electronics

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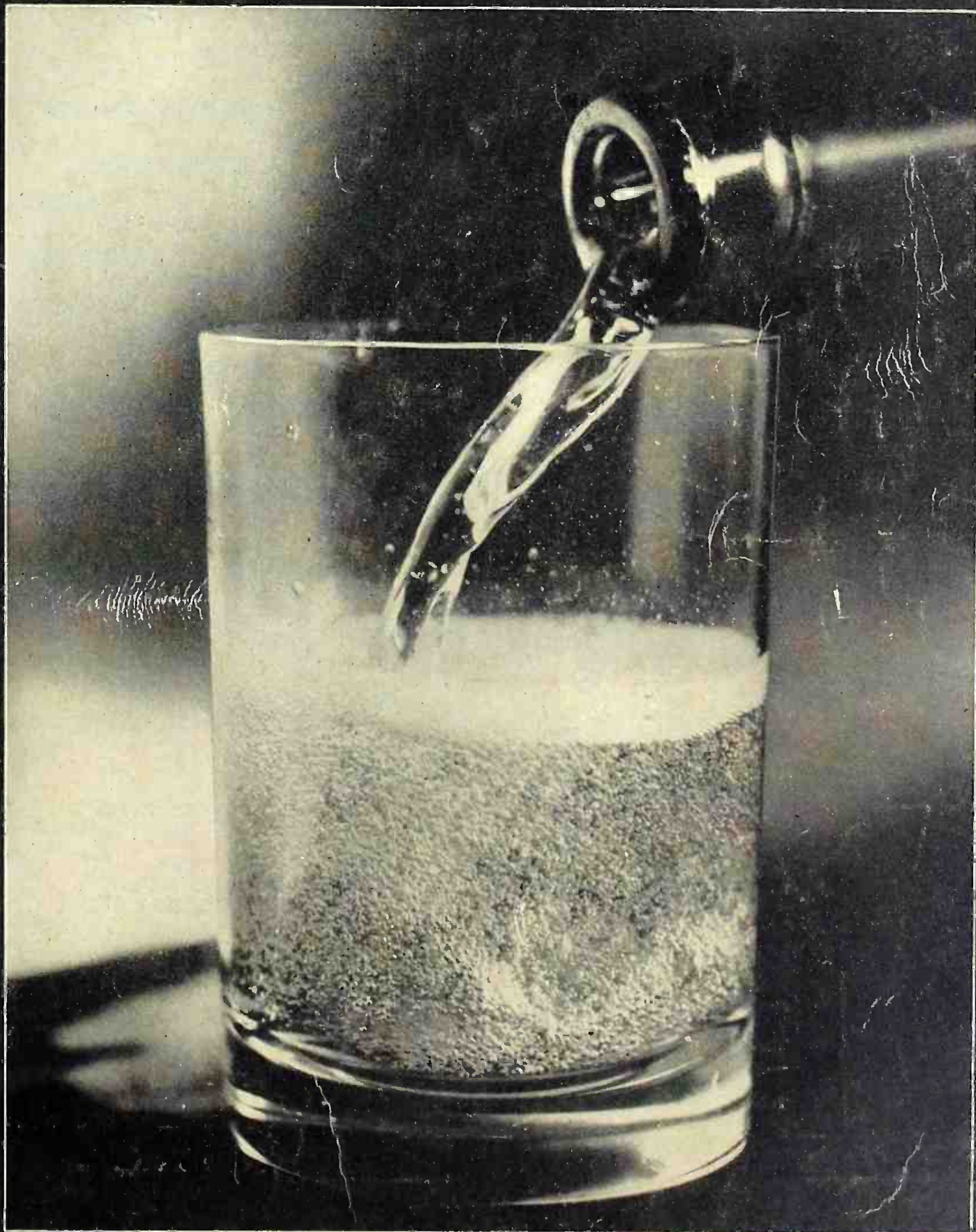
Maintenance costs broadcasting



Snapped in thirteen millionths of a second with tube-timed arc. See page 251

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electronics

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New York, August, 1934

radio
sound pictures
telephony
broadcasting
telegraphy
counting
grading
carrier systems
beam transmission
photo cells
facsimile
electric recording
amplifiers
phonographs
measurements
receivers
therapeutics
traffic control
musical instruments
machine control
television
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Broadcasting up-to-date

SIX years have now gone by since the sweeping broadcast reallocation of 1928. These years have witnessed many important technical advances in the art. New standards of listener service have now come to be requirements. New possibilities have been opened up by inventions and developments and refinements of a dozen laboratories. Experience with the broadcast band and other parts of the radio spectrum has given radio engineers a better understanding of the special properties of various frequencies. New frontiers are now being explored in the shortwave and ultra-shortwave region which may have important effects on broadcasting service itself.

IT is time, we think, to look at the broadcasting picture in terms of these new technical improvements,—to see what could be accomplished for listener service if all this new knowledge were applied to broadcast reallocation.

What about synchronizing? To what extent can it improve regional service? Are we ready for chain operation on common frequencies?

Shall we have 15-kc. or 20-kc. broadcast channels, for high-fidelity service?

What are the new possibilities of "high power"—500 kw. and higher?

Can we not provide for several hundred additional broadcast stations, as well as taking care of the national needs of Canada, Mexico and Cuba?

Is the broadcast band itself rightly located? Shall we continue to ignore the long waves used in Europe? Shall we extend beyond 1600 kc.? Where do the short waves and ultra-short waves belong in this broadcasting picture, for local distribution?

THE materials which the Federal radio authorities now have to work with are far different from those with which a little devoted band of technical advisers to the old Radio Commission sweated at Washington during that tepid August of 1928, when the principles of the present allocation were laid down.

Fair as that allocation was, and is—despite the ravages of political meddlers with radio engineering principles—it is now time to review it critically in terms of the new technical possibilities that have developed since. And if necessary, the broadcast set-up should be *recast* to embody the new principles and the wider, fuller service to the public which is broadcasting's destiny.

"SELF-GOVERNMENT" AND

Autonomy for radio-receiver manufacturing group before NRA, is goal of Radio Manufacturers Association

L. F. Muter,
President RMA

Captain Wm. Sparks,
Chairman Code Committee

A RADIO code of its own, and self-government under a separate NRA administration—these are the principles for which the Radio Manufacturers Association has been waging a vigorous fight. With its own special code, the radio-receiver industry believes it can work more effectively to eliminate industry ills and to improve radio-trade conditions, and has accordingly filed with the NRA at Washington its 1934 "Code of Fair Competition for the Radio Manufacturing Industry."

The RMA has also applied for exemption from the National Electrical Manufacturers Association Code, under which it has been operating for nearly a year, and a hearing on this issue of withdrawal from NEMA and the setting up of a separate RMA Code was conducted at Washington, July 23, with Col. James G. Cowling, deputy NRA administrator, presiding.

President Leslie Muter led the presentation of the case for the Radio Manufacturers Association, and introduced Captain William Sparks, chairman of the RMA Code Committee; Bond Geddes, executive vice-president of the association; Judge Van Allen, counsel, and others. Associated with Captain Sparks in the drafting of the new radio-receiver code, have been: A. S. Wells of Chicago, James M. Skinner of Philadelphia, S. W. Muldowny of New York, chairman of the RMA Tube Division and supervisor of the electrical code for tube manufacturers, and Arthur Moss of New York. Also associated with the RMA committee was Arthur T. Murray of Springfield, Mass., chairman of the RMA Set Division and supervisory agency, under the electrical code, for set manufacturers. Hugh H. Eby of Philadelphia, a founder and former RMA director, and E. J. Ellig of Cincinnati were other witnesses. Also among the RMA delegation were Fred D. Williams of Indianapolis, past president of the RMA; B. G. Erskine of New York, and Roy Burlew of Owensboro, Ky.

A lengthy statement detailing the many reasons in support of an independent code for the radio industry, with a volume of supporting evidence, statistics, etc., was presented to the NRA tribunal by Captain Sparks. It stressed:

1. That the radio industry is a separate and distinct industry.
2. That the Radio Manufacturers Association and its membership is "truly representative" of the industry, and
3. That good cause exists for a separate code instead of continuing under the electrical code.

The representative membership, invested capital, annual sales, labor employment, RMA engineering development, and many RMA services to members were emphasized in stressing the long existence of the radio industry as a separate and distinct industrial group. Its distinct merchandising problems and distribution channels also were cited and the NRA was urged to secure the U. S. Treasury excise tax returns to prove mathematically that the RMA is "truly representative" of the industry as required by the law.

The National Electrical Manufacturers Association was represented by F. E. Neagle, counsel, and W. J. Donald, managing director.

The petitions, statements and briefs presented by NEMA, and the discussions resulting therefrom, brought out the arguments that radio receiving sets are assemblies of electrical parts, all of which are used in other applications than radio and are produced under the provisions of the Electrical Manufacturing Industry Code; that a separate code, including receiving sets and parts thereof, would for that reason acquire the nature of a horizontal code, cutting across the electrical manufacturing industry, also other industries, such as the furniture industry, metal stamping, screws and molded products, etc.; that such horizontal codes, particularly in substantial numbers, through confusion and conflict, make code compliance difficult if not impossible.

It was pointed out by the NEMA speakers that the desires and needs of the manufacturers of radio receiving sets for the establishment of fair-trade-practice code

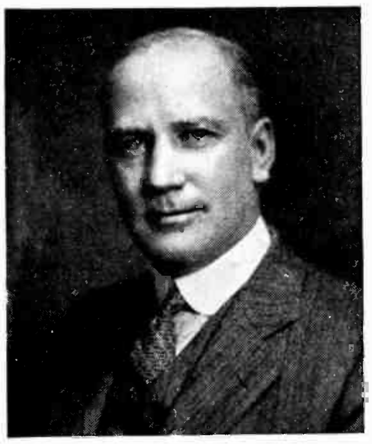
What the radio manufacturers seek to accomplish—

- Self-government of radio-manufacturing industry in NRA matters
- Reduced NRA administration expense, and simplification
- Provision for radio industry's special fall peak-load
- A 40-hour week for factory employees
- Open-price plan with "two-day" notice
- Elimination of sales below cost, leaders, etc.
- Prevention of corrupt sales practices

NEW CODE, RMA AIMS

Officials outline improved industry and trade practices, which special RMA Code would bring about for radio

A. Moss, New York



A. S. Wells, Chicago

provisions, could be met by the formulation of a supplemental code under the Electrical Manufacturing Industry Code, which would obviate the necessity for a separate code.

An interesting point in connection with this hearing was the demand submitted by representatives of labor organizations for representation on the Code Authority of the separate code for which the Radio Manufacturers Associated stated it intended to apply. Labor representatives declared that they were in favor of the proposed separate code because it would afford them their opportunity for such representation.

Administrative costs; labor provisions

The high cost of code administration under the Electrical Code plan, was emphasized by RMA speakers, who declared that the annual expense to the radio industry of administering the code under the NEMA would reach $100,000. In contrast with this, it was declared that a $5,000-a-year outlay would well cover all the costs of administering a separate code from the RMA office at Washington. This estimate of code expense was made by A. T. Murray, administrative officer for the radio group, who declared that he had been one of those at first in favor of placing the radio industry under the electrical code, but that the past nine months of actual operation had shown him his mistake.

Special manufacturing conditions which exist in radio, where under the customary peak load production most of the radio sets for the year are made during two-and-a-half months, were also urged as an argument for special code provisions for radio, which cannot be obtained under the present electrical code. Involved in this is the 40-hour week for which the radio-set makers are applying under their new code.

At the present time the radio and electrical industries are operating under a 36-hour week. Out of the 400 industries operating under codes, at least thirty-five industries have already obtained employment hours in excess of the maximum permitted to the electrical code, and it was urged by the RMA representatives that radio manufacturing should be equally well treated, particularly in view of its special peak employment requirements.

Hours and wages—a 40-hour week

In the new Code of Fair Competition for the Radio Manufacturing Industry, as submitted to the NRA administration, the term "industry" includes those who manufacture for sale (1) radio and television receiving sets, (2) radio and television tubes, electronic tubes and valves, and (3) parts, cabinets and accessories for radio and television sets, including all component parts thereof, and also equipment for the distribution of sound, originating from such receiving sets or an electric phonograph.

Under "Hours" it is provided that "No employee engaged in the processing of products of this industry and in labor operations directly incidental thereto, shall work or be permitted to work in excess of 40 hours per week, averaged over a twelve-month period. . . . provided however that such employees may be employed not more than six days or 48 hours in one week. No office, salaried or other employee receiving less than $35 a week, shall be permitted to work more than six days or 48 hours in any one week, and not more than an average of 40 hours per week for each twelve months' period."

Under "Wages" it is specified that no male employee shall be paid less than 40 cents per hour, and no female employee less than 32 cents per hour. Accounting, clerical and office employees shall not receive less than $15

J. M. Skinner, Phila.

S. W. Muldowny, N. Y.

a week. Such minimum rates of pay shall apply whether an employee is actually compensated on a time-rate, piece-rate, or other basis.

Employees shall have the right to bargain collectively,

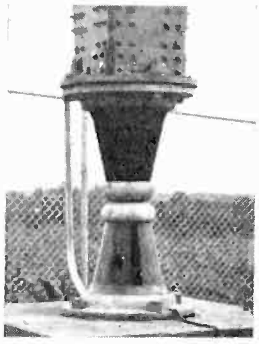
[*Please turn to page 263*]

Increased efficiency from TOWER ANTENNAS

— A REVIEW

By EDMUND A. LAPORT

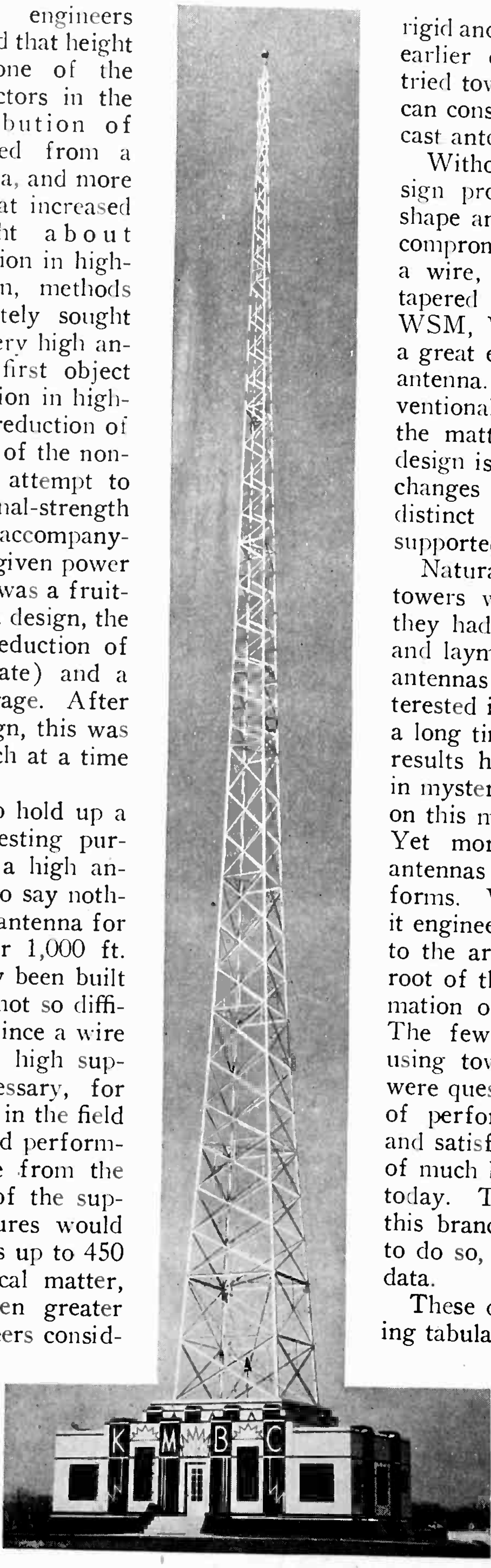
Consulting Radio Engineer, Montclair, N. J.



Base insulator at WCAU.

WHEN engineers learned that height was one of the controlling factors in the space-distribution of energy radiated from a vertical antenna, and more specifically, that increased height brought about marked reduction in high-angle radiation, methods were immediately sought for building very high antennas. The first object for taking advantage of this reduction in high-angle radiation was, of course, the reduction of fading; or, at least, an enlargement of the non-fading area. The second was to attempt to realize the predicted increase in signal-strength along the ground and at low angles, accompanying the high-angle reduction, for a given power input to the antenna. Here indeed was a fruitful field for development in antenna design, the reward being simultaneously the reduction of fading (the worst kind, at any rate) and a stronger signal, giving greater coverage. After years of stagnation in antenna design, this was a great stimulant to antenna research at a time when it was sorely needed.

While a balloon could be used to hold up a small wire of great height for testing purposes, the practical installation of a high antenna brought up new mechanical, to say nothing of financial, problems. A 5/8λ antenna for operation on 550 kc. must be over 1,000 ft. high. Such an antenna has actually been built at Budapest. For 1,500 kc. it was not so difficult, only 400 ft. being required. Since a wire could not be made self-supporting, high supporting structures would be necessary, for which steel was essential. But steel in the field of the antenna is detrimental to good performance, unless it is at great distance from the wire. Therefore, in any antenna of the supported-wire type, two such structures would be required. The use of two towers up to 450 ft. or so was a thoroughly practical matter, and not very expensive; but when greater heights were necessary, some engineers considered the supported wire to be out of the question. As a compromise, they turned to the use of the tower itself as the antenna. This could be made mechanically rigid and only one would be required. Although earlier experimenters, some very early, had tried towers and metallic poles as antennas, we can consider that the story of towers as broadcast antennas starts at this point.

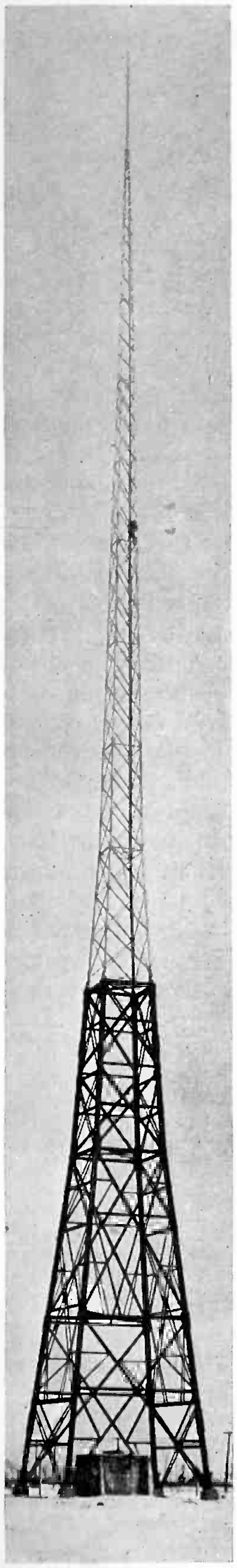


Tower radiator of KMBC mounted on station building.

Without going into a discussion of the design problems which gave a very distinctive shape and construction to the best engineering compromise in the substitution of a tower for a wire, we will merely refer to the double-tapered cantilever steel tower of the WABC, WSM, WLW, WCAU type as the result of a great engineering effort toward an improved antenna. Following this, towers of more conventional form were applied as radiators. As the matter stands at present, tower radiator design is decidedly in a state of flux and rapid changes are imminent. There seems to be a distinct trend of opinion in favor of self-supported radiators.

Naturally, the construction of the new high towers was very spectacular, especially since they had some genuine eye value. Engineers and laymen, those who knew something about antennas and those who didn't, were much interested in these first tower radiators. But for a long time, even up to the present time, their results have been quite generally enshrouded in mystery. The hoped-for engineering papers on this momentous experiment did not appear. Yet more stations were using towers for antennas and the later ones were of different forms. Was this the growth of a fad or was it engineering progress? As a technical service to the art, *Electronics* attempted to go to the root of this mystery and decided to ask information of those who were using the towers. The few stations which were known to be using tower radiators in the broadcast band were questioned upon certain pertinent matters of performance. The response was cordial and satisfactory, and we are thus in possession of much basic data on this subject as it stands today. The stations which have pioneered in this branch of the art and spent good money to do so, graciously permit us to publish their data.

These data are presented in the accompanying tabulation (page 240) in as concise a form as was consistent with clarity. Unfortunately, some of the stations have not yet made the measurements most essential for an analysis of performance on a



Wood-steel tower at WEBC.

comparative basis, but it is hoped that results of such measurements may be published later if they become available. Also some stations did not respond to the questions and it is quite possible that they may wish later to contribute from their experience to this interesting subject.

Analyzing antenna performance

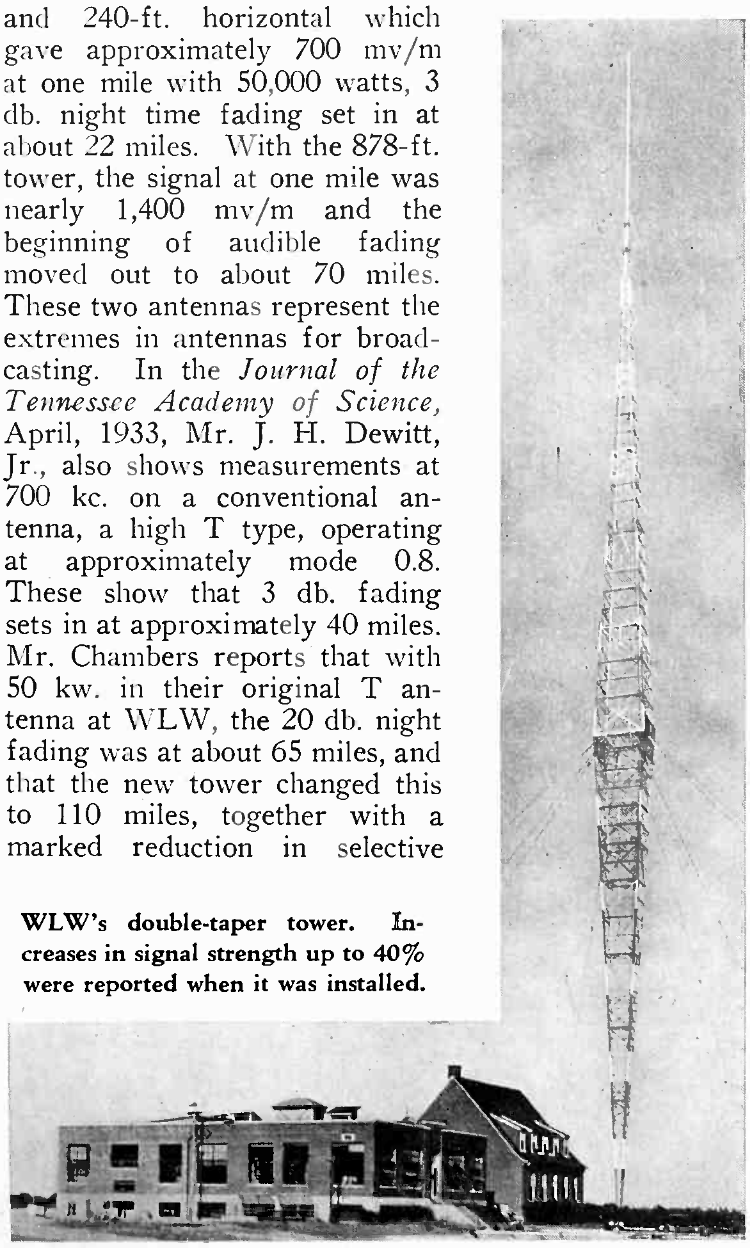
In analyzing antenna performance, the first value one must know is the fundamental wavelength of the system, λ_o. This is the longest wavelength to which the antenna will tune naturally, without any additional inductance or capacitance, when connected directly to earth. From the physical length (λ) of the antenna from grade level and the known fundamental wavelength, the average velocity of propagation of waves in the system can be determined, as well as the mode of operation λ/λ_o. With this value, and the measured antenna resistance, we can check back to theory and find whether or not there is agreement. Hence the second important value to be known is the antenna resistance. With a sufficient number of *accurate* resistance measurements over a great range of modes (say from 1.0 to 0.3) it would be possible to gain much knowledge of the physics of operation of the antenna.

