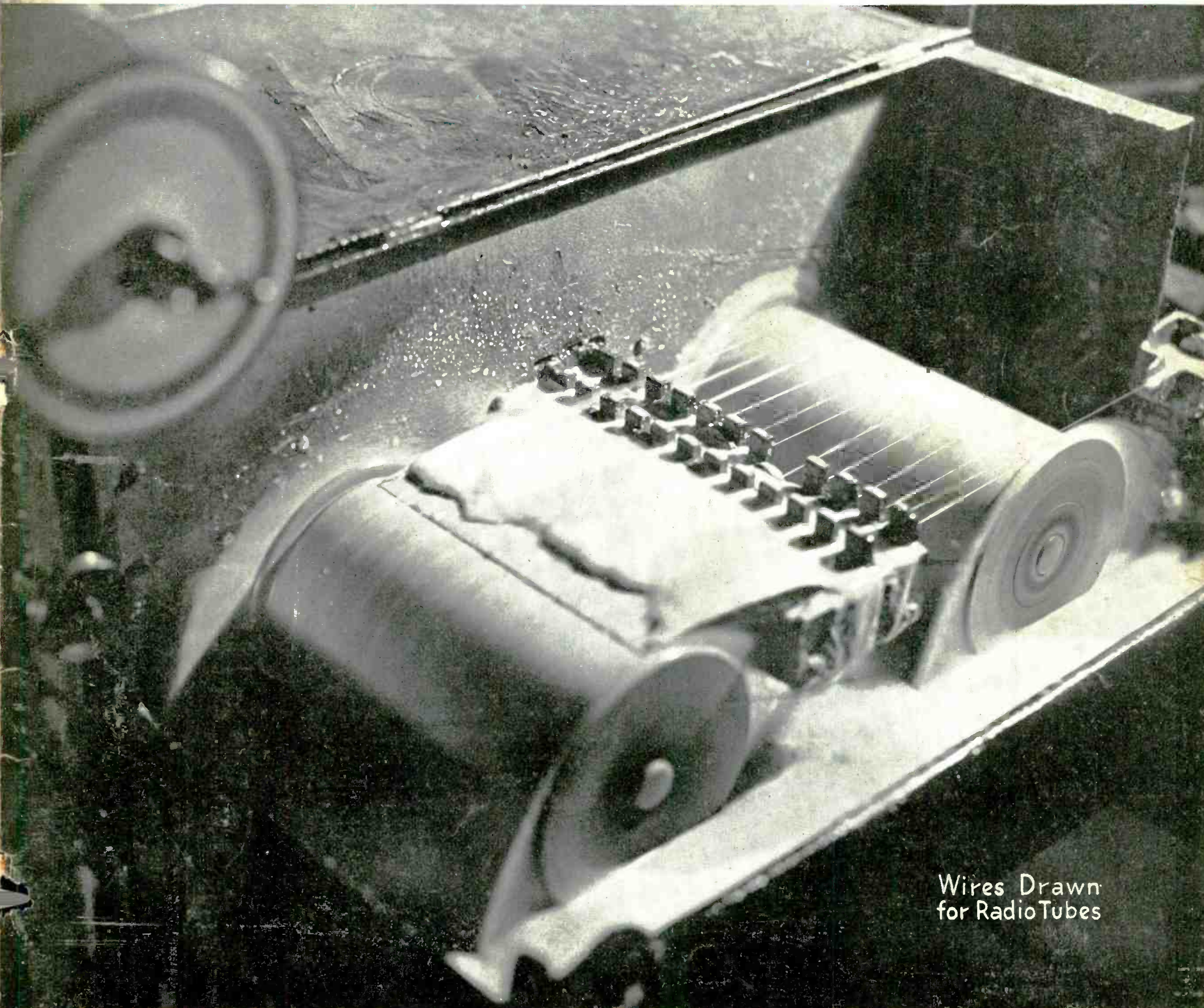
electronics

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



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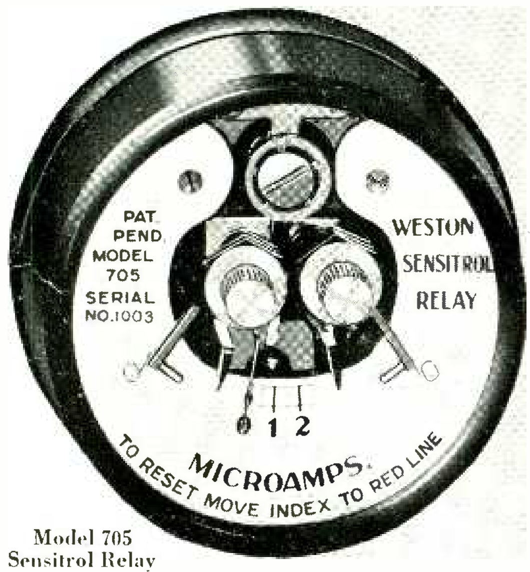

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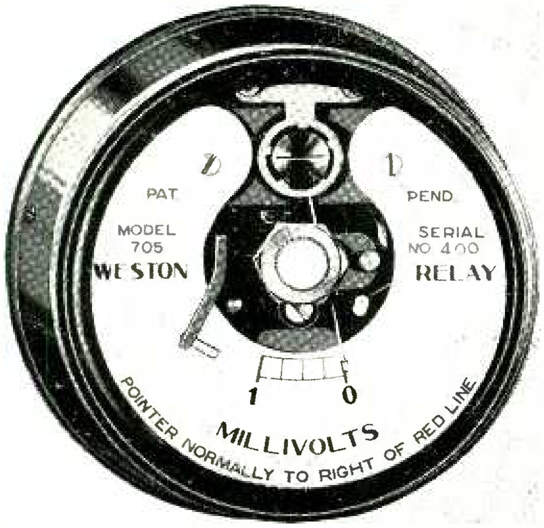

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WESTON *Instruments*

ELECTRONICS

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

Contents • January 1937

COVER: *Drawing grid wires through a soapy lubricant stirs up a foamy lather—a photograph made in RCA Radiotron plant, Harrison*

DEPARTMENTS

Volume 10 . . . Number 1

ELECTRONICS, January 1937. Vol. 10, No. 1. Published monthly, price 50c a copy. Subscription rates—United States, $5.00 a year. Latin America, $5.00 a year. Canada, $5.00 a year. All other countries, $6.00 a year or 24 shillings. Entered as Second Class matter, August 29, 1936, at Post Office, Albany, N. Y., under the Act of March 3, 1879.

Branch Offices: 520 North Michigan Ave., Chicago; 883 Mission St., San Francisco; Aldwych House, Aldwych, London, W. C. 2; Washington; Philadelphia; Cleveland; Detroit; St. Louis; Boston; Atlanta, Ga.

McGRAW-HILL PUBLISHING COMPANY, INC.

Publication Office
99-129 North Broadway, Albany, N. Y.
Editorial and Executive Offices
330 West 42nd Street, New York, N. Y.

James H. McGraw, Jr., Chairman; Howard Ehrlich, Vice-President; Malcolm Muir, President; B. R. Putnam, Treasurer; James H. McGraw, Honorary Chairman; D. C. McGraw, Secretary

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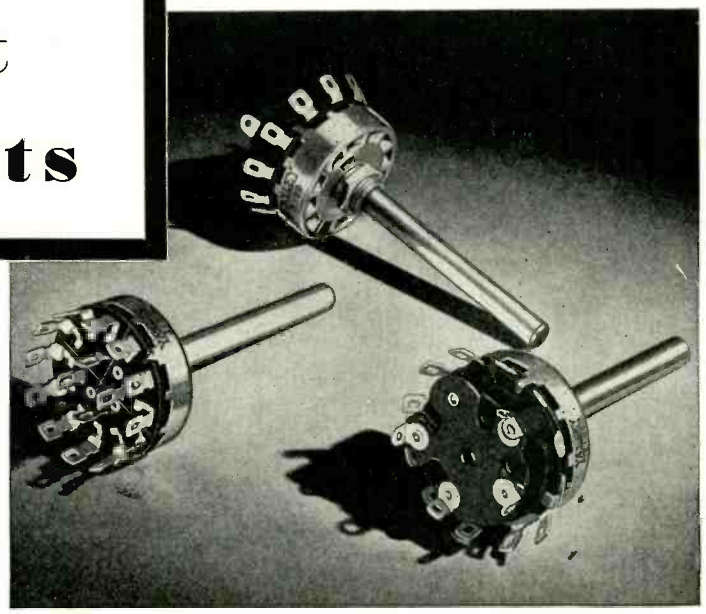
Engineering Progress Results in Important Improvements



Marked improvement in Yaxley switches has permitted the domestic and amateur receiver manufacturers to advance into new fields of all-wave set design. Provision is made in Yaxley switch design for shorting the unused taps of the various antenna, oscillator and other similar coils. The capacity effect between the various parts of the switch has been reduced by proper arrangement of the parts and the use of special materials. This offers the added advantage of the very low losses when used as high as twenty-five megacycles.

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These improvements have been made without any sacrifice of quality or safety as may be shown by the fact that breakdown voltages are still in excess of 1000 volts R. M. S. at 60 cycles between all the component parts of these switches.

A new Yaxley "3100" line of band change switches has the complete mechanism in a self-enclosed cup, grounded and shielded for R. F. purposes from the other component parts of the receiver. One of the features of the Yaxley 3100 switch line is a novel but highly satisfactory method of eliminating the well-known mounting bushing. This is accomplished by extruding part of the cup and rolling an accurate thread on the extruded surface. This eliminates the necessity of providing an expensive brass bushing.

Most suppliers seek to induce manufacturers to adapt their products to the supplier's wares. Mallory-Yaxley, on the contrary, engineers its products to meet manufacturers' requirements — to solve manufacturers' problems. Which is the basic reason why Yaxley switches are synonymous with leading quality in performance.

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ELECTRONICS

JANUARY 1937

KEITH HENNEY *Editor*

Crosstalk

▶ **WOLF!** . . . Two bulletins issued by consumers' organizations which purport to give their subscribers the lowdown on advertised articles have come to hand. They deal with radio receivers. As is customary with reports of this nature, there are very few good words said for anything or anybody and one might easily get the feeling that he would be a lot safer not to buy any radio at all for he is almost sure to get gypped.

One bulletin, in particular, lambasts automatic frequency control stating that it is one of the worst potential sources of trouble that has been added to radio sets. It states that a.f.c. is comparable to automatic gear shift devices on automobiles, and winds up by stating that a radio purchaser would do much better to do his own tuning.

The chip-on-shoulder attitude of these reports is characteristic and annually alienates many subscribers who really wish for honest-to-goodness dope and not biased statements. The difficulty of giving a real survey of radio receivers is apparent when it is considered that annually there are several hundred models from a hundred different manufacturers. For example one of these reports had 6 pages devoted to radio. Three of them were given over to a discussion of labor conditions in the manufacturers' plants. Only a half-dozen sets were completely described.

A recent survey indicates that there has not been much trouble with a.f.c. Probably it is too early for troubles to develop, if they ever will. Out of 200 service calls on sets which had a.f.c. one organization reports that very few found trouble with the a.f.c. circuits or apparatus.

A.f.c. is added to receivers to make certain that a high gain, highly selective superheterodyne is accurately tuned. Slip-shod manual tuning produces bad distortion, making unpleasant the finest program as heard from the finest receiver. A.f.c. is not merely for the lazy man's enjoyment; it serves a purpose and is a real contribution.

These consumers' organizations could perform a distinct service, however, if they could teach advertising managers that inventing trick new names for old gadgets is not good salesmanship. A purchaser of a radio thinking he is getting an exclusive feature, cannot help but be disappointed when he gets the set home to find that his neighbor's equipment has exactly the same gadget (under another name) and that it sounds the same and probably looks the same.

Isn't it possible that set manufacturers are claiming new features a bit too often, and a bit too blatantly? Have they anything new to back up their claims? Is it necessary to claim anything else than that the radio purchaser gets a whale of a lot of equipment for awful little money, these days.

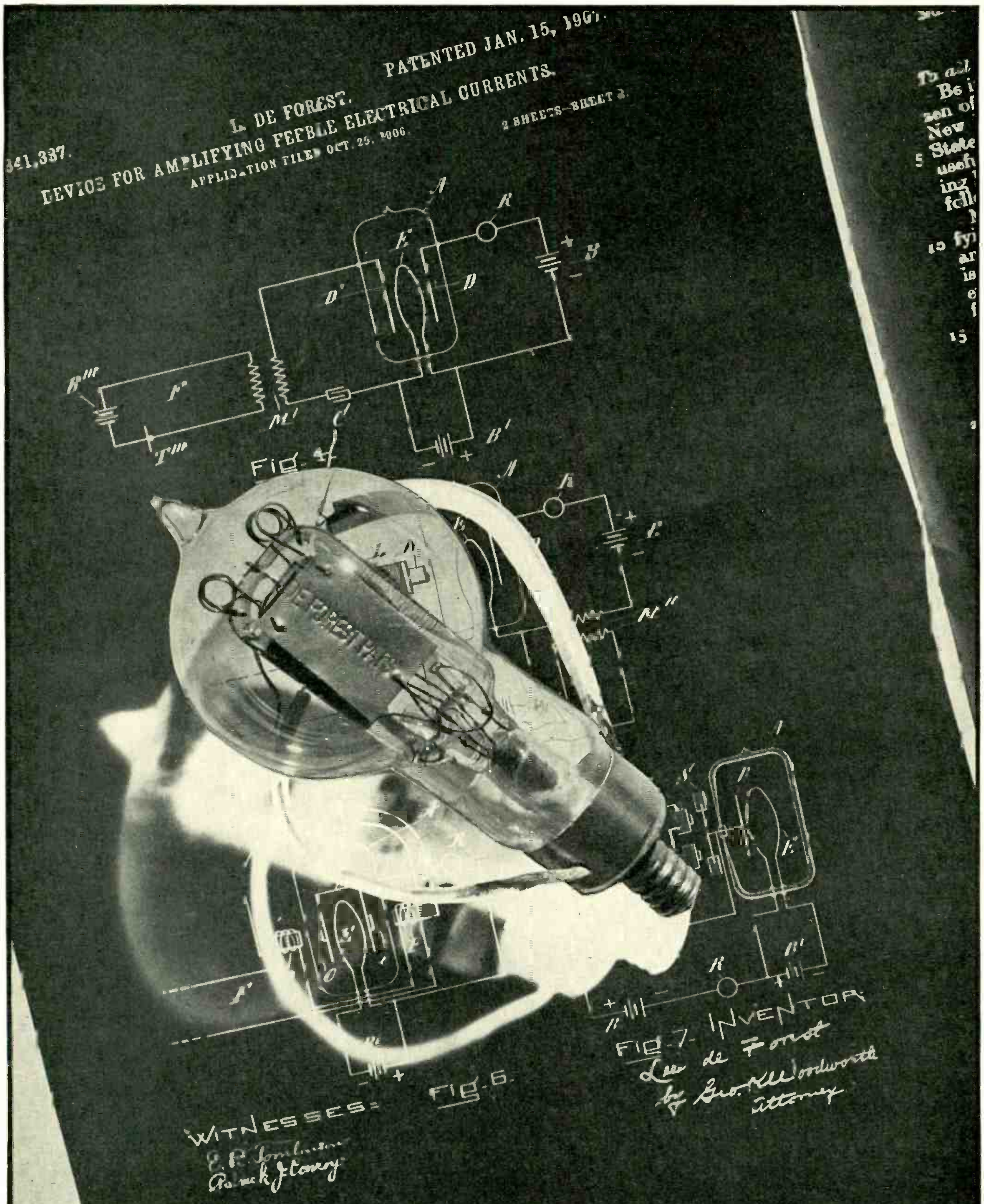
Giancarlo Vallauri

▶ **TELEVISION STOCK** . . . At the request of the Attorney General of New York, a restraining order was issued halting the sale of stock in a television company, capitalized for 6,000,000 shares of $1 par value. The company was without assets. There have been many television stocks nearly all of which have gone boom.

Suppose two successful non-interchangeable systems of television were developed. How would the situation be handled? Restriction of wavelengths to one or the other system would wipe out the investment of the losing company. Granting of wavelengths to both systems would provide a double setup, which no one would want. An interesting speculation.

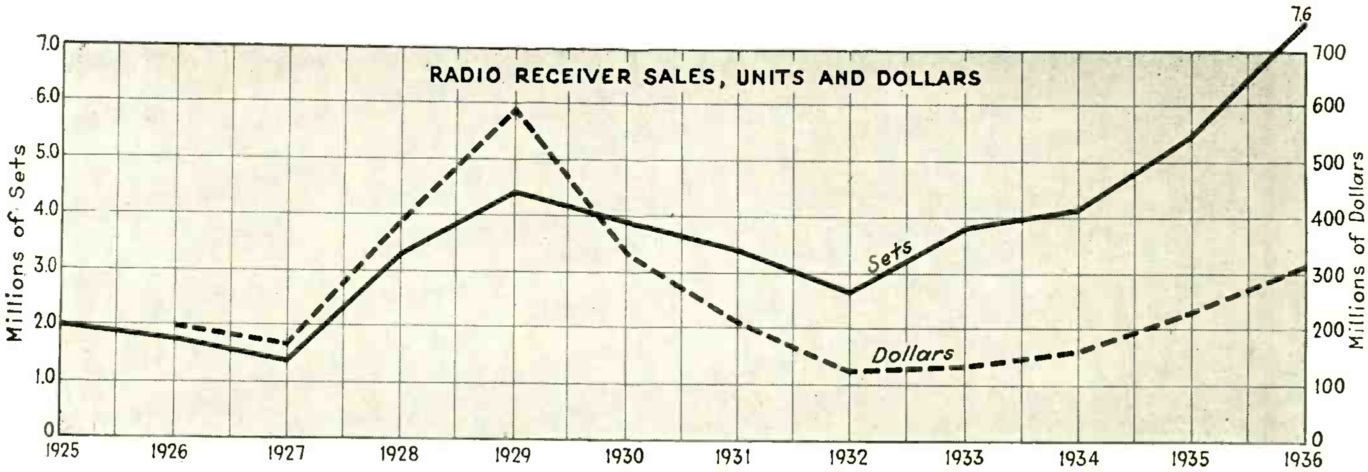
▶ **VISITOR** . . . American radio engineers who recently met and talked with Professor Giancarlo Vallauri of Italy were not aware of the scientific stature of the unassuming, genial professor. Not only is he vice-president of the Royal Academy of Italy, a delegate to the Third World Power Conference and to the Harvard Tercentenary Celebration, an officer of high rank in the Royal Italian Navy, but he is in charge of all broadcasting in Italy except that from the Vatican, is Director of the National Electro-technical Institute "Galileo Ferraris" and professor of electro-technical engineering at Politecnico, both at Turin, president of the Italian Broadcasting Company, editor of *Elettrotecnica* and *Alta Frequenza* and in addition holds a bewildering number of offices in other organizations.

His technical work involves contributions on frequency transformation, ferro-magnetism, operation of three-electrode tubes, measurement of field strength (1920) and other fields of endeavor which mark him as an outstanding figure in science and international broadcasting.



THIRTY YEARS AGO

This month, 1907, U.S. Patent 841,387 was issued to Lee de Forest. It disclosed the three-element electron tube, named the audion. Above, on a copy of the patent is an early example of the triode with grid wound on a glass arbor, and with two parallel plates



What About 1937?

YEAR 1936, an oasis in a desert of depression, has just closed. A spirit more optimistic than that existing in the good-bad 1929 days is abroad. The last of the year was brightest of all, winding up in a burst of bonus payments to employees and dividends to stockholders that put vast quantities of tax-scared money into circulation. Much of this money will find its way into the electronics industry either by direct purchase of radios or by improving manufacturing capacity at plants where modernization of equipment is indicated.

Companies, of course, cannot declare dividends or pay bonuses they have not earned. This plethora of cash payments is only a sign that industry is experiencing profits. Radio manufacturing, the largest of the industries existing on the vacuum tube, built up a new record in point of unit sales. According to the RMA some 7.6 million receivers went out of factories and into homes in 1936, topping all previous figures, doubling in dollar value the 1934 figure (1936 = $315,-800,000).

Not only has the industry showed a marvelous output of units but many companies are enjoying profits for the first time in years. Some are piling up their first profits of all time. It is sad to note, however, in a recent bulletin of the Department of Labor that radio employees are very near the bottom of all manufacturing industries in the point of weekly wages.

Tube manufacturers are hopeful that the metal tube bad news is now past, that 1937 may give them a chance at profits. The cost of developing, selling, stocking multitudinous tube types which are used only sparingly offsets the profits made from quantity production of the few types widely used.

1936, however, is past. An industry like electronics, based upon a science and upon invention, has a future that is always more important than its past.

With 7.6 million new radio sets in use manufacturers wonder what 1937 can bring. It is certain that something new is desirable. With radios looking and sounding much like those of the past, obsolescence must depend more upon some new service than upon trick and individualistic names for gadgets which all sets possess. This new service will probably be television. The present year will see increasing pressure brought upon engineers and scientists working at television to bring out of their laboratories something which can be sold the public. The emphasis must soon be on practice; not theory.

What of electron tubes in industry?

Nearly every electronic application is a special job. It cannot be built unto a package to be sold horizontally to all industry. These specialties require special salesmen-engineers who sell the job, engineer it, service it. Therefore large companies are at a disadvantage compared with a small group, or an individual. Every industry, automobiles for example, provides room for electronic engineers equipped with mechanical and electrical ingenuity. From these statements must be excepted applications like welding, illumination and register control. Here the large companies are carving out considerable business. Thus in electronics there is opportunity for large and small companies.

During the year it is expected that the rising sales of tube-controlled welding apparatus will continue. Ignitrons, which are pool type tubes with immersion starters are now able to deliver continuous currents up to several hundred amperes, peak currents up to 7500 amperes.

Beam tubes developed in 1936 may be expected to appear in new classes in the new year. Already the technique is being applied to higher power tubes and to applications where high efficiency is desired. Degenerative feed-back circuits will become better understood and will find new applications.

1937 is a new year, replete with opportunity for profits, for service.

RCA Describes Television System

Behind the New York field test of RCA's television facilities lies an intricate system of experimental units, including the studio, monitoring groups, cables, transmitter, radiator and receivers. A report of R. R. Beal's paper before the New York I.R.E.

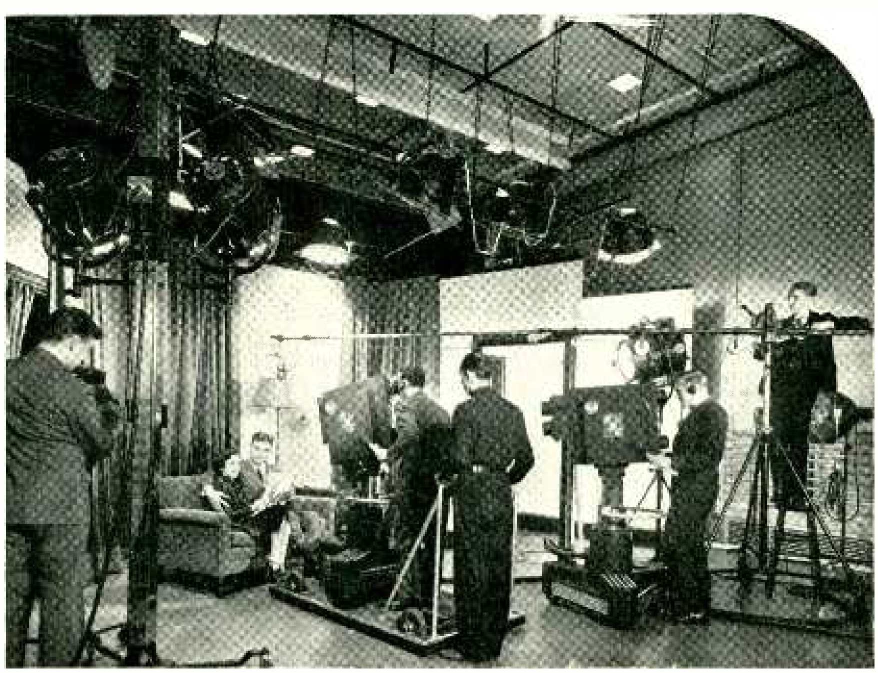
THE decision of the RCA and its service companies to bring their television developments out of the laboratory and to subject them to a comprehensive field test was greeted generally, when it was announced some eighteen months ago, as an excellent contribution to the art. Later, on June 29, 1936, the field test was actually inaugurated with the official opening of the Empire State building transmitter. At the time, the general purpose of the tests and the fundamental dimensions of the system were announced, but the details of the experimental equipment used were not available, because they were not fully worked out until several months after the experimenting got under way. Now, after six months of experience, the system has more or less "shaken down" into a coordinated group of units. While insufficient data have been accumulated and interpreted, as yet, for any worthwhile report of results, the system itself is in complete enough form to warrant a complete description. This description, long awaited by radio and electronic engineers, was given early last month by Mr. Ralph R. Beal, Research Supervisor of RCA who presented before a large audience at the New York Section of the I.R.E. a paper entitled "The RCA Television Field Test System". The paper made no attempt to present or to interpret the information thus far revealed by the tests, but concentrated on describing the experimental units through which the information is being collected. Many questions asked by members of the audience were answered by several RCA engineers in whose province the requested information lay.

The various equipment units in the system may best be described by following a typical program through from studio or film projector to the viewing screen at one of the receivers. Briefly, the video units involved in the RCA building are: A completely equipped television studio for live talent, a projection room for transmitting film, monitoring facilities, a central synchronizing generator for generating synchronizing impulses, and video line amplifier and terminal equipment. This terminal equipment feeds either of two connecting links between the RCA building and the Empire State Transmitter. One link is an experimental coaxial cable; the other is a u-h-f transmitter operating on 177 Mc, which sends a more or less directional beam toward the 85th floor of the Empire State building. At the Empire State building are input equipment (including a receiver for the radio link and terminal amplifiers for the coaxial cable), further monitoring equipment, the transmitter itself, and finally the transmitting antenna. Paralleling all this video equipment is audio equipment of more or less conventional design, including a high fidelity telephone circuit between the studios and the transmitter.

Thus it will be seen that the experimental system is a complete broadcasting plant, and it has been installed, to quote Mr. Beal, "substantially as it would be employed in a radio broadcasting service." The equipment itself, as shown in the illustrations, has a highly professional appearance and has been constructed with a degree of care not often found in an experimental system.

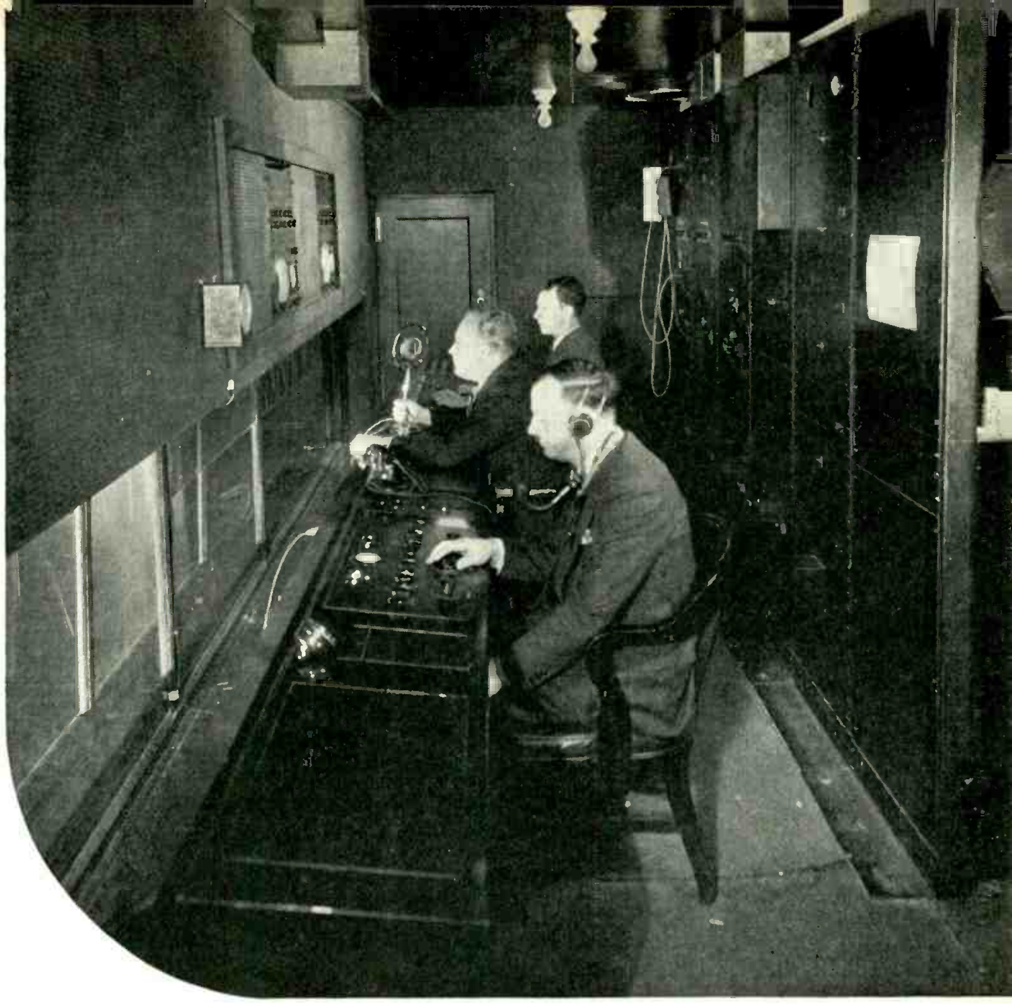
Standards of Transmission

Of basic importance in the tests are the standards used for scanning and for picture repetitions. At present the pictures are scanned in 343 lines per frame, and are completely covered 30 times per second. Odd-line interlacing is used, in a 2-to-1 ratio, giving 60 field scannings per second. The aspect ratio (width-to-height) is 4-to-3. The maximum



video frequency in the RCA system has been set at 1.5 Mc. which is 64 per cent of the value (2.35 Mc.) dictated by the conventional formula for the maximum frequency $= \frac{1}{2}$ (aspect ratio) (frame frequency) (number of lines)^2.

With 1.5 Mc. as the maximum frequency in the sight signal, all of the video equipment from Iconoscope pick-ups through to the modulator of the transmitter must be capable of passing frequencies from about 20 cps. to 1500 kc. The 177 Mc. radio relay link passes two side-bands of this width. The carrier frequencies of the main transmitter are 49.75 Mc. for the picture signals and 52 Mc. for the sound. Both of these carriers are radiated from the same antenna, whose frequency response is wide enough to pass the audio side-bands (10 kc. wide) and the upper side-band of the video signal



The control booth contains three positions, for video, general production and audio monitoring, arranged before a window overlooking the studio below. Note the "Kinescope" monitors in front of the video and production operators ◀

▶ *The camera men wear earphones through which they receive instructions from the production man's talk-back microphone. Five men operate cameras, lights, and microphone boom in the experimental studio*

(1.5 Mc. wide). The lower side-band frequencies (49.75 Mc. to 48.25 Mc.) are partially attenuated by the antenna system. Feeding both audio and video transmitter outputs to the same transmission line requires the use of concentric line filters to prevent interaction between the two transmitters.

It is intended to change the standards of the system sometime in the future to agree with those recommended by the RMA Television Committee, which call for a 441-line picture and a maximum video frequency of 2.5 Mc. but which are otherwise in substantial agreement with the present set-up.

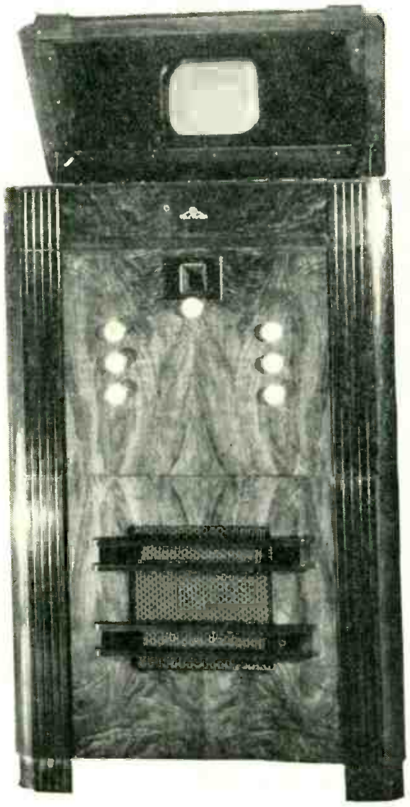
The studio is provided with three Iconoscope pick-up cameras, each with its associated amplifier. The cameras are supplied with synchronizing pulses from the main generator. The cameras are fitted with optical equipment as follows: Telescopic lens, 18-inch focal length; "straight" lens 7.5 inch focal length. The latter lens, when operated at f. 4.5, gives an effective depth of focus of about 3 feet at a distance of 10 feet. The lighting system of the studio is also of considerable interest. Normally, incident light of 800 to 1000 foot-candle intensity is used. The light sources are conventional incandescent lamps, fitted with heat filters which are necessary to protect the actors. An augmented air-conditioning system is installed in the studio and is capable of removing heat-energy at a rate of 50 kilowatt-hours per hour. The audio pick-up is handled with the conventional microphone boom now used in motion picture productions. At least five men are required on the studio floor to handle cameras, lights, and microphone.

