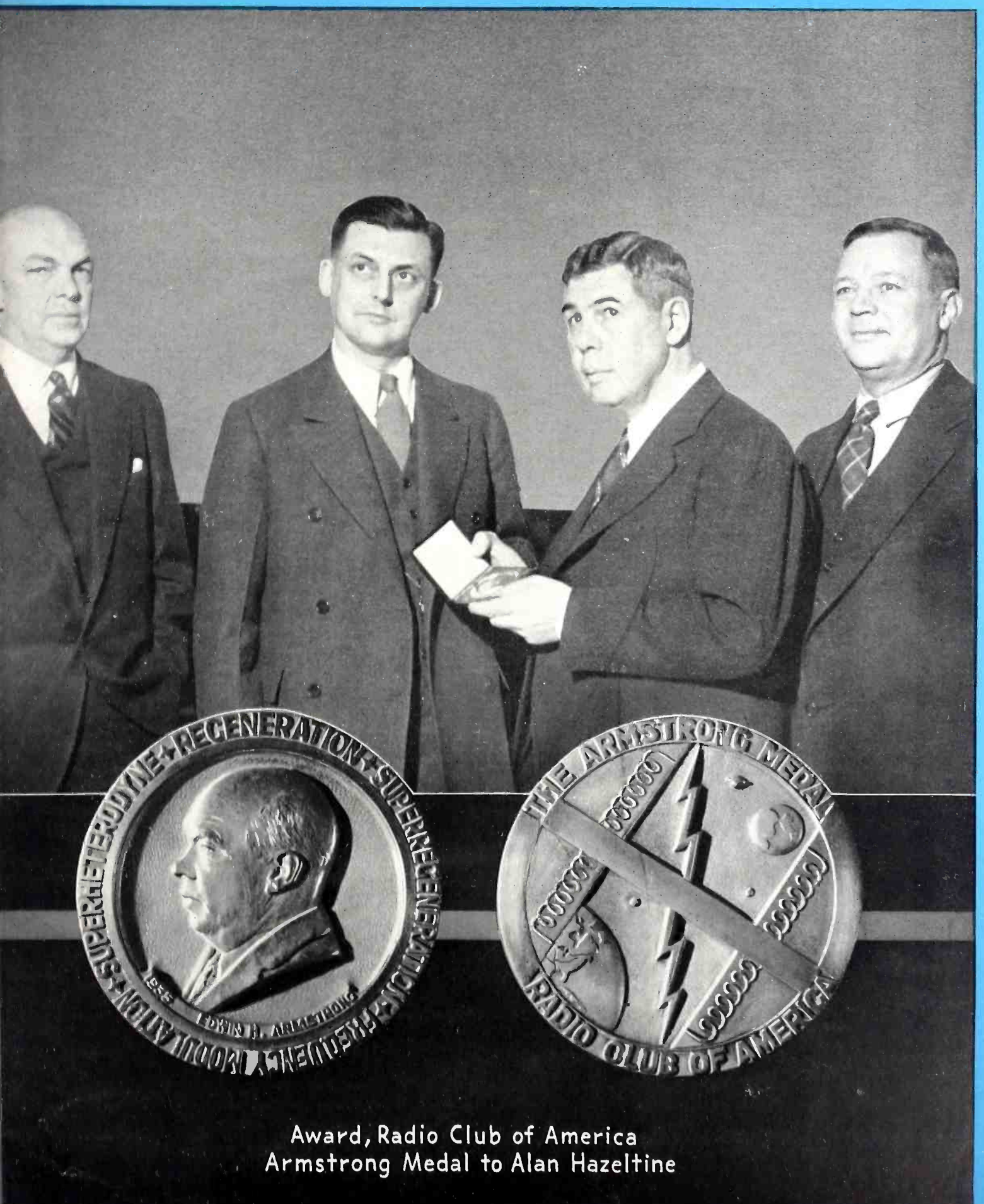
electronics

radio, communication, industrial applications of electron tubes . . . engineering and manufacture



Award, Radio Club of America
Armstrong Medal to Alan Hazeltine

DECEMBER
1937

Price
50 Cents

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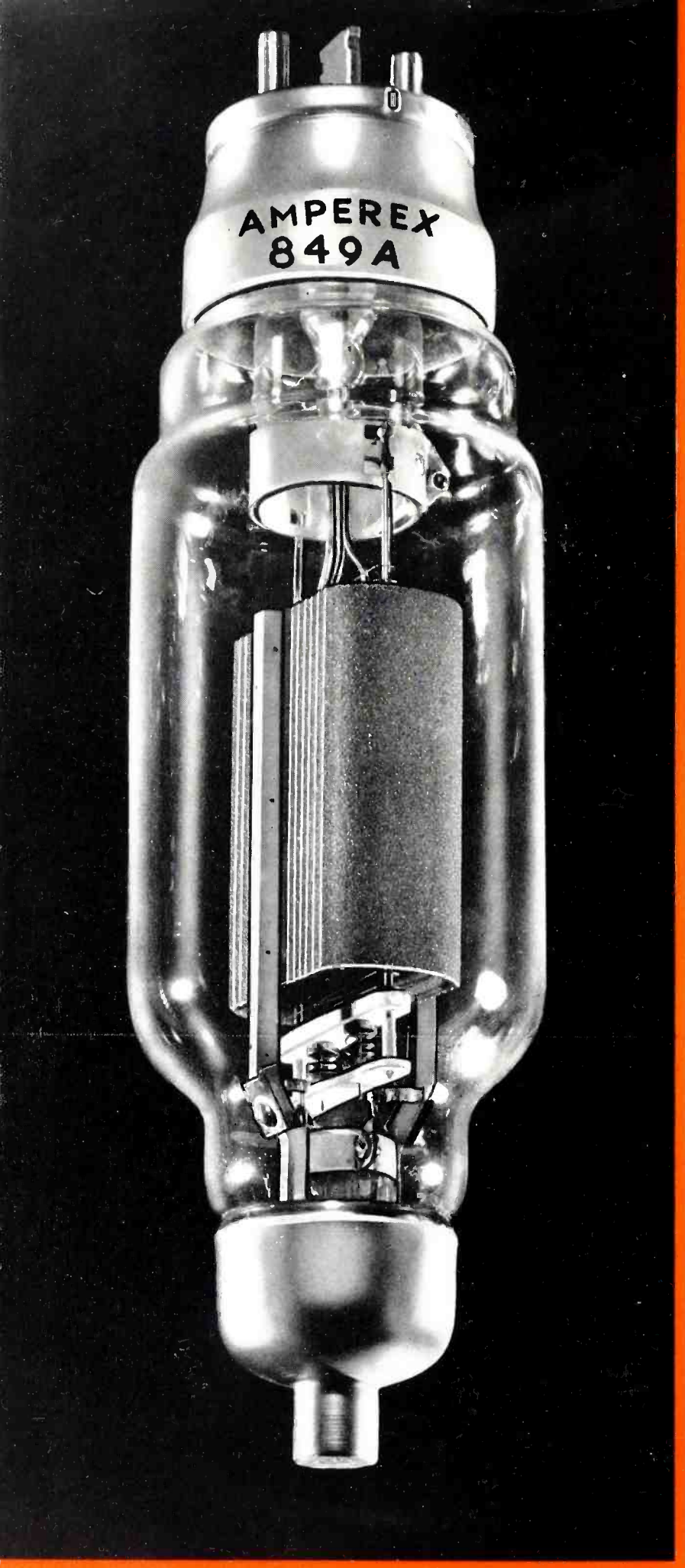

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The application by Amperex of the modern engineering concept of the space relationship of electrodes in a vacuum tube has resulted in the design of a new type with far greater performance capabilities than the standard 849. Simplification of structure because of this new design has also made possible considerable economies in manufacturing processes which are reflected in the price of these tubes.

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* The 849H can be operated at full ratings up to 30 megacycles in many classes of service. It is identical in its characteristics with the 849A. The only point of difference is the grid lead terminal which in the 849H terminates in an arm extending from the side of the bulb.

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RADIO . . . COMMUNICATION AND INDUSTRIAL APPLICATIONS OF ELECTRON TUBES . . . DESIGN . . . ENGINEERING . . . MANUFACTURE

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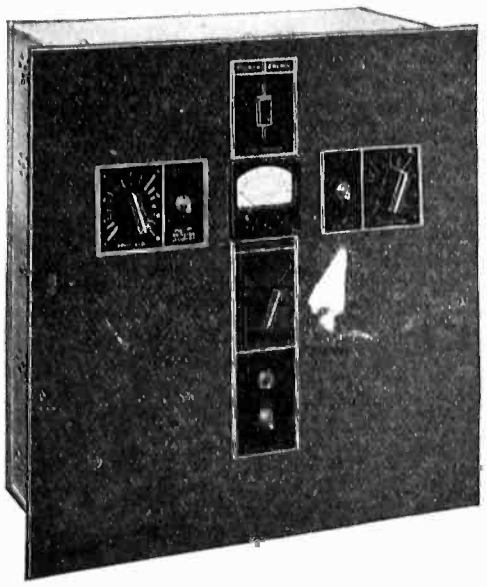
DEPARTMENTS

They took our word



Even before the Western Electric 110A Program Amplifier was officially announced, orders began pouring in from broadcasters. They'd heard what *we* said it would do—and they bought on faith. Now they've been using it for some months—and some of them have written us what it has done for them. Today you need not take *our* word . . .

. . . you can take THEIRS!

WINS: "marked improvement in signal . . . certain dead-spots eliminated . . . both quality and volume improved."

WKBH: "signal at outer edge of service area noticeably improved . . . a great help in maintaining high program level without over modulation."

WOR: "areas where signal was hashed with monkey chatter now cleared considerably . . . 3 db audio increase has definitely aided in clearing this condition."

WTAG: "no difficulty in normal operation at level 3 to 4 db higher than previously used."

WAIM: "a very good investment . . . has increased fidelity of signal."

WDAE: "normal coverage increased 25% . . . quite possible to use 5 db of compression without any particular change in quality of transmission . . . never worry any more about any conceivable sort of line surge."

WISN: "Materially aids in maintaining higher average percentage of modulation . . . signal boosted between 3 and 4 db."

WMBD: "better signal to noise ratio."

KFYR: "average modulation percentage very much higher . . . interruptions due to high audio surges have ceased to exist . . . stations separated 10 KC can be tuned in without monkey chatter."

KXRO: "any station without it can hardly be called modern . . . makes it possible to broadcast most any voice, ballyhoo or shouting without spoiling effect."

WMBH: "unsolicited reports from localities and distances never or rarely heard from before, best prove the 110A is really doing its stuff."

WDAY: "unsolicited reports that we come-in much better . . . average modulation level about 3.5 db higher."

WJBO: "consider the 110A the outstanding development during the past 5 years . . . decided increase in signal . . . practical abolition of monkey chatter."

WHAM: "no fear of distortion from over modulation . . . will raise standards of any station which has one."

KQW: "has improved signal about 100% . . . much favorable comment from listeners and sponsors."

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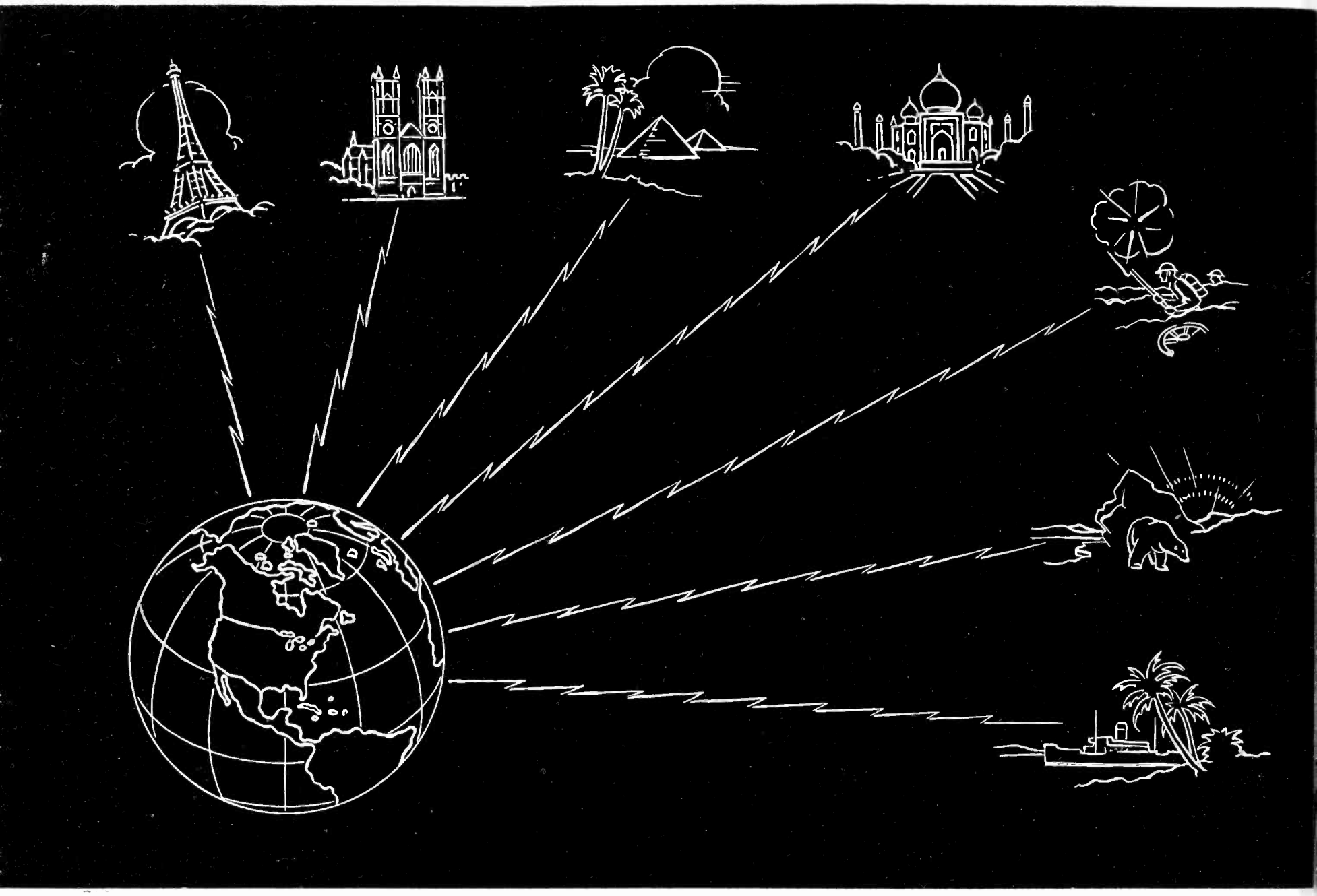
RADIO TELEPHONE BROADCASTING EQUIPMENT

News Across The Seven Seas



TO AND FROM every continent in the world messages are constantly being flashed across the seas via radio telegraph. News . . . business correspondence . . . private messages—all must reach their destination with minimum delay, maximum economy, and accurate transcription.

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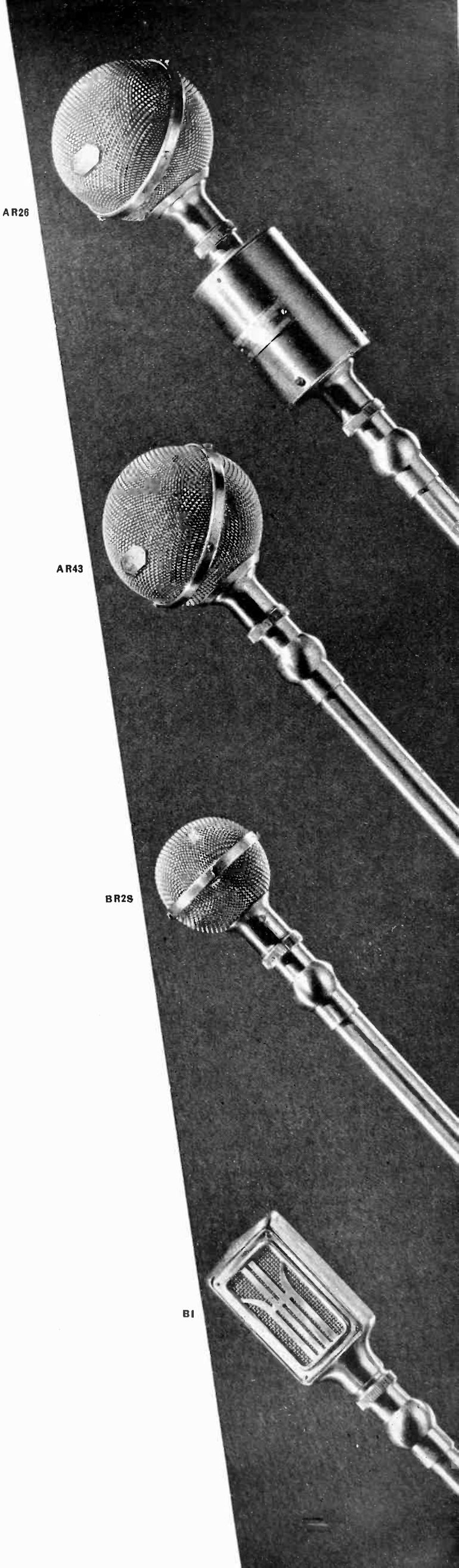

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This new Brush headphone is similar in appearance to the standard Type "A," but with high fidelity response.

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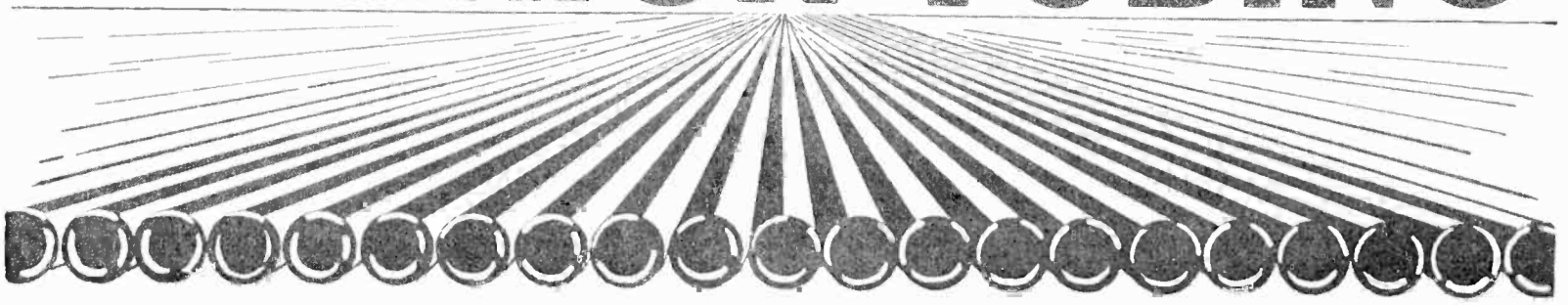
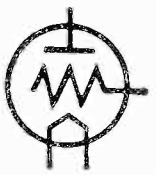


ELECTRONICS

DECEMBER
1937



KEITH HENNEY
Editor

Crosstalk

▶ **MEDAL** . . . Late in October, Radio Club of America (founded in 1909) awarded its first Armstrong medal to Professor Alan Hazeltine of Stevens. Thus the medal, established to honor the achievements of Edwin H. Armstrong now Professor of Electrical Engineering at Columbia but better known for regeneration, superheterodyne, super-regenerative and frequency modulation contributions goes to a professor of physical mathematics, well known in his own right as a contributor to the art and science of radio communication.

Not only did Professor Hazeltine make possible the first stable broadcast receiver, but he contributed the term "mutual conductance" and much mathematics to the literature. Both of these men made most of their important disclosures before the Radio Club of America. Thus the award was most appropriately and happily made.

John H. Miller, assistant chief engineer of Weston Electrical Instrument Company made the presentation. Harry Sadenwater, radio officer on the NC-4 acted as toastmaster of the dinner.

In justice to Professor Hazeltine and Mr. Miller it might be said that their apparent heavenward glances shown on the front cover were due to the fact that they were instructed to look at one camera (a professional) while Arthur Van Dyck made the cover shot with another—using the professional's flash! Mr. Miller, particularly, does not wish to appear so sanctimonious.

▶ **BLATANT** . . . British engineers are somewhat amused and annoyed by boasting statements of American radio officialdom who return to this country announcing that the British television system is only a copy of American practice and that the Britishers have made little or no contributions to our art. (See *Wireless World*, p. 431, October 29.) American engineers, however, after a trip abroad admit that very definite contributions have been made by the English engineers who have been forced to carry commercialization and research along hand in hand. One of the contributions seems to be television pick-up tubes with considerably greater sensitivity than those used here at present.

Any reader who was not in Europe during the summer of 1937 to study English and German television methods can qualify as member of a very exclusive group, the "did-not-go-to-Europe-club."

▶ **FACSIMILE** . . . Most hopeful is the operation by several broadcast stations of experimental facsimile transmitters during the hours the broadcast programs are off the air. WOR and WQXR in New York, several stations in the west and middle west are numbered among this group which has not lost sight of the potential service offered by facsimile apparatus already developed but long looking for a market.

▶ **OUR ERROR** . . . *Electronics* has not been immune to an error which seems to be rather common in this country. This is calling the BBC the British Broadcasting Company when it is really the British Broadcasting Corporation. A reader in British Columbia takes us to task for this error, committed more than once in these pages, and points out the additional fact that the BBC is not supported by government subsidy (page 32, October). Far from being supported, some of the money collected by license fees from listeners gets into the government treasury, whence it never gets free for broadcasting purposes. Thus it is even more remarkable, according to our critical reader, that the BBC can furnish such a fine public service with the funds available, almost infinitesimal compared to those involved in the "fundamentally wasteful American system of commercial broadcasting."

▶ **P.S.** . . . In the article "Television in Great Britain" (October, 1937) the transmission from Alexandra Palace was referred to as the BBC system. It is our understanding that the transmitter in use at Alexandra Palace is that designed and built by the Marconi-EMI Company and selected by the BBC after months of comparison tests with an alternative system. It should therefore be referred to as the Marconi-EMI system.

▶ **454 TUBES** . . . As this issue goes to press the editors have had the pleasure of listening to Captain Richard Ranger's new electronic organ. Runner-up to the Broadway sign (*Electronics*, September 1937) for large number of tubes in use, the new Rangertone uses one tube for each key and for every tonal quality available to the organist. Present instrument has tubes for 7 octaves times 12 notes times 4 keyboards plus power supply plus power amplifiers—100 watts to the speakers.

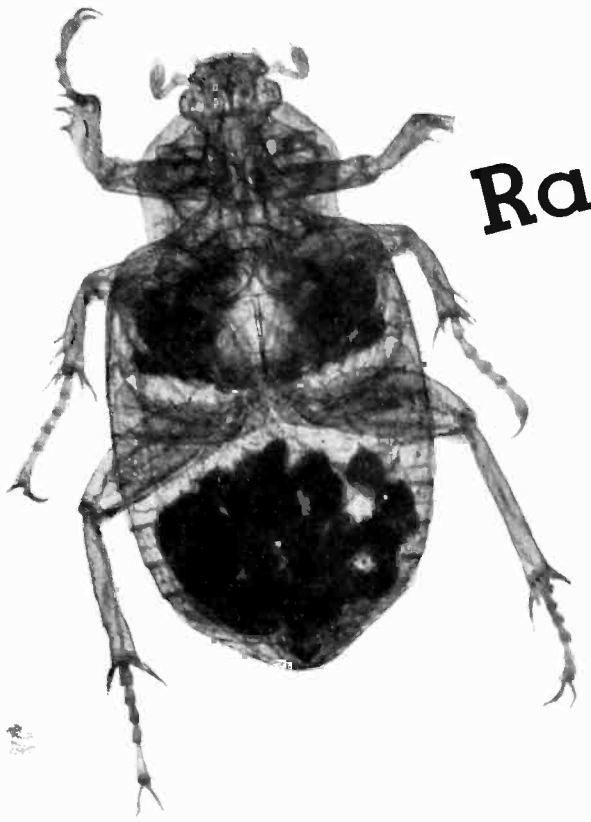
▶ **SWEET VOICES** . . . The Japanese "Den Kino-Tomo" laments the fact that automatic telephone exchanges have eliminated the sweet human voices that used to announce "number, please" and "the line is busy", however they say it in Japanese.

So great has been this loss to the service, that a method of superseding mechanical sounds and dry clicks with the voice again is being worked out by the use of phototubes, etc. It will cost 500 yen to build and "hallo girls with sweetest voices are engaged in recording sound films and when the apparatus are adopted country-wide we may again hear the sweet answers which were ours in the good old times."

Engineers, with your efficiency, be damned!

Soft X-ray photograph (reversed in tone) of columbine showing beautiful detail in buds, blossoms and seed pods

Soft X-Ray Radiography



Flower hermit beetle, x 5

An extension of the application of X-rays is the use of radiations produced by electrons moving at speeds corresponding to 4 to 18 kilovolts. The beautiful examples of radiography shown here give evidence of the utility of these medium speed electrons

By **H. F. SHERWOOD**
Research Laboratories
Eastman Kodak Co.
Rochester, N. Y.

FOR many years after Roentgen's discovery of X-rays, their practical application was confined almost entirely to the field of medicine, i.e., in the examination of internal structures of the human body. Gradual improvement in X-ray apparatus, however, has greatly extended the usefulness of X-rays, particularly in the inspection of a wide variety of industrial materials. One type of this radiation, soft X-rays, have the penetrating power which is especially suited to the radiography of small industrial and biological specimens, such as cloth, leather, paper, portions of plants, insects, etc. This article will deal primarily with the accomplishments of soft X-ray radiography.

X-rays are produced in a special form of electronic tube, in which high-speed cathode rays are focused on a small area of the plate or target. The X-rays are generated by the impact of the electrons upon the target, and the penetrating power of the rays increases with the voltage applied to the X-ray tube. The soft X-rays under discussion are produced in the range 4 to 18 kilovolts, medical X-rays in the range 40 to 100 kilovolts, while X-rays for the radiography of several inches of steel may require 200 kilovolts or more. The target of an X-ray tube generally consists of tungsten, because of its efficiency in the production of X-rays and its ability to withstand the heating effects of cathode-ray bombardment.

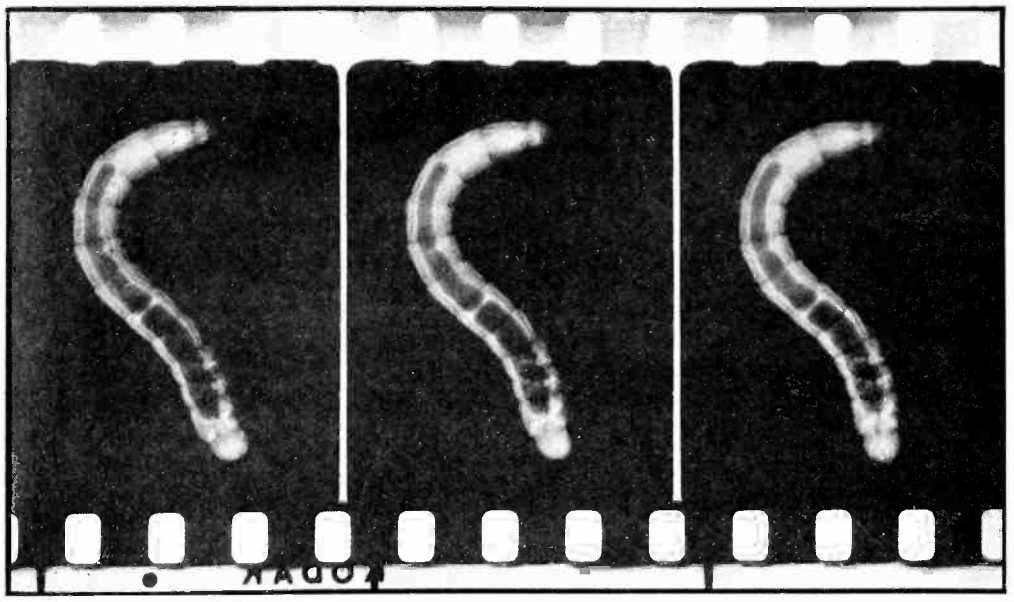
A soft X-ray tube must be fitted with a window sufficiently thin to permit the emergence of the X-rays, and the most satisfactory form is the Slack window consisting of an indrawn bubble of glass measuring approximately 15 microns in thickness. On page 10 is a diagram of such a tube, and the arrangement for radiography wherein the X-rays are directed through the specimen onto the photographic plate or film.

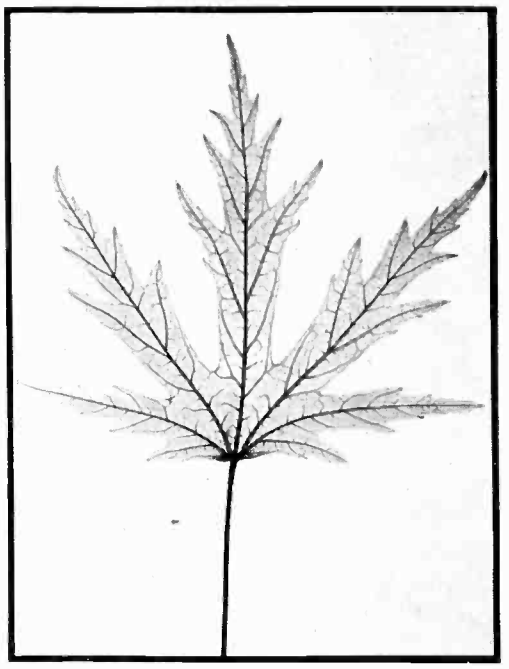
The range of exposure conditions commonly used in soft X-ray radiography is indicated in the following table:

TABLE I

Tube Voltage	4 to 18 K.v.P.
Milliamperes	1 to 8 ma.
Anode film distance	2 in. to 15 in.
Exposure times	3 sec. to 3 min.

In the radiography of cloth, soft X-rays show the presence of metallic weighting, defects in the weave and, when used stereoscopically, make it possible to visualize clearly the paths of the threads in the weave, both through the depth of the cloth, and in its lateral extent.



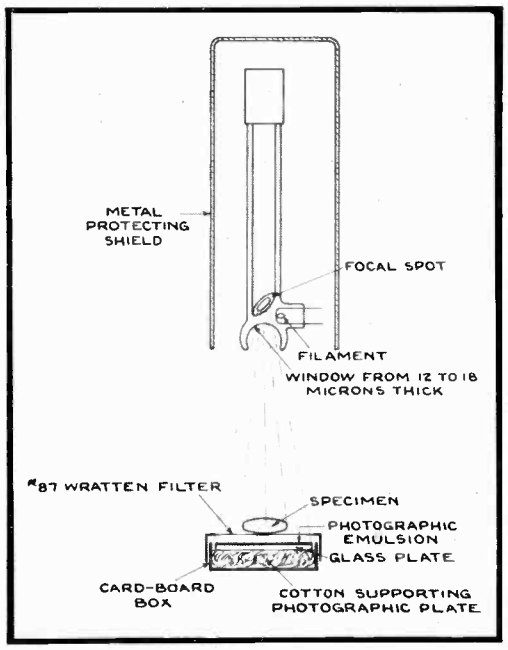


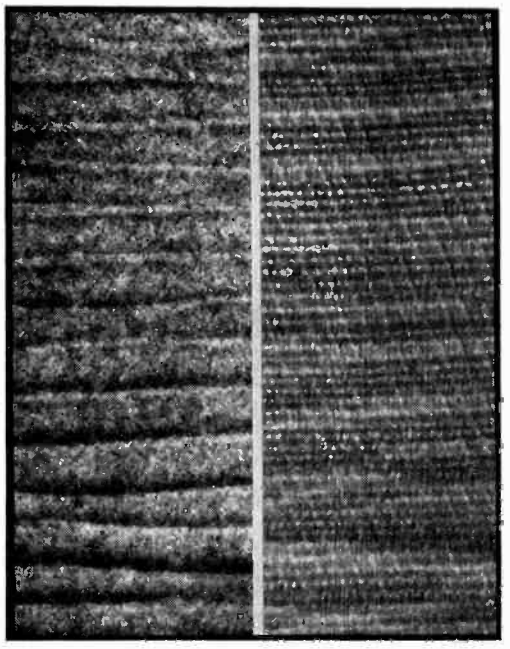
35 mm motion picture of yellow meal worm. Right—maple leaf

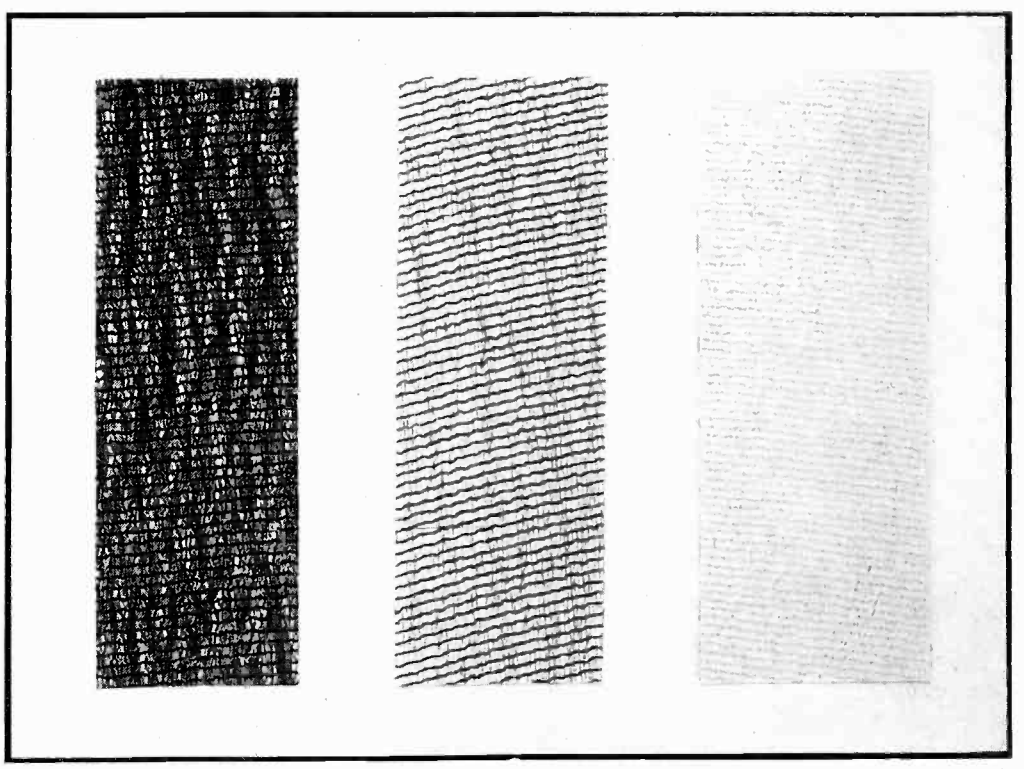
Stereoscopic radiographs of small objects are made by exposing two separate radiographs with two beams of X-rays spaced ten degrees apart, with the specimen held in a fixed position. These radiographs may be enlarged and viewed in an ordinary stereoscope, or they may be examined under a special stereo-microscope which affords sufficient magnification to show the finer details of the image.

The most recent application of soft X-rays is in recording the internal movements of small biological specimens in the form of motion pictures. The motion picture film of 35-mm. width, coated with photographic emulsion especially designed for soft X-ray radiography, is loaded in a standard form of motion picture camera, with lens removed, and with an infra-red gelatin filter covering the gate to protect the film from light. This filter also serves to support the specimen radiographed. Such motion pictures have been made at the rate of 16 frames per second, using a meal worm as a subject. These films show clearly the peristaltic movements of the intestinal tract, both with the worm in normal condition and under gaseous anesthesia.

The experience gained thus far with the method of soft X-ray radiography indicates clearly its value both for teaching and research purposes, in the examination of small biological specimens, and shows promise of valuable applications in the inspection of appropriate forms of industrial materials.





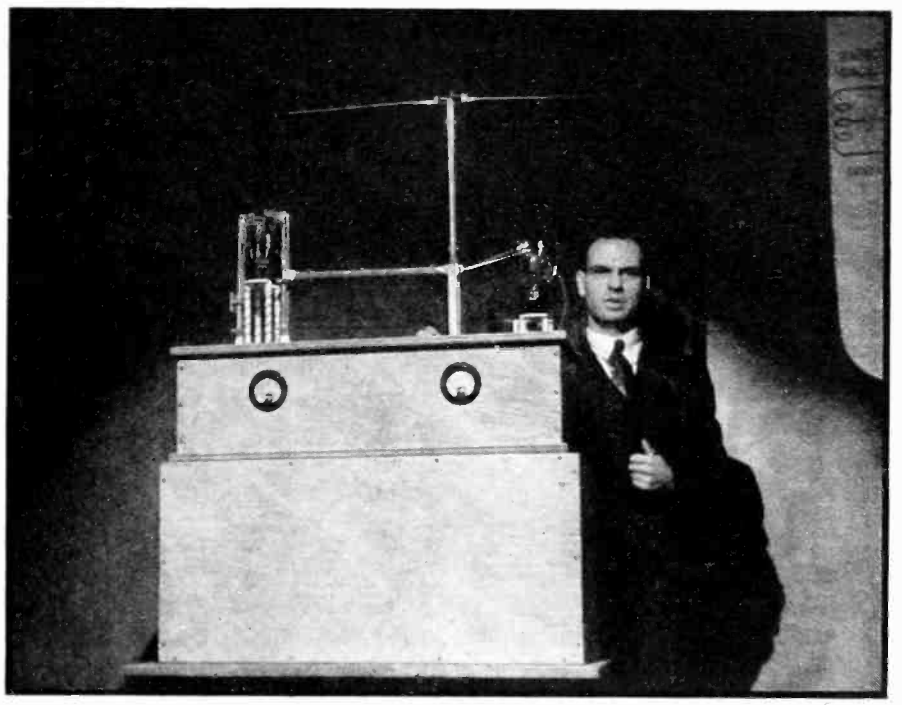


Above—Position of subject, X-ray tube, holder. Radiographs of genuine and imitation leather. Below—Weighted silks x 5. Lead, 40 per cent by weight, tin, 28 per cent by weight, and pure silk, no weighting

Rochester, 1937

Most successful Rochester I.R.E.-R.M.A. Fall Meeting draws record attendance to hear papers on television, new modulation systems, inverse feedback, and "teledynamic control", remote control of radio sets via the power line

BUSINESS recession notwithstanding, the attendance at the 1937 Rochester Fall Meeting on November 8, 9, and 10 broke all previous records, with a registration of 513 and a total attendance estimated at nearly 600. This enthusiastic response was in part a reflection of the growing popularity of the Rochester meetings, and in part due to the highly attractive program arranged by the Committee.