The third requirement for analysis is a knowledge of the field intensity at one mile from the antenna. This is taken as the average radius of the polar curve drawn through a number of individual measurements made at exactly one mile from the antenna in several directions. The signal-producing ability of a broadcast antenna, its radiation efficiency, can thus be determined. The one-mile standard is quite generally used in this country. It is far enough from the antenna to be in the pure radiation field and yet near enough so that attenuation of field is low and often negligible. (European engineers use the one-kilometer circle as standard). Utmost correctness in rating antenna performance, however, requires that attenuation at one mile be taken into account, and that actual measurements be corrected accordingly.

Fading is the fourth point of fundamental interest. Unfortunately, due to unlimited complications in fading phenomena, complete data are hard to obtain, difficult to analyze, and impossible to present descriptively in other than highly technical form. Probably the most important fact in connection with fading is the distance from the transmitter where it becomes audible, on the average (say 3 db. variation in intensity) at night.

The tabulation with appended notes contains some interesting data on these four basic points. The λ/λ_o values have been computed, and the field intensities at one mile converted to 1,000 watts. From this we can see at once how the various antennas compare in performance. To permit comparison of these values with average well-constructed wire antennas supported by towers and operating at approximately mode 0.75, data from a great many such antennas show that field intensities between 140 and 240 millivolts per meter are realized at one mile with 1,000 watts. Several stations report increases in signal strength of from 30 to 40 per cent over that of previous installations.

Performance data as submitted indicate generally some improvement over older forms. Part of this improvement is undoubtedly due to the removal of two towers from the radiation field of a suspended antenna. Stations which used low antennas of the old-fashioned form, of course, noted large improvement after going over to a radiating tower. Some improvement was noted over the conventional high antennas used by the better stations since about 1928. WSM, WLW, and Budapest have obtained actual figures on the improvement and all these stations were able to make direct comparisons from the same geographical location. At WSM, using an inverted L antenna with a 90-ft. vertical and 240-ft. horizontal which gave approximately 700 mv/m at one mile with 50,000 watts, 3 db. night time fading set in at about 22 miles. With the 878-ft. tower, the signal at one mile was nearly 1,400 mv/m and the beginning of audible fading moved out to about 70 miles. These two antennas represent the extremes in antennas for broadcasting. In the *Journal of the Tennessee Academy of Science,* April, 1933, Mr. J. H. Dewitt, Jr., also shows measurements at 700 kc. on a conventional antenna, a high T type, operating at approximately mode 0.8. These show that 3 db. fading sets in at approximately 40 miles. Mr. Chambers reports that with 50 kw. in their original T antenna at WLW, the 20 db. night fading was at about 65 miles, and that the new tower changed this to 110 miles, together with a marked reduction in selective



WLW's double-taper tower. Increases in signal strength up to 40% were reported when it was installed.

fading; also that the fading-free area was increased 62 per cent. Figures published for the Budapest antenna (see *"Electrical Communication"* for April, 1934) show a one-hundred-per-cent increase in fading-free service area, according to listeners' reports, and sets the limits of this area at 180-200 km. from the antenna.

KMBC reports that it tried a high capacity top to its tower antenna (see photograph) composed of four 12-ft. radials, but that a distinct reduction in efficiency resulted. Another station uses a high-capacity top, but found that the size necessary to produce improvement in service was very critical.

Theory vs. practice in tower design

The mathematical research which underlies the present developments, due to Ballantine, shows an optimum height for an antenna. The equations revealed optimum performance to occur when the ratio of operating wavelength to fundamental wavelength λ/λ_0 was 0.39 (c.f. values of this ratio in the table column 10). This condition was shown to prevail when the antenna was 0.625λ high, or $5/8\lambda$. Greater heights were detrimental to the desired performance for broadcasting applications, perhaps even more so than slightly lower ones.

These theoretical results were based on the following important assumptions: (1) a velocity of propagation of waves in the antenna equal to that in free-space; (2) the velocity being the same in all parts of the antenna; and (3) a sinusoidal distribution of the standing wave of current in the system. The velocity considerations are implied in taking the fundamental wavelength as being four times the length and are most nearly realized in real life by a filamentary conductor whose diameter is vanishingly small with respect to the length, such as a small wire. Such a wire also seems to permit as close an approach to sinusoidal current distribution as is possible in a radiating conductor. If a system has natural constants which give (a) a velocity of propagation other than 3×10^8 meters-per-second, (b) non-uniform velocity, or (c) a current distribution other than sinusoidal, of course other modes than 0.39 would be optimum. It might be better to say that optimum performance for broadcast purposes occurs when the center of radiation is 3/8 wavelength above the reflecting ground surface. The data thus far obtained with tower radiators show that conditions (a), (b) and (c) are more nearly in accordance with the facts of physical operation than (1), (2) and (3).

Considerable speculation has existed among antenna engineers regarding the actual existence of the predicted parasitic lobe of high-angle radiation (see Fig. 1) from the $5/8\lambda$ towers. It is now quite definitely established that this lobe does not appear with the present form of radiator. (See pp. 624-25, I.R.E. Proceedings, May, 1934). When the center of current distribution in the antenna exceeds 0.25λ above the electrical ground, the direct and reflected radiations above a certain angle pass through a point of maximum destructive interference and begin to add again vectorially, with the result that the polar diagram of space radiation shows a second maximum, or parasitic lobe, at high angles. The failure of this lobe to appear indicates strongly a center of current equal to or less than 0.25λ above ground. If an antenna 0.62λ high has a center of current less than 0.25λ above ground, the current distribution must depart widely from sinusoidal

Tabulated summary of tower radiator data

Station	Operating wavelength	Tower height[2]	Base resistance at operating mode	Fundamental wavelength	Operating power-watts	Field intensity at one mile	Fading observations	Increase in signal intensity over previous antenna	Mode of operation (λ/λ_0)	Field intensity per 1000 watts at one mile[7]	Ground system: Number of radials	Ground system: Length of radials	Ground system: Depth below grade level[16]
A	348.6	620	200	N.I.	50,000	1,600	See 8, 9	N.I.	N.I.	226	36	326	$1\frac{1}{3}$
Budapest	549.6	1,045	269	1,266	120,000	2,800	See 14	See 15	0.435	254	....	586	$1\frac{2}{3}$
B[1]	243.8	420	220	584	1,000	225	N.R.	N.R.	0.418	220	N.R.	.....	.....
C[1]	212.6	420	185	584	500	175	N.R.	N.R.	0.364	247	N.R.	.....	.....
WFEA	209.7	400	185	N.I.	500	100[1]	N.I.	See 8	N.I.	141	85	360	$1\frac{1}{2}$
WSM	461.3	878	212	1,220	50,000	1,380[10]	See text	See 10	0.378	212	60	450	.....
WCAU	256.3	505	97	690	50,000	1,300	See 8	See 8	0.372	184	Approx. 36	250	.....
WLW	428.3	831	185	1,090	50,000	1,900	See text	See 12	0.393	269[6]	72	450	2
WEBC	232.4	355[11]	1,160	568	1,000	N.I.	N.I.	N.I.	0.41	N.I.	12	150	1
KDFN	211.1	200[3]	N.I.	N.I.	500	N.I.	N.I.[8]	N.I.	N.I.	N.I.		Buried radials	
KMBC	315.6	274[4]	46.5	375	1,000	200	See 5, 8	See 13	0.84	200	32	169	N.R.
Breslau	325	455	.....	.....	....	.....	See text	See text	0.4	.....	N.I.	N.I.	N.I.

N.I. means "no information available."
N.R. means "no report received."
Wavelengths are in meters.
Field intensities are in millivolts per meter.
[1]Data made public in a paper delivered before Boston Section, I.R.E. in March, 1932. An improvement in overall performance was shown. No data received in response to questionnaire.
[2]Height given in feet above grade level.
[3]Lower 20 ft. of tower built of wood, the steel resting upon this wood.
[4]Antenna built upon roof of building.
[5]Reduced fading reported by listeners but no engineering data available.
[6]This is apparently the highest signal intensity at 1 mile ever measured.
[7]Seasonal variations of several per cent are often noted in such measurements, according to reports.
[8]New antenna in new location, therefore no comparative data between old and new antennas from same site.
[9]30% increase in non-fading area.
[10]With low inverted L antenna and 50 kw. approximately 700 at 1 mile. With tower, approximately 1,500 at 1 mile. These values were not specifically reported; data obtained from field intensity curves submitted.
[11]Lower 120 ft. of tower built of wood, supporting steel-work.
[12]32–40% increase in signal throughout primary and secondary service areas.
[13]Reports 4 db. at 5 miles.
[14]Listeners' reports indicate fading audible at 180-200 km. Fading-free area doubled.
[15]25% increase at 1 km. over previous antenna operating at mode 0.63. For description of original antenna see Proc. I.R.E. July, 1929, page 1178.
[16]Depth in feet.

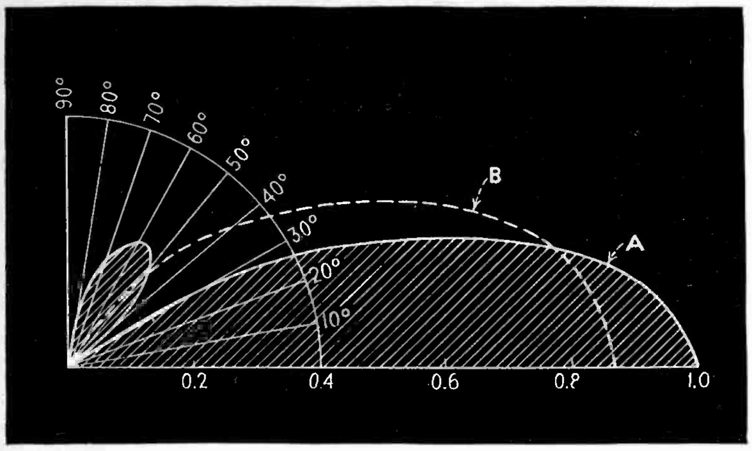


Fig. 1—Cross-section of solid of revolution representing relative field intensities at various angles above the horizon. Curve A corresponds to the current distribution shown in curve A of Fig. 2, while curve B is what might be expected from an antenna operating under the conditions of curve B, Fig. 2. A perfectly conducting ground is assumed.

form. A possible distribution is shown in Curve *B* of Fig. 2 as compared with the theoretical sinusoidal form of Curve *A*, same figure.

When the velocity of propagation in an antenna is uniform, the relation between its fundamental wavelengths for different heights is a straight line. When the velocity is 3×10^8 m/s the slope of this line is 1.23. Average data from a number of vertical wire antennas supported by towers show an average velocity of 2.7×10^8 m/s. A simple and useful method of gaining some idea of wave propagation conditions in a tower radiator is to plot a curve of height against measured fundamental wavelength as the tower progresses in height. Such measurements were taken on the Budapest antenna. At the point where measurements were started, just above the waist of the tower where the guys attach, the average velocity of propagation for that height is 2.35×10^8 m/s, while at its full height it becomes 3×10^8 m/s. Probably even lower velocities would have been found if measurements could have been made at lower heights. It appears that the lower half of the structure does most of the work (hence the low center of current), while the top end contributes relatively little to its useful characteristics.

We may gain some further information as to the comparison between a tower and a wire of the same fundamental wavelength by comparing the resistances at mode 0.50, when the antenna is half a wavelength long. Most of the double-tapered towers give resistances of the order of 500 ohms at this point, whereas a vertical wire in free space measures 3,600 ohms.

With the exception of the Budapest installation, European engineers seem to have preferred not to adopt the tower radiator to date. Breslau and Stuttgart stations employ antennas operating according to the same fundamental electrical principles but employ single vertical wires suspended along the axis of high wood towers. To conserve height of structure, they have used high capacity tops. (See front cover of *Electronics* for April, 1934.) Improvements in coverage and reductions in fading are attributed to these antennas, as might be expected from their very close approach to the conditions of the fundamental theory. Data given for the Breslau antenna are as follows: Tower (wood) height, 140 meters; ring at top, 10 meters diameter, equivalent to an additional 40 meters of vertical wire at 325 meters wavelength; current node 19 meters above ground and current antinode, 100 meters above ground; field intensity along the ground increased 25 per cent over vertical 0.25λ antenna; fading-free area increased 40 per cent over vertical 0.25λ wire. Direct comparisons were made from the same location by means of a disconnect switch in the wire. This antenna was operating at approximately mode 0.40. The curent maximum is 0.31 above ground and hence the space pattern should show a small parasitic lobe of high-angle radiation. No details in this regard are available to date.

To most broadcasters, the least attractive aspect of high antennas is their cost. While all have a desire for highly efficient antennas, few have been able to invest large sums in them. For this reason there are many American as well as European engineers who feel that the tower is not the ultimate solution of the broadcast antenna problem for the greatest number of stations. The ultimate solution must be one which accomplishes all that the present high towers do (and perhaps more) with structures of moderate height and reasonable cost. A few investigators are already convinced that such an objective is possible, and we may have something to look forward to in the near future. More important than building an antenna $5/8\lambda$ high is to get the center of radiation $\lambda/4$ to $3\lambda/8$ above ground.

Grounding systems

The ground system performs two primary functions. It serves as (1) an electrical contact with the earth which forms one electrode of the radiating system, and (2) a wave-reflecting surface. Power lost in the resistance of the ground system can be reduced by making this resistance as low as possible, or by so adjusting the mode of operation of the antenna that the antenna resistance is very high with respect to that of the ground, and the current entering the ground, for a given power, is relatively small.

Important as this entire subject is, there seems to have been a reluctance on the part of engineers to commit themselves. It is to be hoped that the art may soon enjoy the benefit of ideas and data of many workers in this field by more open discussion of the matter.

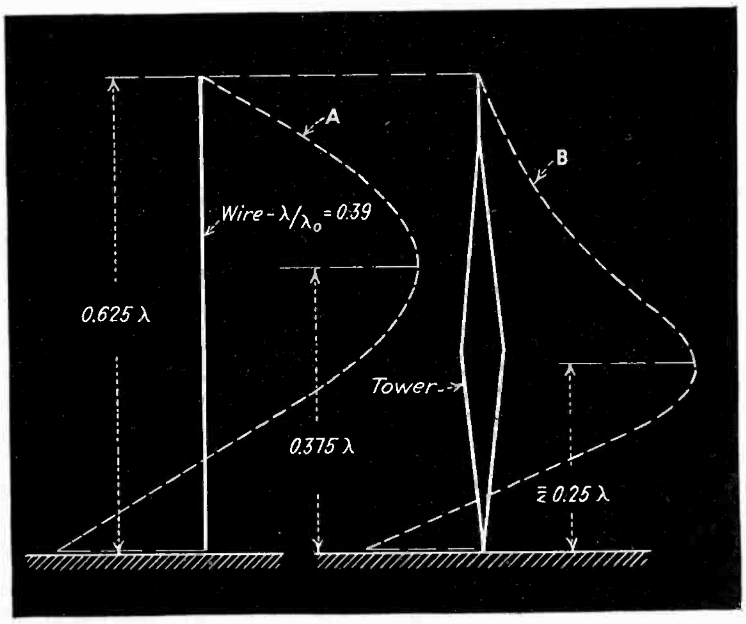


Fig. 2—Curve A: The sinusoidal current distribution in a wire, predicted by theory. Curve B: Possible configuration of current in a tower under actual conditions (cf. curve B, Fig. 1).

An electron multiplier

A new type of cold-cathode tube of high current amplifying ability marks another step toward the solution of television problems

MAKING use of secondary emission, a new type of cold-cathode tube performing all of the functions of conventional thermionic tubes has been developed by Philo T. Farnsworth of the Television Laboratories, Ltd., of Philadelphia and San Francisco. This new tube is a high-vacuum current amplifier of remarkable ability. It is as yet unnamed, and promises much not only for television by making brighter pictures possible but in other ways noted below.

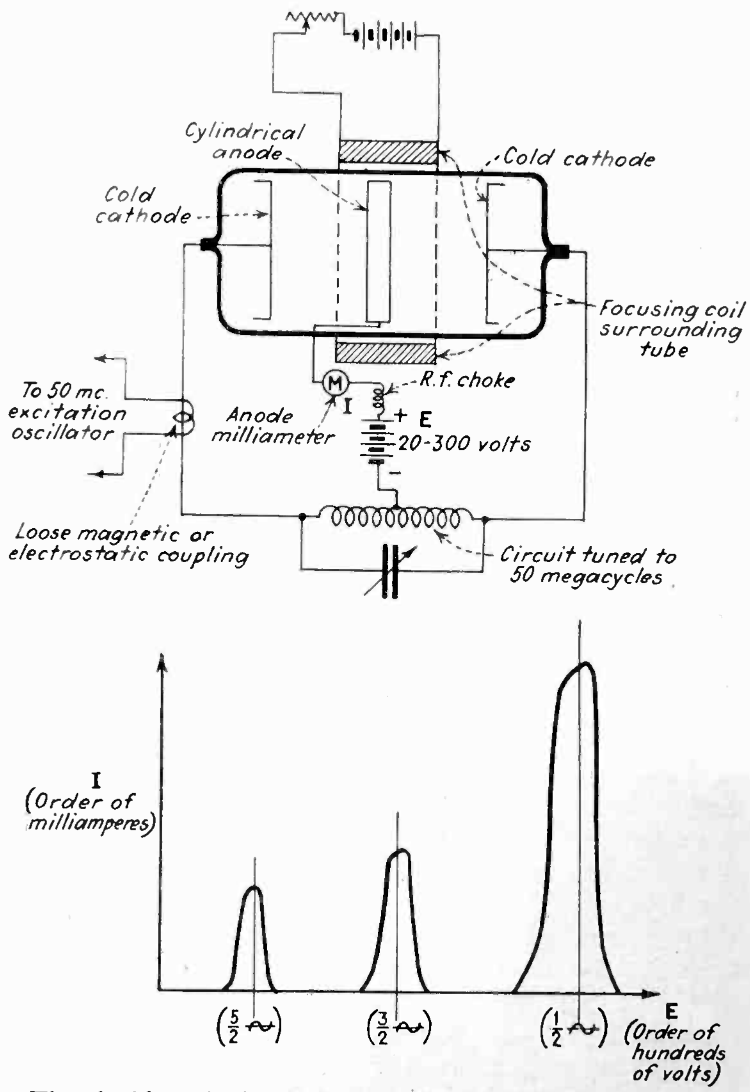
In a demonstration for the editors of *Electronics,* tubes containing two cold cathodes coated to enhance the secondary emission were made to amplify, oscillate and multiply an electron stream. Midway between the two cathodes, which may be flat or curved to automatically focus the electrons, is an anode in the form of a metal ring. An electron produced photoelectrically (as in television) or otherwise free to move is accelerated toward the anode which is kept at a positive voltage (several hundred volts) compared to the cathodes. It is kept from hitting the anode by immersing the tube in an electromagnetic field which imparts an additional component of motion causing it to miss the anode.

Therefore the electron goes through the field of the anode and striking the second cathode produces there additional carriers of electricity by secondary emission. These secondaries then travel to the first cathode through the anode field in exactly the same manner and produce additional electrons. The process, therefore, is cumulative, similar to that occurring in a gaseous discharge or phototube, where ionization electrons are formed. These tubes, however, are pumped to as high a vacuum as modern radio tubes; in fact any introduction of gas immediately reduces the phenomenon or causes it to cease.

The actual current amplification is enormous since the electrons may make as many as 100 complete circuits of the two cathodes, each time producing as many as 6 secondary electrons per original carrier. The order of amplification may be arrived at by the fact that currents of appreciable fractions of a microampere per lumen have been secured from a pure nickel plate not coated to increase its photoemissive ability. The number of electrons ordinarily secured from such a plate is extremely small.

The electron leaves the vicinity of the first cathode because of the positive d.c. voltage on the anode but it may not arrive at the second cathode with sufficient velocity or energy to dislodge an electron, or, in fact, it may not arrive there at all since the electron is decelerated at the same rate upon leaving the anode region as it is accelerated upon approaching it. Therefore some additional energy must be imparted to it. This is accomplished by putting across the two cathodes the terminals of a tuned circuit into which are induced voltages of the frequency of 50 megacycles, or thereabouts. The r.f. voltage across the coil may be 25 to 90 volts. The integral effect of the r.f. voltage acting upon the electron while in flight between cathodes is to provide it with sufficient energy to produce secondary carriers.

Three general types of tubes have been produced. In one type, the tube will not build up this magnified electron stream unless the external r.f. field is applied. In a second group are tubes in which oscillations are generated by the tube after an external exciting voltage has been applied. In a still third group, composed of the most sensitive tubes, self-oscillation occurs without the necessity of applying, even temporarily any exciting force. This seems to be a new phenomenon—a cold cathode, high vacuum tube producing of its own accord oscillations of appreciable power.



The double-cathode electron multiplier and associated apparatus. Connected as shown the tube acts as a highly efficient r.f. current amplifier. The volt ampere characteristics are shown below. The several peaks are produced by anode voltages bearing a definite relation to the transit time of the electron.

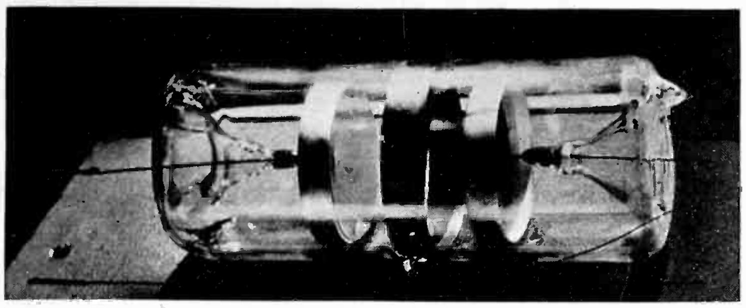


Plate-like cold cathodes with anode ring between. A tube five inches long with cathodes approximately 2 inches in diameter will produce 10 watts or more of high frequency power.