A feature of considerable interest is the monitoring and control booth associated with the studio. The monitoring console has three positions arranged on a single desk, for audio monitoring, video monitoring, and for production control, the latter being the center position. The audio position is conventional. The video position contains detail, brightness, contrast, and scanning-voltage controls for each of two channels, which are each individually monitored by means of a Kinescope and a conventional oscilloscope. The former gives the image in reproduced form while the oscilloscope shows the waveform of the scanned lines in relation to the "pedestal" (d-c signal level) on which the synchronizing impulses are superimposed, thus making possible maximum use of the modulation depth available for the video signal. Two channels are provided so that one may be set up and made ready for use while the other is delivering the program. Also in the control booth are the video and audio amplifiers which feed the signals to the terminal equipment in the main equipment room.

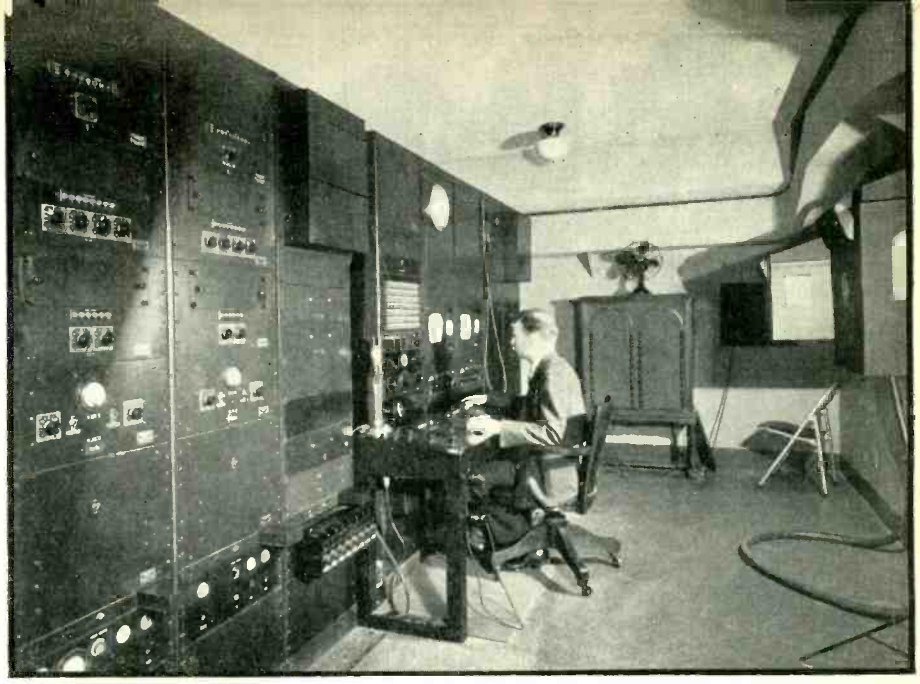
Motion-Picture Projector Equipment

A separate room in the Radio City studios is set aside for film projection, a source from which much program test material has been derived. Two projectors of special design are available. The special design is

Experimental television receiver used by the observers in the Field Test



made necessary by the fact that standard sound motion picture film runs at 24 frames per second, whereas the television image is scanned at the rate of 30 times per second. The film runs through the projector at an average speed of 24 frames per second, so that the sound track is reproduced at proper pitch and tempo, but each individual frame does not remain in place for the same length of time. Instead the frames are projected alternately at a rate of 20 and 30 frames per second, by means of a special intermittent mechanism, which gives an average rate of 24 per second. Two successive frames are available, 1/20 second scanned 3 times and 1/30 second scanned twice, averaging 1/24 of a second each. The projector is fitted with a shutter which admits light from the film to the Iconoscope during only a very small part of the time during which each frame is stationary, actually only during the time when the scanning beam in the Iconoscope is returning from bottom to top of each set of interlaced lines. The light impulse creates a charge-picture on the mosaic of the Iconoscope which remains until scanned.



The film-projection room is fitted with monitoring apparatus for two video and audio channels, one for each projector, so that continuous film programs can be handled.

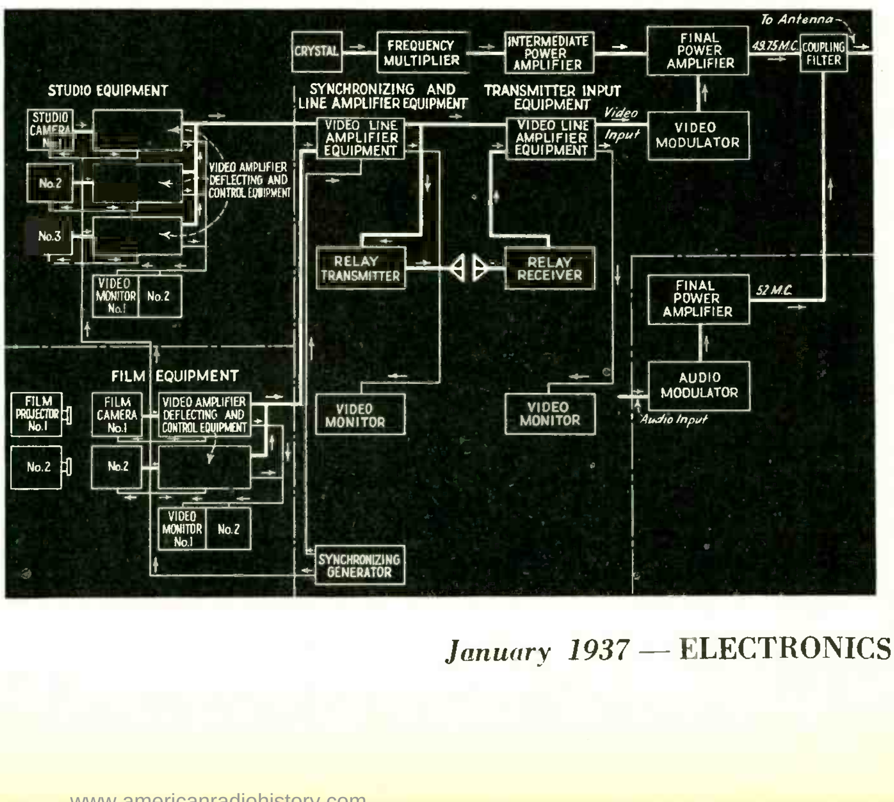
Studio to Transmitter Connecting Links

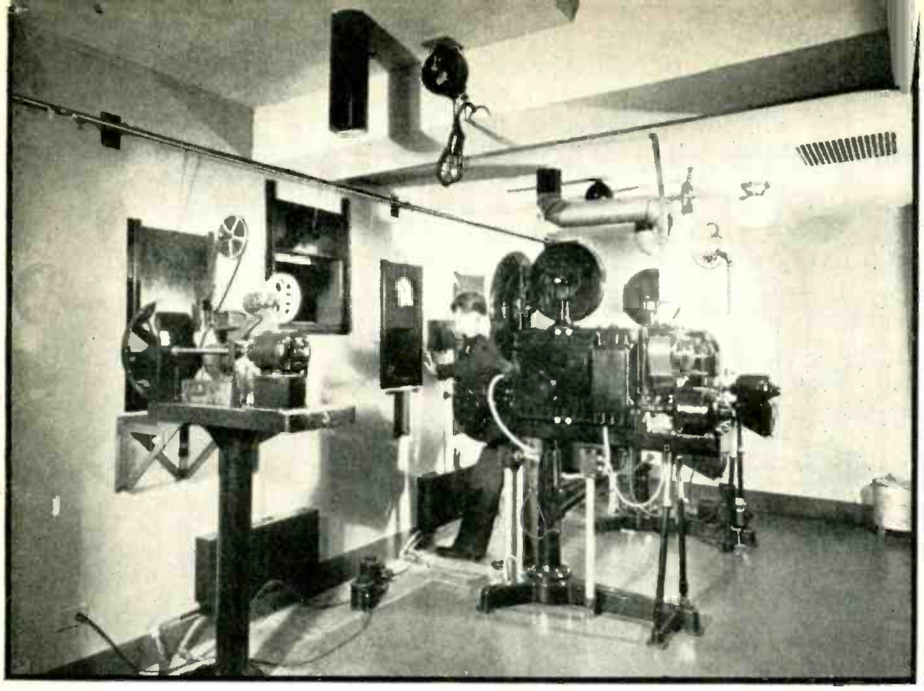
The 177 Mc. "interbuilding radio-relay" circuit consists of a transmitter situated on the 10th floor of the RCA building and a receiver on the 85th floor of the Empire State building. The relay transmitter is fed from the studio or film projection room through a coaxial cable, and the video signal is monitored at the transmitter input. A directive antenna in the 14th floor level consisting of a dipole in front of a plane metal reflector directs a beam toward the Empire State building. Here a receiver (with monitor) converts the 177 Mc. signal back to the video frequencies (from 20 cps. to 1.5 Mc.) which in turn are fed to the modulator of the main transmitter. The radio relay circuit has been found to be highly satisfactory, and gives a picture quality equal, in detail and in freedom from noise, to the signal transmitted over the coaxial cable. The latter is terminated in the Main Equipment Room of NBC and extends to the Empire State building, finally terminating at the modulator input of the main transmitter.

Main Transmitter

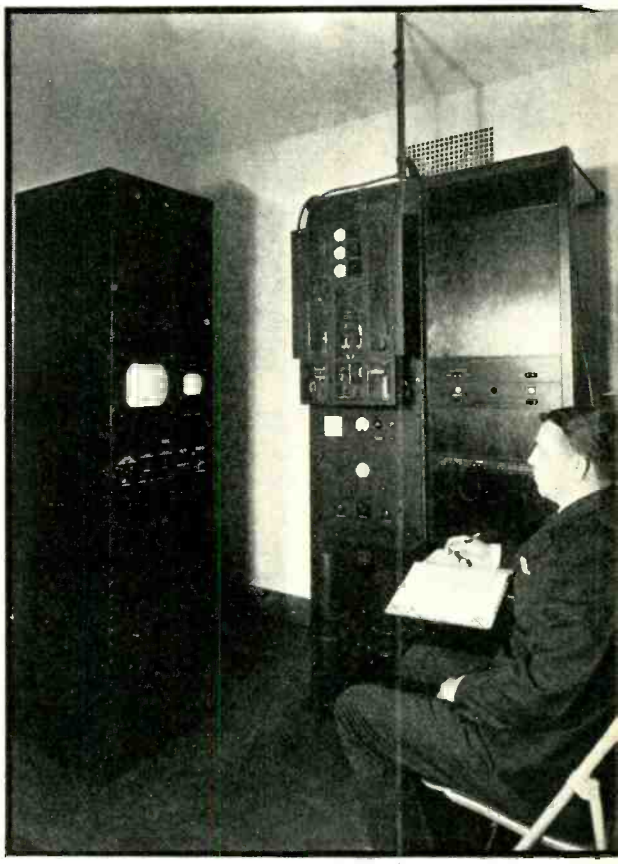
The transmitter in the Empire State building consists of two units,

Block diagram of video units from studio to antenna. Both audio and video transmitters radiate from the same antenna





Left, the film projection room containing the special projectors described in the text. Opposite page, the control and monitoring positions for the film projection apparatus



The radio relay transmitter at the RCA Building which transmits the video signal on 177 Mc. to the main transmitter in the Empire State Building

the video and the audio, which operate at carrier powers of 8 kw. each. Both units use special tubes in the final amplifier which are designed for generation of wide bands at the high carrier frequency required. The tubes dissipate about 30 kw. at the plate, and deliver an electron emission of 18 amperes per tube, a value which permits 8 kw. output when the final tank circuit is loaded to pass the 1.5 Mc. side bands which are produced. No attempt is made to reduce either of the side-bands, at the transmitter, although as pointed out above, the antenna does attenuate the lower side-band frequencies somewhat. In the audio transmitter, conventional plate modulation is used, but in the video unit, it is next to impossible to produce efficiently the high voltages required for plate modulation over the extremely wide frequency band. So grid circuit modulation, impedance-coupled to the grids of the final amplifier, is used.

The transmitter is provided with a control board which gives visual monitoring of the video signal at the input to the modulator. This monitor can be connected either to the coaxial cable or to the radio relay receiver. All video signals throughout the system are sent over coaxial cable, except of course in the case of r-f transmission from the radio relay and main transmitter radiators. Even the line-cord jacks used in the video circuits are of special coaxial design.

The outputs of the two transmitters are coupled through selective filters to a common transmission line of the concentric type which in turn connects with the main radiator mounted on the top of the Empire State building (see front cover, *Electronics*, July, 1936) at a height of 1250 feet. The horizon at sea level viewed from this antenna is approximately 45 miles away.

The radiator is of unusual design; it consists of 9 horizontal dipoles arranged as the sides of three equilateral triangles, one above the other and supported by a pipe framework. The emitted wave is horizontally polarized, and the radiation pattern around the antenna is approximately circular. The vertical spacing between each triangular set of dipoles is so chosen that the high angle radiation from the structure is reduced to a very low figure. Great concentration of radiated energy in the horizontal plane has been achieved. The signal is, in fact, about 3.2 db. stronger in the horizontal plane than it would be if radiated directly from a vertical dipole.

The range of the transmitter has only partially been investigated. The reliable service area seems to be about 25 miles. However, good reception in a favorably-situated suburb 45 miles away is consistently reported.

Field Test Receivers

The reception of the television signals is confined to a small number of receivers, not over 100 in all, which are distributed in New York City and the surrounding suburban area in the homes of various members of the RCA and NBC technical personnel. The receivers are of standard pattern, and are installed in typical as well as specialized locations. The receivers are superheterodynes, tune from 42 to 84 Mc. and accept both the audio and video signals at once. A common video-audio r-f amplifier (using an acorn tube) feeds the two carriers to a common first detector, at the output of which two different i-f frequencies (audio and video) appear. The video i-f is amplified, applied to a second detector and thence to the control electrode of the Kinescope. Included in the receiver are circuits for selecting the synchronizing signals from the incoming wave (amplitude and wave-shape selection are used); these signals control the vertical and horizontal deflection generators. Control knobs are provided for control of tuning; of sound

[*Continued on page* 48]

Feedback Amplifier Design

By paying attention to simple theory it is possible to apply negative feed-back across several stages of amplification without encountering oscillation troubles. Practical single and multi-stage circuits are described and explained

By F. E. TERMAN

Stanford University

THE feedback amplifier can be thought of as an ordinary amplifier in which a certain amount of negative regeneration (or degeneration) has been deliberately introduced. When this is properly done the amplifier acquires new properties, the most important of which are a great increase in stability of amplification with changes in circuit constants, and an accompanying reduction in amplitude distortion.

The operation of a feedback amplifier can be understood by reference to Fig. 1. Regeneration is introduced by superimposing upon the amplifier input a fraction β of the output voltage E, so that the actual input to the amplifier consists of the signal voltage e_s plus the feedback voltage βE. Since the output voltage E is necessarily A times the voltage actually applied to the amplifier input, $E = A\ (e_s + \beta E)$. Solving this equation for the ratio E/e_s, which represents the effective gain in the presence of feedback, gives at once

$$\frac{E}{e_s} = \frac{A}{1 - A\beta} = -\frac{1}{\beta}\,\frac{1}{\left(1 - \frac{1}{\beta A}\right)} \ldots\ldots (1)$$

In this equation the assumption as to signs is such that when the feedback voltage opposes the signal voltage, β is negative. The quantity $A\beta$ can be termed the *feedback factor*, and represents the amplitude of the voltage superimposed upon e_s compared with the actual voltage applied to the input terminals. Thus if $A\beta = 50$, then for each millivolt existing between the input terminals the feedback voltage will be 50 millivolts, and if the phase is such as to give negative feedback a signal of 51 millivolts will be required to produce one millivolt at the input.

Examination of Eq. (1) shows that if the feedback factor $A\beta$ is large the amplification is reduced by the presence of feedback, and furthermore when $|A\beta| >> 1$, Eq. (1) reduces to

$$E/e_s = -1/\beta \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Expressed in words, Eq. (2) states that when the feedback factor $A\beta$ is large the effective amplification depends only upon the fraction β of the output voltage that is superimposed upon the amplifier input, and *is substantially independent of the gain actually produced by the amplifier itself.*

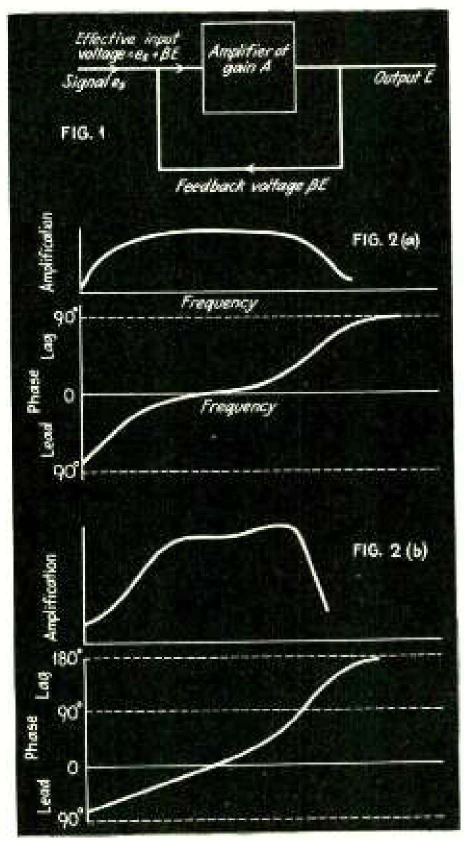


Fig. 1.—Fundamental feedback circuit, showing relation between input, output and feedback voltages

Fig. 2.—Amplification and phase characteristics of (a) resistance or impedance coupled amplifier, (b) transformer-coupled amplifier

This remarkable behavior is a result of the fact that when the feedback is large the voltage actually applied to the amplifier input terminals represents a small difference between relatively large signal and feedback voltages. A moderate change in the amplification A therefore produces a large change in the difference between signal and feedback voltages, thereby altering the actual input voltage in a manner that tends to correct for the alteration in amplification. Thus in the amplifier considered above where $A\beta = 50$, if the amplification A was halved by a change in design it would then take two millivolts across the input terminals to deliver the same output as before. With β unchanged the feedback voltage would still be 50 millivolts, so it would require a signal of $50 + 2 = 52$ millivolts instead of the previous 51 millivolts to produce the same output. Thus a 2 percent change in effective overall amplification results when the gain A is altered by 50 percent.

Inasmuch as the quantity β depends upon circuit elements such as resistances that are permanent, the amplification with large feedback is substantially independent of the tube characteristics and electrode voltages. Furthermore Eq. (2) shows that the amplification with large feedback is inversely proportional to β, so that if the fraction β of the output voltage that is superimposed upon the input is obtained by a resistance network, the amplification will be substantially independent of frequency and will have negligible phase shift. On the other hand, if it is desired to have the amplification vary with frequency in some particular way, this can be readily accomplished by making the feedback network have the same transmission loss characteristic as

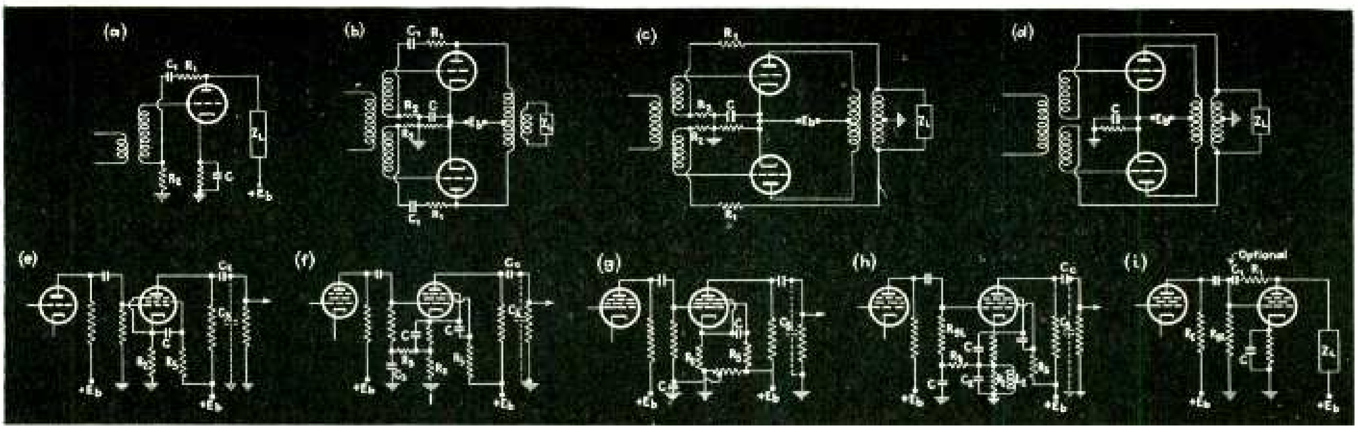


Fig. 3—Single-stage feed-back amplifier arrangements, for single ended and push-pull operation. The special characteristics of each circuit are described in the text

the desired gain characteristic. This last property can be utilized in equalizing an amplifier.

Reduction of Amplitude Distortion and Noise

The presence of negative feedback also greatly reduces the amplitude distortion and crosstalk produced in the amplifier. This distortion can be thought of as being generated in the amplifier, usually in the output stage. If d represents the amount of distortion appearing at the output in the absence of feedback when the output signal voltage is E, then in the presence of feedback the distortion with sufficient excitation to produce the same output voltage E will be less than d. This is because some of the distortion is fed back to the amplifier input through the feedback circuit and reamplified in such a way as to tend to cancel out the distortion originally generated. If D represents the distortion voltage actually appearing in the output in the presence of feedback when the output voltage is E, the distortion voltage applied to the amplifier input by the feedback circuit is βD, and this is amplified A times by the amplifier. The total distortion output is then the distortion d actually generated in the amplifier plus the amplified feedback distortion βDA. That is: $D = d + \beta DA$, or

$$D = \frac{d}{1-\beta A}$$

$$\text{Distortion with feedback} = \frac{\text{Distortion in absence of feedback}}{1-\beta A}$$

This equation shows that feedback reduces the percentage distortion appearing in the output for a given output voltage by the factor $1 - \beta A$. If βA is made large by employing a large amount of feedback, the result is a very great reduction in the distortion.

Noise introduced into an amplifier likewise tends to be reduced by feedback in the same manner as distortion. This is because the noise voltages appearing at the output are fed back to the amplifier input in such a way as to tend to oppose the noise otherwise appearing in the output. The effectiveness of negative feedback in reducing noise in this way depends upon the amount of feedback and upon the place within the amplifier where the noise is introduced. The reduction of noise is greatest when the point of introduction is in the output circuits of the final tube, under which conditions the noise voltages are reduced by the factor $1 - \beta A$. If however the noise is introduced in low level stages the amount of reduction resulting from feedback becomes less, and if the noise is introduced into the input circuits of the amplifier, feedback has no effect in reducing the signal-to-noise ratio. Negative feedback will therefore not reduce thermal agitation noise, hum introduced in low level stages, or microphonic effects in low level stages. The chief usefulness of feedback from the point of view of noise is that it permits the use of a poorly filtered power-supply system for the plate circuit of the final stage of amplification.

Feedback without Oscillations

In order to realize the advantages of feedback, the amplifier and its feedback must be so arranged that oscillations do not occur. This can be accomplished by arranging the circuits so that the feedback voltage is normally in phase opposition to the applied signal (i.e., βA negative and real), and by arranging the circuits so that there is no frequency where $A\beta$ is positive, real, and greater than unity.[1]

The amplification and phase shift characteristics of a feedback amplifier are therefore of fundamental importance in determining whether or not the amplifier will be stable.

The amplification and phase characteristics (phase measured from the midrange value) of single-stage resistance-impedance and transformer-coupled stages are shown in Fig. 2. It will be seen that large phase shifts (never more than 180°) occur in general where the amplification is low, except in the vicinity of the series resonance in the transformer case. So long as the total phase shift of $A\beta$ is less than 180°, it remains negative as required for stable operation. Phase shifts greater than this amount are encountered only in the case of two or more stages, or when the feedback network adds a shift to that of a single stage.

Single Tube Feedback Circuits

Practical amplifier circuits in which there is feedback from the output to input circuits of the same

[1] The exact criterion for avoiding oscillation in feedback circuits is that when the value of $A\beta$ and its conjugate are plotted as a function of frequency on rectangular coordinates with the real part along the X axis and the imaginary part along the Y axis, the resulting curve will not inclose the point 1, 0. See E. Peterson, J. G. Kreer and L. A. Ware, "Regeneration, Theory, and Experiment." *Proc. I.R.E.*, vol. 22, p. 1191, October, 1934.

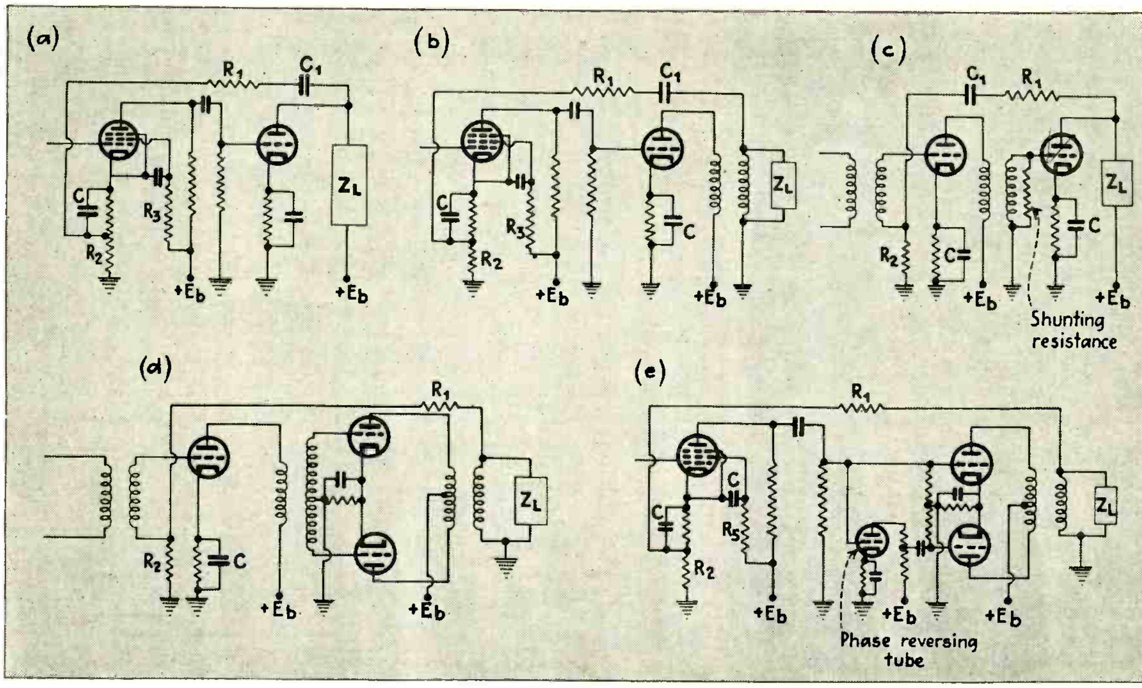


Fig. 4. Two-stage feed-back circuits. The advantages of coupling over two stages can be realized without oscillation troubles if proper procedure is followed

tube (or push-pull pair) are shown in Fig. 3. Arrangements *a* and *b* are commonly recommended for use with beam power tubes to reduce the amplitude distortion generated by the tube. These arrangements also reduce amplitude distortion resulting from saturation of the output transformer core at low frequencies and improve the low-frequency response by tending to maintain the voltage across the transformer primary the same at all frequencies. The falling off at high frequencies as a result of leakage reactance is not affected, however, since this takes place on the load side of the transformer primary. The circuit of Fig. 3*c* overcomes this, but requires that the load impedance be high enough to develop the required feedback voltage. The arrangement at Fig. 3*d* is a special case of *c* where $R_1 = 0$, and $R_2 = \infty$, and is attractive in that it eliminates four resistances and wastes no power in the feedback network, but has the disadvantage that the load impedance is fixed by feedback requirements.

In the circuits of Fig. 3*e*, 3*f*, and 3*g* feedback is obtained by the use of a resistance in the cathode circuit. At *e* the cathode resistor is used simultaneously for bias and feedback purposes, while at *f* and *g* the circuits are arranged so that the feedback factor $A\beta$ is greater than obtainable with only the bias resistor, while the normal bias is still maintained. It will be noted that circuits *e*, *f*, and *g* give a feedback voltage that is proportional to the a-c current flowing in the plate circuit of the tube, so that these circuits tend to stabilize the current in the output circuit rather than the voltage developed across it. Thus when the output circuit is a resistance-capacity coupling network as shown, the shunt capacity C_s causes the output voltage to drop at high frequencies for constant a-c plate current, and likewise the coupling condenser reactance causes the voltage developed across the grid leak to drop at low frequencies even when the a-c plate current is constant. Feedback action does not improve the frequency response in these circuits even though amplitude distortion is reduced. The falling off at high and low frequencies can, however, be greatly reduced by shunting the cathode resistor R_2 by a condenser C_2 to reduce the negative feedback at high frequencies, and shunting by an inductance L_2 to reduce the negative feedback at low frequencies, as in Fig. 3*h*. By proper choice of these reactive elements the response can be made substantially flat over a much larger frequency range than would otherwise be possible. Circuits *e*, *f*, *g*, and *h* are not suitable when the output circuit contains a transformer, because there is no resulting improvement in frequency response, and the stabilization tends to make the magnetizing current of the transformer sinusoidal and so actually produces amplitude distortion in the output voltage.

The circuit of Fig. 3*i* is particularly suitable for use with a power amplifier having a resistance-coupled driver stage. This arrangement reduces the distortion produced in the final tube, and improves the low frequency response of the output transformer. Also, if $R_1 >> R_c$, and $R_{g1} >> R_c$, the feedback voltage varies with frequency in such a way

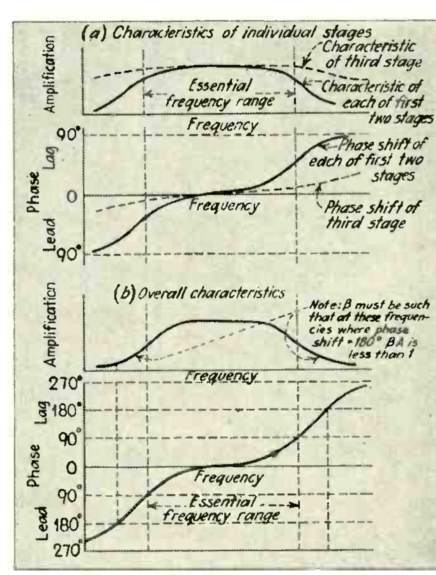


Fig. 5. Multistage operation

as to reduce greatly the frequency distortion produced by the driver stage (but does not reduce the amplitude distortion in the driver).

Two-tube Feedback Circuits.

Circuits in which the feedback takes place from the output of one tube to the input of the next preceding tube have a number of advantages. Since there is more gain available between feedback points, it is practicable to use higher values of the feedback factor $A\beta$ and thereby to realize to a greater extent the potential advantages of feedback. The two-tube circuit also takes care of amplitude and frequency distortion in the driver stage as well as in the power stage. This is of particular importance when the power tube requires a large exciting voltage or when the grid of the power tube is driven positive, as in Class B and Class AB amplifiers. It is a possibility of negative feedback that has so far been largely neglected.

Two-tube feedback circuits must in general use resistance or impedance coupling, or an interstage transformer with a not-too-high resistance across the secondary. Under these circumstances oscillations will not take place since the maximum phase shift that results is $\pm 90°$ per stage. Two stages hence give a maximum phase shift $\pm 180°$ and this occurs only at extreme frequencies where the amplification drops to zero. Interstage transformers with open-circuited secondaries, and other arrangements which give 180° phase shift per stage must be avoided, as then the total shift will reach at least 270 degrees, and considerable gain is possible when there is a 180° phase shift that changes the feedback from negative to positive.

A series of representative two-tube feedback circuits is shown in Fig. 4 and other similar arrangements can be devised to meet situations not covered in the figure. The circuits of Fig. 4 are characteristically different from the one-tube circuits of Fig. 3 because of the reversal of polarity resulting from the additional tube.

