an agreement with the Knickerbocker Broadcasting Corporation of New York, and it is hoped shortly to send out programs from its station WMCA.

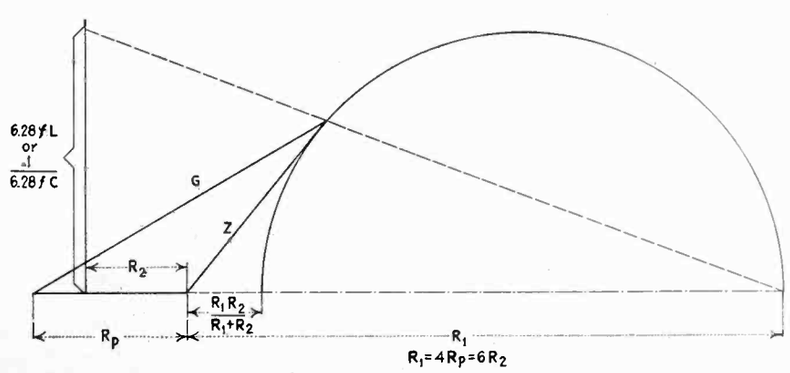
The German Post Office has decided to erect at the Witzleben Broadcasting Station in Berlin an experimental seven-meter short-wave television transmitter on the Baird system with 10,800 elements.—*Television (London) February, 1932.*

✦

Audio frequency compensator methods

[M. G. Scroggie, N. M. Rust] The first tone-compensator circuit considered consists of a resistance R_1 in parallel with a circuit containing resistance R_2, inductance and capacity in series. It may be thought placed between a tube of internal resistance R_p and the grid input of the following tube. The maximum gain is (reactance infinite) "mu" times R_1 over $R_p + R_1$, the minimum gain (zero reactance) R_1R_2 over $(R_pR_1 + R_pR_2 + R_1R_2)$. In other words the maximum is agreed upon, the minimum is determined by the choice of R_2. By dividing Z by G and deducing the frequency "f" from the length $6.28\ fL_2$ or $1/(6.28\ fC_2)$ shown in the graph in case either L_2 or C_2 is alone present or from the difference when both are used in series, the gain is obtained as a function of the frequency without much calculation. When both L_2 and C_2 are present the height of the peak of the gain is controlled by R_2, the frequency "fr" at the peak by L_2C_2, indeed $6.28\ fr = 1/\sqrt{L_2C_2}$ and the width of the peak by L_2/C_2.

In the second article a simple geometrical construction is given for the case where the voltage is applied to a compensator system consisting of L and R and C and R, in parallel or in series, but with $L/C = R$, and the voltage being taken from a point along R. (See also *Electronics, December, 1931. Wireless Engineer, January, 1932. Marconi Review, November-December, 1931.)*



Graphic method of solving compensation networks (Scroggie and Rust)

Science helps the blind

[BRACHET] Description of the Thomas apparatus, in which the light from a projector is reflected by the printed page (the area corresponding to one letter only being illuminated at a time) onto a series of 42 photo-cells. The current from those cells energized is amplified by triodes and actuates a series of electromagnets, one per cell, these in turn raising sharpened plungers above the surface of a "feeling block." In this way the black portion of a printed letter is translated (and enlarged) into its outline in raised plungers and can be "read" by the thumb. A simpler form uses six cells and six plungers only, but "reads" only works printed in flat Braille, even this being however a great advance over the normal embossed Braille.—*Science et la Vie, Paris, March, 1932.*

✦

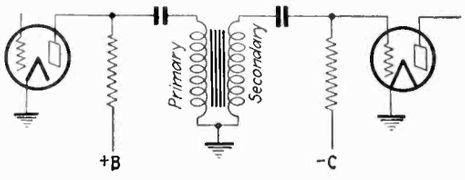
New gramophone problems

[HAGEMANN] Deals especially with home recording the relative advantages of gelatine, of a composition of metal (which must be sent back to the makers for hardening), and of aluminum foil being discussed. In connection with the problem of guiding the recording style, also fully treated, mention is made of the American aluminum discs with pre-inscribed grooves, "not yet available in Germany."—*Funk, Berlin, February 19, 1932.*

✦

Combined audio-frequency amplifier coupling

[SCHR] Swiss patent 142,608 to combine the advantages of resistance and transformer coupling, with the circuit shown.—*Funk, Berlin, February 19, 1932.*



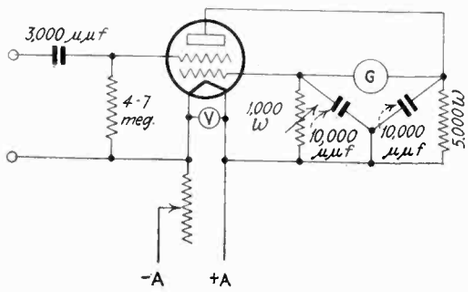
✦

Nickel cathodes for rectifier tubes

[H. G.] Telefunken is now making such tubes, in which the cathode is a strip of nickel instead of a wire. Some advantages are that the probabilities of breakage are reduced, that when such occurs the risk of short circuits with the plate can be greatly decreased since the cathode can be arranged to spring away from it, and that therefore the spacing between the electrodes can be considerably reduced.—*Radio B.F.f.A., Berlin, March, 1932.*

New type of tube voltmeter

[MEDINA] By the use of a double-grid tube (of the space-charge grid and not of the screen-grid type) no B battery or compensation battery for the galvanometer are needed. The variable 1,000 ohm resistance shown in the diagram serves to set the pointer at zero. This setting, and the adjustment of the filament voltage to the value used when the voltmeter was calibrated, are the only adjustments necessary. The calibration process is fully described. Readings from 0.1 to 1.5 volts are possible. At higher values of applied voltage the galvanometer reading tends to decrease, thus providing an automatic pro-



tection against overloads. Frequencies from 50 to 300,000 cycles can be measured without compensation.—*Funk, Berlin, February 26, 1932.*

✦

The latest

[H. G.] Some details of the Lorenz attempts to reduce fading by partially suppressing the space wave, an arrangement of one central and six other antennas being adopted, the latter being on the periphery of a circle of which the first is the center, and the radius of this circle being approximately ⅓ the wave-length. Results are said to be very encouraging. Reimann has developed a broadcast receiver to be tuned to zero beat with the desired transmission, in an oscillating condition. Tuning is said to be easy, no distortion to be caused, and thanks to pre-detector screen-grid stages and other precautions, no interference with other receivers to be caused. The Postal authorities in Berlin are shortly putting into use an ultra-short-wave transmitter of 5 kw., for broadcast and television programs, the latter with a 10,000 point system (90 lines).—*Radio B.F.f.A., Berlin, March, 1932.*

✦

Theory of rectification

[ROCARD] Valuable series of calculations, the results being given in the form of tables and curves, for the various conditions under which rectifiers are normally used. A mathematical article not lending itself to further condensation.—*L'Onde Electrique, Paris, January (published March 4), 1932.*