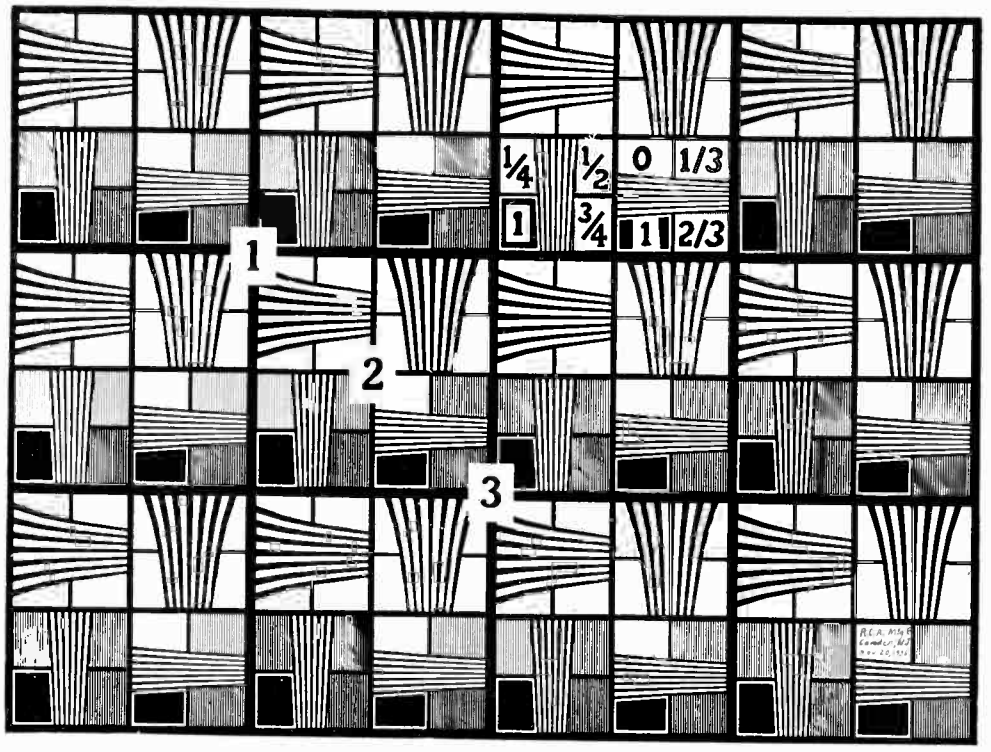
William N. Parker of Philco with his 200-megacycle transmitter, capable of modulation with side-bands 20 megacycles wide. Quarter-wave resonant line sections (to right of base of antenna transmission line) are terminated in modulator tubes, as shown in the diagram on page 14

Television Papers Predominate

Of the nineteen papers on the program, ten were directly or indirectly concerned with television development, and these were presented by engineers of four different companies. Both in variety and in difference of viewpoint these papers constituted a "television symposium" of wide interest.

The first paper was by C. E. Burnett, RCA Radiotron, "The Monoscope", a television signal-generating tube resembling the Iconoscope in general principle but differing in that the signal is derived from the variation in secondary-emission current from a single picture or pattern enclosed in the tube. The tube is not in any sense a pick-up tube, since it cannot convey a moving image and since it does not depend upon photoelectric emission, for the formation of the signal. A typical form of Monoscope is constructed as follows: in the evacuated tube is placed a flat plate of aluminum foil, some 0.004" thick, on which is printed, with ordinary foil-ink commonly used by printers for the purpose, an image, the printing being in the form of a half-tone or a simple black-and-white character. In the processing of the tube the plate is fired in hydrogen which removes the volatile oils from the ink and leaves practically pure carbon. The tube contains an electron gun whose beam scans the signal plate in the same manner as in the Iconoscope. When the beam hits a portion of the plate on which no ink is present, it excites emission of secondary electrons from the aluminum or from the coating of aluminum oxide on its surface. On the other hand, when the beam hits the printed portion secondary electrons are released from the carbon layer but not as freely as from the aluminum. The difference in secondary electrons emitted by carbon and aluminum constitutes a change in electron current flowing from the signal plate, and this current change may be used to develop a video signal voltage across the external coupling resistor. A conductive coating is provided inside the tube to collect the secondary electrons, which are eventually returned to the signal plate. The printing of the plate is accomplished from conventional 133 line-per-inch half-tone engravings or from zinc line-cuts. In the case of half-tones the size of the plate is such that about 450 dots are contained in the vertical direction within the picture, which is somewhat in excess of the number of lines used to scan the plate.

The signal developed by the tube varies with beam current, but under typical operating conditions it delivers about 3 or 4 millivolts across a 10,000-ohm load. The use of the tube is primarily in testing video equipment. Since it provides a stable signal of large amplitude and of very crisp quality it is better suited to testing than is the Iconoscope. The video signal provided by the Monoscope is so rich in the high harmonics (which represent the fine detail of the image) that it can be used to test transient response of



Resolution chart used for testing performance of television systems. The wedged shape lines vary in width and spacing from 100 to 300 lines per picture height, while the shaded areas give an indication of the half-tone performance. This is a typical pattern enclosed in the Monoscope tube

equipment far beyond the limits possible with an Iconoscope signal. Other uses suggested are its use to transmit trademarks and other fixed insignia in television programs and for providing backgrounds for television performances, on which could be "mixed" the action supplied by a conventional Iconoscope pick-up.

Bingley Outlines Case for "Narrow-Vertical" Synchronizing Pulses

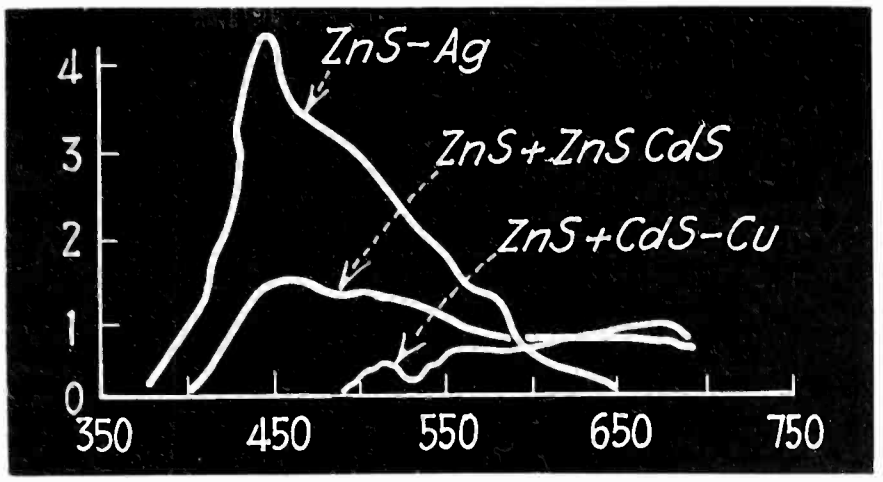
The second paper on television was presented by F. J. Bingley, Philco, who gave a thorough-going resume of the requirements of the synchronizing pulse which initiates each frame of a television picture. This problem is accentuated by the interlacing problem, since if the beginning of each set of interlaced lines is not very accurately timed, the second set of lines will not fall accurately in the spaces left between the lines of the first set. The resulting "pairing" of the lines will produce a loss of picture detail. With the type of vertical sweep-voltage generator now available for receiver purposes, the pulse which initiates each cycle of the generator must be identical with the preceding and following pulse, otherwise "pairing" will result. To meet this requirement the vertical sync pulses must be accurately timed, and equal in duration and in shape. Furthermore, it is necessary that the occurrence of the vertical pulse shall not interrupt the horizontal sync pulses which initiate each cycle of the horizontal (line-scan) sweep generator, since such an interruption would allow the horizontal generator to fall out of step, causing "bending-over" of the upper lines of the picture.

Several forms of vertical synchronizing pulse have been developed to meet some or all of these requirements. The simple amplitude system, shown in A in the diagram, on page 13 permits equal shape and duration of vertical pulses, but interrupts the horizontal pulses, and hence has been found unsuitable. The second form, B, is the simple serrated type, in which a series of wedge-shaped depressions are inserted in the vertical pulse to accommodate the horizontal pulses. However the horizontal pulses do not occur in the same relationship to the vertical pulses in successive cycles, since the horizontal pulses are displaced by a time equal to one-half the line-scanning time. If the frequency with which the horizontal impulses are sent out is doubled during the frame-sync period, then the shape of the composite sync pulse becomes almost exactly the same for every cycle. However if the integration is taken over a long enough time a slight residual difference occurs between successive cycles, which may throw the frame sync-generator off synchronism. This serrated pulse with horizontal "line-doubling" is the type of pulse at present used by NBC-RCA in their experimental transmissions.

The type of pulse advocated by Mr. Bingley is the "narrow-vertical" type shown in C the type used for several years at the Philco television transmitter W3XE in Philadelphia. Here the amplitude of the vertical sync pulse is greater, by 25 per cent, than that of the horizontal sync pulses, but the duration of the vertical pulse is very much shorter than in the serrated form. An amplitude selector is used to differentiate between the horizontal and vertical pulses, hence only the part of the vertical pulse in excess of the horizontal amplitude is used, and this may be made to have exactly the same shape on each successive cycle. If negative modulation is used, the extra power required in the carrier to handle the increased amplitude is negligible. However if positive modulation is used, about 15 per cent additional carrier power is required. The short duration of this type of vertical pulse makes it a very accurate marker of time, an advantage for maintaining good interlace.

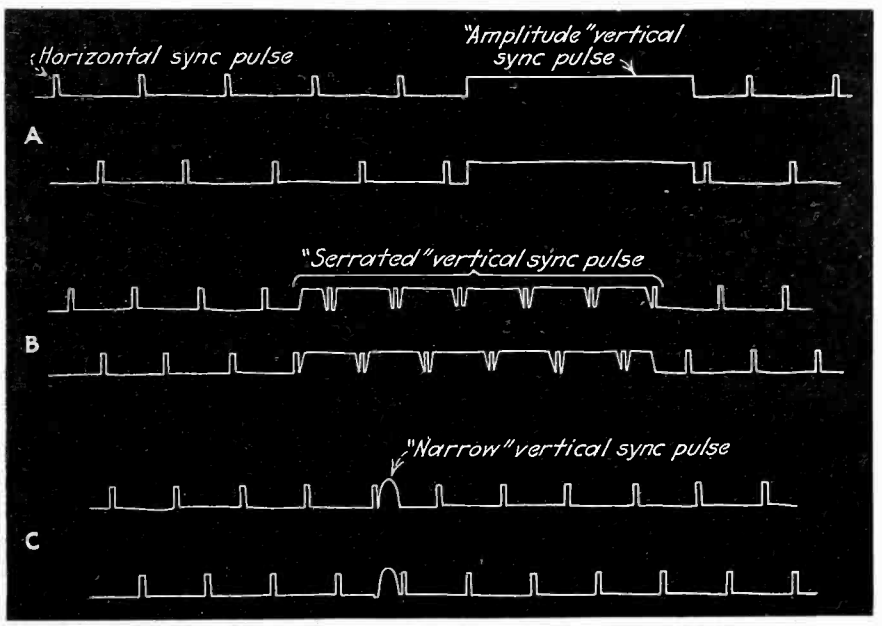
Color analysis of Luminescent Screens

G. A. Fink and R. M. Bowie, Hygrade Sylvania, presented a paper "Specification of Screen Color of Cathode Ray Tubes", which is one of the first attempts to relate scientific color analysis to the luminescence produced by cathode-ray tube screen materials. After outlining the basic theory of color analysis, the authors described three methods of measuring the color components in the light produced. The first is the use of a spectrograph, in which the light is split into its component colors by a prism or grating, and the intensity of the various components measured with a thermopile or by photographic means. The second method, direct visual comparison, makes use of three light sources fitted with tri-chromatic filters and apertures. By combining the outputs of these three sources on a single spot, and by adjusting the size of each aperture, any color may be



Color analysis diagrams of fluorophor cathode-ray screen materials. The scale is in millimicrons (visible limits 400 to 700). Zinc sulphide with zinc-cadmium sulphide gives a white light, but is not as bright as the silver-activated zinc sulphide

Several forms of signal pulses used for synchronizing the lines and frames of television images, discussed by F. J. Bingley



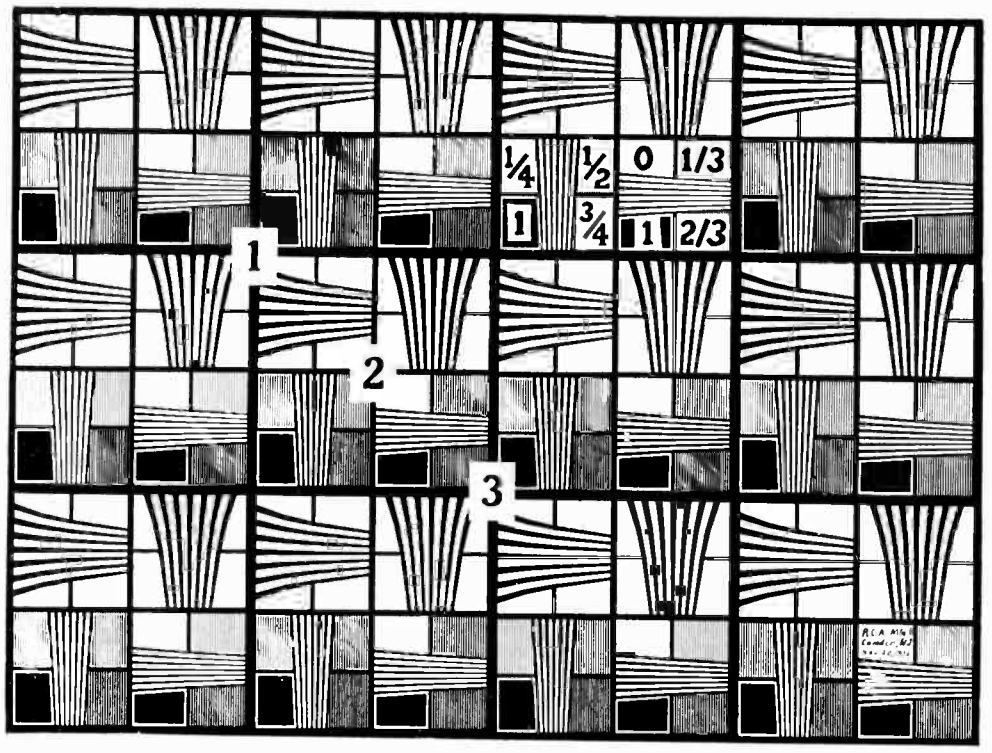
produced, and this color may be superimposed on the light from the cathode-ray screen for comparison purposes. In terms of the known characteristics of the filters used, the spectral composition of the fluorescent light may be determined. A third method, the use of a self-generating photoelectric cell and filters of known characteristic, was investigated and found to be less reliable than the other two. Several spectral composition curves of screen materials taken by the authors are shown in the accompanying illustration. The approach to white light illustrated by the zinc sulphide mixed with zinc-cadmium sulphide is typical of the practical results to be expected.

The fourth paper on television, "Figure of Merit for Television Performance" by A. V. Bedford, RCA Victor, is printed in the November 1937 issue of the *RMA Engineer*, hence only a brief reference to it is included here. It describes the use of resolution charts (one of which is shown in the accompanying figure) to determine the over-all resolution of the received television image, and develops a general mathematical expression for an "over-all resolution figure of merit" which represents the total number of resolvable dots a prescribed portion of the picture in terms of the horizontal and vertical readings given on the chart.

Maloff Describes 3-foot Cathode Ray Tube

I. G. Maloff, RCA Victor, described a cathode ray tube developed to produce large pictures of high brilliance without the necessity of projection. The tube, whose viewing face measures 31 inches in diameter, is intended for experimental use only. The conical shell is welded steel. The viewing end of the tube is glass, two inches thick, and capable of withstanding the pressure of 5½ tons exerted on it by the atmosphere. The tube is continuously pumped, to a vacuum of 10^{-6} mm. of mercury, by a three-stage oil-diffusion pump and fore pump. Electrostatic deflection is used.

The electron gun, a veritable "Big Bertha", measures 8 inches in length and can deliver a beam current of 8 milliamperes. This compares with beam currents of less than half a milliampere in conventional television tubes. The grid voltage necessary for beam cut-off is 150 volts.



Resolution chart used for testing performanc
The wedged shape lines vary in width and s
lines per picture height, while the shaded are
the half-tone performance. This is a typical
Monoscope tube

equipment far beyond the limits possible with an Iconoscope signal. Other uses suggested are its use to transmit trademarks and other fixed insignia in television programs and for providing backgrounds for television performances, on which could be "mixed" the action supplied by a conventional Iconoscope pick-up.

Bingley Outlines Case for "Narrow-Vertical" Synchronizing Pulses

The second paper on television was presented by F. J. Bingley, Philco, who gave a thorough-going resume of the requirements of the synchronizing pulse which initiates each frame of a television picture. This problem is accentuated by the interlacing problem, since if the beginning of each set of interlaced lines is not very accurately timed, the second set of lines will not fall accurately in the spaces left between the lines of the first set. The resulting "pairing" of the lines will produce a loss of picture detail. With the type of vertical sweep-voltage generator now available for receiver purposes, the pulse which initiates each cycle of the generator must be identical with the preceding and following pulse, otherwise "pairing" will result. To meet this requirement the vertical sync pulses must be accurately timed, and equal in durat
more, it
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ments. The simple amplitude system, shown in A in the diagram, on page 13 permits equal shape and duration of vertical pulses, but interrupts the horizontal pulses, and hence has been found unsuitable. The second form, B, is the simple serrated type, in which a series of wedge-shaped depressions are inserted in the vertical pulse to accommodate the horizontal pulses. However the horizontal pulses do not occur in the same relationship to the vertical pulses in successive cycles, since the horizontal pulses are displaced by a time equal to one-half the line-scanning time. If the frequency with which the horizontal impulses are sent out is doubled during the frame-sync period, then the shape of the composite sync pulse becomes almost exactly the same for every cycle. However if the integration is taken over a long enough time a slight residual difference occurs between successive cycles, which may throw the frame sync-generator off synchronism. This serrated pulse with horizontal "line-doubling" is the type of pulse at present used by NBC-RCA in their experimental transmissions.

The type of pulse advocated by Mr. Bingley is the "narrow-vertical" type shown in C the type used for several years at the Philco television transmitter W3XE in Philadelphia. Here the amplitude of the vertical sync pulse is greater, by 25 per cent, than that of the horizontal sync pulses, but the duration of the vertical pulse is very much shorter than in the serrated form. An amplitude selector is used to differentiate between the horizontal and vertical

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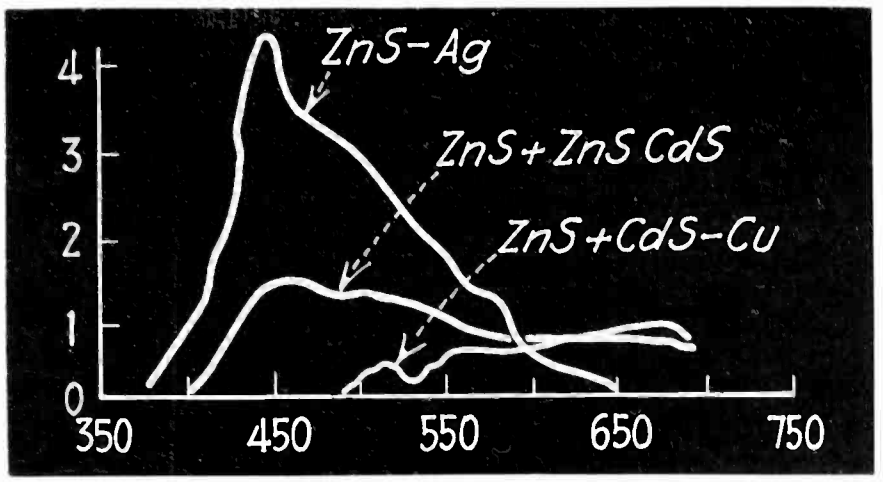

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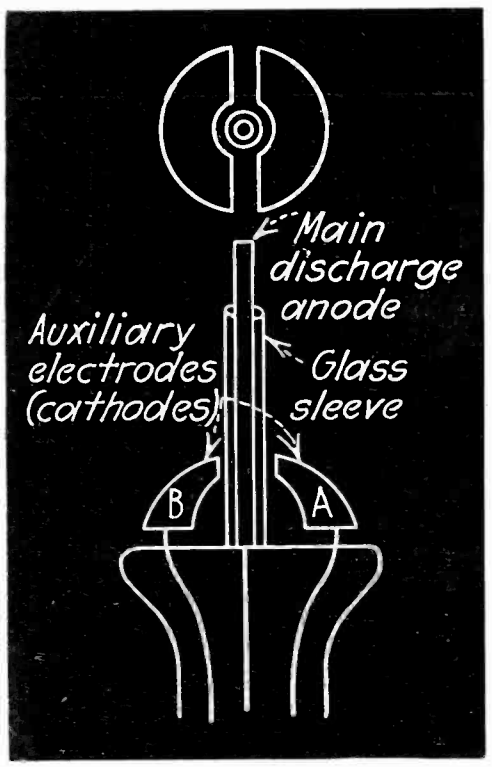

Element structure of the gas-filled cold-cathode tube used in the teledynamic control of radio receivers (see diagram on page 14)

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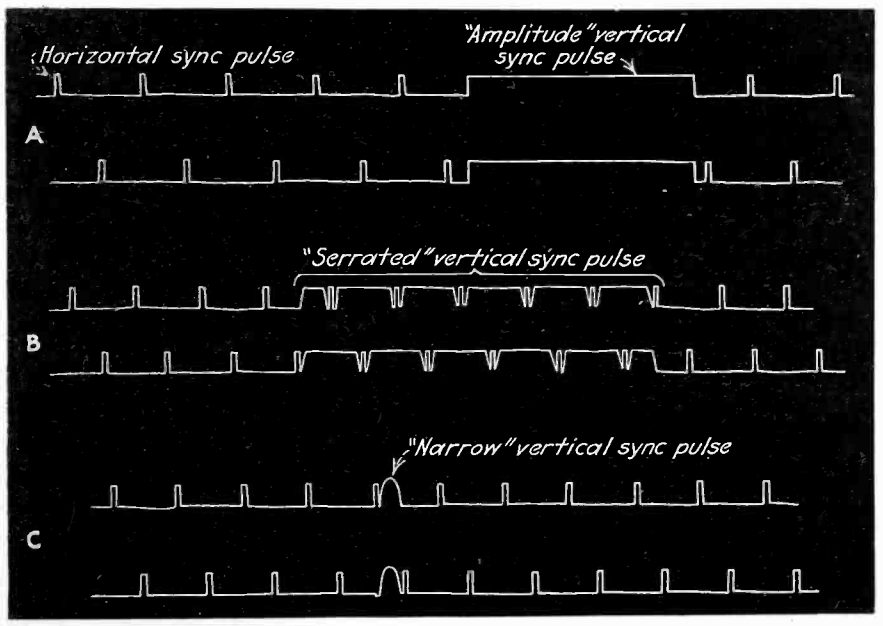

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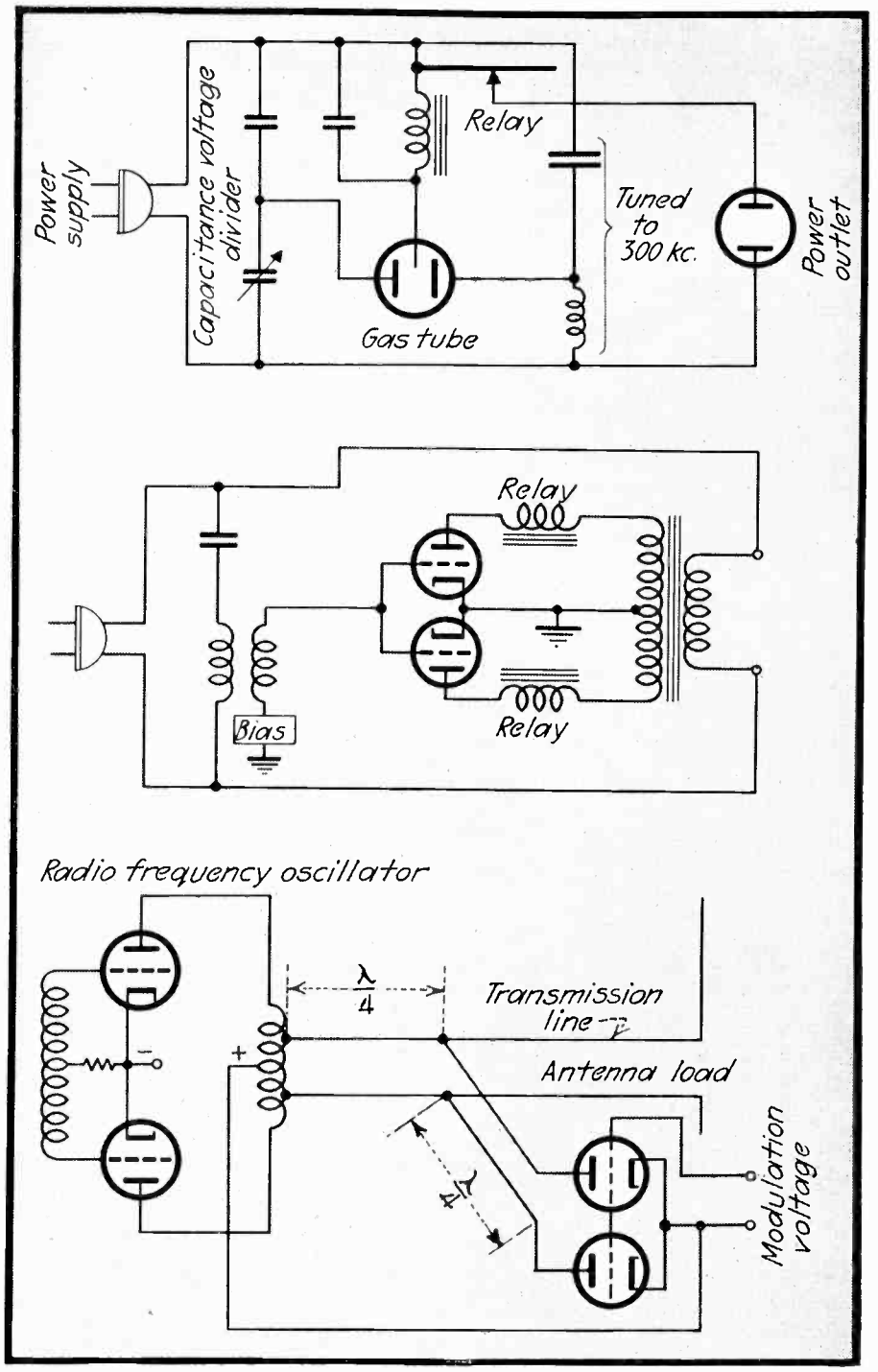


Top: elementary teledynamic control circuit. A 300 kc. carrier sent by the control unit causes the gas tube, held on the point of ionization by the capacity voltage divider, to pass current, closing the relay. The set is thus turned on without "standby" power being consumed. Center: a tube circuit for selecting opposite phases of modulation in the 300 kc. carrier. Above: fundamental circuit of the resonant-line modulation system for television transmitters

The light obtainable from the screen is very great, considerably in excess of the value recommended for motion picture projection by the S.M. P.E., (3.5 candles per square foot) delivering 40 candles per sq. foot. The screen can be viewed in daylight without difficulty. The luminescent coating is applied to a flat glass plate contained within the tube.

"Resonant-Line" Television Modulation System Described by Parker

A television modulator capable of handling a sideband width in excess of 5 megacycles was described by its inventor, William N. Parker of Philco. Mr. Parker explained that the conventional grid modulation used in television transmitters suffers from the inherent difficulty of creating frequency and amplitude voltage changes across a tuned circuit. The suggestion that the modulation be applied between the output tank of the amplifier and the antenna led to the development of an entirely new modulation system. Essentially the system is an absorption method. The impedance which absorbs the energy during modulation is the impedance presented by one end of a quarter-wave resonant line, when the impedance across the other is changed in accordance with the modulation.

The layout of the system is shown in the accompanying diagram. The radio frequency is generated in a conventional oscillator or amplifier and applied to a quarter-wave transmission line. At the end of this line a junction is made to another quarter-wave transmission line which is in turn terminated in the plates of two modulator tubes. The cathodes of the modulator tubes are connected to the positive terminal of the high voltage supply, while the modulating voltage is applied between the modulator grids and cathodes connected in parallel. The junction between the transmission line and modulation line connects to the antenna through another transmission line. The impedance between the modulator tube plates changes in accordance with the modulating voltage, and this change in impedance is transferred, by the impedance-inversion characteristic of the quarter-wave line, to the junction point in the antenna circuit. Here absorption occurs, changing the output power in accordance with the modulation.

In a demonstration of the system, a small transmitter operating on 200 Mc., was modulated with a voltage whose frequency was varied up to 20 Mc. The beat between the carrier and the modulation was then received in a conventional short-wave receiver. It was shown that the 200 Mc. carrier could be modulated to 20 kc. with the same ease as at 5 Mc. or lower. In general, in the resonant line method, the maximum modulation frequency can be 10 per cent as great as the carrier. In the 50 Mc. television band, therefore, a maximum side-band width of 5 Mc., or twice that contemplated in the tentative R.M.A. standards, can be accommodated. Slides showing the application of the system to a one kw. transmitter (W3XE at Philadelphia) were shown. In this transmitter the system has operated with great success for about two years.

A. F. Murray Reports on R.M.A. Television Standards

The Chairman of the RMA Subcommittee on Television Standards,

A. F. Murray, reported on the present status of the committee's work. A most important announcement was that of the action of the FCC in setting up definite 6-Mc. channels for television transmitters. As shown in the allocation chart given on page 34 in this issue, the assignments to television include seven channels between 44 and 108 Mc., and 12 others between 156 and 294 Mc. In the important region between 40 and 90 Mc. which can be utilized readily with present equipment, there are five channels, but the band is not continuous, being interspersed with amateur, government and aviation services. The committee expressed satisfaction that the assignments are definite and that they meet the specifications as to width suggested by the committee.

Concerning the fundamentals dimensions of the system, Mr. Murray reported "no change" in the number of lines, 441, the number of frames, 30 interlaced 2-to-1, and the aspect ratio, 4-to-3. These standards correspond to those now used in England and Germany, and no immediate change in them is in prospect. There is evidence of a change in sentiment concerning the polarity of transmission, which was tentatively standardized last year as negative. A recent vote of the committee showed a preference for positive polarity of modulation, provided that a satisfactory system of a-v-c is available. In addition there is a growing sentiment in favor of transmitting the d-c component directly in the signal, with the same proviso regarding a-v-c. There appears to be no general agreement on the type of vertical synchronizing pulse to be used. RCA and Hazeltine favor the serrated type of pulse, Philco and Farnsworth favor the narrow vertical pulse, while G. E. and CBS have not yet reached a decision on this point. This item has accordingly not yet been standardized, even tentatively. Evidence supplied by RCA has indicated that horizontal polarization is less prone to noise and variations than vertical polarization, and it appears that standardization on this point may soon be settled. It is also the sentiment of the committee, in the event a satisfactory system of attenuating one sideband in the television signal is developed, that the lower frequency sideband be the one attenuated.

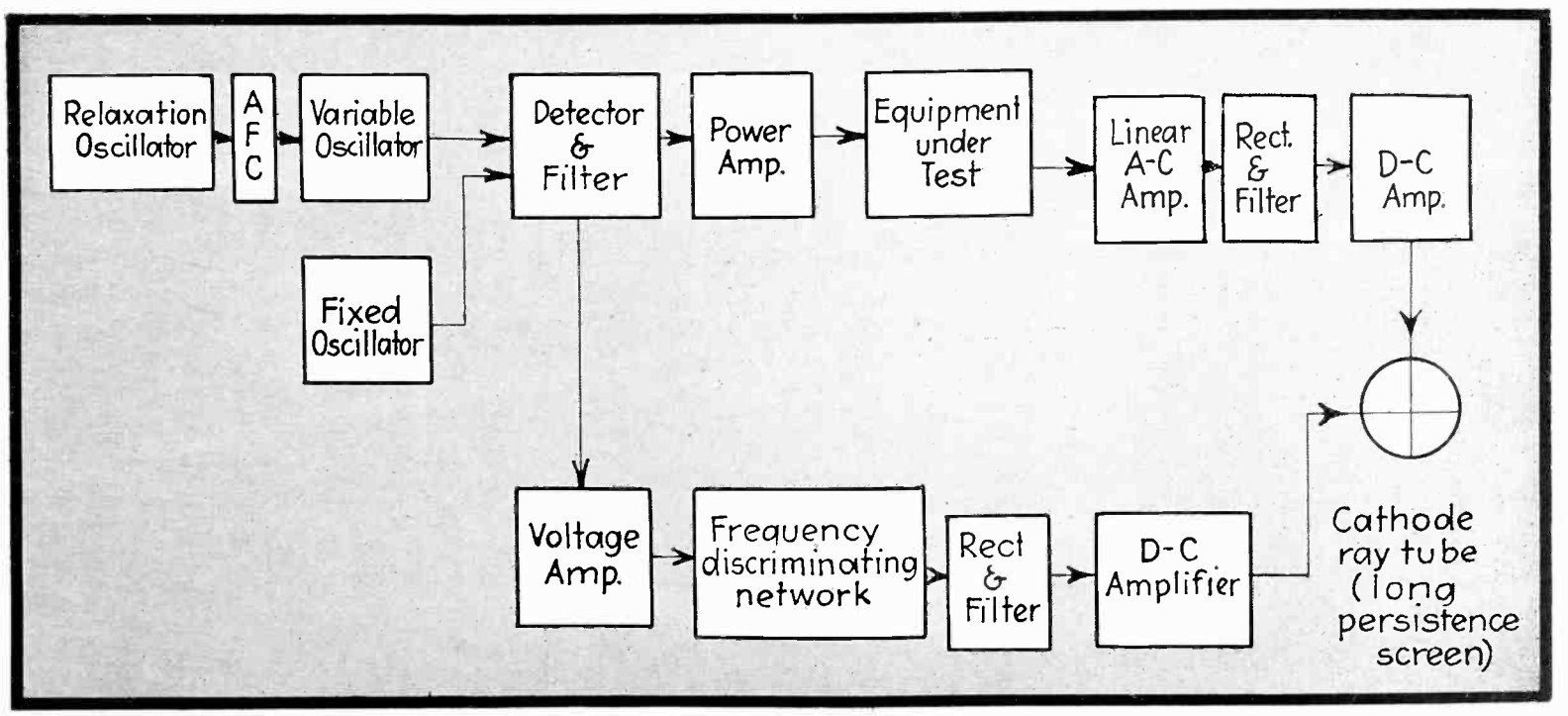
E. H. B. Bartelink, General Electric, presented a mathematical treatment of regeneration in wide-band amplifiers such as are used in television work. He derived a general expression for the stability condition of such amplifiers in terms of the amplitude and phase characteristics of each stage and of the feed-back path. His work applies not only to circuits in which feedback is intentionally introduced but also to cases where feed-back is present inadvertently, as by coupling in the common plate supply of a multistage amplifier.

D. B. Sinclair Describes "Parallel" Resonant Measurement Methods

The paper "Parallel Resonance Methods for Measurement of High Impedances a High Frequencies," by D. B. Sinclair, General Radio Company, compared the methods of measuring impedances by substitution in tuned circuits. The series methods now used determine the total series resistance in the circuit. When an unknown impedance is inserted in series with the circuit its contribution to the series resistance may be determined by subtracting the two measured values of series resistance. These circuit resistances are necessarily small, if the resonance curve of the circuit is to be sharp. For high resistance measurements, a parallel circuit may be used in a similar manner. For this type of parallel circuit, methods are available to find the effective parallel conductance (or inversely the resistance) using equations of the same form as are used for the series methods. In the parallel case, if an unknown conductance is connected in parallel, its value may be determined by subtracting the two measured values of circuit conductance, one with, the other without, the unknown present. Mr. Sinclair's analysis reveals that errors

(*Continued on page 67*)

Block diagram of the cathode-ray curve tracer for recording the frequency-response curves of audio-frequency apparatus. A beat-frequency oscillator is varied by an a-f-c circuit operating under the control of voltage from a relaxation oscillator. The varying beat frequency is impressed on the equipment under test, and also used to fix the horizontal frequency scale



Recording Resistance-Welder Secondary Currents

By H. W. LORD
General Electric Company
Schenectady, N. Y.