As the secondary emission process builds up the current in the tuned circuit increases. This current can be controlled by not only the steady external magnetic field, but by the d.c. voltage on the anode. If the anode voltage bears a certain relation to the geometry of the tube such that an electron is caused to make a complete transit in one-half cycle of the applied r.f. voltage, a maximum of anode current is secured. Other peaks of current occur at other voltages corresponding to transit times of other odd half-cycles. Current peaks corresponding to the 9/2 cycle have been observed, making 5 in all. The current-voltage relations in the anode are shown in the figure.

In a tube on demonstration, an anode current of 45 milliamperes flowed under a potential of 200 volts.

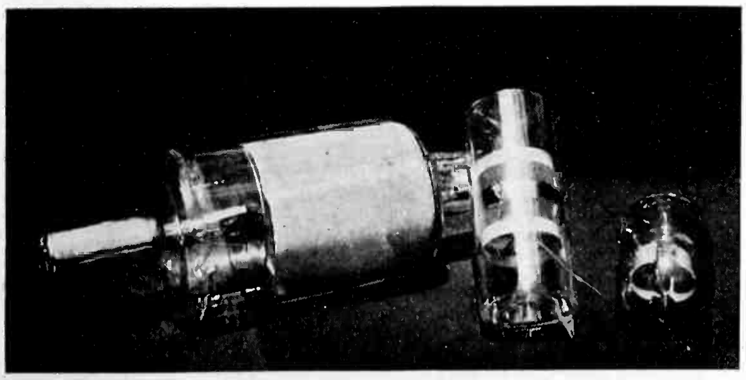
Resistance must be placed in the cathode leads to prevent the cumulative current multiplication process from continuing until the elements over-heat. It has been possible to ruin a tube by removing the current limiting resistors. In one case the cathodes burned up, not being able to dissipate the 100 watts flowing to them.

Thus the tubes not only act as current multipliers of high degree but they can be made to oscillate and because of non-linear portions of the E-I characteristic they will detect and modulate. As an amplifier, the tube and circuit become very efficient since the anode current may be kept extremely small by proper adjustment of the external steady field surrounding the tube. On the same basis as Class A amplifiers are rated, the tube may approach 100 percent efficiency compared to a maximum of 50 percent for a conventional thermionic amplifier.

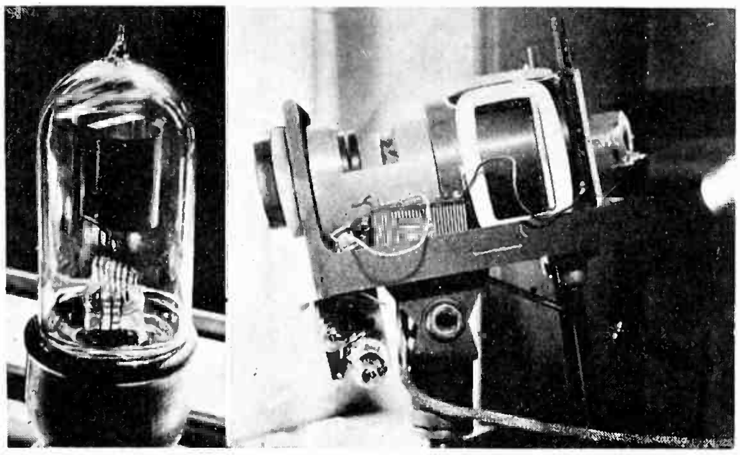
Application to television

In a practical demonstration of the value of the tube in amplifying weak photoelectric currents, Mr. Farnsworth pointed a television pick-up camera out the window of his laboratory. The camera consisted of a high-grade fast lens which focussed the picture or scene on a photoelectric surface at the rear of an evacuated tube. In the front of this tube, i.e. near the lens, was an anode which caused the electrons emitted from the light-sensitive surface to advance in a horizontal layer forming an electron picture of the original scene. By conventional scanning means, this electron picture was made to pass a small exit hole which let the electrons enter the electron multiplier where their current-carrying ability was increased as described above.

These currents operated the cathode-ray television receiver producing a 220 line, 30-frame picture of considerable brightness. It was possible to see, distinctly, moving automobiles and passengers leaving their cars. The swaying leaves of nearby trees could easily be distinguished.



Several types of multiplier tube. The large tube with pure uncoated nickel cathodes produced one-half microampere per lumen sensitivity acting as a photoelectric device.



Left—tube with curved cathodes to eliminate necessity of external focussing field. At the right is the television camera which uses the electron multiplier. The small tubes below the lens produce the 50 Mc. voltage mentioned in the text.

The efficiency of the tube depends entirely upon the virtues of the cathodes. Therefore considerable research has been necessary to develop surfaces which emit secondary electrons. This research continues, hampered somewhat by the fact that all previous endeavors by tube makers, at least, have been to limit secondary emission. The surfaces used at present closely resemble photoelectric surfaces (caesium deposited on silver) but the heat treatment differs considerably from that employed in the light-sensitive art. The cathodes in the new tubes are not highly photo-emissive.

Large tubes—small tubes

Some work has been done with small tubes such as would be used in a radio receiver. The Television Laboratories, however, admit that their chief interest to the present time has been to develop large tubes of considerable power handling ability. The small tubes, practically the same size as conventional thermionic amplifiers, work, i.e. they amplify and oscillate, but not much time has been spent on this phase of the research. Tubes which will deliver considerable power (100 watts or more) have been developed. This is really remarkable considering the fact that the cathodes are cold, and in fact may be caused to emit by illumination.

Immediate research must be aimed at the problem of making tubes uniform and efficient. The problems of why some oscillate of their own accord and some do not, and of making still more emissive cathodes, are still in the pre-solution stage.

All-wave signal generator for production tests

By RICHARD F. SHEA*
Chief Engineer
Freed Television and Radio Corporation

GENERALLY speaking, there are two methods widely used in receiver testing. In the first there is a complete signal source at each test position, with its associated attenuator system. In the second the signal generating equipment is located at some central point; the test signal is piped to the individual test positions, and there attenuated as desired by the operator. The former method is preferable for the smaller manufacturer, the second for the bigger concerns, the decision resting upon the relative cost of the master generating apparatus and the individual generators. Also, the number of test frequencies is a very important deciding factor. For example, in broadcast set testing ordinarily IF's of 175, 262, 370 or 456 kilocycles, or very near these values, are used, while the broadcast band points are usually around 600 Kc., 1,000 Kc., 1,350 Kc. and 1,500 Kc. In long wave receivers the IF may be 115, 125 or 132 Kc., and there are at least two test frequencies in the long wave band, such as 160 and 310 Kc.

In the case of short wave sets the IF is usually 456 or 462 Kc., and at least four short wave positions determined by the over-lap ranges of the particular receiver under test. In most cases the important short wave points are around 2,450 Kc., 3,700 Kc., 8,500 Kc. and 18,000 Kc. Thus, for a production test system to be capable of handling any or all of the above receivers it must be capable of delivering any one of eighteen different frequencies, ranging from 115 to 18,000 Kilocycles. If the master oscillator system be used eighteen separate oscillators will be necessary, in addition to eighteen feeder systems to each position, and an attenuator system at each position capable of selecting any one of these eighteen frequencies at will and properly varying the output.

It is clear that only in the cases of large-scale mass production will any such system as above outlined be economically advisable. In by far the majority of cases the best instrument will be an individual signal generator for each position, designed to supply any of the above eighteen frequencies (or, of course, any others dictated by particular requirements), and to attenuate them. The signal generator described herein is capable of handling twenty test frequencies, with output continuously variable from one to twenty thousand microvolts per meter, as well as a high output of two volts maximum. By slight modification of design the number of test positions may be easily increased, as well as the range of output.

The complete cabinet containing the generator is 31 inches long, 15 inches high and 10 inches wide. Two switches select the desired frequencies; a third switch supplies the attenuator control. The frequency switches are so arranged that the IF and long wave frequencies are on the left, the broadcast and short wave frequencies on the right. In addition to the switches there are mounted on the panel a pilot light, in a metal cowl; an on-off switch; a selector switch which throws in either the left hand or right hand set of frequencies; and an output variation control. The output meter is directly calibrated in microvolts, while the attenuator switch provides multiplying factors of 1, 5, 20, 100, 500 and 2,000. The meter goes up to 10 microvolts, so that the range is 1 to 20,000 microvolts per meter. In addition, there is the high output connection, just above and to the right of the meter, from which a maximum of approximately two volts is available, for certain alignment requirements, or AVC checks.

Fundamentally, the design consists of an electron-coupled oscillator, arranged so that the oscillator elements can be switched to any one of a number of tuned circuits, and so that the output can also be individually limited on each position. By this means it is possible to simultaneously select the desired frequency, and also keep the output variation constant. Each coil is so arranged that the reading of the meter with full volume will be 10 microvolts, thus the device has the advantage of constant output at all frequencies.

Design of flexible electron-coupled oscillator

As shown in the circuit diagram, a 6D6 tube is used as an electron-coupled oscillator, this particular tube providing a dependable oscillator in this circuit over a very wide range of frequencies. The oscillator tuned circuit is switched into the control grid and cathode circuits by means of switches A, B and C. The plate of the 6D6 has a 3,000-ohm load, and voltage is taken off this and applied across the 1,000-ohm volume control. In addition, one section of the selector switches cuts in an individual 1,000-ohm rheostat in each coil assembly, this

▼ ▼

JUST AS the design of all-wave receivers entails many considerations not encountered in conventional broadcast receiver design, so does the design of a suitable production test signal generator for this class of receiver depart from conventionality. In this article is described an instrument capable of testing any type of receiver, regular broadcast, long wave, or short wave.

rheostat being shunted directly across the volume control. By the proper adjustment of the individual rheostats it is thus possible to obtain a maximum voltage of two volts from the volume control at all frequencies.

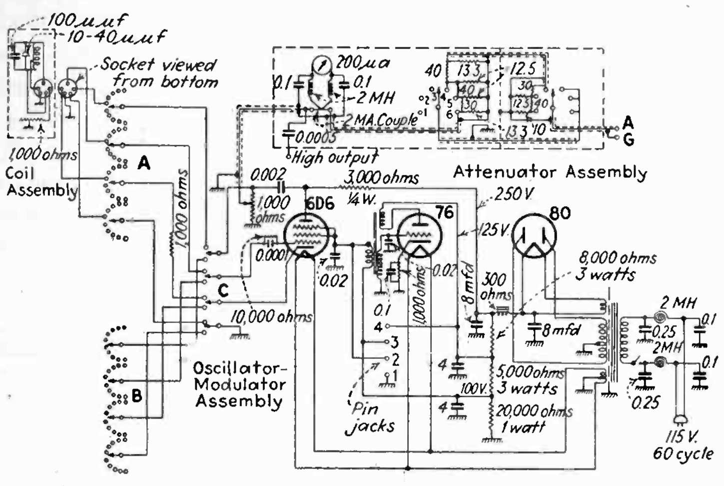


Fig. 1—Circuit diagram of the signal generator which provides a frequency range from 115 to 16,000 kc.

Each coil assembly is completely self-contained in a shield can $2\frac{1}{8}$ inches in diameter and 4 inches long. The assembly consists of the coil, a variable trimmer condenser covering a range of approximately 10 to 40 micro-microfarads, a fixed condenser of .0001 mfd. shunted across this trimmer, and the 1,000-ohm rheostat. All these elements are mounted on a bracket arrangement, which terminated in a five-prong plug. The shield fits around the whole, and fastens to the base, and the complete assembly plugs directly into a five-prong socket. The shaft of the rheostat protrudes through the end of the shield, and there is also a hole there through which the trimmer can be adjusted. In Fig. 3 is shown a complete coil assembly, and also a shield and separate internal assembly.

A type 76 tube is used as audio oscillator tube. A standard design push-pull audio transformer was used for the audio oscillator transformer, the secondary being split up, one-half being in the grid circuit, the other half in the plate circuit. The primary is used to supply audio voltage for the 6D6. The audio note can be adjusted by means of the condenser across the grid coil. In this particular case a .02 condenser gave a 400-cycle note. There is an $\frac{1}{8}$-inch gap in the transformer core. Modulation is accomplished in the screen circuit, the suppressor also being tied to the screen. The working voltage on the 6D6 screen should be about 100 volts, and the audio voltage will be about 25-30 volts, giving about 40 per cent modulation.

The power transformer is provided with an electrostatic shield, and, in addition, a filter is placed in the supply line, to reduce radiation along the lines to a minimum. It will usually be found necessary to also use a similar filter in the supply line to the receiver under test, to reduce the pick-up encountered when the ground wire of the receiver is connected to the signal generator ground post.

It will be noted that in series with the cathode circuit of switch *A* there is inserted a 1,000-ohm resistance. This switch section is used for the lower frequencies, and the resistor is employed to reduce the harmonics, which are most severe at these frequencies. Particular precautions must be employed to keep these harmonics low, as they will seriously impair the accuracy of the instrument.

Figure 2 shows the construction of the oscillator unit proper. There is a large upright panel which carries the sockets for the coil assemblies, together with the associated switches, pilot light and volume control. This upright panel is fastened to a base which carries the power equipment and audio oscillator. The 6D6 tube is shown in Fig. 2 in the center of the upright panel, directly under the volume control. The audio transformer is on the right of the base, together wih the 76 audio oscillator tube. In the back of the base are seen four pin jacks, which are used for measuring audio and plate voltages from the rear of the completed oscillator. There is a copper shield placed over the 6D6 socket and its associated wiring to reduce the stray field from this "hot" wiring. The volume control is also included under this shield, and the output is taken from it in the large shielded cable seen emerging on the left in Fig. 3. This shielded lead passes through large rubber grommets into the attenuator assembly. Large shields are placed around the switches *A* and *B*, as much to protect the wiring when changing coils, as for the purpose of shielding.

This oscillator unit is placed in a large steel box, cadmium plated, measuring 24x13x8 inches. The upright panel is securely fastened to the front of the box, with the shafts extending through it, and the base is fastened to the bottom of the box. Bakelite extension shafts are used on every control. The back of this large steel box is removable, and is held onto the box by brackets and screws.

Attenuator unit design

The next assembly is the attenuator unit. This is housed in another steel box 4x13x8 inches. There is a partition dividing this box in two, and the meter and associated filter is in the upper half, the attenuator being in the lower section. A 2 milliampere couple, having a resistance of 1,000 ohms, is used, and calibrated directly in microvolts, 2 milliamperes corresponding to 10 microvolts. The high voltage tap is taken off the input to the thermocouple, through a blocking condenser.

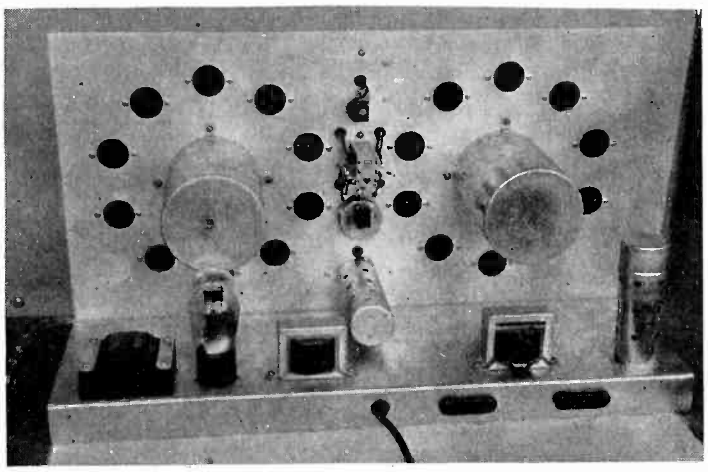


Fig. 2—The oscillator assembly showing socket for the coils for each frequency.

The shielded lead coming from the oscillator assembly enters the attenuator assembly near the top, through a large rubber grommet, and is completely insulated from the case. Likewise the filter for the meter is grounded to the sheath on this lead, not to the case, and the sheath on the wire going into the lower section continues this circuit, and is also insulated from the case. The only place that this case is grounded is to the copper lining of the outer box, as will be brought out later, and, through the shield around the attenuator proper, to the zero potential point of the attenuator. The meter used with the couple is a standard 200 microampere instrument, type 600, and the filter chokes should have at least 2 millihenries inductance, and not over 3 ohms resistance.

The attenuator proper is divided into two sections, contained in a copper box 3½ inches square and 6 inches long. Each section contains a six-position switch, and there is a shield between the sections, securely grounded to the framework of the switch, which fits snugly into the enclosing box. The individual resistors may be any of a number of conventional high-frequency designs. The writer prefers to make them by doubling the wire and looping it in a figure eight back and forth. This makes a compact, self-supporting unit of minimum inductance and capacity. Manganin is suggested as the best wire for high frequency work, with Advance next best.

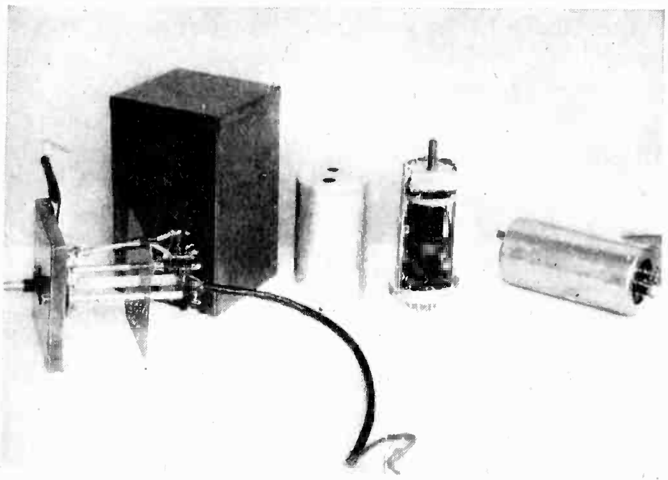


Fig. 3—Component parts, left to right: Attenuator, attenuator shield, coil shield, coil unit, coil assembly.

Ground-shield requirements

Particular care must be taken regarding the grounds in this attenuator. The incoming and outgoing shielded leads are insulated from the case. The common ground ends of the resistance units in each section are brought directly to a single point terminal, and the sheaths of the connecting wires brought directly to these points. The whole box is grounded directly to the point terminal in the low potential section. The ground terminal on the outer case is insulated from the case and connected to the sheath on the antenna wire.

Figure 3 illustrates the construction of this attenuator proper, showing the inside construction with the outer box removed.

The attenuator unit steel box has a large cut-out for the meter, which is mounted directly on the outer box, and projects into the attenuator box.

This outer box is of wood, and is completely lined with sheet copper, well soldered. The back is removable, and also lined with copper, and makes a good contact onto the rest of the shield. The two inner boxes are mounted on wooden blocks which insulate them completely from the copper lining, except where the two inner steel boxes are grounded directly to the copper by heavy springs in the front, near the ground binding post. There is a ground terminal on the copper extending out the back of the generator, to which the ground terminal of the line filter of the radio receiver may be connected.

The accompanying table gives the necessary data for the construction of the coils used in this particular model. If other frequencies are desired they can easily be computed. The grid is connected across the whole coil, the tap going to the cathode. In all cases excepting the three highest frequencies, 1 inch tubing was used. The IF and long wave coils are universal windings, the broadcast and short wave coils single layer solenoids. The inductance values for the three highest frequency coils are approximate. The 3,700 Kc. coil consisted of 49 turns on a ½-inch form, tapped at 9 turns, of No. 24 wire. The 8,500 Kc. coil had 19 turns on a ½-inch form, tapped at 5. The 16,000 Kc. coil had 15 turns of No. 18, self-supporting, ½ inch in diameter, tapped at 4. No. .0001 condenser was shunted across the trimmer in the 8,500 Kc. coil, and the trimmer was also omitted in the 16,000 Kc. coil, the coil being adjusted to get the desired frequency. The 1,000-ohm rheostats are unnecessary in the 8,500 and 16,000 Kc. coils.

The average associated tuning capacity, including strays, is about 180 μμf.

In adjusting each coil assembly, the switch *A* or *B* is set to the proper position for that coil, then the trimmer is adjusted to the proper frequency, and the rheostat adjusted until the meter reads 10 microvolts with the volume control on full. It will be found that the backs of the steel boxes and outer case have little effect on frequency.

In the model described the high output terminal is unshielded. This will result in some leakage at the highest frequencies, hence it is suggested that this design be modified to provide some sort of sliding shield over this tap, so that it is covered when not in use.

VALUES OF INDUCTANCE USED IN COILS FOR VARIOUS FREQUENCIES

Frequency	Inductance to Tap	Total Inductance
115 KC	1.1 mh	10 mh
132 KC	.8 mh	7.8 mh
160 KC	.7 mh	5.6 mh
172 KC	.6 mh	5.1 mh
262 KC	.2 mh	1.9 mh
310 KC	.2 mh	1.4 mh
456 KC	90 μh	730 μh
462 KC	90 μh	670 μh
600 KC	50 μh	410 μh
1000 KC	25 μh	150 μh
1350 KC	15 μh	85 μh
1500 KC	6 μh	55 μh
2450 KC	5 μh	22 μh
3700 KC	2 μh	10 μh
8500 KC	1 μh	5 μh
16000 KC	¼ μh	2 μh

If the range of the attenuator is to be increased it is easily accomplished by using the thermocouple as a voltmeter across the line, rather than as a milliammeter, and increasing the number of steps of the attenuator accordingly. By this means it is possible to go continuously up to 2 volts. However, it is the author's experience that 20,000 microvolts is entirely sufficient for 90 per cent of the present-day tests.

**Mr. Shea completed the work described here while chief engineer of Freed Television & Radio Corporation. Subsequently he became chief engineer of Empire Electrical Products Corporation. He is with this company now.* —THE EDITOR.

Chart for simple attenuator design

By W. W. WALTZ

THE determination of the loss introduced into a circuit by the insertion of an attenuator, or "pad," and conversely, the design of such an attenuator to have pre-assigned loss characteristics, represent enough mathematical calculation to make it extremely worth while to have available a chart of the kind shown in the accompanying figure.