New Patin photocells

[ENSBRUNNER] These cells can be used with applied voltages of from 20 to 1,000 volts, the sensitivity increasing with the higher values and without risk of glow discharge occurring. A variation of this applied voltage thus provides a very convenient volume-control, especially when this is desired from a distant point. Frequencies up to 25,000 cycles are truly reproduced. Practically no electrical inertia exists. A great advantage is that under normal working conditions the cell gives some 0.5 volts output, so that it can be connected directly to the power amplifier without preliminary stages of amplification. Circuits and frequency curves are given.—*Radio Amateur, Vienna, March, 1932.*

✦

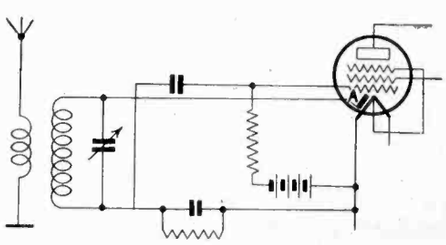
Gas discharge tubes and sodium tubes for television

[H. EWEST, Osram combine and G. SCHUBERT] Fernsch Laboratory. The brightness of the positive column of a discharge tube is greater than that of the negative glow, and the potential available at the plate of the last tube in the receiver is high enough for starting and operating a tube showing a positive column when an incandescent cathode is used. Nevertheless only V-shaped sodium discharge tubes placed in a heater have proved satisfactory for the ordinary disk (0.1 ampere, 100 volts, 126 candles, 2.5x4.5cm. surface). Such a lamp responds to frequencies as high as 100,000 cycles (estimated). It has a life of close to 200 hours. A disadvantage is that for steady operation a high-frequency current from a separate small oscillator must be sent through the lamp. At a temperature of 180 deg. C. the operating voltage remains nearly constant when the current is varied from 20 to over 100 ma., and the brightness is proportional to the current.—*Fernsehen, January to March, 1932.*

✦

Receiver circuit

[SCHR] Description of French patent 701,700 in which a pentode tube with an added electrode (A of diagram) is used,



to separate the function of detection and amplification, the former being performed by the diode composed of the filament and this extra electrode.—*Funk, Berlin, February 26, 1932.*

✦ NEW PRODUCTS

THE MANUFACTURERS OFFER

Photocell colorscope

THE NEW COLORSCOPE, developed for color matching and color measurement shows whether the colors of two materials match, and also indicates numerically how much lighter or darker one color is than another.

The device will show immediately whether a misdye can be corrected by additional dyeing. In the absence of a match, it indicates in terms of primary colors how corrections should be made. It also enables the operator to calibrate the coloring of each dye and to measure

the amounts of dye needed. Besides measuring comparative "mileage" or tinctorial value of coloring materials, it offers a precise method for insuring color uniformity in case packing or car loading and for color measurement in general.

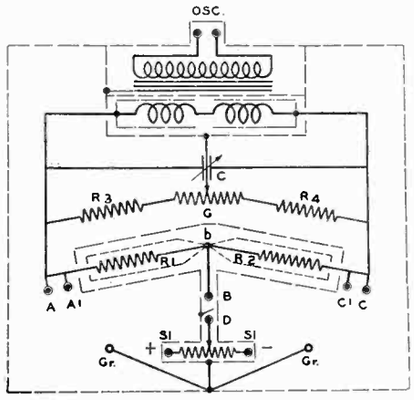
According to the Sheldon Electric Corporation, 100 Fifth Ave., New York City, makers of the Colorscope, the readings are made without error from the effect of weave, surface or texture.—*Electronics, April, 1932.*

✦

Shielded ratio box

THE CAMPBELL-SHACKELTON shielded ratio box is a new Leeds & Northrup instrument for high-precision a.c. measurements. It contains all the parts, except the standard and the detector, which are necessary for a one-to-one impedance bridge.

The feature of this box is the shielding which is so arranged that the instrument may be used either with one point grounded, or with a Wagner earth.



The ratio box is designed for use at frequencies of 50 to 50,000 cycles per second. An input potential of 30 volts at 60 cycles may be used under average conditions. The limit of error is either 0.01 per cent, 0.01 ohm (resistance, inductive or capacitive reactance) or $2\pi f\ (10^{-7})$ micromhos (conductance, inductive or capacitive admittance). *Electronics, April, 1932.*

✦

Full-wave mercury rectifier

HYGRADE SYLVANIA CORPORATION, Emporium, Pa., has developed a new full-wave mercury vapor rectifier tube, known as the SX-82. The filament rating is 2.5 volts and 3 amperes. It is essential that this voltage be held as closely as possible to this value. This tube will find especial application in connection with power supply devices for Class B amplifiers, where the load is constantly varying.—*Electronics, April, 1932.*

✦

5,000-volt hot cathode rectifier

THERMIONIC LABORATORIES of Kearny, N. J., announces a new half-wave hot cathode rectifier. It is intended for all applications which require up to 5,000 volts and up to 300 milliamperes. Two of these tubes in a suitable rectifier circuit makes full-wave rectification possible. Rating and filament data: Voltage—2.5, current—2.0, maximum peak inverse voltage, 5,000 volts, maximum peak plate current—300 mils, approximate tube voltage drop—15 volts. Two of these tubes may be operated in series from a 5-volt transformer as the total filament current and voltage of the two tubes in series is equal that of a 280 type tube. Filament and plate current can be applied simultaneously. List price, $2.50.—*Electronics, April, 1932.*

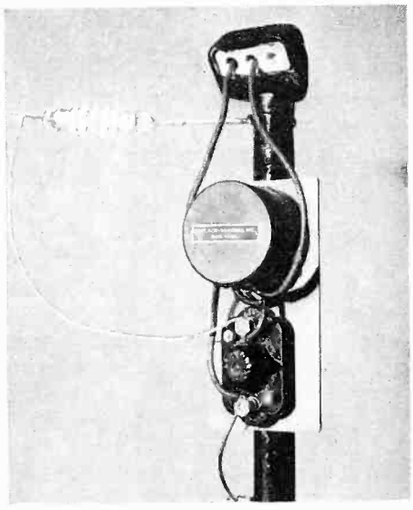
High power output pentode

TUNG-SOL RADIO TUBES, INC., Newark, N. J., announces the development of a new tube called a d.c. power amplifier pentode bearing the designation, TS-257. This new tube is intended for use in the power output stage of 115-volt d.c. operated sets especially designed for it. The tube is designed to operate at a maximum plate and screen voltage of 110 volts and will produce a power output of 800 m.w., which is approximately $3\frac{1}{2}$ times the power output of the 171-A type and more than twice the output of the TS-233 or TS-238 types when operated at the same plate voltage.—*Electronics, April, 1932.*

✦

Aerial transformer

AMY, ACEVES & KING, INC., 11 West 42nd St., New York City, announces that it has perfected a new device called the "Aeroformer" for obtaining better radio reception from any outdoor antenna. Essentially, the device is a radio-frequency transformer of special design



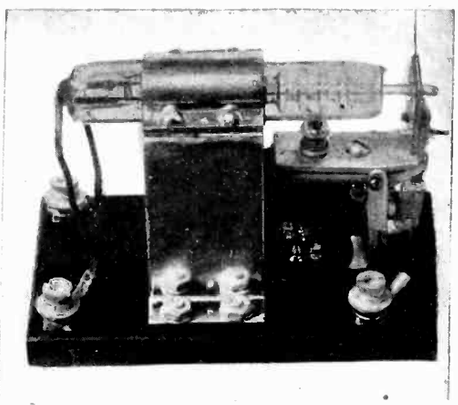
for matching the impedance of the average broadcast receiving aerial to any downlead of 40 or more feet in length.