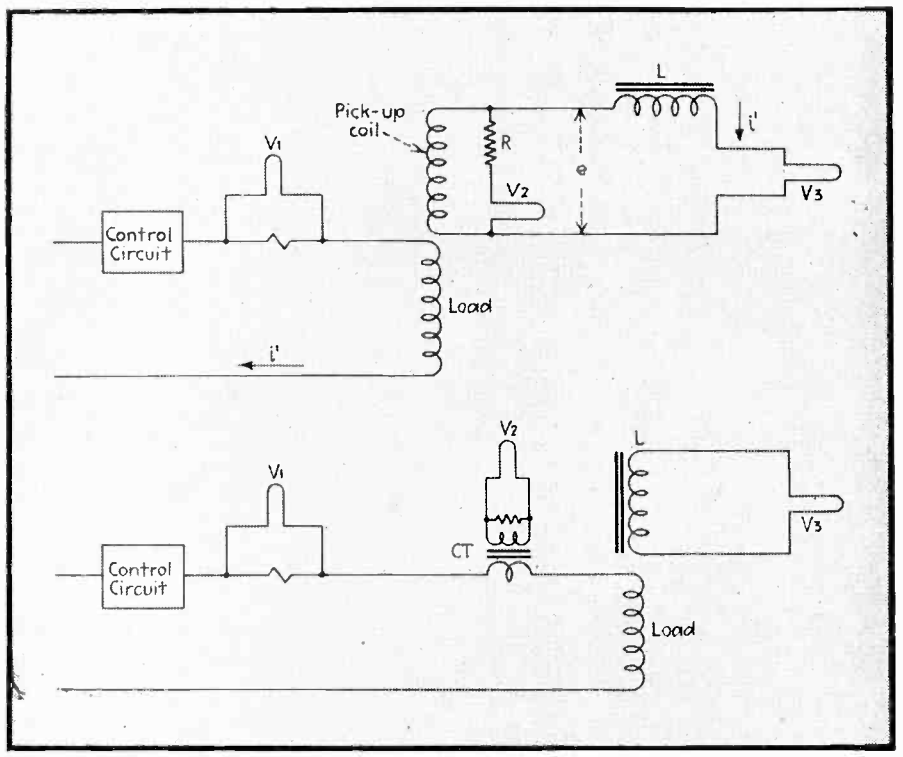


Fig. 1—(above) Circuit for making oscilligrams of Fig. 8. Fig. 2—Connections for making Fig. 6

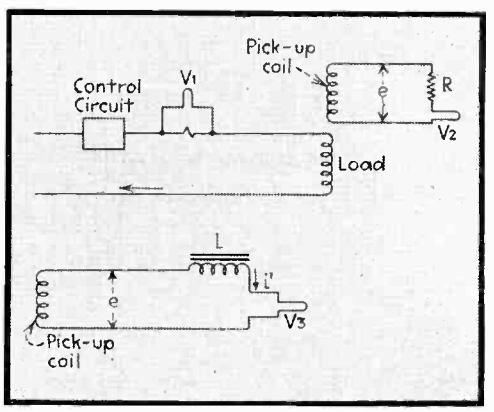


Fig. 3—(below) Substitution of inductor for aircore coil of Fig. 4 (above)

BECAUSE of the high currents (300,000 amperes in some cases) delivered by resistance welders, oscillographic recording of the secondary currents of resistance welder transformers presents several problems to the engineer who desires to make such tests.

It is the purpose of this paper to discuss the advantages and disadvantages of some of the methods commonly used, and to describe a new method, the "pick-up" coil method, which may prove a useful tool to the engineer interested in studying resistance welders under various conditions of loading and timing control settings.

The Shunt Method

This method has the advantage of allowing one to calibrate the shunt before installation; the oscillograms, therefore, will yield a quantitative as well as qualitative result. However, since the vibrator of an oscillograph such as the General Electric Company's type PM12 requires about 100 millivolts for reasonable deflections, power is consumed in the shunt at the rate of $0.1 \times 300{,}000 = 30$ kilowatts when measuring a 300,000 ampere circuit. Under such conditions and with a welder operating on a 10 per cent duty cycle, the shunt would have to dissipate 3 kilowatts continuously. This would require a shunt of comparatively large size. Moreover, the inherent inductance of the shunt would probably be sufficient to distort the wave form to a noticeable degree. Further, this method has the disadvantage of being difficult to connect into a welding circuit.

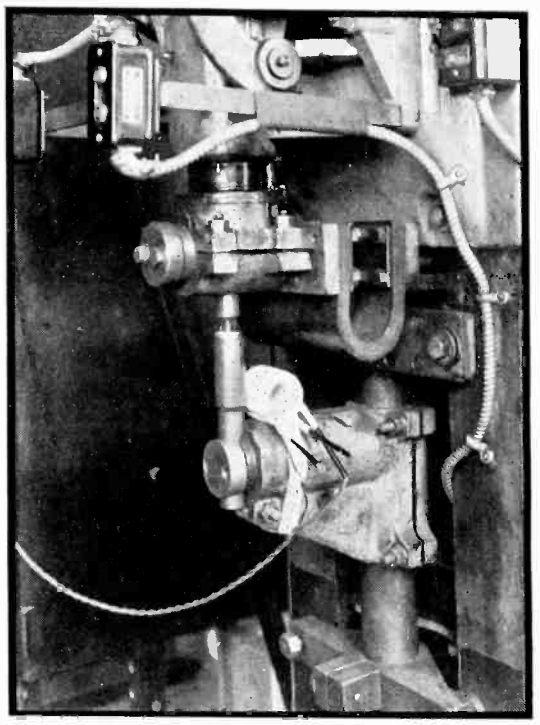


Fig. 5—Pick-up coil on 150 kva. welder

The Current-Transformer Method

A current transformer with a core which may be slipped over the arms of a welder could be used to obtain oscillograms and to measure the secondary current. However, a current transformer capable of handling 300,000 amperes without ratio changes or wave-form distortion would weigh several hundred pounds and would be difficult to move. The size of such a current transformer would prohibit its use on welders having small throat clearance.

"Pick-up" Coil Method

It is expected that the following discussion of the "pick-up" coil method will demonstrate its advantages over either of the two methods just described, for recording sec-

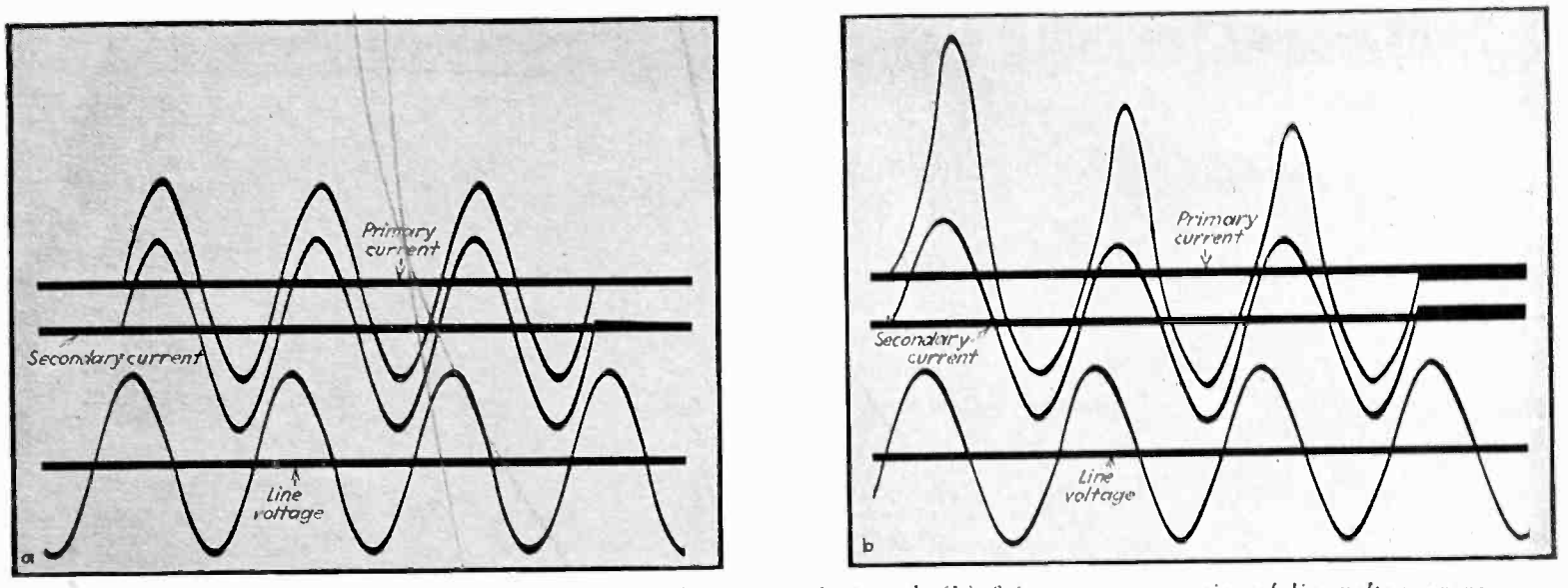


Fig. 6—Oscillograms showing (a) firing for minimum transient and (b) firing near zero point of line-voltage wave

ondary currents of resistance welders. A small air-core coil placed in the throat of a welder so as to be coupled inductively to the secondary load circuit provides a convenient method for obtaining a voltage which is a function of the secondary current. The voltage e induced in this air-core coil, which may be called the "pick-up" coil, is related to the secondary or welding current in accordance with the expression

$$e = M\ di/dt \quad \ldots\ldots\ldots\ldots\ldots (1)$$

where M is the mutual inductance between the secondary loop of the welding circuit and the pick-up coil in the throat, and di/dt is the rate of change of current in the secondary circuit at any instant. With the highly inductive secondary circuits usually encountered in most welders the wave-shape of the voltage induced in the pick-up coil corresponds very closely to that of the secondary voltage of the welder transformer. Figure 8 shows an oscillogram which illustrates this point and Fig. 4 shows the method used for taking curves V_1 and V_2 of this oscillogram.

Although the pick-up coil provides a small and lightweight means of obtaining a voltage that is a function of the secondary current, without disturbing the load circuit conditions, it does not in itself provide a means for deflecting an oscillograph element in accordance with the wave form of the welding current. However, this may be accomplished by replacing resistor R of Fig. 4 by a reactor as shown in Fig. 3. The instantaneous current i' flowing through the oscillograph element is then related to the instantaneous voltage e induced in the pick-up coil in accordance with the following expression:

$$e = L\ di'/dt \quad \ldots\ldots\ldots\ldots\ldots (2)$$

Where L is the inductance of the reactor and where the resistance of the circuit is assumed to be negligible. Then if e is eliminated by combining Eq. (1) and (2)

$$M\ di/dt = L\ di'/dt \quad \ldots\ldots\ldots (3)$$

Since M and L are circuit constants, then

$$i' = ki + C \quad \ldots\ldots\ldots\ldots\ldots (4)$$

and at the boundary condition

$i' = 0 = i$ therefore $C = 0$ and

$$i' = ki \quad \ldots\ldots\ldots\ldots\ldots (5)$$

where k is some constant determined by the circuit constants; therefore the currents flowing through the oscillograph vibrator has the same wave-form as the current flowing in the secondary circuit of the welder. Figure 1 shows the complete circuit used to take the oscillogram of Fig. 8, where V_3 is the element for recording the secondary wave-form. The reactor L should be an iron core reactor with a small air-gap.

Figures 6a and 6b show oscillograms taken on a welder, using the pick-up coil method for recording the secondary current. Figure 6a was taken with the welder control "firing" at the proper point in the line-voltage wave for minimum transient. Figure 6b was taken with all conditions the same as for Fig. 6a except that the control "fired" near the zero part of the line-voltage wave. This oscillogram shows the high primary current transient caused by saturation of the transformer core, the secondary load transient caused

(*Continued on page* 48)

Fig. 7—Oscillogram made with pick-up coil and resistance

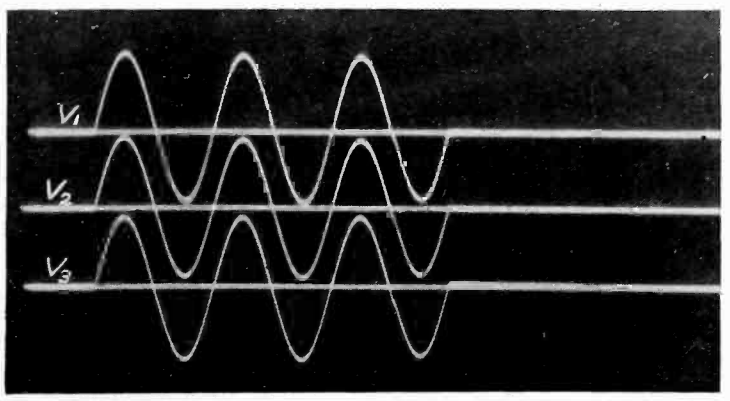
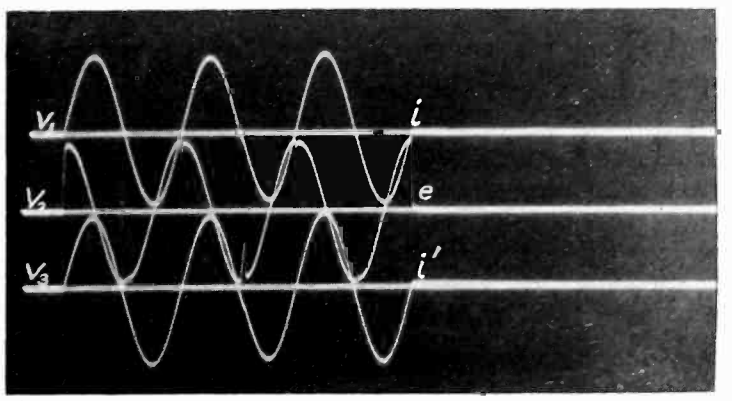
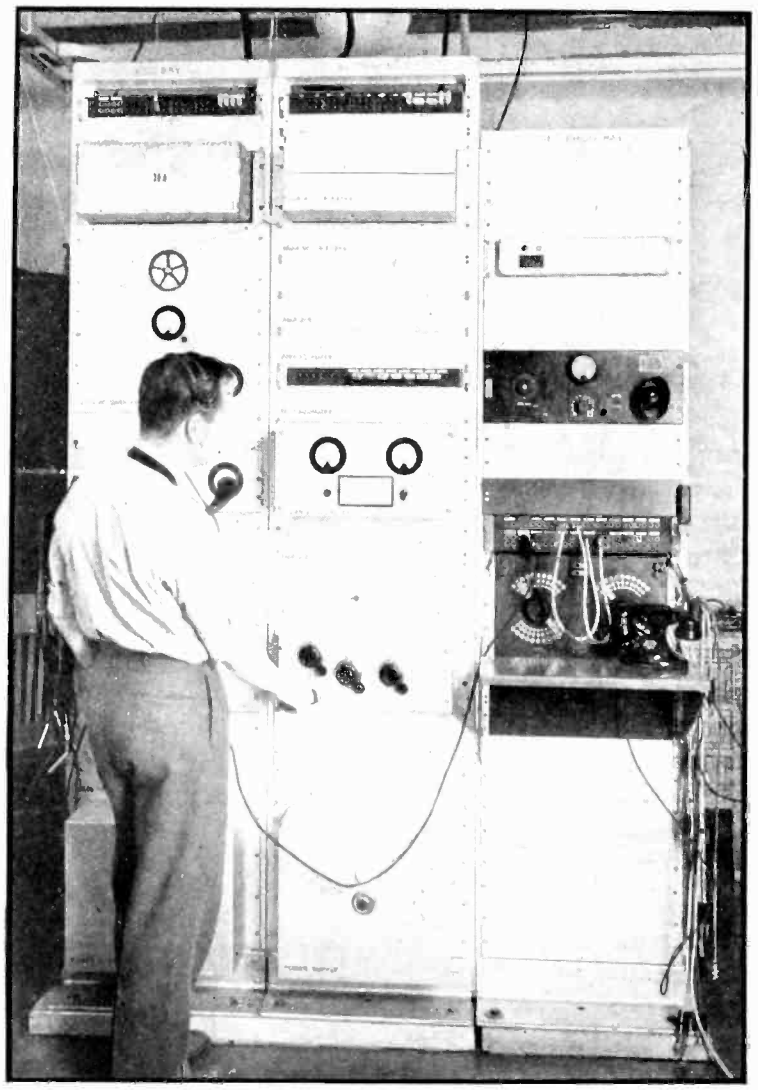


Fig. 8—Oscillogram of welding circuit



Bell Labs Test Coaxial Cable

Video signal, produced by scanning film at 240 lines, 24 frames per second, is applied to coaxial system linking New York and Philadelphia. Results compare favorably with 441-line images shown elsewhere



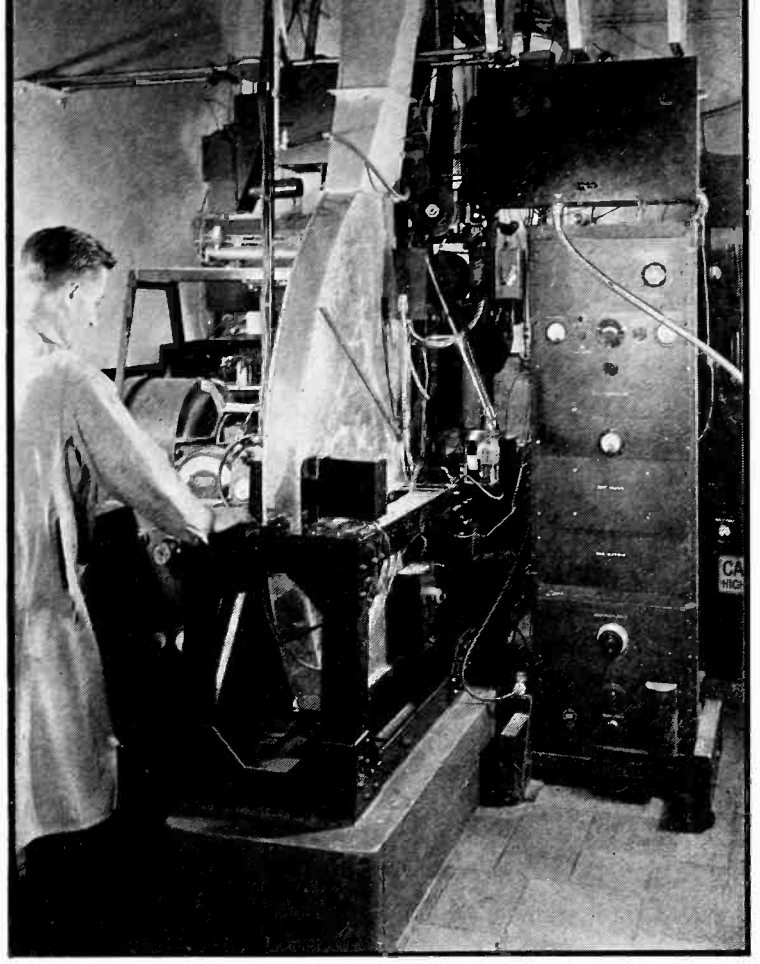
Carrier current equipment at the Philadelphia end of the New York — Philadelphia coaxial cable

ON NOVEMBER 9, while many of the leading television engineers were in Rochester hearing papers on the video art, the Bell Telephone Laboratories demonstrated for the first time the transmission of television images over the million-cycle coaxial cable system recently installed between New York and Philadelphia. This first demonstration was held for executives of the A. T. and T. and operating Bell Telephone Companies, but subsequent demonstrations were made for members of the technical press. Many who viewed the demonstration felt that the images produced, while based on the limited possibilities of 240 lines, and 24 frames without interlacing, were the equal to, if not actually superior to the 441-line, 30-frame images recently demonstrated in New York and Philadelphia. The system, having been proved out on its original plan of a one-million-cycle band-width, will shortly be returned to further research looking toward a two-million-cycle band, capable of handling the definition of a 350-line television picture having, of course, superior detail.

The intended use of the coaxial system is, in part, the transmission of carrier channel telephony, 240 separate channels being carried simultaneously, each on a 4 kc. band-width. By a double modulation scheme the carriers of each telephone channel are spaced between 60 and 1,020 kc. In testing the multiple channel system, the channels were connected end to end, so that the equivalent length of the circuit was 3800 miles, looping back and forth through the same cable some 45 times. Satisfactory telephone service was possible over this arrangement.

To test the entire range of the cable with *one* signal required use of some sort of video generator. The type of generator decided upon was a mechanical scanner, used in conjunction with ordinary motion picture film. The frame repetition rate of such film is 24 per second. To fill the available band width of 1000 kc. a picture of 240 lines was decided upon, making the nominal channel width $\frac{1}{2} \times 240^2 \times 4/3 \times 24 = 960$ kc.

The scanner is a six foot steel disc, rotated at 24 revolutions per second (1440 rpm), in which are set 240 high speed lenses, each located at the same radius from the center. The lenses focus a light beam on the film, which is passing at a constant rate of speed, the beam being square, about 0.003 of an inch on a side. Each lens thus scans one line in each frame of the film. The light, passing through the film, is collected by a phototube containing an electron multiplier, the multiplier being necessary to increase the current output. The output of the multiplier, containing frequencies from 0 to 800 kc. is then applied to a double modulator which raises the entire spectrum 100 kc. The region between 0 and 100 kc. is then available for the sound channel and for sending synchronizing pulses. Furthermore, the low frequencies in the video signal, which might be interfered with due to shielding difficulties in the cable, are removed to a high point in the spectrum.



Mechanical scanning disc in the Bell Telephone Laboratories which slices the motion picture frame pictures into elementary areas

The entire coaxial line, including repeaters at ten mile intervals is equalized over the million cycle band, and delay equalizers have been inserted to reduce phase distortion to less than 0.25 microsecond (corresponding to the time required to scan a distance equal to one-half the width of the scanning spot.)

Synchronizing is obtained from light shining through holes drilled in the scanning disc which produces (in a phototube) the line scanning frequency of $240 \times 24 = 5760$ cycles per second. This frequency is then used to modulate a 72 kc. carrier and this modulated carrier is sent over the cable in the unused region between 0 and 100 kc. At the receiving end demodulation is used to obtain the line scanning frequency of 5760 cps. and subharmonic generators to obtain its 240th subharmonic (24 cycles per second) which is used as the frame scanning frequency.

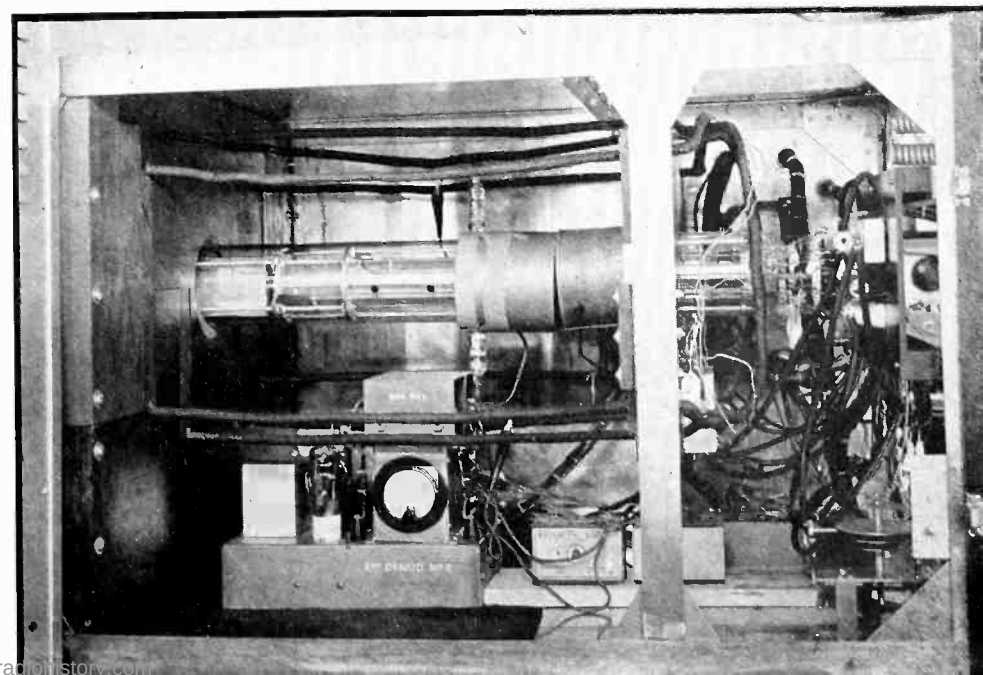
The receiver uses a conventional cathode ray tube producing a picture about 7 by 9 inches in size, green in color. The tube is scanned by electrostatic deflection, the sweep voltage generators being controlled by the 5760 cps. and the 24 cps. frequencies previously mentioned.

Perfect synchronism and even illumination obtained

The received image is distinguished by several features. In the first place there is some flicker, especially in the brighter portions of each scene, since no interlacing is used. In the second place the line structure of the image is visible at a distance of perhaps six times the picture height, since only 240 lines are employed. But aside from these limitations imposed by the dimensions of the system, the picture quality was excellent. There was no noticeable geometrical distortion of the picture. The contrast range was excellent. The synchronism, throughout the 12 minutes of the demonstration, was perfect. Even when sudden changes of over-all brilliance occurred in the film—which ordinarily throw the picture out of step—there was no perceptible loss of line or frame synchronism. The illumination over the face of the image was completely uniform, greatly adding to the apparent contrast and intrinsic interest in the picture. The illumination level was low, presumably to inhibit the effect of flicker on the eye, but it was perfectly adequate in a darkened room. The outstanding characteristic of the image was the crispness of the detail along each line, the sharp demarcation and detail in the shadows, and the freedom from phase "hang-over" effects.

The high quality of the picture is explainable on several counts. First, the amplifier and modulator system was very highly engineered within the limits of the million cycle band. Second, since no iconoscope was used, there was no shading (uneven illumination) problem. Third, since non-interlaced sequential scanning was used, the ability to preserve detail in each line was greatly enhanced, since in interlaced pictures, improper timing of the lines is apt to reduce definition. Fourth, the use of a separate channel for synchronism and the fact that the vertical and horizontal synchronism frequencies were integrally related, made for comparative simple and reliable sync circuit performance.

In connection with the demonstration, Dr. Frank B. Jewett, President of the Bell Laboratories, issued a statement to the effect that while the demonstration was not intended to demonstrate television, the system did show a "unique and economical utilization for television currents of the frequency band of a long coaxial cable". This referred to the fact that single side-band transmission was used to transmit the video signal, made possible by double modulation and the use of very precise filter structures. The frequency spectrum was thereby placed 100 kc. above zero, thus avoiding the low frequencies where transmission and amplification are difficult to accomplish. This arrangement, together with the system used to reduce phase distortion, represent new departures in the communications art.



The "socket end" of the cathode ray receiving tube

A Volume Limiter

A peak chopper for broadcast transmitters, which raises average level of modulation; makes impossible over-modulation for any extended period

By C. F. SHEAFFER
KTUL, Tulsa, Okla.

THERE has been an increasing interest of late in the use of peak choppers, or volume limiters in conjunction with amplitude modulated transmitters.

Their use affords two very decided advantages:

1. The average level of modulation is increased.

2. Over-modulation, for any notable length of time, is within the limits of the chopper, impossible.

The device described in this paper was designed for use in conjunction with the Barnsdall CBS Program, originating in Tulsa, Oklahoma. It is equally adaptable, however, to the use suggested.

Essentially the "chopper" is an attenuating network the loss of which is controlled by the amplitude of the applied signal. In tube operated devices this is accomplished by rectifying and filtering a part of the signal voltage and applying it either to control the gain of an amplifier, or to add loss in the circuit by changing the plate resistance of a tube.

Several methods were examined but were not entirely satisfactory. The one finally chosen offered four distinct advantages all of which could not be obtained in any one of the others. They are as follows:

1. Both the operating and releasing time can be controlled independently.

2. Current surges inherent in tube operated devices are effectively blocked out allowing a considerable reduction in operating time.

3. Current drawn by the attenuator tubes is indicative of the amount of attenuation present making it possible to read the over-shoot on a suitably calibrated meter.

4. No elaborate filtering of the rectified control voltage is necessary due to the plate bucking arrangement of the attenuator tubes.

A schematic diagram of the complete device is given in Fig. 1 together with the type and sizes of parts used. Amplifiers incorporated in the input and output circuits make possible the use of the desired levels as well as do away with impedance variations which would otherwise affect the input and output circuits. The attenuator section consists of an H type resistance network, the shunt of which is formed by the plate resistance of the attenuator

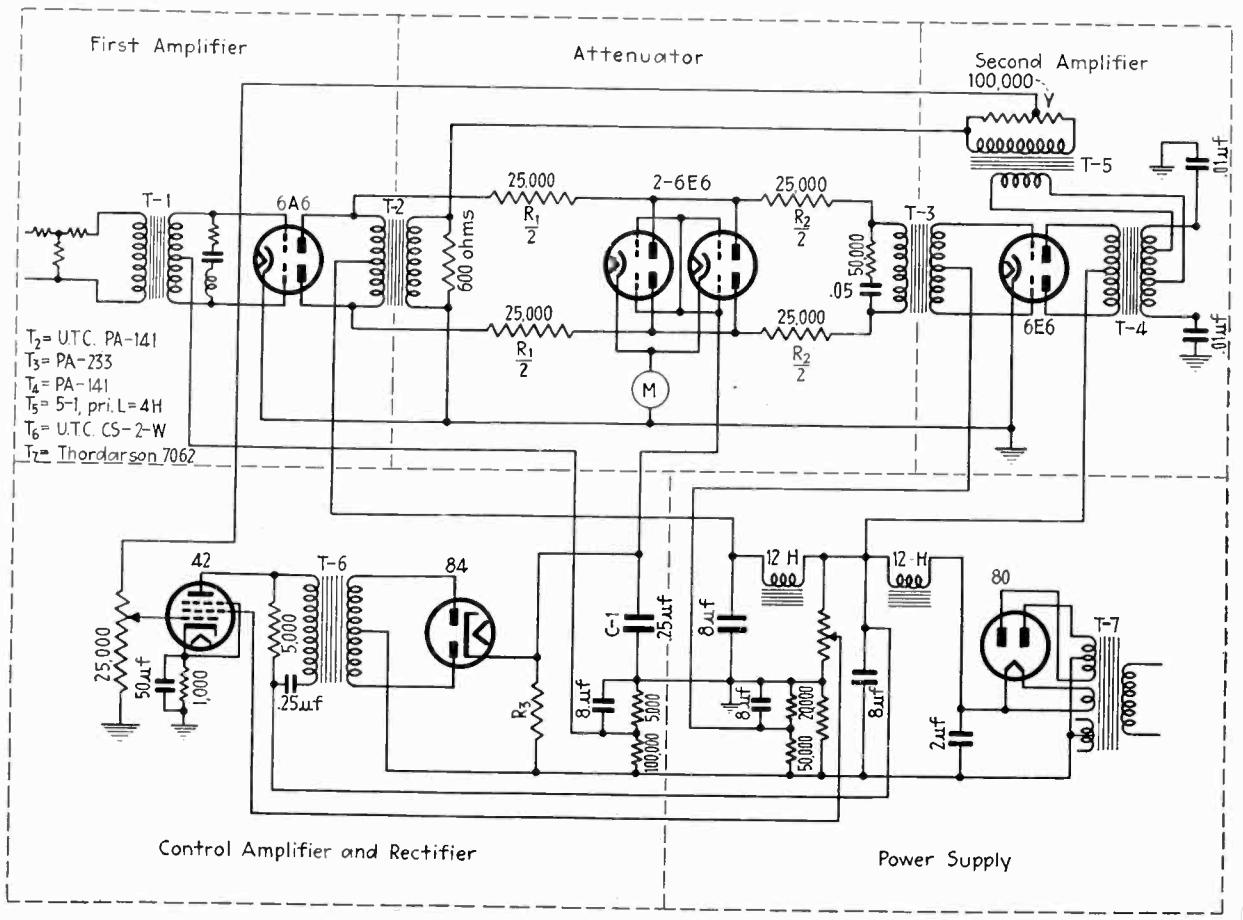


Fig. 1—Diagram of the volume limiter with circuit constants

tubes. These tubes are supplied with a fixed bias somewhat greater than cut-off which is applied in series with the output of the control rectifier so that the two voltages are in reverse polarity. If a signal is applied to the input of the chopper and gradually the level is increased, the output will increase in direct proportion to the input as in any linear amplifier or network until the rectified output of the control amplifier has discharged C_1 sufficiently to reduce the bias on the control tubes to cut-off. When this point is reached further increase in input level will simply shunt a lower and lower resistance across the attenuator network, increasing the loss with the signal increase.

It is necessary that the loss increase in direct proportion to the signal if the output is to be held at a certain limit. This would not ordinarily be true were the control amplifier supplied directly from the attenuator input. Under proper design conditions the action would then reduce the output as the signal increased. To meet this problem it was found necessary to make the input to the control amplifier a mixed function of the input and controlled voltages. With the proper mixture the input-output curve can in this way be made to follow practically any desired law.

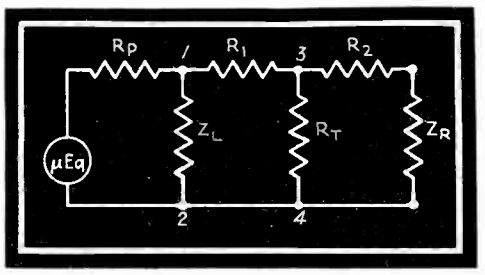


Fig. 2—Equivalent circuit of attenuator section

In designing the volume limiter, particular attention was given to the minimizing of amplitude and frequency distortion for all degrees of operation. Z_s and Z_r were adequately loaded to prevent impedance variation and impedance correcting networks were applied where necessary. The resistance R_1 was made sufficiently large to insure that the load facing the plate circuit of the first amplifier would not be less than the combined plate resistance for the maximum attenuating condition. With this as a minimum for R_t, R_1 and R_2 were selected in terms of the desired attenuation range and practical values of Z_s and Z_r.

It is practically impossible completely to do away with surges caused by the changing current in the attenuator tubes during operation. For this reason closely matched attenuator tubes must be selected and the input to the attenuator must be sufficiently great to override the remaining surge.

The operating time, which is defined as the time taken to reduce a specified overload to normal level, may be increased or reduced by increasing or reducing respectively the impedance facing the control rectifier plates, or the capacity C_1. The releasing time is proportional to R_3 times C_1. These may be selected from listening tests. In general, if the operating time is too low, a copious amount of unpleasant distortion will result, while if it is too high overloads of too long a duration will be passed to the output. The releasing time should be high enough to assure that tremolo effects will not be destroyed.

In adjusting the instrument for proper operation, the amplitude-frequency characteristic should be made flat over the desired range to the attenuator input as well as to the output terminals. The control rectifier output must also have a flat frequency characteristic. Voltage runs should be made for various settings of the second amplifier input and one selected which will give the required input-output curve.

The first amplifier, which is a 6A6, has a rather high effective grid shunt capacity and if a high impedance input transformer is used it will be necessary to apply compensation. Both the input and output amplifiers operate into relatively high load impedances. This assists in keeping the distortion low and indicates that the output impedance is much lower than the impedance into which it is designed to work, which is 500 ohms.

The instrument worked out exceptionally well; the amplitude-frequency characteristic was successfully made flat within ½ db from 30 to 10,000 cycles. The distortion at 400 cycles for normal input level was unmeasurable and was less than 1% when the input was increased 20 db (peak of attenuation range). The hum level was — 70db. Normal input level was — 26db, delivering an output of .006 watts into 500 ohms. The attenuation range was 20 db being amply sufficient to meet any normal monitoring situation.

Design Data

Sizes of all parts are included in the schematic diagram of Fig. 1 for those who may want to build an identical device. If a variation is necessary, the following considerations will be helpful in selecting a desired attenuator combination:

$$R_1 \leqq \frac{Z_1 R_p}{Z_1 - R_p} \qquad Z_s = \frac{Z_1 R_p}{Z_1 + R_p}$$

Z_s = The impedance looking backwards from terminals 1, 2.

Z_1 = Plate load with attenuator section disconnected.

R_p = Plate resistance of amplifier preceeding attenuator unit.