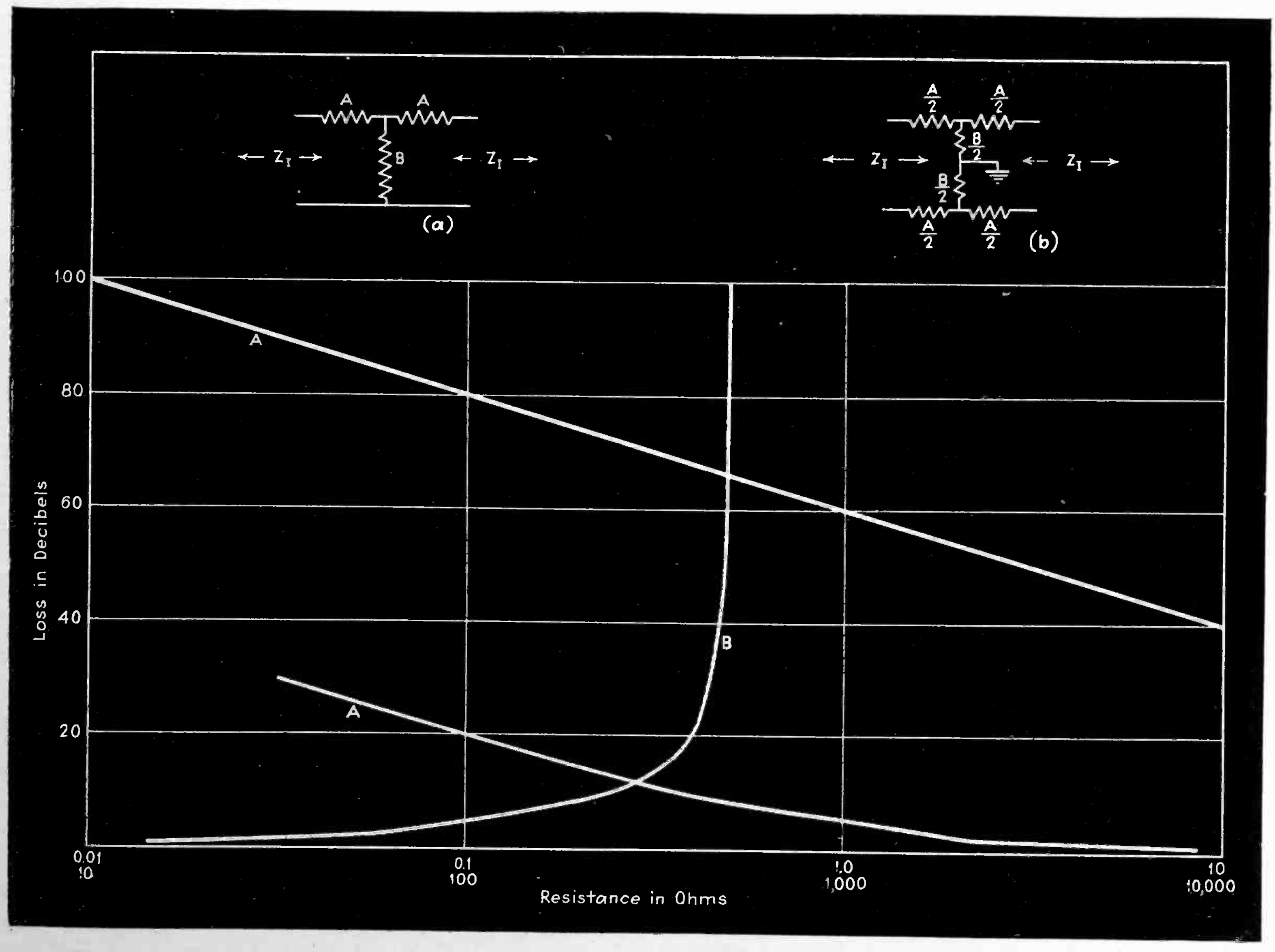
The curves shown are for a symmetrical T network of the kind commonly used for volume control in circuits where the impedance in either direction must remain constant regardless of the setting of the volume control; this is usually the case in any circuit designed to handle speech and music with a high degree of fidelity. This type of symmetrical network can easily be adapted to circuits requiring the maintenance of a balance to ground, the adaptation being shown in (b) of the figure.

The ordinate of the curves gives the loss in decibels from 0 to 100. The abscissa, plotted to a logarithmic scale by reason of the fact that the shunt arm of the network must vary logarithmically if the network loss at any given setting is to be directly proportional to the angle of rotation of the control knob, gives the resistance required in either arm for various degrees of attenuation.

Some care is necessary when using these curves, the doubling-up of the resistance scale tending to confuse the unwary. However, if it is remembered that in a symmetrical T network the shunt arm approaches zero resistance as the attenuation increases, while the series arm approaches a limiting value of Z_1 as the attenuation increases, no particular difficulty should be experienced.

The terminating impedance (Z_1) used in the calculation of these curves was 500 ohms, that being one of the most commonly used values in communication circuits. The values derived from the curves can, however, be changed to make the network fit any condition of terminating impedance by multiplying the curve values of the series arms and the shunt arm by the ratio $Z_0/500$, where Z_0 is the impedance, other than 500 ohms, with which the network is to be terminated at each end.

As an example of the use of these curves, assume that it is desired to design a "pad" to have a loss of 28 DB, the pad to be inserted in a 1500-ohm circuit. From the curves, it is found that a shunt resistance of 40 ohms, and a resistance of 440 ohms in each of the series arms will give this loss with 500-ohm termination. However, 1500-ohm termination has been specified, making it necessary to multiply the values read from the curves by the ratio 1500/500, or 3. The network then becomes: series arms 1320 ohms each, shunt arm 120 ohms.



HIGH LIGHTS ON ELECTRONIC

New aviation beacon system

A DEVICE WHICH visually interprets the signals of aeronautical radio range beacons which are received through headphones and are relied upon by airmen for directional guidance under conditions of poor visibility, has been developed by W. E. Jackson and L. M. Harding, radio engineers of the Aeronautics Branch, Department of Commerce.

According to Rex Martin, Assistant Director of Aeronautics in charge of Air Navigation, the device includes an indicator which fits into the instrument panel. It is similar to that developed for use with the experimental radio system for blind landings (see *Electronics*, p. 158, June, 1933) and can be used for this purpose. It has two needles, one vertical and the other horizontal. The vertical needle is the chief indicator. If the aircraft moves off the course defined by the radio beacon, this needle moves accordingly in the same direction. If the plane is exactly on course, this pointer remains in the center of the dial. The horizontal indicator shows the volume of the received signals.

In addition to the indicating instrument there is a small converting set which is attached to the regular radio receiver. No changes are necessary in the regular receiving set. Signals are passed into the converting box and changed into impulses which actuate the visual instrument in front of the pilot. The signals may be received through the headphones simultaneously, thus giving visual or aural indication as the pilot desires.

✦

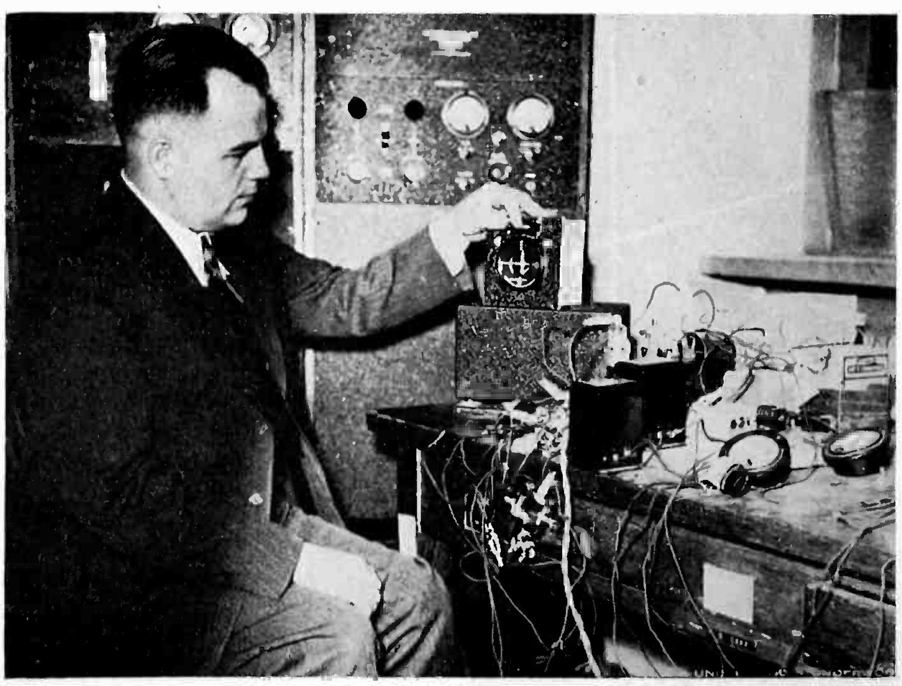
Library of Congress to have 28 PE doors

THE LIBRARIAN of Congress at Washington, D. C., has ordered the installation of twenty-eight sets of photoelectric controlled doors in the bookstack section of the famous Congressional Library Building, wherein are housed copies of every book and magazine published in the United States, and many other book treasures besides.

Each door will have a 36-inch opening, with two 18-inch panels, which will swing open when an attendant approaches. Ordinarily the library staff enter or leave the stack-rooms with arms filled with books, and it has proved inconvenient to attempt to open doors. Sometimes, even, valuable books have been dropped and damaged.

But with the light-beams operating the Stanley compressed-air doors, the door-panels will jump open at the approach of a book-laden librarian or an attendant pushing a hand-truck. The new photocell door installation is to be completed before Fall.

AVIATION BEACON RECEIVER



C. E. Jackson, chief of the development division of the Aeronautics Branch, Department of Commerce, and a model of the new indicator to be used on aircraft.

New radio uses for cathode-ray tubes

IN ADDITION TO its use in fundamental radio research, several new practical applications of the cathode-ray oscillograph are suggested by the British radio board.

For example, the signal arriving along the ground from a wireless station gives a correct bearing, but with an ordinary closed-coil direction-finder the nearly simultaneous arrival of the echoes of that signal from the upper atmosphere may introduce large errors. However, it has been found that the response of the cathode-ray oscillograph is so rapid that with pulse-signals lasting only one 2,000th of a second, a bearing can be read correctly without confusion by the echoes, the correct bearing being obtained in the form of a bright line, while the echoes produce only a faint pattern round it. Such signal pulses can be produced cheaply and simply by modification of an ordinary wireless transmitter, and they last such a short time that they should cause no serious interference with ordinary wireless traffic. As a development of this idea, a compact and inexpensive cathode-ray receiver can be placed on the bridge of a ship, and used as a collision-preventer in fog.

The cathode-ray oscillograph can also be used as a relay device by employing an additional electrode or electrodes within the tube as collectors of the electron beam, when the whole or part of it is directed upon them. This permits the oscillograph to control an external circuit, and applications based on this device include a receiver by which Morse signals can be read through very heavy atmospherics, and a receiver by which Morse signals can be recorded separately from two stations of the same wavelength, provided the signals are not arriving from exactly the same direction.

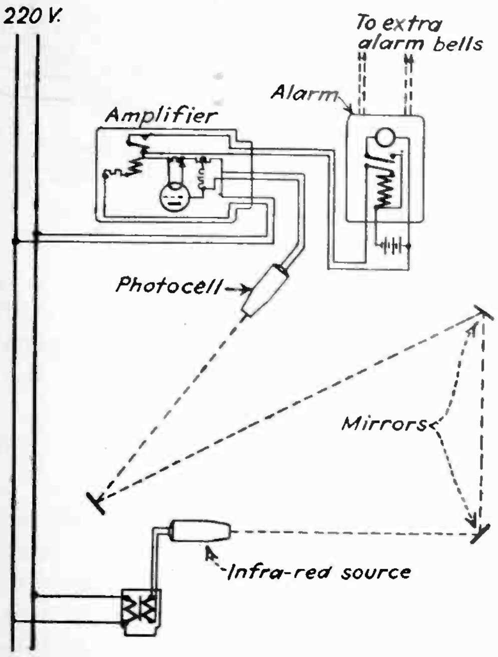
✦

Infra-red photocell burglar alarm marketed in Europe

THE EUROPEAN FIRM of Telefonaktiebolaget L. M. Ericsson, prominent manufacturers of telephone equipment, have recently announced a complete photoelectric burglar alarm for the general market. Infra-red light is used, because of its invisibility, and a series of mirrors reflects the beam in several criss-cross paths, thus providing a wide coverage of the space protected by the alarm.

DEVICES IN INDUSTRY + +

The accompanying figure shows the general layout of the device. The light transmitter and filter at the bottom of the diagram provide the source of the infra-red light. The beam is reflected by mirrors back and forth as shown until it finally enters the photocell housing. The number of reflections can



Layout of infra-red photocell alarm.

be increased to meet the particular requirements of the installation. The use of the multiple light path has the same advantage as the use of a series circuit in electric alarm practice, that is, interference with the light at any one or more points of the beam will actuate the alarm. A neatly mounted amplifier and alarm unit are connected to the photocell output. The power supply for the entire system is obtained from regular 110 or 220 volt lines.

✦

Sludge-level in sewage plant made automatic

In the Morristown, N. J., sewage-disposal plant, difficulty was experienced with sludge material rising in the settling tanks, and coming over with the treated water, discoloring the discharge streams and proving objectionable to the neighborhood of the sewage-treatment plant.

A photocell installed in the settling tanks below the water-line but at the top limit of the sludge level, has now eliminated this trouble. If the black sludge rises in the tank, it eclipses the photocell which at once starts an automatic air-lift pump which removes the sludge from the bottom of the tank, and passes it back to the earlier stages of the process. Thus the photocell permits only clear liquid to flow out of the settling basin. At the same time the sludge material returned to the process tanks is found to be so much more effective than new chemical, that the re-use of this active material has been found to increase the efficiency of the whole sewage-purification plant.

✦

Facsimile to chart ice fields

An international ice-patrol is maintained by the nations interested in trans-Atlantic travel. A ship is kept continually in service, skirting the floating field of ice and icebergs, and reporting the extent of the flow by radioing the corners of its extent, to any vessels that may be in the neighborhood. Sometimes the middle of the field drifts southward further than the corners, and then the ice patrol has the difficulty of reporting the irregular contour of the ice.

George Lewis, vice-president Arcturus Radio Tube Company, Newark, N. J., himself a former Navy man, suggests that facsimile transmitters and receivers might well be used for reporting the day-to-day shape and location of the ice field, in this way transmitting graphically the necessary outline of the dangerous area, in the same way that weather-maps are already transmitted to ships at sea.

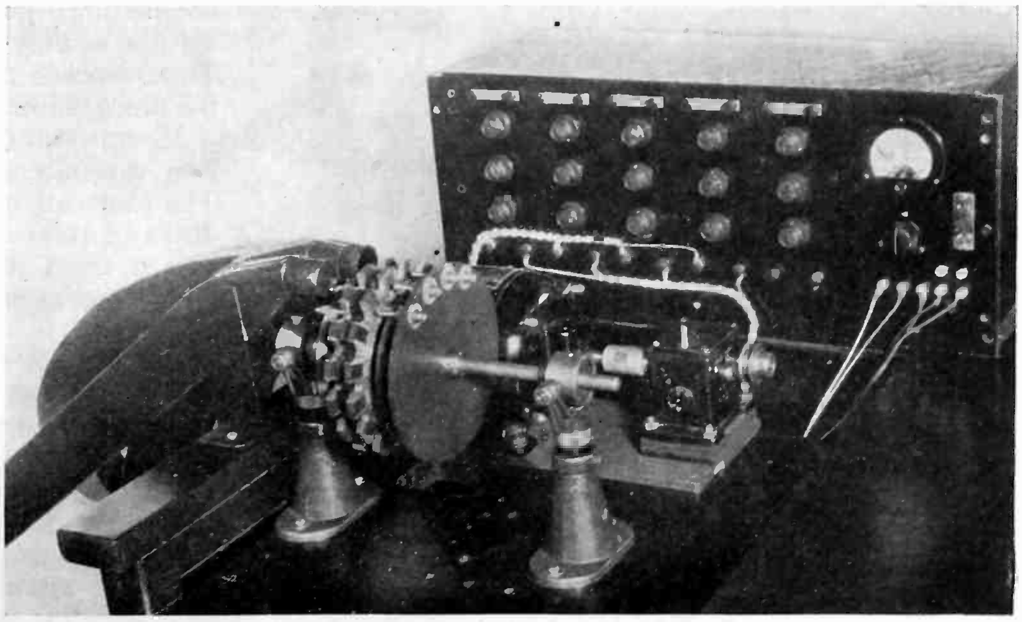
High-speed electronic resistor sorter

By a series of bridge measurements, made automatically, resistors of the type used by the million in the annual production of home and auto radio receiving sets, are tested and sorted by this machine developed by Rex D. McDill, of Cleveland, Ohio, and installed in several of the larger plants.

The machine will test in production 80 resistors per minute and reject those not within plus or minus 0.5 per cent. In one installation the device, controlled by electron tubes, saved $1 per 1,000 units and therefore paid for itself very quickly.

Hoppers, not shown in the photograph, feed the resistors to the notched discs rotated by a motor. The resistors are picked up and brought past a pair of contacts which connect them individually into a Wheatstone Bridge. If the bridge indicates that the resistor is below a certain value, an air jet led to the machine through hose, not shown, rejects the resistor by forcing it into the first of the three chutes. If the resistor is above this value of resistance but below some other value, the resistor gets past the first but not the second air gun. If the resistor is still higher in value than that for which the first two contacts are set, the unit is either shot down the third chute, which represents the correct and desired value, or is carried clear around to fall through the hole in the bottom of the table and is thereby rejected completely.

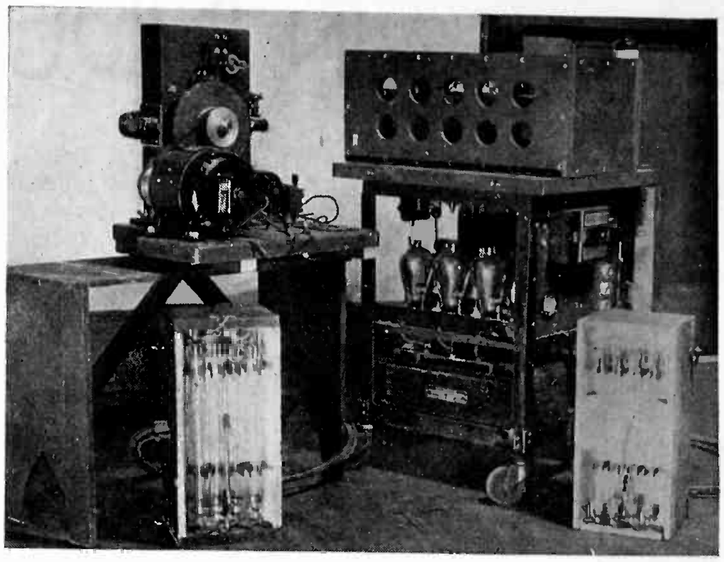
ELECTRONIC RESISTOR SORTER



As each resistor makes contact with the Wheatstone Bridge, air-jets are turned on, blowing the resistor into one of the three chutes or discarding it altogether.

Electron control for high-speed motion pictures

By DONALD G. FINK
Editorial Dept., Electronics



The Electronic Camera with its accessory equipment. The mercury tubes are shown in the box-like housings, while the condenser and thyratron circuits are shown to the right of the camera.

THE motion-picture camera has long been recognized as an engineering tool of first importance. As a recorder of motion, capable of slowing down or speeding up the apparent motion of any moving object, the movie camera has enjoyed an extensive use in many branches of science and industry. As the speed of modern machinery has increased, the need has arisen for a camera capable of taking pictures extremely rapidly. The ordinary camera, with its start-and-stop motion, is useless when it is desired to take pictures faster than 200 per second. But cameras using an intermittent light source, which replaces the conventional shutter mechanism, have been developed which are capable of photographing at ten times this speed or more. A recent development in this line is a new stroboscopic camera, described before the Society of Motion Picture Engineers by Doctor Harold E. Edgerton and K. J. Germeshausen of M.I.T., who developed it. The new device, an outgrowth of studies of synchronous machinery, is an important contribution to the practice of high-speed photography, and it has produced startling results in the many fields to which it has been applied.

▼

Electronic light for the photographer

The use of spark and arc discharges of extremely short duration is opening a new and fertile field in all branches of photography. The highly actinic light of these sources can be controlled with precision, and as a result high-speed photography, stroboscopic photography, and high-speed motion-picture photography are performing tasks once thought impossible. This description of the stroboscopic camera developed by Professor H. E. Edgerton and Kenneth Germeshausen at the Massachusetts Institute of Technology presents the mechanical and electrical features of the instrument.

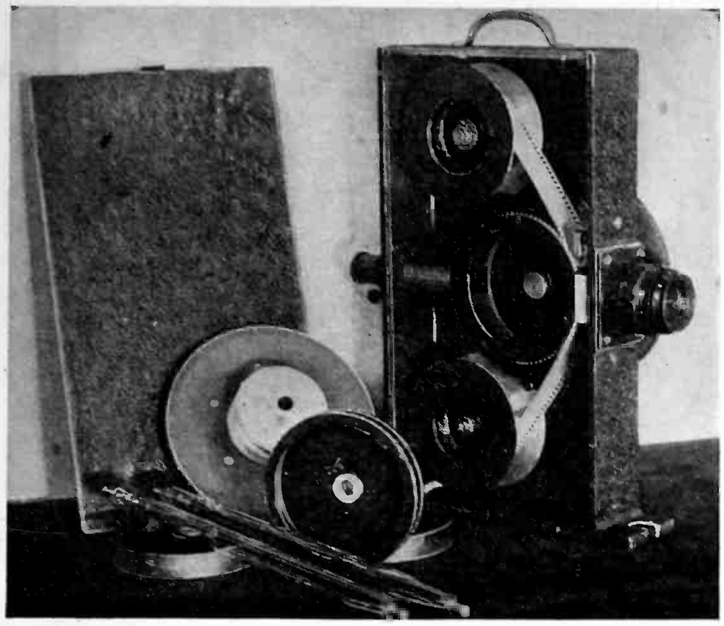
Light source combined with camera

The new camera is more than a camera; it is a camera and a stroboscopic light source built into an integral unit. The light is produced by the collision and recombination of electrons and ions in mercury vapor, and to this extent, at least, the camera is "electronic" in its action. In fact, it is only because ions and electrons act so rapidly that flashes of great intensity can be produced in the almost instantaneous time required for high-speed picture taking. The intermittent light produced by the mercury discharge illuminates the subject to be photographed, with flashes that last only a few millionths of a second.

The camera uses ordinary motion picture film, but the film is carried on a continually moving motor-driven sprocket. The film speed is such that 1,200 pictures, each $\frac{3}{4}$ of an inch high can be taken in one second. At such speeds the generation of heat and static electricity become important limiting factors, hence any sliding of the film against the camera structure must be eliminated. To accomplish this, a motor driven take-up reel removes the film from the sprocket as it is exposed.

Mounted on the same shaft which carries the sprocket is a carefully constructed contactor wheel and brush. The contactor wheel, similar to the commutator used in direct current motors, has metallic segments evenly spaced about its circumference, so that the contact is closed once as each new frame of the film appears behind the lens. The contactor is used to trip a thyratron circuit, which in turn allows a bank of condensers, previously charged between flashes, to discharge through a bank of mercury vapor tubes. The tubes are specially constructed to give light of intense brilliance and high actinic properties, particularly well suited to photographic work.

As the film sprocket revolves, the contactor closes the thyratron circuit periodically, and the mercury tubes flash once for each frame (separate picture), in the film. To prevent blurring it is necessary that the light flash be only 1/1,000 as long as the time during which the



The internal mechanism of the camera, showing the film pocket and film reels.