Feedback Circuits with Three or More Stages

A three-stage amplifier has a possible phase shift of at least ± 270 degrees at extreme frequencies, and so when feedback is introduced will generally oscillate unless especially designed. When it is desired to employ feedback with a three-stage amplifier the proper procedure is to use a form of coupling for which the phase shift will not exceed ± 90 degrees per stage. Two stages of the amplifier are then given a frequency response very little if any better than that required for the purpose at hand, while the third stage is designed to have a substantially flat frequency response with negligible phase shift up to frequencies much lower and much higher than the remaining stages. The third stage therefore introduces a negligible phase shift (except the reversal of polarity produced by the tube action) until the frequency is so high or so low that the remaining stages cause the amplification to drop greatly. Consequently the feedback factor $A\beta$ can be made to drop to less than unity as a result of the falling off in amplification A before the additional phase shift introduced by the third stage is sufficient to make the total shift of all three stages reach ± 180 degrees. This situation is illustrated in Fig. 5, which shows the desired amplification and phase shift characteristics of individual stages together with the combined characteristic. It will be noted that the maximum permissible mid-frequency value of the feedback factor $A\beta$ under these conditions is determined by the flatness of the third stage compared with the response characteristic of the other stages.

Examples of three-stage amplifiers with feedback are shown in Fig. 6. Arrangements *a* and *b* require no particular comment. Circuit *c*, however, gives stabilization of the a-c current in the plate circuit of the output tube exactly as circuits 2*e* and 2*f*, which have already been discussed, unless suitable compensating reactances L'_2 and C'_2 are used. In each of the circuits of Fig. 6 two of the stages should have a frequency response no wider than necessary, while the remaining stage should have uniform gain and substantially negligible phase shift to much higher and lower frequencies than the other stages. Under these conditions no oscillation occurs.

[*Continued on page* 50]

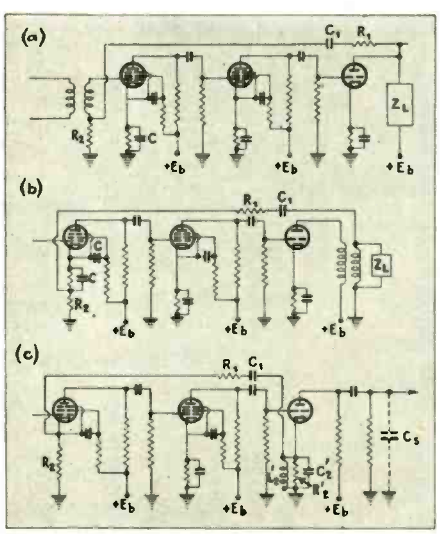


Fig. 6—Three-stage circuits

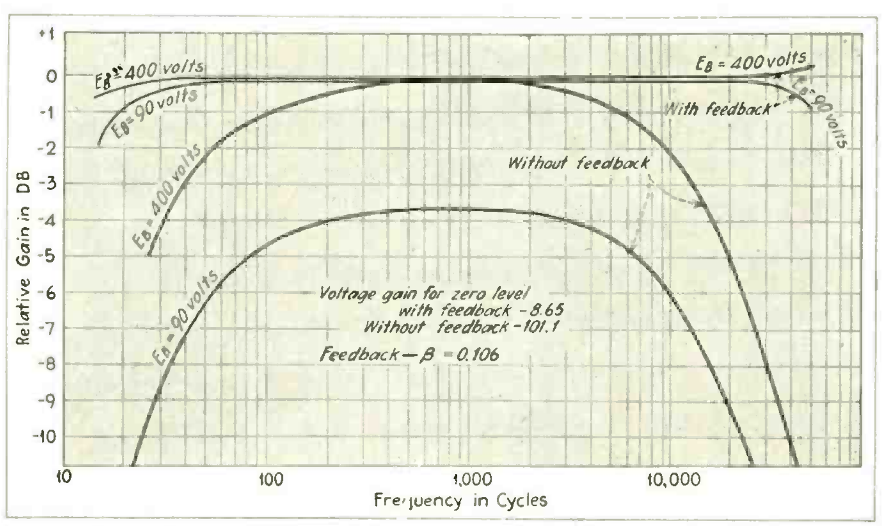


Fig. 7—Experimental characteristics of amplifier built by the author

1936—NEMA Radio and

Two former sections of NEMA are reorganized into one compact group for industry cooperation on technical and commercial matters

THE manufacture of radio transmitting apparatus, electronic tubes, commercial receivers, and public address and music distribution apparatus, like other branches of the radio industry, has grown like the proverbial Topsy. Individuals in the art had their attention riveted so long to their own problems and on their own efforts to keep pace, that when they finally looked about they found that the industry had indeed grown but that it worked at tangents and cross purposes, without a wholly acceptable terminology, and without acceptable methods of tests and rating.

Realizing the virtues of organization for the purposes of exchanging viewpoints, and stimulated by the necessity for cooperative effort under NIRA, members of the industry organized in NEMA a section in which the desired cooperation could occur. Until late Spring, 1935, activities were confined largely to NIRA matters and therefore problems specific to the art have been under discussion only since that time. It is expected that tangible results of the organization will now be forthcoming.

Prior to December 1935, manufacturers of radio apparatus and electronic tubes were organized in two NEMA sections: One dealing with radio and public address apparatus and one devoted to industrial and electronic tubes. The work of these two sections differed in detail but definitely overlapped and as of the above date the two sections were merged into one known as the Radio Apparatus and Electronic Tube Section.

Organization

An initial step in organizing was the development of a product scope. This was determined to be as is outlined below:

Radio Transmitting Apparatus for all applications such as (but not limited to) broadcasting, television, facsimile, trans-oceanic, marine, beacon, point to point, aircraft, amateur and government services and comprising all apparatus from and including the pick-up of sound waves and/or signal source to the antenna, including all generating, measuring, switching, signalling, testing and accessory equipment.

Public Address and Music Distribution apparatus construed as combinations of microphone, pick-up with turn-table and loud speaker with or without electrical amplification for the reproduction of sound (but excluding phonographs.)

Commercial Radio Receivers and Direction Finders for commercial and special purposes including broadcast receivers for radio distribution systems but excluding all other broadcast receivers for entertainment purposes.

Electronic Tubes: all vacuum and gas-filled electronic tubes and light sensitive devices having functions similar to such tubes (such as photovoltaic cells) for all applications other than sun lamps, X-ray, light source and radio broadcast receivers. Specifically excepted from this definition are rectifier tubes of the tungsten-argon and tungsten-argon-mercury types having a maximum d-c rating of 120 volts.

Three types of committee were organized by function: Engineering, commercial (or line) and administrative. The powers of the committees are limited to that of recommendation. Recognizing the fact that all members do not have the same technical or commercial interests, a technical and a line subcommittee were designated for each of the main divisions of interest: radio apparatus, audio apparatus and tubes. The commercial subcommittees report directly to the Section; the engineering sub-committees report to the General Engineering Committee which coordinates the work and reports to the Section. Regular meeting dates have been set for each of the several committees, and an executive secretary has been employed.

The Section has not maintained a definite campaign for additional membership for the reason that it seemed advisable first to develop a written program of activities based on a period of operating experience. Such a program is now complete and will be brought to the attention of members of the industry.

Among other projects is that of collecting for members, statistics in dollar volume broken down properly as to products and as to domestic and export business. Several technical standards have been adopted and published during the past year. They are: Bulletin entitled "Useful Information on Police Radio Systems"; Standardization of Positive Grid Characteristics; Transmitting Tube Ratings and Operating Information; Standard Output Ratings for Transmitters for Police Communication.

Work Outlined by Section

Projects now under consideration will ultimately lead to standards of value to the industry. On tubes they involve nomenclature, model numbers, electrical and mechanical design standards, performance data specifications, warranties, definitions and symbols. Other work involves rating police radio transmitters, sound system specifications and standards. Still another project involves the possibility of and procedure for a cost comparison study of vacuum tubes.

Electronic Section—1937

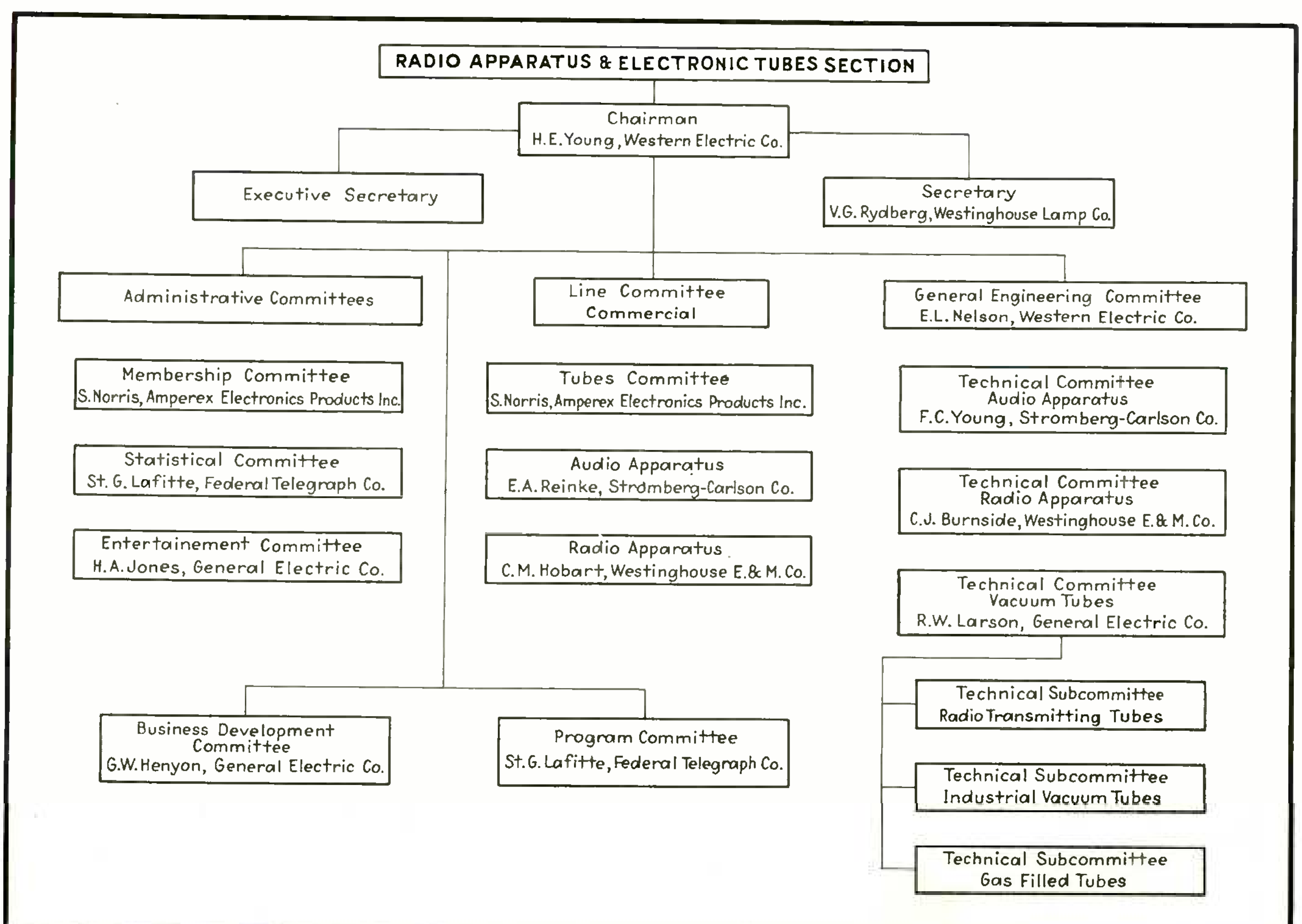
Annual report indicates that Radio and Electronic Tube Section will provide members with valuable data during the year 1937

This electronic section of NEMA contacts and cooperates with other organizations which have mutual interests.

Contact is maintained with ASA, IRE and RMA in connection with standards for the radio industry. Cooperation is offered the U. S. Government on questions of general interest, for example, warranties on tube life. The Department of Commerce, Bureau of Navigation and Steamboat Inspection is consulted regarding specifications for sound apparatus as required by the 52nd Supplement of the General Rules and Regulations. The Section cooperates with the Federal Communications Commission for obvious matters of mutual interest.

Individual members are compiling data regarding rates on transporting electronic tubes. National legislation of interest to members is reviewed through NEMA so that individual members may be informed and so that the Section as a body may undertake such projects as will conform to such legislation.

Thus is it seen that the electronic section of NEMA represents an opportunity for members to consult on matters of mutual interest, for cooperation leading to standardization of technical matters, and for gathering commercial and statistical data of value to the industry. The group is now organized so that the ensuing year should show material benefits resulting from the unification of the two previous groups into one compact single-purposed Section.



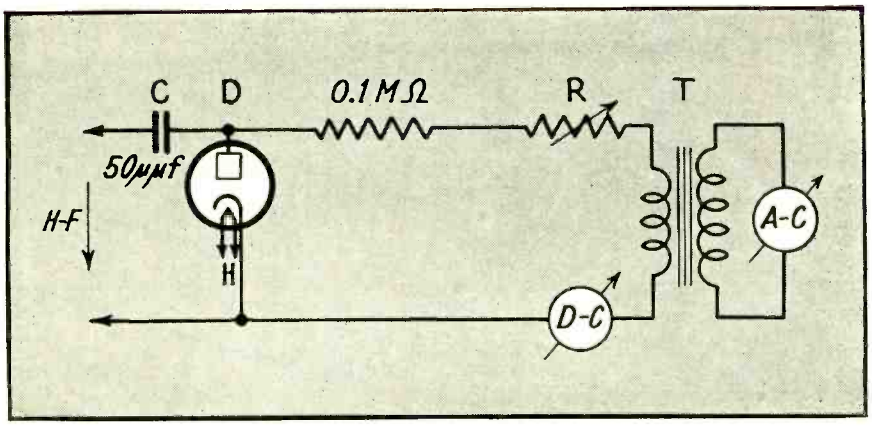
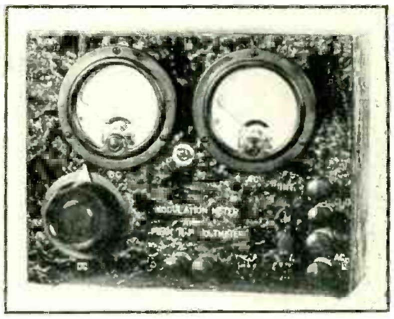


Fig. 1—Fundamental schematic wiring diagram for modulation meter

Fig. 2—The completed meter



Vacuum Tube Modulation Meter

Simple, inexpensive, vacuum tube meter for measuring modulation by noting ratio of two meter readings. Discussion of errors and method of accurate calibration are given

BY P. M. HONNELL
Houston, Texas

THE rapid and accurate measurement of carrier modulation is absolutely essential to the proper operation of a double-side-band modulated radio transmitter, whether in routine operation to obtain the maximum permissible modulation for economic utilization of the plant, or in design and development testing in which modulation is one of the fundamental operating characteristics which must be known. While numerous methods of making modulation measurements exist, the modulation meter here described is particularly inexpensive, quite accurate, and of the utmost simplicity in operation. While the modulation meter can safely be used without direct calibration, a simple and highly accurate calibration process is also described.

The principle of operation of the modulation meter is most easily understood from Fig. 1, in which D is a diode rectifier with a 0.1 megohm resistance load to insure a high degree of linearity in the demodulation of the carrier supplied through the blocking condenser C. The rectified current in the load resistance is directly proportional to the high frequency carrier envelope. The d-c component of this current is proportional to the average carrier amplitude and is measured by the d-c milliammeter; the a-c component of the load current is proportional to the carrier modulation and is measured by the a-c milliammeter. The purpose of the current transformer T is to isolate the copper-oxide a-c milliammeter from the d-c component.

The modulation of a carrier signal applied to the diode rectifier is then equal to the ratio of a-c to d-c milliammeter readings. Since the a-c milliammeter is calibrated in r-m-s values, and modulation is essentially a ratio of peak values, the (sinusoidal) modulation M of a carrier supplied to the diode is:

$$\% M = \frac{A-C}{D-C} \times 1.41 \times 100$$

where A-C is the a-c milliammeter reading and D-C is the d-c milliammeter reading.

While the factor 1.41 represents no great mental hazard in the computation of the percentage modulation, it is none the less undesirable. By using a current transformer T with a 1.41:1 step-up ratio this factor is automatically applied, and we have the very desirable and convenient result of equal readings on the a-c and d-c meters indicating 100% modulation, with other values equal to the ratio of a-c to d-c meter readings. By adjusting the input carrier until the d-c milliammeter reads 1.0 ma., the modulation factor is read directly from the a-c milliammeter. The adjustment of the d-c reading is made approximately by varying the coupling of the rectifier to the radio-frequency circuit and set precisely by means of the variable resistance R.

The modulation meter consists of two parts: the rectifier tube and 0.1 megohm load resistance placed at the transmitter connected through a shielded four-wire cable to the indicating meters and transformer contained in a compact aluminum cabinet 7″x10″x4″, illustrated in Fig. 2. The complete circuit diagram is shown in Fig. 3.

A type 6C6 or similar tube is used as diode rectifier, the control grid acting as the rectifier plate, the shield-grid, plate and other elements connected to the ground conductor and shield. The 0.1 megohm load resistance is a one watt IRC unit. For ultra-high-frequency work an acorn tube and metallized resistor would be preferable.

The d-c milliammeter is a Weston model 301, 0-1 ma.; the a-c meter a Weston model 301, 0-1 ma., rectifier type. The variable 50,000 ohm resistance is a wire-wound General Radio type 471-A rheostat.

The current transformer—wound on a husky audio-frequency transformer core of silicon steel—has a 1900 turn primary and a 3000 turn secondary both wound with No. 34 enameled wire. The 3000 turn secondary winding has approximately 30 henries inductance, the 1900 turn primary has 12 henries inductance and the coefficient of coupling is 99.7%. An electro-static shield between the two windings grounded to the aluminum cabinet is of material assistance in shielding the copper-oxide meter from radio-frequency currents. The measured loss in the transformer at 1000 cycles per second is one decibel or 12 percent. This loss is compensated over the useful frequency range by making the turns ratio 1.58:1 (3000 to 1900 turns) instead of the theoretical 1.41:1.

The connections are such that throwing the Federal anti-capacity switch on the modulation meter to the "Int" or internal position connects the instrument for modulation measurements; throwing the anti-capacity switch to the "Ext" or external position makes the copper-oxide milliammeter available for external use at the CuO terminals and the signal modulation components available at the terminals marked AC. These connections make the modulation meter available for various purposes: for instance, in making distortion measurements the AC terminals feed into a high-pass filter and calibrated amplifier and back to the copper-oxide meter; or, the modulation from the terminals AC is fed to an amplifier and loudspeaker for auditory monitoring, etc.

Although the modulation meter as described can be used without serious error, the following calibrating method is so simple and the required apparatus so easily available as to warrant the actual calibration.

The essentials of the calibrating circuit, shown in Fig. 4, are a source of audio-frequency of low harmonic content, such as a beat-frequency oscillator or audio-oscillator; a good 10 μf paper condenser and approximately 500 henries of inductance in series with a 100,000 ohm rheostat and 145 volts of "B" battery. The direct current from the "B" battery simulates a carrier voltage while the audio-frequency voltage simulates the audio modulation on the carrier.

The calibration is performed as follows: with the rectifier heater energized, the "B" battery voltage is adjusted until the d-c milliammeter reads a convenient value, say 1.0 ma. Now if the output voltage from the audio-frequency source (set at any desired frequency) is increased from zero, the a-c milliammeter will begin to register in direct proportion to the a-c voltage applied as read by V. (V is desirable but not essential in the calibration process.)

It will be noted that the deflection of the d-c milliammeter remains constant as the audio voltage is increased up to a certain definite voltage. Further increase in the audio voltage results in an increase in the deflection of the d-c milliammeter. At the point where the d-c milliammeter deflection just fails to increase, the peak value of the audio current in the primary of the current transformer, T, is just equal to the direct current flowing in that circuit. If the current transformer ratio is sufficient to overcome losses, the a-c milliammeter will indicate a value equal to the d-c milliammeter reading, or one milliampere in this instance.

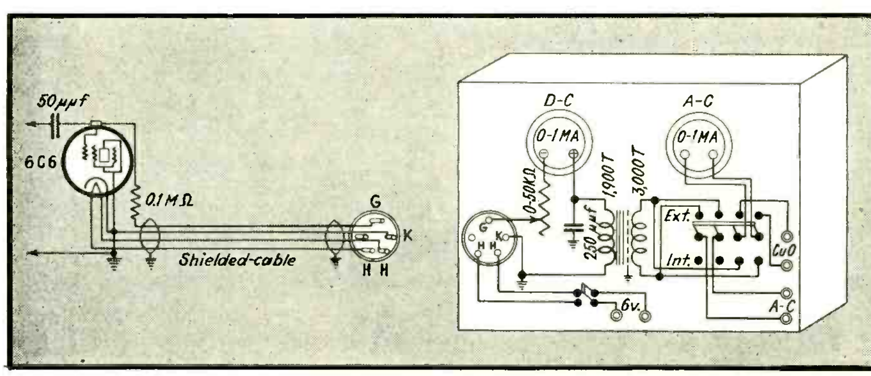


Fig. 3—Schematic wiring diagram and layout of the complete meter. The tube is connected through the shielded cable to the measuring circuit

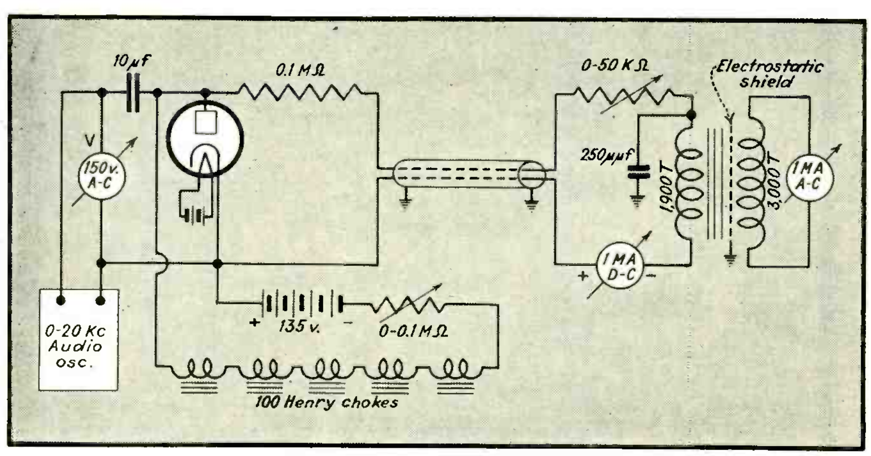


Fig. 4—Circuit arrangement for making accurate meter calibrations

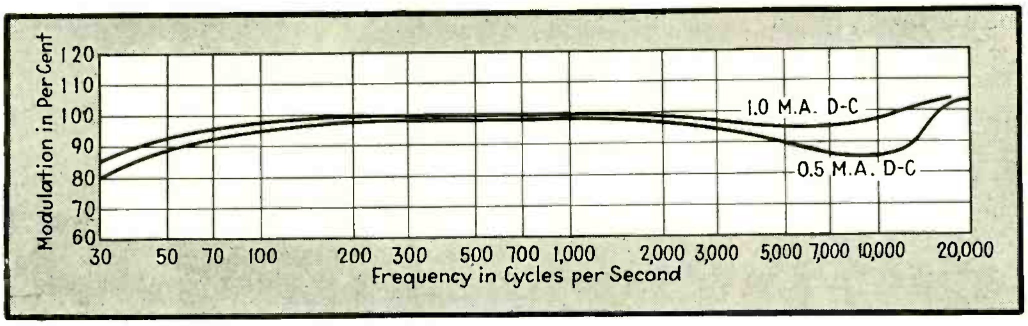


Fig. 5—Typical calibration curves at 100% modulation and carrier levels giving d-c readings of 0.5 and 1.0 milliampere

Since the peak value of the modulation component (the audio-frequency current) is equal to the carrier component (the direct current) the indicated percentage modulation is 100%. Should the a-c milliammeter read higher or lower than the d-c milliammeter the modulation measurement will be in error by the inverse of the same factor. The calibration is continued point by point for the range of audio frequencies desired.

It should be noted that this calibration process includes the effects of d-c saturation in the current transformer T. Saturation effects will be found by repeating the calibration at lower values of direct current, say 0.5 milliamperes. Calibrations at other than 100% modulation — the important figure — can be made by first obtaining the 100% calibration point, noting the value of V, and then setting V to the desired percentage, lower modulation percentages being directly proportional to the setting of V for 100%.

The precision of setting and calibration at 100% modulation and 1.0 ma. carrier level is better than 1% since the d-c milliammeter can be read to better than one-half a scale division. The measurements at lower percentages of modulation, or at lower carrier levels, are correspondingly less accurate, but always well within the rated accuracy of such meters.

Typical calibration curves for a 1.0 ma. and a 0.5 ma. carrier amplitude are shown in Fig. 5. The departure from a straight line parallel to the abcissa and intersecting the ordinate at 100% is due to variations in the current transformer loss, due in part to impedance variations in the copper-oxide meter; to insufficient inductance in the current transformer windings; to the frequency error in the copper-oxide meter; and to the effect of the shunt capacitance across the rectifier tube and in the shielded cable between the rectifier tube and the modulation meter. It is essential that the capacitance of the coupling condenser C be kept to 50 $\mu\mu f$ or lower if at all possible to preclude high-frequency cut-off. Similarly, for minimum error at the higher audio-frequencies the series resistance R should be set at zero and any desired adjustment of the d-c milliammeter reading made by varying the coupling capacitance to the rectifier tube R. Fig. 6 shows the magnitude of the error due to zero, 10,000 ohm and 20,000 ohm settings of the series rheostat R.

The importance of the frequency discrimination errors in the modulation meter depends upon the type of measurement to be made. If a modulation percentage measurement at 400 cycles per second is desired, the errors are negligible. If used with associated equipment for distortion measurements at 400 cycles fundamental, the errors are again unimportant. For measurements of percentage modulation as a function of frequency, that is, in obtaining a modulation amplitude-frequency measurement on a transmitter, the error below 70 cycles and above 5000 cycles per second becomes appreciable, but can be corrected for from the calibration curve.

Although the modulation meter does not measure separately positive and negative modulation peaks, this is only a minor limitation on the usefulness of the instrument, while the inclusion of the necessary circuit elements for this purpose would have unduly complicated the construction and calibration of the meter. On single-tone modulation tests the inherent error involved is of the order of magnitude of the distortion components in the modulation envelope, while on speech the modulation meter indications are as significant as those obtained on audio-frequency volume indicators utilizing similar copper-oxide meters as indicating instruments.

The use of a copper-oxide meter, relatively insensitive to radio-frequency currents, greatly simplifies the problem of shielding, as those who have tried using either thermocouples or vacuum tube voltmeters for measuring the a-c modulation component will readily agree. Further, copper-oxide meters with the d-c movement most suitable for the type of monitoring may be used.

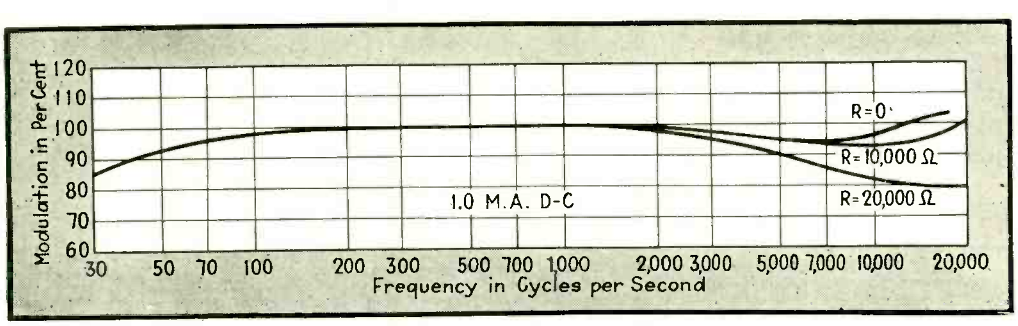


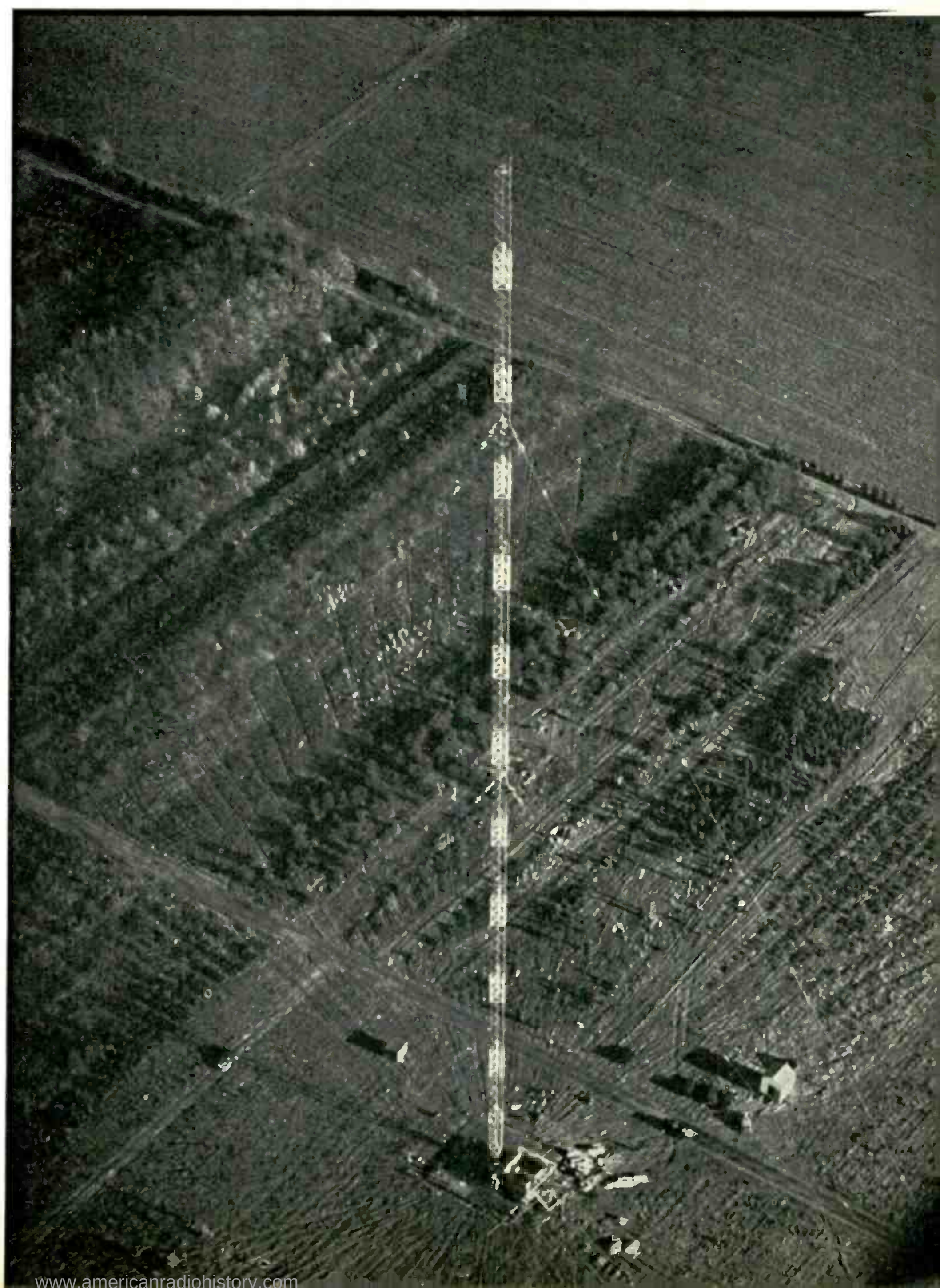
Fig. 6—Typical calibration curves at 100% modulation, 1 ma. direct current, and various values of circuit resistance

WJZ's New Tower "Proves In"

New 640-foot vertical structure more than doubles non-fading radius and increases signal five db. Tower and transmission line designed to handle 500 kw., for which a construction permit has been requested from the FCC

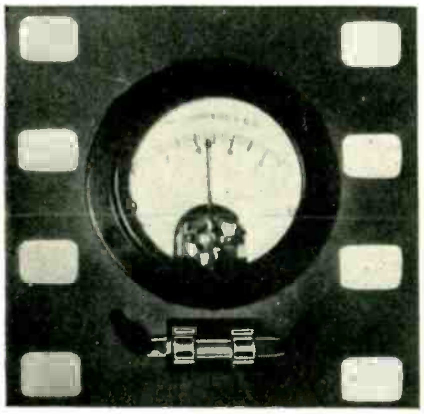
ON NOVEMBER 15th, the Tenth Anniversary Day of the National Broadcasting Company, the NBC engineers celebrated by putting a new 640-foot vertical tower in service at WJZ, Bound Brook, N. J. After a month of operation with the new antenna, sufficient evidence had been amassed from field strength measurements and from listener's letters to determine some preliminary estimates of the increase in service. The results are impressive: With 50 kw. of power in the antenna, the measured field intensity at one mile averages almost 2 volts (1800 millivolts), equivalent to an increase in power to 115 kw. The night non-fading area has been increased more than five times, corresponding to an increase of radius of greater than two times. This latter figure has been obtained by an analysis of letters received from listeners living within 150 miles of New York.