Non-operative loss = minimum when $Z_s + R_1 = Z_r$ and $R_2 = 0$ (2)

Attenuation range = 20 Log_{10} $\dfrac{(Z_r + R_2)\ (Z_s + R_1)}{R_t (Z_s + R_1 + Z_r + R_2)}$ (3)

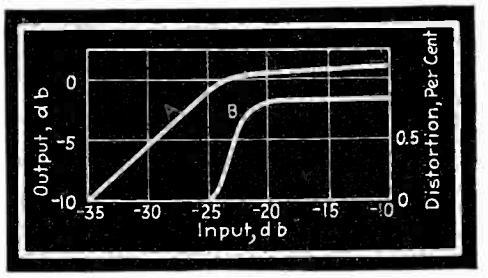


Fig. 3—Characteristics of the peak chopper. A — input-output; B — 400 cycle distortion

R_t = combined attenuator tube plate resistance at zero bias.

$$E_2 = \frac{E_1 Z_r}{Z_s + R_1 + Z_r + R_2} \quad (4)$$

E_1 = Open circuited voltage at Z_s when signal is sufficient to reduce attenuator tube bias to cut-off.

E_2 = Voltage supplied to Z_r when signal is sufficient to reduce attenuator tube bias to cut-off. (This is the maximum input voltage to the second amplifier.)

It can be shown by a rather involved differential equation that

$\dfrac{\text{Attenuation range}}{\text{Non-operative loss}}$ = maximum when $Z_s + R_1 = Z_r + R_2$.

Therefore from (3)

$R_1 + Z_s = R_2 + Z_r = 2\,R_t$ (Antilog $\dfrac{\text{Attenuation range}}{20}$) (5)

In designing the attenuator section it must be remembered that the amplifier preceeding the attenuator unit must be capable of delivering (antilog $\dfrac{\text{attenuation range}}{20}$) times the required value of E_2 without distortion.

In all of these equations the attenuation range is considered as positive.

Inductance Tuning

Old in principle, new in practice, inductance tuning of broadcast receivers offers several advantages according to demonstration of 0.54—65 Mc receiver before Radio Club of America. Fine adjustment in tuning high frequencies is possible

BEFORE the Radio Club of America on November 18 Paul Ware of P. R. Mallory described and demonstrated a most interesting system of tuning a superheterodyne or a t-r-f receiver by means of variations in inductance as contrasted to the present-day method of tuning by capacity variations. The inductance in this case is a single layer solenoid which rotates with the tuning dial. On this coil is a phosphor bronze rider which makes contact with bare silver-plated hard drawn copper wire and effects the tuning. Several of these coils may be ganged together. Across each coil is a fixed capacity which is about 1200 micro-microfarads for the broadcast band and 50 micro-microfarads for short-waves. These large fixed capacities swamp variations in capacity due to changes in tubes or to circuit variations.

Advantages of the system of tuning by inductance rather than by capacity cited by Mr. Ware are ease of alignment; greater frequency coverage per switch position; lower variations between units due to variations in wiring; better oscillation in superheterodynes; switchless skipband design; push-button tuning without the necessity of automatic frequency control; ease of getting band spread without extra gadgets.

The receiver demonstrated covered from the broadcast band to 65 megacycles with three switch positions. Mr. Ware stated that the cost of his system compared to condenser tuning could be stated in this manner; if an all-wave receiver is to be built with two switch positions for inductance tuning and three positions for condenser tuning, the new method would be cheaper. On the other hand if three switch positions are used in both sets, the cost would be about the same. The inductance system, however, would have a much better tuning coverage of the desired frequencies. For example it seems to be possible to have an all-wave set in which certain portions of the spectrum can be spread out to occupy a large position of the tuning scale with all other portions covered but in a hurry. Thus the important frequencies can be covered slowly and accurately; the others can be jumped over but without any actual skip bands.

The accuracy of alignment and tuning is high compared to capacity tuning. For example a condenser is restricted to a 180 degree rotation. Thus the tuning dial must effect all the tuning in this half-circle of motion. On the Ware coils, however, there are 30 feet of wire for the broadcast band. Since the contact can cover each quarter-inch of this thirty feet the total dial motion amounts to the number of turns times 360 degrees and the accuracy amounts to one quarter inch in 30 feet. It would be expensive to get this sort of motion with a condenser unless one resorted to gears such as now go into General Radio precision condensers.

This very fact of long tuning range presents a difficulty—that of manually tuning the system. On Mr. Ware's demonstration receiver, it was necessary to install a crank with which the tuning system was literally wound up to the required frequency. Motor tuning, however, would simplify this tuning tremendously and make inductance tuning practical.

The question of tracking in a superheterodyne naturally arises. Using inductance trimmers it seems possible to equal and perhaps better tracking when accomplished as in present day circuits. As a matter of fact the system makes it possible to have four cross-over points with the variations due to mistracking somewhat less than with a three cross-over capacity trimmed system. So far as feedback is concerned, Mr. Ware pointed out that a two-gang job with a tight metallic shield over the two coils operated without disturbing feedback. In this case the broadcast band coils were about $2\frac{1}{4}$ inches in diameter with a shield about 4 inches in diameter.

On the question of life and noise, it was stated that the receiver on demonstration had been tuned the equivalent of 30,000 round trips of the contactor which amounted to several hundred miles of motion. No noise developed in this period. Experiments were also made to determine the noise that came about after the receiver had been out of service for an appreciable period. Here, again, no noise seemed to arise. Since the inductance with the moving contactor need not be hermetically sealed, to prevent development of noise, the system is inherently quiet. It is free from Mocrophonics.

In addition to the possibilities of inductance tuning for radio receivers is the advantage of it when used in signal generators. Mr. Ware indicated that he had constructed a generator covering a range of 90 kc. to 35 Mc. which delivered 2 volts into 20 ohms and which had constant output. This was a MOPA circuit. Using a 954 acorn tube it was possible to make an oscillator covering the range of 40 to 150 megacycles.

Discussion brought out the fact that with small shunting capacities, one would be able to work near the natural wavelength of the coils; that a typical coil had 53 turns on a 2 inch diameter form and would cover a range of from 0.54 to 18 megacycles; that in actual practice small "end" coils were connected to the tuned inductance, these additional coils having values of Q higher than the tuning inductance. These end coils brought up the overall Q considerably with evident advantage. The use of conical coils to improve straight line tuning and several methods of increasing the alignment ease were brought out in the ensuing discussion.

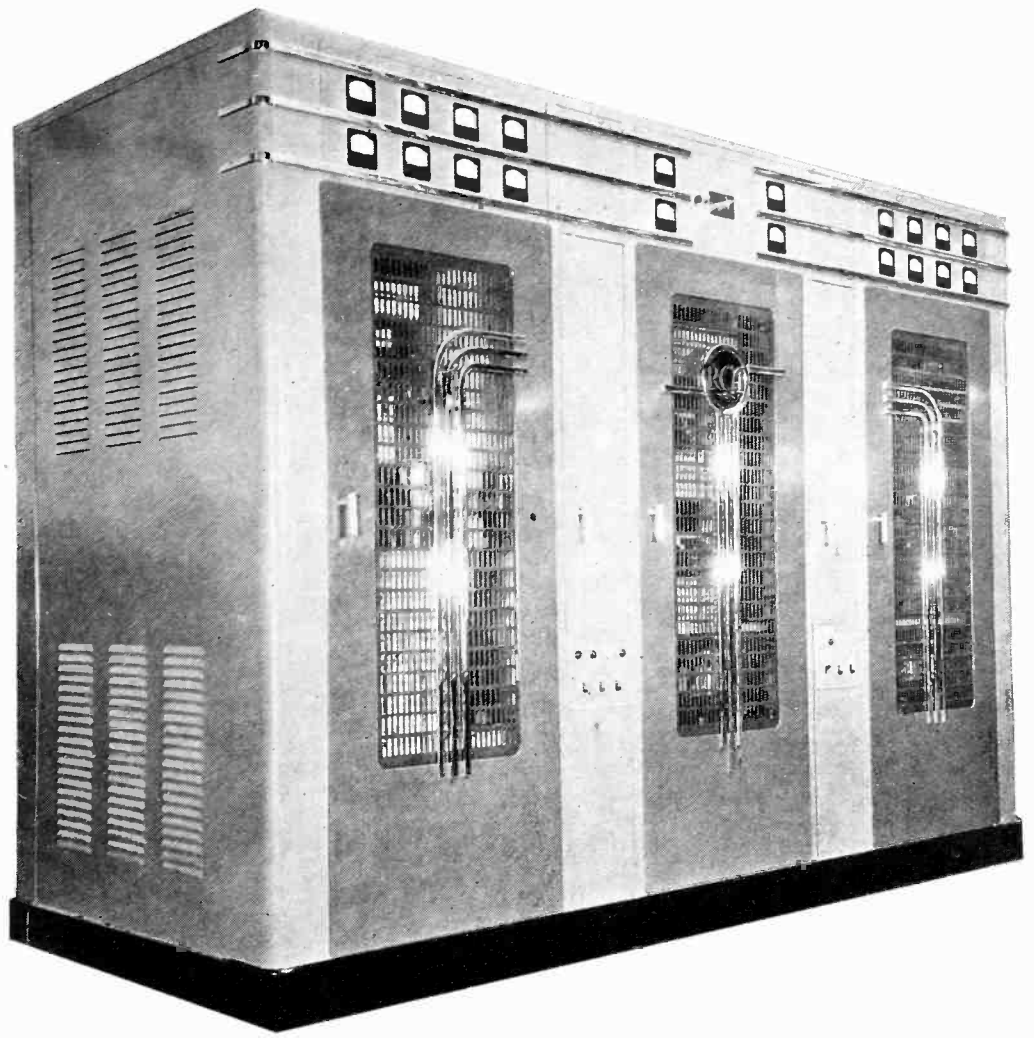


Fig. 1—Front view of the new 10 kw., 6-20 Mc. transmitter at W2XE, short wave station of the Columbia Broadcasting System, Wayne, N. J.

W2XE SHORT WAVE TRANSMITTER

By JOHN P. TAYLOR

A DECADE of experimental short-wave broadcasting, and four years of all-band receiver production have failed to define the possibilities of international broadcasting. Nevertheless, there are signs and portents that here is another of radio's "watched pots" which may be getting ready to boil. Foremost of these indications is the fact that at least three short-wave broadcasters have new transmitting plants planned or under way. The several-fold increases in power, plus new equipments throughout, must represent more than premise.

First of these three installations to approach completion is that of the Columbia Broadcasting System. Comprising complete new equipment for W2XE (located at Wayne, N. J., in the same building as WABC) this installation features an especially designed factory-built transmitter which sets up entirely new standards in this field. As the newest development—and hence most recent commentary on the advance in short-wave broadcasting—this installation has many features of general interest.

Technically the new equipment of W2XE is of more than usual interest in that it marks a definite turning point in the development of equipment of this type. With advertising revenue prohibited and with little governmental encouragement American broadcasters have in the past been loathe to undertake the expense of installing permanent equipment for operation on the international frequencies. As a result, while American short-wave stations have held their own with stations of other countries, with respect to power, the equipment made use of have in general been of a decidedly experimental nature. This is not to imply that these transmitters have not been up to the required performance standards, but they have been of composite construction, often using experimental type tubes. In more or less degree they have lacked the advantages of standardization and operating convenience associated with modern broadcast transmitters. By contrast with this, the new transmitter of W2XE is a finished permanent-type equipment which brings together all of the recent developments in radiophone transmitter design. It is the first high-power short-wave transmitter designed from beginning to end specifically for broadcast use. It is capable of performance fidelity equivalent to the finest new broadcast transmitter; incorporates such features as high-level modulation, low temperature coefficient crystals, and advanced design of power and control circuit features. In appearance and constructional design it follows the modern lines developed in broadcast transmitter design.

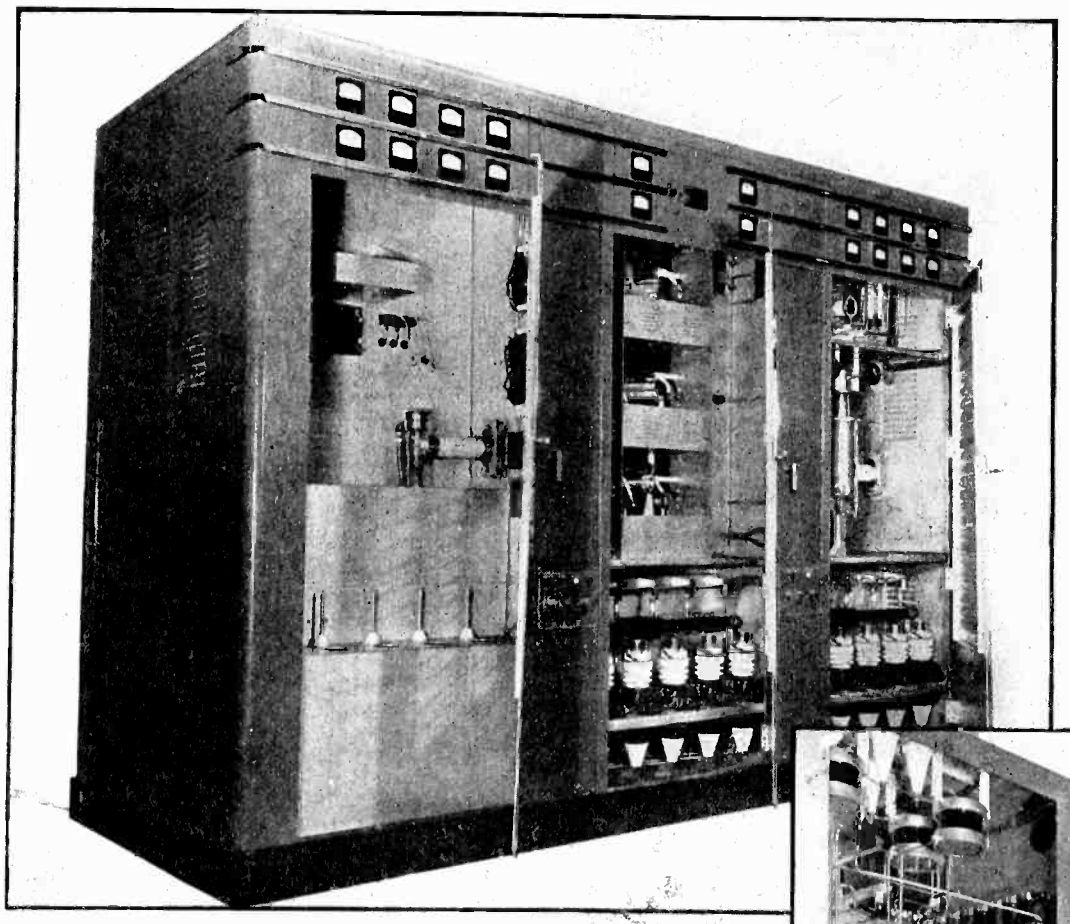


Fig. 2—Front view with main doors open to show the unusual accessibility of all parts. Tuning controls are located behind the two small doors which are here shown closed

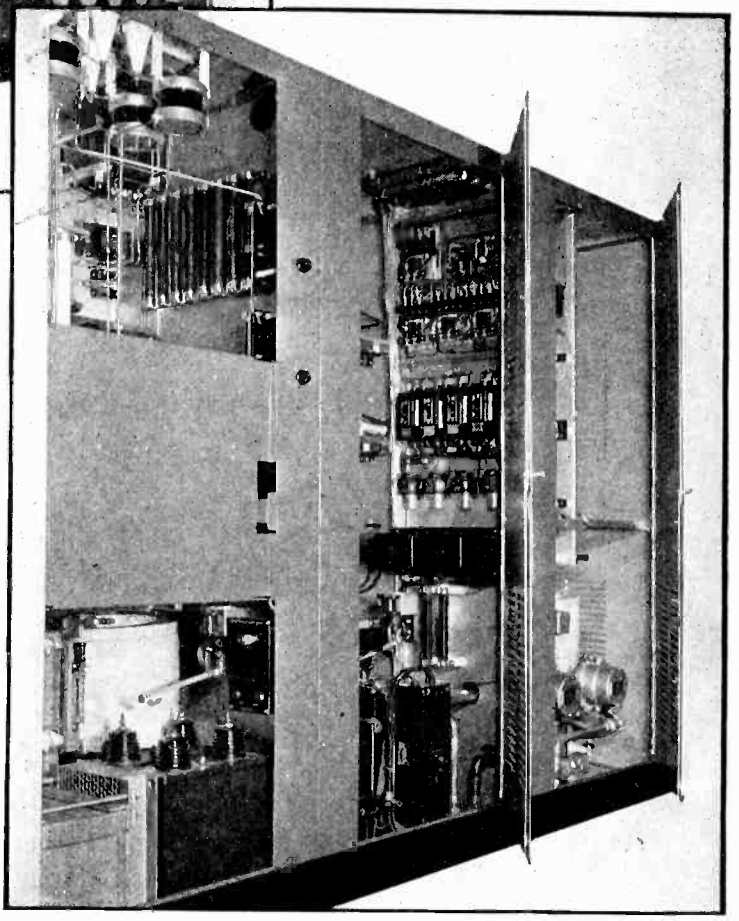


Fig. 3—Rear view with doors open. The three sections are merely for purposes of convenience, as the transmitter is constructed as a single unit

Since modern short-wave stations operate on several frequencies during the day (present W2XE frequencies are 6120, 11830, 15270, 17760, 21520), provision for a number of crystals is necessary. Four positions are provided, so that four crystals may be kept up to temperature and ready for instant use. Each of the four positions has an indicator light associated with it for showing operation of the heater element. Selector switches are so arranged that two crystals may be permanently connected in the circuit. This provides a set-up, such that instantaneous changeover between any two pre-selected frequencies can be accomplished. The crystal units utilized are the small plug-in interchangeable type. Each unit contains a low temperature coefficient crystal, a heater element, and a thermostat of the glass-enclosed bimetallic type. The crystal units are capable of keeping the total frequency deviation of the transmitter within .01 of one per cent. Since they are inexpensive, uncritical and rugged, any desired number of them may be kept on hand and substituted at will in the four positions.

Tube Line-Up

The crystal heater units are used in conjunction with an oscillator stage employing a 42 with an untuned plate circuit. The crystal frequency is from three to five megacycles, depending on the output frequency in use. The oscillator is followed by a buffer stage employing a 802 operating at the crystal frequency. This is followed by a first doubler-stage using an 803, and a second doubler-stage using a pair of 803's. The latter drives an intermediate power amplifier which uses four 803's and operates at the output frequency. These in turn drive the power amplifier which consists of a pair of 207's in push-pull, feeding an output circuit designed to match a 500-ohm line.

The audio portion of the transmitter consists of two audio amplifier stages and the modulator stage. All three are push-pull connected

and utilize interstage transformers. In the first stage 843's are used, 845's in the second stage, and 891's in the modulator stage. The latter, operating Class B, modulates the power amplifier stage.

The power supply consists of three separate rectifiers. The first employs a pair of 866-A's and furnishes 250 volts to the plates of the oscillator and buffer stages, in addition to supplying bias voltage for all stages of the transmitter. The second employs three 872-A's in a three phase half wave circuit and supplies plate voltages for the two doubler stages, the intermediate power amplifier stage and the second audio amplifier. The third is the high-voltage supply for the modulator and power amplifier stages. It consists of twelve 872-A's in two banks, each of which is in itself a full-wave three-phase rectifier, the two banks being connected in series. This arrangement furnishes 10,500 volts with convenient taps at 50% and 75% of maximum. It has the advantage of using small tubes which are inexpensive and may be replaced at a stipulated number of hours, thereby avoiding frequent time losses due to tube failures.

The control system of the transmitter represents a marked advance in this field. It closely follows the systems worked out for the more recent designs of broadcast transmitters and is the equal of these latter in every respect. All units are interconnected and so arranged that either manual step-by-step or full automatic starting may be employed. Circuits are interlocked so that voltages are applied in proper sequence and the necessary time delays assured. The usual devices are employed to protect the equipment in case of excessive plate current, inadequate water flow, or high temperature of the cooling water. An automatic induction voltage regulator is supplied so that variations in line voltage up to ±10% are automatically corrected.

Frequency Changeover

Short-wave broadcast transmitters are operated at several frequencies during the day in order to obtain optimum results according to the diurnal variations of the ionosphere and the desired direction of transmission. Since it may often be required to transmit successive programs at different frequencies, some method of quick frequency changeover is highly desirable. If instantaneous changeover is to be accomplished, retuning of stages is obviously impossible. In order to avoid this, use has been made of an arrangement previously employed in commercial communication transmitters (where a somewhat similar problem exists). Changeover from one frequency to another is accomplished by means of a single switch; the operation is practically instantaneous and no program time is lost. The primary feature of this arrangement is the provision of alternative tank connections in all r-f stages. In the four low-power stages, which are housed in the center unit of the transmitter, the alternative connections consist of independent tank circuits, each complete in itself. The arrangement of these tank circuits is illustrated in Fig. 4. In the case of the power amplifier stage, the changeover is accomplished by means of taps on the tank coil so arranged as to short circuit portions of the coil when changing to a higher frequency. In addition to these changes in the r-f stages, it is also necessary to reduce the voltage on the power amplifier at the higher frequencies (the maximum allowable power out-

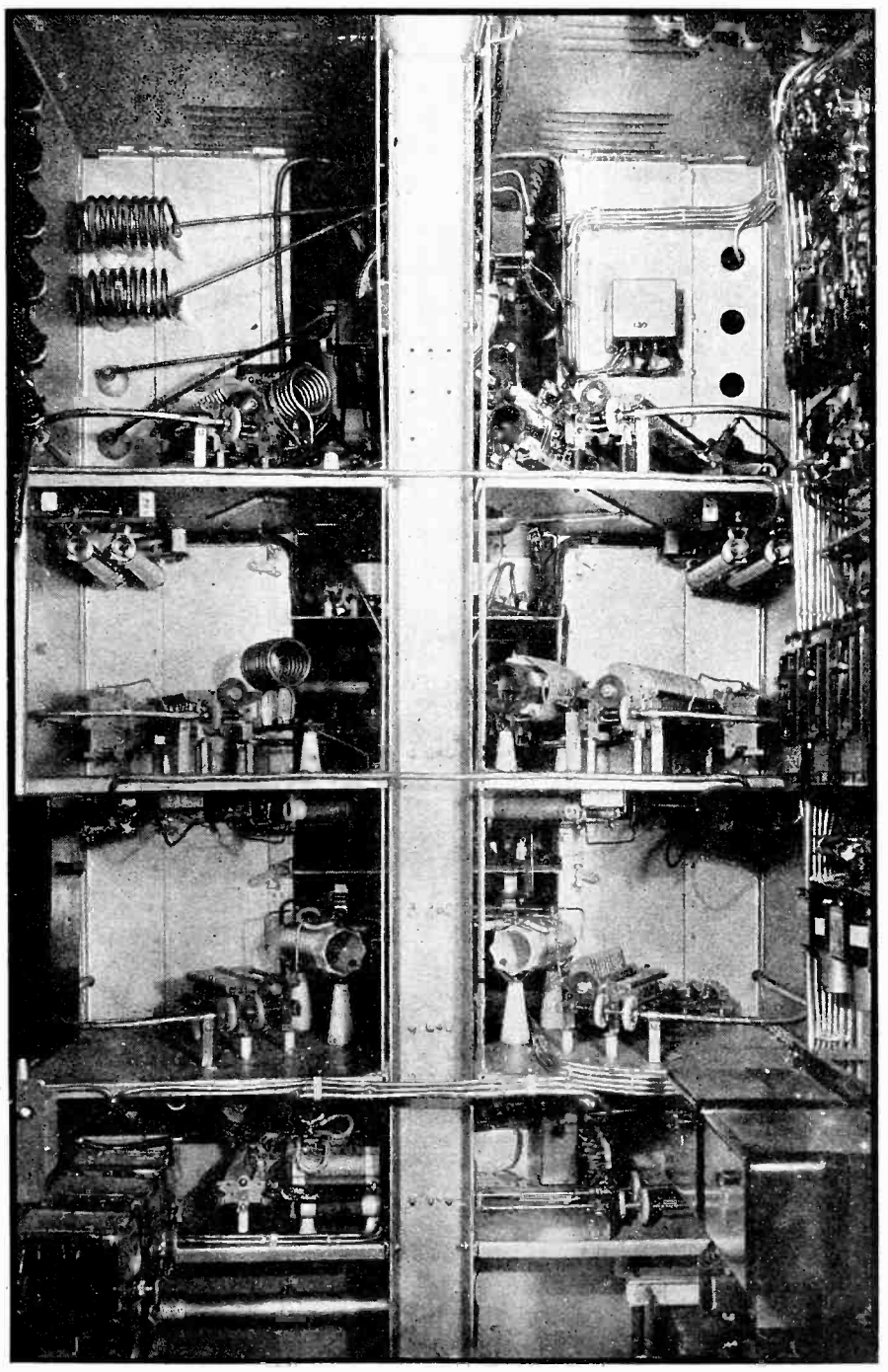


Fig. 4—Close-up of rear of exciter unit showing duplicate tank circuits in each of the four low-power stages. Tuning is accomplished by flexible cable coupling the condenser shaft with the panel dial

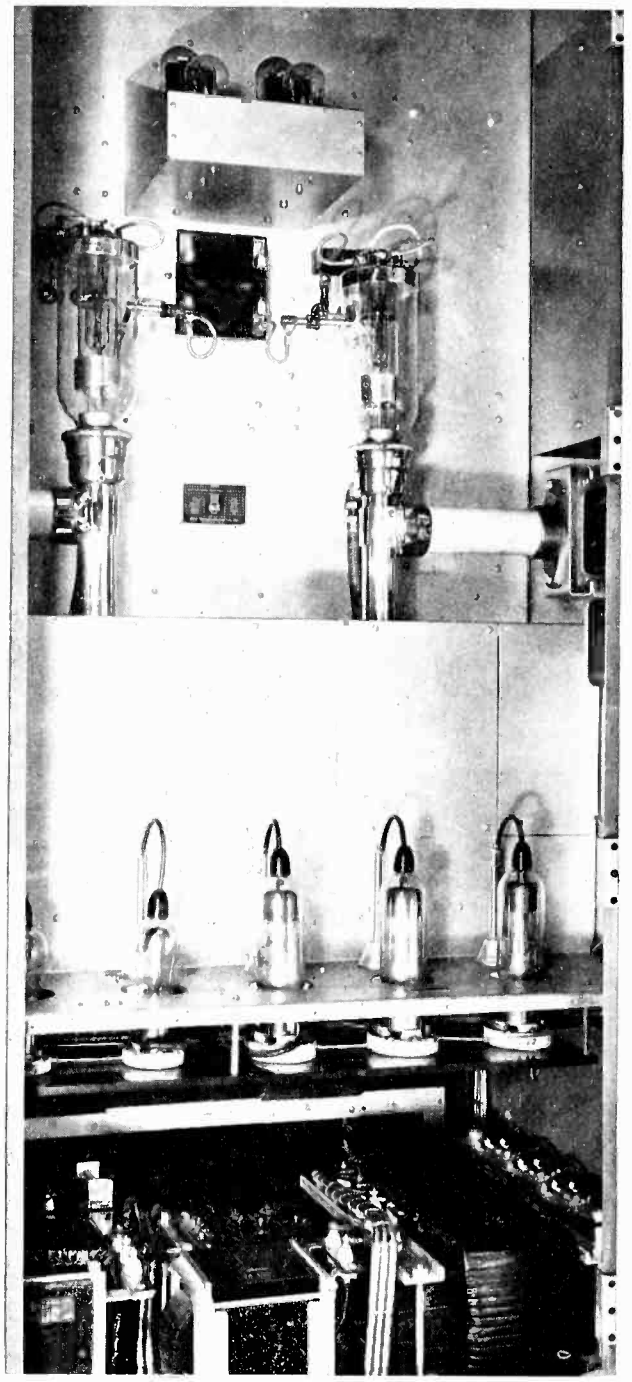


Fig. 5—Front view of the modulator unit. Audio tubes are on the shelf at the top; low power rectifiers may be seen at the bottom

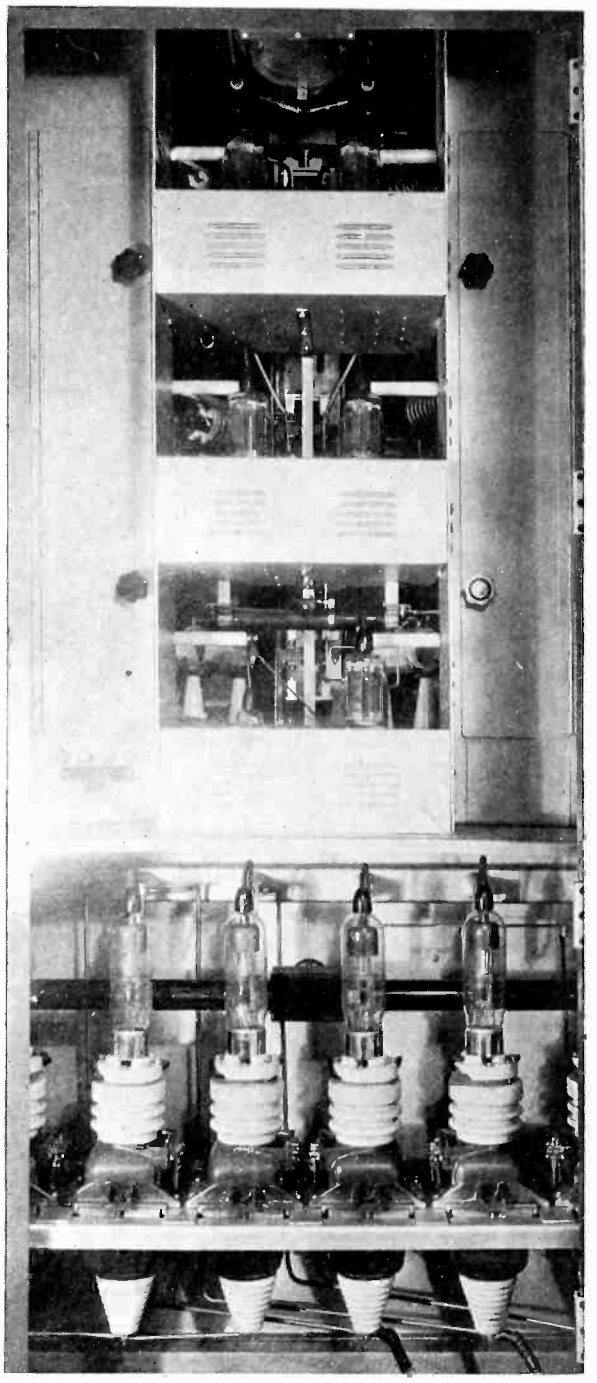


Fig. 6—Front view of the exciter unit. The two small doors on each side of this assembly may also be opened to provide additional accessibility

put varying from 10 kw at 6 Mc) to 6 kw at 20 Mc) and to change the tuning circuit of the oscilliscope which is used as a modulation indicator. Still another change is accomplished in the output circuit, this being so arranged as to connect to either of two alternative transmission lines, which may in turn be connected to antennas designed for the corresponding operating frequencies. All of these changes are accomplished by mechanical switches operated by solenoids so that closing the switch in the solenoid exciting circuit provides the complete operation.

The construction of the unit is unique for this power and type of transmitter. Not only is it much smaller in dimensions, but the mechanical design and appearance are quite different from any previous designs. With the exception of the cooling system, plate transformer, modulation transformer and choke, and minor items, it is entirely self-contained. The transmitter housing proper is approximately 9½ ft. long, 7 ft. high, and 4 ft. deep. Unlike any previous transmitters of comparable power, it is a single unit, built, shipped and installed as such. Thus, although it is divided into three sections, these are chiefly for purposes of shielding and convenience, and are not separable.

The general aspects of the design and construction will be evident from the several views which are shown. Externally the transmitter is a single unit marking a new high in attractiveness of design. Internally it is divided into three sections, housing (from left to right) modulator, exciter, and power amplifier. The rectifiers extend across the bottom of all three units. The method of mounting components is similar to the vertical chassis-type construction developed for a new line of broadcast transmitters. All tubes are mounted on the front of vertical panels so that they are immedi-

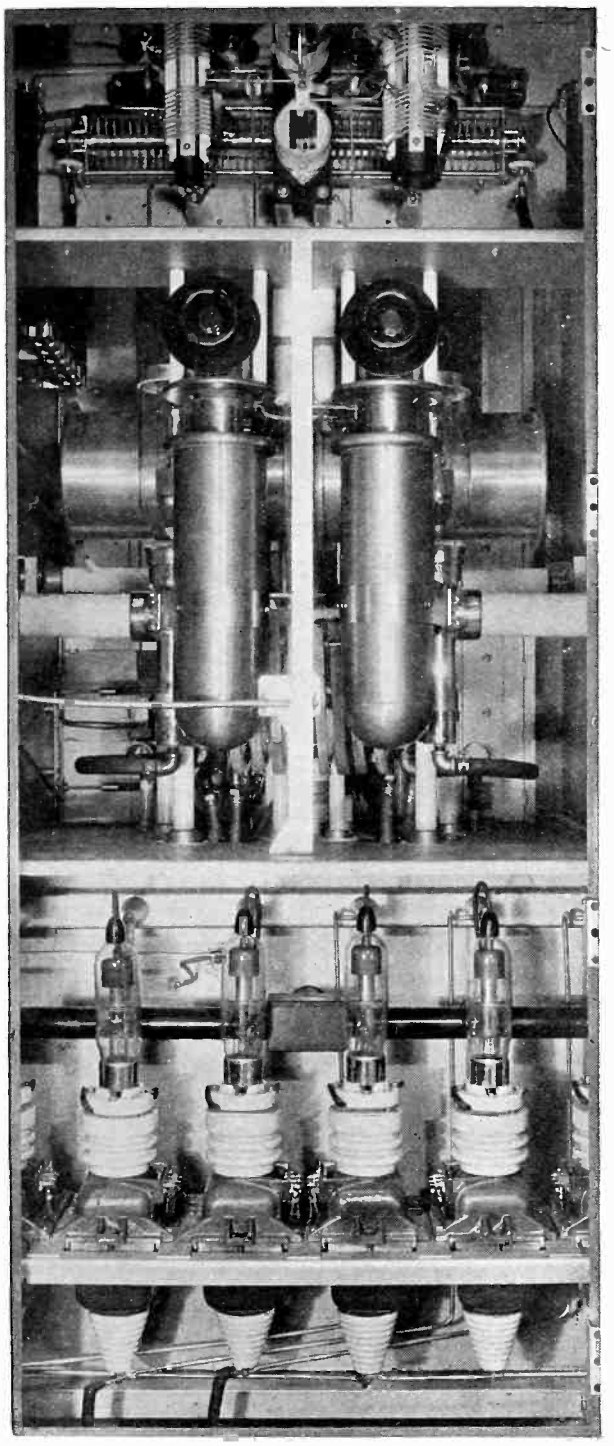


Fig. 7—Front view of the power amplifier unit. The large "bullets" in the foreground are the neutralizing condensers

ately accessible through the front doors of the unit. All other components are mounted on the back of these panels or on shelves attached thereto so that they are immediately available when the rear doors are open. It is interesting to note that in this new transmitter the "walk-in" idea has been carried to the ultimate end, i.e., full length doors are provided in front and rear. This arrangement is made possible by providing small vertical panels (between the main front doors) on which are located all tuning controls. These are ordinarily hidden by small doors which, unlike the main doors, are not interlocked.

In addition to the major constructional details there are many minor features of interest which it is hardly possible to mention in a short description. Close inspection of the several interior views will reveal many of these. For instance, in Fig. 6 is shown the front view of the exciter unit. In this may be seen the arrangement of alternative tank circuits used to obtain rapid frequency-changeover in the low-power stages. At the right of this view, behind the vertical door is part of the control circuit components of the transmitter. To the right of this door (not shown) are the magnetic circuit-breaker, the gravity-operated high-voltage switch, the porcelain cooling reels, and the water-flow indicators. In Fig. 7 is shown a close-up view of the power amplifier section. Directly in front will be seen the bullet-like neutralizing condensers which are provided with micrometric controls. Just behind these are the tubes, water-cooled tank coil and enclosed-type tank condenser. Above may be seen the antenna coupling circuits, and below, four of the twelve tubes which compose the high-voltage rectifier. In general these glimpses give a good idea of the advanced and finished design of this new short-wave broadcast transmitter.

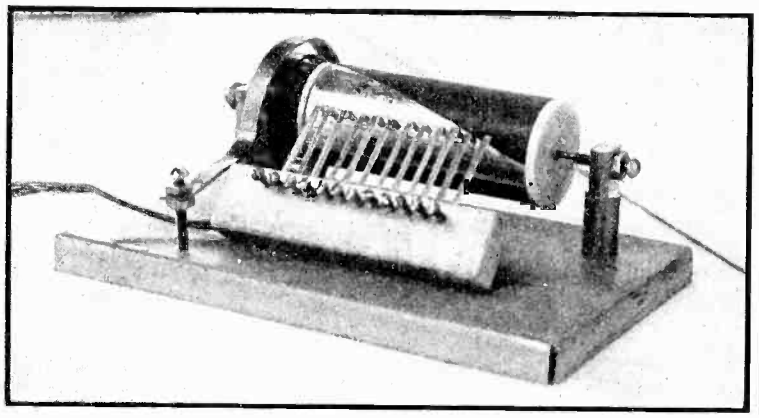
Broadcast Quality

Such factors as crowded allocations, dependence on sky-wave transmission, and the prevalence of the DX reception idea, place limits on the fidelity which it is possible to obtain at present in short-wave broadcasting. However, good engineering practice requires that the designer look ahead over the period of years extending to likely obsolescence of the transmitter, and provide for meeting any standards likely to be set up by changing conditions during that period. From this viewpoint, nothing less than the minimum standards as defined for high-fidelity transmission can be tolerated in a modern broadcasting transmitter, whether for short-wave, or broadcast band operation.