This device is especially recommended for broadcast listeners in apartment houses where a long downlead from a crowded aerial on the roof is the only means of obtaining radio reception, where radio pickup is poor, or where there is excessive noise from nearby electrical equipment. The device also compensates for losses when a shielded lead-in wire is used, in which case it is installed at the beginning of the shielded lead-in.—*Electronics, April, 1932.*

Vacuum-contact midget relay

THE WARD LEONARD COMPANY, Mt. Vernon, N. Y., has added to its line of midget relays a vacuum-contact relay.

The vacuum contact element, which is actuated by the relay armature, is rated at 8 amperes intermittently, and 6 amperes continuously, at 220 volts.



Relays equipped with this type of contact are especially applicable to operation in hazardous places. They have a high rating, making them heavy-duty midget relays. They may be obtained for normally-open or normally-closed operation. Coils may be wound for 6 to 110 volts a.c. or d.c.—*Electronics, April, 1932.*

✦

Midget television set

IN A CABINET no larger than the usual midget broadcast receiver, there is now offered for home living-room use a complete television tuner, amplifier and televisor combination. The pictures appear on a ground-glass screen measuring 4 in. by 5½ in., with sufficient brilliancy and detail to entertain half a dozen persons. Illuminated scale and control knobs are placed below the screen.

This midget set which is the development of the Globe Television & Phone Company, 26th and 11th Ave, New York City, comprises a metal chassis receiver employing two screen-grid -24 tubes for r.f. stages, one -27 detector, one -24 first audio, one -27 second audio and two -45 power tubes for the third audio stage, together with the -80 full-wave rectifier. A power pack is included for full a.c. operation. A 60-line lens disc is employed, in combination with a crater neon lamp, for projected images.—*Electronics, April, 1932.*

✦

Luminaires with ultra-violet

THE VIOLITE ADAPTER, manufactured by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., makes it possible to obtain dual-purpose lighting, a combination of general interior illumination plus ultra-violet irradiation, easily and economically.

The Violite adapter consists of a socket for a 200-watt ballast lamp and an aluminum reflector and socket for a type G-1 ultra-violet glow lamp. The G-1 lamp is in series with the incandescent or ballast lamp, which acts as a ballast resistance. No transformers or other equipment are necessary.

The ballast lamp in the adapter occupies the proper position in the globe and hence the user gets well diffused general illumination, plus the health-maintaining ultra-violet radiations. It is estimated that a daily exposure to an average installation of this type of dual-purpose lighting equipment is equivalent to approximately 15 minutes of the rays from a therapeutic floor lamp.—*Electronics, April, 1932.*

✦

Resonator speaker

THE VOLF RESONATOR and modulator introduces a new principle in radio reproduction apparatus, giving the quality of resonance to all frequencies of the musical scale equally so that each note is faithfully reproduced true to pitch and its proper wavelength.

The small model of the Volf instrument illustrated has a dynamic unit and 65 resonating tubes, all of different length and diameter and appropriate to different notes and overtones.

The water in the bottom container is for the purpose of changing a surface sound wave into a compressional wave system—the only wave-form that progresses by simple radiation and is therefore not distorted by obstructions such as walls and objects in a room or auditorium.

The resonator and modulator model is priced at $100. It is on sale through Marthens, Schroter & Co., Inc., 54 Dey St., New York City.—*Electronics, April, 1932.*

✦

Mercury electric switch

THE CECO MANUFACTURING COMPANY, INC., Providence, R. I., announces the formation of an industrial division to develop electrical and electronic devices for industrial purposes, with C. O. Cressy as engineer in charge. One of the products of this division is the "Mertact," a mercury electric switch. Mertacts are made in sizes from 1 to 100 amp. capacities. Many unique and novel features are employed in their construction. The Mertact operates in a very narrow angle of swing. Sizeable currents can be broken by a very small mechanical force, oftentimes eliminating the necessity of using intermediate relays. Another distinct advantage possessed by mercury switches is the enclosed-arc feature which permits its use where combustible gases or material are apt to accumulate. The life of this switch is declared to be far greater than any mechanical switch now employed in industry.—*Electronics, April, 1932.*

Television receiver with brighter image

A HOME TELEVISION and radio receiver combined, producing a well-lighted, black-and-white halftone image on a 12 in. by 14 in. screen, was demonstrated by William Hoyt Peck, at the St. Moritz Hotel, 50 Central Park South, New York City, during February.

The inventor has developed a lens system which he declares utilizes 80 per cent of the available light instead of 0.02777 of 1 per cent obtained with the usual punched-hole scanning disc. In the Peck apparatus, all the light of the neon-crater tube is concentrated into a beam through a condenser lens, and is focussed onto a prismatic reflector. Housed in the same cabinet as the screen are twin receiving sets and a dynamic speaker. One set is used to carry the audible part of the program; the other, the visible portion. The inventor estimates that such a set can be sold for $100. Mr. Peck announces that he does not plan to go into the radio manufacturing business, but plans to demonstrate his receiver to leading set manufacturers and to issue licenses.—*Electronics, April, 1932.*

✦

Record-playing attachment

A NEW PORTABLE and completely self-contained unit for reproducing records through radio sets and power amplifiers has been announced by the Operadio Manufacturing Co., St. Charles, Ill.

Housed in a leatherette carrying case are an electric phonograph motor and turntable, and a sensitive electro-magnetic pick-up. A carrying case in the cover provides for storage of several records without danger of breakage.

This unit is adapted for use with all radio sets and amplifiers having provision for connection to either high or low impedance pickups. Adapters are available for connections to most other radio sets. The unit can be furnished with either high or low-impedance pickup and with 78 or 33⅓ r.p.m. motors, for 25 or 60 cycle, 110-volt electricity supply.—*Electronics, April, 1932.*

U. S. PATENTS

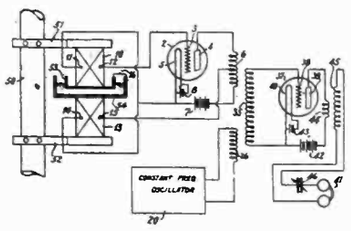
IN THE FIELD OF ELECTRONICS

A list of patents (March 29) granted by the United States Patent Office, chosen by the editors of *Electronics* for their interest to workers in the fields of the ralio, visio, audio and industrial applications of the vacuum tube

Electronic Applications

Photoelectric regulating device. A method for indicating the varying conditions of a variable element by a source of light and a photoelectric cell. Herbert Hausrath, and Hermann Saacke, assigned to Neufeldt & Kuhnke. No. 1,848,882.