The tower itself has a length-to-width ratio of 100-to-1, yet it will withstand an indicated wind velocity of 115 miles per hour in the upper sections. This was actually tested by straining the guy-wire supports to 48,000 pounds tension, which corresponds to the force exerted on one guy by a 125-mile wind. The tower base, which consists of 300,000 pounds of concrete, resists a total down-thrust (tower weight and vertical component of guy-wire tension) of 230,000 pounds. This thrust is supported by the base insulator, the largest single porcelain cone insulator yet built. 90,000 feet of one-inch copper ribbon were plowed in for the ground system. The whole antenna system, including the transmission line, is designed for possible future use on 500 kw. power, pending action of the FCC on the application recently made by NBC for a construction permit for a 500 kw. installation.



New vertical radiator and ground (note radials) at WJZ. The cost: 70,000 dollars. The result: More and better-satisfied listeners

When Meters Blow



Edgerton photographs show how instrument fuses protect against overload and what happens to meters that "blow"

By LOUIS J. FOHR, JR.
Littlefuse Laboratories, Chicago

MOST every laboratory using electrical measurement instruments has at some time, experienced ruined equipment because some unforeseen development crept in and spoiled an important experiment. Most every production line that uses sensitive electrical meters for checking the quality of their product has, sometime at the highest peak of production, experienced a blown test board. And the question arises: "What happens when the meter circuit is overloaded?" The experience is very costly and unnecessary. The following study is a record of true experience on blowing delicate electrical test instruments under the most exacting conditions. The meter illustrations were taken by Mr. Harold E. Edgerton of Massachusetts Institute of Technology with the aid of his famous stroboscopic light. Each picture shows what happens in 1/600 second.

Several methods of protection were studied at Littlefuse Laboratories to determine their individual effectiveness. Instrument fuses ranked over every test between circuit breakers, fusible alloys, thermostatic breakers, and electrolytic valve action.

It is the popular misconception that the meter needle is wrapped around the stop on severe overloads. However, in the photographs we see a 0-1 milliammeter subjected to a direct short circuit on a 110 volt line, and the experiment showed that many things happen. The needle was bent in one frame, or 1/600 second, but it did not wrap itself around the meter stop. In fact, the needle point never overcome the starting inertia. The coil and movement turned 30° in 3/600 seconds, but the pointer remained stationary. When the movement reached full deflection, the needle just started to move. In 4/600 seconds the needle gains headway, but, by this time, the coil movement bounces back on the advancing needle, and the bearing points are badly dulled and out of line. After 7/600 second, the coil and both hair springs burn up and release the strain on the circuit. This arc registered as a "smear" of light on the film. After the experiment, the meter was examined, and it was found the bent needle needed replacement; the core inside the coil movement was badly charred and needed polishing; the coil and hair springs were completely burned out; and the two bearings were badly damaged.

Whether the overload is great enough to burn out the coil or just change the meter calibration, the result in the plant will be interrupted production.

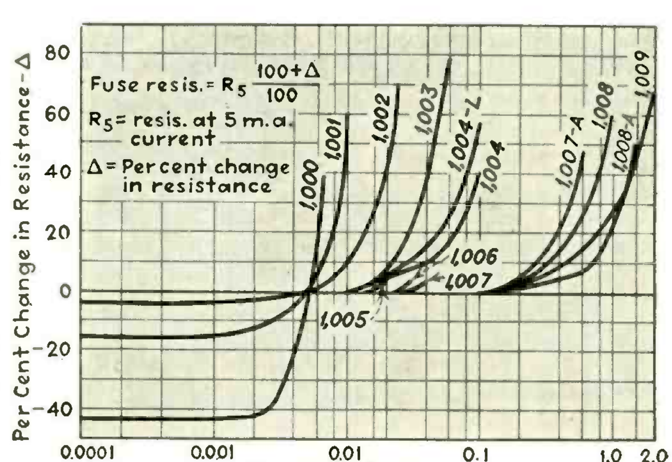
It must be remembered that even small overloads are apt to be the source of everlasting trouble in precision instruments. Quick shocks to the movement may cause the bearing points to become dull which would cause the response of the meter to become sluggish. The pointer may be shifted around on the shaft or bent. In this case, the zero adjustment will not bring the indicator into even approximate agreement with the scale marking.

In high grade spring-controlled instruments, every effort is made to keep the moving parts in gravitational balance. Severe shocks to the movement will change the action of the unit which may go unnoticed for several months.

Fast Protection

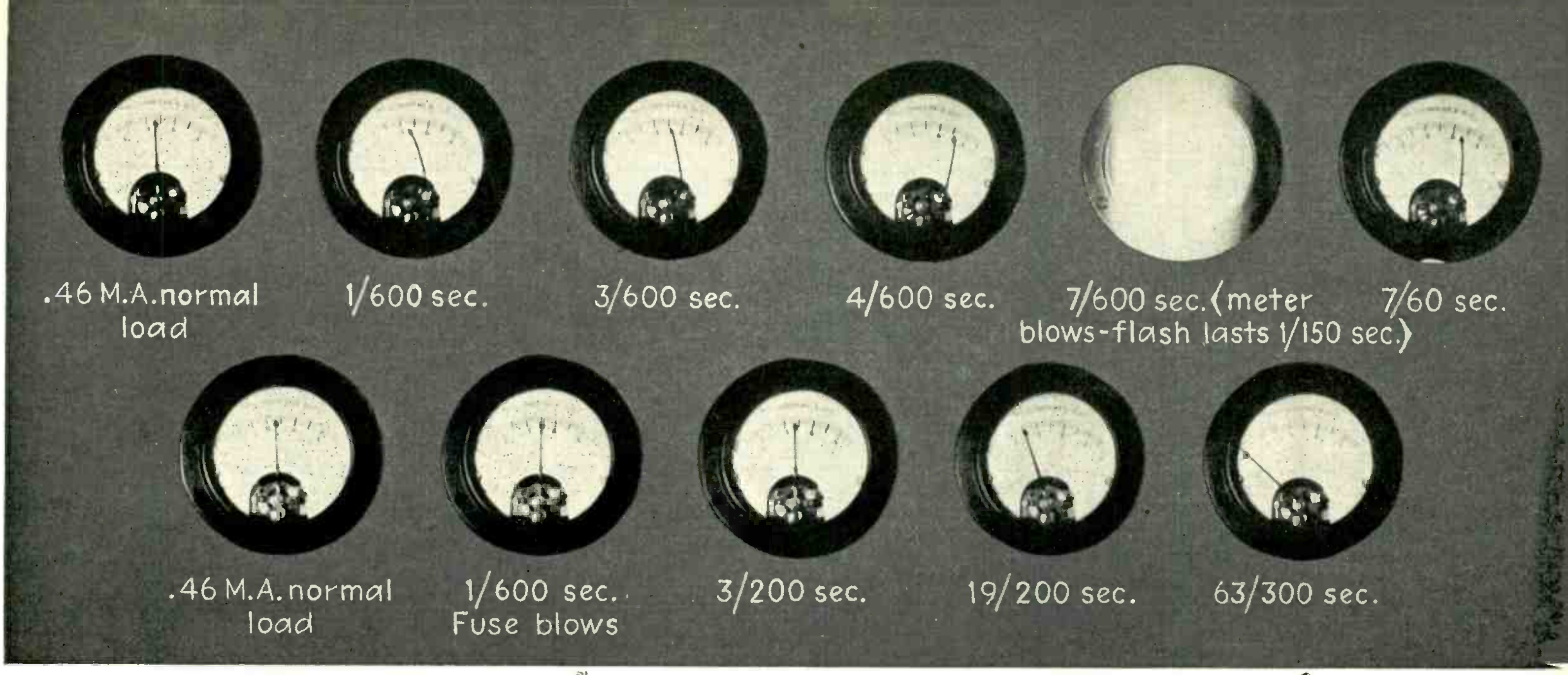
A very simple, but effective cure is to fuse the meter circuit. Such installations must be very accurately designed for each type of meter, but, nevertheless, standard sizes are available on the market at low cost. Where possible, the fuse should be used before the meter shunt or multiplier. In most cases, the added resistance of the fuse will add negligible error to the meter reading. If, however, the error should be greater than the allowed tolerance, a push button switch may be shunted across the fuse to short it out for final readings only.

Now suppose we use a duplicate meter, but protect it with a 1/100 ampere fuse. When we consider the



Effect of various loads upon resistance of fuse

Opposite page — Effect of various loads upon blowing time of fuse

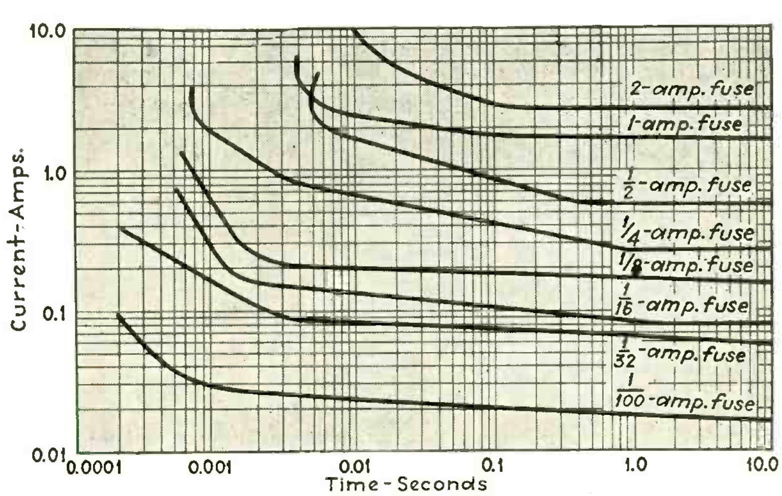


Top line—Milliammeter (0-1) subjected to direct short circuit across 110 volts. Bottom—Effect of fuse in protecting meter against direct overload

speed of "Old Man Overload," we can easily conclude that the fuse must act very fast or the needle will be bent. This time we again have an operating load of .46 milliamperes. The meter in series with the 1/100 ampere fuse is shunted directly across the line. There is a short lag due to the heating action of the fine platinum wire inside the fuse, and also the weight of the meter movement. The fuse resistance is 115 ohms at 5 milliampere load. As the current changes on the 1/100 ampere fuse from .0014 to .01 amperes, the fuse resistance changes from 109 ohms to 161 ohms. This is due to a ballast action; therefore, the needle rises from normal load of .46 milliamperes to .50 milliamperes under the severe direct short circuit. There is no quick motion of the needle, because the ballast action and the high speed blowing of the fuse released so little energy into the meter circuit. After the fuse blows the circuit is opened and the needle slows up and returns to zero in 1/5 second.

The reason for this fact action of the fuse is better described with time-current curves on the standard fuses. The curve for the fuse in this test is on the bottom of the graph, and shows that an overload of .02 amperes will blow the fuse in .1 second, but an overload of .1 ampere is interrupted in .0002 second. On an extreme overload, the blowing time is instantaneous, because the time required for an instrument fuse to blow is an inverse function of the degree of overload. This is a very important characteristic when protecting the calibration of a delicate instrument.

Now, let us use the same meter, but add a 300 ohm resistor for added ballast and connect it in series with the fuse to slow up the action of the needle still more. After the overload occurs (direct short across 110 volt d-c line in series with the 3,000 ohm resistor) the movement and needle point keep in step with each other. The action starts at normal load of .46 milliamperes and moves up to .52 in 1/100 second; up to .74 milliamperes in 41/600 seconds. At this point, the pointer is just gaining momentum; then, the fuse blows, and the needle drops to zero. The entire action takes place in 4/15 second, and the highest reading was only .74 milliamperes. Then the fuse blew before the movement could gain sufficient inertia to hit the stop and bend the needle or dull the bearing points. With this test, no quick action was noticed to damage even the most delicate instrument.



A word may be said about the construction of the instrument fuse used in these experiments. Platinum wire .000075 of an inch in diameter was soldered across a bridge of two parallel wires supported by a small glass bead. This is the same construction as the bead inside automobile lamps. The entire unit was hermetically sealed inside a 1" x ¼" glass tube with .025 brass ferrules, forming the caps, which were mounted into clips, supported at the base of the meter panel. The fuse resistance was 116 ohms in all tests, and their action was identical.

This 1/100 ampere fuse wire is 30 times finer than a human hair; it costs $11,280,000 per pound, but one pound would measure 25,100,000 feet; it is 16,800 times heavier than air yet it floats in air like a spider web; it is twice the size of the 1/200 ampere fuse wire, and both these wires are in commercial use today.

Broadcast Station Statistics

Capital investment, maintenance costs, revenue from sale of time, broadcast station personnel by occupation and average weekly salary, are among credit and debit items in broadcast station operation

Although carefully regulated by the Federal Communications Commission which issues licenses for their operation, although providing entertainment, education and news of one type or another, and although frequently engaged in interesting and exciting program pick-ups as well as the more usual and prosaic routine testing of equipment, broadcast stations are primarily operated for profit and to make a living for their owners. And whatever glamor or commonplace affairs may enter into station activities, the operation and maintenance of broadcast stations are subject to the same economic principles and laws that govern other businesses.

The costs going into the construction and operation of broadcasting stations, the revenue from sale of time on the air, the number of persons necessary to keep the station in operation, the distribution of personnel according to occupational function, and wage expenses are problems that are answered here for the typical or "average" broadcast station of the United States. The material presented on these pages has been taken from the statistical surveys made by the United States Department of Commerce and the National Advisory Council on Radio in Education.

From Table I it can be determined that (excluding those items which depend very largely on local economic conditions) the capital investment of broadcast stations is approximately proportional to the square root of the power rating. The cost of the transmitter is also proportional to the square root of the power and varies from 35% to 65% of the total capital investment. The studio speech input expense varies with the power of the station up to 50 kilowatts, after which it is constant.

From Table II, showing the annual maintenance costs of stations it can be determined that salaries vary approximately as the cube root of the station power and form from 76% (in the case of 100 watt stations) to 35% (estimated for 500 kw stations) of the total maintenance charges. Tube replacement costs are proportional to the cost of the transmitter, except that 50 kw stations appear to be unusually economical as regards this item.

In all of the pie charts, the values are given in thousands of dollars. In the field of local advertising, stations up to 100 watts account for 20% of the revenue, stations between 100 watts and 1 kw account for 22%, and stations between 1 kw and up to (but not including) 5 kw account for 34% of the total revenue. In the case of regional and national advertising, however, the lowest power group accounts for 2.9%, the next two groups for 10.4% and the 1 to 5 kw group accounts for 29.6% of the total revenue. The highest power group accounts for 49% of the total regional and national advertising, as measured by sales revenue.

In the analysis of revenue by geographical districts the Middle Atlantic and East North Central states account for 43.2% of the local advertising revenue and 51.9% of the regional and national advertising. All of the southern groups combined account for only 21.5% of local ad-

TABLE I—Capital Investment of Broadcast Stations

CAPITAL INVESTMENT	POWER OF BROADCAST STATIONS 100 W	1 KW	5 KW	50 KW	500 KW
PLANT					
Transmitter	$4,000	$12,500	$29,000	$120,000	$375,000
Speech Input Equip	....	2,000	2,500	3,500	5,000
Installation	200	1,000	3,500	10,000	25,000
RADIATING SYSTEM					
Antenna System	2,000	4,000	6,000	15,000	40,000
Ground System	....	1,500	2,000	3,000	5,000
STATION BUILDING					
Structure, etc.	....	7,500	15,000	40,000	75,000
Furniture, etc.	100	400	1,000	3,000	6,000
SERVICE					
Power Lines, etc	....	....	2,000	20,000	30,000
Water System	Dependent Upon Local Conditions				
Telephone Lines	Dependent Upon Local Conditions				
ENG'G. SURVEYS, ETC	100	500	1,000	3,000	6,000
MISCELLANEOUS	200	600	1,000	6,000	15,000
STUDIOS, OFFICES, ETC	Dependent Upon Specifications Adopted				
STUDIO SPEECH EQUIP	2,000	4,000	6,000	12,000	12,000
OUTSIDE PICK-UP EQUIP	....	1,600	1,600	3,200	3,200
TOTAL (Excl. Real Estate)	$8,600	$35,600	$70,600	$238,700	$597,200

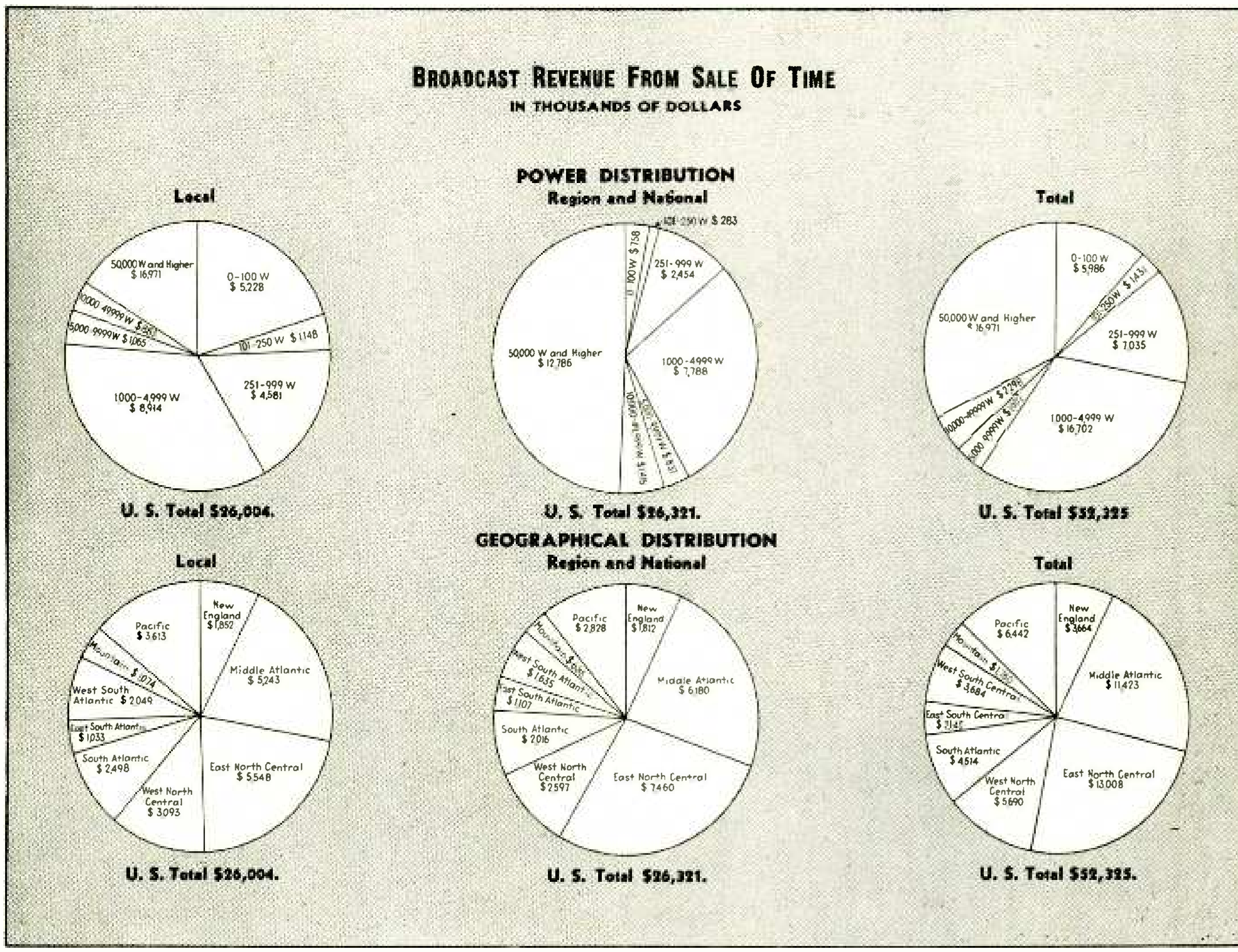


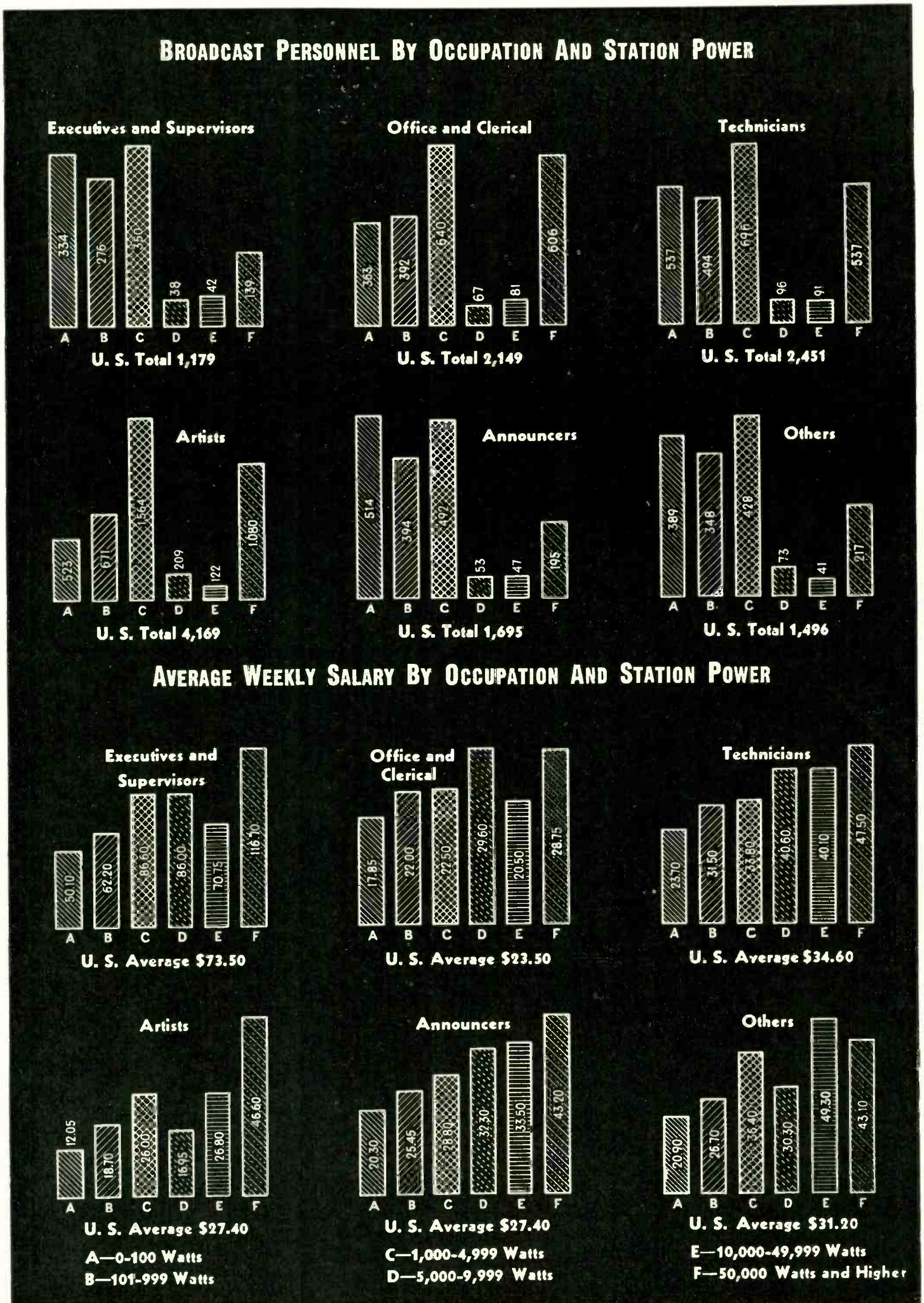
TABLE II—Maintenance Costs of Broadcast Stations

ANNUAL MAINTENANCE COST	100 W	1 KW	5 KW	50 KW	500 KW
	POWER OF BROADCAST STATIONS				
5% INTEREST ON CAPITAL	$325	$1,500	$3,000	$10,200	$27,600
DEPRECIATION					
Transmitter (At 20%)	1,320	6,000	12,000	40,800	110,400
Buildings (At 3%)	Depends Upon Investment				
Furnishings (At 10%)	10	40	100	300	600
RENTAL	Depends Upon Local Conditions				
SALARIES					
Executives	2,650	9,000	9,000	20,000	31,000
Office and Clerical	940	2,340	3,080	5,200	7,500
Technicians	1,230	5,250	11,000	31,200	49,500
Artists	1,250	5,400	10,600	25,100	60,500
Announcers	2,110	4,500	5,050	7,000	13,500
Salesmen and Others	2,180	5,500	6,300	10,600	11,200
POWER	400	1,500	4,000	19,000	100,000
MAINTENANCE OF PLANT					
Electrical	300	1,000	2,000	5,000	8,000
Structural	100	200	300	500	1,000
Tube Replacements	600	2,000	4,000	10,000	60,000
WIRE LINES	....	....	3,600	7,500	15,000
MISCELLANEOUS	....	....	....	350	1,000
TOTAL	$13,415	$44,230	$70,430	$188,070	$496,800

vertising revenue and 18% of the regional and national revenue.

The individual bar charts are not all drawn to the same scale although the bars in each individual chart are proportionally correct. One chart cannot, therefore, be compared directly with another and still maintain a proportionally correct visual picture. The upper half of the page shows the number of persons engaged in broadcast activities, classified according to power of station and occupational function. The total number of persons of one particular occupational classification engaged in broadcasting in the United States is shown at the bottom of the separate bar charts.

The lower half of the page gives the average weekly salary of the various occupational groups according to station power. These figures are averages for the United States and are subject to fairly wide geographical variations. Obviously individual wages are subject to still wider fluctuations. —B. D.



BROADCAST PERSONNEL BY OCCUPATION AND STATION POWER
Executives and Supervisors
334 276 350 38 42 139
A B C D E F
U. S. Total 1,179
Office and Clerical
363 392 640 67 81 606
A B C D E F
U. S. Total 2,149
Technicians
537 494 696 96 91 537
A B C D E F
U. S. Total 2,451
Artists
523 671 1564 209 122 1080
A B C D E F
U. S. Total 4,169
Announcers
514 394 492 53 47 195
A B C D E F
U. S. Total 1,695
Others
389 348 428 73 41 217
A B C D E F
U. S. Total 1,496
AVERAGE WEEKLY SALARY BY OCCUPATION AND STATION POWER
Executives and Supervisors
50.10 62.20 86.60 86.00 70.75 116.10
A B C D E F
U. S. Average $73.50
Office and Clerical
17.85 22.00 22.50 29.60 20.50 28.75
A B C D E F
U. S. Average $23.50
Technicians
23.70 31.50 33.80 40.60 40.10 47.50
A B C D E F
U. S. Average $34.60
Artists
12.05 18.70 26.00 16.95 26.80 46.60
A B C D E F
U. S. Average $27.40
Announcers
20.30 25.45 28.80 32.30 33.50 43.20
A B C D E F
U. S. Average $27.40
Others
20.90 26.70 35.40 30.30 49.30 43.10
A B C D E F
U. S. Average $31.20
A—0-100 Watts
B—101-999 Watts
C—1,000-4,999 Watts
D—5,000-9,999 Watts
E—10,000-49,999 Watts
F—50,000 Watts and Higher

Nomogram for Coil Calculations

Chart for determining inductance-dimension data of single-layer solenoids, based on the Nagaoka formula, which eliminates the need of calculation. Applicable especially to transmitting coils

By CARL P. NACHOD

THE chart printed on the reverse side of this sheet is a nomogram based on the Nagaoka formula (*Bureau of Standards Circular*, No. 74) which gives the inductance of a single-layer solenoid in terms of its length, diameter, and winding pitch. The formula is:

$$L = \frac{0.025\, D^2\, l\, K}{p^2}$$

where L is the inductance in microhenries, D the diameter of the coil (helix) in inches, l the length of the coil in inches, p is the pitch of the coil (inches per turn), and K is the Nagaoka "form factor" which is a function of D/l. This ratio D/l can be calculated if desired, but it may be found also by reference to Fig. 1 below. By connecting the given values of D and l with a straight line, the right-hand scale marked R gives the ratio D/l. This value of D/l is then used in connection with the scale marked R in the inductance nomogram.

In the nomogram it will be noticed that there are five vertical lines. The line at the extreme left (marked V) is simply a turning scale and is not graduated. The inductance scale L is marked from 5 to 500 microhenries. The middle scale gives the pitch P in inches and also serves as a turning scale (Q). Values of the ratio $R = (D/l)$ from 0.1 to 10 are given. The scale at the extreme right is graduated both in length and diameter, covering values of l from 1 to 100 inches and of D from 2 to 20 inches. The use of turning scales and the combination of D and l in one scale make the nomogram highly compact without lessening accuracy.

To find inductance when dimensions are given, the line lpV is drawn through the given values of length and pitch. The intersection of lpV with the V scale is then connected with the given value of diameter, in the line VQD. Finally the intersection of VQD with the Q scale (same line as p scale) and the given value of R (as found from Fig. 1) are connected in the line LQR, intersecting the L scale in the value of inductance. In the example given, a coil 7 inches long, with a winding pitch of 0.26 inches per turn, and a diameter of 2.1 inches is found to have an inductance of 10 microhenries.

When one dimension is to be found from the given inductance and given remaining dimensions, the order of drawing the lines is changed. For example if p is to be found when L, D and l are given, the intersecting lines are drawn in the order LQR, DQV and lpV. The values of l, D, and R used must always be in the relation $D/l = R$ and the lines must always intersect the turning scales V and Q.

By making use of Fig. 1, the value of $n = l/p$ which is the total number of turns in the coil can also be found. Since single-layer solenoids are now used principally in inductances for transmitting purposes, rather than in receiving-set applications, the dimensions included in the scales apply to coils of fairly large size.

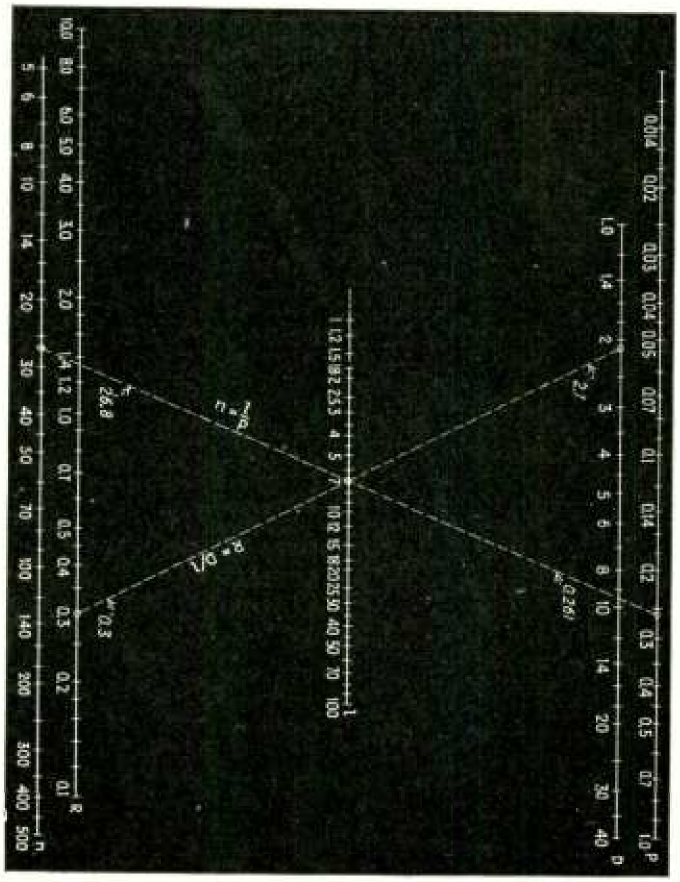
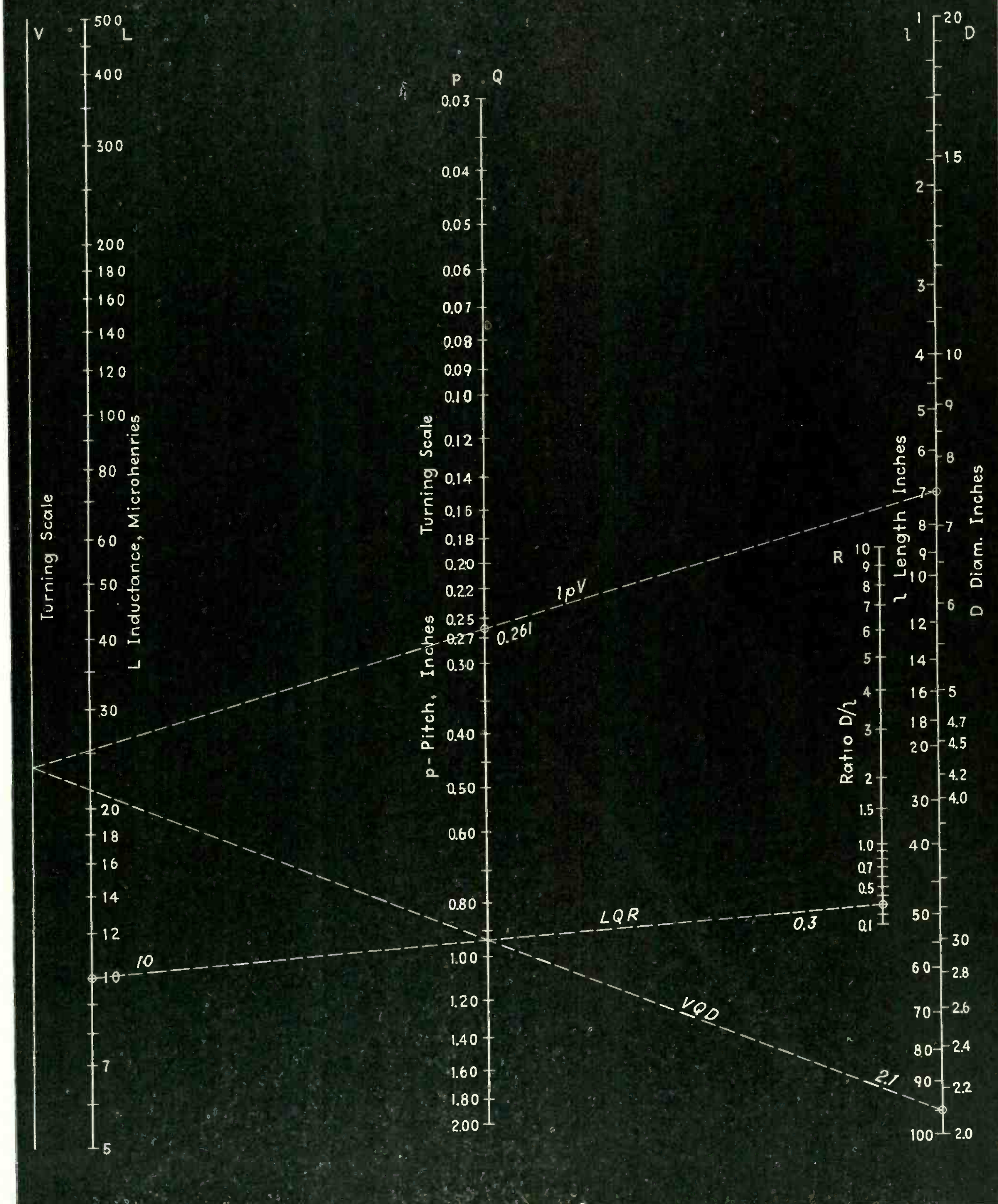


Fig. 1. Auxiliary nomogram for determining diameter-to-length ratio and total number of turns

SOLENOID INDUCTANCE CHART

BY CARL P. NACHOD



The Band-spread Problem

Adapting an earlier work in *Electronics* by Landon and Sveen to the problem of computing band-spread circuits for modern all-wave superheterodyne receivers

By R. C. WOODHEAD
Montreal, Canada

THE growing popularity of short wave superheterodyne receivers for both communication and amusement purposes has made it desirable that there should be some simple and accurate method of designing band spread radio frequency and oscillator tuning circuits without the necessity of laborious "cut and try."