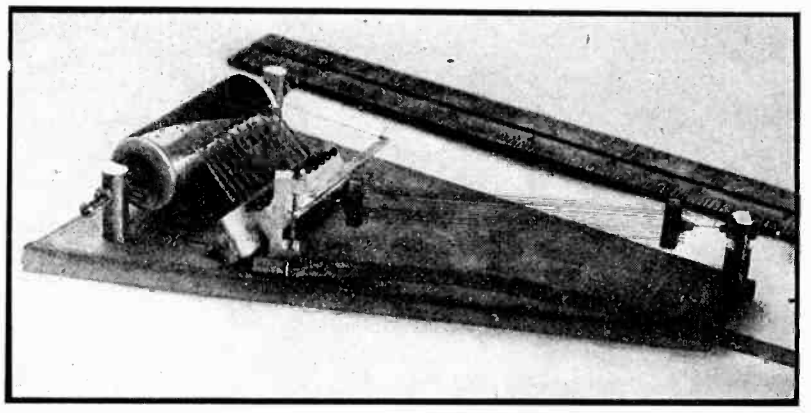
The performance characteristics of the W2XE transmitter not only provide for the ordinary standards of high fidelity transmission, but also for that safety factor necessary to insure such performance in day-to-day operation. Generally speaking, the specifications are the equivalent of those of the more recent broadcast transmitters. The frequency response is within 1 db. from 100 to 5000 cycles, and within 1.5 db. from 30 to 10,000 cycles. The audio frequency distortion is less than 4% r-m-s for the range of 50 to 7500 cycles, from zero to 100% modulation. The unweighted background noise level is 45 db. down. This latter is not quite the equal of the new broadcast transmitters, but is in all probability, fully as great as can be utilized in short-wave broadcasting.

Radio in the Sky

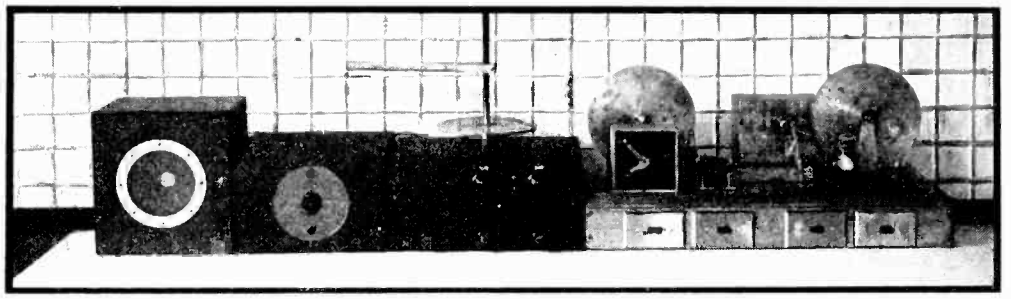
Most ingenious are the radio transmitters carried by balloons to investigate meterological conditions in the upper atmosphere. Photos on this page from University of Minnesota and on opposite page from the Blue Hills Observatory, Harvard University



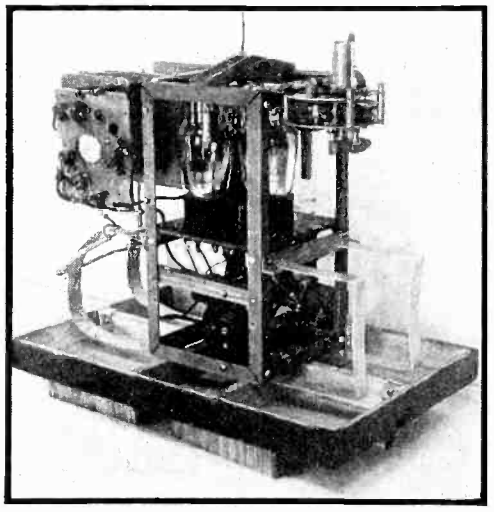
Thermometer unit using bimetal coil which causes drum to rotate similar to the action of the hygrometer unit

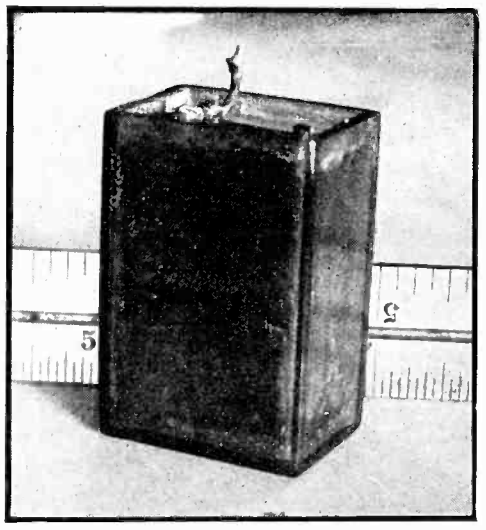


Human hair hygrometer. Change in length revolves drum providing contact between silver inlay and contacts

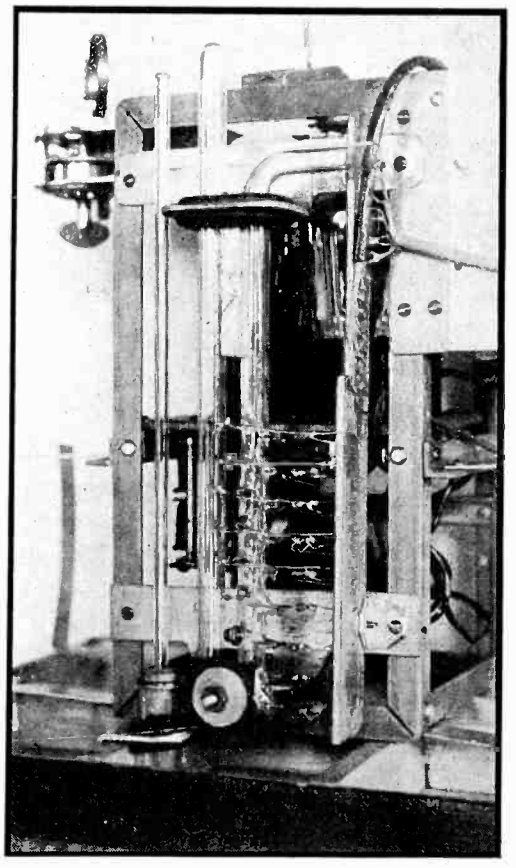


Receiver with (left to right) loud speaker, amplifier, directive receiver and tape recorder—the latter really not being necessary



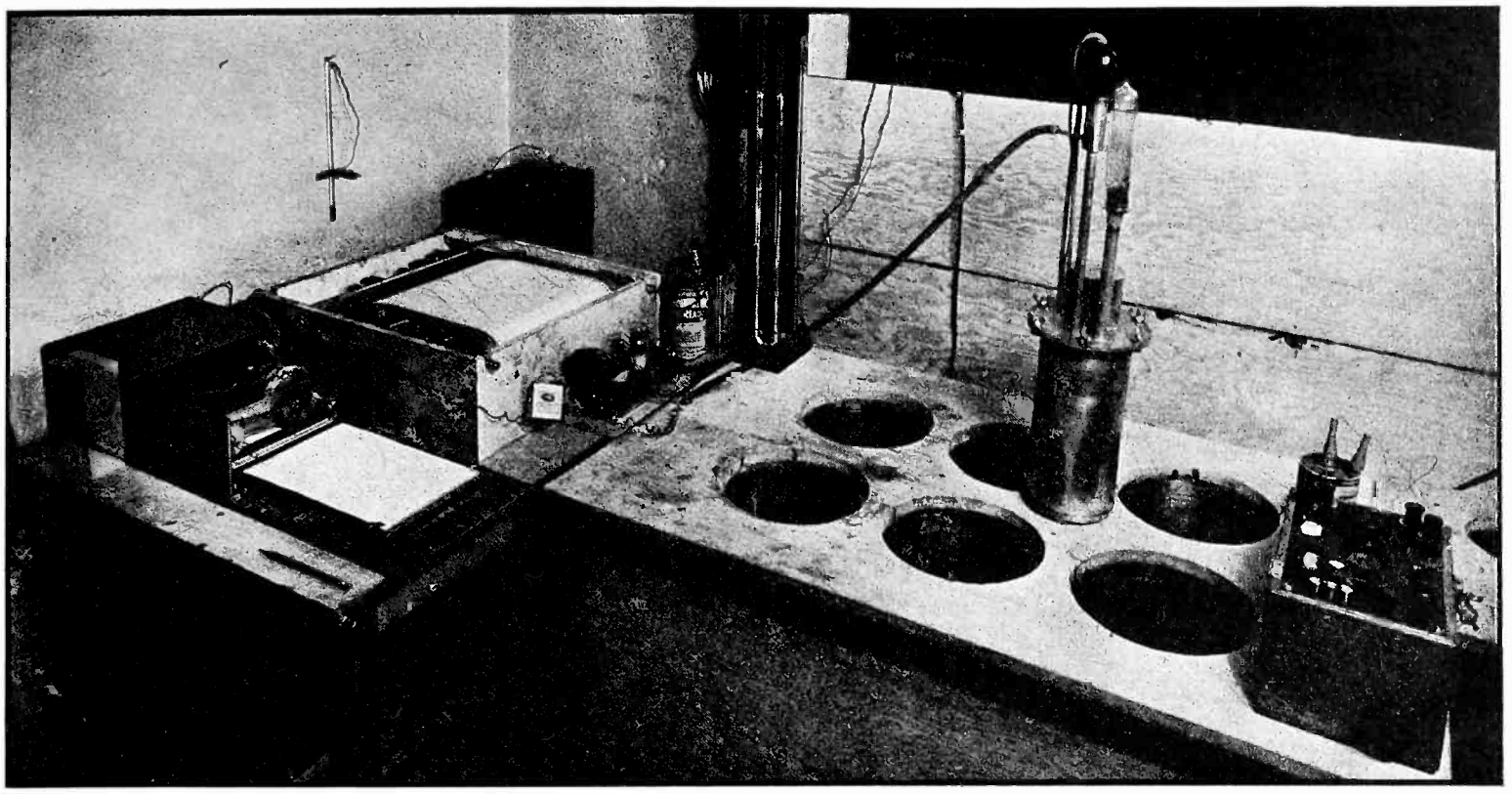


Transmitter, battery powered, 62,000 kc, modulated at 400 cycles. It uses push-pull 30 tubes. Without batteries, weighs 1 lb. 14 oz. At right is storage battery to light filaments. Weighs 5 oz. will operate transmitter 7 hours. Plate supply is 135 volts of Burgess batteries

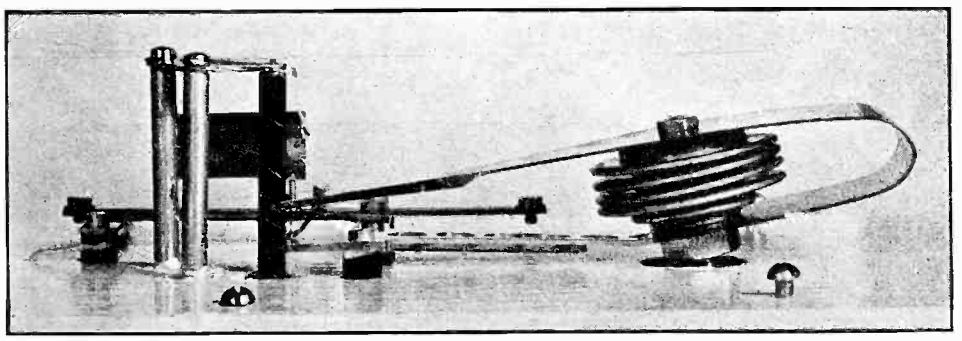


Minimum and recording barometers. Right is glass U tube with tungsten points in wall. Will indicate 22 different altitude readings

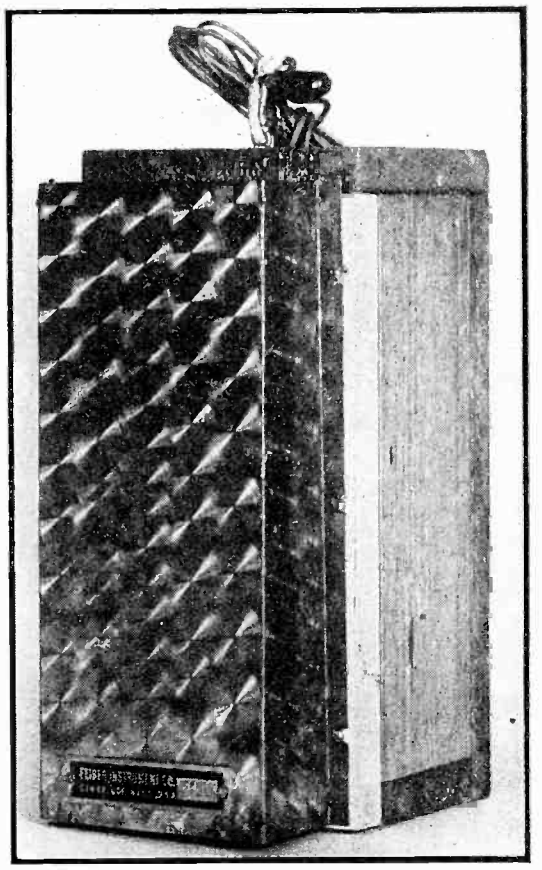
U N I V E R S I T Y O F M I N N E S O T A

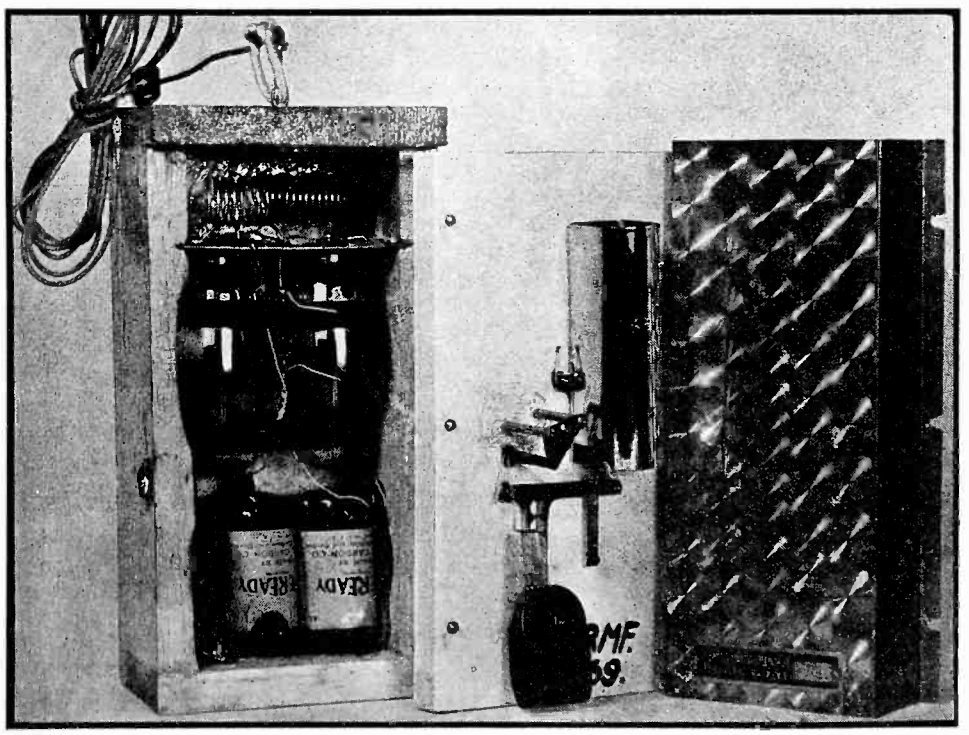


Calibration equipment. Instrument is inside cylinder in which pressure is reduced, then put into various holes in which are different temperatures

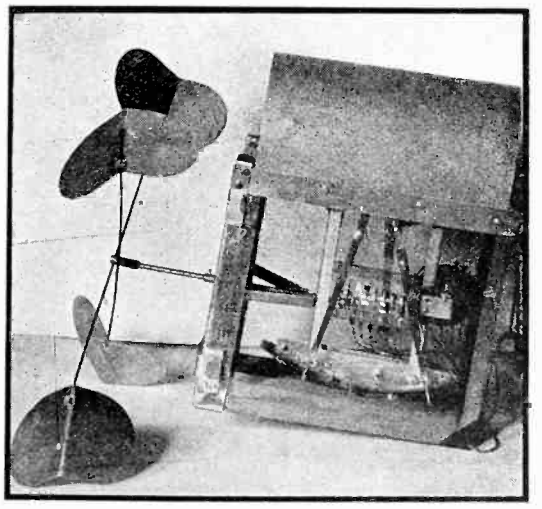


Blue-Hill modified Olland-type meterograph. Gold wire, spiral, turned by clock, twice a minute makes contact with 4 arms, one fixed, 3 moved by bimetal thermometer, single hair hydrometer, aneroid barometer. Clock and radio are in balsa wood to protect them from extreme cold



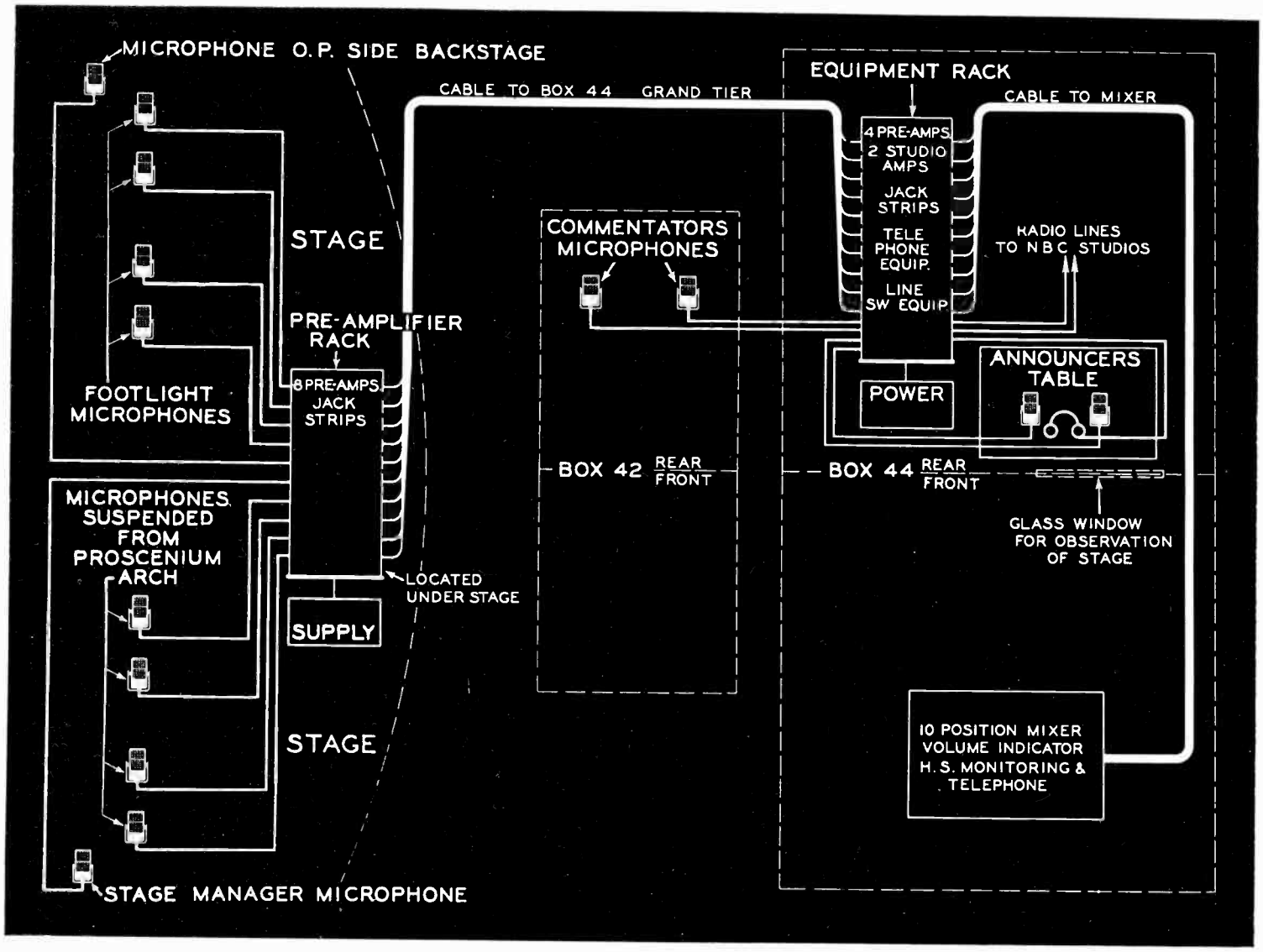


Complete transmitter. Two 45 volt B batteries, one 4.5 volt A battery. Snap on left of box connects A battery just before releasing balloon. Above, right, transmitter box closed, ready to go aloft. The metallic shield protects the instruments



Early (1926) Moltchanoff radio-meterograph used in Russia. Air moving past instrument turns fan, operates switching

Metropolitan Opera



Complete layout of microphones and control equipment in use at the Metropolitan Opera House, New York City for NBC broadcasts

SATURDAY matinee performances at the Metropolitan Opera House have become a radio institution. Since Christmas Eve, 1931, with the broadcast of "Hansel and Gretel," no week during the season at the historic American center of grand opera has gone by without its complete performance given over one or the other of the National Broadcasting Company's two networks. Some of the greatest singers of our times—Flagstad, Melchior, Ponselle, Martinelli, Pons, Gigli, Schorr, Tibbett, Scotti, Jeritza, Bori, to name only a few—have sung for an audience that extends from coast to coast and beyond to Hawaii, and by short-wave to South America and Europe.

Naturally, any such broadcast—three hours of leading singers, chorus and orchestra united in a single presentation—would come to have a technique of its own. This is particularly true of the Metropolitan broadcasts, since these are, from an operation viewpoint, field broadcasts. Radio, in other words, must make the best of any adverse circumstances, and there are many at the Metropolitan.

To begin with, the opera is given for the audience in the great auditorium; no concessions are made to broadcasting, beyond allowing NBC equipment to be installed and the opera itself broadcast Saturday afternoons. In fact, none of the apparatus must be in evidence so that either performers or members of the audience be aware that the performance is being broadcast. Next, the elements of opera, which in the studio would be carefully rearranged to permit best microphone pick-up, follow in the strict tradition of the stage. Finally, the acoustics at the Metropolitan, although satisfactory for the present audience, are far from ideal for radio.

In solving the numerous problems raised at the Metropolitan, NBC engineers have devised one of the most flexible systems of microphone pick-up in the world. During an actual performance the engineer, sitting in the famous Box 44 of the Grand Tier, has at his command ten microphones placed at the most strategic of the available pick-up points. And it is by the use of these microphones in different combina-

on the Air

Since 1931, the Metropolitan has been broadcast by NBC. A description of the apparatus; the technique; the liaison between musicians and broadcast pickup engineers.

Herbert Liversidge signals "chorus is coming in soon." The number of fingers showing indicates the nearness of the chorus musically

Charles Grey, at faders, interprets Mr. Liversidge's signals at the 10-stage mixer. This is Box 44 at the Met"

tions that he puts grand opera on the air. In short, the engineer acts as a second conductor, determining the relative volume of each of the elements of opera and blending them into a harmonious whole.

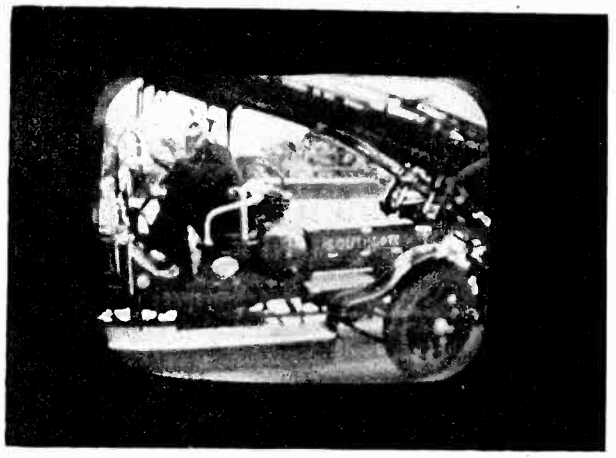
Of the ten microphones, seven are of the inductor type. Four are placed, in pairs, in the footlights at either side of the stage. One of each pair is tilted upward to receive sounds from the stage sets, the ceiling, etc.; the other is directed at the floor so that it registers sound intensity at a point some two feet in front of the instrument. This arrangement provides clear and sharp recording of performers' voices, regardless of their positions on the stage. Two other inductor microphones, for occasional use, are placed in the wings at either side of the stage.

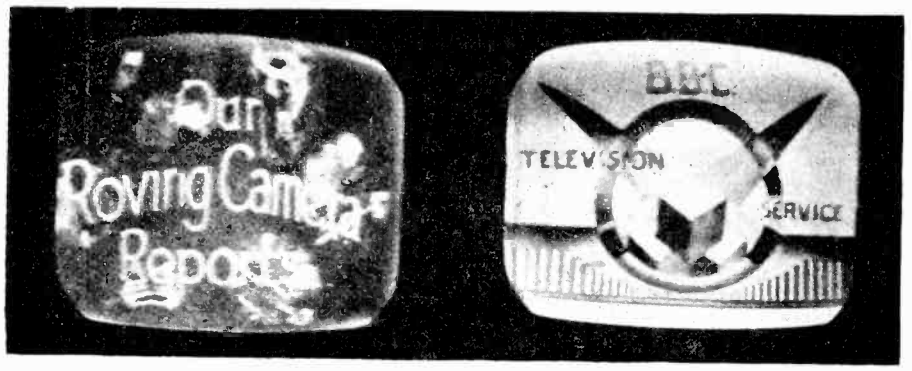
Pick-up facilities are rounded out by four microphones suspended from the proscenium arch, three being of the uni-directional ribbon type. Two of these provide orchestra pick-up; one is hung slightly to the left of center of the orchestra, the other about five feet further to the left, or directly over the string section. The former is used when the orchestration is evenly balanced as between strings and brasses. If, however, brasses predominate, the microphone over the string section is used to maintain the balance. These two microphones are also adjustable as to height, varying from thirty-five to forty-five feet above the orchestra. The level chosen varies inversely with the level of the orchestra pit. When the orchestra is lowered to diminish the volume for the present audience, the effect is to intensify the directional characteristics of the sound. It is as if the orchestra were playing in a well above which the microphone is placed. To counterbalance this effect the microphone is raised. The third uni-directional microphone is often used to pick up choruses over the heads of the ballet. The fourth instrument, an inductor microphone, records audience applause.

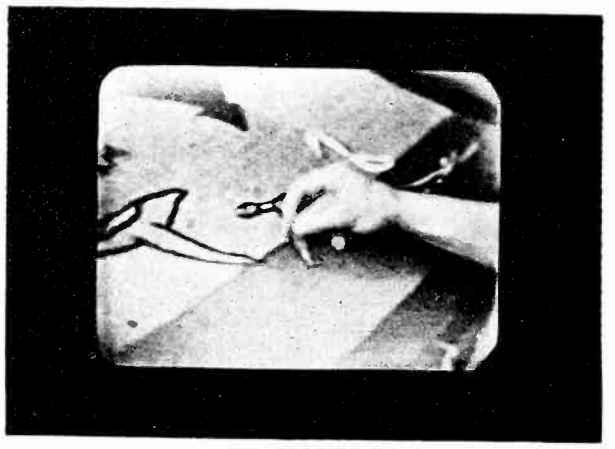
Cables joining microphone receptacles and preamplifiers understage are made up of individually shielded pairs of copper braid, encased in lead sheaths. These cables,

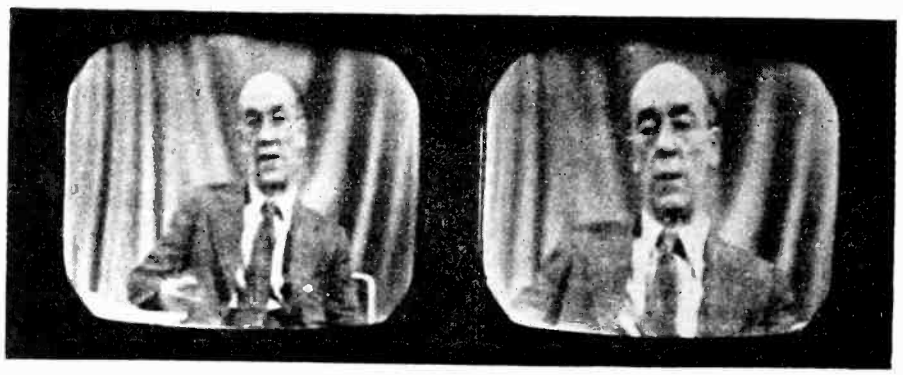
[*Continued on page* 37]

Backtalk









See for Yourself

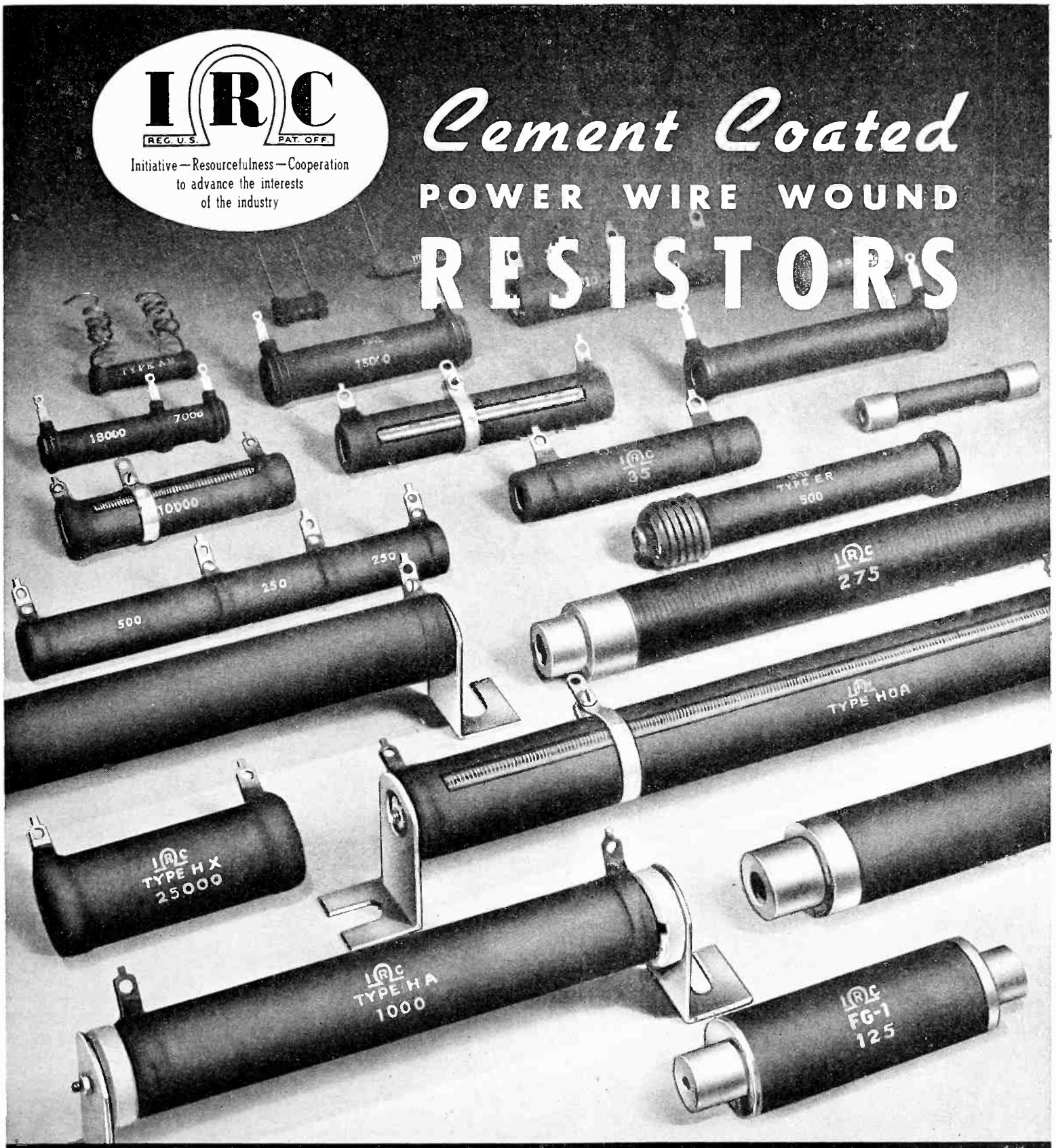
Concerning your article "Television in Gt. Britain" (October, 1937) I do not think that the reproduced photograph of a Wimbledon relay race does justice to the results generally obtained. I admit that the subject is of greater interest than a studio item, and I agree that it is not an easy one to photograph.

In the hope that they will interest I enclose a few rough prints of snaps taken at my location (70 miles from the transmitter, low ground level) and some taken at 40 miles by a Mr. Westhead from a standard "Cossor" receiver.

The receiver used for my own snaps was that designed for the home constructor and described in "Television & Short Wave World".

S. WEST
15, *St. Matthews Street*
IPSWICH
Suffolk, England

UNEQUALLED DEPENDABILITY
UNDER THE MOST SEVERE CONDITIONS



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Allocations in the U-H-F Spectrum

Channels between 30 and 300 megacycles have been assigned to definite services by the FCC, as a result of the hearings held in June, 1936. This listing is supplementary to the general allocation chart published in *Electronics*, September 1934.

30.02	G(13)	33.50	P	37.46	F	66.00	T(1)	132.40	SV	139.82	AV
30.50		33.54	GMP	37.50	P	72.00		132.54	CSH	139.96	EX
30.54	CSH	33.58	PR	37.54	EX	72.04	G(75)	132.68	EX	140.10	MF
30.58	P	33.62	SV	37.58	CSH	77.96		132.82	P	140.24	F
30.62	GMP	33.66	MF	37.62	RB	78.00	T(2)	132.96	B(2)	140.38	EM
30.66	EX	33.70	G	37.66	IS	90.00		133.10		140.52	AV
30.70	P	33.74	RB	37.70	G	90.04	G(75)	133.24	F	140.66	B
30.74	SV	33.78	P	37.74	MF	95.96		133.38	SV	140.80	SV
30.78	F	33.82	EM	37.78	P	96.00	T(2)	133.52	P	140.94	P
30.82	RB	33.86	F	37.82	EM	108.00		133.66	EM	141.08	F
30.86	PR	33.90	P	37.86	AV	108.04	G(50)	133.80	F	141.22	AV
30.90	G	33.94	F	37.90	P	111.96		133.94	AV	141.36	EX
30.94	FO	33.98	PR	37.94	CSH	112.00	AM	134.08	B	141.50	F
30.98	P	34.02	G(25)	37.98	RB	118.00		134.22	PR	141.64	EM
31.02	SV	34.98		38.02	G(25)	118.06	G(71)	134.36	EX	141.78	AV
31.06	GMP	35.02	RB	38.98		126.42		134.50	P	141.92	SV
31.10	P	35.06	EX	39.02	PR	126.54	ATC	134.64	F	142.06	B(14)
31.14	EX	35.10	P	39.06	AV	126.66	G(3)	134.78	B(2)	143.88	
31.18	F	35.14	EM	39.10	P	126.90		134.92		144.08	G(80)
31.22	RB	35.18	PR	39.14	SV	127.02	ATC	135.06	P	155.88	
31.26	CSH	35.22	P	39.18	P	127.14	G(3)	135.20	AV	156.00	T(2)
31.30	G	35.26	RB	39.22	CSH	127.38		135.34	SV	168.00	
31.34	FO	35.30	G	39.26	RB	127.50	ATC	135.48	CSH	168.04	G(68)
31.38	F	35.34	CSH	39.30	G	127.62	G(3)	135.62	SV	179.86	
31.42	EM	35.38	F	39.34	EM	127.86		135.76	B	180.00	T(2)
31.46	F	35.42	FO	39.38	P	127.98	ATC	135.90	PR	192.00	
31.50	P	35.46	SV	39.42	FO	128.10	G(3)	136.04	F	192.14	G(61)
31.54	SV	35.50	P	39.46	EX	128.34		136.18	P	203.94	
31.58	FO	35.54	GMP	39.50	P	128.46	ATC	136.32	AV	204.00	T(2)
31.62	RB	35.58	AV	39.54	SV	128.58	G(3)	136.46	EM	216.00	
31.66	CSH	35.62	RB	39 58	CSH	128.82		136.60	F	216.11	G(36)
31.70	G	35.66	CSH	39.62	RB	128.94	ATC	136.74	B(2)	223.81	
31.74	EM	35.70	G	39.66	EM	129.06	GB	136.88		224.00	AM
31.78	P	35.74	FO	39.70	G	129.18		137.02	AV	230.00	
31.82	FO	35.78	P	39.74	FO	129.30	ATC	137.16	CSH	230.12	G(16)
31.86	F	35.82	RB	39.78	P	129.42	GB	137.30	P	233.72	
31.90	P	35.86	IS	39.82	RB	129.66		137.44	SV	234.00	T(2)
31.94	F	35.90	P	39.86	EM	129.78	ATC	137.58	MF	246.00	
31.98	PR	35.94	FO	39.90	P	129.90	GB	137.72	F	246.12	G(46)
32.20	G(25)	35.98	PR	39.94	FO	130.02		137.86	SV	257.76	
32.98		36.02	G(25)	39.98	PR	130.30	ATC	138.00	PR	258.00	T(2)
33.02	PR	36.98		40.02	G(25)	130.44	GB	138.14	EX	270.00	
33.06	F	37.02	RB	40.98		130.72		138.28	AV	271.14	G(39)
33.10	P	37.06	F	41.02	B(75)	130.86	ATC	138.42	P	281.78	
33.14	F	37.10	P	43.98		131.00	GB	138.56	B(2)	282.00	T(2)
33.18	EM	37.14	SV	44.00	T(2)	131.28		138.70		294.00	
33.22	P	37.18	EM	56.00		131.42	ATC	138.84	SV	294.15	G(20)
33.26	PR	37.22	P	56.00	AM	131.56	GB	138.98	AV	299.85	
33.30	G	37.26	CSH	60.00		131.70		139.12	P		
33.34	EX	37.30	G	60.02	G(150)	131.84	ATC	139.26	EM		
33.38	RB	37.34	RB	65.98		131.98	GB	139.40	F		
33.42	AV	37.38	P			132.12	AV	139.54	SV		
33.46	SV	37.42	PR			132.26	B	139.68	PR		

SYMBOLS

AM—Amateur
ATC—Airport Traffic Control
AV—Aviation
B—Broadcast
CSH—Coastal and Ship Harbor
EM—Special emergency
EX—Experimental
F—Fixed
FO—Forestry
G—Government
GB—Guard band
GMP—Geophysical and motion pictures
IS—Intership
MF—Marine Fire
P—Police
PR—Mobile Press
RB—Relay broadcast
SV—Special services
T—Television

Numbers in parentheses indicate number of channels

ELECTRONICS REFERENCE SHEET

TUBES AT WORK

TUBE applications for this month include u-h-f oscillator, voltage regulator, keying transmitters with tubes, a high resistance bridge.