Stress measuring system. A method of measuring stress by means of Piezo electric effects and beat frequency oscillators. A. M. Nicolson, assigned to Federal Tel. Co. No. 1,848,490.

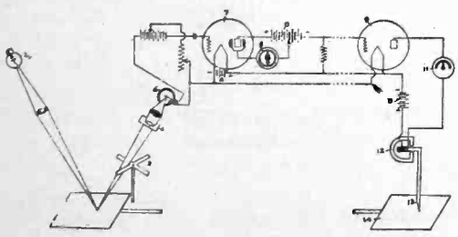


Circuit breaker. A method of mounting one of the electrodes in a vacuum tube so that it can be moved to such a distance that an arc formed may be broken. Irving Langmuir, assigned to G. E. Co. No. 1,849,842.

Telemetering system. An indicator of a measuring instrument changes the frequency and produces a beat which operates the meter indicator at a distant point. A. S. FitzGerald, assigned to G. E. Co. No. 1,849,870.

Apparatus for measuring irregularity of movements. A magnetic method of measurement, in which a continuous uniform conductor moves past the magnet and variations in flux are indicated on a meter. C. W. Hewlett, assigned to G. E. Co. No. 1,849,831.

Photo-electric engraving system. The subject to be engraved is scanned by a conventional system, and the variations in light are amplified and caused to actuate a stylus, which does the engraving. Walter Howey, New York, N. Y. No. 1,849,544.



Apparatus for testing condensers. Variable condensers under test vary tuning in an oscillating circuit whose output is compared to a fixed frequency. M. H. Bennett, Scovill Mfg. Co. No. 1,845,576.

Synchronizing system. Use of two glow discharge tubes for synchronizing a local with a distant body. J. van der Mark, RCA. No. 1,845,368.

Synchronizing system for television. Scanning and synchronizing system. Philo T. Farnsworth, Television Laboratories, Inc. No. 1,844,949.

Voltage regulator. Glow discharge in series with an inductance across the load of a filter rectifier system. D. E. Replogle, Raytheon, Inc. No. 1,844,977.

Electronic musical instruments. An oscillator carrying currents of acoustic frequency is coupled electromagnetically with the grid circuit of a vacuum tube amplifier. Paul Lertes and Bruno Helberger, Frankfort, Germany. No. 1,847,119.

Speed measuring apparatus. By a beat frequency method, the speed of a moving body is determined. Myron C. Ferrell, assigned to W. E. Co. No. 1,846,678.

Musical instruments. A method of producing a tremolo effect in an electronic musical instrument by means of valving the light through a photo-cell. R. K. Potter, assigned to A. T. & T. Co. No. 1,848,222.

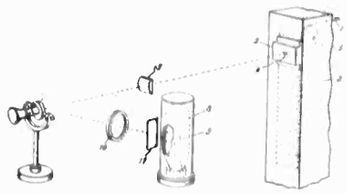
Control system. A source of current of varying amplitude, a mirror which reflects light at an angle corresponding to the difference in amplitude between the instantaneous value of the current of the source, and an arbitrary and predetermined value, light cells, etc., to control the rotation of a motor. R. H. Lindsay, assigned to A. T. & T. Co. No. 1,848,220.

Television, Facsimile Transmission, etc.

Multiplex transmission. A method of putting together the modulation of several carrier frequencies, and by means of nicol prisms, etc., reproducing the original modulation. C. R. Hanna, assigned to Westinghouse E. & M. Co. No. 1,849,488.

Television system. Two Neon tube oscillators, a method for adjusting the frequency of each oscillator separately, a method of causing oscillators to keep in step when adjusted, and means for adjusting both oscillators simultaneously. H. J. McCreary, assigned to Associated Electric Labs., Inc. No. 1,849,679.

Recording on film. A film is exposed to a narrow transverse light beam of uniform width, and the intensity of the beam is varied transversely in accordance with the sound wave. C. A. Hoxie, assigned to G. E. No. 1,848,886.



Transmission and reception of pictures. A light controlled screen with electrostatically controlled pivotally-mounted shutters, a means for projecting light through the screen and for causing shutters to assume positions of light interception, dependent on the shade of the pictures to be produced. J. M. Kendall, assigned to G. E. No. 1,848,888.

Picture transmission system. Light from different sections of the picture is transmitted upon a light sensitive cell at a uniform rate, and the current changes are utilized to vary the number of modifications of uniform duration and amplitude energy impulses per unit time. R. H. Ranger, assigned to RCA. No. 1,848,839. Also No. 1,848,840.

Television system. Transmitting signal energy over a variable frequency range, a luminously responsive inductance screen, and method of varying the inductance of parts of the screen. C. L. Davis, assigned to Wired Radio, Inc. No. 1,848,324.

Power Applications

Control circuit. An electric tube having several electrodes and means for changing an electrical condition of one of the electrodes in accordance with changes in electrical property of one of the electrodes. H. L. Palmer, assigned to G. E. No. 1,847,893.

Power converting apparatus. A circuit containing two ionization tubes for translating power between a.c. and d.c. circuits. R. B. Ayer, assigned to G. E. No. 1,848,092.

Amplifications, Detection, Etc.

Volume control. A method of simultaneously varying two characteristics of a receiver system for volume control. W. L. Carlson, assigned to G. E. Co. No. 1,849,821.

Oscillation generator. Piezo electric elements are placed on a tuning board at diametrically opposite points, at which the mass of the Piezo electric elements will have a minimum effect upon the frequency vibration of the board. W. E. Bower, Washington, D. C. No. 1,849,271.

Volume control system. In a diversity reception method, several energy collections of relatively different fading characteristics are combined together. J. B. Moore, assigned to R.C.A. No. 1,849,632.

Gain control. A method of controlling the gain of a pair of amplifiers. W. H. T. Holden, assigned to A. T. & T. Co. No. 1,849,189.

Transmission regulator system. Resistances so placed with a source supplying direct current potentials which vary in accordance with temperature, that the transmission on a line is regulated. T. D. Dutton, assigned to A. T. & T. Co. No. 1,849,141.

A.C. rectifier. A double-wave mercury arc vacuum tube rectifier circuit. R. H. Maxson, assigned to the Burdick Corp. No. 1,849,103.

Sound reproducing and recording system. Apparatus for recording sound on, or reproducing from, a film having several sound tracks. A. V. Metzger, assigned to G. E. Co. No. 1,849,819.

Telemetering system. A. S. Fitz-Gerald, No 1,849,827, assigned to G. E. Co.

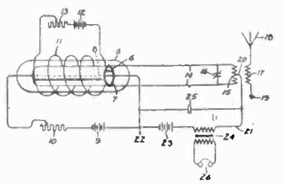
Picture transmission system. In a television scanning system, at the end of each scanning line an auxiliary impulse is transmitted, whose magnitude substantially corrects any unbalance in light and dark portions of the line. A. V. Bedford, assigned to G. E. Co. No. 1,849,818.