The majority of household multiwave receivers are equipped with ingenious forms of mechanical band spread, the idea apparently being to make each receiver a "Jack of all waves and Master of none." If electrical band spread were employed, it would be possible to extend the popular broadcast areas, such as those at thirty and fifty meters, over the entire dial, and omit the "poor hunting grounds" lying in between.

This method of designing the band spread tuning circuits (which, by the way, is mathematically exact) is an extension of the method given by V. D. Landon and E. A. Sveen in *Electronics* August 1932.

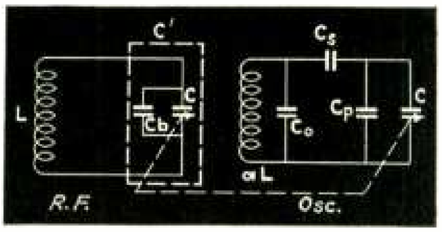


Fig. 1—Radio frequency and oscillator circuits

Figure 1 shows the radio frequency and oscillator circuits, together with the symbols representing the various component parts. While the diagram shows the radio frequency tuning circuit arranged for simple parallel band spread, the actual type of band spread employed in the radio frequency stages is immaterial as long as the symbol C' is taken to represent the equivalent capacity shunting the coil L when the capacity of the variable gang tuning condenser is C. Series band spread would probably be more satisfactory for frequencies above ten megacycles, as the L/C' ratio will be much higher. C_o represents the self capacity of the oscillator tuning coil (of self inductance aL), while the self capacity of the coil L is assumed to be included in C_b. In the work that follows, all capacities are expressed in $\mu\mu$f, inductances in μh, and frequencies in megacycles, although in most of the steps, the results do not depend on the units used as long as they are used consistently. The resonance equation expressed in these units becomes:

$$\text{Frequency} = 1000 \div 2\pi\sqrt{(LC)}$$

The steps are as follows:

(1) Calculate the values of the fixed band spread condensers for the r-f circuits to cover the desired band of frequencies with the given variable condenser. In the case of parallel band spread shown, C_b is given by the familiar relation:

$$C_b = \frac{(F_{min})^2(C_{max}) - (F_{max})^2(C_{min})}{(F_{max})^2 - (F_{min})^2}$$

(2) Calculate L using the resonance equation. In the case of parallel band spread, the values of ($C_b + C_{max}$) and (F_{min}) are substituted in the equation.

(3) Choose the three frequencies (F_1, F_2, F_3) within the band at which the tracking is to be perfect. For optimum tracking over the entire band, the positions of the three frequencies with reference to the ends of the band should be approximately the same as in the numerical example which follows.

(4) Find C_1', C_2', C_3', the three values of the equivalent capacity C' corresponding to the three chosen freqencies by substituting L and each of the frequencies in turn in the resonance equation.

(5) Find C_1, C_2, C_3, the three corresponding values of the capacity of the variable tuning condenser. In the case of parallel band spread, $C_1 = C_1' - C_b$ etc.

(6) If F_m is the intermediate frequency, calculate:

$$N_1 = C_1'[F_1/(F_1 + F_m)]^2$$

$$N_2 = C_2'[F_2/(F_2 + F_m)]^2$$

$$N_3 = C_3'[F_3/(F_3 + F_m)]^2$$

(7) Calculate $x = (N_1 - N_2)(C_2 - C_3)$
$y = (N_2 - N_3)(C_1 - C_2)$

(8) Calculate $b = (N_1 y - N_3 x)/(y - x)$

(9) Calculate $d = \dfrac{(C_1 - C_2)(b - N_1)(b - N_2)}{(N_1 - N_2)b}$

(10) Then, $C_s = d + C_o$ (almost exactly).
If C_o is not small compared to d, the exact relation: $C_s = \dfrac{d + \sqrt{(d^2 + 4C_o d)}}{2}$ may be used.

(11) $a = \dfrac{b}{C_o + C_s}$ hence aL, the oscillator inductance, may be found.

(12) $C_p = \dfrac{(C_1 + C_s)(N_1 - aC_o) - aC_1C_s}{b - N_1}$

As a check on the ideal accuracy of tracking in a typical case, the following problem was worked out using seven figure logarithms:

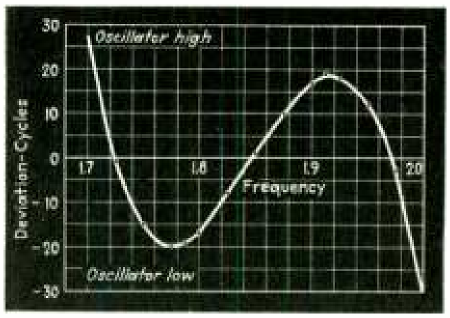


Fig. 2—Graph showing deviation from perfect tracking

A set of coils is to cover the 160 meter band (say 1.7 to 1.0 Mc.) using a 150 $\mu\mu$f variable condenser (15 to 165 $\mu\mu$f). The self-capacity

[*Continued on page 48*]

RECENT

Radio Operating Questions and Answers

BY ARTHUR R. NILSON AND J. L. HORNUNG. *McGraw-Hill Book Company, 1936. (425 pp. Price $2.50.)*

THOSE WHO TAKE examinations for radio operator's licenses under the Federal Communications Commission have the fortune to be able to go to a selected list of questions asked on all sorts of radio problems and situations—and to find answers that, presumably, have satisfied the examiners in the past. The questions, of which there are 639 in the latest (sixth) edition, have been taken from many sources. They, plus the answers, ought to give any prospective license holder sufficient ammunition to crack any of the grades of examinations now held.—K. H.

Television–A Guide for the Amateur

BY F. A. MOSELEY AND HERBERT McKAY. *The Oxford University Press, London and New York, 1936. (144 pp., illustrated. $2.)*

THIS SMALL book, evidently written in response to the demand for information on the part of the British television public, comes dangerously close to being "just another book on television." The book is well written, so far as it goes, and the illustrations are numerous and well chosen, but the information presented is not sufficiently detailed to interest the technical reader. For the intelligent layman who has but a smattering of technical knowledge, however, it serves the purpose very well. It covers the field from the early mechanical scanning days up to the present cathode ray systems, and includes the latest advances in the way of pick-up cameras and similar devices.

We think it high time that books on television should be illustrated, where necessary, with *actual* television images rather than with "pasted-in" photographs. This the authors have not seen fit to do; in the book there is only one "image" (page 44) and it is obviously a paste-pot job. This objection should not be taken as typical of the book, which is a creditable job considering the type of reader for whom it is intended.—D. G. F.

Electronics and Electron Tubes

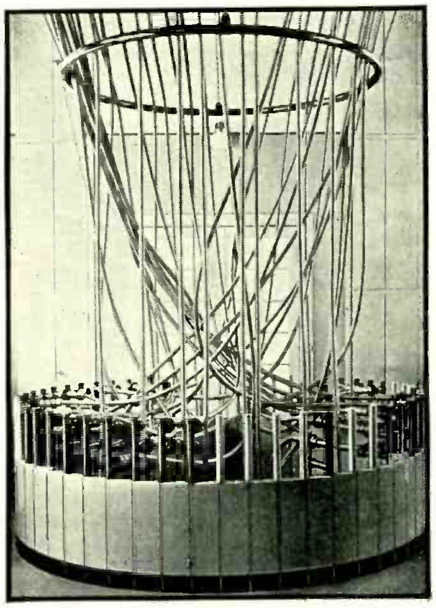
BY E. D. McARTHUR, *General Electric Company. John Wiley and Sons, Inc., New York, 1936. (181 pages. Price $2.50.)*

THIS BOOK, reflecting the author's broad experience in power tube engineering, is concerned more with large power tubes than with the smaller receiving types, and in this it differs from most previous books on the subject. The fundamentals of the subject, which apply to large and small tubes equally, are well presented, but the examples are taken almost exclusively from power-tube practice. This in no way detracts from the value of the book, but it does startle the reader to see characteristic curves given in terms of kilovolts of grid potential and amperes of plate current.

The book opens with a discussion of the elementary particles involved in electronics, discusses the properties of gases and then proceeds to the theory and practice of vacuum electron tubes.

• • •

ANTENNA TERMINAL



This basket-like maze is the antenna termination system of the German directional receiving station at Beelitz. The circular base permits switching on any of the 54 lead-ins, each of which can feed three receivers

• • •

This latter section includes chapters on the elements (principles rather than structures) of the electron tube, on the two-element tube, on the theory of grid control and on the practical applications of triode and multi-grid tubes. Well written sections on gas and vapor-filled tubes and their applications are also included. The bibliographies under each subject are well chosen and extensive.

Despite its general excellence the book suffers from poor arrangement in several respects. For example, in the chapter on two-electrode tubes, ordinary vacuum diode rectifiers are classed with phototubes and selenium tubes. The latter two classes are two-electrode tubes, to be sure, but their action is so very different from that of a vacuum diode that they belong in a chapter by themselves together with introductory material on the photoelectric effect. Likewise, it appears that the material on properties of gases should be presented in connection with gas-filled tubes instead of in an unrelated chapter. There are also a few errors in proofreading, including an incorrectly stated formula on page 5.

The book is recommended for those who require a short treatment of the field on a technical plane which does not entail too much mathematical theory, and which can be used as a basis for further reading.—D. G. F.

Radio Field Service Data

BY ALFRED A. GHIRARDI, *Radio and Technical Publishing Co., Publishers, New York City. (Price $2.50.)*

THE SECOND EDITION of this book, appearing in loose-leaf form with supplement sheets issued at regular intervals, is intended as an up to date working text for the service man. An interesting feature of this book is the rather large section on "case histories" which outlines the more important and frequent service operations required for various types of receivers. In addition to circuits, a large list of intermediate frequency values for superheterodyne alignment, a table of tube characteristics, socket connections and other strictly service data, the volume contains a number of tables and charts not directly bearing on service work but useful to the radio mechanic.—B. D.

Control of Electric Motors

BY PAISLEY B. HARWOOD, *John Wiley and Sons. (1936) (Price, $4.50. 390 pages.) Illustrated.*

IN THE PREFACE the author of this book, who is Engineering Supervisor of Cutler-Hammer, Inc. states that, "the object of this book is to describe briefly the characteristics of various types of motors, and to explain how these characteristics are used for control purposes. The design, construction, and operating characteristics of a number of controllers and control devices are discussed, and methods of combining these devices to secure a desired result are described." The aim as here expressed has been quite adequately met.

An interesting and desirable feature of the book is the last chapter on "Electronic Devices" which is devoted to a

BOOKS

brief description of the operation of gaseous and vacuum tubes and their use in control circuits. The details of tube theory and operation are not touched but the subject is well handled considering the range of material covered in 47 pages. While, perhaps, more space could have been given to tube control applications in view of the newness of the subject, it appears that the space allotted is in keeping with the present commercial application of electron devices to the control of motors. Two pages are devoted to a bibliography and references on electron tube theory and applications for those who desire to go into this subject more thoroughly.

The author has written a practical treatment on the subject which will enable the reader to obtain immediate usefulness from the volume. Except for a brief discussion of wave form in tube circuits, the book is almost completely non-mathematical. The few undesirable features, such as the use of the symbol f rather than R_f to indicate field resistance, the fact that the meaning of some of the mathematical symbols is not as well indicated as might be expected, and that sometimes the illustrations and diagrams are several pages removed from the text which they illustrate, are entirely minor matters which do not detract seriously from the usefulness and general excellence of the book.—B. D.

Cathode Ray Oscillography

BY J. T. MACGREGOR-MORRIS AND J. A. HENLEY. *The Instruments Publishing Co., Pittsburgh, 1936. (249 pp., illustrated. $6.00.)*

THIS BOOK, one of a series written and printed in England, but published in this country, is a worth-while modern treatment of cathode-ray technology. The opening chapters discuss electron theory, including the dynamics of the moving electron, and the methods of producing beams by the methods of electron optics. Both cold-cathode and hot-cathode types of oscillographs are then described in detail, the former being somewhat unfamiliar in American engineering practice, but of great scientific importance. In the more familiar hot-cathode types, examples are taken from German, British and American practice. The chapter on sweep-circuits might, in this reviewer's opinion, be somewhat larger than it is, but adequate circuits for most purposes are presented. The remainder of the book is concerned with practical applications of cold- and hot-cathode types, including those involved in television transmission and reception. The book should be useful to those who require a review of cathode-ray systems and methods.—D. G. F.

Electronic Television

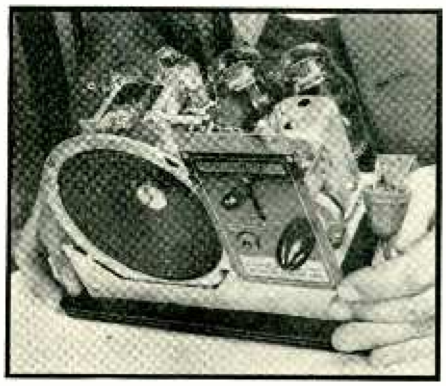
By GEORGE H. ECKHARDT, *Goodheart-Willcox Company, Chicago, Publishers. Illustrated. (162 pages; price $2.50.)*

"ELECTRONIC TELEVISION" is a book intended for the non-technical reader who desires to become acquainted with recent television trends. The descriptions, which are limited to the Farnsworth and RCA systems of this country, are up to date. The photographs, of which there are a large number for a book of 162 pages, are well reproduced, and in general the printing, make-up, and binding are good. The line drawings, however, are poorly executed.

The book is divided into three parts dealing, respectively, with the transmission of pictures, the reception of pictures, and by-products of television research. It is evident that the author had access to both Farnsworth and RCA information in the preparation of this book. Most of the descriptions are short, incomplete, and lacking in essential details. There is a repeated statement that filters permit selection of impulses by amplitude selection, and on page 27 the author states, "The circuit is similar to that of an ordinary oscillator circuit, except the capacity of current is small compared to the inductance capacity of the tube and winding of wire."—B.D.

• • •

CARRIER TELEPHONE VIA LIGHTING WIRES



This carrier telephone unit for inter-office use sends r-f energy over the power line. The dynamic speaker serves as speaker and microphone

• • •

Radio Amateur's Handbook

1937 *(14th) Edition. American Radio Relay League. (422 pages plus advertising.)*

NEARLY 400,000 of these *vade mecums* for amateurs have been sold by the home office of the ARRL. Since 1926 when the first small edition appeared the volume had steadily increased in size and value and in distribution until now, it hardly seems necessary to review the latest issue. All amateurs of any standing have been exposed to its data on principles, tubes, circuits, transmitters, receivers, power supply, antennas, measurements, station operation and message handling.

This year, in line with technical trends, special attention is devoted to noise silencer circuits. New tube types are explored for new and useful applications. Ultra high frequencies get a large share of space as is natural.

But why go on — it is a bang-up good book on radio, for amateur or engineer, it is well known, and it is a swell buy for a dollar.—K. H.

Official Radio Service Handbook

By J. T. BERNSLEY. *Gernsback Publications, Inc. New York, N. Y. (1008 pages 1936. Price $4.00.)*

THIS REVIEWER HAS the greatest of respect for radio service men. Not only must they take care of the natural illnesses of radio receivers but they must clean up a lot of dirty work often left in the receivers by the engineers who designed and built them. So complex has the modern service man's job become that books for him are now larger and more expensive than books for radio engineers!

This book does not state why it is the "official" handbook, but it is a textbook for service men containing practical radio theory and servicing information. It is intended to make the serviceman's daily tasks easier.

It starts off with the fundamentals of radio, goes into more intricate circuits used in present day sets, how to align them; it treats control and indicator circuits, A.V.C., power supply, audio systems, loud speakers and P.A. apparatus. Finally it carries one along into commercial set analyzers, including the cathode-ray tube equipment, has a chapter on hints on receiver repairs, another on unusual service experiences, a chapter or two on automobile radio—there's going to be a lot of service here, one of these days—follows with noise elimination. Finally it has several hundred pages of facts about modern receivers, the i-f frequencies used, voltage divider data, tube complements etc.—K. H.

Backtalk

THIS PAGE is the result of a letter from C. J. Franks of Ferris Instrument Company. Mr. Franks believes there ought to be a page in *Electronics* where the reader (10,500 of him) can have his say — just as the Editor has his page called Crosstalk.

Having decided to have such a page, the question of title comes up. Crosstalk is a technical term widely used in the communication art. Its meaning is well known. There is another, somewhat similar, term that comes to mind, "monkey chatter". Anyone can see there are difficulties with it. Monkey chatter might fit the Editor's page, but it would be ungenerous to use it as a label for this, the Readers' page. Letters published in Backtalk represent the writer's viewpoint with which the Editor (and reader) may disagree.

Short-Wave Therapeutics

In your article, "Electron Tubes in Diathermy," November *Electronics*, you state "it appears that one frequency is, roughly, as good as any other." The following references to the literature should be interesting to your readers:

Dr. Paul Liebesny, head of General Hospital, Vienna, author of "Kurz und Ultrakurzwellen Bilogie und Therapie" has demonstrated 15 meter waves to be destructive in certain diseases, whereas 4 meter waves were curative.

Dr. E. Schliephake in "Short Wave Therapy" states that in diseases of the liver 12 meter waves were without results but with 6 meter waves a lightning-like improvement set in and he also stresses, in his later papers, the point of the biologic efficiency of the still shorter waves.

Dr. Stefan Jellinek, University of Vienna, uses only 1 watt, 3 meter waves for his successful biologic experiments on both living tissue and eggs and he attributes, as I did in 1928, that these changes are due to a catalytic effect. Dr. E. Weissenberg of Dr. Potzl's Neurological Clinic in Vienna has treated many patients with ultrashort waves of low intensity, from a fraction up to 5 watts.

Dr. Lee de Forest states "My observations have led me to the same point of view as you take in the interesting paper by yourself and Dr. F. T. Woodbury, that it is by no means the selective heating and general thermal increase of body tissue which produces the surprising beneficial results obtained with radio therapy."

J. H. HALLBERG
303 Fourth Avenue
New York City

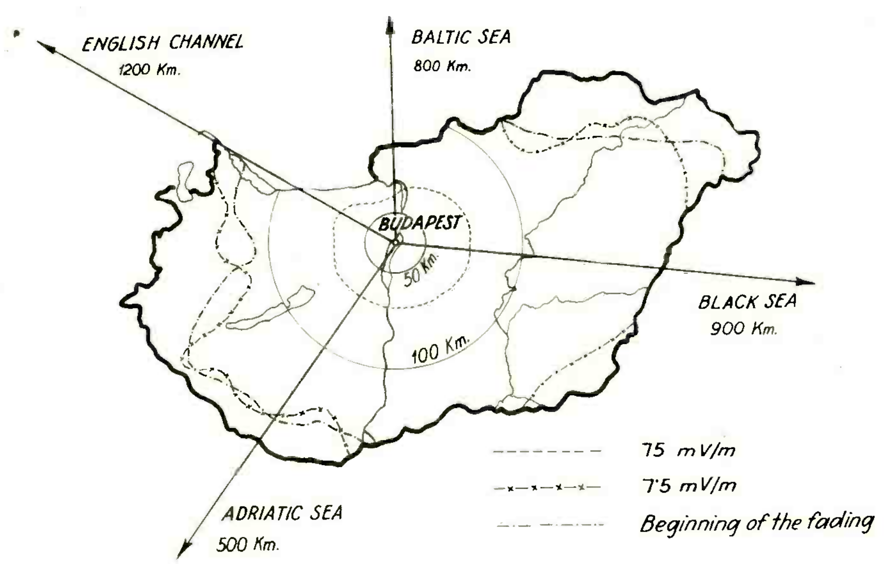
Broadcasting on 546 Kc

In view of the fact that the U.S.A. broadcasters are in need of an additional band of frequencies, it has been considered to use the 500-550 kc band. As is also known from Aiken's article, one of the most serious objections to using this band for broadcasting is that: "it would be a menace to safety of life and property on sea". The existing Governmental regulations prescribe in general the equipping of ships with radios, but no mention is made in them as to the quality of the equipment.

With regard to the foregoing, it must be seriously considered at what distance from the sea coast (as a function of the antenna power) broadcasting stations working in the mentioned band were to be erected, and whether these stations should work with directive antennae, to reduce interferences. Budapest I. is working on 546 kc and with an antenna power of 120 kw, and it might be of interest to report the experiences and observations made with this transmitter, as conclusions can be drawn from them.

The Budapest I. (Lakihegy) station was erected a couple of miles to the South of Budapest, on an island on the Danube river. Its antenna was designed as a half-wave, vertical antenna, so as to have a fading-reducing and a horizontal-radiation property. The antenna's iron construction itself is the radiator. The radiated frequency response on 7 kc is —2 db, on 9 kc —6 db relative to the 1 kc level. The modulation by speech is 40–50%, and increases to 90% in the case of a musical fortissimo.

In the radiation diagram we see the circles of 50 km and of 100 km, the distance of the transmitter from the surrounding seas, further the curves of daylight field intensity of both 75 mV/m and 7.5 mV/m, and also the curve where the fading, i.e. the night variation of field intensity begins to be noticeable.



The Hungarian Post Office has received no complaints whatsoever indicating that Budapest I. was interfering with radio service on the surrounding seas. The equipment of the ships on the above seas does not differ from those used on the ships communicating towards or along the coasts of the U.S.A.

The data given here prove that, even in the case of broadcasting transmitters of high radiation power (and where the antenna is not even a directive one), in the case of 500-550 kc, it is not necessary to retire too far back from the coast.

VICTOR A. BABITS,
University of Technical Sciences, Budapest

TUBES AT WORK

THIS month's crop includes tubes at work examining razor blades, producing current pulses, amusing rifle enthusiasts, testing enamel insulation, protecting wild life, creating swing music, testing textile gelatines

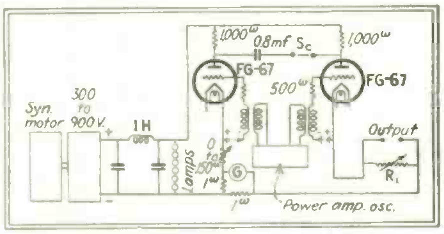
Phototubes Examine Edges of Razor Blades

RECENT ADVERTISING has informed the public that the edges of razor blades are being tested automatically by the "Electric Eye." The method by which this is accomplished is described in a letter from Mr. A. R. Stargardter of the Gillette Safety Razor Company.

As a blade undergoing examination passes through the machine, a high powered light source casts a beam of light of very small cross section at an angle across the shaving edge. A photo-electric cell is so arranged that any light reflected from the blade edge will act upon its face. The amount of light reflected into the cell window is measured by means of a galvanometer, since the current emission from the photo-electric cell is proportional to the amount of light acting upon it. The mirror of this measuring galvanometer casts a spot of light on the recording chart of the instrument, so that as the blade proceeds through the machine the position of the light on the chart gives a constant reading in terms of amount of light reflected from the corresponding position along the blade edge. The sharper the edge the less light will be reflected from it, so that it is possible to calibrate the sharpness of the blade according to the amount of light it reflects.

Thyratron Inverter Used in Studying Filament Characteristics

IN A RECENT STUDY of the thermionic emission of tungsten and thoriated tungsten filaments reported in the *Physical Review* by Prof. W. B.. Nottingham, of M.I.T., it is pointed out that for accurate measurements of emission, especially with low accelerating or retarding fields it is necessary that there be no voltage drop along the filament itself. In order to avoid this voltage drop, the filament under test may be heated with pulsating current produced by a thyratron inverter circuit. This circuit, similar to the one previously developed by Prof. Nottingham, is shown in the Figure. The type of pulse generated is such that the current is on for exactly one-half of the time. This adjustment was accomplished by regulating the shunt resistance R_1 until the proper output current was obtained and then opening the switch *SC* so that both thyratrons remained on continuously. The other variable resistance (marked 0-150 ohms in the diagram) was then adjusted until the galvanometer *G* indicated static balance. Then with the switch closed, the input to the grids of the thyratron from the power oscillator (200 cycles in this particular case), was adjusted until the same galvanometer indicated a dynamic balance. The circuit then delivers equal on and off pulses. This could be checked by observing the thermionic current delivered by the filament connected to the output of the



Thyratron inverter circuit

circuit. This thermionic current under the action of the pulses was exactly one-half as great as that delivered when the filament was heated with straight direct current. By confining the measurement of emission to the time when no current was flowing through the filament, and while the filament still retained the proper temperature by virtue of its thermal inertia, the measurement was carried out under the required condition of zero potential drop along the filament itself. While the application in this inverter circuit is primarily of a scientific nature, it is believed that it may find uses in other applications in the electronic industry.

Electronic Shooting Galleries

THE OLD "SHOOTING GALLERYS" offered a cigar or a kewpie doll if you hit the bull's eye with a rifle. A new type of shooting gallery is made of a duck in motion, into the body of which is fixed a photo-cell. The light from an incandescent lamp fixed into the gun stock is put on momentarily by the trigger controlled by the customer. The light is focussed by means of an optical system.

If the light falls on the "target" (photo-cell), the duck flaps its wings, and simultaneously takes your photograph shooting the duck, and this is delivered to you all within a few minutes. The entire operation is controlled

PROJECTED TELEVISION

This Telefunken receiver, ready for the market, has a 20,000 volt cathode ray tube behind the lens, through which the image is projected

A three-by-four foot screen may be illuminated with sufficient brilliance for theatre use. Two Berlin movie houses have bought receivers at about $2000 each

by a set of relays functioning from the plate circuit of a suitable amplifier controlled by the photo-cell.

Tube Recorder Used in Testing Enameled Wire

ENAMELED INSULATION on copper wire has long been used as a most economical material. In the application of the enamel, which is baked on the wire, the temperature at which it is baked and the length of time allowed are important factors in determining the strength of the insulation, both mechanically and electrically. A new machine, described in the November 1936 issue of *Bell Laboratories' Record*, has been designed to test samples of enamel covered wire for the mechanical strength of the coating. The wire from a spool is wrapped around two drums, which rotate and carry the wire under a scraper which rests on the insulation with a pressure which can be accurately adjusted. After having passed under the scraper the wire passes through two mercury pools, separated by about ½-in., and connected in the circuit shown in the Figure. If the scraper removes the insulation from the wire and the bare spot is long enough to connect the two pools of mercury through the wire, then the grid bias of the tube is short-circuited. At once a magnetic "scraper" register in the plate circuit of the tube records the fault in the insulation. By means of a make and break commutator arrangement another register counts each two-inch length of wire

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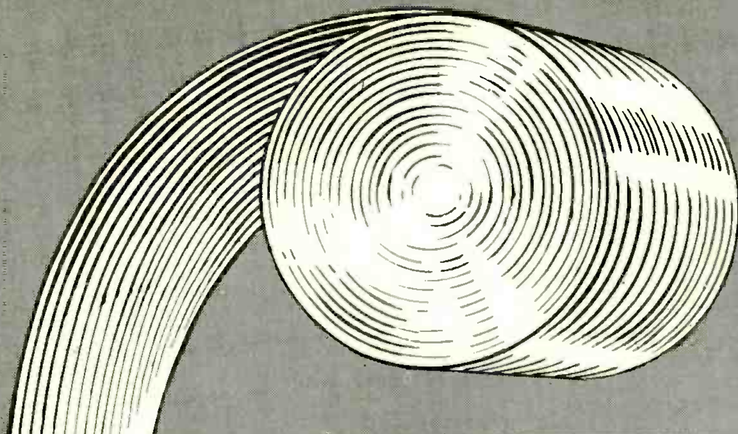
LABYRINTH MICROPHONE

The stream-lined housing in this electrodynamic unit concentrates the sound input and, with the aid of close tolerances in the air-gap, is claimed to produce a very high output level



*T*o the end that the Radio Industry may be better served

- - - *and more economically*

We have entered a new field—added a new product—taken a step forward—to the end that we may better serve the radio industry. We now own the Cathode Sleeve business of Juno Fasteners, Inc.—are in production and are ready to supply tube manufacturers with Lockseam Cathode Sleeves. This type of sleeve is a precision product, produced under accurate control and inspection methods. *With it economies heretofore impossible are assured.*

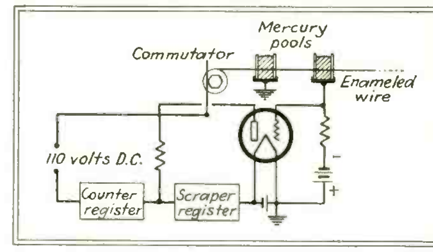
We continue the manufacture of seamless tubing. The quality of this product too, can be still further refined. And here also economies of operation are possible.

We are headquarters now for more than just fine Seamless Cathodes. Users can depend on "Superior" Lockseam quality and service.

SUPERIOR TUBE CO., NORRISTOWN, PA.

25 miles from Philadelphia • 100 miles from New York

passing through the machine. The percentage of the wire scraped bare is then obtained by comparing the reading of the scrape register with that of the count register. An additional test is made by running the wire between two



Circuit for testing enamel wire

rollers, the rollers being connected in the same manner as the mercury pools. These rollers detect any defect in the enameled insulation and operate a recorder in the same manner. By running many samples through the machine it has been determined what types of baking produce the strongest insulation.