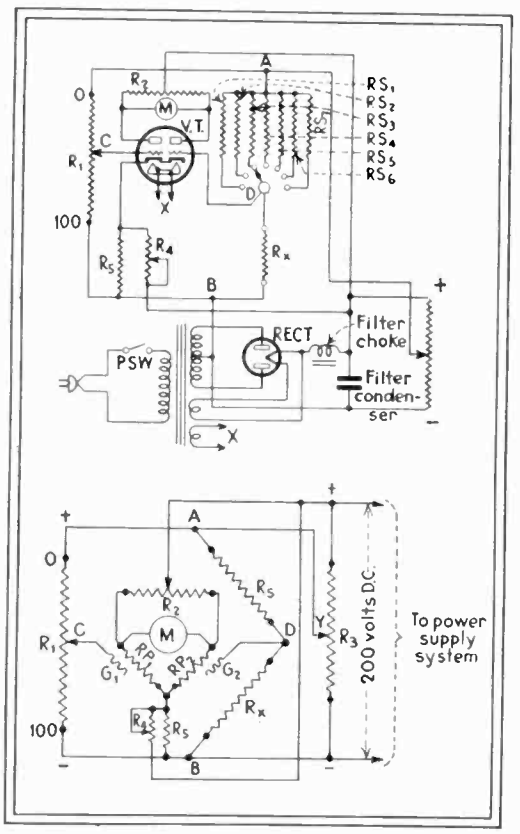
Vacuum Tube Resistance Bridge

A VACUUM TUBE BRIDGE sufficiently sensitive to measure resistances of from less than 100 ohms to more than 200,000 megohms and developed for determining the electrical resistance of chemically treated wood is described by I. I. Davies in *Instruments* for October, under the title "A Wide Range Vacuum Tube Resistance Bridge." The bridge consists of the bridge circuit proper, the bridge balance indicating circuit, and a power supply.

The portions of the slide wire R_1 on either side of the sliding contact point C form two arms of the bridge. Any one of the seven resistors RS_1 to RS_7 which may be selected by means of the switch key form the third arm of the bridge and the unknown resistance is the fourth arm of the bridge and is designated as R_x.

The bridge balance indicator, which is itself a bridge circuit, consists of a double triode vacuum tube, an adjustable resistance R_2 and a zero center low range milliameter, *M*, together with a grid bias in resistance, R_5, and a grid bias adjusting voltage divider, R_4. The power supply for this resistance bridge is similar to that used in many radio receivers and consists of a transformer, double wave rectifier and simple filter.

The complete connection for the bridge as well as a simplified schematic wiring diagram are indicated. With slight modifications of the circuit the bridge can be used as a vacuum tube voltmeter, in which case it is capable of measuring an unusually wide range of voltages without drawing current from the voltage source.



Schematic wiring diagram of high resistance bridge developed for determining resistance of chemically treated wood

50 to 100 Cm. Oscillator Design

BY A. BINNEWEG, JR.

THE DESIGN OF equipment for use below one meter wavelength presents many new considerations. Ordinary tubes will not function at these frequencies, but the 955 Acorn tube will operate about as easily at ¾ meter as the ordinary receiving tubes will function at 2.5 meters. A 75-cm. oscillator is shown in Fig. 1.

This oscillator consists of about 1½ inches of No. 22 wire in both grid and

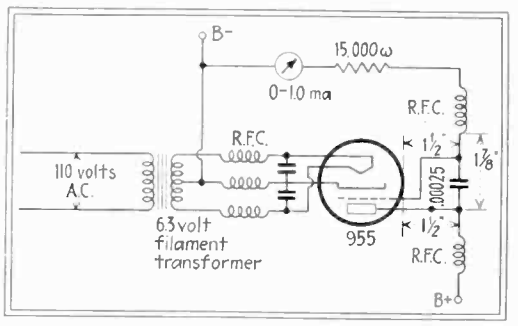


Fig. 1 Wiring diagram of 50-100 cm. oscillator

plate leads and a 0.00025 μμfd mica condenser shunted across their ends. Five chokes are essential. Each choke consists of about 40 turns of No. 34 wire spaced ⅛ inch on a ⅜ in. bakelite or hard rubber rod.

The Lecher wavemeter of Fig. 2 consists of two wires drawn taut between two supports with a meter stick arranged below the wires, so that the wavelength can be read directly. In using this wavemeter, the coupling coil is bent down to the oscillating circuit until there is loose coupling as indicated by the grid meter. Then the shorting link is moved along the wires until resonance is shown by the grid-meter dip. The distance along the wires between two resonance positions is one-half wavelength. It is necessary to use at least 50 volts on the 955 at 75 cm.

75 Cm. aerials

For coupling to an aerial a thin piece of copper, ⅜-in. square, is soldered directly to point *A* on the plate lead in Fig. 2. Another thin copper plate of the same dimensions was soldered to the end of a short length of No. 20 bare wire. This second plate was placed 1/16 in. from the plate on the plate lead.

The best way to determine the proper

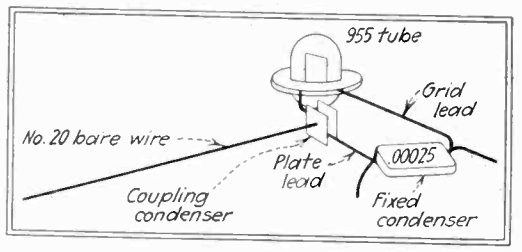


Fig. 2 Coupling the oscillator to the Lecher wire system

antenna length is to attach an aerial which is too long, and then shorten it, a little at a time, until resonance is reached. When the aerial is tuned to the oscillator, the grid current in the oscillator will decrease to a minimum. The complete aerial coupling scheme is shown in Fig. 3. A typical set of

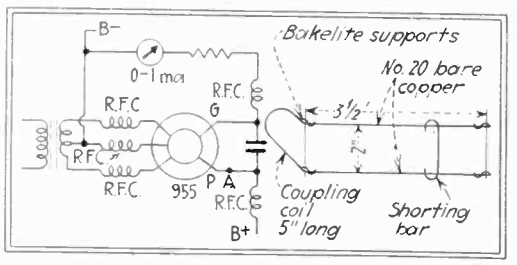


Fig. 3 Complete oscillator and Lecher Wire arrangement

values for grid current values and corresponding aerial lengths is given below. Correct antenna length is indicated by minimum grid current.

VALUES FOR No. 20 TINNED COPPER AERIAL WIRE

Length of aerial wire in inches	Grid current in Oscillator, Mils.
13¾	.54
13¼	.20
13	.14
12¾	.08
12½	.06
12¼	.02
12	.04
11¾	.08
11¼	.13
10¾	.28

The aerial length for which the

(*Continued on page* 39)

Congress Needs YOUR Guidance....NOW

An Opportunity for the Million Readers of McGraw-Hill Publications to Help Business Recovery

TODAY, everybody sees that private industry *alone* can lead the march back to prosperous times. Business leaders, labor leaders, legislative leaders, and now the National Administration, all agree that the leadership must pass from government to private enterprise. As spokesman for the Administration, Secretary Morgenthau has said:

"The basic need today is to foster the full application of the driving force of private capital. We want to see capital go into the productive channels of private industry. We want to see private business expand."

So do we all. Nothing can take the place of expanding business. The business man needs it to meet his expenses and earn a profit. The investor needs it to put his capital to productive use. More than anyone else, the workman needs it for a steady job at regular wages. And the government needs it to get the revenues required to carry on. Everyone needs better business; there is no other way forward. But if business is to resume its leadership, government must revise its policies to make the shift possible.

Everyone who knows anything about federal taxes knows that the present system is not sound; it has been made even less so by some of the experiments of the last few years. However good those experiments may be in theory, their practical result is to frighten business men and investors from taking the risks that are necessary for business revival. As Secretary Morgenthau puts it:

"We realize that our tax laws are too complicated; we want to make them less so. We realize that there are inequalities; we want to eliminate as many of them as we can."

With this encouragement from the Administration, Congress now must get at the job. Many see the need, but it is Congress that must do something about it. What it does will depend on how it interprets the views of the people. *The time has come for the people to tell their Congress what they want.*

At no time since 1929 have business people — employers and employees — had so promising an opportunity to impress their views and their needs on the Washington government. The iron is hot; now is the time to strike!

Specifically, these three needs are urgent:

First — *Repeal the undistributed earnings tax.* As a producer of revenue it is discredited. Its chief effect has been to obstruct recovery and curtail employment by holding back the normal plant improvements by industry. Such improvements make for higher efficiency, *the only means by which consumers can get more*

for their money, without loss of income as producers. Altogether, the undistributed earnings tax obstructs development, destroys employment, and encourages unsound financial practices. It should be repealed.

Second—*Repeal or amend the capital gains tax.* As it now stands, the investor who sells securities when prices are rising must give the government a large slice of his profit; but when he sells on a falling market he must eat his own losses. That is a one-sided, unfair proposition. It is heads-the-government-wins, tails-you-lose. It discourages the sound investment practice required by stable business. It should be repealed or amended to allow adequate deductions for losses.

Third—*Reduce the excessive personal surtaxes.* These high taxes were designed to reach for 75 per cent of the rich man's income. Whatever may be said for that objective in theory, it doesn't work in practice. It *appears* to "soak the rich" but in fact it is a blow in the air. For the rich can escape by hoarding their wealth in tax-exempt securities—municipal and government bonds rather than industrial securities. It is the latter that create productive enterprise, with orders for business and jobs for workers. So the effort to exact excessive taxes from the rich drives funds out of industrial employment and into government bonds; at the same time it dries up the source of the desired taxes. Excessive surtaxes are a good example of losing all by over-reaching; they should be amended to encourage enterprise and increase revenues.

The America of today is possessed of the same driving force that created it. All it asks is a chance to resume its progress. In the early days of our national development, government paid huge bounties to encourage private construction of the railroads. Today industry asks no bounties; it asks only a chance to invest in national progress the surplus wealth that it has itself created. It is willing to meet the increased obligations of social progress and to pay its share of the governmental costs, but it asks relief from the shackles of restrictive and confiscatory taxation. It is ready to resume its interrupted march toward restored prosperity if only Congress will loosen the bonds that now confine it. Only Congress can effect that release. It can do so only by revising restrictive taxation. And only the American people can prevail upon Congress to meet that appeal *and to meet it NOW.*

Congress needs *YOUR* guidance. Will you give it *NOW?*

James H. McGraw, Jr.

President, McGraw-Hill Publishing Co., Inc.

If private capital and business initiative are to take a leading role in recovery—then it is the obligation of the business and technical press to study ways and means by which this is possible; to keep business and industry currently informed; to mobilize opinion and to make that opinion felt and understood by the government, which has the power to obstruct or to encourage business and industrial progress. The McGraw-Hill Publications recognize that obligation. We are seeking in this editorial effort to provide an avenue through which our one million readers—America's business and industrial leaders—may indicate to the Congress the need to change the tax system so that industry can move forward more surely and rapidly.

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Opera on the Air

(*Continued from page* 31)

permanently installed in duplicate, also extend through the mixer. Also understage is an equipment rack mounting, besides the preamplifiers, the associated power and control equipment. A cabinet for storing spare microphones is located nearby.

Broadcasting activities center in the adjoining boxes 42 and 44 of the Grand Tier, at the rear of the house. The equipment rack, in the foyer of Box 44, houses duplicate high-gain studio amplifiers, four preamplifiers for the announcer's and commentator's microphones, line switching keys, telephone apparatus and jacks for terminating all circuits. This rack is permanently installed in one corner of the foyer and, when not in use, is covered by a red plush curtain in harmony with the Metropolitan's scheme of decoration. Also in the foyer of Box 44 is the announcer's table, removed from the noises of the audience. Milton Cross, the announcer, is provided with two microphones of standard studio (ribbon velocity) type.

The foyer of Box 42 is used as a miniature broadcasting studio during intermissions. Here it is that commentators and guests make their appearances. The equipment consists of standard studio type microphones and "Stand By" and "On the Air" lights for warning announcer and guests. On several occasions a miniature piano has been moved into this room for the use of a commentator in illustrating remarks on the day's opera.

The nerve center of the Metropolitan broadcasts is at the front of Box 44. Here all the equipment heads up in a ten-position mixer, specially designed and built for its present use. Each microphone of the stage installation is controlled by a "fader," the controls on the mixer panel being arranged in two pyramids at either side of the instrument to correspond to the position of the stage microphones. The only illumination permitted is a small cowl lamp to light the volume indicator.

The positions of engineer and announcer reverse the usual order. In the radio studio the announcer, in the presence of a controlled audience, needs no protection from audience noises. At the Metropolitan, however, the patrons move about and raise a hum of conversation during intermissions, so the announcer is shielded from the audience in the foyer of Box 44. In studio practice the engineer is located in the control booth, separated from the main studio by a thick plate glass. At the Metropolitan, on the other hand, the stage must be plainly visible so the engineer sits at the front of the box.

This, then, is the apparatus. A simple description of it clearly indicates that the work of broadcasting Metropolitan Opera demands more than a knowledge of circuits. A background of the operatic art and the technique of the stage are indispensable. NBC engineer Charles C. Grey is the veteran of grand opera broadcasting. His experience dates back to 1929 when NBC began broadcasting the performances of the Chicago Civic Opera. Two years later, when the Metropolitan series began, Grey was brought to New York. Eight years of experience have given him familiarity with the scores of most of the operas in the Metropolitan repertory.

Obviously, however, no man could be so completely acquainted with all of the details of all of the operas broadcast as not to require assistance from the score. And since the engineer must keep his eyes on the stage during a performance, a production man is needed. This man during the last season was Herbert E. Liversidge, a graduate of New England Conservatory and a singer of considerable experience. During the broadcast he sits beside the engineer with the score of the day's opera in an illuminated rack before him. Communication is maintained between the two by an elaborate and ingenious set of hand signals. A clenched fist raised, for example, indicates an orchestra crescendo; dropped, it means a diminuendo. Other signals tell of impending entrances, cues, stage action, and so on.

The NBC staff at the Metropolitan is rounded out by announcer Milton Cross and an engineer in the foyer of Box 44, a commentator and an engineer in the foyer of Box 42, an extra engineer for emergencies and another production man who might be described as a scout, in the wings of the stage. This last man must be thoroughly acquainted with Metropolitan backstage routine and also familiar with the half-dozen languages used by members of the Metropolitan stac. The information he receives is telephoned to the men in Box 44.

The work of broadcasting an opera performance begins several hours before the curtain rises. All apparatus for the two boxes, except that mounted on the rack, must be taken from storage, set up and checked. Ten minutes before two o'clock everything must be in order and final tests are made throughout the system as far as Radio City. Announcer Cross then opens the broadcast from the foyer of Box 44 with a description of the first act. Out of the corner of his eye he notices that the light at the front of the box is snapped off and he announces that "the house lights are dimming and in just a moment our conductor will appear in the orchestra pit." This information, of course, was indicated in the switching off of the light since Cross is not in a position to be aware of what is happening in the auditorium. The scout in the wings has warned the staff that the conductor has passed on his way to the pit.

Immediately the center of activities switches to the front of Box 44 where Grey and Liversidge take up the task of presenting what Cross has described. Here the wisdom of arranging the fader controls in pyramids at either side of the mixer is demonstrated, for Grey must work in the darkened auditorium. The conductor raises his baton, the overture begins and Grey, apprised of what comes next by Liversidge's hand signals, begins manipulating the faders singly and in combinations and listeners in Honolulu, Montevideo, San Francisco, Uganda and London settle down for another performance at one of the world's great centers of the operatic art.

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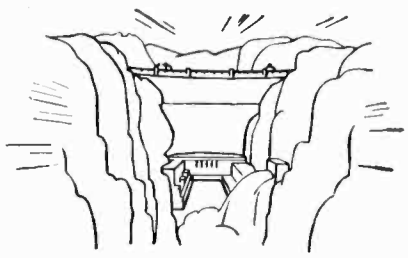

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Tubes at Work

(*Continued from page 36*)

grid current in the oscillator is a minimum is 12¾ inches.

Very short lengths of wire connected to the high voltage parts of the grid and plate of oscillator have surprising effects on the efficiency; for this reason, no superfluous leads or metal lugs or parts should remain connected to the grid and plate leads.

It will be found, in general, that the cathode as well as the heaters of the tube will be at a relatively high r-f potential. This means that chokes have to be used in the heater and cathode leads in order to obtain the best efficiency. Results are also improved by using by-pass condensers connected directly at the tube. The best condensers for this purpose are small midget type 0.00025 $\mu\mu$fd fixed condensers.

• • •

Regulator Maintains Voltage for Motion Picture Printers

By T. A. Reid and E. W. Morris

Industrial Division, Westinghouse Elec. & Mfg. Co., Los Angeles, Calif.

The daily printing of thousands of reels of motion picture film presents one of the most exacting requirements encountered in the application of electrical apparatus. The high speed at which printing is accomplished in the modern printer necessitates the use of a very constant voltage for the lamp from which the light exposes the positive stock, as it, and the developed negative film, passes the light aperture.

After a negative has been developed, it is tested for density and this test determines the light level to be used for making additional prints. Once the light source has been adjusted to a given intensity, no change is permitted while the print is being made. It is this necessity for a constant intensity of the light source that presents the problem. A typical installation may consist of seven to ten printers, each with two 500 watt lamps, all operating from a 10 kw. generator. Each printer is equipped with a rheostat in series with a lamp to establish the proper light level.

A serious change in load occurs when individual printers are turned on or off. Such a change in load materially affects the output voltage of the direct-current generators, even if compound wound. To maintain the constant voltage value which is essential for film printing procedure vibrating types of regulators have been used, but the inherent time lag due to the inertia of

moving parts and the fact that the low sensitivity of such equipment required a considerable change in machine voltage before the regulator functioned, has caused them to be abandoned.

Voltage changes of less than ½ volt plus or minus from normal were demanded, without hunting. These exacting requirements lead to the development of the electronic voltage regulator for direct-current generators. Upon applying it to this type of work in a number of different film laboratories, it was found that the required tolerances could readily be maintained or bettered.

The electronic regulator shown in the figure is instantaneous in its response to voltage changes at the terminals of the generator to which it is

Compact electronic regulator operating on less than one microwatt of control energy

applied. It is designed to operate on a control energy of less than one microwatt, which may be contrasted to a control energy requirement of approximately 100 voltamperes for the operation of most mechanical types of regulators. Quick response is obtained through the use of electronic tubes and the elimination of friction and inertia inherent with all mechanical regulators. The operation of an electronic regulator is simple. A slight voltage change detected at the terminals of the generator is applied to the grid of an amplifier tube, and a proportional correction immediately applied to the field current of the generator.

Two arrangements were developed, one in which the correction is applied directly to the field of the generators rated from 2 to 10 kw., and the other where the correction is applied to the exciter of a separately excited generator, as indicated in the figure. Where the separate exciter is used, capacities up to approximately 300 kw. can be regulated with this device.

The electronic regulator has ideal anti-hunting characteristics, the anti-hunting force being proportional to the rate of recovery of the regulated voltage and is zero when the regulated voltage is normal; the anti-hunting device does not affect the regulator calibration, and it is independent of the adjustment for regulated voltage and regulator response.

From the diagram it may be seen that a potentiometer voltage from the generator terminals is bucked against a battery, the voltage difference (approximately 2 volts) being applied to the grid of a voltage amplifier tube,

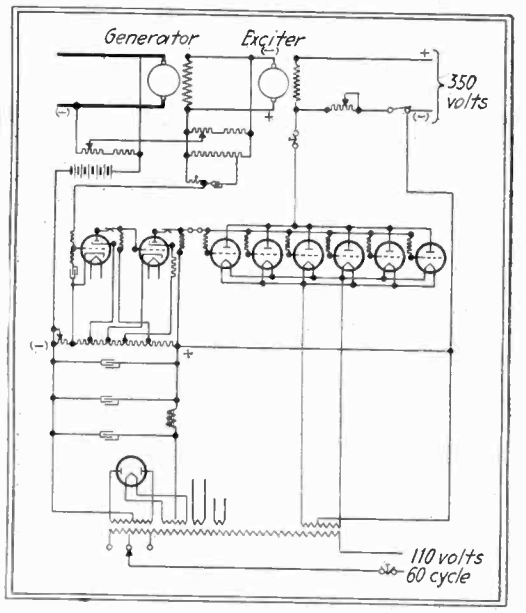
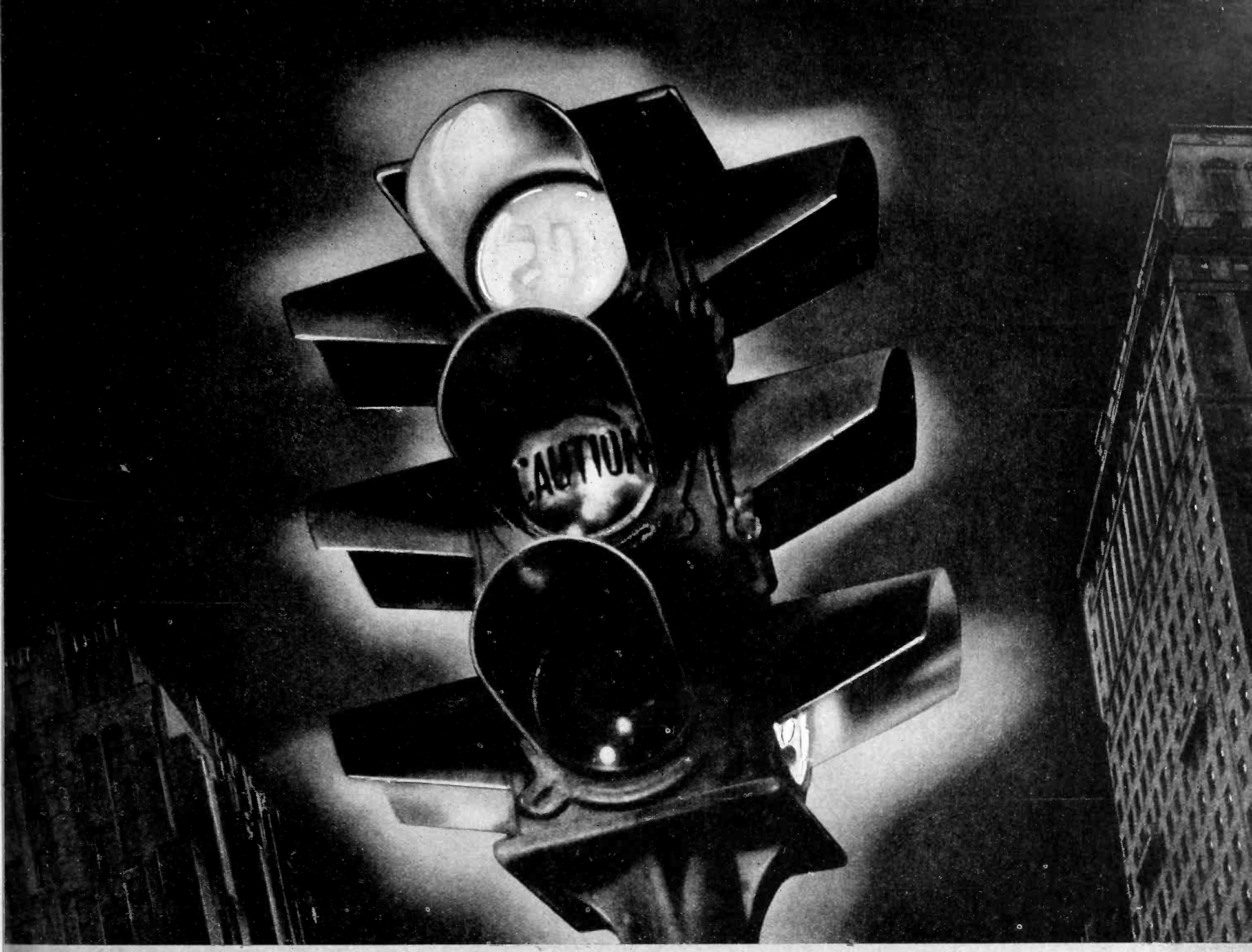


Diagram of electronic voltage regulator for d-c generators

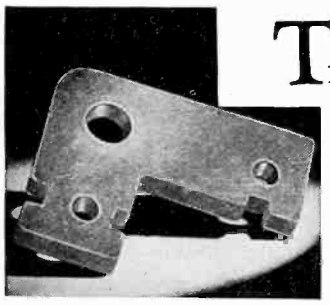
and the plate current from this tube is applied across a resistor to the grid of a second voltage amplifier tube, the output of this second voltage amplifier tube then being of sufficient magnitude to control the grids of six current amplifier tubes connected in parallel. These current amplifier tubes supply a portion of the field current of an exciter that is energized from a separate 350 volt d-c. supply. In this manner, voltage changes at the terminals of the generator as small as 0.1 or 0.2 volts are amplified through two voltage amplifier tubes until they are of sufficient magnitude to control the grids of current amplifier tubes that apply a corrective force to the field of the exciter.

A rectifier with filter provides a source of d.c. from an a-c supply for energizing the various elements of the tubes in the regulator. The regulator can easily be adjusted to be insensitive to changes in a-c voltage of plus or minus 5 per cent.

The anti-hunting device consists of a potentiometer across the exciter armature and a capacitor in series with a resistor. When the regulated voltage is normal, the exciter armature voltage is constant and the voltage drop across the resistor is zero. If the exciter armature voltage is changing



THIS EYE NEVER SLEEPS



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in order to correct a variation in the regulated voltage, there will be a voltage drop across this resistor. The polarity of this voltage drop depends upon whether the exciter voltage is increasing or decreasing, and the magnitude of the voltage drop will be proportional to the rate of change of the exciter armature voltage. The anti-hunting connection is not made if an exciter is not used, and the field of the generator is supplied from a separate source of 350 volts d.c. to which the corrective action of the regulator is applied.

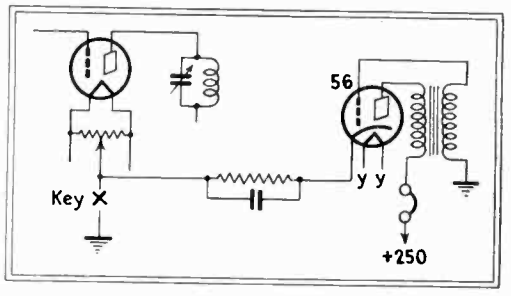
• • •

Keying Monitor for C-w Transmitters

By Henry Perozzo

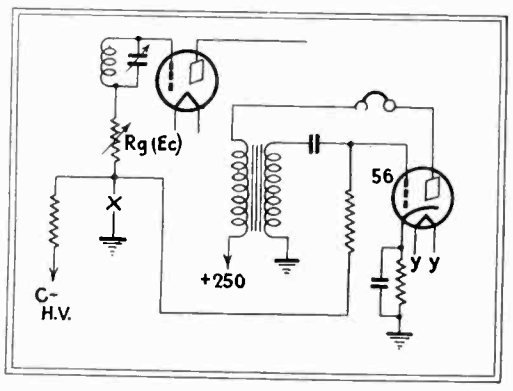
Braniff Airways, Oklahoma City

A KEYING MONITOR having clear characteristics, and which will operate automatically without switching between receiving and sending periods is a distinct aid toward good keying, particularly when traffic is heavy, and the



Center tap keying circuit

operator cannot bother to switch his receiver, or other monitor. Relays and an audio oscillator answer the purpose, but the modern trend is to incorporate keying systems which do not



Keying in the grid circuit of power tube

use relays. The circuit shown can be used in most cases with very little change in the equipment used. In the first circuit, because of the high voltages involved, a separate filament transformer is usually necessary for the keying tube, but when the grid circuit is keyed, a case that is rather difficult to monitor in any other simple manner, the second circuit proved out admirably.

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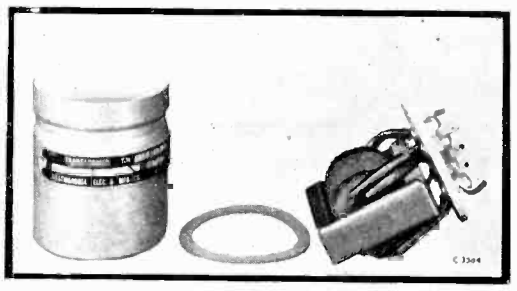
Audio Transformers Sealed in Aluminum Cans

By REUBEN LEE
Westinghouse Elec. & Mfg. Co.
Chicopee Falls, Mass.

THE OLD DIFFICULTY of protecting small transformers against tropical humidity conditions recently has been solved by the use of the familiar aluminum condenser can. Obvious advantages of this type of can are: There is only one joint to seal, the can is very light, and it is inexpensive because of the enormous quantities used in condenser manufacture. This method is one of the unusual cases where a better product turns out to be easier to make, once the proper manufacturing facilities are set up.

The principal parts of such a transformer are displayed in the figure: the can, gasket and electrical parts unit. Some care naturally has to be given to these constituents. The gasket material is a cork and synthetic rubber compound, providing strength and sustained resilience. The terminal board is made of a non-hygroscopic ceramic, and the terminals must be very carefully soldered to avoid blow holes. All terminals are sealed by individual gaskets and special non-absorbent varnish filler. By mounting the terminal board on the core before the complete assembly is done, manufacture is much facilitated. The electrical parts unit is dropped into the can, the terminal board resting on the formed ledge. After being coated with varnish filler,

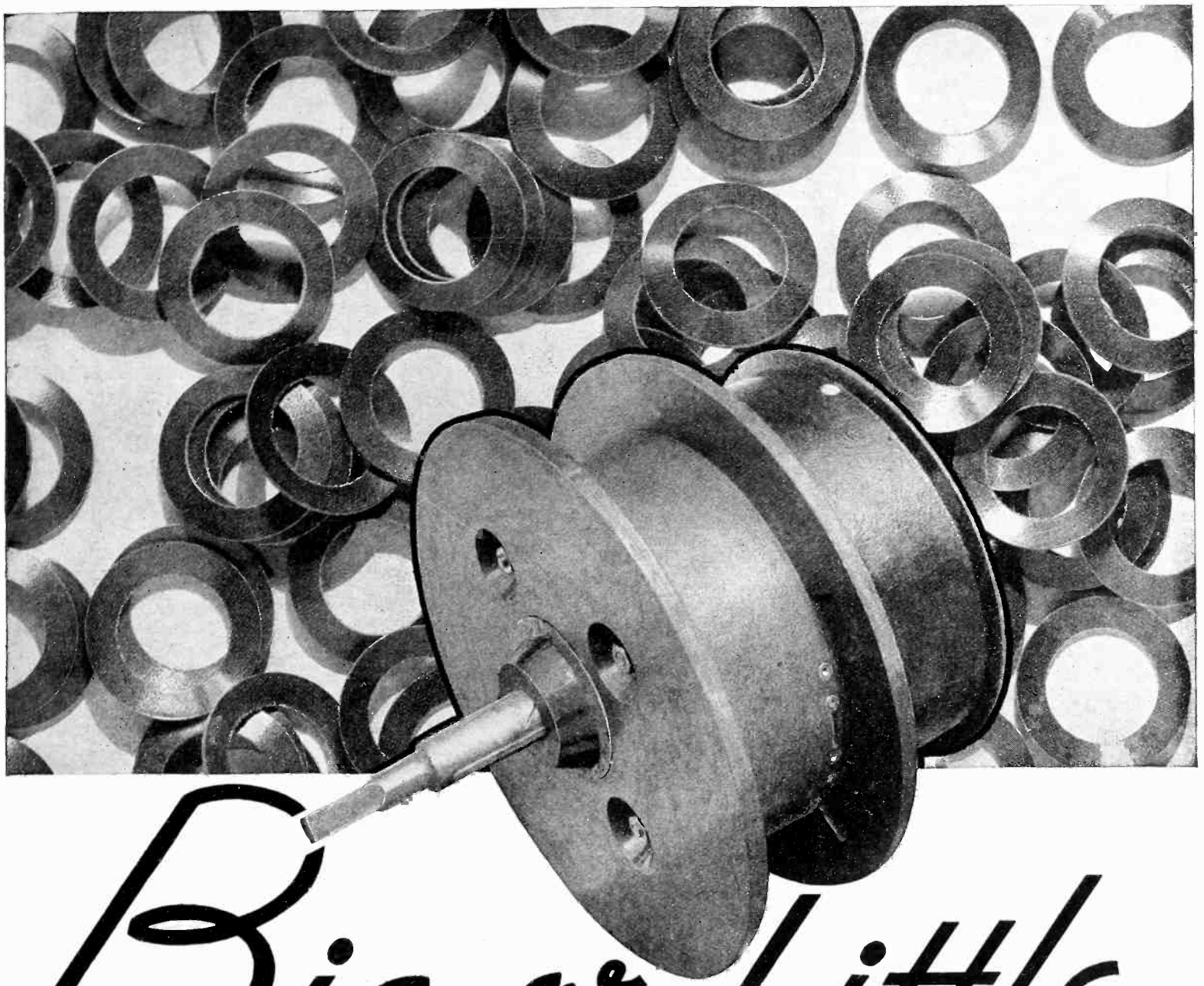


Shield can and transformer

the gasket is placed on the terminal board, and the transformer is ready for spinning.

Spinning the top of the can likewise calls for some care. It must be uniformly done, else the can or the terminal board will crack. The edge of the can must penetrate the gasket without mutilating it, and must penetrate evenly to produce a tight seal. This difficult operation is performed readily by using a drill press fixture having adjutable rollers, which rounds the edges of the can down the requisite amount with but slight pressure from the operator's hand.

After spinning, the seal is given a final coat of varnish and the transformer is baked to drive off the solvent in the seal. Samples are subjected to a severe cyclic humidity test, and no failures traceable to the seal have occurred.



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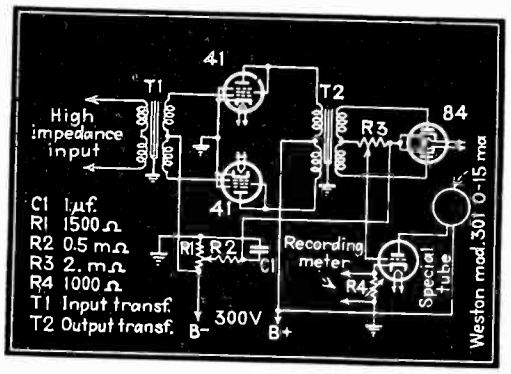
Transmission Measuring System

IN THE JULY 1937 issue of the *Journal of the Society of Motion Picture Engineers*, W. W. Lindsay, Jr., describes a "Transmission Measuring System Utilizing a Graphic Recording Meter." The equipment described may be used to make gain-frequency runs on communication equipment, as a recording microdensitometer, a recording volume indicator or for making records for various transient phenomena. The output of the pick-up is sufficient to operate a 5 milliampere Esterline Angus recording meter.

In order to obtain the logarithmic response connecting the input and output of the system, the author has developed the simple circuit shown. This circuit requires the use of a special triode in which the plate current and grid bias bear a logarithmic relation to one another. The author indicates that the usual variable μ or exponential control types of tube do not follow this characteristic accurately or over a sufficient range to be of much value. Essentially, the circuit consists of a push-pull class A amplifier which terminates in a full-wave linear rectifier. Linearity of the rectifier characteristics is assured by making the external load resistance large compared with the tube conductance. The negative bias voltage produced as a result of signal rectification is applied to the grid of the triode. With this arrangement the plate current of the special triode is a logarithmic function of the signal voltage applied to the class A push-pull amplifier.