Loud speaker system. A dynamic loud speaker and a vacuum tube amplifier, a common source of supply current connected to the plate circuit, and field coil. The voice coil is in series in the plate circuit, and the field coil is in shunt thereto, and a transformer coupling set connects these to the grid circuit. F. W. Lyle, assigned to Westinghouse E. & M. Co. No. 1,849,495.

Beat frequency and phase indicator. A method of determining the phase and frequency relationship between a known and an unknown frequency. Alfred Crossley, South Haven, Mich. No. 1,846,314.

Vacuum tube circuit. The input to the circuit is between anode and filament, the anode being maintained negative with respect to filament, and the output is between grid and filament, with the grid being maintained positive. F. E. Terman, assigned to Wired Radio, Inc. No. 1,846,043.

High frequency detector. A magnetron tube with split anode arranged as a detector. E. D. McArthur, assigned to G. E. No. 1,846,888



Frequency control. A method of controlling frequency by controlling the crystal temperature. H. A. Affel, assigned to A. T. & T. No. 1,847,160.

Voltage regulator. An auto transformer and a constant current device, the transformer secondary being so related that it tends to restore to normal a supply voltage reduced by the constant current device. J. I. Cornell, assigned to G. E. No. 1,847,865.

High frequency amplifier. An interstage coupling system, two tuned circuits, the first of which is damped to a greater degree than the second circuit. C. E. Bailey, R. C. A. No. 1,850,784.

Voltage regulator. Device for suppressing variation in voltage comprising a layer on the order of between .2 and 5. mu of low and variable conductivity under electrical stress, having a specific conductivity dependent on the variations of voltage applied to the layer. Abraham Joffé, Industrial Research Co., Cambridge, Mass. No. 1,850,587.

A.C. operated set radio receivers. Detector tube cathode is a photo-electric emitting surface. Alexander Nyman, assigned to Dubilier Condenser Corp. No. 1,850,270.

Band receiving system. A pre-selector system for radio receivers. F. K. Vreeland, assigned to Vreeland Corp. No. 1,850,973.

Selective radio receiver. Complicated network for pre-selecting signals before admitting them to a superheterodyne receiver. H. F. Elliott, assigned to R. C. A. No. 1,850,831.

Pre-selector. Network of variable impedances for selecting signals before admission to an amplifier. L. L. Jones, Oradell, N. J. No. 1,850,754.

Direction finder. Apparatus for aerial navigation. August Leib, Berlin, Germany. No. 1,850,080.

Direction finder. A vacuum tube oscillator having co-acting induction coils in input and output and means for concentrating the horizontal components of the lines of force of the earth's magnetic field and directing them through the coils. Paul Schwerin, assigned to Perryman Electric Co. No. 1,850,874.

Monitor system. A glow lamp with more than one light aperture for recording and monitoring. T. H. Nakken, assigned to Nakken Patent Corp. No. 1,850,467.

Recording system. Method of operating electric, graphic, recording means, including an inscribing needle responsive to current variation for making a chart including a curve whose form directly characterizes the spectrum of a particular incandescent material. R. H. Vahney, assigned to Republic Steel Corp. No. 1,850,909.

Volume control. The process for sound reproduction involving producing a photo-electric record of constant frequency, the amplitude of which is varied in accordance with the desired sound intensity. Julius Weinberger, assigned to R. C. A. No. 1,850,701.

Radio Circuits

Side band selector receiver. A method of filtering one side-band from the heterodyne energy, another filter for filtering the heterodyne carrier from the heterodyne energy, local oscillator, detector, etc. H. O. Petersen, assigned to R.C.A. No. 1,849,884.

Radio receiver. Conventional tuned amplifier for audio circuit with crystal detector, all operating from an a.c. circuit. E. G. Van Trabert, Bronx, N. Y. No. 1,849,967.

Modulation system. A method of combining a signal input with a high frequency source to get a modulated output, by means of altering the conductivity of an electronic tube. R. L. Davis, assigned to Westinghouse E. & M. Co. No. 1,849,865.

Signalling system. A motor is interposed between the cathode of one tube and the negative terminal of the source, and another between the cathode of a tube and the negative terminal, and the mechanical connection between this motor and generator. R. L. Davis, assigned to Westinghouse E. & M. Co. No. 1,849,792.

Frequency modulator. A method of signalling, which includes frequency modulating energy according to the intelligence to be transmitted. A method of limiting the resultant energy so that it occupies only a pre-determined band of frequencies. C. W. Hansell, assigned to R.C.A. No. 1,849,620.

Fading eliminator. A method of eliminating the effect of partial fading on a high frequency carrier, by frequency modulation. H. H. Beverage, assigned to R.C.A. No. 1,849,608.

Radio receiver. A variable condenser with movable plate in such a shape that the resonant frequency of the tuned circuit varies at the straight-line function at the angle of rotation. S. E. Anderson, assigned to W. E. Co. No. 1,849,651.

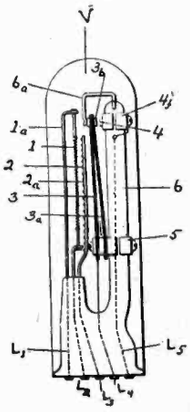
Frequency modulation system. Modulating wave varies the frequency of a continuous single frequency oscillation. L. J. Sivian, assigned to W. E. Co. No. 1,847,142.

Constant gain circuit. A multi-stage amplifier in which regeneration from one tube to a previous tube is utilized to compensate for the discrimination in amplification of certain waves over a band of wave lengths. David Grimes, assigned to RCA. No. 1,847,759.

Crystal circuit. Patents No. 1,847,124 and 1,847,190 to W. A. Marrison, assigned to W. E. Co., on the use of quartz crystals in oscillation circuits.

Volume control. Impedances in input and output of an amplifying system, and an electrically-conducting structure between them connected to earth, to prevent noises in the loudspeaker when the volume is adjusted. W. H. Schaeffer, assigned to Atwater Kent. No. 1,846,616.

Vacuum Tubes



Vacuum tube relay. An anode, comprising a bi-metallic expansion couple, and a circuit-making and breaking means located within a tube. Samuel Ruben, New York, N. Y. No. 1,847,669.

BRITISH PATENTS

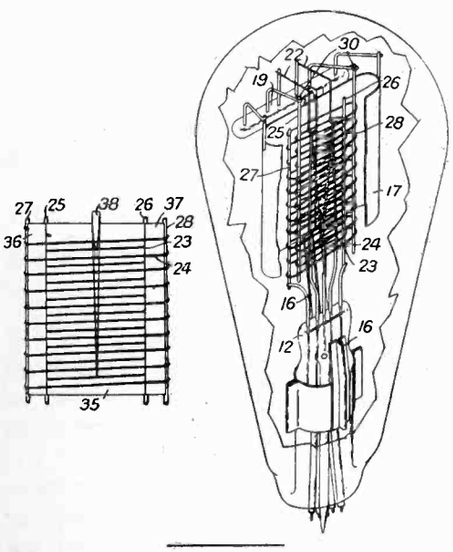
IN THE FIELD OF ELECTRONICS

Because patents are issued in Great Britain some months before issuance in the United States, and because British patents reflect what is going on in Europe better than the American Patent Gazette, the editors of *Electronics* choose representative disclosures each month for this page.