THE COVER PICTURE

The cover picture of this issue was taken by the men who developed the camera dscribed in this article. The unusual effect of arrested motion is obtained by the use of an extremely short exposure time, 1/75,000 of a second, and a stop opening of f:11. No shutter is used. Instead, intensely brilliant light is furnished by an electron-controlled arc discharge which lasts only thirteen millionths of a second.

▼

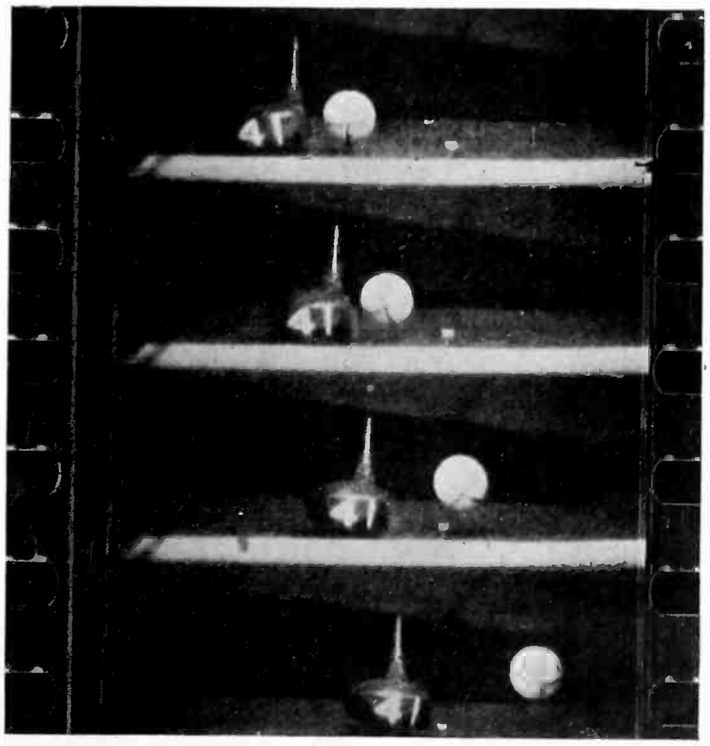
frame passes behind the lens. Therefore, if 1,000 pictures are being taken each second, the major part of the light flash must not last more than 1/1,000,000 of a second. Very carefully designed controlling circuits are necessary to produce flashes of this sort, especially since as much as 10 kilowatts of power may be used in operating the tubes.

After the negatives are developed and the positives printed, the positive film is run off in a regulation projector at the ordinary film speed of 16 pictures per second. The speed of motion is thereby reduced by the ratio of the speed of the film projector to that of the camera, i.e., 1 to 75, if 1,200 pictures per second is the camera speed.

This process, that is, the reproduction of high-speed motion at a much reduced speed so that the eye may readily comprehend it, is only one of the uses to which the camera can be put. It produces the most spectacular results, but a second use, that of measuring the positions of moving objects as a function of time, is of greater importance to the engineer. When the camera is used for this latter purpose, the flashes are timed either by the contactor wheel or by an accurate frequency standard. The time interval between pictures is thereby fixed with precision. The distance the object has moved during this interval can be measured directly from the film; the velocity of the object is thereby determined. A more detailed study will give the rate of change of the velocity, i.e., the acceleration.

A striking example of the camera's effectiveness in analyzing motion in this manner is of interest to golfers. The speed at which a golf ball starts its journey down the fairway and the spin which provides its lift may be accurately measured by the camera. The accompanying illustration shows the method used. Before being teed in position before the camera the ball is marked with black crayon, as shown in the picture, so that the equator and meridian of the ball are clearly visible. These marks will show the rate of spin of the ball. The camera is then set in motion, the picture speed used depending upon the type of stroke to be photographed. For a drive about 1,000 pictures per second is satisfactory. While the camera is in motion, the ball is driven in the usual manner. The resulting picture shows both the speed, as measured by the number of inches moved between picture frames, and the spin, as measured by the number of revolutions made between frames. It is possible also to photograph the ball during the exact instant of contact between clubhead and ball, thus indicating the nature of the action during the all-important "click."

The golf stroke of Francis Ouimet, captain of the 1934 Walker Cup team, was photographed with the camera. The result showed that the golf ball and the club were in contact during a very brief period (much less than 1/1,000 of a second), that the ball picked up a speed of 186 feet per second (more than two miles per minute), and a spin of 5,000 revolutions per minute. Other investigations have been made into the speed of a house fly's wing-beat, the initial motion of an arrow shot from a bow, and the operation cycle of an automatic tapping machine. The device, with all accessories, is soon to be marketed in a form suitable for practical use by engineers.



Pictures taken at the rate of 960 per second, showing the motion of a golf ball after it has been struck by the club. Note the black markings which are used to indicate the rate of spin of the ball.

+ + NOTES ON ELECTRON

Linear Rectification

By K. C. DeWalt
Vacuum Tube Engineering Department
General Electric Company
Schenectady, New York

Many instances arise where the characteristics of linear rectification are of importance and it has not been realized generally that certain Pliotrons* and Thyratrons* can be made to furnish

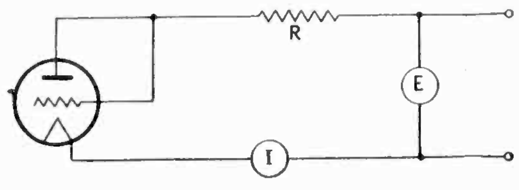


Fig. 1—Circuit for determining characteristics of rectifiers.

these characteristics. When operated at certain values of plate and grid voltages or in conjunction with simple circuit arrangements, the current-voltage characteristics of some tubes are suited admirably to furnish straight line response.

The circuit used for determining the characteristics is shown in Fig. 1. All the curves were taken with direct potentials and with the grid and plate returns connected to the negative filament terminal. In the case of vacuum tubes, the grid is connected to the plate so that the minimum impedance is obtained. Since the current in a high vacuum device is dependent on space charge and varies approximately as the three-halves power of the voltage impressed, it is impossible to obtain perfect straight line response. The distortion caused by the tube may be masked by utilizing a resistor in series with the rectifier. Such circuits, in combination with bias voltages have been used frequently in the past and have given good results. The input characteristics of such devices do not correspond to a pure resistance but to a resistance plus the impedance of the tube. The latter characteristic is a function of the one-third power of the current and, therefore, some distortion always is present. However, by utilizing tubes which have very low impedance it is possible to reduce the distortion to less than one per cent. Tube type FP-110 is a three electrode, high-vacuum tube particularly designed to have a low impedance. The design of this tube differs from the usual

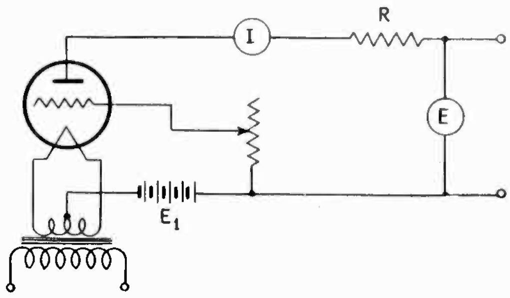


Fig. 3—"Holding-arc" circuit, using FG-57 thyratron.

tube in that the position of the filament and grid are interchanged, thus allowing a close spacing between the filament and the anode. Typical characteristics are shown in Fig. 2.

Gas tubes, because of their practically straight current-voltage characteristics, are of particular interest. These characteristics have been investigated before but generally have been discarded because of erratic operation present at the start of breakdown. To eliminate these difficulties a simple circuit arrangement employing an FG-57 Thyratron has proven very useful. The FG-57 is a hot cathode, mercury vapor, grid-controlled rectifier in which the emission is obtained from an indirectly heated cathode.

The feature of the circuit of Fig. 3 is the utilization of the grid of the FG-57 Thyratron as a "holding arc" electrode. In this manner a discharge is maintained and the anode is ready to pass current whenever its potential starts positive. Although operation is not linear until the anode potential passes the normal tube drop value, a current flow is obtained which is uniform in character and does not show the erratic operation characteristic of a sudden breakdown. The holding battery is used also as the bias battery to start operation at some point beyond the tube drop potential. The Thyratron arrangement then will produce the impedance characteristic of the series resistance employed.

*Registered tradenames of General Electric Company for high vacuum and gaseous triodes, tetrodes, etc.

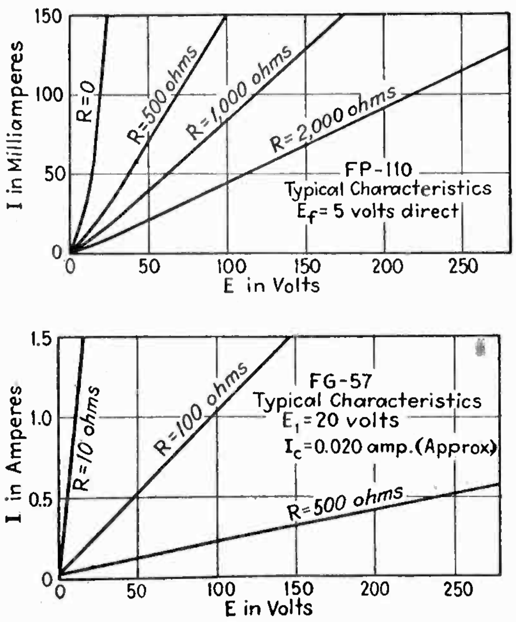


Fig. 2—Characteristics of both vacuum and gas triodes used as rectifiers.

✦

Applying neutralization to a.f. amplifiers

By Paul W. Klipsch

The effective capacity existing between the grid and ground in an amplifier circuit is responsible for the reduced gain at high frequencies. This capacity consists of the wiring capacitance, the tube input capacity, and in the case of transformer coupled circuits, the distributed capacity of the transformer windings. The tube input capacity constitutes a considerable portion of the total capacity, becoming especially important in the case of power tubes because of the size of the elements and in the case of high gain triodes because of the part played by the amplification in increasing the input capacity to a value much greater than the actual electrode capacities. It will be shown how the high frequency response can be improved in an amplifier by reducing the tube input capacity.

The input capacitance and resistance of a triode tube are:

$$C_{input} = C_{gf} + C_{gp}(1 + A \cos\theta) \ldots\ldots (1)$$

$$R_{input} = -\frac{\dfrac{1}{\omega C_{gp}}}{A \sin\theta} \ldots\ldots\ldots\ldots (2)$$

Where
C_{gf} = grid-cathode tube capacity
C_{gp} = grid-plate tube capacity
A = ratio of voltage developed across load impedance in plate circuit to signal applied to grid; the voltage amplification
θ = angle by which voltage across load impedance leads equivalent voltage acting in plate circuit (the angle ordinarily bears the opposite sign and is smaller in magnitude than the power factor angle of the load)

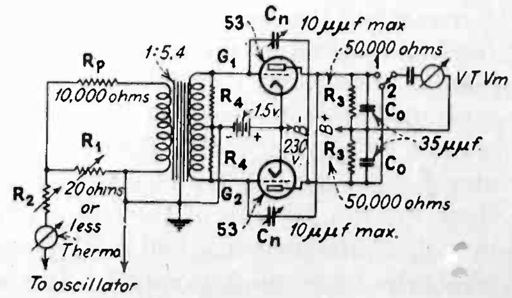


Fig. 1—Circuit diagram of neutralized push-pull audio amplifier.

TUBES AND CIRCUITS + +

It is evident that in most triode amplifiers the effective tube input capacity is several times the actual interelectrode capacity, and the resistance may be infinite or finite and either positive or negative.

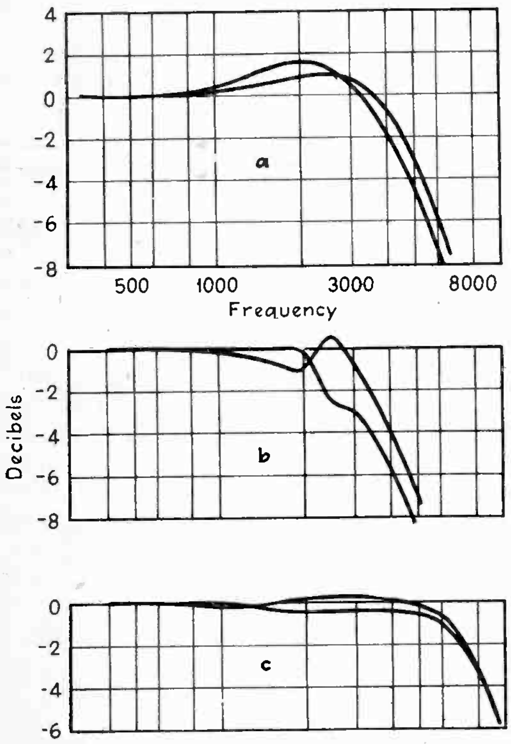


Fig. 2—Response characteristics referred to in Mr. Klipsch's article, showing improvement provided by neutralization.

When the input capacity and resistance due to feed-back or neutralization and due to tube capacity are combined in parallel they are:

$$C_{input} = C_{gf} + C_{gp}(1 + A\cos\theta) + C_n(1 - A\cos\theta) \quad \ldots (3)$$

$$R_{input} = \frac{-\dfrac{1}{\omega}\cdot\dfrac{1}{C_{gp}}\cdot\dfrac{1}{C_n}}{A\sin\theta\left(-\dfrac{1}{C_{gp}} + \dfrac{1}{C_n}\right)} \quad \ldots (4)$$

Where
C_n = capacity of the neutralizing condenser

Evidently the input capacity may be made independent of load, in which case it will be positive and the input resistance will be infinite, or it may be made more positive or slightly negative, in which cases the resistance will not be infinite and may be either positive or negative depending on the load impedance. In the audio amplifier, it is desirable to over neutralize so that the input capacity is less than zero; this negative input capacity reduces the effect of the winding and stray capacity to less than would exist for the transformer alone.

The amount of improvement was determined experimentally. One of the experimental trials and results will be described in detail. Fig. 1 shows the circuit and constants for this particular test.

The transformer alone, shunted by only the small input capacitance of a tube voltmeter gave the response curves of Fig. 2a, the two curves shown being for the two halves of the secondary. When used in the circuit of Fig. 1, with the resistances R_4 and capacitors C_n disconnected, the response was as indicated in Fig. 2b. Insertion and adjustment of the neutralizing condensers gave a rising characteristic out to 6,000 cycles which was flattened off by the use of the two resistors R_4 (500,000 ohms each). It was then found that the absence or presence of C_o up to 70 micromicrofarads on each side produced less than 0.25 decibel change for the curves of Fig. 2c.

Other transformers having constants more in keeping with modern design were tried. One such transformer of the "laboratory" type which was advertised as giving a flat response out to 12,000 cycles had to be operated with half the rated plate impedance in its primary in order to keep the curve flat to 9,000 cycles; with neutralization and readjustment of the resistances the response could be made flat to within 0.5 db out to 18,000 cycles.

The writer is indebted to Dr. F. E. Terman for the use of the Communication Laboratory facilities of the Electrical Engineering Department at Stanford University.

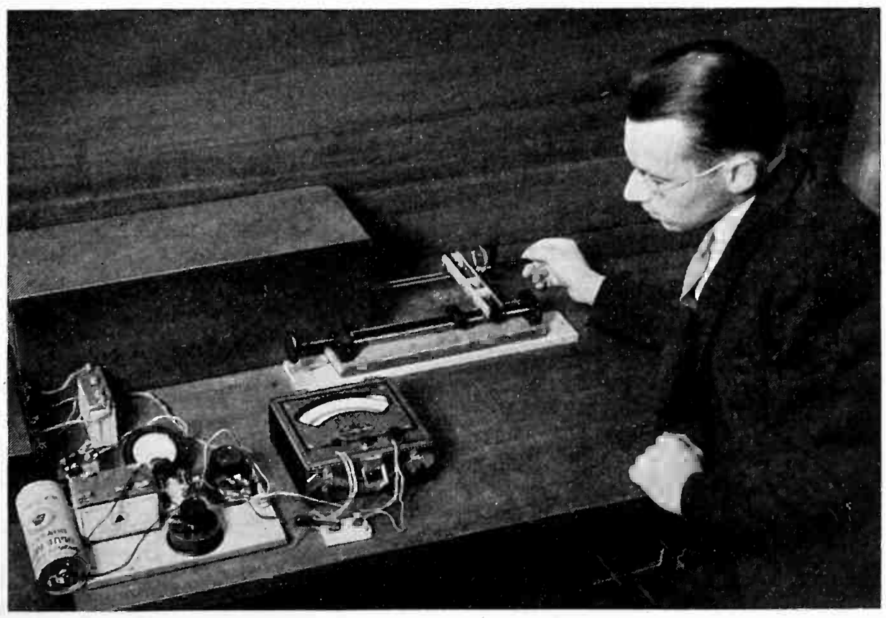
Television scanning technique applied to x-ray diagnosis

The difficulties involved in x-ray diagnosis are said to be greatly reduced by the invention of a three-color reproduction process which permits x-ray pictures to be transmitted by wire. Luther G. Simjian, former head of the photographic department of the Yale Medical School, developed the process by using the well known scanning technique used in the mechanical systems of television.

The patient undergoing the examination is placed between the x-ray tube and a fluorescent screen in the usual manner. The image appearing on the screen is scanned by a lead disc containing holes arranged in a spiral about its circumference. The light which passes these holes is allowed to fall simultaneously upon three photocells. These cells are fitted with special filters, the first cell responding to the portions of the picture containing considerable light, the second to portions containing a medium amount of light, and the third to the dark portions of the picture.

The output of the photocells, after amplification, is used to acuate gaseous discharge lamps of three different colors. The image is then recreated by a second disc, and the three color-elements combined. By the use of telephone lines between the scanning equipment and the receiving equipment, the image may be sent to various hospitals for diagnosis.

MEASURING "Q" AT ULTRA-HIGH FREQUENCIES



Set-up used in the Bell Laboratories for measuring the "Q" (ratio of inductive reactance to resistance) of circuits tuned to wavelengths in the neighborhood of 60 centimeters.

PRESENT COSTS OF

Actual and estimated figures grouped by station ratings

THE Committee on Engineering Developments of the National Advisory Council on Radio in Education, with offices at 60 East 42nd Street, New York City, has just issued a complete revision of its report "Present and Impending Applications to Education of Radio and Allied Arts." Included in this compilation are cost figures on broadcasting stations, which have been brought up to date, as for 1934.

The committee comprises Dr. Alfred N. Goldsmith, chairman; Dr. W. G. Cady, Edward K. Cohan, Lloyd Espenschied, W. E. Harkness, Erich Haussman, John V. L. Hogan, Charles W. Horn, L. M. Hull, C. M. Jansky, Jr., R. H. Manson, E. L. Nelson, R. H. Marriott, and O. H. Caldwell.

1,000-WATT STATION

CAPITAL INVESTMENT

1. *Transmitter and control room apparatus*	
1000-watt crystal controlled transmitter.	$15,000.00
Installation of above	2,500.00
	$17,500.00
For two-studio, low-level switching	3,400.00
For two sets of outside pickup equipment	2,000.00
2. *Antenna*:	
2-150 foot towers non-insulated complete, erected	2,500.00
Antenna and ground material	500.00
3. *Speech input equipment* (if station is remote from studio)	3,000.00

4. *Other items*:
   Studios
   Reception rooms
   Offices
   Control and radio room
   Studio acoustical treatment
   Costs in connection with the above are entirely dependent upon the specifications adopted.
5. *No estimate* for land or buildings for 1,000-watt transmitters, as these are generally installed in existing structures.

MAINTENANCE

Studios and offices:

Maintenance costs of studios and offices depend upon the type of service the station is rendering and the number of personnel required for that service, also upon how elaborate is the "layout" which governs the rent, etc.

1. Offices, studios (including depreciation of furniture, insurance and rental)
2. Salaries
3. Miscellaneous (telephone, printing, publicity, etc.)

Plant—1. Apparatus:
Depreciation and obsolescence on
(a) Transmitter—25%
(b) Other equipment—15%
(c) Buildings—3%
(d) Furnishings—10%
Insurance and taxes

2. Rentals	
3. Salaries:	
Chief operator and two assistants	$7,200.00
4. Power	1,550.00
5. Maintenance of apparatus including towers	1,600.00
6. Tubes	2,000.00

The above is based on eight hours of operation per day. For longer periods the costs are proportionately greater.

5,000-WATT STATION

CAPITAL INVESTMENT

1. *Transmitter*	$34,000.00
Speech input equipment	3,000.00
Installation of above	4,000.00
(This is an average figure; labor costs vary according to locality)	
For two-studio operation, low-level switching, add	3,400.00
For two outside pickup equipments, add	2,000.00
2. *Land*:	
Ten acres (outside of city)	....
3. *Building* (outside of city): (including water system, power line and building furnishings	20,000.00
4. *Antenna*—including two 250 foot towers, (non-insulated)	9,000.00
5. *Engineering services*, surveys, etc	1,500.00
6. *Offices* and studios	

MAINTENANCE

Studios and offices:

1. Offices and studios, including depreciation of furniture, insurance and rental
2. Salaries
3. Miscellaneous: telephone, printing, publicity, etc.

Plant—1. Apparatus:
Depreciation and obsolescence on
(a) Transmitter—25%
(b) Other equipment—15%
(c) Buildings—3%
(d) Furnishings—10%

2. Electrical equipment	2,000.00
3. Structures	500.00
4. Tubes	4,000.00
5. Land and buildings:	
Taxes	
Insurance	
6. Salaries:	
Engineer-in-charge and staff of three men	8,500.00
7. Power	4,500.00
8. Wire Lines:	
(a) Three pairs between studio and station at $80 per mile per year	3,600.00*
(b) Local service for outside pickups	

The above is based on twelve hours of operation per day. Large number of outside pickups will require a larger technical staff.

*Estimated on basis of average distance of 5 kw. transmitters from their local studios.

BROADCAST STATIONS

Compiled by Engineering Committee of National Advisory Council

50,000-WATT STATION

CAPITAL INVESTMENT

1. *Transmitter*—50 kw.	$130,000.00
Speech input equipment	3,000.00
Installation (varies with labor costs in different localities)	15,000.00
2-300' non-insulated towers, antenna, ground system	13,000.00
For insulated towers add	1,500.00
Outside pickup equipment (2 sets)	2,000.00
2. *Land*:	
20 acres (outside of city)	....
3. *Station building*—average	50,000.00
4. *Transmitter* house furnishings, fittings, etc.	4,000.00

5. *Service*:
Power lines, sub-station, water system, etc.

6. *Offices and studios*:
Furnishing of studios, offices, reception rooms, acoustical treatment, ventilation, etc.

MAINTENANCE

Based on sixteen hours of operation per day as stations in this class are required to operate at least twelve hours a day by regulation of the Federal Radio Commission.

Studios and offices:

1. Offices and studios, including depreciation of furniture, insurance and rental
2. Salaries
3. Miscellaneous: telephone, printing, publicity, etc.