Photo-electric Tube Controls Game in Large German Preserve

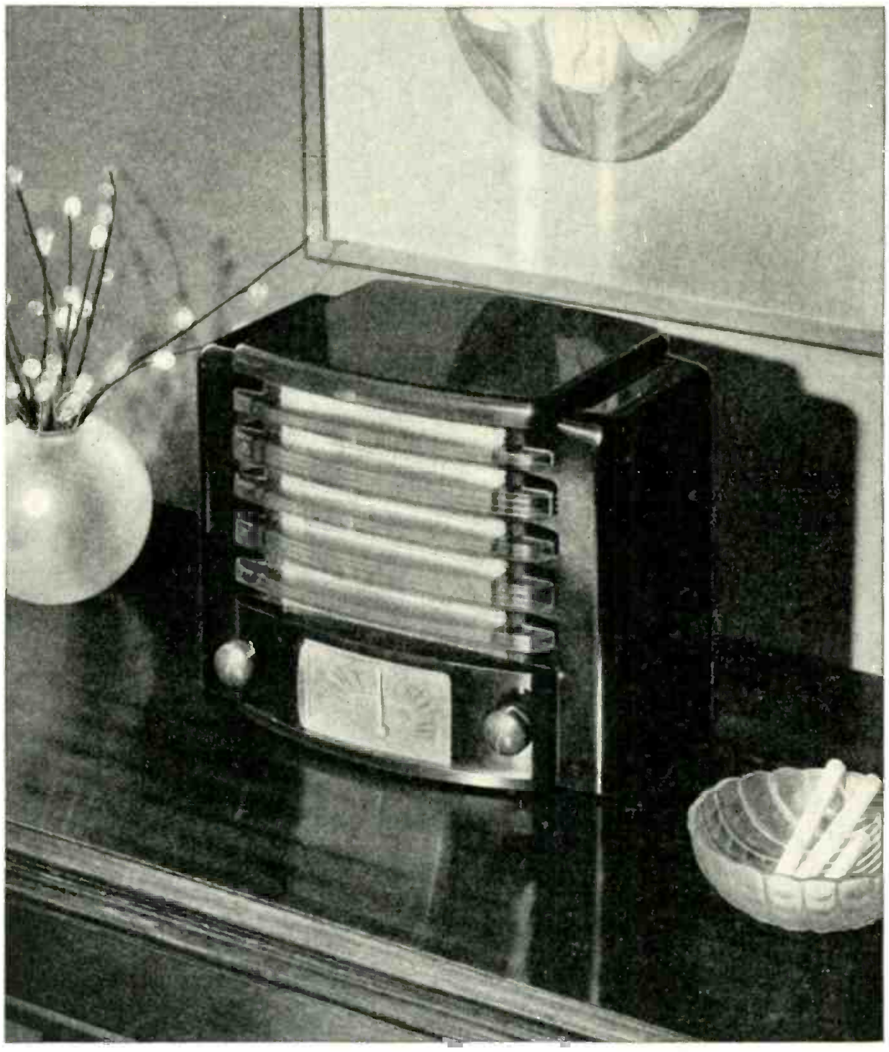
THE SCHORFHEIDE GAME PRESERVE near Berlin is fenced with a high lattice, to prevent deer, elk, Canadian buffalo and other animals from trespassing on adjoining fields. The preserve, however, is traversed by a main highway formerly closed by a large gate, which the motor car driver had to open and was supposed to close behind him. As the gate was often left open by careless motorists both at the entrance and exit from the preserve, a photo-electric tube has been set up at each entrance and the gates removed entirely.

These tubes operate a battery of floodlights and a large horn. Any attempt by the animals to pass through the exit provided by the road intercepts the beam and the animals are frightened back into the preserve by the light and sudden sounds. The equipment is directed so that motor cars passing through on the highway do not affect it. Although the plan appeared somewhat fantastic at its inception, in actual practice, it has worked out as intended so that damage to the fields of adjoining farms by wandering game has ceased.

"Swing" Music from Cathode Rays

THE EDITORS are in receipt of a highly interesting patent recently issued to Merlin Davis by the United States Patent Office. It concerns a cathode ray tube of unusual design, one form of

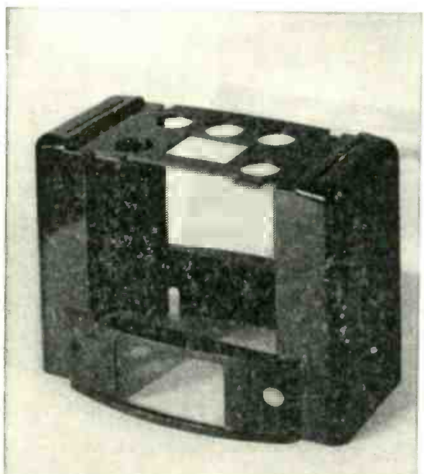
Helping Radio ***to set its own Style Standards***



THERE'S a trend in cabinet design today that is definitely *away* from the traditional furniture styles which have influenced radio styling in the past. Step by step, the radio industry is establishing an individual style-identity more appropriate to the importance of radio in modern life.

In the development of these new style standards, Bakelite Molded has played an important part. Its lustrous, fine-textured surfaces, varied colors and high adaptability of form are ideally suited to express modern conceptions of design. Its production merits make possible the forming of quality cabinets at quantity costs.

A recent example of the new trend in styling is the Kadette Classic radio. The body of the cabinet, shown below, is completely formed in one piece, and with one operation of the molding press, through use of Bakelite Molded. All necessary slots and through-holes, and the final surface lustre are provided in the same operation, obviating further machining or finishing.



Radio manufacturers and designers are invited to consult us regarding improved methods for forming either large or small cabinets from Bakelite Molded; also, to write for our comprehensive booklet 13M, "Bakelite Molded."

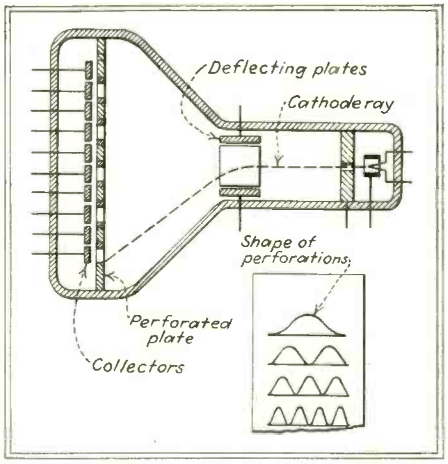
Photo shows Kadette Classic Radio with rich green Bakelite Molded cabinet. Designed by Carl Sundberg. Also made in black and brown. Molded for International Radio Corp. by Chicago Molded Products Co.

BAKELITE CORPORATION, 247 PARK AVENUE, NEW YORK, N.Y.
BAKELITE CORPORATION OF CANADA, LIMITED, 163 Dufferin Street, Toronto, Ontario, Canada

BAKELITE

THE MATERIAL OF A THOUSAND USES

which is shown in the Figure. The dotted line represents a cathode ray generated by a cathode, accelerated by an anode, and deflected by deflecting plates in the usual manner. The unusual features of the tube are the collectors shown in the diagram and the perforated plate immediately in front of them. The perforated plate is maintained at a potential somewhat lower than that of the collectors. By the application of alternating voltages to the two sets of deflecting plates the cathode ray beam is caused to scan the perforated plate,



"Swing" music-maker

in much the same fashion as in a television cathode ray tube. The alternating voltage applied to the vertical deflection plate may be of very high frequency compared to the alternating voltage applied to the horizontal deflecting plates. The shape of the openings in the perforated plate may have any desired form, one typical type being shown in the diagram. The electric currents resulting from the collection of the cathode ray at the collectors are then of predetermined wave form and may be amplified and reproduced as musical impulses. The flexibility of the arangement permits, as the reader may readily see, a wide variety of wave forms depending upon the deflecting voltages and their frequency. The patent was isued on September 8, 1936 under the number 2,053,268.

Measuring Textile Gelatines with a Phonograph Pick-up

By DR. IRVING J. SAXL

IN THE INVESTIGATION of gelatines and similar materials used as binders in the textile and other industries, the surface condition is of great importance in the performance of such substances. For instance, a gelatine that is used for sizing and similar purposes in the textile industry must be so constituted that it will dry up with a surface that will give the least possible friction with the objects with which it comes in contact. This friction should not only be as

BRUSH

ATTENTION!

PUBLIC ADDRESS AND BROADCAST ENGINEERS

Four years ago, Brush announced the first commercial crystal microphone, sound cell, grill type. During this period, many improved models have been developed and manufactured. AND NOW—it is a pleasure to announce—TWO NEW TYPES—of sound cell spherical microphones—the AR-4S3P and AR-2S6P. The AR-4S3P is designed for HIGH OUTPUT with average lengths of high impedance lines. AR-2S6P with slightly lower output is ideal for cable lengths as high as 800 FEET without serious loss of output. This microphone is also available with a transformer for operation into existing low impedance equipment (50 AND 200 OHM LINES).

AR-4S3P

A beautiful bronze or chromium finish—3" spherical case is available for the AR-4S3P sound cell microphone. The AR-2S6P is supplied in a standard bronze finish unless chromium is specified.

WHY A SOUND CELL MICROPHONE?

The answer is in the photograph—note in the shadow how clearly the sound cells are outlined—sound passes on!—Consequently—no pressure doubling—no cavity resonance.

ANNIVERSARY

Brush is the Leader—the First to Produce Commercially

1. The rochelle salt crystal bimorph element, the heart of most crystal devices—
2. The sound cell microphone, grill type, eliminating diaphragm and cavity effects, permitting sound to pass through from any direction—
3. The spherical, grill type, microphone—
4. The sound cell uni-directional microphone—
5. Internal spring mounting, minimizing response to mechanical shock—
6. A laboratory microphone with a flat frequency response to 17,000 c. p. s.
7. A crystal phono-pickup—now manufactured by licensees—
8. Other industrial rochelle crystal devices—

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BR2S

The Brush BR2S . . . 2" spherical microphone . . . bronze or chromium finish, ideal for public address work.

The BRUSH DEVELOPMENT COMPANY
PIEZO ELECTRIC
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MICROPHONES • MIKE STANDS • TWEETERS • HEAD PHONES • LOUD SPEAKERS

BL-1

The Brush BL-1 lapel microphone . . . small and light weight, easily attached to coat lapel.

small as possible but, in addition, such gelatine surfaces should be so hard that an abrasive action, such as that of the heddles of a loom, will not cut into the material.

Specifically speaking, a yarn is coated with a gelatine or other binder to protect it against abrasion and at the same time to reduce its surface friction. In other words, loom heddles or some other resistance the yarn has to pass through should not enter into the yarn and should not be obstructed by irregularities on the surface of the yarn.

A similar condition once before was encountered in the beginning of the acoustical industry. At that time, Thomas Alva Edison while working on one of the early models of his phonograph using wax cylinders, was troubled by the fact that the background noise of such recording means was excessive, a condition that repeated itself at a later date when the proper materials for conditioning the surface of phonograph discs had to be found.

It therefore occurred to the writer to use this production of noise, not for the development of smooth, recording materials, but for measuring the combined penetration and granular condition of the surface of materials, particularly of gelatinous nature. It will be readily understood that an analogous technique lends itself to the investigation of other materials not necessarily of colloidal structure and that measurements can be taken by other means than estimates of sound intensity.

The method developed is based on the fact that a phonographic pickup will produce increased electromotoric force the more violently its needle is moved. Accordingly, if the needle of the phonographic pickup is brought together with gelatine surfaces, then the needle will hardly move if the surface is glasslike in hardness and smoothness and the needle penetrates little. If, however, the surface is rough or if the needle can enter the surface on account of the fact that the specimen has little cohesion, then a voltage will be generated in the pickup. This voltage may then be amplified in the customary manner and the final output determined. It will be understood that the same method of investigation can also be used in the study of other materials, such as lacquers, varnishes, shellacs, etc., and that it lends itself, in addition, to the investigation of bearings, finely machined surfaces and similar materials.

The Apparatus

Figure 2 is a schematic wiring diagram of the working model while Fig. 1 is a photograph of the actual working apparatus. The motor, M, is geared at a slow speed over a worm drive, W. The motor is reversible with the aid of the reversal switch, S. Inasmuch as the a-c motor is of the synchronous type, a constant speed is achieved.

This driving arrangement, with the aid of a spiral, moves a sled, L, on which is attached the gelatine-carrying slide B. The preparation of the test specimen will be described in detail hereafter.

The slide, B, moves under the phonographic pickup, P, and thus introduces motion of the needle relative to the slide, resulting in the generation of electromotoric force in the pickup. This e.m.f. is fed to the amplifier, A. In order to avoid the connection of a high voltage to the output meter, I, a properly grounded transformer, Tr, is switched in between the amplifier and the output meter. The low e.m.f. fed into the output meter is then proportionate to the motion of the needle in the pickup and can be read in either milliwatts or decibels on the metering instrument directly.

It will be realized that the conditions of the gelatine surface have to be

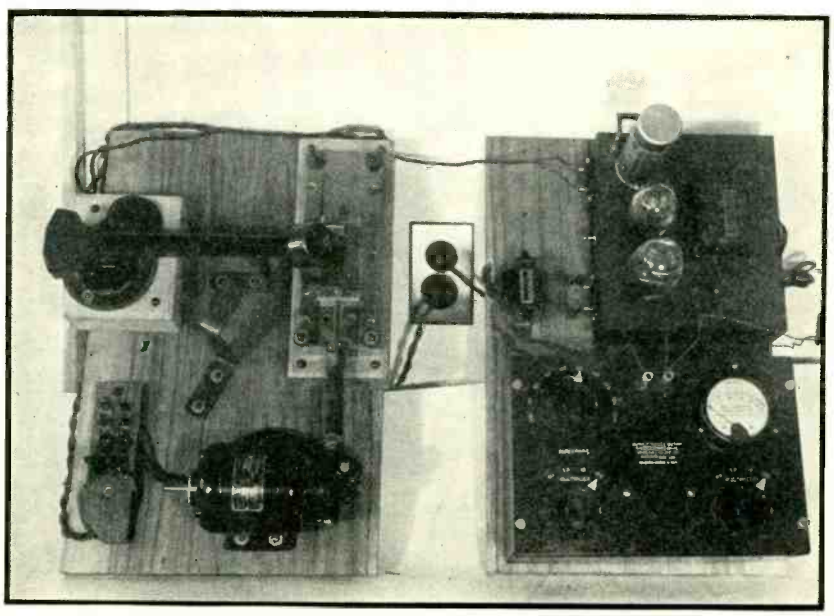

Fig. 1. Pick-up surface tester and amplifier

New

HIGH VACUUM CATHODE RAY TUBES

12
Outstanding Features

1. Small and brilliant spot.
2. High deflection sensitivity.
3. Completely electrostatically shielded.
4. Individual deflector plate connections.
5. Undistorted deflecting field.
6. Full range modulation without defocussing.
7. Low interelectrode capacities.
8. High insulation between elements.
9. Wide range of accelerating voltage.
10. Complete separation of high and low voltage terminals.
11. All tubes interchangeable in sockets and circuits.
12. All terminals in moulded bases give maximum protection against accidental breakage.

The general characteristics of the series are as follows:

Heater Voltage .... 5.0 Volts
Heater Current .... 0.55 Ampere
Accelerating Potential .... 1000—5000 Volts
Deflection Characteristic with Accelerating Potential of 2000 Volts (325 Series) .... 130 Volts/ inch
Deflection Characteristic with Accelerating Potential of 2000 Volts (326 Series) .... 80 Volts/ inch

	325A	326A	325B	326B	325C	326C
Max. Length (in.)	16½	22	16½	22	16½	22
Max. Screen Size (in.)	4⅝	7⅛	4⅝	7⅛	4⅝	7⅛
Fluorescent Characteristics	Green. Medium Persistence	Green. Medium Persistence	Blue—Green. Long Persistence	Blue—Green. Long Persistence	Blue. Highly Actinic	Blue. Highly Actinic
Application	Visual Observation. Photography with green sensitive film.		Observation and Photography of non-recurrent and low frequency phenomena.		Photography with blue-sensitive film.	

Western Electric
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standardized as to make comparative results possible. The method of preparing the slides and their drying under specified humidity conditions are as follows:

Twenty per cent gelatine solutions are prepared in beakers whose height is

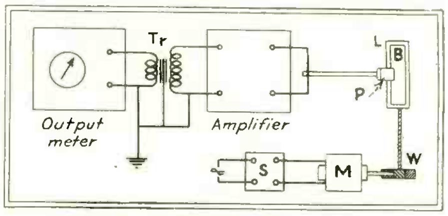


Fig. 2. Pick-up surface tester

equal to the length of a microscope slide. The solutions are held at 60°C in a water bath, being covered to prevent scum formation. A microscope slide, held by forceps, is dipped three times in one of the solutions, drippings removed by wiping on the edge of the beaker, care being taken to wipe all the solution from the bottom of the slide. The preceding operations must be done quickly to prevent uneven scum formation.

After wiping, the slides are placed on a level support and allowed to stand for fifteen minutes in a dust-free atmosphere; then laid in level position in a dessicator, using anhydrous calcium chloride as a dessicating agent. In practice, it has been found desirable to maintain the temperature of the dessicator and its contents at 35-40°C. for two hours to facilitate drying. Higher temperatures or longer periods of drying are liable to cause peeling and cracking of the dried gelatine film.

It should also be noted that it is advisable to use new slides for each experiment. The glass cracks off with the gelatine while drying, producing an irregular surface, particularly if higher grades of gelatine are used.

The sample, prepared in the above manner, is now inserted into the slide, L, and fastened there with a screw. The pickup is inserted and the motor started. After the slide has moved through, it may be shifted sideways and moved to the original position by reversing the direction of the motor with the aid of the 8 pole double throw switch, S.

For comparison, the following data received from various American manufacturers may be mentioned:

Gelatine received from manufacturer A is relatively smooth and hard. The output meter reads from 40-50 milliwatts. Under the same conditions, the slides from manufacturer B gives a reading from 100-110 milliwatts indicating that this latter product is rougher and/or softer than product A.

It is interesting to note in this connection that gelatine received from manufacturer B has a higher jell strength than gelatine of the A type. It will be realized therefore from the preceding figures that jell strength is not necessarily representative of smoothness, hardness and freedom from grains.

Photocell Measures Dust in Chemicals

In the manufacture of fine chemicals, it is absolutely essential that the percentage of "dust" be held to a minimum, particularly so in medicinal preparations. Dust in such a case will undoubtedly introduce new difficulties, chemically and pathologically speaking.

The Victor Chemical Works, of Chicago, Ill., measure the amount of dust in percentage by means of a photocell, in the following manner: A definite weight of the compound in question to be tested is dropped through a "chimney" onto the floor of a "tunnel", the dust thereby created partially cuts off a beam of light directed down the length of the tunnel upon a photo-cell at the other end. The degree of light interference, accurately measured by the percentage deflection of the milliammeter is an index of the amount or percentage of dust present in the compound.

Tube Manufacturers Bulletins

Recent notes of RCA Radiotron deal with the operation of the 6L6 with equal plate and screen voltages. Here it is pointed out that with feed-back circuits it is advantageous to get screen and plate voltages from the same point on the voltage divider. There are other advantages of equal voltage conditions as pointed out in this Application Note, No. 66.

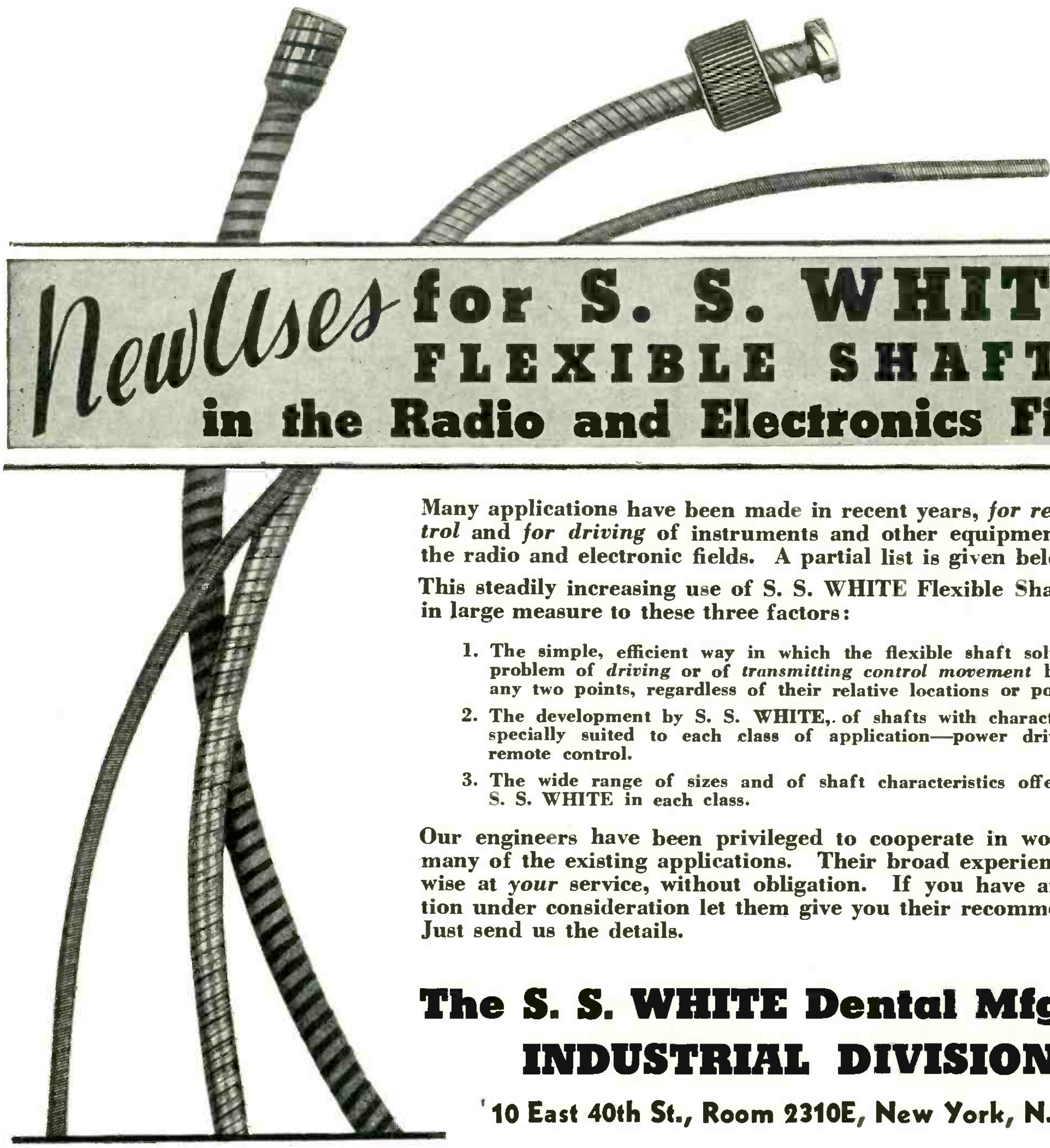
Ken Rad has issued a bulletin (CEB 36-10) on the 6L6, dealing with the effects of power supply regulation.

Two Hygrade Sylvania bulletins, No. 30 and 31, have been issued recently. The first deals with input capacitance of tubes at audio frequencies. The second is concerned with the modulation capabilities of infinite impedance detectors.

Slot Machine Starts Phonograph by Radio

A novel slot machine appearing in cafes, taverns and tea shoppes this summer offers one answer to phonograph makers who used to wonder what radio might do to them. Produced by a Chicago manufacturer of amusement devices, the new slot machine embodies a tiny mobile radio transmitter which is used to start a phonograph.

If you want music with your meals, you simply request the waiter to bring along the portable "radio station" with the menu card. Drop a coin into the proper chute on this and instantly the phonograph begins to grind out the latest musical hit. As the coin enters the box tendered by the waiter, it actuates the broadcasting apparatus, which, working on two small batteries, sends a short wave impulse directly to the phonograph. Picked up by a light aerial wire, the wave is conducted to a special receiving set inside the cabinet, then travels on to the mechanism.



New Uses for S. S. WHITE FLEXIBLE SHAFTS in the Radio and Electronics Field

Many applications have been made in recent years, *for remote control* and *for driving* of instruments and other equipment used in the radio and electronic fields. A partial list is given below.

This steadily increasing use of S. S. WHITE Flexible Shafts is due in large measure to these three factors:

1. The simple, efficient way in which the flexible shaft solves the problem of *driving* or of *transmitting control movement* between any two points, regardless of their relative locations or positions.
2. The development by S. S. WHITE, of shafts with characteristics specially suited to each class of application—power drive and remote control.
3. The wide range of sizes and of shaft characteristics offered by S. S. WHITE in each class.

Our engineers have been privileged to cooperate in working out many of the existing applications. Their broad experience is likewise at *your* service, without obligation. If you have an application under consideration let them give you their recommendations. Just send us the details.

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Partial List of S. S. WHITE Flexible Shaft Applications in the RADIO and ELECTRONICS Fields

REMOTE CONTROL SHAFTS

Auto Radios
Aircraft Radio Receivers and Transmitters
Broadcast Transmitters
Variable Frequency Crystal Holders
Radio Telephone Equipment
Aircraft Direction Finder
Aircraft Antenna Control

COUPLING SHAFTS

Electrical Instruments
Broadcast Transmitter
Auto Radio Receivers
Auto Radio Antennas
Portable Track Recorder
Auto Radio Control Panels

FLEXIBLE SHAFTS for POWER DRIVES, REMOTE CONTROLS and COUPLINGS

TELEVISION

(Continued from page 11)

volume, sound high-frequency tone, sound low-frequency tone; sight detail, sight brightness, sight contrast; horizontal and vertical scanning and synchronization. The Kinescope image-tube is mounted vertically, screen uppermost and protected by a shatterproof glass plate. The image is viewed in a front-surfaced mirror on the underside of the cabinet lid. Including the Kinescope, 33 tubes are used in the receiver; two power supplies, one for the high accelerating voltages in the Kinescope and the other for all other requirements, are used. The receiver draws approximately 350 watts from the power line. The audio system in the receiver is high fidelity (to 10,000 cps.) throughout.

The receiver so far as the video channel is concerned is a quasi-single-sideband type. The i-f circuits in the video channel pass only the high-frequency side-band without attenuation, whereas the low-frequency side-band is considerably attenuated. This practice is adopted solely in the interest of economy, since the narrower band involved permits much higher amplifications per stage with the tubes at present available.

Each observer in the area has been provided with forms to be filled in during each observation. The information reported on concerns the settings of the controls, and the necessity of resetting them, whether or not trouble was encountered with the vertical and horizontal framing or synchronization, with the type of noise interference encountered, and similar items.

Noise Interference

While no specific data were presented, it was brought out in the paper that the two most troublesome sources of noise interference with the video signal were those resulting from automobile and airplane ignition systems and from electronic diathermy machines. In the absence of such interference a signal of one millivolt is generally considered satisfactory to drive the receiver. However, when those noises are present, a much stronger signal is necessary to overcome their effects. Ignition noise usually affects a part of one or more lines in the picture, causing that part to remain either completely bright or completely dark. Interference from diathermy machines, especially when the machine is operated with unrectified plate supply, takes the form of a blanketing of many successive lines, sometimes as much as one-fourth of all the lines in the picture.

Mr. Beal pointed out at the I.R.E. meeting also that the technical part of the field test was only a part of the program, although it has formed the major part of the activity up to the present. The development of program technique is also being pursued actively.—D.G.F.

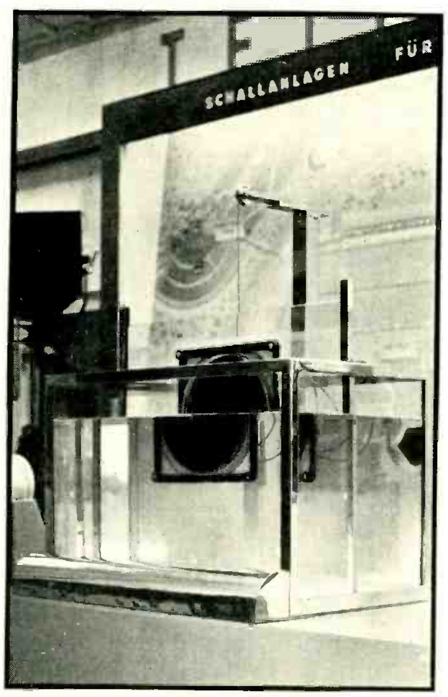
References:

The reader is referred to the following articles which have appeared in *Electronics* and which describe in greater detail certain parts of the RCA system than was practical in the above report:

1. Television—A Review of Present-Day Systems, p. 300 October 1934
2. Television Today—The Status Quo, p. 27, June 1936
3. FCC Plans Future of UHF Region, p. 9, July 1936

Also, reference may be made to the collection of papers entitled *"Television"*, Volume I. RCA Institutes Technical Press, which consists in the main of I.R.E. papers written by members of the RCA organizations.

LOUDSPEAKERS FOR MERMAIDS



At a recent Berlin Radio Show, a water-proof speaker was shown. The demonstration above, proved its submarine qualities by dipping the unit into water while operating

BANDSPREAD

(Continued from page 29)

of the oscillator coil is assumed to be 5$\mu\mu$f, and the intermediate frequency is 0.465 mc.

(1) $C_b = 375.5404\ \mu\mu$ f

(2) $L = 16.21490\ \mu$ H

(3) $F_1 = 1.725\ F_2 = 1.85\ F_3 = 1.975$ mc.

(4) $C_1' = 524.9860\ C_2' = 456.4387\ C_3' = 400.4900\ \mu\mu$ f

(5) $C_1 = 149.4456\ C_2 = 80.8983\ C_3 = 24.9496\ \mu\mu$ f

(10) $C_s = 2564.221\ \mu\mu$ f (using the approximate relation)

$= 2564.212\ \mu\mu$ f (using the exact formula)

(11) $a = 0.7175328$ hence $aL = 11.63471\ \mu$ H.

(12) $C_p = 394.7725\ \mu\mu$ f

The deviation from true alignment was calculated for a number of frequencies in the band. (Fig. 2)

Signal freq.	Deviation.	
1.7000 mc.	28	cycles high.
1.7250	1	low
1.7500	15	"
1.7750	20	"
1.7875	19	"
1.8000	17	"
1.8250	8	"
1.8500	1	high
1.8750	10	"
1.9000	17	"
1.9125	19	"
1.9250	18	"
1.9500	12	"
1.9750	3	low
2.0000	31	"

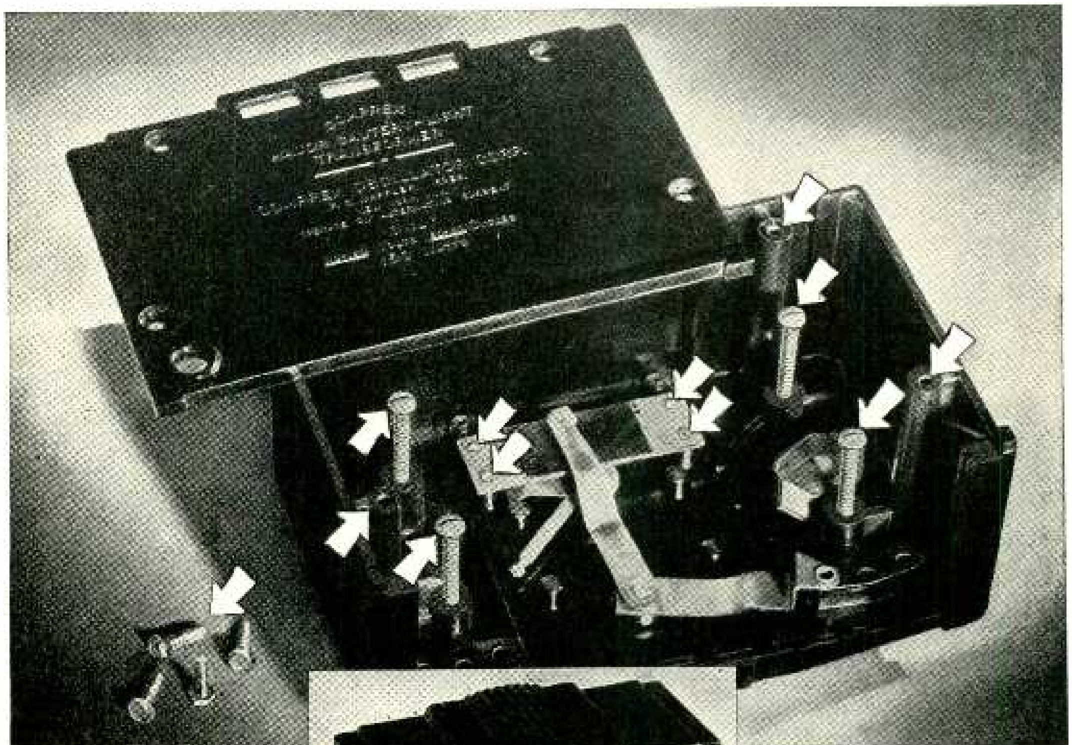
These figures show that the perfection of tracking leaves nothing to be desired. It would be expected that the tracking would improve as the band spread is increased, since the differences between the chosen "perfect" frequencies are reduced.

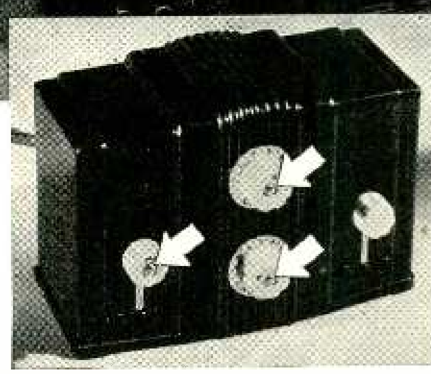
This method may, of course, be used equally well in cases where band spread is not required, by making C_b equal the self capacity of the radio frequency coil.