Circuit Patents

Modulating system. System for tuning a radio receiver or modulating a transmitter by varying the specific inductive capacity of the dielectric of a condenser by direct electrical action. The dielectric may be a monocrystal such as Rochelle Salts. V P. Wologdin, Leningrad, Russia. No. 362,377.

Co-planar tube. Construction of a vacuum tube in which the grid electrodes are interlaced so that at each side of the cathode the wires of one are intermeshed with those of the other on the same surface. H. A. Pidgeon and J. O. McNally, assigned to Standard Telephones and Cables. No. 362,408.



Television scanning. A system whereby the rate of scanning is retarded when the center of interest of the picture is being scanned. The method is applicable to cathode ray and moving mirror scanning systems. J. H. O. Harries, Shirley, England. No. 357,143.

Frequency multiplier. Overbiased amplifier getting part of its bias from fixed potential and part from resistances in grid circuits which increases the bias in accordance with excitation. With such bias the multiplier is not rendered inoperative by variations in amplitude of the input wave. Lorenz, Berlin. No. 356,988.

Sound recorder. Tube to supply sound recorder has an impedance inserted in series circuit to damp lower frequencies and thus avoid needle jumping the groove. W. S. Barrell, Surrey. No. 357,211.

Push-pull amplifiers. Push-pull amplifiers without grid biasing batteries. H. A. Wheeler, Hazeltine Corp. Nos. 357,286 and 357,306.

Fading reducer. Reduction of fading by varying amplification of tube by varying heating current of cathodes. Telefunken. No. 357,379.

Modulation system. Frequency variations are isolated from the carrier wave having both amplitude and frequency variations by means of a cathode-ray tube. J. Robinson and British Radiostat. Corp. No. 362,914.

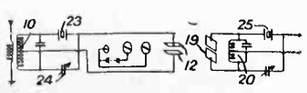
Noiseless recording. The mean amount of light acting upon the photographic film is varied in accordance with the volume of the sound being recorded, and this mean amount is subjected to a substantially constant degree of modulation. W. E. Co. No. 362,993.

Grid rectification. Amplification and grid leak condenser rectification are obtained from separate grids in the same electron stream of a tube, the rectifying grid having negligible control upon the anode current. The tubes have three grids. Lissen, Ltd., and M. V. Calendar. No. 361,848.

Photo-cell construction. A process for introducing the electrolytic decomposition products of glass, for example, the alkali metals and oxygen into vessels. A metallic film on the inner surface of the glass ball forms the internal electrolytic electrode and is less than 0.001 mm. thick to allow the passage of the decomposition products. No. 361,925.

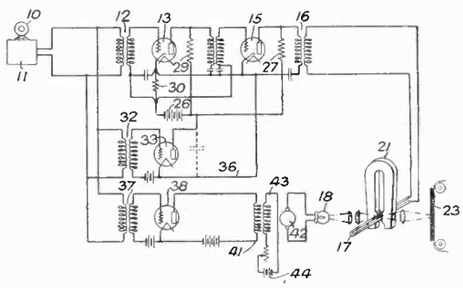
Band-pass filter. Two tuned circuits, variable coupling between the circuits and means for varying the coupling simultaneously with the tuning to maintain the accepted band width constant. R. A. Braden, Marconi Co. No. 362,170.

Highly selective circuits. A receiver having a high order of selectivity and provided with means for correction of the inherent signal distortion due to the high selectivity, the selective device comprises a tuning fork set in vibration by the signals. The tuning fork is preferably used as an intervalve coupling in the intermediate stage of a superheterodyne. J. Robinson and British Radiostat. Corp. No. 362,514.



Pentode-triode circuit. The output pentode valve of a radio gramophone is converted to operate as a triode when records are being reproduced. I. Schoenberg and W. A. Connell, London. No. 362,687.

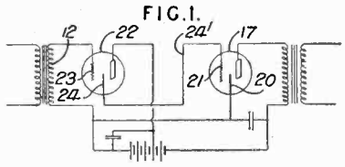
Noiseless recording system. The film is moved at a uniform speed through light of constant intensity and the time of exposure of the elements of the recording material is varied directly with the volume of sound recorded while the light is modulated completely for all volumes of sound recorded. W. E. Co. No. 362,915.



Direct-coupled amplifiers. Rather complete specifications of circuits known in this country as Lootin-White direct-coupled amplifier circuits. S. Y. White, 1931 Broadway, N. Y. No. 362,419.

Direct-coupled amplifier. Amplifier in which to prevent distortion due to grid current, two valves are used in cascade, one valve having its grid cathode path in series with the grid cathode circuit of the main amplifying valve. This is a circuit which is being mechandised in this country built around the Cable "Triple Twin" Tube. Revelation Patents-Folding Co., Wilmington, Del. No. 362,504.

FIG. 1.



Receiving circuit. To prevent disturbances in the detector stage of a radio receiver, an indirectly heated tube is employed, the heater being energized by the anode current of the other tubes. W. van B. Roberts, Marconi Company. No. 362,243.

Detector circuit. A method of preventing the damping of the oscillatory circuit and thermionic detector, due to the shunting effect of the valve conductance across the anode-filament capacity, the anode-grid capacity is neutralized, the input circuit having low effective resistance in the order of that of a tuned circuit subject to considerable reaction. H. J. Round, Marconi Company. No. 360,463.

Local-distance circuit. A radio receiver adapted to distance reception is rendered suitable for local reception by rendering an amplifying stage inoperative and converting it into a band-pass filter. R. A. Braden, Marconi Co. No. 360,813.

Output amplifiers for 110-volt d.c. receivers

[*Continued from page 129*]

resistance R_L, the impedance of R and L in parallel, and in the grid current characteristics of the output tube.

Figure 5 shows the results obtained with a 237 tube directly connected to a 171-A output tube. The circuit components used are indicated on the sheet. The effect of using too high a value of R shunting L is clearly seen.

The output tube part of the combination tube has a higher mu and mutual conductance than the 171-A. Figure 6 shows the power output and distortion curves obtained with a 237 type first audio-frequency and a tube having a somewhat higher amplification factor and mutual conductance than the 171-A. This tube does not have the best possible characteristics but serves the purpose to illustrate the principles of operation. The value of cathode resistor in the 237 tube was 2500 ohms and the value of R shunting L was 25,000 ohms.

Figure 7 shows the effect of varying R_L when the output is approximately 0.98 watt. This output level corresponds to grid current in the first tube. The similarity of the variation of second harmonic content to that obtained in the pentode case should be noted.

Comparison of tubes and amplifiers

1. Triodes operated as Class B amplifiers offer the best means of obtaining large power outputs at relatively low plate voltages provided sufficient power is available to swing the grids.