The power range of this system is limited by the ability of the class A amplifier to supply signal voltage to the rectifier without overloading. It is also limited by the tube parameters of showing the special logarithmic triode. The author shows a curve in which a range of 40 decibels has been obtained. It should be possible to extend this range considerably through the use of several similar cascaded stages. The reader should also consult F. V. Hunt, *Rev. Sci. Instruments*, December, 1933.



Schematic wiring diagram of the recording transmission system

Compensating Circuit for Blocking-Layer Photoelectric Cells

A COMPENSATING circuit comprising two blocking-layer photoelectric cells in a parallel combination with galvanometer and voltage dividing rheostat is described by Brooks A. Brice in the August issue of the *Review of Scientific Instruments*. Analysis of the compensating circuit shows that a uniform scale attached to the rheostat may be used to indicate transmission of light by a sample if the resistance of the potentiometer and series internal resistance of the cells are small in comparison with the parallel internal resistance of the photoelectric cell. With moderate illumination on the photoelectric cells and using a 50-ohm potentiometer rheostat, carrying the scale from 50 to 100, errors in indicating transmission are believed to be not greater than ± 0.1 on this scale.

Listing of Cathode Ray Tubes

AN INTERESTING and useful listing of commercial cathode ray tubes is given by Ralph R. Batcher in the October issue of *Instruments*. This list gives characteristics on about 40 vacuum and gas type cathode ray tubes made by DuMont, General Electric, General Radio, Hygrade Sylvania, National Union, Radiotron Division of RCA, Western Electric and Westinghouse.

Recording Resistance Welder

[Continued from page 17]

by the application of voltage to the reactance of the secondary in advance of the power-factor angle, and the reduction of secondary current on the positive half-cycles caused by internal voltage drop due to the exciting current transient.

The pick-up coil method may be further simplified by eliminating the air-core coil and using the reactor L as both pick-up coil and reactor. Figure 6 shows an oscillogram of this method of recording, and Fig. 2 shows the diagram of connections. Vibrator V_2 on the secondary of a current transformer was added to compare the three methods of recording. The shunt across V_1 is a 25-ampere oscillograph shunt, that across V_2, a 1-ampere shunt on the secondary of a 100:1 current transformer, and the pick-up reactor L is a type 9XD-83A1 reactor manufactured by the General Electric Company. The reactor must be placed relative to the secondary circuit of the welder so that the current flowing in the vibrator shunting the reactor is just sufficient for a good deflection. Too strong a field will saturate the iron of the reactor and cause distortion in the recording. This is a disadvantage when used on a welder having a wide range of operating currents as the reactor position must be shifted to cover the range without introducing distortions from saturation. However, if the reactor is mounted so as to permit rotation through a 90 degree arc, this method of pick-up will cover a large range of currents.

Application of Pick-up Coil Method

Since the calibration of the pick-up coil method depends upon the mutual inductance between the secondary circuit and the pick-up coil, it is necessary to calibrate the equipment after it is attached to the welder. The secondary current at low heats, with the electrodes shorted, may be fairly accurately determined by multiplying the steady-state primary current by the turns ratio of the welder transformer for the corresponding heat setting. A measurement of the oscillograph deflection for a known secondary current provides a reasonably accurate over-all calibration. A tapped pick-up coil provides a convenient means for varying the calibration to suit the different operating currents of the various welder sizes. Figure 5 shows such a coil in position on 150-kva welder. The coil consists of 800 turns of No. 25 enameled wire wound on a 2-inch diameter tube 3 inches long and tapped at 200 and 400 turns. The reactor used in series with the vibrator and coil was the General Electric type 9XD-83A1. This reactor is rated one henry with 0.3 ampere d.c. through the winding and weighs about one pound. The pickup coil described above weighs about ten ounces so the entire accessory equipment for a PM12 oscillograph weighs about one-fifth that of a standard 500-ampere "clamp-on" current transformer.

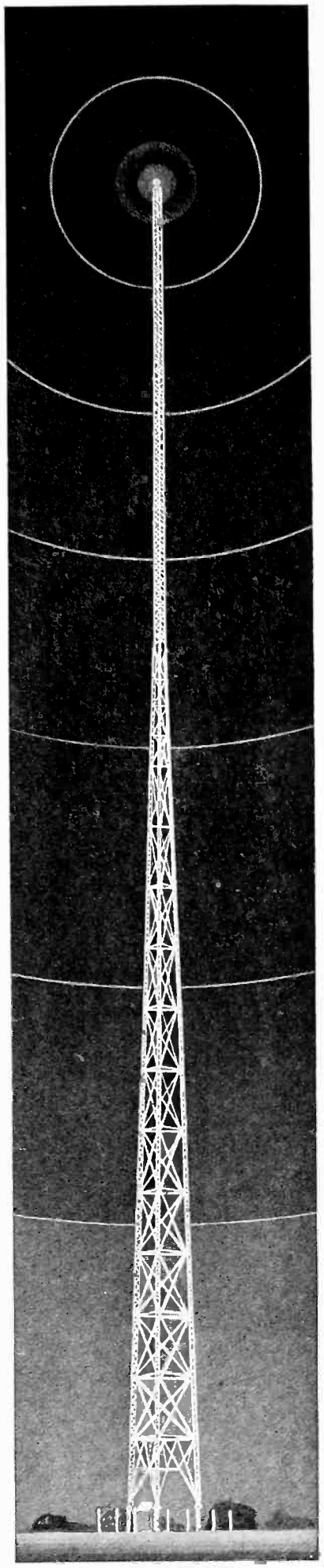
STATION	LOCATION	TOWER HEIGHT
WDOD	Chattanooga, Tenn.	320'
WADC	Akron, Ohio	350'
WLW	Cincinnati, Ohio (2 towers)	322'
WDGY	Minneapolis, Minn.	184'
KGHL	Billings, Mont.	558'
WSVA	Harrisonburg, Va.	182'
WTMV	E. St. Louis, Ill.	154'
WMFE	New Britain, Conn.	185'
KTRH	Houston, Texas	375'
WBNX	Cliffside, N. J. (2 towers)	235'
WIS	Columbia, S. C.	352'
WIS	Columbia, S. C.	260'
WOKO	Albany, N. Y.	180'
WGAR	Cleveland, Ohio	374'
WCOP	Boston, Mass.	227'
WELI	New Haven, Conn.	281'
WJAX	Jacksonville, Fla.	281'
WEMP	Milwaukee, Wisc.	173'
WJJD	Mooseheart, Wisc.	281'
WREC	Memphis, Tenn. (2 towers)	410'
KOMO	Seattle, Wash.	570'
KFBK	Sacramento, Calif.	334'
WDRC	Hartford, Conn.	308'
WFBC	Greenville, S. C.	375'
KBTM	Jonesboro, Ark.	189'
WIBA	Madison, Wisc.	430'
WIBA	Madison, Wisc. (2 towers)	195'
WTAQ-WHBY	Green Bay, Wisc. (4 towers)	196'
WDAE	Tampa, Florida	238'
WFMD	Frederick, Md.	257'
WSAI	Cincinnati, Ohio	225'
WHBL	Sheboygan, Wisc.	285'
	Canton, China	622'
WSPR	Springfield, Mass.	222'
KFEL	Denver, Colo.	285'
WROK	Rockford, Ill.	238'
WAAF	Chicago, Ill.	231'
WCLO	Janesville, Wisc.	259'
WSIX	Nashville, Tenn.	195'
KFPY	Spokane, Wash.	466'
WSBC	Chicago, Ill.	195'
WTRC	Elkhart, Ind.	174'
	Tallin, Esthonia	645'
WKY	Oklahoma City, Okla.	285'
KMA	Shenandoah, Iowa	488'
KWYO	Sheridan, Wyo.	187'
KRSC	Seattle, Wash.	218'
WNBF	Binghamton, N. Y.	227'
WORL	Boston, Mass.	308'
WCBM	Baltimore, Md.	231'
KLRA	Little Rock, Ark.	300'
KVI	Tacoma, Wash.	444'
KID	Idaho Falls, Idaho	330'
WGRC	New Albany, Ind.	231'
WIRE	Indianapolis, Ind. (2 towers)	330'
WTAD	Quincy, Ill.	280'
WDWS	Champaign, Ill.	152'
KOBH	Rapid City, S. D.	174'
WILL	Urbana, Ill. (2 towers)	333'
WEEI	Boston, Mass. (2 towers)	364'

POLICE TOWERS

WMP	Framingham, Mass. State Police	220'
WQPS	Springfield, Ill. State Police	338'
WQPC	Chicago, Ill. State Police	338'
WQPP	Pontiac, Ill. State Police	338'
WQPG	Sterling, Ill. State Police	338'
WQPM	Macomb, Ill. State Police	338'
WQPD	Duquoin, Ill. State Police	338'
WQPF	Effingham, Ill. State Police	338'
KACD	Atlantic, Iowa State Police	227'
KACC	Fairfield, Iowa State Police	227'
W9xHG	Terre Haute, Ind. City P. D.	154'
	Boston, Mass. City P. (3 towers)	132'
	Oregon State P. D. (8 towers)	120'
	Dept. of Commerce Lighthouse Service, New York	125'
	Montgomery, Ala. Police Dept.	95'

ERECTED IN 1937

WHDL	Olean, N. Y.	308'
KDKA	Pittsburgh, Pa.	710'
KFEQ	St. Joseph, Mo.	330'
WFOY	St. Augustine, Fla.	200'
WSMB	Algiers, La.	375'
KGLO	Mason City, Iowa	290'
WRBL	Columbus, Ga.	210'
KRNT	Des Moines, Iowa (2 towers)	194'
WGR-WKBW	Buffalo, N. Y.	400'
WCAX	Burlington, Vt.	250'
WXYZ	Detroit, Mich.	277'
WATL	Atlanta, Ga.	154'
KGW	Portland, Ore.	625'
KOIL	Council Bluffs, Iowa	308'
KSFO	San Francisco, Cal.	350'
KSRO	Santa Rosa, Cal.	190'
WKBN	Youngstown, Ohio	344'
WEDC	Chicago, Ill.	210'
KPQ	Wenatchee, Wash.	174'
WIND	Gary, Ind.	359'
WAGA	Atlanta, Ga.	375'



STATION	LOCATION	TOWER HEIGHT
WCBD	Elmhurst, Ill.	410'
KPFA	Helena, Mont.	160'
WICA	Ashtabula, Ohio	217'
WJDX	Jackson, Miss.	340'
KICA	Clovis, New Mexico	179'
WCOC	Meridian, Miss.	273'
WOAI	San Antonio, Texas	425'
WRC	Washington, D. C.	400'
KGVO	Missouli, Mont.	220'
WOMI	Owensboro, Ky.	185'
KOTN	Pine Bluff, Ark.	154'
KFYR	Bismarck, N. Dakota	700'

POLICE TOWERS

WPFW	Northampton, Mass. State Pol.	218'
KGHO	Des Moines, Iowa Bur. of Invest.	227'
KNFN	Cedar Falls, Iowa Bur. of Invest.	135'
	Niagara Falls, N. Y.	110'
	Tampa, Fla. Police Dept.	94'
WMDZ	Indianapolis Police Dept.	215'
WPDK	Milwaukee Police Dept.	225'
WPEC	Memphis Police Dept.	218'

THE ELECTRON ART

EACH month the world's technical literature is scanned to see what physicists and engineers are doing with tubes, for presentation in tabloid form to Electronics' readers.

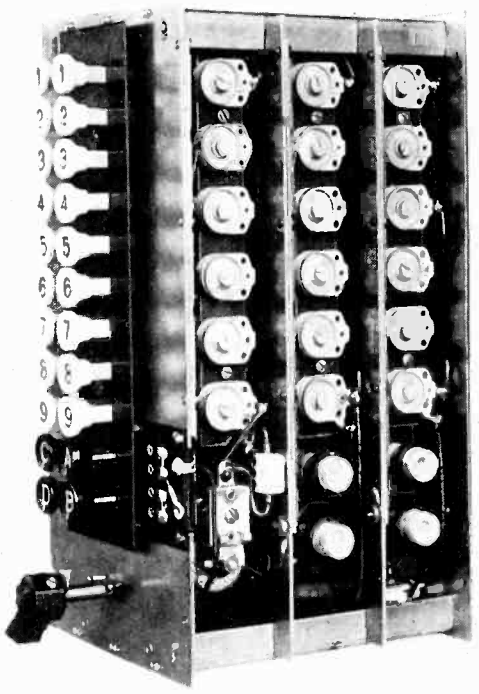
French Push Button Radio Receiver

ALTHOUGH PUSH BUTTON TUNING is one of the features brought out this year by American radio manufacturers, push button tuning has also received considerable attention in Europe.

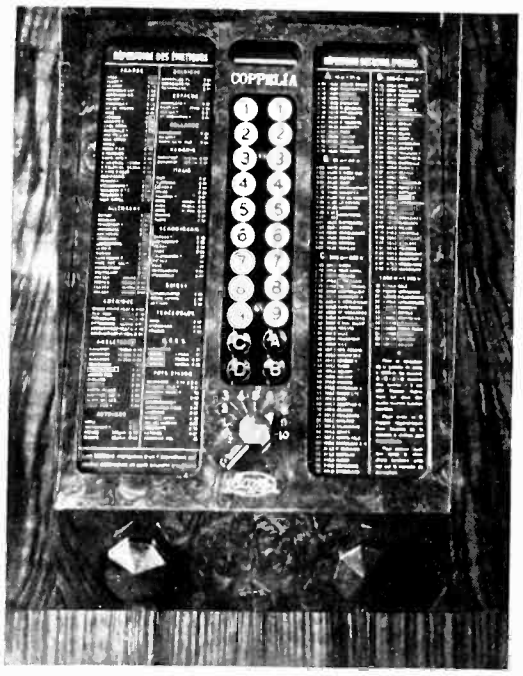
Shown in the accompanying photographs are views of the Coppelia automatic receiver of Electro-Construction S.A., at Strasbourg. Introduced in 1936, this receiver makes provision for automatic tuning of up to 150 stations by pressing down not more than two keys, one in each column. Selection of the correct wave band is attained by pressing down the keys A, B, C, or D, these four keys permitting the user to select five wave bands.

Advantages claimed for this French receiver are that selection is noiseless, stations can be identified easily at all times, the selector scheme used is stable and will withstand shipment, and finally no relays or motors are employed.

The construction of the automatic selector is relatively simple. Only eight fixed capacitors are necessary for each variable tuned circuit for station selection. In one of the photos showing the interior construction of the coil of the station selector unit, the first column of units nearest the push button are the oscillator coils and condensers. The corresponding elements for the high frequency amplifier are in the middle column, whereas those



Interior of the push button tuning assemble showing the coils, condensers, and trimmers



Panel of French push button tuned radio receiver showing the two rows of buttons by which stations may be selected. The four keys at the bottom, select the wave band

for the antenna circuit are at the column at the right. The coils are shown at the bottom of the illustration whereas the adjustable condensers are shown as the upper six adjustments in each column.

In operation, the time required to select a station is less than one second and as soon as the station has been selected, broadcast reception is instantaneous. The station selected can be identified at all times, the system can be used for remote control, and a change of the station wave length necessitates only an exchange of the scale without any technical manipulation. A supplementary code will serve to find broadcasting stations which are not indicated on the main scale as well as newly constructed stations.

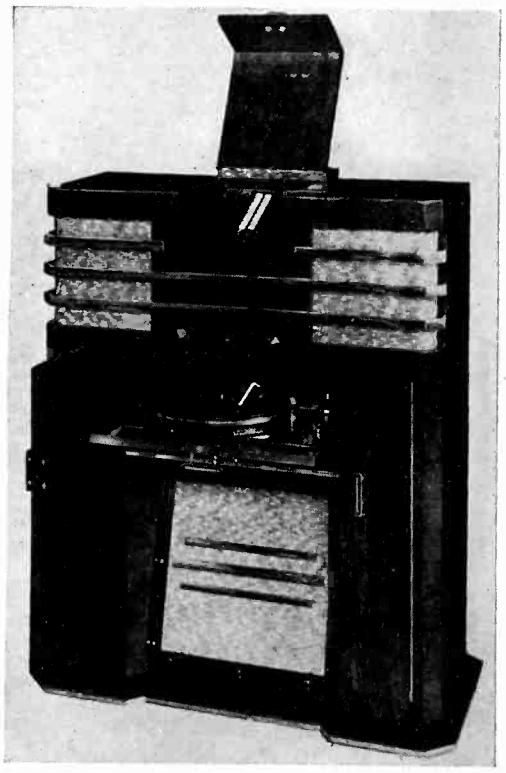
Production of Millimeter Waves

EXPERIMENTAL METHODS of production and applications of electromagnetic waves in the millimeter region are described by Neil H. Williams in the October issue of the *Journal of Applied Physics*.

One of the significant features of the work on short electromagnetic waves and described by Williams in his article "Production and Absorption of Electromagnetic Waves from 3 cm. to 6 mm. in Length" is that it opens a new region of the spectrum for quantitative study. It is pointed out that this region is not likely to be a very exciting one since, because it falls between that of the shorter electric wave and the longer heat wave, its properties may be estimated by interpolation.

For the production of these millimeter waves, magnetrons are used. Depending upon the wave length to be produced, the anode voltage varies from 800 to 1,400 volts. The magnetic field surrounding the tubes is adjusted almost to cut-off so that an increase of the potential of one-half of the anode will cause the electron stream to be deflected to that half. The potential of the other half of the anode is thereby reduced and the electrons are sent to the other half. Oscillations may thereby be set up whose frequency is dependent upon the time of flight of electrons between the two halves of the anode and the LC constants of the tuned circuit attached to the tube.

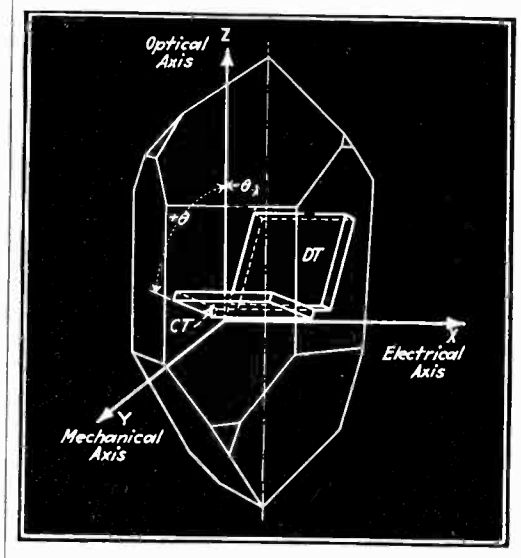
In the magnetron used for production of the shortest waves, the radius of the anode is only two-tenths of a millimeter and the Lecher system attached to it is less than 4 mm. in length.



Phonograph-radio combination with "cash register" push button tuning

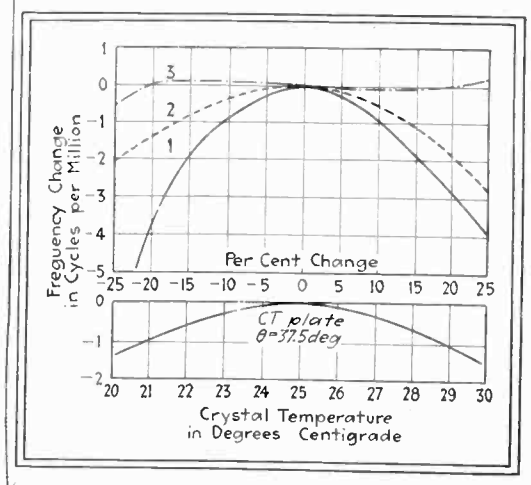
Standard Frequency Quartz Plates

EVER SINCE the fundamental work of Cady, Pierce and Miller in applying quartz crystals to stabilize the frequency of vacuum tube oscillator, the search for improved frequency stability has continued. In an article "Quartz Plate for Frequency Sub-Standards," F. C. Hight describes some new experiment in the September issue of the *Bell Laboratories Record.*



Orientation of zero temperature-coefficient quartz plates

Developed for use at frequencies lower than the common broadcast spectrum, the new CF and DF cut crystals developed by the Bell Laboratories have several advantages over former cuts. The frequency of these new quartz plates may be either raised or lowered by simple abrasion and the temperature coefficient may be changed either positive or negative by abrading the faces so as to alter effectively the orientation of the cut a slight amount with regard to the crystal axis. These two adjustments enable a plate to be precisely adjusted to frequency, so that slight errors in large scale production methods may be counteracted if necessary.



Stability with variations in (1) feedback, (2) plate reactance or (3) applied voltage

For operation at room temperature, the angle of cutting for the CT plate should be +37°30′ with respect to the Z axis. With this type of cut the frequency will be maintained to within one part in a million of the desired value for a variation in temperature of from 20° C. to 30° C. Even less frequency variation occurs for the type DT cut.

The article concludes with a graph which shows that the temperature is maintained to within one part in a million for the CT cut plate with an operating temperature of 25° ± 5° C. For the CT cut plate, the frequency change is considerably less than one part in a million for any normal voltage variations which are likely to be encountered. A change of frequency of one part in a million may result from a 15 per cent change in the feedback capacity, or by a 17 per cent change in the reaction of the plate circuit.

The net result is that the new type of plate can be used as a sub-standard without requiring the elaborate voltage compensating and temperature regulating devices which have been standard equipment on most of the better crystal control frequency standard installations.

• • •

Nine Audio Channels on Single Carrier in Scotch-Irish Telephone Circuit

MAKING USE of the ability of ultra high frequency transmitters to modulate over a wide band of frequencies, engineers of the British Post Office have recently put in service an ultra high frequency radio link between Belfast, Ireland and Stranraer, Scotland which transmits nine telephone conversations simultaneously over a single carrier. The main carrier operates on a frequency of 76 megacycles. This carrier is modulated over a side band 150 kc. wide. Each side band is divided into nine channel frequencies separated by 15 kc. Each of these channel frequencies is in turn modulated at audio frequency (maximum frequency about 3,000 cycles). The system in effect employs double modulation, the main carrier being modulated by a system of "channel frequencies" which in turn are modulated at audio frequencies.

The receiver, of the superheterodyne type, employs a bank of nine selecting circuits operating as band-pass filters to separate the individual channel frequencies, which are then detected and delivered to the nine audio channels. Both the transmitter and the receiver are crystal controlled to maintain the necessary constancy of frequency. For the reverse-direction circuit the nine channels are transmitted on a carrier frequency of approximately 83 megacycles. The transmitted and received waves are polarized at right angles to each other, to minimize mutual inter-

electronics

Catalog & Literature Service

Manufacturers' literature constitutes a useful source of information. To make it easy to keep up to date, "Electronics" will request manufacturers to send readers literature in which they are interested. Merely fill in the card—we do the rest.

1. Receiving Tubes. Technical information has recently been made available by the RCA Manufacturing Company, Harrison, N. J., dealing with the 6U7-G triple grid super-control amplifier, the 6ZY5-G high vacuum full wave rectifier, and the 6AC5-G high new power amplifier triode.

2. Test Equipment. A condensed catalog of measuring and testing instruments for laboratory design and quality control of radio frequency components and materials, and known as Bulletin A, may be obtained from the Boonton Radio Corp., Boonton, N. J.

3. Radio Specialties. A folder describing knobs, dial plates, miscellaneous radio parts and an electric clock giving standard or G.M.T. time is available from the Gordon Specialties Company, 440 South Dearborn Street, Chicago, Ill.

4. Microvolter. Designed to extend the frequency range previously covered by signal generators, so as to provide means for making reliable measurements for receiver sensitivity in the range from 20 to 100 megacycles, the model 18B microvolter has been developed by the Ferris Instrument Corporation, of Boonton, N. J., and is described in a 12-page bulletin.

5. Radio Condensers. A 6-page folder describes a new line of electrolytic and paper condensers for radio purposes manufactured by the National Union Radio Corp. Copies are available from the corporation at 570 Lexington Ave., New York City.

6. Resistors. Bulletin No. 37 describes the complete line of resistors from 1,000 ohms to 1 megohm manufactured by the S. S. White Dental Manufacturing Co., 10 East 40th St., New York City.

7. Instrument Bulletin. Bulletin GES-1092B available from the General Electric Co., Schenectady, N. Y., called "How to Select Instruments for Motor Testing."

8. Speaker Catalog. Catalog No. 937 describing in detail their new line of permanent magnet speakers has been released by the Cinaudagraph Corp., Stamford, Conn.

9. On Lamps. "How to Judge a Lamp" with a reading time of 12 min. 45 sec., is the title of a 16-page folder issued by the Westinghouse Electric & Manufacturing Co., Bloomfield, N. J.

10. Condenser Construction. The engineering news bulletin issued by the Tobe Deutschmann Corp., Canton, Mass., describes advances in condenser construction.

11. High Voltage Condensers. Pyranol distribution capacitors are described in an 8-page General Electric bulletin GEA-2561A. Copies are available from the General Electric Co., Schenectady, N. Y.

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12. Transformer Folder. A folder on various types of power and audio transformers is available from the Thordarson Electric Manufacturing Company, 500 West Huron Street, Chicago, Ill.

13. Permanent Magnets. A 16-page loose-leaf bulletin issued by the Taylor-Wharton Iron & Steel Co., Highbridge, N. J., describes the development, construction, theory, and properties of permanent magnets manufactured by this concern.

14. Resistant Finishes. "Chemical Resistant Finishes" and "High Resistance to Spots and Tarnish" are the subjects covered in two bulletins recently released by the Roxalin Flexible Lacquer Co., Elizabeth, N. J.

15. Metals Booklet. "The Haynes Stellite Library" a useful booklet published by the Haynes Stellite Company of Kokomo, Ind., lists and briefly describes eighteen books, reprints and folders dealing with hard facing alloys, cutting tools and alloys for chemical processing equipment.

16. Washing and Stamping. A new catalog bulletin entitled, "Over 20,000 Varieties," and describing their washers and stamping, has been published by the Wrought Washer Manufacturing Co., Milwaukee, Wis.

17. Industrial Cement. A 14-page bulletin describing the uses of a plastic, rubber cement known as "Flex-O-Fix" is available from the Frund Products Co., 43 E. Ohio St., Chicago, Ill.

18. Aluminum Booklet. A completely revised edition of the booklet "Machining Aluminum" containing detailed data on the machining of aluminum and its alloys is available from the Aluminum Company of America, Pittsburgh, Pa.

19. High Speed Heat Production. A 4-page folder entitled "High Speed Heat Production" describes a 10 kw. high frequency furnace for heating of metals with a minimum of time and contamination. It is available from the S. Corrugated Quench Gap Co., 107 Munroe Street, Garfield, N. J.

20. Electric Furnaces. Outlining the principles of operation as well as giving catalog information on commercially available equipment, Bulletin No. 11 of the Ajax Electrothermic Corporation, Trenton, N. J., deals with high frequency induction furnaces.

21. Chemical Products for Tubes. Information Bulletin No. 14 issued by the Lamp Division of the Westinghouse Electric & Manufacturing Co., Bloomfield, N. J., describes special chemical products for general industrial use.

22. Nickel Alloy Steel. Bulletin U-3 entitled "Nickel Alloy Steels for Hand Tools," is a 16-page bulletin giving technical information on the general subject of nickel alloy steels and their application. It is available from the International Nickel Co., 67 Wall St., New York City.

23. Sound Recorders. A 4-page bulletin describing the Presto Jr. sound recorder is available from the Presto Recording Corp., 139 W. 19th St., New York City.

24. Industrial Control Instrument. "Bristol's System of Coordinating Process Control" outlining methods to place the most intricate manufacturing process under complete automatic control, "Bristol's Electric Recorders" (bulletin 436) showing single and multiple voltmeters and ammeters for recording purposes, and "Bristol's Electronic Instagraph" (bulletin 476) outlining a method of temperature measurement using photoelectrically sensitive devices, are all available from the Bristol Company, Waterbury, Conn.

25. House Organ. *Sound,* makes its appearance in November as Vol. 1, No. 1, as house organ for the Bruno Laboratories of New York City.

26. Flexible Shafts. Flexible shafts, casings, and remote control drives are described in Bulletin 1037 issued by the S. S. White Dental Manufacturing Co., 10 East 40th St., New York City.

27. Power Pumps. A new line of duplex power pumps, for general purpose requiring pressures up to 800 lb. per sq. in. and capacities up to 187 g.p.m. is described in Bulletin 6130, issued by Fairbanks, Morse & Company, 900 South Wabash Avenue, Chicago, Ill.

28. Indicating Lamp. Bulletin No. 1037 of the H. R. Kirkland Company, Morristown, N. J., describes a complete line of indicating lamps, and signal indicators for industrial or communication purposes.

29. Stampings. Catalog No. 14 describes automatic stampings, terminals, lugs, and similar equipment for electrical purposes which is manufactured by the Zierick Manufacturing Corp., 385 Gerard Ave., New York City.

ELECTRONICS **December**

330 W. 42nd Street, New York, N. Y.

Please request manufacturers to send me, without obligation, literature identified by numbers circled below.

1	2	3	4	5	6	7	8	9	10	11	12	13	14
15	16	17	18	19	20	21	22	23	24	25	26	27	28
29													

NAME..... TITLE.....

COMPANY.....

ADDRESS.....

CITY..... STATE.....

YOUR FINAL CHANCE

Because orders for the 1937 set of electronic charts were continually arriving in large numbers we have postponed the publication date to December 20th.

If YOU have not already placed your order, do so NOW because sets will be printed for only the number of orders on hand.

Electronics Yearly Service was inaugurated at the request of subscribers for an opportunity to secure an extra set of the Reference Sheets that had appeared in all the issues during the current year. These will be printed on heavy stock, punched and ready for insertion in the notebook. Only bona fide subscribers as of publication date are entitled to secure this extra service.

The 1937 set will consist of 21 pages with the following Reference Sheets: Solenoid Inductance Chart — Resistance-Amplifier Data — Resistance Values for Multiple-Circuit Pads—Electronic Engineers' Library — Slide-rule Impedance Calculations — Universal Amplification Charts — Mutual Inductance Chart — Nuclear Physics Chart — Television Terms — Condenser Discharge Chart — Bars Compensation Design Chart — Class B R-F Amplifier Chart — Allocation in the Ultra-high Spectrum.

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ference between them. One of the features of the receiver are the special channel selecting circuits which must have extremely sharp characteristics to avoid crosstalk between the separate channels.

The equipment is designed for remote operation in unattended stations, controlled from the nearest telephone exchange. Complete duplicate equipment is provided in case of failure; this spare equipment is switched automatically into the circuit in the event of failure of the normal circuit. Extensive protective measures of this sort are necessary since all nine channels are lost if the equipment fails. For the same reason power supply is duplicated, an emergency Diesel-operated generator being switched in the event of failure of the public supply, within one minute of the failure. The equipment was installed and designed by engineers of Standard Telephones & Cables Limited, of London.

• • •

Re "Screens for Television Tubes"

MR. I. G. MALOFF, one of the co-authors of "Screens for Television Tubes" which appeared in the November issue calls attention to errors in the integration limits of Eq. (2) and Eq. (3) on page 34. Equation (2) should read

$$I_1 = N \int_{\theta=0}^{\theta=2\pi} d\theta \int_{\phi=48°}^{\phi=90°} \cos\phi \sin\phi \, d\phi$$

$$= 0.448\,\pi N \text{ lumens} \quad \ldots\ldots\ldots\ldots (2)$$

and Eq. (3) should read

$$I_2 = N \int_{\theta=0}^{\theta=2\pi} d\theta \int_{\phi=0}^{\phi=48°} c_0 \, \phi \sin\phi \, d\phi$$

$$= 0.552\,\pi N \text{ lumens} \quad \ldots\ldots\ldots\ldots (3)$$

• • •

Magnetic Recording

IN AN ARTICLE entitled "Magnetic Recording and Reproducing," by C. N. Hickman in the September issue of the *Bell Laboratories Record*, it is pointed out that during the past quarter of a century the failure of utilizing Poulsen's system of magnetic recording on a steel wire was due to a number of causes. In the first place the original experiment used round wire whose magnetic properties were not ideally suited to the intended purpose. Furthermore, suitable amplifiers were not available at the time the Poulsen system was invented.

Through the use of a very thin and narrow tape instead of a round wire, and the use of perpendicular magnetization (i.e. the magnet element in the tape had no appreciable component along the length of the tape) the Bell

trying to build a piano?

A piano has 18,000 parts — more than three times as many as are incorporated in an automobile. It contains 9,000 pieces of wood. The *action* requires 5,648 separate pieces.

That is a Complicated Job!

Here is a simple one!

The electronics field has six major divisions, namely: 1. The Radio Industry — 2. Broadcasting and Communication — 3. The Sound Industry — 4. Industrial Manufacturers — 5. Electrical Manufacturers — 6. Electrical and Testing Laboratories.

These six major divisions are divided into 16 important groups, namely: *Manufacture* (1) of home and auto radio, facsimile, television, phonograph — (2) of commercial communication equipment, broadcast, etc. — (3) Of non-communicating tube equipment including therapy — (4) of measuring equipment — (5) of components. *Operating companies* (6) in sound, records, pictures, public address — (7) in broadcasting — (8) in radio communication including amateurs — (9) in wire and cable communication. *Industrial companies,* such as (10) utilities—(11)metal mining and fabricating—(12) process industries — (13) transportation. (14) Universities and their laboratories. (15) Independent laboratories and consultants. (16) Government, State and Municipal executives and engineers.

Every important man and company in these groups — 12,000 of them, with 30,000 pass-on readers — study ELECTRONICS sales messages every month. There is no (dead) wood in this circulation, because they pay $5.00 a year for a publication they need in their $2,000,000,000 business.

Action in this field requires ELECTRONICS alone. No other single publication — NO GROUP OF PUBLICATIONS — can reach the buyers and influencers of purchase of products in fields allied to electronics with the depth of penetration, height of reader interest — and *economy.* We can prove it statistically — our advertisers prove it by *results.* It's easy to build business on the simple ELECTRONICS pattern.

add ELECTRONICS to your Sales Organization

Laboratories have developed a system in which magnetic recording and reproducing can be satisfactorily carried out. In this system, the wire or flat tape which is used is strongly magnetized before reaching the recording magnet, in a direction opposite to the magnetization to be given by the recording magnet. Because the two poles of the recording magnet on opposite sides of the wire are offset with respect to each other, the flux from each pole does not follow a straight line from pole to pole. Rather, it is distributed as indicated in Fig. 1. The flux line number 1 produces little or no effect

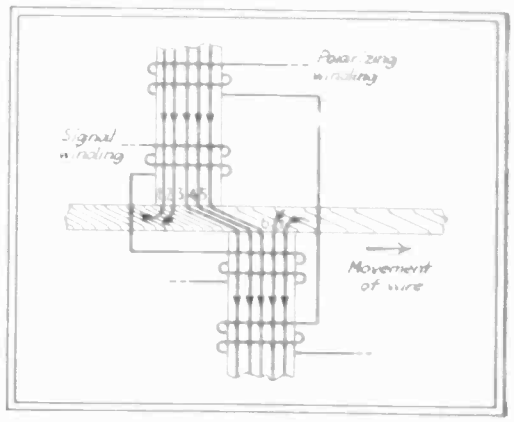


Fig. 1—Cross section of iron wire recording system

since it is approximately parallel to and in the same direction as magnetization already in the tape. However, since flux line number 2 is at right angles to this steady magnetization it reduces magnetic distortion in the tape. The flux represented by lines 3, 4 and 5 run diagonally across the wire from pole to pole. These would produce correct flux modulations in the wire if it were not for the distorting flux represented by line 2 already mentioned, and that represented by lines 6 and 7 which are similar in their effect to that represented by line 2.

An improvement brought about by the Laboratories consists of providing better magnetic material, in rolling it into a thin tape, and in properly heat-treating it. In the Bell Laboratories system shown in Fig. 2, the magnetizing portion of the polarizing poles is

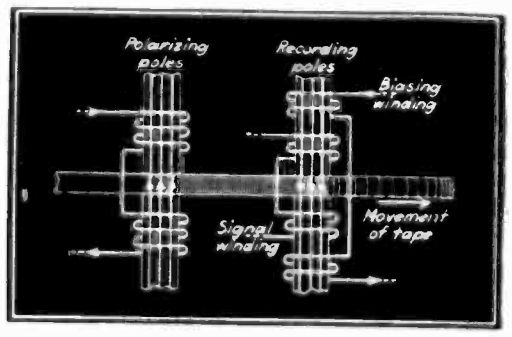


Fig. 2—Cross section of perpendicular magnitization method developed by Bell Laboratories

great enough to produce magnetic saturation of the tape as it passes between these two poles. As the tape moves from the polarizing pole the

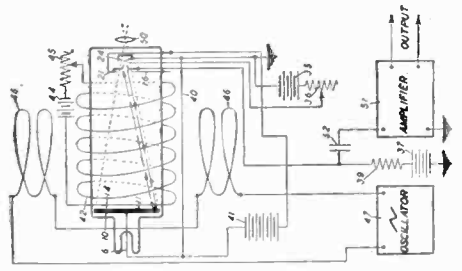
(*Continued on page* 58)

U. S. Patents

Television

Interference Prevention. Circuits for generating interfering signals along with picture signals and then getting rid of interfering signals. R. L. Campbell, RCA. No. 2,092,875.

Image Dissector. P. T. Farnsworth, No. 2,087,683. Image amplifier, No.