Following this method, coils were constructed to cover the 160, 80, and 40 meter bands when used with a 100 $\mu\mu$f variable gang condenser, and another set was made to cover the broadcast band with a 350 $\mu\mu$f gang. In each of the four cases, adjustment of the parallel condenser trimmer was all that was required (the series condensers were not even equipped with trimmers).

This shows how a Parker-Kalon Assembly Engineer can help

TO MAKE A FINE PRODUCT -YET KEEP PRICE DOWN





HOW cost and quality are directly affected by the assembly method employed is shown by this instrument made for physicians. To assemble the various parts of the Comprex Major Cautery-Diagnostic Light Transformer to the molded housing is not a complicated matter.

It could be done by using machine screws in tapped bushings molded into the housing. Yet, because the maker was well-informed on the advantages of Parker-Kalon Hardened Self-tapping Screws for assemblies of this kind, a worthwhile saving was made. Use of these unique Screws eliminated bushings and brought a direct reduction in the cost of the housing. It also removed the possibility of trouble and expense from stripped threads. In addition, stronger assemblies were obtained since Self-tapping Screws hold better.

The assemblies involved are indicated by arrows and include fastening a coil and core unit; the small resistance coil; the two contact arms and knobs; the switch knob, and also the housing cover.

In 7 out of 10 cases where metal or plastic assembly is involved Self-tapping Screws can be used to make a product better, at less cost. The function of Parker-Kalon Assembly Engineers is to help design and production men employ the Screws where benefit can be obtained. Having a practical background of assembly work and a specialized knowledge of Self-tapping Screws, a Parker-Kalon Assembly Engineer is able to uncover all of the possibilities for using the Screws to simplify fastening jobs and save money.

Whether your product is in the drawing stage or in actual production it would pay you to take advantage of this service. It will show whether you are missing benefits that might be obtained without upsetting schedules or changing designs. An invitation will bring one of the Parker-Kalon Assembly Engineers.

PARKER-KALON CORPORATION
198 Varick Street New York, N. Y.

PARKER-KALON *Modern* FASTENING DEVICES

TYPE "Z" HEX CAP A HARDENED SELF-TAPPING SCREW FOR EVERY KIND OF ASSEMBLY TYPE "A" TYPE "U"

SOLD ONLY THROUGH RECOGNIZED DISTRIBUTORS

Feedback Amplifiers

[*Continued from page 15*]

It is possible to obtain equalization in an amplifier by suitably modifying the feedback network. For example, if in the circuit of Fig. 3*a* the resistance R_2 is shunted by a capacity the negative feedback will be reduced at high frequencies, tending to compensate for the falling off occurring in the output transformer.

Notes on Design

Uniform nomenclature is employed in the circuits of Figs. 3, 4, and 6 with respect to essential circuit elements. Thus R_2 in every case represents a resistance across which the feedback voltage is developed, while C_2 and L_2 represent reactive elements shunted across R_2. Likewise R_1 denotes a resistance used to reduce the output voltage for feedback purposes, while C_1 is a blocking condenser in series with R_1. By-pass condensers are indicated by C wherever there might be some doubt. The effective shunting capacity across a resistance-capacity coupling unit is indicated as C_s, while C_c represents the coupling condenser in such a unit.

In the construction of a feedback amplifier it is necessary to avoid as far as possible capacities in shunt with the resistances of the feedback network. Capacities across R_1 are particularly troublesome in circuits where R_1 must be large, as for example in Fig. 3*i*. In circuits such as Fig. 3*a* it is to be noted that the capacity to ground of the transformer secondary is effectively in shunt with R_2, and because this capacity cannot be eliminated it sets an upper limit to R_2, which in turn fixes an upper limit for R_1 with a given value of β. This limitation of R_1 and R_2 is important because $R_1 + R_2$ is in shunt with the load of the output stage and so consumes power inversely in proportion to the resistance. The condenser C_1 that appears in a number of the feedback networks must be large enough to have, at the lowest frequency that is amplified appreciably, a reactance very small compared with R_1.

In circuits where a resistance in series with the cathode is used for feedback purposes, as in Fig. 3*e*, it is necessary to return the screen bypass condenser and the suppressor grid directly to the cathode instead of ground, in order to prevent the feedback voltage from also being applied to these electrodes. Under these conditions it is essential that a voltage dropping resistance shown as R_s of relatively high value be employed in the screen circuit, since otherwise the resistor R_2 would be effectively short circuited through the battery to ground as far as a-c currents are concerned.

In all circuits involving transformers between feedback points, the proper polarity of primary and secondary must be selected. This can be readily done by trial since the wrong polarity will cause oscillations.

The ratio β of feedback voltage to output voltage can be readily calculated from the circuit elements. Thus in arrangements such as Fig. 3*a*, 4*b*, 6*a*, etc., $\beta = R_2/(R_1 + R_2)$. Similarly in circuits such as Fig. 3*e* where the feedback voltage is developed by a cathode resistor, the value of β in the mid-frequency range where the effects of C_c and C_s can be neglected is

$$\beta = \frac{\text{Resistance of } R_2 \text{ and } R_s \text{ in parallel}}{\text{Resistance of } R_c \text{ and } R_{g1} \text{ in parallel}}$$

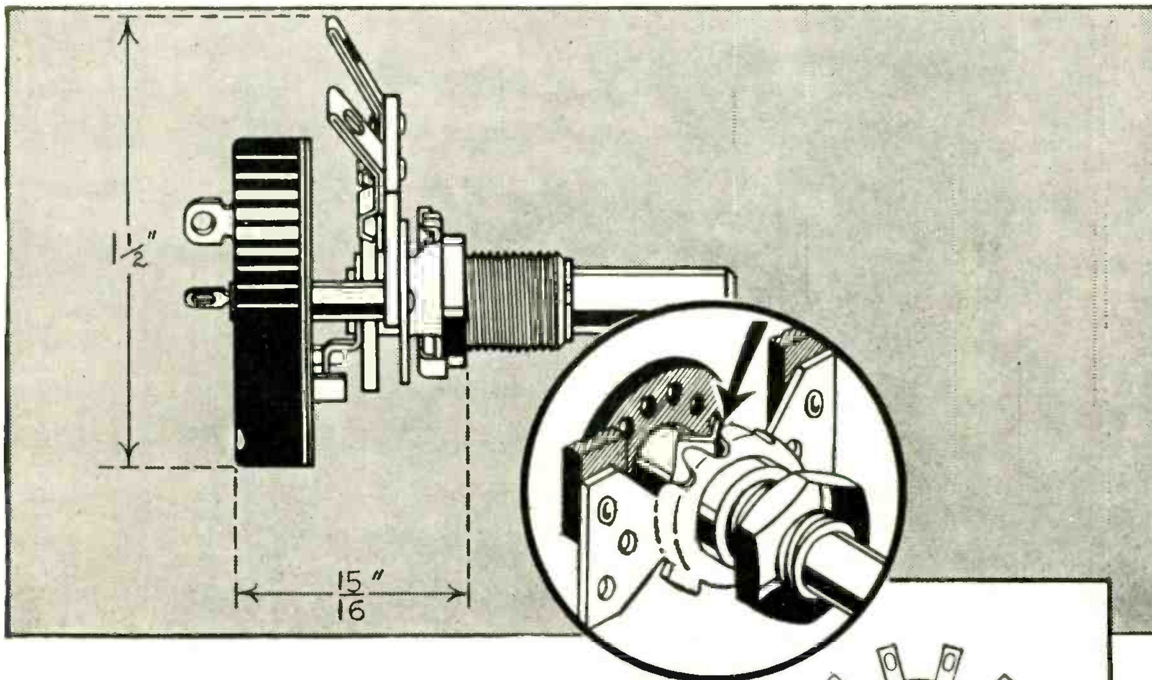
At high and low frequencies, where C_s and C_c must be considered, the computation is more involved but is of the same general character. It is to be noted that in all cases where a cathode resistor is used to develop the feedback voltage, the screen dropping resistor R_s is effectively in shunt with R_2, while in circuits such as Fig. 3*h* a filter resistance R_3 and the effective shunt resistance representing the eddy current resistance of inductance L_2, also shunt R_2.

Practical Uses of Feedback Amplifiers

The reduction in amplitude distortion and cross talk, the improvement in frequency response, and the increased stability of amplification which result from feedback are the properties which are usually of greatest interest. The reduction in amplitude distortion effected by feedback is probably the most familiar because of the beam power tube. It is to be noted however that the feedback circuits usually recommended for beam tubes reduce the distortion only to about one-third of the value otherwise obtained, and so barely scratch the possibilities. A much more effective arrangement from many points of view is to employ a two-stage feedback circuit by applying the feedback voltage to the input of the driver stage rather than to the input of the power stage. Such an arrangement provides much more gain between feedback points and hence makes it practical to use values of $A\beta$ of 5 to 10 or even more. This makes it possible to operate a power tube with sufficient excitation to produce under normal conditions 25 percent or even more distortion, and so greatly increase the power output, yet with low distortion in the actual output. Furthermore, distortion in the driver stage such as occurs when the grid of the power tube is driven positive or when large exciting voltages are required, is likewise reduced. This makes it possible to redesign the driver to obtain more driver gain. Finally, with larger feedback the frequency response can be greatly improved.

Experimental results obtained by the author for a typical case are shown in Fig. 7. It is seen that the presence of feedback makes an enormous improvement in the flatness of response, and causes the amplification to be virtually independent of tube voltages. It is further to be noted that when a resistance feedback network is employed the amplifier has practically zero phase shift throughout its response band, a property of importance in certain types of measuring work and in television.

The cost of this improvement, loss of gain, is readily overcome by using more amplification.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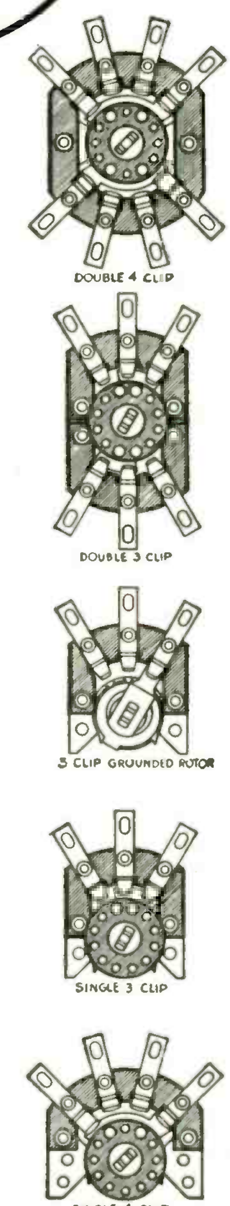
15/16"


DOUBLE 4 CLIP
DOUBLE 3 CLIP
3 CLIP GROUNDED ROTOR
SINGLE 3 CLIP
SINGLE 4 CLIP

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.

Design and Manufacture of Receiving Tubes

ESPECIALLY BECAUSE SO FEW authoritative articles on the manufacture and design of thermionic vacuum tubes have appeared in the technical press, the paper *"Modern Receiving Valves: Design and Manufacture,"* by Benjamin, Coscrove, and Warren, read before the Institution of Electrical Engineers on December 2 deserves special comment.

The paper is a thorough exposition covering the main features in the geometrical design of modern radio receiving tubes, and the various factors, mechanical and chemical, which impose limitations in manufacture. The paper includes a brief historical survey of the recent improvements in the thermionic emitters and gives details of the precautions necessary in the production of modern, highly efficient oxide-coated cathodes and insulated heaters. The minimum tolerances to which it is possible to reproduce characteristics in the manufacture of tubes are indicated. Pumping and activation processes as practiced by the M. O. Valve Company are described and the main factors affecting the life of the tube are discussed. The manufacturing processes described are sufficiently like those practiced in this country to give the general reader a good survey of American practice.

The technical portion of the paper begins with a discussion of diodes both as power rectifiers and as detectors and the paper gives the equations correlating the electrical characteristics of the tube with its physical dimensions. In rectifiers consisting of a cylindrical anode and cathode, the advantage of increasing the length and decreasing the diameter of the anodes in order to decrease the internal plate resistance are pointed out.

Although it is not possible to calculate with any great accuracy the characteristics of small receiving tubes of given dimensions or, conversely, to determine the dimensions required for a tube of any desired characteristics, the approximate equations giving the amplification factors, transconductance, and internal plate resistance in terms of the physical dimensions of the tubes are given. These equations may be used to arrive at the first approximation in the design of new tubes, although it is usual (at least for manufacturers in the United States) to supplement the theoretical calculation with curves and charts based on their past experience with similar tubes.

The authors show what are the upper limits of transconductance in a triode. The upper limit of mutual conductance in high-μ triodes is set by the minimum distance between grid and cathode which may be obtained in manufacture without the risk of excessive variation in electrical characteristics. In low-impedance triodes the upper limits of mutual conductance are established by (a) the minimum size of the grid wires which may be employed, (b) the minimum values to which it is possible to reduce the grid to cathode and grid to plate spacing without danger of emission from the grid or excessively high plate temperatures, and (c) the ratio of the grid pitch to the grid cathode distance. The manner in which the transconductance depends upon the pitch of the grid winding for a particular type of tube is given in Fig. 1.

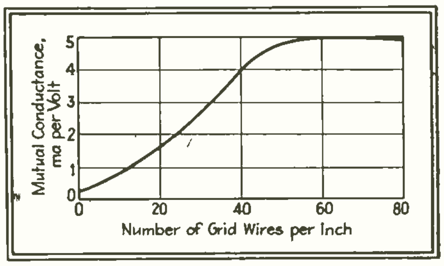
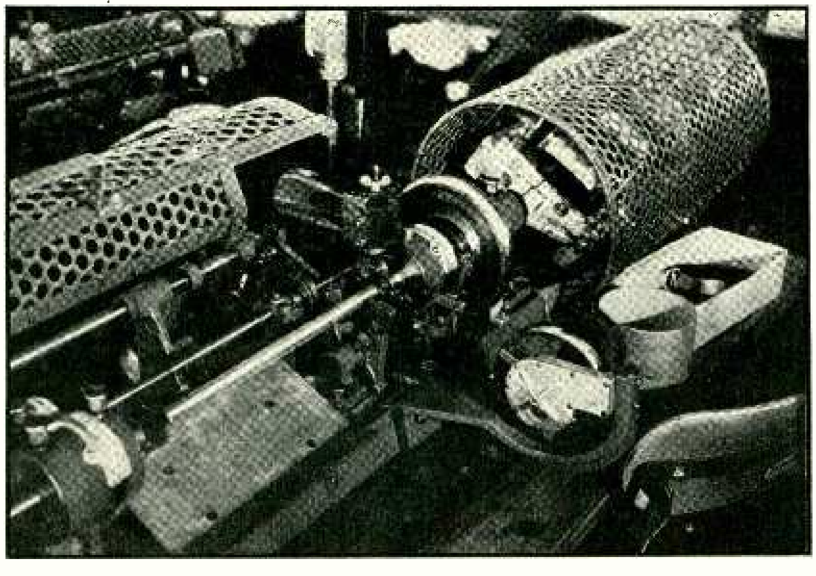


Fig. 1—Effect of pitch of grid wires on transconductance of receiving triode

The principal considerations which are essential in the design of tetrodes, pentodes, and other multiple element and multiple unit tubes are enumerated. The mathematical calculations which are applicable to diodes, cannot, of course, be applied to multiple element tubes with any degree of precision. A number of curves are given, however, to indicate the manner in which various designs and manufacturing considerations affect the characteristics of the tubes and qualitative information is provided as a guide in the design of muti-element vacuum tubes.

The authors have prepared an interesting table showing the affect on the electrical characteristics of the tubes with small variations in the mechanical dimensions of the element. The results given have been determined by differentiation (with respect to the various parameters) of the theoretical equations correlating the mechanical dimensions of the tube with its electrical characteristics. The results given are applicable to a common type of receiving tube. By means of these mathematical calculations it is shown that an error of 1 per cent in the cathode radius, will introduce an error of almost 2½ per cent in the value of the plate current, transconductance, and internal plate resistance of the tube.

SEMI-AUTOMATIC GRID WINDING MACHINES



A grid winding machine at the Radiotron plant at Harrison, N. J. The English practice is identical in its essentials to that shown above

PRODUCTS OF THE CERAMIC ART

ALSIMAG

● The several ALCO ceramics are carefully designed to suit satisfactorily various engineering requirements. During the past year our research laboratory has released the superior Steatite ceramics Alsimag 192, Alsimag 196, Alsimag 197 and Alsimag 202.

The high dielectric constant and low power factor makes **Alsimag 192** an ideal ceramic for use in condensers.

The very low loss factor of ultra-steatite **Alsimag 196** recommends this body for all high frequency applications. The unusual mechanical properties make it obviously superior in its field.

Designed to meet the rigid requirements where high temperatures are encountered and used especially by range manufacturers, **Alsimag 197** has been enthusiastically received.

Alsimag 202 with its low coefficient of expansion will be of interest to those engineers seeking a ceramic body with excellent thermal shock properties.

Our standard **Alsimag 35** has for many years met the requirements of engineers for a dense Steatite body with low electrical losses and exceptional mechanical strength.

Alsimag 72 for thermocouples and **Alsimag 203**, a porous body for resistance, have special applications well known to engineers.

Lava (machined Steatite) where limited quantities or watch-like accuracy are desired—experimental samples machined from the crude material without any die expense. Extensively employed in electronic tubes.

Our engineers and laboratories are at your disposal to work out a body to meet special needs.

If ALCO supplies your ceramics your engineers are not limited to one body.

35th Year of Ceramic Leadership

Write us today for additional information and samples of such Alsimag bodies as are of interest to you, instructing your Purchasing Department to secure our attractive prices on your insulating parts.

AMERICAN LAVA CORPORATION

CHATTANOOGA, TENNESSEE

BRANCH OFFICES (SEE Phone Book)

CHICAGO	SAN FRANCISCO	NEW YORK
CLEVELAND	LOS ANGELES	BOSTON
ST. LOUIS	PHILADELPHIA	TORONTO

If, in addition to a small error in cathode radius, other errors are introduced (such as variations in the length of the heaters, plate, pitch of grid wire, etc.) the electrical characteristics may deviate widely from the desired results. For these reasons, it is necessary to take unusual care that the physical dimensions of the component parts of a vacuum tube have extremely close tolerances.

In addition to these mechanical variations which influence the electrical characteristics of the tube, chemical variations, likewise may be detrimental and require all efforts toward minimization. A fairly large portion of the paper is devoted to manufacturing methods, and it is interesting to observe that a good number of the manufacturing processes which are described are very similar to those used in American manufacturing operations. For instance, the manufacture of grids is carried on by semi-automatic grid winding machines which are very similar to those used in this country. The side rods (Fig. 2) are fed into grooves on the rotating mandrel and the grid wire is wound into notches cut into the side rods by the cutting wheel. The winding wire is fixed in position in the notches by a swaging wheel which presses the metal of the side rod over the grid wire. For constant-μ tubes the pitch of the grid winding is held constant, but for variable-μ tubes cams are provided on the grid winding machine so as to provide gaps or variations in the pitch of the grid winding, to give the desired characteristic. The automatic grid winding machines prepare grid strips about 2 ft. in length, from which perhaps half a dozen or a dozen individual grids are later cut.

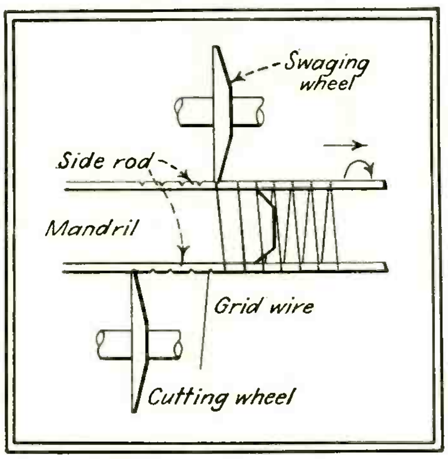


Fig. 2—Details of grid winding machine

The most important part of any thermionic tube is the emitting surface. Thermionic emitters may be divided into three groups: (a) clean metal emitters, (b) contaminated metal emitters, (c) oxide-coated emitters.

The oxide emitters are perhaps the most interesting of the three classes of cathode material and provide the greatest difficulty in manufacture. The usual oxide coating consists of barium and strontium oxide present in equimolecular proportion or equal parts by weight. In manufacturing, the Wehnelt cathodes are formed by passing the core material of the cathode through a suspension of barium and strontium carbonate in a liquid binder. In the exhausting process the carbonates are reduced to oxides and the carbon dioxide which is liberated is pumped off. The electron emission of Wehnelt cathodes is a function of the relative weight of the barium and strontium oxides used, as shown in Fig. 3.

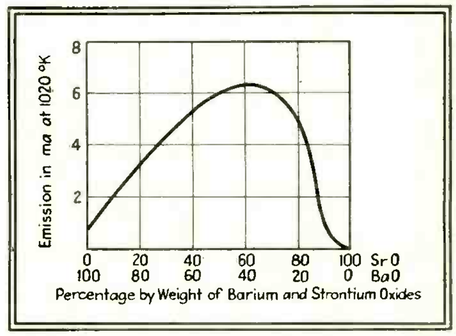
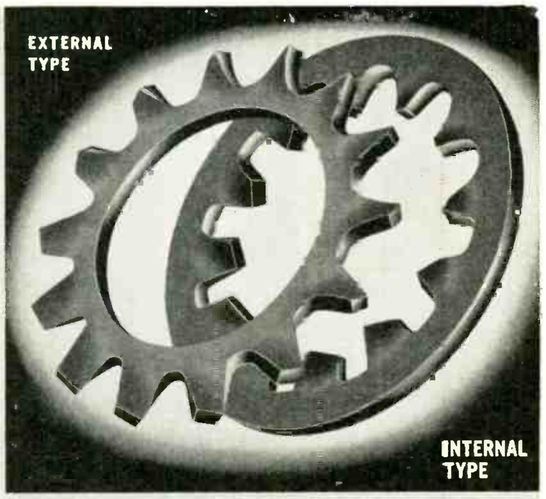


Fig. 3—Electron emission of oxide cathodes as a function of the relative percentages of barium and strontium oxides

For directly heated cathodes, in the form of a wire or strip, the cathodes are made by drawing the core material through a series of baths and ovens. The baths contain a water suspension of the carbonate together with about 12 per cent of barium or strontium nitrate, which acts as a binder. After passing through a bath, the wire passes through electrically heated ovens maintained at 750 deg. C. In order to avoid any decomposition of the carbonate, the coated core material is heated in an atmosphere of carbon dioxide. The authors have found that oxidation of the core due to nitrate decomposition can be avoided by the use of suitable mixed gases. For indirectly heated cathodes, a suspension of carbonate in an organic solvent is made and sprayed on to a nickel base.

Heater-cathode design, "getters," pumping technique, activation processes, and tube life are treated in the article with considerable detail. The last section of the paper deals with some of the limitations encountered in the use of tubes, such as hum, microphonics, noise, and frequency limitation, and the methods of minimizing these factors are given. All in all this article, which undoubtedly will appear in a forthcoming issue of the *Journal of the Institution of Electrical Engineers*, is an interesting and worthwhile contribution on tube design and manufacture.

Everyone Agrees on



SHAKEPROOF

THE *Triple-Action* LOCK WASHER

NEW *TAPERED-TWISTED* TEETH PROVIDE AMAZING LOCKING POWER

WHEN connections are locked with Shakeproof they are positively protected against the damaging effects of vibration. Three vital mechanical forces function co-operatively to prevent the nut or screw from working loose. First, there's Strut-Action, produced by each tooth biting into both nut and work surfaces and setting up a powerful leverage against any backward movement of the nut. Second, is Spring-Tension, the force that, under vibration, keeps the teeth biting ever deeper and assures a permanently tight lock. And, third, there's Line-Bite at initial contact, which means that a substantial portion of each biting edge is effective immediately to form a really tight lock.

FREE TEST RING PROVES IT!

You can see for yourself how Shakeproof Lock Washers do deliver greater locking power. Our free test ring, holding an assortment of five different sizes in both External and Internal types, is yours for the asking. Get acquainted with Shakeproof's new tapered-twisted teeth now—write for your Free Test Ring today!

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Distributor of Shakeproof Products
Manufactured by Illinois Tool Works

2539 N. Keeler Avenue, Chicago, Illinois

In Canada:
Canada Illinois Tools, Ltd., Toronto, Ont.

U. S. Patent Nos.
1,862,486 1,909,476 1,909,477 1,419,564 1,782,387 1,604,122 1,963,800. Other Patents. Patents Pending. Foreign Patents.

THE DESIGNING ENGINEER *Says...*

To insure the performance of any metal product all connections must be locked permanently tight. That's why I specify Shakeproof—I've tested its new tapered-twisted tooth principle and I'm convinced it's the one lock washer that never let's go!

THE PRODUCTION CHIEF *Says...*

On the production line we need a lock washer that's easy to handle, doesn't spread and locks tight with a minimum of time and effort. Shakeproof provides all these advantages and, what's more, we never have complaints on nuts or screws working loose during shipment.

THE PURCHASING AGENT *Says...*

I'm looking for uniform high quality, dependable performance and a reliable source of supply. Shakeproof meets these requirements fully and also knows how to co-operate with their customers so that orders are handled efficiently.

Corrections

To Mr. J. G. Sperling's article, "Transmitter Adjustments" July *Electronics* make the following corrections:

1—Page 15, 2nd column, 17th line from bottom, formula should read:

$$C = E_p \div (I_p \times 100)$$

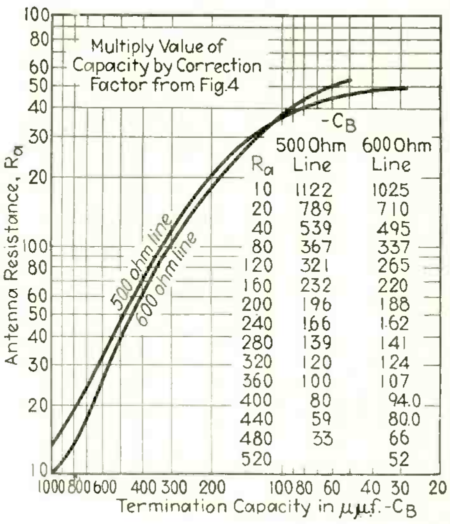
2—Page 54, 2nd column, 1st line, formula should read:

$$M = \frac{10^6 X_c}{2\pi f} \sqrt{\frac{R_a}{Z_0}}$$

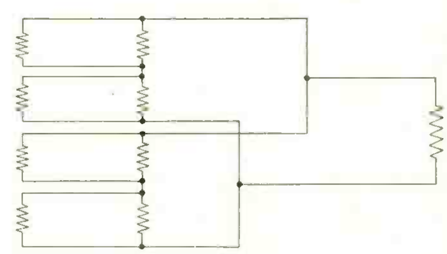
3—Page 54, 2nd column, 14th line from bottom, formula should read:

$$I_{cap} = \frac{(KVA/KW)\ P}{E_{rms}}$$

4—A corrected graph for Fig. 6 is given.



For Fig. 4, page 33, November, Mr. Smeltzer's article, substitute the figure given here.



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Electric Photographic Timer

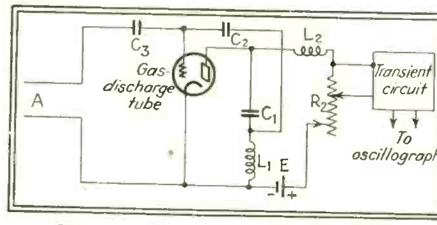
A METHOD by which photographic exposures are timed and governed by the discharge rate of a condenser through a variable resistance is described in the July 1936 issue of *X-Ray Technology*. Thyratrons actuating electromagnets are used to start and stop the exposure at a definite part of the voltage wave.


THE dream of yesterday is the accomplished fact of today. Regular air service across the Pacific by Pan American Clipper ships has added an important link in the world's transportation facilities.
Back of this spectacular service, and making its success possible, is a complete system of radio beacons and communication. Technical excellence and reliability distinguish the radio equipment both in the air and on land. RF switch gear, bushings, tube sockets, inductances, condensers and other parts make use of ISOLANTITE insulation in all this radio equipment. ISOLANTITE in your equipment will assure best results.
ISOLANTITE, Inc.
233 Broadway, New York, N. Y.
Factory at Belleville, N. J.
SAN FRANCISCO
MIDWAY IS.
HAWAIIAN IS.
WAKE IS.
CANTON
PHILIPPINE IS.
GUAM IS.
Western Electric 14-A Transmitter used at all of the land stations along the route of the Clipper ships. Note the liberal use of ISOLANTITE.
ISOLANTITE
INC.
CERAMIC INSULATORS

Cathode Ray Transient Oscillograph

WITHIN RECENT YEARS the cathode ray oscillograph has become a common and useful piece of equipment for recording periodic phenomenon. Extensions of the field of application of this instrument to include visual observation of transients greatly increase its value. This can be done by the simple expedient of repeating the transient in synchronism with the sweep voltage. Cathode ray oscillographs for the visualization of transient phenomenon and making use of grid-control arc rectifiers are described in the article "Electronics Transient Visualizers" by Herbert J. Reich in the December 1936 issue of "Electrical Engineering."

Although most of the circuits shown make use of several grid-controlled triodes, relatively simple circuits have been developed which



Gaseous discharge tube circuit for transient oscillograph

make use of only one gaseous discharge tube. One of these circuits is shown in the accompanying schematic wiring diagram. The voltage from the sweep oscillator is applied to the input or grid circuit of the gaseous discharge tube in such a direction that the sudden voltage change at the end of the sweep makes the grid positive. This causes the tube to fire and allows the condenser in the plate circuit to discharge through the tube. Because of the inductance in the plate circuit, plate current continues to flow until C_1 is charged with opposite polarity to a voltage somewhat lower than the applied voltage. The voltage induced in L_1 causes a flow of grid current charging C_2 and C_3 in such a direction as to leave the grid negative. This current cannot leak off through the grid owing to the rectifying action and the tube is prevented from firing until another positive pulse is applied at A.

Journal of Applied Physics

The American Institute of Physics is initiating a new journal beginning in January 1937 devoted to the interests of the applied physicist. The "Journal of Applied Physics" (which replaces the monthly, "Physics") will carry on the program initiated by its predecessor, in the publication of research papers. In addition new features will be developed which will in many ways alter entirely the character of the Journal. Each month some particular laboratory will be discussed with emphasis on the personnel and organization rather than on the building and equipment. Reviews of recent important articles in other journals will be published along with short sketches concerning the authors of the papers published in this journal. Non-members may obtain the monthly "Journal of Applied Physics" for $7 per year (in the United States and Canada) by making application to the American Institute of Physics, 175 Fifth Avenue, New York City. It is expected that the first issue will appear about the middle of January.

Tonlars

The December issue of the "Bell Laboratories' Record" contains its contribution to the enrichment of the American language in the article entitled "Tonlars." This term, like several others which have originated with Bell System, is taken from the initial letters of a descriptive phrase which has little meaning outside of the Bell System. In this particular case Tonlars is taken from tone operated net loss adjuster receiving. According to the article by Mr. L. D. Abraham, the "tonlar" is essentially a device that will despatch a test message just prior to each regular message and, at the distant end, compare the amount of the test current received with the desired amount at that point. If the amount received differs from the desired amount, an adjustment in the circuit net loss will be made automatically, and left there until the next test message is sent.

MANUFACTURING REVIEW

News

✦ **William F. Hedges**, formerly manager of NBC operated stations, has been appointed vice-president in charge of broadcasting of the Crosley Radio Corp. The announcement became effective January 1. Mr. Hedges has been with the National Broadcasting Company for the past five years and prior to that was associated with WMAQ and the Chicago Daily News as executive and editor.

✦ **A new service**, known as radio coverage rating, has been announced by **Edgar H. Felix** of New Rochelle, N. Y. The radio coverage reports will give a comprehensive summary of day and night service for all important communities being served by networks and radio stations throughout the United States.

✦ **The Gates Radio & Supply Company** of Quincy, Ill. announces their appointment as midwestern distributors of all transmitting and industrial tubes manufactured by the **United Electronics Co.** of Newark, N. J.

✦ **Beginning the first** of the year **Victor J. Andrew** established his own business. He is specializing in engineering and custom manufacturing of antennas and radio frequency transmission equipment.

✦ **Mr. Gerald R. Brophy** has recently joined the development and research staff of the **International Nickel Co.** according to an announcement by Vice-President A. J. Wadhams. Mr. Brophy will be located at the company's research laboratory at Bayonne, N. J. and will devote his time to problems relating to nickel alloy steels, nickel cast irons and other ferrous materials.