2. Two tubes of the 171-A type in push-push will give a fair amount of output with good quality when worked with a low ratio input transformer from a single audio stage.

3. The problem of feeding the input voltage to grids of the tubes used in push-push is difficult so that a push-pull first audio-frequency stage will probably be necessary if the full capabilities of the push-pull output stage are to be realized at low plate voltages.

4. The use of standard type pentodes in class A amplifiers at 110 volts will result in fair results with very little trouble from feeding them.

5. Considerable power may be realized with direct coupling but all the circuit conditions are rather critical to obtain any considerable power with a reasonable amount of distortion as the effect of frequency variation will be considerable due to the two iron core impedances used in the input and output of the last tube.

New tubes—detectors, rectifiers, amplifiers

[*Continued from page 120*]

The end of the new tube list is not yet in sight. At least three other tubes of great technical interest are well on the way. These are tubes in smaller envelopes, of strange characteristics and construction, of value at 5 meters as well as at broadcast frequencies. Two are triple-grid affairs in which each grid apparently can be connected to everything in sight, simultaneously or in sequence with strange and varied results. One of the new tubes not yet publicly announced is a triode of greater amplification than the 227, of a mutual conductance of about 1,500 and specially adapted to economical set construction. The multi-grid tubes have a peculiar shape occasioned by an internal shield which reduces the interelectrode capacities when in proper circuit and properly shielded.

Notes on the Wunderlich tube*

THE Wunderlich tube can be thought of as a triode with a second grid wound between the meshes of the usual grid. Its purpose is grid leak power detection, and gives full wave grid rectification in a balanced circuit in which negligible r.f. currents flow in the plate circuit. This feature has two important advantages—it approximately doubles the output voltage by eliminating simultaneous plate and grid rectification and makes unnecessary the r.f. filter in the detector plate circuit.

When the grid leak and condenser are properly proportioned the voltage developed across them is almost exactly proportional to the r.f. signal amplitude and hence is a faithful reproduction of the modulation envelope. The voltage across the load consists of a d.c. component proportional to the carrier amplitude and an a.c. component varying with the modulation. The d.c. component places a negative bias upon the grids and is of proper polarity for automatic volume control.

The values of grid leak resistance and condenser capacity must be properly chosen with regard to rectification efficiency, distortion, input resistance to radio frequencies and the r.f. input to the tube. When it is desired to obtain extremely high quality, the resistance can be about one-quarter megohm but in general a resistance of one-half to one megohm can be used.

The power capacity of this new detector is determined by the maximum audio voltage the tube can amplify without distortion. With the two grids connected together the tube is essentially a triode with a mu of the order of 9 to 12 and a plate resistance of between 10,000 and 20,000 ohms.

On the assumption of a d.c. rectification efficiency of 70 per cent the largest carrier voltage that can be handled is about 21.3 peak volts and when 100 per cent modulated the peak audio voltage across the grid leak would be about 10.65 volts, which would develop ample output to excite any pentode or push-pull amplifier.

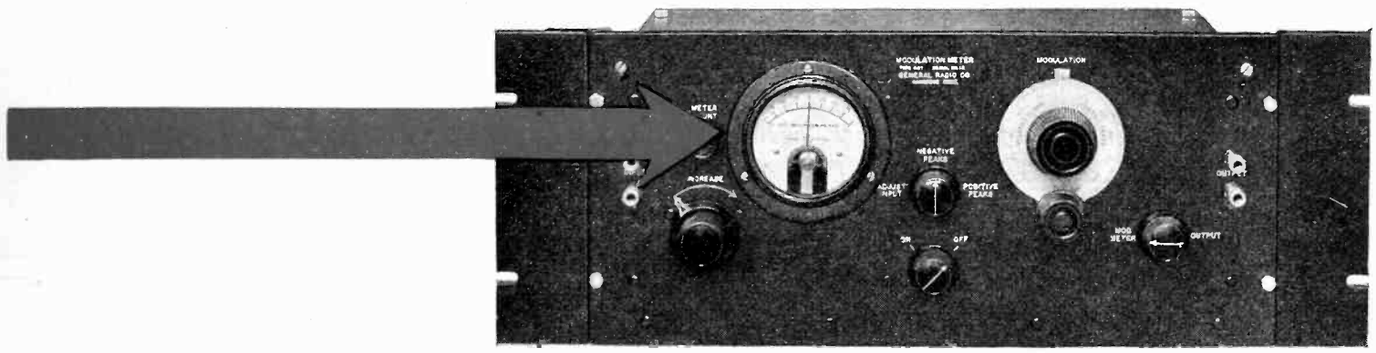
The amount of negative d.c. voltage available for automatic volume control purposes depends upon the way in which the plate circuit is arranged and in the case of the Wunderlich tube can be of the order of 15 volts.

When compared with the plate rectifier commonly employed in broadcast receivers, the Wunderlich detector has the advantage of a somewhat greater rectification efficiency, particularly when the signal voltage is in the order of several volts. The tube has ample power capacity to excite the power amplifier of any broadcast receiver now on the market, and also supplies a voltage which can be used directly for automatic volume control purposes. When compared with the triode type of grid leak power detector, this push-pull detector has about the same efficiency, introduces less distortion because the balanced input circuit prevents simultaneous grid and plate rectification, and develops approximately twice as much output voltage. The only disadvantage when compared with the corresponding triode rectifier is that the center-tapped input circuit requires twice as great a signal voltage for excitation.

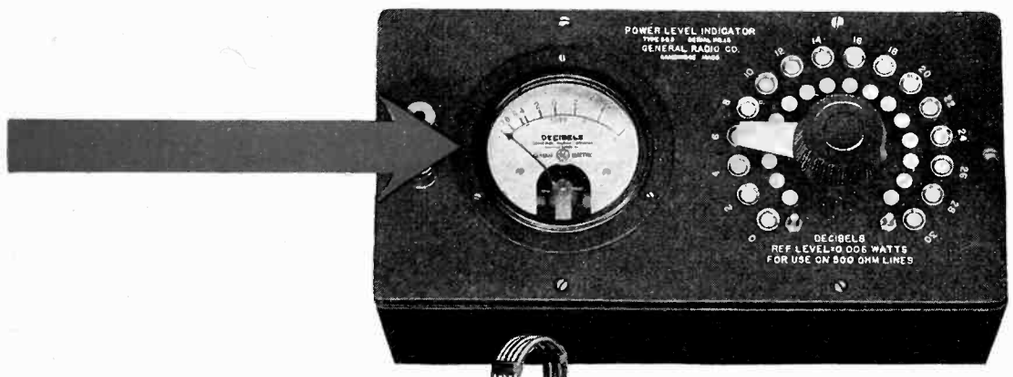
*By F. E. Terman, Sc.D., Stanford University.