Plant—1. Apparatus:
Depreciation and obsolescene on
(a) Transmitter—25%
(b) Other equipment—15%
(c) Buildings—3%
(d) Furnishings—10%

2. Land and buildings:
Taxes
Insurance

3. Salaries (station personnel only)	18,000.00
The number of additional technical men depends upon type of service, number of pickup points, number of studios, etc.	
4. Power	30,000.00
5. Maintenance of equipment:	
(a) Electrical	5,500.00
(b) Structures	500.00
(c) Tubes, etc	15,000.00
6. Wire Lines:	
(a) Studio to transmitter	7,500.00*
(b) Local wire pick-ups	....

**Estimated on basis of average distance of 50 kw. transmitters from their local studios.*

In addition to the estimated figures shown there follow *actual expenditures* incurred in the construction of eleven stations associated with one of the networks. While it was requested that stations comprising this list be not identified, the figures have been taken from the books of the companies and are vouched for by the engineer in charge of the network with which the stations are associated. They are submitted herewith to show the variations which can take place and how; the cost of the items depends greatly upon the location of the transmitter station and the various local conditions prevailing.

	Property	Building	Equipment	Installation	Antenna System	Miscell.
½ KW	$1,500	$7,500	$13,800	$2,000	$4,240	$1,500
1 KW	1,000	8,500	16,000	2,500	4,900	1,000
1 KW	(a)	(b)200	23,500	1,200	(c)800	500
1 KW	15,000	43,050	21,500	4,250	10,600	4,200
5 KW	......	15,200	43,200	6,400	6,800	2,500
10 KW	Leased	19,026	22,544	6,800	9,175	5,270
25 KW	......	23,989	98,000	14,000	12,000	2,500
25 KW	......	27,000	107,000	15,000	13,000	2,200
50 KW	28,300	49,291	142,485	17,000	27,050	25,000
50 KW	......	43,826	175,000	18,364	21,282	2,680
50 KW	......	60,200	161,186	17,500	19,600	5,364

(a) Utilized own building.

(b) Utilized own building—amount indicated represents alterations.

(c) One wooden mast. Antenna runs from mast to building.

▼ ▼ ▼

SOCIAL SERVICE AND ELECTRONICS

Research, through its discovery of the electron, has added to human enjoyment, decreased human suffering, raised the standard of living, and supplied new and powerful tools for extending scientific knowledge . . .

We should not worry about the advances in natural science. They hold untold benefits for man. Our anxiety should be for the social sciences, which are lagging far behind, and which only now are beginning to awaken to the fact,—known to the physical sciences since Galileo's day, 350 years ago,—that there is only one road to new and certain knowledge —the road paved not by theorizing, but by experiment.

—Dr. W. D. Coolidge

electronics

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O. H. CALDWELL, *Editor*

Volume VII —AUGUST, 1934— Number 8

A waiting flood of business activity

AS THE radio industry plans ahead, sight should not be lost of the bright spots in the picture. Take the field of deferred housing and the need for dwellings, which eventually will have to be supplied, with resulting employment and business activity all along the line.

Right now there are 13,000,000 dwellings in the United States in need of repairs. And there is an immediate shortage of nearly two million homes. The construction which this implies, compares with the rebuilding of Belgium and Northern France after the War. Building of homes has been postponed and delayed, year after year, since 1929. We have as a result accumulated a vast waiting flood of construction which when released will mean widescale employment, widespread production and sale of materials, and reviving business activity. The radio and electronic industries will get their share.

The school market

FOR the first time in any depression in American history, expenditures for public schools have been seriously curtailed. In an attempt to remedy this condition, an exposition to be known as the National Schoolmart is being held in New York August 15 to 24.

There are many uses for electronic equipment in the modern school. These include public-address systems for assembly halls, school-address systems by which the principal may address the classrooms, radio and phonograph installations for entertainment and educational features, and electronic control devices, such as automatic light control.

As the public is made conscious of the necessity, and as general business conditions improve, school budgets will inevitably increase. There is no reason why electronic devices should not gain entry to this vast school market.

Standard equipment for broadcast transmitters

THE radio transmitter field has been marked by many special designs and special pieces of apparatus built for some particular station's order, only to be followed by some other new design to accomplish the same purpose. Such special designs are desirable because they give operating experience with new ideas and so create progress. But special orders are always expensive, and as soon as possible, production should be standardized to regulation models.

Radio insulator practice has been a case in point. Such insulators in the past have been produced along unrelated lines and usually represented the diversified ideas of ingenious users, co-operating with the manufacturers. Now radio insulator design is being simplified and standardized to a wholesome degree. In place of a large number of special pieces,—involving complicated stocks, and difficulties in replacement,—insulators are being put on a sound production basis, with resultant saving to all parties interested.

Daily notes for engineers

DR. C. F. BURGESS, chairman of the board of the Burgess Battery Company, requires his key men in all the affiliated Burgess industries to keep daily diaries recording observations, actual happenings, new ideas, and facts pertinent to their work. Indeed, employees of his laboratories have been keeping daily notes since 1910 at Dr. Burgess' behest. Such notebooks often become of great usefulness in value in patent cases, in dating inventions, etc.

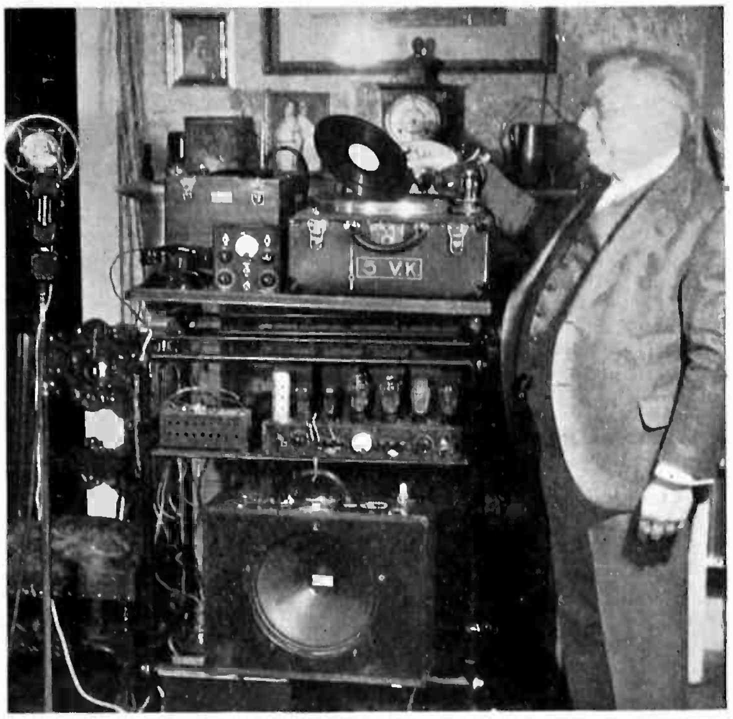
"There is no more difficult rule to enforce than that pertaining to daily notes," says Dr. Burgess. "But once a man sees the value of recording his accomplishments and plans, he becomes equally enthusiastic. An employee whose daily work does not uncover something of interest to himself and his company which is worthy of writing about should look for another job."

It is human nature to resent criticism—and *to resist new ideas*

Broadcast cross-modulation in the reflecting layer

DURING his visit to America for the IRE convention, Dr. Balth van der Pol of Eindhoven, Holland, called the attention of engineers to the phenomenon of cross-modulation in the ionized reflecting layer which has been observed in several European cases. Given two broadcast waves which are undergoing reflection in the same part of the Heaviside Layer, it has been found that the signal of the stronger wave seems actually to modulate the less powerful signal, so that cross-talk results. Careful checks have shown that this phenomenon occurs in the reflecting layer itself, but only when the geometrical paths intercept.

No similar instance of ionization modulation has been reported in America. Dr. van der Pol suggested that undoubtedly it exists here also, and urged American engineers to watch for it. Some radio men with whom the subject was discussed doubted that modulation in the reflecting layer is really the cause of this phenomenon, pointing out that it must have shown up long before this in code transmissions where the reflection paths traverse the same ionized region.



Professor Karapetoff and his recorder.

A recorded library of famous voices

Editor ELECTRONICS:

The apparatus shown in the photograph reproduced herewith has been designed and assembled for the purpose of making high-grade phonograph records of speech and music, on aluminum, celluloid, or acetate disks. A stand is shown to the left, with a ribbon microphone and a carbon microphone, which may be used interchangeably. The following apparatus is shown on the top shelf of the main stand: a turntable with a cutting head, a control box, a pre-amplifier for the ribbon microphone, and a telephone set for communicating with the next room. On the next shelf an amplifier is shown and a rectifier for a six-volt storage battery. Below the amplifier a Jensen auditorium-size loud speaker may be seen, and below it a six-volt storage battery. In actual operation, the microphones are placed in a room across the hall, with two closed doors in between, so that the performer does not see or hear the recording apparatus.

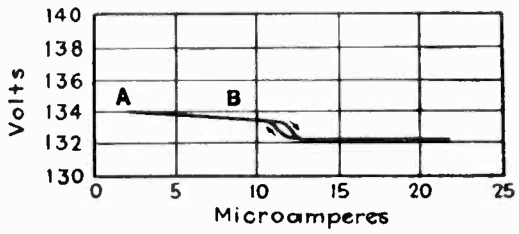
This equipment is used for the following purposes: (1) Records are made of piano accompaniments of vocal and instrumental pieces, and then soloists actually perform with these records. A special reproducing turntable is used, with distant volume and speed control, so that the performer may adjust the sound while playing or singing with the record. In other cases, unaccompanied solo pieces were recorded and later played to the accompaniment of a real piano. (2) Many friends, music students, professional speakers, and musicians come and ask to make records for them, to hear themselves speak, play, or sing. This has proved to be a potent stimulus for improvement and practicing. In some cases a person's playing or manner of speaking has been considerably modified within a couple of hours, as a result of his listening to his own successive records. (3) The writer has offered to Cornell University to make records of prominent persons, either connected with the Institution or coming here on a visit. So far records have been made of the voices of the following persons: the famous astronomer, Sir Arthur S. Eddington; Dr. William L. Bragg, a noted British physicist and a Nobel prize winner; and Dr. James Francis Cooke, editor of the *Etude* and president of the Presser Foundation. Such records will be made regularly beginning this Fall and will be permanently preserved in the University Library. Some duplicate records will be available for performances at Cornell Alumni gatherings throughout the country.

VLADIMIR KARAPETOFF,

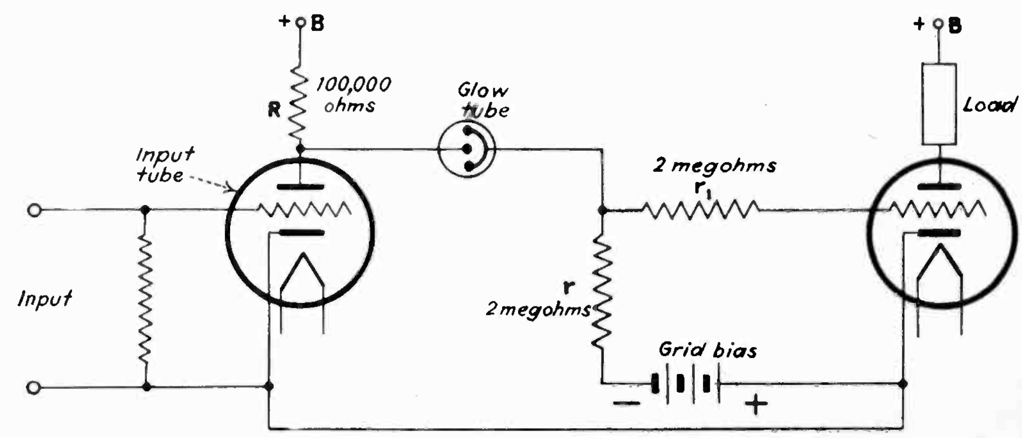
Professor of Electrical Engineering,
Cornell University, Ithaca, N. Y.

Gas discharge tube for interstage coupling

[H. Smith and E. G. Hill.] Whenever transients, impulse voltage changes, or frequencies below 50 cycles are to be amplified the problem of interstage coupling is difficult to solve, particularly if very small signal voltages must be used. A practical method of overcoming this difficulty involves the use of a gaseous discharge tube as the coupling device. The accompanying circuit diagram shows the glow-tube, in this case a neon filled lamp having a striking voltage between 120 and 170 volts, inserted between the plate circuit of the input tube and the grid of the following stage. The success of the method depends upon the voltage-current characteristic of the glow-tube, shown above, which is obtained when the tube is connected as shown in the circuit diagram. Except for the unstable region at the center of the characteristic, the voltage across the tube is very nearly constant. Hence the plate-voltage variations of the input tube will be transferred to the grid of the second tube. If the resistor r is made large enough to limit the current through the discharge tube to a value small compared with the plate current of the input tube, the coupling is fully efficient. The portion of the discharge characteristic used should be limited to that to the left of the unstable loop (portion A-B), which in the tube used corresponds to a discharge current of from one to nine microamperes. To insure this the bias battery must be carefully adjusted. The resistor r_1 is inserted to suppress parasitic oscillations. The anode resistance R should be approximately 100,000 ohms, if the plate potential is 200 volts, which value will insure the discharge of the glow-tube. Oscillographic tests indicate extremely faithful amplification of transients lasting as long as 5 seconds. —*Wireless Engineer* and *Exp. Wireless 130: 359-361, July, 1934.*



Voltage-current characteristic of glow lamp.



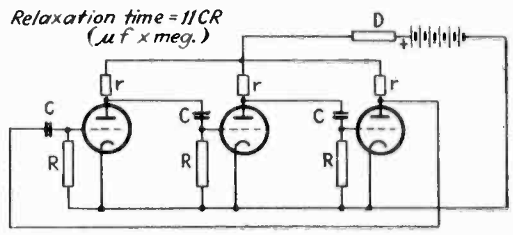
D.C. amplifier which uses a glow discharge lamp as the interstage coupling.

Resistance of tuning coils at radio frequencies

[M. Beauvilain, Arts et Métiers.] Three methods are available for determining the resistance R of a coil in an oscillating circuit for frequencies which are not too close to the natural period of the coil itself; it is possible either to study the resonance curve, when the coil is used in an oscillating circuit and the capacity of a low loss condenser is gradually varied, or to insert a known resistance r which reduces the current I at resonance to the value i, so that R is equal to $ri/(I - i)$, or the coil is placed in the tuned plate circuit of a dynatron oscillator and the negative resistance is determined. The three methods are applied to several coils, the results obtained for the same coil varying by as much as 50%. Part of the difference is due to differences in defining the high frequency resistance in the different circuits, and the other part by losses which vary from method to method. The method of the resonance curve is long and not very accurate, the method using a known resistance is precise but requires a complicated set-up, the dynatron method is quite practical, although it requires highly accurate values of the frequency and of the inductances. It is best to use a lamp giving a small negative resistance.—*Onde el,* 13: 127-148, *March (published June),* 1934.

Sinusoidal oscillations without tuned circuits

[J. Van Der Mark and Balth. Van Der Pol, Philips' Research Laboratory, Eindhoven] A kind of regenerative resistance coupled amplifier (or three stage multivibrator) with three or more identical stages is shown to become a source of very nearly sinusoidal oscillations if μr equals 2 (r the resistance in each plate lead). The period depends on the product CR, and may vary from half an hour to the values used in broadcasting; it is equal to 11 CR. With r = 2,000 ohm, C = 3,200 $\mu\mu f$., and R = 5,000 ohm, the frequency is 500 per second and the system takes several hours to reach the final amplitude. It is possible to design a sharply tuned radio receiver embodying no tuning coils. Systems with an even number of stages give non-sinusoidal waves (relaxation oscillations).—*Physica 1: 437-448, April, 1934.*



Source of sinusoidal oscillations.

Stability of oscillations in three electrode tube

[E. Divoire and P. Baudoux, Institute of Technology, Brussels] An analysis of the tuned plate circuit, the grid being excited by magnetic coupling, shows that when the grid current is neglected, the frequency of oscillations is less sensitive to changes in the internal resistance r (caused by fluctuations in filament and plate voltage) the higher the internal resistance r, the smaller the amplification factor μ, the smaller the ratio R/r of coil to internal resistance, the smaller L/C, M/L and the larger LC, that is, the lower the frequency. An artificial method of increasing the stability is to insert resistance between the plate of the tube and the tuned circuit. When the grid is positive and grid current flows, the internal resistance of this circuit being assumed to have a constant value, the stability suffers more the lower the internal grid filament resistance and the resistance in series with the grid coil.

Besides observing the conditions valid in the absence of grid current, it is also necessary to work near the critical value $L + CRr = \mu M$. The tube behaves as if the grid current were zero when a condenser shunted by a very high resistance is placed in series with the grid coil and this circuit tuned to the frequency to be produced. An experimental study confirms these deductions.—*Onde él. 13: 53-79, 1934.*

✦

The time constant

IN THE JULY 6TH number of *Science* attention is called by Charles R. Underhill to the fact that the time constant of a circuit containing self-inductance and resistance is the same, numerically, as the time required for the current to reach its final value if the initial rate of increase were maintained, i. e., if no resistance were present. Reference is also made to published tables calculated by him whereby various transient phenomena of this general character may be determined easily by simple algebraic means.

✦

Temperature coefficient of selenium barrier plane cell

[A. MITTMANN, Breslau Institute of Technology] Between room and liquid air temperatures the photoelectric current reaches its highest values when the cell is at —20° C. The decrease between —75° and —174° C. is nearly linear. The short circuit voltage increases steadily with falling temperature (from 1 to 4 millivolt). Assuming that the barrier plane cell may be considered as a vacuum cell having the internal resistance R (in the non-conducting direction), which is shunted by the output resistance w in series with the resistance r in the backward direction, as the total number of electrons set free and sent into the transparent film must be the same whatever the temperature, the result indicates an increase in the barrier resistance R with falling temperature, and an even more rapid increase in r. In contrast with the copper oxide cell the current measured at descending temperatures is not exactly the same as that obtained on going to higher temperatures except near the end points.—*Zeits. f. Physik 88 (516): 366-371, 1934.*

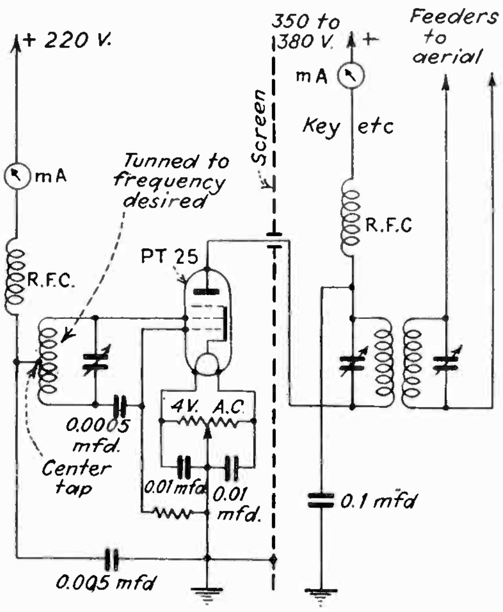
✦

Number of elements and effect of picture

[R. THUN] The human eye is able to see two objects separately, for instance two stars, if the light rays from the stars form an angle of not less than 30 seconds or even one minute. Many eyes require at least 1½ minutes or 1/40 degree. This sharpness extends over a field of view comprised within an angle of about five degrees. The angle of distinct vision is about 24 degrees. For a picture subtending this angle and having a height h, all those elements d cm. apart will appear separated for which the ratio h/d is at least equal to 24:1/40 or about 960. Splitting the picture up into more than 960 lines would serve no useful purpose for observers looking at it from a comfortable distance. For television pictures where objects are not seen against a dark background, the number of lines may be appreciably reduced. A large number of illustrations from magazines were placed at distances at which the details were still recognizable. At a distance which corresponded to 450 lines (when the angle of sharpest vision was assumed to be 3.4 minutes instead of 1.5 minutes) all the pictures were satisfactory, from a distance equivalent to 180 lines about 84 per cent, and with 90 lines 30 per cent.—*Ferns. Tonf. 5: 13-15, April, 1934.*

Electron-coupled transmitter used in Malaya

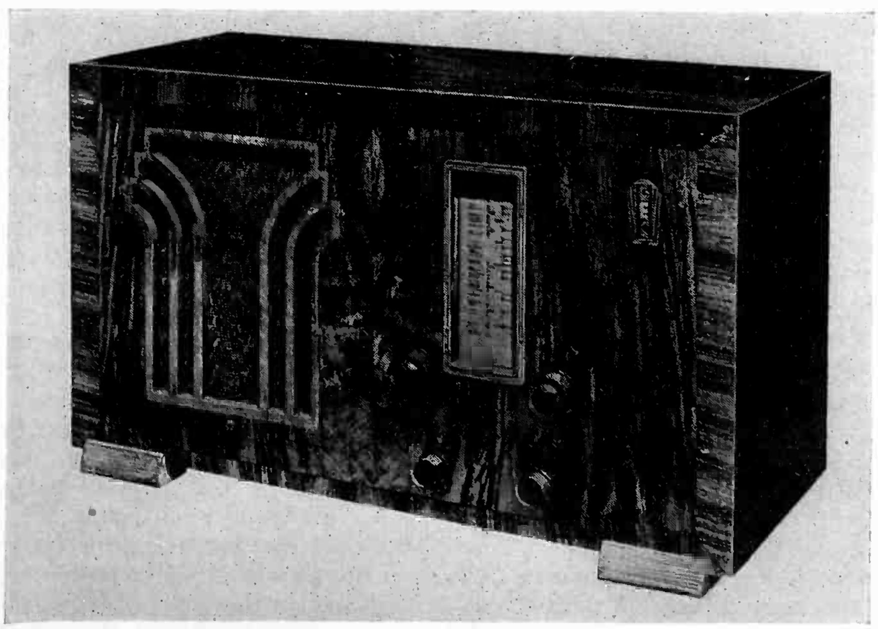
IN A COMMUNICATION to the *Wireless Engineer*, Mr. J. MacIntosh, of Kuala Lumpur, Fed. Malay States, reports the use of several pentodes, Marconi types P. T. 4 and P. T. 25, as electron-coupled oscillators for short-wave transmission.



Electron-coupled oscillator for short-wave transmission.

The circuit used, shown in the figure, provides an output of approximately 16 watts; the frequencies used were 7,100 and 14,200. Communication with Australia and Europe is reported. The drive circuit is tuned to a frequency one-half that of the output, no neutralizing being used.

EUROPEAN MULTI-WAVE RECEIVER



The waveband in use in this English superheterodyne is shown by colored lights behind the tuning indicator.

+ NEW PRODUCTS

THE MANUFACTURERS OFFER

Oxide-crystal phonograph pickup

The new phonograph pickup of the Amperite Corporation, 561 Broadway, New York City, requires only one stage of audio amplification and gives life-like reproduction. Former phonograph pickups have required at least two stages of amplification.

The Amperite pickup has an output large enough so that the single audio stage used in many radio sets, provides the necessary amplification to obtain full power output of the receiver. The output of the Amperite pickup is —10 dbs—the magnetic —15 dbs.