2,085,742; Multipactor, 2,091,439; Projection system, No. 2,091,705.

Generator. Saw-tooth wave producer. M. Bowman—Manifold, EMI. No. 2,097,334.

Braun Tube. Use of material having greater fluorescence than phosphorescence. M. Von Ardenne, D. C. Loewe, No. 2,096,986. See also No. 2,096,895 von Ardenne on a deflection system. Also 2,096,987, 2,096,988.

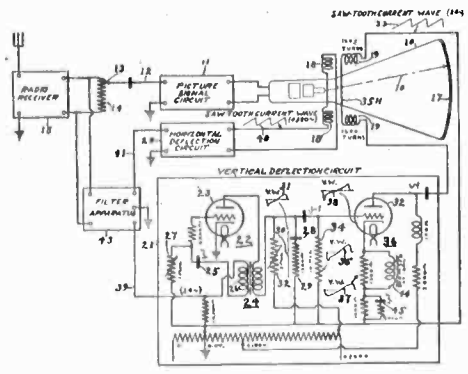
Saw-tooth Generator. Kurt Schlesinger, Berlin. No. 2,096,982.

Deflecting System. Electromagnetic system. T. Nakashima and K. Takayanagi, Japan, No. 2,093,157.

Synchronizing Impulses. R. C. Ballard. RCA. No. 2,093,395.

Deflection Circuit. A. W. Vance, RCA Nos. 2,085,402 and 2,093,177.

Reshaping Circuit. Method of reshaping saw-tooth waves so they will



pass through an inductive circuit without loss of shape. A. V. Bedford, RCA. No. 2,085,409. Also No. 2,092,871.

Amplitude Filter. Kurt Schlesinger, No. 2,097,804. Also No. 2,083,202 to Schlesinger on an arrangement for tilting oscillations. Also 2,083,205 on a safety means for television tubes.

Photoelectric System. Impressing an image on a photo sensitive surface, collecting the electronic emission to form an electrostatic reproduction of the image, causing an electron stream to be emitted from each point of the surface and causing the stream to be modulated by the electrostatic image. F. C. P. Henroteau, Ottawa. 1931, No. 2,083,995.

Scanning System. Cathode ray scanning. V. K. Zworykin. No. 2,084,364. RCA.

Level Control. Cathode Ray pick-up system. G. N. Ogloblinsky, RCA. No. 2,084,700.

Radio Receiver Circuits

Automatic volume control. No. 2,083,026, W. R. Koch; No. 2,083,025, W. R. Koch; No. 2,083,243, O. H. Schade and F. H. Shepard; No. 2,082,961, W. R. Koch; No. 2,094,902, G. L. Beers; No. 2,093,094 and 2,093,095, H. O. Peterson; No. 2,093,548, K. A. Chittick and W. L. Carlson; No. 2,097,281, K. W. Jarvis; No. 2,076,814 and 2,078,072, C. J. Franks, all to RCA. No. 2,077,045, C. K. Huxtable, Hazeltine Corp; No. 2,083,501, W. C. Lane, Hygrade Sylvania Corp.; No. 2,093,560 and 2,093,561 to H. E. Hollman, Telefunken.

No. 2,077,126, W. J. O'Brien; No. 2,048,738, P. O. Farnham; No. 2.055,891, E. T. Dickey; No. 2,072,283, H. A. Snow; No. 2,065,910, H. A. Snow; No. 2,085,068, G. L. Beers; No. 2,088,179, W. B. Roberts; No. 2,093,565, W. R. Koch; re-issue No. 20,442, Stuart Ballantine; No. 2,088,230, D. G. Burnside; No. 2,092,885, L. R. Kirkwood; No. 2,092,500, K. A. Chittick and No. 2,092,503, L. T. Fowler; No. 2,088,178, B. D. H. Tellegen, all to RCA.

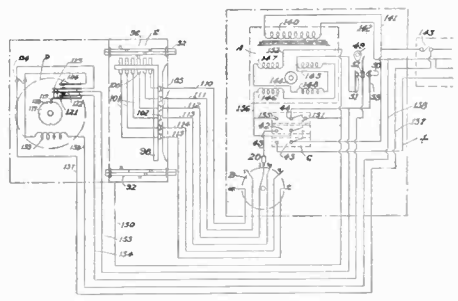
No. 2,088,206, Gunther Jobst, Telefunken; No. 2,085,928, S. A. Stevens and L. E. Thompson, Union Switch & Signal Co.; No. 2,093,564, Ernst Klotz and R. Rechnitzer, Telefunken; No. 2,072,740, D. P. Earnshaw, Philco.

Automatic tone or selectivity circuits. No. 2,076,812, P. O. Farnham, tuning selectivity control; No. 2,054,839, J. S. Starrett, automatic fidelity control; No. 2,073,504, Charles Travis, automatic tone control circuit to RCA. No. 2,074,852, combined volume and bass tone compensation control circuit, W. H. Nelson, G.E. Co.; No. 2,092,070, tone control, P. F. G. Holst; No. 2,069,869, automatic tone control, Jacob Yolles; No. 2,085,196, selectivity control system, W. R. Koch; No. 2,088,229, automatic fidelity control, R. A. Braden to RCA; No. 2,090,538, variable band coupling device for superheterodyne, H. J. Lyman, Philco; No. 2,091,134, G. L. Beers, Westinghouse, automatic fidelity control, filed 1929, 30 claims; No. 2,078,077, L. C. Hollands, RCA. automatic fidelity control. This circuit involves an i-f amplifier having a band pass characteristic designed to pass a maximum band of 12 kc. at 90 per cent of the resonance value, a second detector and a following second i-f amplifier tuned to a frequency substantially less than the frequency of the first and passing a band width of 4 kc. at 90 per cent of resonance. No. 2,077,466, automatic volume expander, John F. Dreyer; No. 2,078,762, automatic tone control, P. F. G. Holst; No. 2,094,073, tone control system, V. D. Landon; No. 2,083,232, automatic selectivity control, W. R. Koch; No. 2,054,892, automatic fidelity control, R. A. Braden, all to RCA.

Tuning Systems

Remote control. No. 2,091,681, E. B. Hansell, New York, N. Y.

Tuning apparatus. Clock-controlled mechanism. A. A. Thomas, RCA. No. 2,097,901.



Motor tuning. J. McWilliam Stone, Operadio Mfg. Co. No. 2,093,494.

Automatic frequency control. N. M. Rust, RCA. No. 2,097,937.

Automatic station selector. Frederick W. Kiena, West Brighton, N. Y. No. 2,097,330.

Automatic frequency control. M. G. Crosby, RCA. No. 2,065,565.

Resonance indicator. The following patents are on various means of indicating resonance: No. 2,080,646, H. A. Wheeler, Hazeltine Corp.; No. 2,087,652, H. D. Oakley, RCA; and No. 2,094,684, F. H. Shepard, Jr., RCA.

Noise Suppression Circuits. No. 2,078,055 to W. L. Carlson, RCA, on a.v.c. with noise suppression. No. 2,076,803, J. van Slooten, RCA, No. 2,088,210 W. R. Koch, RCA interstation noise suppressor. No. 2,096,625 Geo. M. Brown, G.E. Co.

(*Continued from page* 56)

magnetic force is reduced until, at a sufficient distance from the polarizing pole piece it is zero and the tape has only the residual flux density.

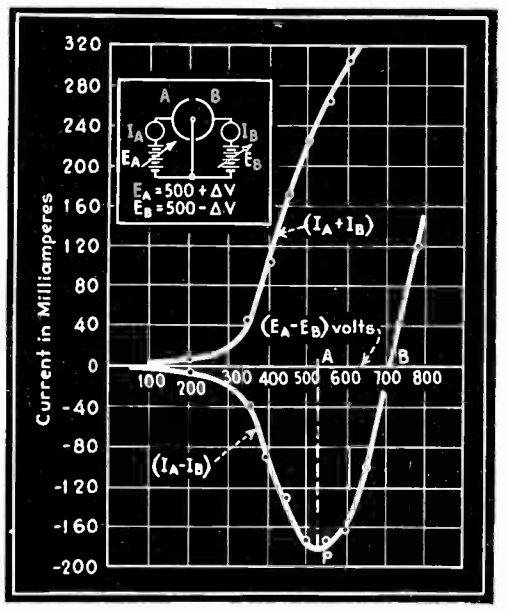
The bias windings on the recording magnets provide a magnetizing force opposite that of the polarizing magnet. The function of the bias winding is to demagnetize the wire strips in the absence of signal current flowing through the signal windings. In the presence of a signal the relation between the magnetizing force due to the current through the signal winding and the flux density is approximately linear so that distortion is minimized. With a constant tape speed, the rate of change in magnetization is proportional to the frequency of the recorded signal. Consequently, the response for a given signal voltage increases directly with the frequency, up to the point where the width of the pole faces approaches a full wave-length of the recorded sound after which the response falls off rapidly. The uncorrected frequency response curve of such a system is not very satisfactory and equalization is necessary to produce a curve which is sensibly flat between 100 and about 7,000 cycles per second.

• • •

High Frequency Magnetron Generators

IN A PAPER "The Magnetron as a High Frequency Generator" appearing in the October issue of the *Journal of Applied Physics*, a survey of the various types of magnetron generators is made by G. R. Kilgore with particular reference to their performance and limitations at ultra high frequencies.

After giving in some detail the various types of magnetron generators which may be used in the ultra high frequency region, and outlining some of the limitations of circuit and power output, the author concludes: "In one mode of operation where the oscillations depend on a static negative resis-



tance, the magnetron offers a means of generating larger amounts of power at wave lengths below 100 cm. than can be generated by any other type of vacuum tube generator at the present time. In another mode where the oscillation mechanism depends upon electron transit time, the magnetron offers a means of generating the shortest continuous radio waves.

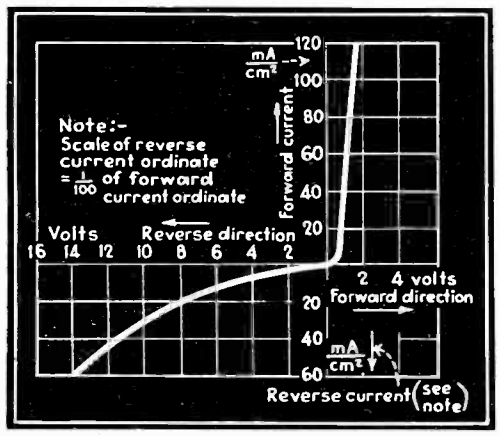
"The negative resistance magnetron is particularly useful in the range of wave lengths extending roughly from 100 cm. to 30 cm. Radiation cooled tubes of this type are capable of generating power of the order of 50 watts at a wave length of 50 cm., and special water cooled tubes can deliver more than 100 watts output at the same wave length.

"The transit time magnetron is useful in generating high frequency currents at wave lengths below 30 cm. Power output of a few watts can be generated at wave lengths around 10 cm. and dependable currents can be generated at wave lengths as short as a few millimeters."

• • •

Selenium Rectifier

FOR MANY YEARS the variation of resistance of selenium as a function of the impinging light flux has been known and has been utilized in a number of electro-optical applications. The use of selenium as a power rectifier is a more recent development but is rather thoroughly covered in the article "The Selenium Rectifier" by Erich Kipphan in the July issue of *Electrical Communication,* issued by the International Standard Electric Corp.



Selenium rectifiers were first used for charging storage batteries but were later used to supply direct current from the a-c main without the use of an intermediate battery. They have also been used to supply power for electro-acoustic systems, electroplating, or welding applications. They may also be used as spark quenchers for industrial circuits, for instrument rectifiers, as well as for detectors in high frequency work.

The article by Dr. Kipphan gives some rather complete curves and technical characteristics of selenium rectifiers and discusses the use of these rectifiers for various industrial applications.

FASTEST LENS ON MT. WILSON SPECTROGRAPH

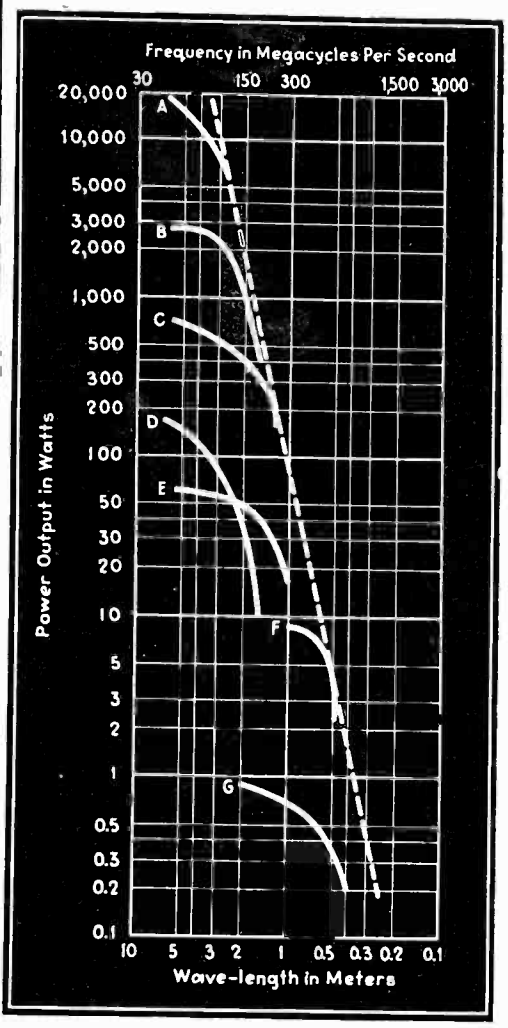
Dr. Milton Humason of the Mt. Wilson Observatory inspects the f/0.59 lens which has recently been installed on the astronomical spectrograph. It is believed to be the fastest photographic lens ever constructed, and has more than halved the necessary speed of exposure

• • •

Triodes Operated at High Frequencies

SOME OF THE FUNDAMENTAL limitations which appear at ultra high frequencies with negative grid three element tubes used as oscillators or power amplifiers are discussed by A. L. Samuel in the October issue of the *Journal of Applied Physics* under the title "Extending the Frequency Range of the Negative Grid Tube."

Although Barkhausen and magnetron tubes are finding extensive use in the ultra high frequency range as oscillators, amplification which is possible with the triode, together with ease of modulation and the improvements in design of high frequency triodes and similar negative grid tubes, leads the author to conclude that the negative grid tube will be able to meet the demands of the circuit designer for some time to come.



Power output versus wavelength for a number of commercially available and experimental tubes. All tubes show a sudden decrease in output at a critical frequency. The dotted line shows the present limit of high frequency operation of triodes.

Index to electronics — Volume X

January to December issues, inclusive, 1937

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FASTEST LENS ON MT. WILSON SPECTROGRAPH

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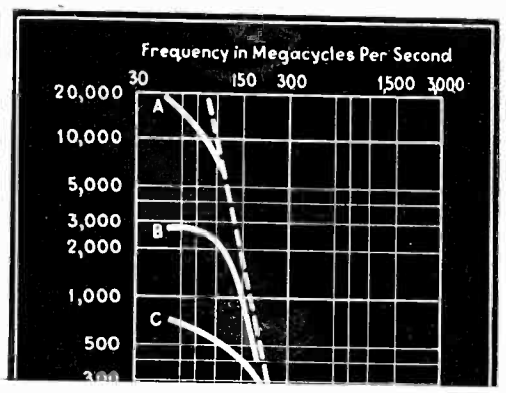

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* Illustrated.

AUTHOR'S INDEX

MANUFACTURING REVIEW

News

✦ According to an announcement made on Nov. 16 by David Sarnoff, president of the Radio Corporation of America, Ralph R. Beal, has been placed in the newly created position of research director of that company. For the past year and one-half Mr. Beal has been supervisor of the RCA television field tests. Mr. Beal's new duties will be to coordinate the activities of the research men in the various RCA subsidiary organizations and to guide all research activities so that there will be no duplication of effort. This step has been made necessary by the extensive research activities of the RCA and its affiliates which are being conducted at Camden and Harrison, N. J., Riverhead, L. I., as well as in various parts of New York City.

The new RCA research director is an alumnus of Leland-Stanford University and has been continuously active in radio engineering since 1912.

✦ Dr. Frederick Bedell, for many years professor of physics at Cornell University, has retired from teaching and will devote himself to research in the electronics field at Cornell as well as in the R. C. Burt Scientific Laboratories at Pasadena, Calif. In the electronics field, Dr. Bedell is perhaps best known for the sweep circuit which bears his name.

✦ In the decorative group of the second Modern Plastics competition which closed October 16, radio cabinets played an important part. A Kadette radio cabinet made of fiberloid by Paul Norris for the International Radio Corporation, of Ann Arbor, Mich., won second prize. Third honorable mention was given to a cabinet made of durez and beetle by the American Insulator Corporation for the Colonial Radio Corporation of Buffalo, N. Y.

✦ The Board of Directors of the Stewart-Warner Corporation declared an extra dividend of 25 cents per share on the capital stock of the Corporation in addition to the regular semi-annual dividend of like amount on October 23. Both were payable December 1 to stockholders on record November 5. At the same time, the Board announced that the consolidated net earnings for the first quarter of 1937 are equivalent to almost 44 cents a share of capital stock, an increase of approximately 6 cents a share over the 38 cents a share earned in a similar period of 1936. Net earnings for the third quarter of the current year amounted to $542,625, as compared with $469,795 for the third quarter of 1936.

✦ Completion of a new assembly plant, fully equipped for the manufacture of heavy industrial transformers has been effected and manufacturing operations are being carried out in it, according to an announcement by the American Transformer Co., 178 Emmett St., Newark, N. J. The new branch factory is at 273-301 Emmett St., Newark, and was built for the purpose of enabling the company to direct more intensive effort on the sale and manufacture of large transformers, including distribution and power transformers.

✦ Immediate construction of a fully modern, air conditioned plant, at a cost exceeding $125,000 is being undertaken by Motiograph, Inc., according to an announcement by Joeeph B. Kleckner, President. The new plant will be located at 4431 West Lake Street, Chicago, where Motiograph will have available complete facilities for the fabrication of amplifiers, horns and sound reproducer heads, and similar equipment. A research laboratory will also be included in the building.

✦ On November 11 Stewart-Warner Corp. announced the purchase of plant No. 2 of the Marmon Motor Car Co. at Indianapolis, Ind. By this purchase, Stewart-Warner acquired 22 acres of land and buildings aggregating 539,000 sq.ft. of floor space. All refrigeration manufacturing operations will be transferred from Chicago to this new plant in Indianapolis.

✦ A dividend of $1 per share, payable to common and preferred stockholders on record as of November 9 was declared by the Board of Directors of the Westinghouse Electric & Mfg. Co. recently. This is the fourth dividend declared this year, bringing the total up to $4 per share. Net income for the nine months was $16,726,520 as compared with $11,123,706, or an increase of 50 per cent over the corresponding period for 1936.

✦ Ellery W. Stone, in charge of the radio telephone and radio telegraph operations of the International Telephone & Telegraph Corporation and its subsidiaries, has been elected vice-president of All America Cables, Inc. Mr. Stone will be in active charge of the radio activities of that company throughout its system as well as of the radio communication activities of other I. T. & T. subsidiaries.

✦ Immediate construction of new broadcast studios for the National Broadcasting Company in Hollywood was recently announced by Lenox R. Lohr, NBC President, replacing modernistic studios erected only two years ago. The new site comprises approximately 5 acres, two city blocks square.

✦ Dr. Paul Dyer Merica, director of research of the International Nickel Company and vice-president of the International Nickel Company of Canada, has been awarded the 1938 John Fritz gold medal, highest of American engineering honors for "important contributions in the development of alloys for industrial uses."

✦ Crowded out of its present quarters in Upper Montclair by the rising volume of business and the positive indication of expanding applications of cathode ray tubes, the Allen B. DuMont Laboratories will move into their own factory building at 2 Main Avenue, Passaic, N. J., about the first of the year.

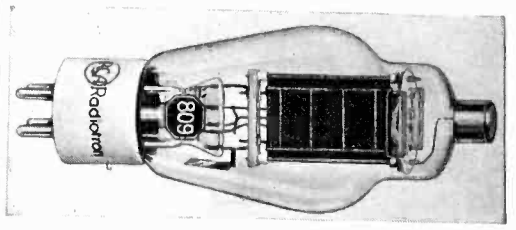
✦ Organized for the purpose of manufacturing high quality permanent magnet loud speaker units, the University Laboratories have recently opened their offices at 191 Canal Street, New York City. The company is prepared to do repair work as well as to manufacture equipment to order.

✦ Philco celebrated the manufacture of its ten millionth radio receiver by presenting this receiver to the Walter Reed Hospital, in Washington, D. C. on Armistice day. It was given to the veterans in the hospital by the Philco Radio & Television Corp. and presented by Boake Carter, radio news commentator. Replicas of the ten millionth Philco receiver were presented simultaneously with the Armistice Day ceremony at Walter Reed Hospital to the various veterans hospitals throughout the country.

✦ The election of G. A. Throckmorton, as president of RCA Manufacturing Company, Camden, N. J., was recently announced by David Sarnoff, president of RCA and chairman of the board of directors of the Manufacturing Company. Mr. Throckmorton had been executive vice-president of the RCA Manufacturing Company and the operating head following the retirement in April of E. T. Cunningham, former president.

25-Watt Triode

SUITABLE FOR OPERATION at maximum rated input at frequencies as high as 60 megacycles, and designed to provide high plate efficiency with low



driving power, the RCA Manufacturing Company of Harrison, N. J., announce the type RCA-809 transmitting triode. For class B service, the maximum plate dissipation is 25 watts.

I-F Transformers

A NEW LINE of standard intermediate frequency double tuned transformers has recently been placed on the market by the Meissner Manufacturing Company, Mount Carmel, Ill. Because of the wide range to which these transformers may be tuned, only four types of transformers are required to tune to any frequency from 121 to 650 kilocycles.

Portable Audio System

THE MODEL 108 portable public address system manufactured by the Operadio Manufacturing Company, St. Charles, Ill., is rated at 8 watts normal and 15

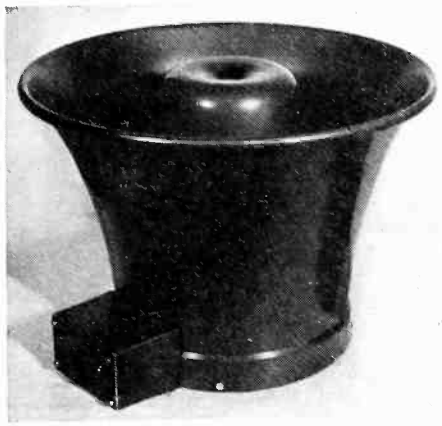
watts maximum. It is small, compact and adaptable to practically any use where a public address system is required.

Midget Volume Control

MIDGET VOLUME CONTROLS with 300 deg. effective rotation, and known as the series 37 and 37-F (with switch) have been recently released by the Clarostat Manufacturing Company, Inc., 285 North Sixth Street, Brooklyn, N. Y.

Marine Speakers

ESPECIALLY DESIGNED to operate under adverse weather conditions, such as on ocean-going ships, the marine speaker built by the University Laboratories,



191 Canal Street, New York City, is constructed to conform with the specification required by the Bureau of Marine Inspection and Navigation.

Radio Hardware

A COMPLETE LINE of small hardware assortments, intended for electrical, radio and automotive service shops and for home use by amateur craftsmen, is being brought out by the Insuline Corporation of America, 25 Park Place, New York City.

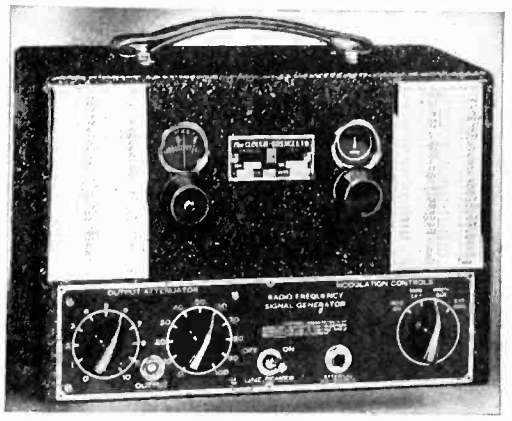
Loud Speaker System

DEVELOPED TO FILL the need for a superior quality speaker, economically, the Lansing Manufacturing Company, of Los Angeles, Calif., announces its

new Iconic loud speaker system. This system includes a high frequency unit for use up to 10,000 cycles and a multi-cellular horn which gives uniform coverage over an angle of 80 deg.

Signal Generator

THE MODEL 110 signal generator manufactured by the Clough-Brengle Com-



pany of Chicago features a direct-reading scale which may be used on any of the five-bands for which the generator operates.

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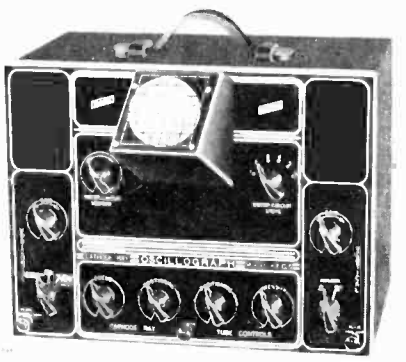
3-inch Oscilloscope

INTENDED FOR COMPLETE visual alignment and servicing of radio receivers



when used with any good frequency modulator or frequency modulated oscillator, the type RFO-5 3-inch oscilloscope is introduced by the Hickok Electrical Instrument Company of Cleveland, Ohio.

• • •

Plug-in Condensers

CONDENSERS THAT PLUG into tube sockets, thus making replacements and alterations as simple as tube changes,

are a new development introduced by the Tobe Deutschmann Corporation of Canton, Mass. The units fit a standard 4-prong UX type of tube space and are rated for operation at 475-volt d-c.

Rochester, 1937

(*Continued from page 15*)

due to tight coupling to the a-c source are automatically eliminated in substitution measurements by any resonance method. The errors are usually caused by residual inductance and resistance in the standard condenser (cf. Field and Sinclair, *Proc., I.R.E.*, Feb. 1936).

Vibrational Tube Analysis

A criticism was made by A. B. Oxley, RCA Victor, Canada, of the current method of testing for microphonics in vacuum tube production using the method of striking the tube envelope with a hammer and judging the acceptance limits either by aural or visual indicators. Although such impact tests do produce noise and show up the more flagrant cases of microphonics, the method is one in which the various elements vibrate at their own natural periods.

To investigate the causes of microphonics, as well as to provide a simple production test system which would detect tubes likely to produce trouble in use, a vibrating platform was arranged upon which the tube to be tested was mounted. The platform was vibrated about 0.001 inch by means of a dynamic loud speaker motor fed from a beat frequency oscillator, so that the tube could be vibrated at any audio frequency. The elements were connected to proper voltages and circuits and the plate current was observed as the frequency was varied. Whenever the beat frequency reached a point corresponding to a resonance of one or more of the elements in the tube, the plate current increased sharply. The resonance peaks were recorded on the screen of a cathode ray tube, and by setting upper limits on this screen, tubes could be rejected or accepted in a factory test.

It was found that similar tubes had very similar frequency-resonance patterns, most of whose peaks were very sharp. By connecting various elements, one at a time to the cathode, certain of these peaks disappeared. Those which disappeared were due to the element connected to the cathode. By a process of successive connection-to-cathode, it was

possible to determine the resonances of all of the essential parts of the tube.

Thomson and Headrick Discuss Electron Beam Focus

"Space Charge Limitation on the Focus of Electron Beams," delivered by Dr. L. B. Headrick, RCA Radiotron, discussed the effect of space charge on the focussing of beams of both circular and rectangular cross section in vacuum cathode ray tubes. It was shown that with the case of beams of circular cross section, the beam reaches a minimum cross section, is no where perfectly circular, and, beyond the minimum cross section, increases in area more rapidly than distance between the focal point and the screen of the tube. In the case of beams of rectangular cross section, it was shown that the minimum beam width may become zero at a certain distance from the tube, beyond which the width increases.

Negative Ion Components of the Cathode Ray

C. H. Bachman and C. W. Carnahan, Hygrade Sylvania, discussed a study of negative ion components made by using the cathode ray tube as a mass spectrograph. Photographs of the screen of the tube showed, by the deflection of the cathode beam, that there were a considerable number of negative ions within the tube. Those which were definitely or tentatively identified include C, O_2, CH_4, H_2O, H_3O, CN or H_2O_2, N or HCHO, and Ca.

Audio Curve Tracer

An audio frequency curve tracer, using the image formed on the screen of a cathode ray tube for producing the frequency response curve was described by J. B. Sherman, Radiotron. The frequency determining ordinate is a beat frequency oscillator actuated by a relaxation oscillator. The frequency of the b-f oscillator is made proportional (by the use of an a-f-c circuit) to the d-c voltage generated by the relaxation oscillator. As the relaxation and beat frequency oscillators are set going, a trace sweeps across the screen horizontally. The vertical deflection, or amplitude ordinates, are obtained from the

equipment under test. In the demonstration which was given, the amplitude was determined by a loud speaker, fed by the same beat frequency oscillator as actuated the cathode ray tube beam, and a microphone pick-up. The demonstration showed conclusively the various deep humps and valleys in the loud speaker output which were considerably "ironed out" when the microphone was placed very close to the speaker. A block diagram of the curve trace is given on page 15.

The equipment covered the entire audio frequency range, in either logarithmic or linear fashion, and a method was described in which any portion of the audio frequency spectrum could be expanded at the expense of some other portion, so that for special studies, interest could be given to a portion of the a-f band.

High Efficiency Modulation

The two methods of modulation discussed at the convention at first sight may seem to be decidedly similar. One, the Parker system described above was developed for the purpose of securing wide bandwidth for television purposes and the other the Dome system, for attaining higher efficiency than prevailing in conventional systems.

R. B. Dome, General Electric, attains high efficiency (of the order of 50 to 60 per cent) in a modulator by modulating both grid and plate. Positive peaks are taken care of by shifting the load line; negative peaks by modulating the grid of the output stage.

By an absorption circuit coupled to the antenna circuit, the load line can be changed. The current taken by this absorption circuit is rectified by tubes whose grids are modulated and the rectified current is put back into the power supply system thus reducing the power required. A circuit equivalent to a quarter wavelength line shunts the modulator tubes. This line acts as a variable resistance in effect across the antenna circuit. The total input to a 50 kw. transmitter of this sort would be about 139 kw. A single 2A3 will modulate a 50 watt amplifier by Mr. Dome's system.

Measurements on Auto Antennas

Considerable discussion resulted after the paper by H. Lyman, Philco, on the methods of measuring auto-

mobile antennas at the Philco plant. After describing briefly the characteristics of typical car antennas in use at the present time, as well as the past, Mr. Lyman described how he used a vertical rod antenna of fixed dimensions as a comparison antenna. The power factor, effective height, capacity of unknown antennas were compared to this rod which had the dimensions of 32 inches length, 0.3 inches diameter.

Dudley Foster, RCA License Laboratory, in discussion mentioned the fact that if the rod antenna is short compared to a wavelength its effective height is equal to one-half its physical height if erected on and over an infinite ground plane. To simulate this plane, a 24 inch diameter disc around the base of the antenna under test was used.

Several of the papers presented at the convention are to be found in toto in the *RMA Engineer*, Vol. 2 No. 1, and will not be reviewed here to any extent. Thus the paper by A. V. Bedford, "Figure of Merit for Television Performance," "Oscillation Stabilization," by C. E. Grandquist, "Use of Negative Regeneration in Radio Receivers," by C. B. Fisher, may be found in the RMA magazine.

Teledynamic Control

Rochester conventions are noted for stimulating, not to mention occasional startling, innovations. This year's prize went to the RCA License Laboratory for a paper with a high sounding title which meant simply a new and extremely interesting method of remotely controlling a radio receiver—or any other device operating from the power lines.

Essentially the method consists in generating a radio frequency, say 200 or 300 kc. at the remote control point. This signal is sent over the power line to the controlled-receiver point. Here a gaseous tube, with a breakdown voltage of the value of 70 volts, is operated. By a resonant circuit the entire break-down voltage may be secured from the control signal, or by means of a biasing circuit the gas tube may be held continuously somewhat under the breakdown point at all times and merely in readiness to conduct and initiate the control functions when the additional voltage is secured from the control point. Not only can the set be turned on and off but also tuned and its volume regulated remotely.

By means of using either phase of a-c modulation on the carrier, two functions may be performed. If two frequencies and both halves of the cycle are used as many as 10 functions may be carried out. In the actual demonstration 4 relays at the receiver and two frequencies at the control point enabled the operators to turn on and off an a-f-c receiver, control its volume and to tune in as many as 6 stations. With three tubes, 26 functions could be performed.

From the standpoint of domestic amity, however, the new system seems to have certain disadvantages (or advantages). Thus the decision as to who in each household controls the receiver is not settled—the only difference being that the contestants need not both be near the receiver. Thus the lack of single control might be even worse than under present conditions. If one member wants jazz and another opera, or one prefers loud noises while the other wishes to be lulled to sleep with all-bass cosmetic bands, strife under the teledynamic system may be just as bad as under the present grab-the-dial-yourself system.

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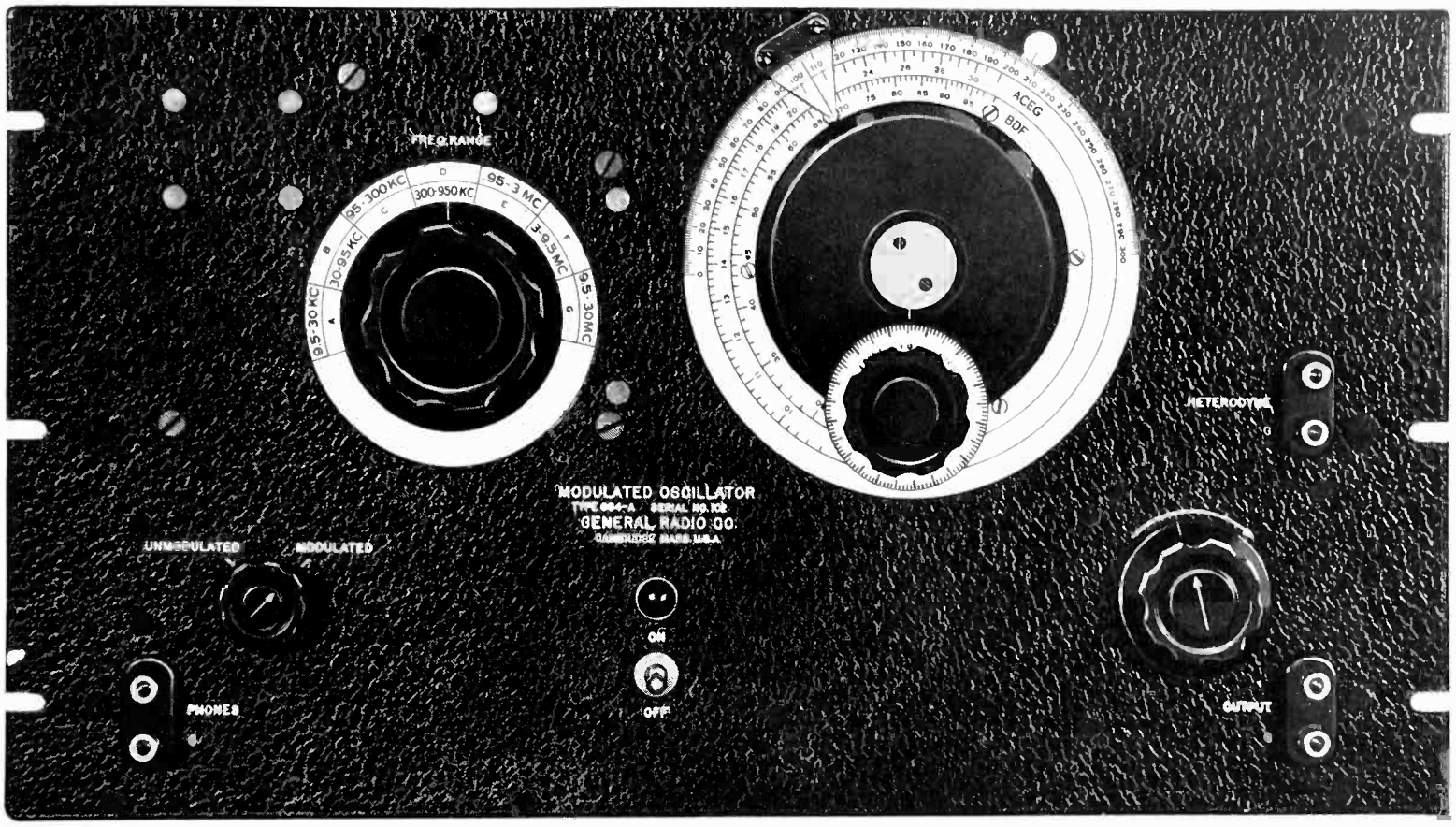

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EASY MOUNTING . . . with either end up so that tube's glass envelope insulates upper terminal

ACTUAL SIZE

RCA's new cartridge-type phototubes are the 921 and 922. Shown here in actual size is RCA 922. A vacuum-type tube, its sensitivity is 20 microamperes per lumen. Interelectrode capacitance —0.6 uuf. The RCA 921 looks the same as the tube shown, is the same size, but is a gas-type tube, with sensitivity of 100 microamperes per lumen—Interelectrode capacitance 1.1 uuf.

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RCA 868.. A gas-type phototube, especially designed for sound-on-film equipment.

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