Instruments of Quality

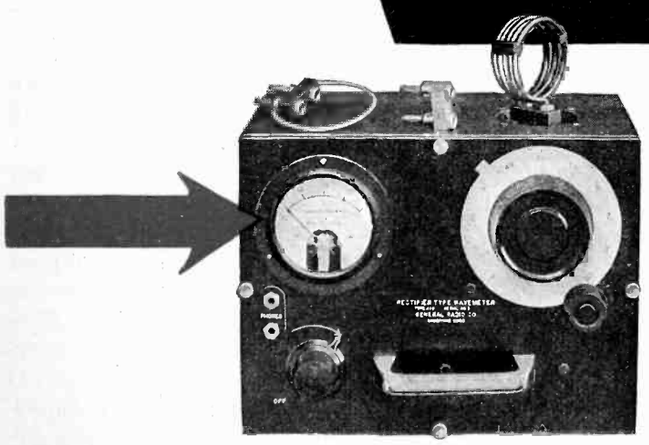
PRODUCTS OF GENERAL RADIO COMPANY WITH GENERAL ELECTRIC MINIATURE INSTRUMENTS



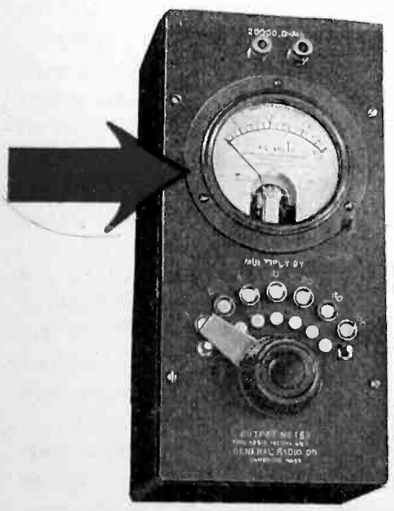
Modulation Meter



Power Level Indicator



Rectifier-type Wave Meter



Output Meter

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Power detection characteristics of pentode tubes

[*Continued from page 127*]

to note their effectiveness compared with the heater type three-electrode detectors. It is quite interesting to note that a load resistance of 7,000 ohms gives the best power output for pentode detectors as well as for pentode amplifiers. The value of these measured results lies not so much in the possibility of satisfactory operation of sensitive loudspeakers directly from a pentode detector, but rather in the fact that they indicate that the high power output is available in many applications where it is desired. For instance, it would be desired in the excitation of power amplifiers at the high frequencies encountered in television, or in carrier current long-distance telephony. Figure 5 shows what can be obtained from a pentode detector with greater input voltages, and a one-megohm grid leak resistance. When using this value of grid leak the distortion seems to vary somewhat, but did not seem to be objectionable at any time. In all of the experimental work reported in this paper the cathode grid was connected to the filament. Biasing the cathode grid in specially constructed tubes did not seem to improve detection noticeably.

Very briefly, it may be concluded that pentode tubes show quite highly desirable detection characteristics. The pentode type of tube seems to be not merely a tube functioning satisfactorily on power detection, but it really seems to be a *power detector,* putting out, roughly

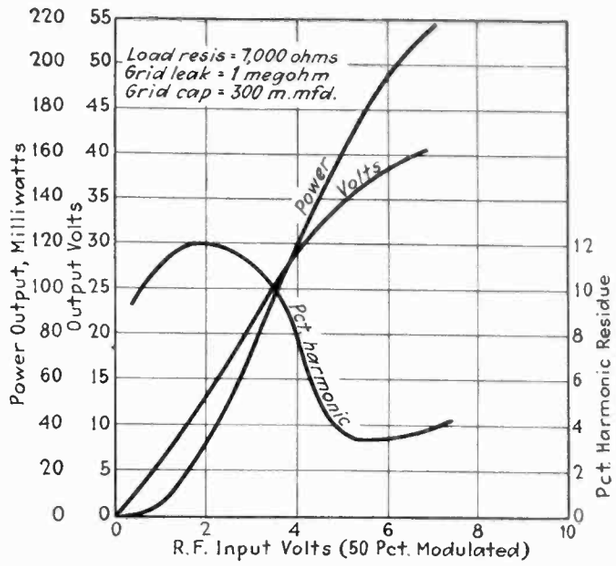

Fig. 5—Pentode detector performance

estimating, ten times as much power as any other type of detector with which the writers are familiar. The authors regret that the measurements were not carried out in a more complete fashion, using higher values of input potential modulated 50 to 30 per cent, and using a sensitive precision harmonic analyzer to obtain quantitative measurements of the amplitudes of the harmonics of different orders present in the detector output voltages.

A thyratron voltage regulator

[*Continued from page 133*]

"bucking" action, however, is that when the generator is shut down, either purposely or by failure of voltage supply to its driving motor, the regulator automatically takes itself out of operation, instead of going to an unreasonably high output trying to maintain a falling voltage, as would be the case with a circuit connected for boosting. With the time delay relay L in the circuit and the bucking connection, the motor generator set giving regulated voltage may be brought into or taken out of operation by pressing of the motor control button.

Several voltage regulators have been proposed using pliotrons, the output of which supplied at least part of the field current for the exciter generator. With such an arrangement the time constants of both exciter and generator fields enter, with the result that hunting effects must be controlled by special means. In the present instance the time constant of the generator only enters, with the result that hunting effects are of such high frequency and small amplitude that they are negligible.

The regulator was assembled on a panel 16 in. by 40 in. and mounted alongside the generator control panel. In Fig. 2 is a photograph of the motor generator set with regulator in operation. At the top of the panel may be seen the thyratron, below it the four lamps of the control bridge, then the plate ammeter and filament rheostat knob and voltmeter, followed by the time delay relay, fuses, test-operated switch, and the voltmeter receptacle.

In describing the performance of the regulator on the count of steadiness some idea may be conveyed by the fact that the frequency of the hunting action is a function of the regulator output current, varying from 5 or 10 cycles per second at low output currents to a very high rate at an output of 1.2 amperes. Since the very slowest rates of hunting can be easily avoided by slightly increasing the exciter voltage and consequently increasing the average regulator output current, no difficulty has been experienced in obtaining quick enough action to enable reading the meters in the load circuits to good precision. It may also be mentioned that the steadiness of the thyratron regulator is better than that of a regulator of the saturated core transformer type controlled by mechanical relays and especially designed for a high speed of action.

The second feature of regulator behavior, constancy over long periods of time, may be indicated in part by load and excitation-regulation curves, for these are the two major causes of voltage variation in the unregulated generator. Fig. 3 shows the variation of generator output voltage, as measured at the lamp bridge, with variation of generator load, up to three fourths of the rated capacity of the generator, which is at present more than 200 per cent of the working load of the laboratory. Fig. 4 shows the variation of generator output voltage with changing exciter voltage. It may be readily seen that neither of these two causes of variation cause the voltage to deviate more than about ½ per cent from minimum to maximum. Some daily change in voltage has been observed, presumably due to changes in ambient temperature, but this has amounted to a variation of only 0.1 to 0.2 per cent.

Since completion of the regulator one thyratron tube gave continuous service for about 3,200 hours, while the second tube is still in operation. On the whole the performance of the thyratron has been so satisfactory that plans are under consideration for converting the above mentioned saturated core regulator to thyratron control.