The new pickup consists of an oxide crystal with an average resistance of approximately 100,000 ohms, making it possible to connect it directly to any radio set without any changes whatsoever. The operation of the set itself is not affected, and no background noise is produced.

The new construction is simple and rugged. Proper damping makes it possible to eliminate all resonant peaks, the cause of poor reproduction. Contrary to the magnetic pickup, the response does not fall at the lower frequencies but shows a marked rise. Combination of radio set and pickup give a straight-line output.

The die-cast construction eliminates tone-arm resonance. Ball-bearing pivots give free motion to the arm resulting in perfect tracking. Long record life is obtained by the exceedingly low weight on the record—50 grams.—*Electronics.*

+

Visual capacity meter

The Premier Crystal Laboratories, Inc., announce a new capacity meter, with visual indication, for production testing of capacities. In use, the main dial of the instrument is set for the value of the capacity to be tested, and a second control is adjusted for the required degree of tolerance (1% or 10%). If the condenser being tested falls within these limits, the neon lamp glows, otherwise it remains dark. The meter uses the substitution principle. A fixed frequency oscillator acts as a standard, the unknown capacitance being connected to a resonant transformer, the output voltage of which is amplified to a value suitable for controlling a grid controlled gaseous discharge tube, which in turn lights the neon indicator. The same company is developing an instrument based on the same principle for use in the rapid production testing of inductances.—*Electronics.*

+

Resistance cord

A new radio power supply cord which incorporates a line cord with a voltage-drop resistor, is announced by the Belden Manufacturing Company, 4689 W. Van Buren St., Chicago, Ill.

The new cord is made with three resistances for all A.C. or D.C. radios using this kind of power supply:

No. 8920—total resistance 135 ohms; total filament drop 25.2-31.5 volts.

No. 8921—total resistance 165 ohms; total filament drop 56.5-68.9 volts.

No. 8922—total resistance 290 ohms; total filament drop 68.9-75.2 volts.

These cords are six feet long and attached with the handy midget type unbreakable soft-rubber plug.—*Electronics.*

+

Porcelain cooling-coils for transmitting tubes

To eliminate the troublesome water hose for water-cooled transmitting tubes, the Lapp Insulator Company, Inc., LeRoy, N. Y., has produced porcelain cooling coils for standard tube sizes. These white glazed porcelain coils are non-absorbent, and eliminate the deterioration and contamination of the cooling water which results from rubber hose, thus reducing the frequency of change of water. An electrolytic target can be projected into the hole in the porcelain, past the gasket, thus eliminating any electrolytic action on the fittings. Coils approximately 28 ft. long can be supplied. All coils are proof-tested to 50 lb. per sq. inch of pressure, and the design has been tested to 200 lb. per sq. inch. These porcelain coils have been tested in actual use over a year, and have been adopted by leading set-builders as standard equipment.

The lower end of the porcelain cooling coil is firmly cemented into the spider-type, cast aluminum base. A base may also be cemented to the top of the porcelain coil, thus using the coil as both the support for the tube and the insulator.—*Electronics.*

+

High-speed, low-speed power-level indicators

For years the Weston Electrical Instrument Corporation, Newark, N. J., has offered indicating instruments to determine power level in lines carrying audio-frequency current. The usefulness of direct indications in maintaining correct average levels, and in keeping peak values below the distortion point has materially widened the application of these instruments.

In line with these increasing applications, Weston has now developed two new DB meters, so that these instruments are now obtainable in three classes, differing in pointer action; namely, high-speed, general-purpose and slow-speed. The DB, or power level indicators, that have been used to date, have been of the general-purpose type. The new high-speed instruments are so designed that indications of peak values are available with a negligible amount of overswing of the pointer. As contrasted with the high-speed instrument, the slow-speed type tends to indicate average values, the pointer being slow enough in its action to avoid indications of sharp peaks or valleys.—*Electronics.*

+

Power supply for 6-volt farm radios

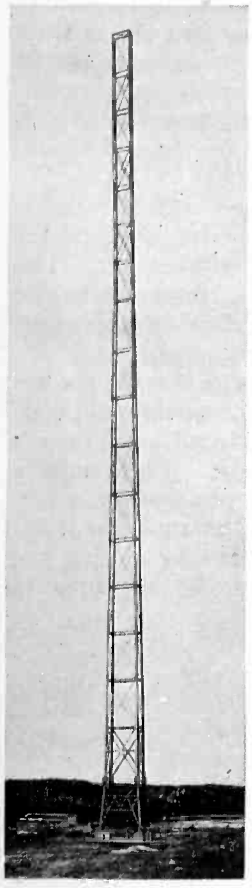
A new economical and more compact unit for supplying all C and B voltages from a 6-volt storage battery has just been announced by the Pioneer Gen-E-Motor Corporation, of 464 West Superior Street, Chicago, Ill. This unit is being used in many of the new farm radios just announced for operation from 6-volt storage batteries. Models are available with any desired maximum and intermediate voltages.

Additional Gen-E-Motor designs are available for auto-radio, air-craft, and 32-volt power systems.—*Electronics.*

Self-supporting antenna tower

THE TRUSCON STEEL COMPANY, Youngstown, Ohio, has designed its new Truscon Antenna, to approach the ideal vertical radiator as nearly as is possible with a mechanical structure. Fundamentally, this approach is to keep the base capacity as low as possible and top capacity as high as possible consistent with economical design. This is accomplished in a number of ways depending upon the height of tower, power available, economic investment permissible for station, etc.

In the broadcasting range, all these factors can vary widely, and accordingly a flexible scheme of construction was developed which affords the radio engineer new tools to work with, opening up possibilities of antenna performance not hitherto possible. Self-supporting towers up to $\frac{5}{8}$ wave for the complete range of broadcasting frequencies, are now economically feasible.



On smaller towers a single-column construction is generally used with or without a capacity spreader at the top, and base width is made unusually narrow but with perfect safety because of the low mechanical loads imposed on the insulators.

On the larger towers the top width may be kept large to provide high top capacity and it is even possible to make an antenna with the top diameter considerably larger than the bottom diameter, thus making a very close approach to the ideal radiator, commonly described as an "A tower upside down."

By insulating the lower end of the tower and breaking it up into sections to remove ground potential a single lead can be used for a considerable part of the total height.

In the Truscon towers, insulators are located high above the ground in order to further reduce ground capacity losses, and in some cases engineers have favored the use of additional insulators to sectionalize the lower part of the tower, thus removing ground potential from the immediate vicinity of the radiator.

The removal of limitations hitherto inherent in self-supporting towers has been accomplished by a unique method of utilizing round bars for the structure, thus reducing the wind load and consequently the mechanical duty at the base of the tower.—*Electronics.*

✦

Self-generating photo-cell

A LAYER OF COPPER oxide on a copper disc has some unusual and interesting properties. Many readers are familiar with the Westinghouse "Rectox" or copper-oxide rectifier which has been widely used for several years. The new Photox photo-cell may be called the cousin of the Rectox. It, too, is a copper disc with a coating of oxide, but instead of rectifying, it acts as a tiny primary battery when light strikes its surface. The current generated is measured in micro-amperes but is sufficient to be extremely useful.

The current output is directly proportional to the intensity of the light which strikes it and retains this property indefinitely. Its response to colored light is another interesting characteristic. The response is almost exactly the same as that of the human eye. Thus a colored light which seems bright to the eye seems bright to the Photox. This property has become the basis of the light-intensity meter and the transparency meter (transometer).—*Electronics.*

✦

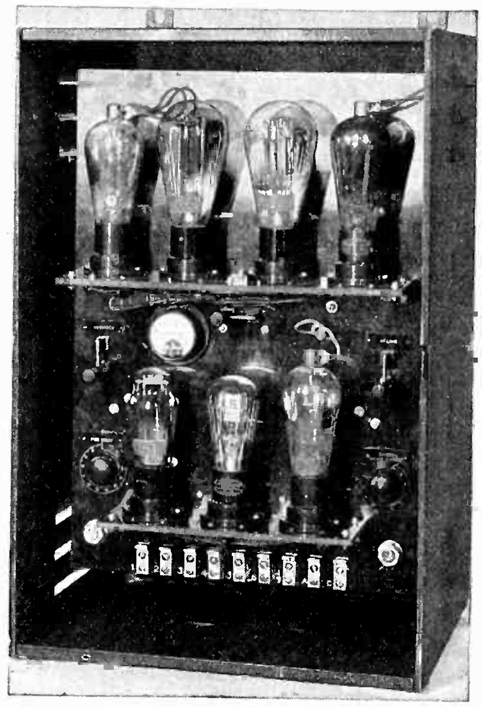
Cathode-ray screen

IMPROVEMENTS in technique have enabled the Allen B. Du Mont Laboratories of Upper Montclair, N. J., to overcome the blackening of the fluorescent screen when the electron beam is allowed to remain stationary on all tubes having the high intensity screen developed previously by that laboratory. This means that the life of the screen is materially increased as the darkening caused deterioration of the fluorescent screen and hence loss of light. Furthermore because of this defect in cathode-ray tubes previously it has not been practical to use them for certain uses, such as sound recording or indicating meters where the spot or line might remain stationary for a considerable period of time.—*Electronics.*

✦

High-speed photo-electric "lock-in" controllers

THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, East Pittsburgh, Pa., announces a line of electronic industrial control devices for initiating a control function from an actuating impulse as brief as 1/5,000 of a second. The impulse may be a minute current or voltage received from a phototube, delicate contacts, control circuits, or similar sources where the impulse is too small or too brief to directly actuate the usual type of relay. Equipments are available which will maintain the response indefinitely or for an adjustable predetermined length of time. In other words, these devices are photo-electric, high-speed, lock-in controllers.



A few of the numerous applications are:

1. *Photo-electric control applications:*

(*a*) Limit or "flag" switch where size, weight or temperature of material makes mechanical switch undesirable, and where material is moved very rapidly.

(*b*) Determining the exact speed of rapidly moving objects, by obtaining an instantaneous time record of material or object position, as timing of races.

(*c*) Counting any sort of rapidly moving objects.

2. *Current or voltage control applications:*

Any relatively low power and voltage control sources which cannot operate mechanical relays reliably can be used to operate the Photo-Troller.—*Electronics.*

✦

Sound-film recording

SEVERAL INNOVATIONS in methods of light-valve recording were announced by Electrical Research Products, Inc., 57th and Broadway, New York City. Changes have been made in the input circuit to the light-valve so as to compensate for the time shift of the effective exposure produced by the light-valve ribbons, which is equal to the time required for the film to travel from the neutral position of the image of one ribbon. With a constant film speed of

90 feet per minute and a ribbon spacing of one mil, the loss in effective exposure is dependent upon the frequency of the input current, amounting to approximately 3 db at 9000 cycles. Compensation for this loss is accomplished by splitting the input circuit to the light valve and inserting a delay in that part of the circuit which feeds the upper ribbon. The delay is adjusted so that maximum response at 8000 cycles is obtained. The use of toe recording up to the point of preparing the master negative by re-recording, further improves quality by eliminating a printing operation with its consequent losses and distortions.—*Electronics.*

✦

Mercury switches

A COMPLETE LINE of tilting mercury switches for interrupting currents carrying up to 20 amperes and thus controlling up to 4,000 watts of non-inductive load, is offered by the Mercoid Corporation, 4201 Belmont Avenue, Chicago, Ill., makers of automatic controls. Such mercury switches permit a very small operating energy to control considerable power apparatus and so form an essential link between sensitive electronic devices and the heavy power loads they are often required to control.

In the Mercoid type of switch the glass tube contains sealed contacts of special material, and is filled with an inert gas which stifles the arc. Since the circuit-interruption is glass-enclosed there can be no open arcing, oxidization or corrosion. The contact is permanently clean, instantaneous and silent in operation, and will last indefinitely without deterioration. Ratings run from 1 to 20 amperes, and prices of the glass-tube switch elements (which have ferrules for clip mounting) are listed at from $2 to $4.—*Electronics.*

✦

High-fidelity speaker

A REPRODUCER capable of delivering high frequencies has been brought out by the Lansing Manufacturing Company, 6920 McKinley Avenue, Los Angeles, Calif.

For example, designed for public-address work and for use in the finest radio receivers, the Lansing Model 15X will handle 30 watts of undistorted output, and in connection with the new high-frequency unit, offers a wide tone range of high-fidelity requirements.

The Lansing company also manufactures a complete line of loud speakers for general use, including console speakers, 6-inch speakers, diminutive 5-inch speakers, and moderate-priced units.—*Electronics.*

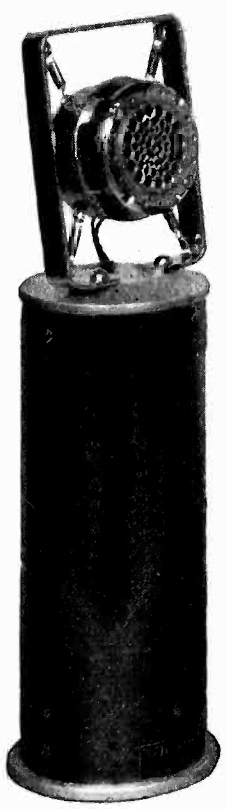
Five-inch speaker for small sets

BECAUSE OF a wide variety of requirements covering performance and dimensions of 5-in. speakers, the Magnavox Co., Ltd., Fort Wayne, Ind., now offers a revised model of the 5-in. speaker, designated as Model 195. The mechanical design permits it to go into closely crowded receiving sets, leaving a maximum of space on all sides for other set components.—*Electronics.*

✦

Electro-dynamic microphone

VICTORY SPEAKERS, INC., Oakland, Calif., announces a new electro-dynamic microphone featuring mechanical and electrical improvements. The microphone is housed in an indestructible



chromium-plated all-steel head, which is entirely shock-proof. Its directional characteristics are such that it can be used actually within a few feet of the loud-speaker without feed-back. The head itself can be operated at distances up to one hundred feet from the pre-amplifier, if necessary, and several heads can be fed into a single preamplifier unit. The free-edge duraluminum diaphragm is supported by a light and flexible suspension system. Operation of the head is not adversely affected by changes in humidity. Electrical dampening of the diaphragm is constant.

The two stage high-gain preamplifier is housed in a four-inch seamless steel tubing finished in lacquered statuary bronze.

This new microphone was designed by L. C. Rayment, who has made engineering contributions to the Sargent-Rayment receivers.—*Electronics.*

✦

Protective relays for transmitters

A LINE OF PROTECTIVE midget overload and underload relays for radio transmitters is being marketed by the Ward Leonard Electric Company, Mount Vernon, N. Y.

Ward Leonard midget overload relays are specially designed for use in transmitter circuits to provide protection to the tube against overload or current surges. These overloads may occur while tuning the transmitter or if resistance bias is used on the power amplifier, the tube may become overloaded should loss of excitation occur.

The normally-closed relay contacts are connected in series with the primary of the plate rectifier transformer. The relay overload coil is connected in the negative return lead from the rectifier so as to operate at low potential.

When a current surge occurs, the relay armature pulls in, opening the contacts in the rectifier circuit and protects the tube from damage. The contacts are held in the open position by a mechanical latch until the operator trips the latching device, thereby closing the contacts and reconnecting the tube in the circuit.—*Electronics.*

✦

High-frequency dielectrics

HIGH-FREQUENCY insulators for commercial service are described in the new booklet issued by Dielectric Products Corporation, 63 Park Row, New York City, which covers Steatite, ultra-steatite, and Vitrolex.

At room temperature, the volume resistivity of Steatite is 2.5×10^{14} ohms per centimeter cube, and the surface resistivity 10^{12} ohms per square centimeter. This compares with about 10^{11} ohms per square centimeter for surface resistivity of organic dielectrics such as phenolic insulating materials, and 10^{13} for hard rubber.

Unglazed Steatite ceramic bodies provide insulation resistance equal to the finest grades of technical ceramic ware produced. Using the substitution method, the power factor of Steatite is found to be 0.0018 or .18% at a frequency between 800 and 1,000 K.C. The audio frequency bridge gives a value slightly higher than this, while the power factor as determined with the reactance variation apparatus for higher frequencies is somewhat below 0.18%.—*Electronics.*

"Self-government" and new code

[Continued from page 237]

through representatives of their own choosing, and shall not be required to join any company union or refrain from joining, as a condition of employment.

"Open-price" plan; trade practices

At the present time the radio industry operates under the Open Price Plan of the NEMA Code. This open-price feature would be continued under the new plan, except that the time element under the RMA proposal would be much reduced—from 10 days to 2 days. The new draft reads as follows: "Every member if required by the Code Authority shall file with the Code Authority or its duly constituted agency not less than two days prior to the first sale or shipment of any product. . . . a minimum net price list or a price list and maximum discount sheet, showing current prices or prices and discounts and terms of sale and payment and advertising or any other allowances for products sold to branches, distributors and/or dealers, and the Code Authority shall send copies thereof to all persons known to it manufacturing or promoting the manufacture of such articles, and shall make such prices and lists available to any person upon application therefor.

"Thereafter no member shall sell or offer for sale any product or service of the industry or any combination thereof below the price stated in such filed schedules—provided however, that such schedules may be changed on not less than two days' notice to the Code Authority or its agency. No advance notice of change need be given in the event that any member advances prices over his last filed schedule. This article shall not apply to direct export sales of any product, or to sales of any product destined ultimately for export."

Under Article VII, devoted to "Trade Practices" it is provided that no gifts or money shall be offered to employees or representatives of competitors' customers to influence sales; no offers shall be made to prospective purchasers without reporting same to the Code Authority; no products shall be sold at cost for the purpose of furthering the sale of some other product; no product shall be improperly branded or labeled, so as to mislead; no advertising shall be done to mislead; no false or misleading statement shall be made of competitors' business policies, methods, conduct, etc.

Further that no member shall sell any article at a price below cost, as defined in the sixth edition of the NEMA accounting manual. Such member may, however, with the approval of the Code Authority, meet the price of any other member of the industry whose cost under this provision is lower, or may sell dropped lines or distress merchandise below such cost. Such approval shall be impartial and not unreasonably withheld.

NEW BOOKS ON ELECTRON TUBES

Short wave wireless communications

By A. W. Ladner and C. R. Stoner, Marconi's Wireless Telegraph Co. Ltd., Great Britain. Second edition. John Wiley and Sons, Inc., New York. (384 xii pages, 12 plates. Price $3.75.)

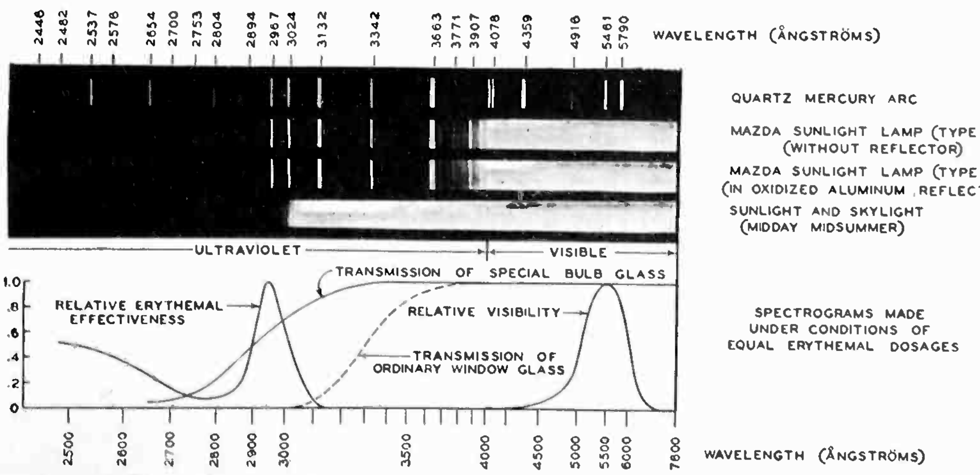
THE FIRST EDITION of this book, which appeared two years ago, was one of the first to deal with the technical problems peculiar to short-wave communication systems. The second edition is brought up to date and includes some additional material. The book concerns itself with the problem of communication from point to point as distinguished from broadcasting; although the treatment is sufficiently general to include the latter classification also. It is written from the British point of view with its differences in phraseology which, while noticeable, need not confuse the American reader.

The first section of the book develops the physical theory of radio wave propagation, and points out the factors which are peculiar to the high frequency spectrum. This development is not rigorous, but it presents the end results of the theory in many useful tables and diagrams. Use is made of the Eckersley and Tremellen "shadow charts" in discussing the problem of long distance transmission over sunlit and dark portions of the earth's surface. The various forms of interference, echo-effects, and reflection problems are fully discussed.

Modulation theory as applied to high frequencies, the circuits used to produce "constant-frequency" oscillations and transmitter circuits in general occupy the next section. Following are chapters on high frequency feeders, aerials, and aerial arrays (for directional transmission), subjects of great interest upon which too little information has been available heretofore. These chapters contain both the theoretical and practical aspects of antenna design and constitute, to this reviewer at least, the most interesting and valuable part of the book.

Reception problems, which come in for attention at the end of the volume, are dealt with rather briefly, possibly because of the authors' belief that success lies in sending a strong, well-directed wave in the first place rather than in depending upon a receiver to make up for deficiencies in transmission. Ultra-short waves are also discussed.

THE VISIBLE AND ULTRA-VIOLET SPECTRUM



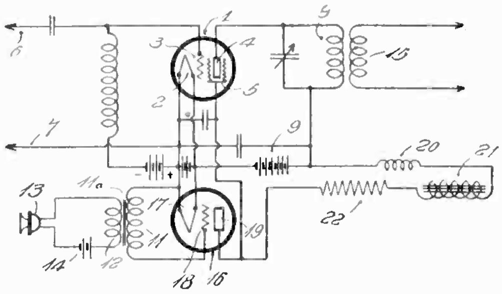
Wavelengths emitted by various light-sources; absorption by glass materials, and points of greatest eye and skin sensitivity.

U. S. PATENTS

IN THE FIELD OF ELECTRONICS

Radio Circuits

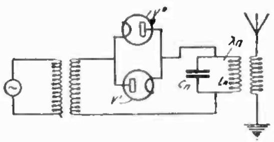
Modulation system. A means of modulating an oscillator by impressing upon an auxiliary grid in the oscillator



tube an audio frequency voltage. Ross Gunn, Radio Corporation of America. No. 1,966,065.

Radio control device. A means for silencing the output of the radio receiver when a switch is closed by independent instruments such as a telephone handset, a resistance being shunted to the voice coil of the loud speaker thereby. Arthur M. O'Neill, New York, N. Y. No. 1,966,184.

Frequency multiplier. A means of multiplying the frequency of an oscillator by two rectifier tubes connected to the output thereof by means of a transformer. The anode of one rectifier tube



is connected to the cathode of the other and feeds into a tuned circuit which resonates at the multiplied frequency. Rudolph Gurtler, Telefunken Gesellschaft, Berlin. No. 1,965,641.

Filter circuit. A filter circuit for reducing ripple in a direct current supply system by means of neutralizing the ripple with a phase shifting device and an auxiliary transformer. Homer J. Loftis, Radio Corporation of America. No. 1,965,661.

Amplifier circuit. A means of coupling a source of signal energy to an output device through a screen grid tube, a coupling network and a triode. Herre Rinia R.C.A. Eindhoven, Netherlands. No. 1,966,221.

Antenna system. A method of measuring the maximum intensity of the energy radiated by a transmission antenna by means of a U-shaped receiving antenna having a length approximately equal to a half-wave length of the incoming wave and placed so as to absorb immediately after emission energy from both the horizontally and vertically polarized components of the radiated wave. Enoch B. Ferrell, Eaton Town, N. J., Bell Telephone Laboratories. No. 1,966,491.

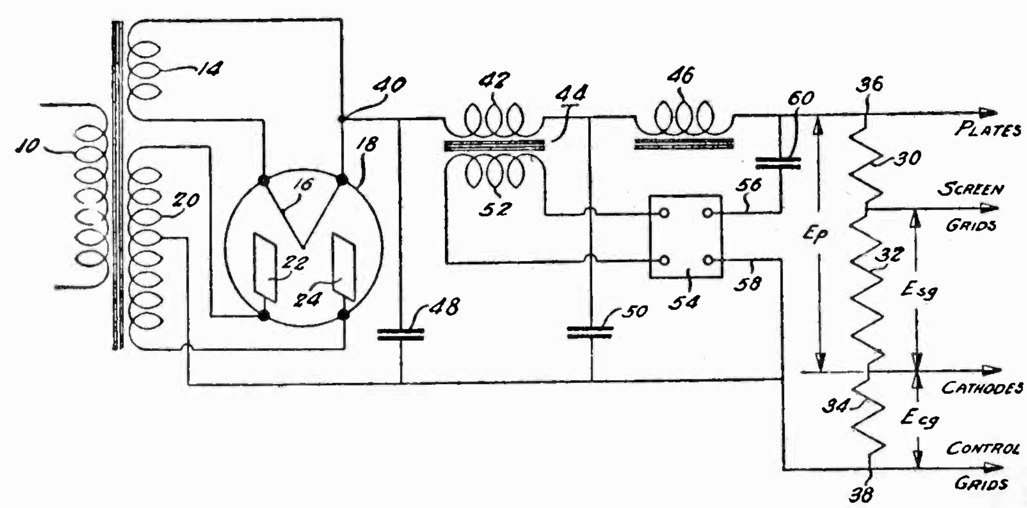
Automobile receiver. A method of mounting and shielding an automobile radio with tuning control mounted on steering column. Earl C. Booth and Walter E. Peek, Columbus, Ind., Noblitt-Sparks Industries, Inc. No. 1,965,628.

Parallel push-pull circuit. A pair of triodes connected with the grid circuits in parallel and the plate circuits in push pull and with the grid biased to different extents, used for amplifying the oscillations from an independent source. Reynolds D. Brown, Jr., Philadelphia, Pa. No. 1,966,607.

Oscillator. A circuit for generating oscillations in which a vacuum tube is used having two control grids biased at different values, which receive voltage impulses by coupling to the plate circuit. Pierre Bernard Francois David, Paris, France. No. 1,966,616.

Gaseous discharge amplifier. An amplifier system using a two-electrode gaseous discharge lamp polarized to produce a discharge only within one electrode whereby the tube is caused to have a negative resistance characteristic. August Hund, West Orange, N. J., Wired Radio, Inc., No. 1,967,008.

Automatic volume control. A circuit in which the field excitation of a phonograph pick-up is varied in accordance with the output of the armature coil



Power supply ripple neutralized by a "self-bucking" system. U. S. Patent No. 1,965,661

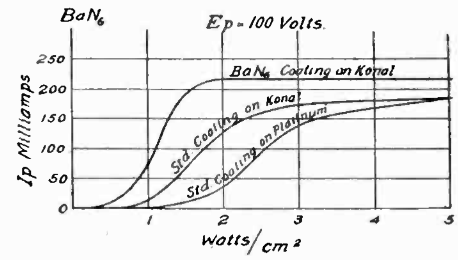
through suitable thermiodic amplification equipment, thereby automatically monitoring the amplitude of the output vibrations. Robert W. Miller, New York, N. Y. No. 1,967,125.

Stable oscillator. A regenerative feedback system for reducing the effects of the feedback with increasing amplitude of oscillations. Walter van B. Roberts, Radio Corporation of America. No. 1,966,046.

A.C. measuring circuit. A circuit for measuring alternating current over a wide range of values on a single instrument comprising a d.c. instrument, a rectifier, a current source, and a second rectifier connected in shunt with the d.c. instrument. Leonard E. Ryall, Associated Electric Laboratories, Inc., Chicago. No. 1,966,047.

Electron Tubes

Cathode. A method of increasing the electron emissive content of a cathode containing the compounds of barium and strontium which comprises mixing



barium azide with barium and strontium compounds, with subsequent reductions of the azide to free metallic barium. Walter T. Millis, Wilkinsburg, Pa., Westinghouse Electric & Manufacturing Company. No. 1,966,211.

Electronic tube. A photo tube containing cathode and anode with conductors sealed in the wall to make contacts with cathode and anode. Oran T. McIlvaine, East Cleveland, Ohio, McIlvaine Patent Corporation. No. 1,965,849.

Applications of Electron Tubes

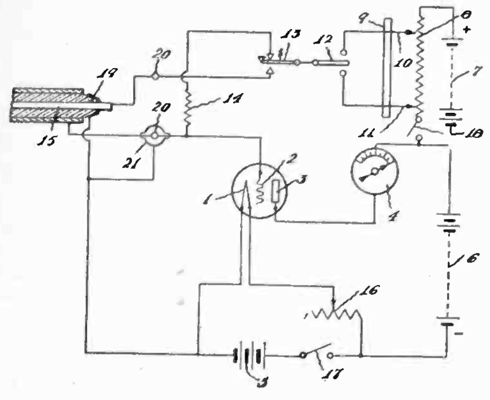
Sound reproduction system. A method of greatly reducing variations in the polarizing potential of a photo-cell used for sound reproduction by shunting the ripple component of the recitified and filtered supply directly to ground through a low impedance path at a point adjacent to the photo-electric cell. Henry B. Yager, New York, N. Y. Assigned to Freeman H. Owens, New York. No. 1,965,934.

Signaling system. A gaseous discharge tube used as a receiver of telegraphic signals by indicating whether the remote end of the connecting line is open or short-circuited. John P. Radcliff, New York, N. Y., American Telephone & Telegraph Co. No. 1,965,711.

Control system. A means responsive to variation in the tension of a moving material which will vary the speed of the driving mechanism to restore normal tension, with triode tubes used for initiating the control. Harry L. Palmer, Scotia, N. Y., General Electric Co. No. 1,966,214.

Synchronous machine starting. An electronic method of applying rectified voltages to synchronous machinery at appropriate intervals until synchronous speed is reached. Clodius H. Willis, Princeton, N. J., General Electric Co. No. 1,966,940.

Conductivity measurement. A triode circuit in which a material whose conductivity is to be measured is placed between the grid and cathode, the reaction



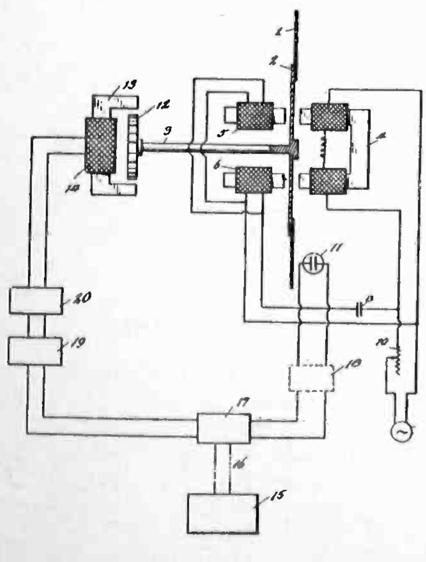
in the plate circuit being an indication of the measured conductivity. Albert Preisman, Bronx, N. Y. No. 1,966,185.

Telemetric device. A gaseous discharge tube connected across the transmitting line so as to short-circuit the line when an impulse is to be transmitted and a gaseous discharge tube connected as a receiver at the remote end of the line for indicating whether the transmitter is open or short-circuited. Ernst Sommerfeld, Berlin-Neutempelhof and Wilhelm Stablein, Berlin-Hermsdorf, Germany, General Electric Company. No. 1,966,224.

Glow discharge lamp. A glow discharge device comprising a capillary tube and two electrodes, one of which surrounds the tube and in which a glow discharge is initiated upon applying an electric potential. Fritz Schroter and Fritz Michelssen, Berlin. Telefunken Gesellschaft. No. 1,965,752.

Television

Scanning device. A scanning disk for television a portion of which serves as the rotor of an eddy current motor, and driven on a shaft which contains a syn-

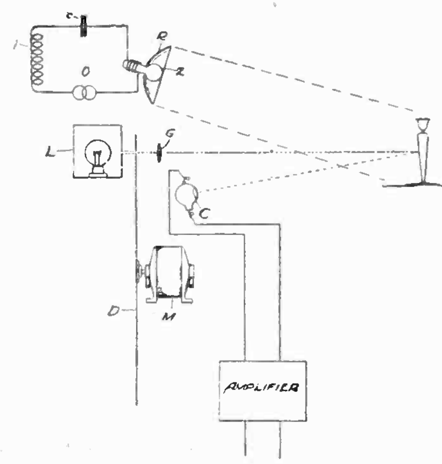


chronizing rotor for coupling together and synchronizing the rotor and shaft. Garrett Vander Veer Dillenback, Jr., Slingerlands, N. Y., Radio Corporation of America. No. 1,966,617.

Tube construction. A gaseous discharge tube containing an ionizing cathode and anode, the ionizing surface of which is relatively smaller than that of the cathode and a means for localizing the glow discharge in a region surrounding the anode and cathode. August Hund, West Orange, N. J., Wired Radio, Inc. No. 1,967,009.

Electrical gaseous discharge device. A gas discharge tube in which the pressure is regulated to maintain a discharge in the vicinity of the anode. Albert Paul Hans-Gerd Nickel, Charlottenburg and Johannes Joachim Spanner, Berlin. No. 1,966,830.

Modulating system. A television system in which two light sources are used to illuminate the image, one of which varies at a predetermined rate from extinction to full briliancy. The lights from the two sources after being varied by the image are combined with one another. Delbert E. Replogle, Newton, Mass., Raytheon Production Corp. No. 1,967,041.



Patent Suits

1,251,377, A. W. Hull, Method of and means for obtaining constant direct current potentials; 1,297,188, I. Langmuir, System for amplifying variable currents; 1,707,617, 1,795,214, E. W. Kellogg, Sound reproducing apparatus, D. C. Mass., Doc. E 3955, General Electric Co. v. Automatic Radio Mfg. Co., Inc. Consent decree for plaintiff for an injunction Apr. 10, 1934.

1,573,374, P A. Chamberlain, Radio condenser; 1,231,764, F. Lowenstein, Telephone relay; 1,618,017, same, Wireless telegraph apparatus; 1,702,833, W. S. Lemmon, Electrical condenser; 1,811,095, H. J. Round, Thermionic amplifier and detector; Re. 18,579, Ballantine & Hull, Demodulator and method of demodulation; 1,403,932, R. H. Wilson, Electron discharge device; 1,465,332, H. D. Arnold, Vacuum tube amplifier; 1,403,475, same, Vacuum tube circuit, D. C., Mass., Doc. E 3956, Radio Corp. of America et al. v. Automatic Radio Mfg. Co., Inc. Consent decree for plaintiff for injunction Apr. 9, 1934.

1,879,863, H. A. Wheeler, Volume control, filed May 4, 1934, D. C., E. D. N. Y., Doc. E 7238, Hazeltine Corp. v. B. Abrams et al.

1,920,162, Amy & King, Radio aerial attachment; 1,938,092, Amy & Aceves, Radio receiving system, filed Mar. 7, 1934, D. C. Mass., Doc. 7 3963, Amy, Aceves & King, Inc., v. Tobe Deutschmann Corp.

1,231,764 (a), F. Lowenstein, Telephone relay; 1,618,017, same, Wireless telegraph apparatus; 1,465,332, H. D. Arnold, Vacuum tube amplifier; 1,573,374, P. A. Chamberlain, Radio condenser; 1,702,833, W. S. Lemmon, Electrical condenser; 1,811,095, H. J. Round, Thermionic amplifier and detector; Re. 18,579, Ballantine & Hull, Demodulator and method of demodulation, filed May 5, 1934, D. C., S. D. N. Y., Doc. E 78/111, Radio Corp. of America et al. v. Pyramid Radio Distributors, Inc.

1,231,764 (b), F. Lowenstein, Telephone relay; 1,618,017, same, Wireless telegraph apparatus; 1,465,332, H. D. Arnold, Vacuum tube amplifier; 1,403,475, same, Vacuum tube circuit; 1,702,833, W. S. Lemmon, Electrical condenser; 1,403,932, R. H. Wilson, Electron discharge device; 1,811,095, H. J. Round, Thermionic amplifier and detector; Re. 18,579, Ballantine & Hull, Demodulator and method of demodulation, filed May 4, 1934, D. C., S. D. Calif. (Los Angeles), Doc. E 254-J, Radio Corp. of America et al. v. F. T. Cawood (Cawood Radio Co.). Doc. E 256-H, Radio Corp. of America et al. v. C. F. Sexton (Radio Products Sales Co.).

1,231,764 (c), F. Lowenstein, Telephone relay; 1,618,017, same, Wireless telegraph apparatus; 1,465,332, H. D. Arnold, Vacuum tube amplifier; 1,403,475, same, Vacuum tube circuit; 1,702,833, W. S. Lemmon, Electrical condenser; 1,403,932, R. H. Wilson, Electron discharge device; 1,573,374, P. A. Chamberlain, Radio condenser; 1,811,095, H. J. Round, Thermionic amplifier and detector; Re. 18,579, Ballantine & Hull, Demodulator and method of demodulation, filed May 9, 1934, D. C., S. D. N. Y., Doc. E 78/125, Radio Corp. of America et al. v. Bel-Rad Products Co., Inc., et al.

1,244,217, I. Langmuir, Electron discharge apparatus and method of operating the same; 1,558,437, same, Electrical discharge apparatus; 1,537,708, W. Schottky, Thermionic vacuum tube; 1,696,103, G. Seibt, Electric discharge tube; 1,748,026, L. E. Mitchell, Electron discharge device; Re. 15,278, I. Langmuir, same, filed May 7, 1934, D. C. Conn. (New Haven), Doc. E 2354, Radio Corp. of America et al. v. C. S. Mersick & Co. Doc. E 2355, Radio Corp. of America et al. v. Roskin Distributors, Inc.

1,251,377, A. W. Hull, Method of and means for obtaining constant direct current potentials; 1,297,188, I. Langmuir, System for amplifying variable currents; 1,573,374, P. A. Chamberlain, Radio condenser; 1,728,879, Rice & Kellogg, Amplifying system, filed May 4, 1934, D. C., S. D. Calif. (Los Angeles), Doc. E 255-H, Radio Corp. of America et al. v. F. T. Cawood (Cawood Radio Co.).

1,297,188. (See 1,251,377.)

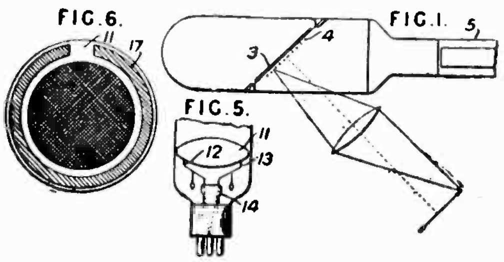
1,354,939, H. D. Arnold, Vacuum tube device; 1,459,412, A. M. Nicolson, Thermionic translating device; 1,479,778, H. J. Van Der Bijl, Vacuum tube device; 1,672,233, W. J. Skinner, Radio grid and filament spacer; 1,850,981, H. P. Donle, Rectifier, filed May 4, 1934, D. C. Conn. (New Haven), Doc. E 2352, Radio Corp. of America et al. v. C. S. Mersick & Co. Doc. E 2353, Radio Corp. of America et al. v. Roskin Distributors, Inc.

BRITISH PATENTS
IN THE FIELD OF ELECTRONICS

Television, Facsimile, Etc.

Cathode-ray tubes. Metal electrodes are applied to the glass walls of the tube and interengage thereon without mutual overlap, part of these electrodes being electrically connected to the fluorescent screen. Potential gradient of the electric field along the tube is thus made constant and all points corresponding to possible deflections of the ray are kept at the same potential in the same transverse cross-section. Fernseh Akt., Berlin. No. 406,009.

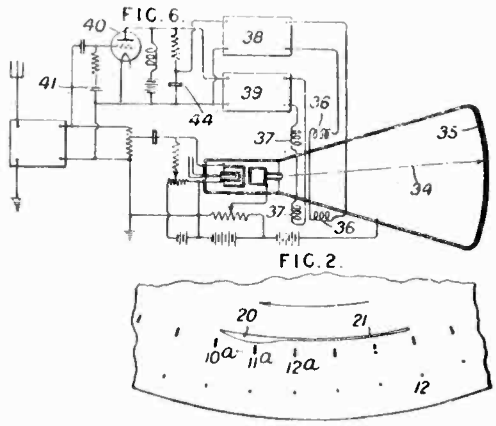
Cathode-ray scanning tube. Construction of a screen of many photoelectric elements on which the picture to be transmitted is focused by means of an external lens. The electrode comprises a glass disc mounted at an angle of 45 deg. to the axis of the tube. It is coated on one side with a conducting layer and is provided on the other side, by means of clips, with a mesh of 300 lines to the inch. The narrow portion of the tube is provided with a tungsten helix carrying a silver pellet. The tube is exhausted and a current passed through the helix to vaporize the silver on to the glass plate, at the same time the tube is



cooled by a surrounding layer of cotton wool on to which liquid air is poured. The helix and the screen are removed, and the tube is baked and evacuated and the silver deposits are then oxidized by passing a high-frequency discharge in oxygen at a pressure of 0.3 mm. Excess oxygen is removed and caesium is distilled over on to the oxidized silver elements from a side tube containing calcium turnings and caesium bromide powder.

Alternate methods of coating this light sensitive layer are contained in the patent. Electric & Musical Industries, Ltd. No. 406,353.

Synchronizing system. In a television system in which two sets of syn-



chronizing impulses are transmitted with the picture signals in the same channel, the synchronizing impulses are separated from the picture signals by amplitude selection and the synchronizing impulses of one set are developed with a steepness of wave front substantially different from that of the other set. R. D. Kell, Marconi Co. No. 407,409.

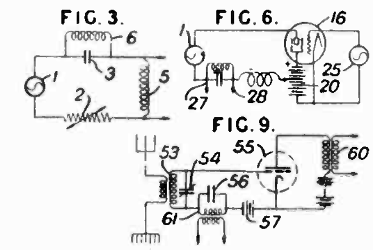
Film television. Transmission of a continuously moving cinema film in which synchronizing impulses are produced at the end of each line and picture frame. Marconi Co. No. 406,845.

Film transmission. To facilitate the transmission of cinema film having different average transparency, a photo cell is illuminated by light which depends on the average transparency of the film, and controls, through a thermionic tube, the amplification factor of a variable-mu amplifying tube in cascade with the first amplifying tube for the television signals. Compagnie pour la Fabrication des Compteurs et Materiel D'Usines A Gaz, Seine, France. No. 407,230.

Synchronizing system. In a television system in which synchronizing signals of greater amplitude than the peak picture signals are transmitted over the same channel and in which the synchronizing signals are, at the receiver, separated from the picture signals by amplitude selection. The transmitter includes a control arrangement by which the general level of the picture signals is prevented from reaching a value such that the peak picture signals may be of such an amplitude as to cause faulty operation of the synchronizing means. P. J. Konkle, Marconi Co. No. 407,322.

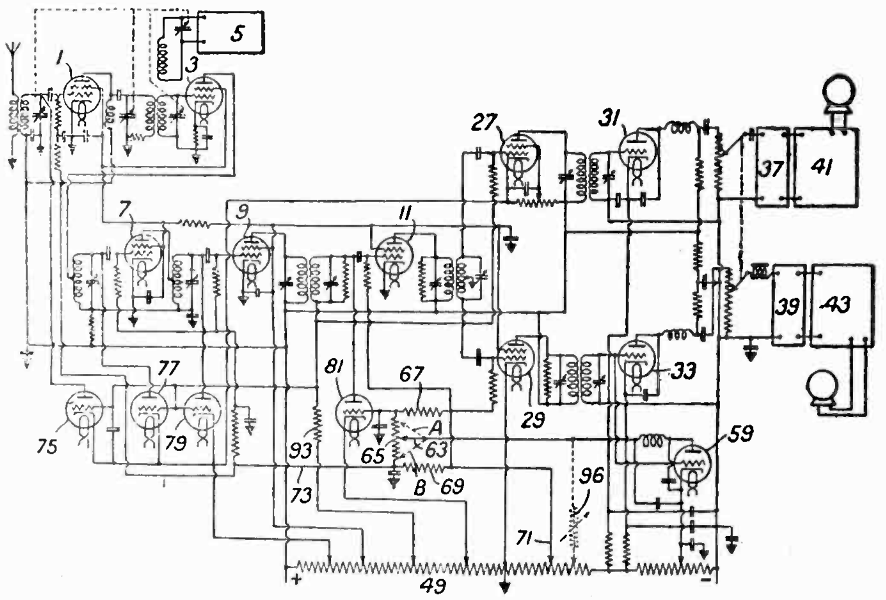
Superheterodyne circuit. The frequency changing tube comprises three grids, the middle one of which is maintained at a constant positive potential, the second of whch receives the incoming signals and the third receives the local oscillations. W. v B. Roberts, Marconi Co. No. 406,895.

Modulation. Frequency change is effected by imposing one frequency on a circuit containing a tube, the resistance of which is varied at a second frequency Sum and difference frequencies are produced in the circuit, and the second frequency may be entirely eliminated. The tube may be a dynatron



operating as a negative resistance. F. B. Dehn, C. F. Elwell and F. E. Terman. No. 407,933. See also 407,934 on the same subject. Also 407,935.

Automatic volume control. A tube is rendered operative or inoperative according to whether a signal is applied to it or not by arrangement of signals applied to an auxiliary grid in addition to their being applied to the control grid. Igranic Electric Company, London. No. 405,004.



Circuit for automatic selectivity and fidelity control. British patent number 405,897.

Radio Circuits

Selectivity and fidelity control. Automatic regulation of circuit characteristics in accordance with the level of signal strength to maintain the same standard of quality under varying conditions. An associated manual control is used to minimize side-band "beat" interference by reducing the high-note output. Selectivity is altered by varying the effective impedance of auxiliary tubes shunted across certain of the tuned circuits. G. L. Beers, R.C.A. No. 405,897. Marconi Co.