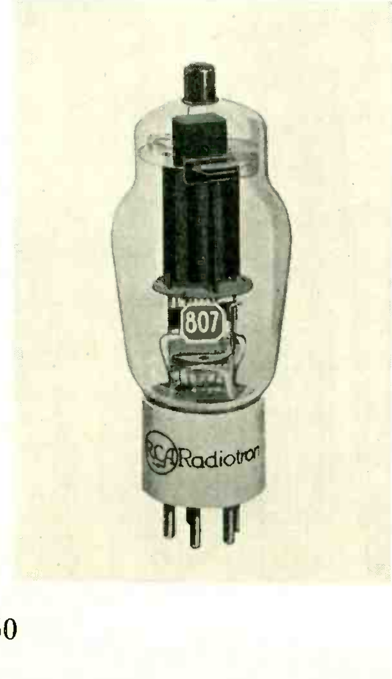
✦ **Formation of** an industrial and transportation color service under the direction of **R. H. Hookway** has just been announced by the Sherwin-Williams Co. This service has been established to aid industrial designers in securing effective color treatments and suitable types of finishing materials.

✦ To provide increased facilities for the manufacture of public address, sound equipment, and machine tools and dies, construction of a new Chicago factory on Bloomingdale Street at Central Ave. has been started by the **Webster Co.** It is expected that this modern factory, which will have the advantage of a railroad siding, will be completed by the first of April.

New Products

Beam Power Amplifier

RCA Manufacturing Company, Inc., Harrison, N. J., has made available through their transmitting tube distributors a new transmitting beam power amplifier known as RCA-807.



This tube is designed particularly for r-f transmitting applications, and incorporates the beam-power features of the receiving type 6L6. It has been provided with a ceramic base, top cap connection for high insulation and low interelectrode capacitances, and improved shielding. This tube has a plate dissipation of 21 watts and high power sensitivity. This last quality makes it well suited for use as a crystal oscillator, frequency multiplier or buffer amplifier. In the output stage, two 807's in class C telegraph service can give a power output of 50 watts or better. These are the manufacturers' ratings: D-c plate voltage, 400 max. volts; d-c screen voltage, 300 max. volts; max. signal d-c plate current, 100 max. ma.; max. signal d-c plate input, 40 max. watts; plate dissipation, 21 max. watts; screen dissipation, 3.5 max. watts.

Flux

Solder and Flux users will be interested in the Alumaweld flux which makes it possible to make high strength permanent repairs on joints of any metals. The Alumaweld Company of America, 2442 S. Parkway, Chicago, Illinois, also announces Alumaweld solder for use when greater tensile strength (12,000 lbs.) is desired.

Rack Construction

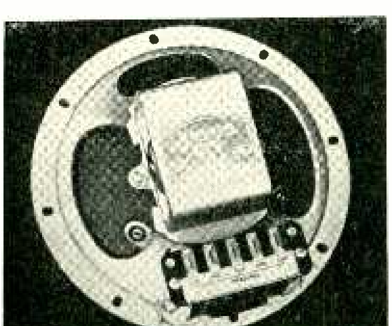
Radio Receptor Co., Inc., has developed a new rack and panel assembly known as the RH-1. This is a front removable rack and panel assembly and is constructed upon the usual heavy channel and angle iron framework. Panels are attached to side channels by means of sturdy continuous hinges on one side and screws on the other side. Special brackets are provided with all equipment to be mounted upon the rear of the rack. These brackets are so constructed that the apparatus to be mounted upon them can be slid back and forth after the attachments are removed. All components of the rack are provided with terminals at the front so that removal of connections is simple. The entire rack and panel assembly is provided with a steel dust cover enclosing it on top, rear and sides so that the entire assembly can be placed against a wall or built into the wall. Radio Receptor Co., Inc., 108 Seventh Ave., New York City.

Sound Effect Apparatus

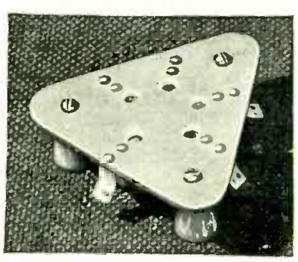
SOUND EFFECT equipment intended for use in studios has recently been announced by Jenkins & Adair, Inc., 3333 Belmont Ave., Chicago, Ill. The model A unit described in Bulletin No. 40 consists of three continuously variable speed turntables which operate from approximately 10 r.p.m. to 125 r.p.m., four crystal type reproducing heads and associated filters, mixing and gain controls, cut-off filters, etc. This unit is intended to be used with the sound effect records which are popularly used in broadcast studio operation. Mechanical sound effects, such as automobile horns, sirens, bells, or buzzers may be remotely operated from the machine. Eight keys allow a maximum combination of eight musical sound effects to be operated simultaneously. The audio-frequency amplifier in the lower portion of the cabinet, together with its power supply unit, provides a maximum peak power of 30 watts output.

Adjustable Impedance Speakers

A NEW LINE of loudspeakers with adjustable impedance transformers has recently been announced by the Jensen Radio Manufacturing Co., 6601 South Laramie Ave., Chicago, Ill. Two types of speakers are available, one to match conventional plate



impedance values and the other to match conventional line impedance values. The illustration shows a speaker for plate impedance matching suitable for impedances of 4,500, 7,000, 10,000, and 14,000 ohms. Besides a full line of speakers with adjustable impedance transformers, the speakers and impedance matching transformers may be obtained separately from Jensen.



Surge Meter

TO MEASURE large current impulses of only a few cycles duration such as are employed in electric welding practice, Welding Timer Manufacturing, Inc., 251 Ogden St., Newark, N. J., has developed a surge meter. Essentially this meter consists of a current transformer, a vacuum tube rectifier which charges a condenser, and a high resistance

meter shunted across the condenser to determine the condenser charge. The instrument has three ranges, obtained by shunting the transformer secondary by resistors of different values. The instrument is calibrated in r.m.s. values of current. In operation the primary lead to the electric welder is passed through the doughnut shaped coil which forms the current transformer.

Cathode Ray Oscillograph

ALLAN B. DUMONT LABORATORIES, INC., Upper Montclair, N. J., have recently announced their type 156 oscillograph using a 5 in. cathode ray tube. This equipment has been designed for use in recording in connection with motion picture film cameras or for observing slow speed phenomena at less than 10 cycles per second. In the first application a tube having a blue trace of high actinic value and extremely short persistence, is used. For observing slow speed phenomena a screen having a high persistence of image is employed.

Audio Transformers

A COMPLETE LINE of audio frequency transformers with flexible mounting cases, thoroughly shielded, and available in a wide variety of impedance ranges is available from the Thordarson Manufacturing Co., Chicago, Ill.

Replacement Resistors

A NEW WIRE-WOUND replacement resistor, designed especially for service men, has recently been made available in 5 and 10-watt sizes by the Muter Co., 1255 South Michigan Ave., Chicago, Ill. These units are compact, impregnated with waterproof cement and are provided with a small aluminum tag giving the resistance value of each unit. A wide range of the "Zipohm" units are available and are described in the "Zipohm" catalog.

Precision Plug-In Resistors

PRECISION RESISTORS in handy plug-in form and available in a wide variety of resistance values are now

offered by Clarostat Manufacturing Co., Inc., 285 North Sixth Avenue, Brooklyn, N. Y. These units are housed in a standard four-prong tube base and are available in values of from 1 to 10,000 ohms, with an accuracy up to 1/10 of 1 per cent. According to the manufacturer, the method of construction is such as to permit the units to be retailed at a relatively low price.

Capacity-operated Relay

THE ELECTRONIC LABORATORY, 306 S. Edinburgh Ave., Los Angeles, California, announces a new capacity-operated relay of small size, known as the type CR-1 relay. This unit is of the 110 volt AC-DC type and is contained in a crackle-finish, metal case, approximately 4¼ in. long, 4¾ in. high and 3⅛ in. deep. The control relay is of the

single-pole, double-throw type with silver-alloy contacts of 100 watts capacity. Relay sensitivity is controlled by a small bakelite knob on the side of the case. In operation, the antenna is connected to an insulated terminal at the top of the case. The relay may be used in a number of applications such as counting metallic objects, control of certain industrial operations, animated advertising displays, opening doors, etc. The CR-1 relay lists at $25.00 complete.

DC-AC Inverters.

A NEW LINE OF DC-AC inverters is announced by the American Television and Radio Co., of St. Paul, Minn., listing at $18.50 without filter or $22.50 with filter, and having overall dimensions of approximately 7¾ x 8 x ⅞ in., weighing 17 lb. There are sixteen different types for voltages ranging from 6 to 220 volts d.c. and output a.c. for both 110 and 220 volts. The inverters are equipped with a plug-in type vibrator unit of new design, having ¼ in. diameter contacts. Advantages claimed for the unit are freedom from interference on radio operation, long life vibrators and four point voltage regulators.

Winding Head

A COIL WINDING HEAD of new type which winds single phase motor coils in gangs or groups up to six in a nest, in all sizes and shapes, connected in series, has been developed by Ideal Commutator Dresser Co., 1631 Park Ave., Sycamore, Ill. The coils can be removed and inserted in the stator without series soldering.

Internal Spring Mounting in Microphone

A NEW DEVELOPMENT in microphone construction is the spring mounting in the Brush Development Company's Model BR2S. This mounting makes it unnecessary to use external mounting rings or rubber stand shock absorber, and makes it possible to pick up or move the microphone while in use. It is formed by fastening springs to two opposite sides of the unit of sound cells and pieces of felt on the other two sides, making the instrument unresponsive to jarring or handling. This microphone is especially good for p.a. work. Brush Development Company, 1899 E. 40th St., Cleveland, Ohio.

Portable 5-Watt Sound System

A PORTABLE SYSTEM in which speaker, amplifier, microphone and desk stand are contained in a luggage case. When in operation, the amplifier is removed from the case, and the case acts as a baffle for the speaker. The amplifier is of the high-gain type and the system can therefore be used with any modern microphone, velocity, dynamic, diaphragm-crystal or sound cell-crystal type. Clarion model, for 110 volt, 50–60 cycle a-c operation lists at $59.00, less tubes and microphone. Transformer Corporation of America, 69 Wooster St., N. Y. City.

Power Charger

BRIGGS & STRATTON CORPORATION, Milwaukee, Wisconsin, announces a 6 volt 200-watt charger to supply motor power for running small equipment as well as for battery charging. It is electric starting; the motor and generator are separate units; it has a four-cycle, air-cooled, single cylinder motor and is shielded to prevent radio interference.

Crystal Coupler

A PRELIMINARY COUPLING amplifier for use with any type crystal reproducer is available from the Radio Engineering & Mfg. Co., 26 Journal Square, Jersey City, N. J. It has low and high frequency compensation. Bulletin 14-A describes this unit known as the R20-A, for broadcasting stations, sound studios, transcription studios.

Enclosures

THE SERIES K meter enclosures made by Radio Engineering & Manufacturing Company, 26 Journal Square, Jersey City, New Jersey are designed for front of panel mounting on radio transmitters where protruding meters and other high tension apparatus must be effectively covered for the protection of personnel.

Adjustable Condenser Mounting

SOLAR MANUFACTURING CORP., 599 Broadway, N. Y. City, had designed "Flex-Mount", a movable universal tube which makes the condenser actually reversible. May be mounted flat or on edge. Designed to take care of tight corners and difficult installations where it is advisable to mount the condenser rigidly.

Styli

UNIVERSAL MICROPHONE COMPANY, Inglewood, Cal., has added to its recording accessory line professional steel cutting styli to be used in conjunction with its professional blanks, Silveroid discs and all nitrate or acetate records. It is said to be the closest approach to sapphire yet produced commercially.

Cam Lever Switch

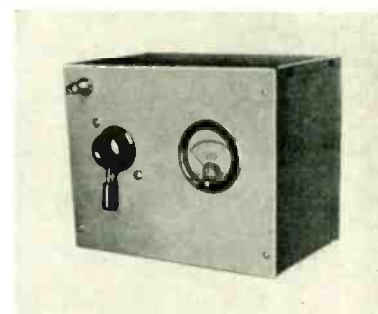
GAMEWELL engineers have designed a switch of several advantages as follows: It is positive in operation, handling 5 amperes a-c, 1 ampere d-c, at 110 volts; rugged construction, easy installation, numerous contact arrangements; high insulation breakdown. Known as Type 3CL switch, it is manufactured by General Control Company, Cambridge, Mass.

Regulator Condenser

AEROVOX CORPORATION, 70 Washington Street, Brooklyn, N. Y., announces a new type of wet electrolytic condenser with such leakage properties that it can be employed to prevent undesirable voltage rises, when a radio set is first turned on. At other times the condenser operates in normal fashion with a powerfactor less than 10% and low leakage. They are to be connected across the output of the filter and not across the rectifier.

Capacity Control Unit.

A NEW UNIT KNOWN as "Capacitrol" is manufactured by J. Thomas Rhamstine, 300 Beaubieu St., Detroit, Mich. The unit, which is self-contained, consists of a capacity operated relay with an antenna which may be from five to fifty feet of rubber covered



wire. If a person or car approaches within 3 ft. of the antenna the device operates closing a relay for operating any desired device. The device is useful where photo-electric apparatus or the installation of "Treads" is not possible. The complete unit less antenna lists for $40. The size of the box is 6½ x 8 x 5½ in. overall.

Mono-hand Microphone Stand

BRUNO LABORATORIES, INC., 20 W. 22nd St., N. Y. City, announces their Model B-22 one-hand button action microphone stand. The ingenious arrangement makes it possible to move the movable part of the stand by the pressure of a button placed below the microphone. The base of this stand is triangular and rests evenly on any floor. Maximum height 59", list price $22.50.

Radio Instruments

SIMPSON ELECTRIC COMPANY, 5216 W. Kinzie St., Chicago, Illinois announces its complete line of radio instruments and service equipment, incorporating the "roto ranger" rotary dial. As the selector switch is moved to any one of twelve positions, the scale comes into view which coincides with the circuit which has been cut in, actually switching circuit and dial simultaneously.

✦ **Audio Attenuators.** A bulletin on sound projection control listing T and L pad attenuators, gain controls and faders suitable for audio frequency amplifier circuits is available from the Central Radio Laboratories, 900 East Keefe Avenue, Milwaukee, Wis.

✦ **Microphone Data.** An interesting loose-leaf folder suitable for standard three ring binders of letterhead size and describing the specifications, characteristics and applications of Shure microphones has been published by Shure Bros., 215 West Huron St., Chicago. This specification chart, which in some respects is similar to the tube data charts, gives typical applications, prices, performance curves, load impedance, current requirements, size, dimensions and other technical information relative to carbon crystal, condenser, and other microphones.

✦ **Tube Bulletin.** Technical bulletins describing the RCA, 807 transmitting beam power amplifier, the 808 radio frequency power amplifier, and the 956 super-control acorn pentode have recently been issued by the RCA Manufacturing Company. The bulletins may be obtained from the Commercial Engineering Section, RCA Manufacturing Company, Harrison, N. J.

✦ **Metal Furnaces.** Induction Furnaces having a melting capacity from a fraction of 1 lb. to several tons are described in bulletin of the Ajax-Electrothermic Corporation of Trenton, N. J. In the laboratory units described in this bulletin, high frequency spark generators are used to provide the induction field.

✦ **Vacuum Pumps.** The Beach-Russ high vacuum pumps of the single stage rotary type are described in Bulletin No. 70 of the Beach-Russ Company, 50 Church Street, New York City. The single stage units discussed in the bulletin are designed to maintain a constant vacuum to within 5 millimeters of mercury.

✦ **Rotary Converters.** The Janett Manufacturing Company, 553 West Monroe Street, Chicago, has recently issued a 4-page bulletin describing their rotary converters which are especially suitable for radio, sound apparatus, and gaseous signs. Standard converters are built for a d.c. supply of 6, 12, 32, 115 or 230 volts, and deliver single phase, 110 volts, 60 cycle current.

✦ **Insulating Material.** The William Brand & Company, 276 Fourth Avenue, New York City, has available for distribution their catalog No. 11 describing electrical insulating material. Mica plates, varnished tape and varnished tubing having extensive application in the electrical, radio, and automotive fields are listed.

Literature

✦ **Resistance Welding.** "Theory and Application of Resistance Welding" by L. H. Frost, welding engineer of the Electric Controller & Mfg. Co. Data on welding procedure and hints for the prevention of faults encountered when using this method of fabrication. A limited number of copies free, additional copies available at 10 cents each. Electric Controller & Mfg. Co., 2700 E. 79th St., Cleveland, Ohio.

✦ **Replacement Guide.** A supplement to the 80-page volume control replacement guide issued several months ago by Clarostat, a handy reference list of exact duplicate volume control replacement numbers. Clarostat Manufacturing. Co., Inc., 285 No. Sixth St., Brooklyn, N. Y.

✦ **Telephone receiver test equipment.** Bulletin No. 1 of the Ballantine Laboratories, Inc., Boonton, N. J. describes the artificial ear, type 502, for receiver test, and type 500A, a complete rack-mounted assembly incorporating the artificial ear and all of the apparatus required for receiver testing.

✦ **Metal Data.** A loose-leaf bulletin has recently been released by the Stupakoff Laboratories, Pittsburgh, Pa., describing the technical characteristics of Kovar. Kovar is an iron-nickel-cobalt alloy, having the thermal coefficient closely approaching that of glass and is particularly useful in making the glass to metal seals in radio vacuum tubes.

✦ **Quartz Crystals.** "Bliley Quartz crystals" is the name of a technical bulletin describing quartz crystal mountings, temperature-controlled ovens and frequency standards manufactured by the Bliley Electric Company, of Erie, Pa. Crystals having a fundamental range of 20 kilocycles to 25 megacycles are listed.

✦ **Rectifier Tubes.** "Westinghouse Rectifier Tubes" is the title of a 4-page bulletin dealing with high vacuum, mercury vapor and gas-filled rectifiers and low-voltage Rectigons which are available from the Lamp Division, Westinghouse Electric & Manufacturing Company, Bloomfield, N. J.

✦ **Multiple Antenna.** A 12-page bulletin describing antenna systems for multiple-set operation in apartment houses, hospitals, hotels and private dwellings is available from the Technical Appliance Corporation, 17 East 16th Street, New York City.

Cathode Ray Tube

A HIGH VACUUM, low-voltage cathode ray tube having two sets of electrostatic deflecting plates has recently been announced by the Radiotron Division, RCA Manufacturing Co., Harrison, N. J. This tube, which is known as the RCA-913, has an indirectly heated cathode, a fluorescent screen about 1 in. in diameter and

is encased in a metal can which may be grounded to eliminate the effects of local magnetic fields. The tube is provided with the standard 8-prong octal base and is designed to operate with an anode voltage of between 250 and 500 volts.

The low operating voltage, low price, and small size of this tube together with its shielding case make the tube especially suitable for amateur work.

Ceramic Dielectric Condensers

SMALL SIZE fixed condensers having ceramic insulation are available from the Cornell-Dubilier Corp., South Plainfield, N. J. The condensers are available in disc, cup, and tube shape. The cup and disc type cover ranges of capacities between 2 and 100 $\mu\mu f$ and the tubular form is available in ranges up to 1,200 $\mu\mu f$. Subject to a limited tolerance in all cases of not less than 0.2 $\mu\mu f$., these condensers may be obtained to values of within 1 per cent of the required capacitance.

✦ **Dynamic Speakers.** Standard specifications for Magnavox dynamic speakers are presented in a 4-page bulletin issued by the Magnavox Company, of Fort Wayne, Ind. Technical details and prices of thirty-six different dynamic speakers are listed.

✦ **Radio Switches.** The Yaxley Manufacturing Division of P. R. Mallory & Company, Indianapolis, Ind., has recently issued a 4-page bulletin of engineering data on Yaxley switches. A feature of this bulletin is a printed insert on semi-transparent paper showing the outline and dimensions of the switches. These drawings may be used in making blue prints or in ordering switches to meet certain specifications.

✦ **Resistor Data.** A type of folder giving the specifications and engineering data on I.R.C. fixed and variable resistors has recently been issued by the International Resistance Company, 401 North Broad Street, Philadelphia, Pa.

✦ **Dielectrics.** High Frequency Insulators for Commercial Service is the name of a 20 page booklet published by the Dielectric Products Corporation, 63 Park Row, New York City, and outlining the principal electrical and mechanical characteristics of steatite and vitrolex. This company also has available a small folder giving the principal electrical and mechanical characteristics of solid and liquid Vitron.

✦ **Condenser Catalog.** The Cornell-Dubilier Corporation, 4377 Bronx Boulevard, New York City, has recently issued two catalogs describing their condenser products. Catalog No. 128 lists the technical details of condensers suitable for radio receiving purposes. Condensers for industrial, high voltage and radio transmitting work are listed in catalog No. 127. Catalog No. 133 A lists the Cornell-Dubilier condensers which are especially suitable for amateur transmission.

✦ **Magnavox Dials.** A 4-page bulletin describing engraved dials suitable for automobile gages, meters, and speedometers, thermostats, electric clocks, testing meters and radio receivers, has recently been issued by the Magnavox Company, of Fort Wayne, Ind. Luminous dials are available, enabling one to determine a dial setting in the absence of direct illumination.

●

Superior Tube buys Juno Fasteners

Through purchase of the business, patents and machines of the manufacturers of Lockseam cathodes, Superior Tube Company (Norristown, Pa.) announce that they will be able to supply both seamless tubing for cathodes and the patented Lockseam product. Thus tube manufacturers can get from a single source, both kinds of cathode materials.

British Patents

Radio Circuits

Oscillator. A brake-field oscillation generator in which there is arranged between the cathode and the positive grid a negatively biased grid screening the positive grid from electrons passing from the cathode, the circuit determining the oscillations being connected between the positive grid and the cathode. No. 441,341. See also No. 441,538, I. Hausser, Heidelberg, Germany.

Feed back amplifier. A thermionic amplifier of the kind employing negative feed back between output and input for distortion correction, in which the amplifier gain-frequency characteristic is variable with frequency to correct for line attenuation. No. 441,-626, Standard Telephones & Cables, Ltd.

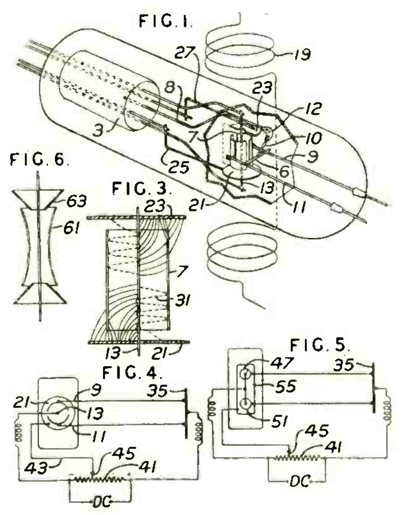
Transmitting system. A push-pull short-wave oscillator has its frequency accurately regulated by a resonant circuit of the long-line type. The oscillator is kept in frequency agreement with the constant frequency by a zero beat method which distinguishes between excursions above and below the standard and automatically corrects them. C. W. Hansell, Marconi Co. No. 441,793.

Directive system. To insure a clear-cut directional indication, free from ambiguity due to waves reflected from a nearby conductor, the receiving aerial is given a pick-up characteristic which has a zero direction lying inside a small solid angle of full-strength recepton, outside which it again receives no signals. Telefunken, No. 441,964.

High selectivity circuit. This patent relates to the reduction of interference from stations of neighboring frequency to that desired and contemplates broadly the shifting of the intermediate frequency band upwards or downwards with respect to the normal intermediate carrier by varying the frequency of the local oscillator only, at the same time the resulting preponderance of the lower frequencies of the audio frequency band is corrected by a band-expanding arrangement prior to the second detector stage. J. K. Johnson, Hazeltine Corp. No. 442,477.

Anti-noise circuit. A receiver is disabled for the duration of a disturbing impulse or has its amplification considerably reduced, so that the disturbance is not heard in the reproducer. A glow discharge relay or a dynatron is arranged in the aerial circuit and responds to an excess voltage to operate the relay. Ideal Werke, Berlin. No. 442,626.

High frequency oscillator. An electronic-period oscillator of the magnetron or Barkhausen-Kurz type provided with means for setting up an electrostatic field with a component



in the direction of the axis of the electrodes. E. G. Linder, Marconi Co. No. 442,465.

Magnetron oscillator. The magnetic field is increased to at least a critical value at which, under dynamic conditions, electrons leaving the cathode with zero velocity arrive at the anode with zero radial velocity. This critical value is much larger than the value of the normal critical field, and the transit time of the electrons is substantially increased as compared with the transit time obtained when the magnetron is operated in the normal manner with a magnetic field near to the normal critical field. Formulas for the transit time and critical value of magnetic field are given for magnetrons having plane and cylindrical electrodes in terms of the electrode gap and anode-cathode voltage. W. E. Benham, Marconi Co. No. 442,776.

Synchronizing circuit. No. 2,005,153 to A. M. Marks, Communication Patents, Inc., and 2,023,505 to Rene Barthelemy, France.

Tuning indicator. A shadow meter for giving visual indication when a receiver is exactly in tune. P. R. Mallory & Co. No. 434,932.

Blind landing system. A radio navigational system for assisting airplanes to land under conditions of poor visibility. Telefunken, Germany. No. 444,194.

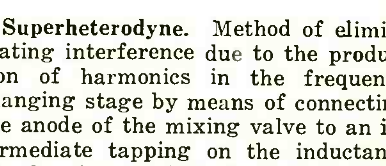
Multi-channel system. Picture signals and sound signals are carried on separate short wave carriers spaced from each other by a frequency interval such that at the receiving station a single local oscillator can be used for producing the two subcarriers required for superheterodyne reception. D. S. Loewe, Berlin. No. 439,866.

Interlaced scanning. The scanning beam is swept over a set of fixed mutually inclined mirrors, and the time of complete scanning is equal to a number of line periods which is one more or one less than to span an integral multiple of the number of partial scans in a complete scan. C. O. Browne, London. No. 439,121.

Superheterodyne. Method of eliminating interference due to the production of harmonics in the frequency changing stage by means of connecting the anode of the mixing valve to an intermediate tapping on the inductance of the intermediate-frequency band-pass coupling. By this means and the provision of a bypass condenser with a low impedance to the harmonic frequencies but high impedance to the intermediate - frequency, currents of harmonic frequencies are balanced out. R. E. Spenser, London. No. 438,972.

Film system. In an intermediate film television receiver, selected images, for example, alternate images, are presented to an observer several times. This allows the ratio of the rate of presentation of images to the rate of transmission of images to be some other than an integer. J. L. Baird, London. No. 439,771.

Reflex circuit. Received oscillations are impressed on one grid of a multi-grid tube and after a change in fre-



quency are fed back to another grid of the same tube for reamplification. Marconi Co. No. 439,047.

Automatic tuning control. A manually tuned radio-receiver has automatic means for finally adjusting the tuning exactly to the desired signal comprising a variable tuning member to vary the resonant frequency to the desired frequency in one sense, movement of the tuning member being arrested on reaching the desired frequency on the reverse travel. E. K. Cole. No. 442,897. See also No. 442,-903 to E. K. Cole on a circuit in which the knob controlling the degree of noise suppression is adapted simultaneously to modify other parts of the circuit to suit the modified setting. Also No. 442,951 to Cole on a noise suppression-device.

Patent Suits

1,403,475, H. D. Arnold; 1,403,932, R. H. Wilson; 1,507,016, L. de Forest; 1,507,017, same; 1,811,095, H. J. Round; Re. 18,579, Ballantine & Hull, filed July 22, 1936, D. C., W. D. Wash. (Seattle), Doc. 1149, *RCA et al.* v. *F. V. Buckley* (*Buckley Radio Co.*)

2,047,863, W. G. Finch, Telecommunications system; 2,048,604, same, Electromagnetic coupling device, filed Sept. 8, 1936, D. C., S. D. N. Y., Doc. E. 83/353, *W. G. Finch* v. *Wide World Photos.*

1,763,380, 1,798,962, C. E. Trube, Electric coupling system, D. C., S. D. N. Y., Doc. E 59/255, *Hazeltine Corp.* v. *Westinghouse Electric & Mfg. Co.* Doc. E 59/256, *Hazeltine Corp.* v. *General Electric Co.* Doc. E 59/257, *Hazeltine Corp.* v. *Radio Corp. of America.* Doc. E 59/258, *Hazeltine Corp.* v. *R. C. A. Victor Co., Inc.* Consent and order of discontinuance without prejudice (notice Aug. 20, 1936), in each of above cases.

1,573,374, P. A. Chamberlain; 1,707,617, 1,795,214, E. W. Kellogg; 1,894,197, Rice & Kellogg; 1,728,879, same, D. C., S. D. Calif. (Los Angeles), Doc. E 893-C, *RCA et al.* v. *R. A. Cottrell.* Decree proconfesso, holding patents valid and infringed, injunction Sept. 8, 1936.

1,507,016, L. de Forest, Radio signaling system; 1,507,017, same, D. C., S. D. Calif. (Los Angeles), Doc. E 967-Y, *RCA et al* v. *El-Rey Radio Mfg. Co. et al.* Patent held valid and infringed, injunction Sept. 8, 1936.

1,403,475, H. D. Arnold; 1,403,932, R. H. Wilson; 1,507,016, L. de Forest; 1,507,017, same; 1,618,017, F. Lowenstein; 1,702,833, W. S. Lemon; 1,811,095, H. J. Round; Re. 18,579, Ballantine & Hull, D. C., S. D. Calif. (Los Angeles), Doc. E 892-Y, *RCA et al.* v. *R. A. Cottrell.* Decree pro confesso holding patents valid and infringed, injunction Sept. 8, 1936.

1,231,764, F. Lowenstein; 1,618,017, same; 1,465,332, H. D. Arnold; 1,573,374, P. A. Chamberlain; 1,702,833, W. S. Lemmon; 1,811,095, H. J. Round; Re. 18,579, Ballantine & Hull, D. C., S. D. N. Y., Doc. E 78/111, *RCA et al.* v. *Pyramid Radio Distributors, Inc., et al.* Interlocutory decree of Feb. 5, 1936 for plaintiff affirmed Aug. 5, 1936.

1,973,039, M. H. Benedek, Electrical Condenser; des. 93,653, J. Greenberg, same, filed July 30, 1936, D. C., E. D. N. Y. Doc. E 8026, *Micamold Radio Corp.* v. *Aerovox Corp.*

2,020,211, J. P. Quam, Loud Speaker; 2,020,212, same, Method of making dynamic speaker, filed August 3, 1936, D. C., N. D. Ill., E. Div., Doc. 15283, *Quam-Nichols Co.* v. *Oxford Tartak Radio Corp.*

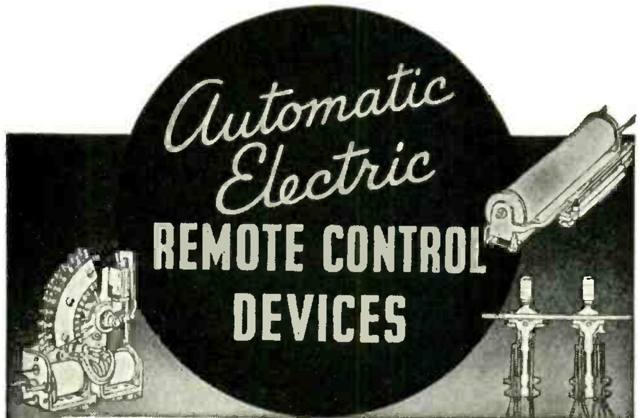
Decree for plaintiff by default, injunction granted (notice July 27, 1936).

1,403,475 (*c*), H. D. Arnold; 1,403,932, R. H. Wilson; 1,447,773, Espenschied & Brown; 1,507,016, L. de Forest; 1,507,017, same; 1,531,805, R. C. Mathes; 1,596,198, S. Loewe; 1,618,017, F. Lowenstein; 1,869,323, P. H. Evans; 1,936,162, R. A. Heising; Re. 18,579, Ballantine & Hull, D. C., N. D. Ill., E. Div., Doc. 15220, *R. C. A. et al.* v. *Ultramar Mfg. Corp. et al.* Consent decree, finding patents valid and infringed, injunction granted June 15, 1936.

1,403,475 (*d*), H. D. Arnold; 1,403,932, R. H. Wilson; 1,507,016, L. de Forest; 1,507,017, same; 1,811,095, H. J. Round; 1,936,162, R. A. Heising; Re. 18,579, Ballantine & Hull, D. C., N. D. Ill., E. Div., Doc. 14978, *R. C. A. et al.* v. *E. Mraz* (*Hi-Lo Radio Co.*). Decree pro confesso, finding patents valid and infringed, injunction granted Mar. 18, 1936.

1,570,297, F. L. Dyer, Art of recording and reproducing sounds; 1,628,658, same, Talking machine record; 1726,546, same, Apparatus for making phonograph records; 1,783,498, same, Method of making phonograph records, C. C. A., 3d Cir., Doc. 6034, *F. L. Dyer* v. *Sound Studios of N. Y., Inc.* Decree affirmed June 20, 1936.

(D. C. N. Y.) Georgiev patent, No. 1,789,949, for electrolytic cell, claims 11, 18, and 19 *Held* valid and infringed. *Aerovox Corporation* v. *Micamold Radio Corporation*, 15 F. Supp. 279.



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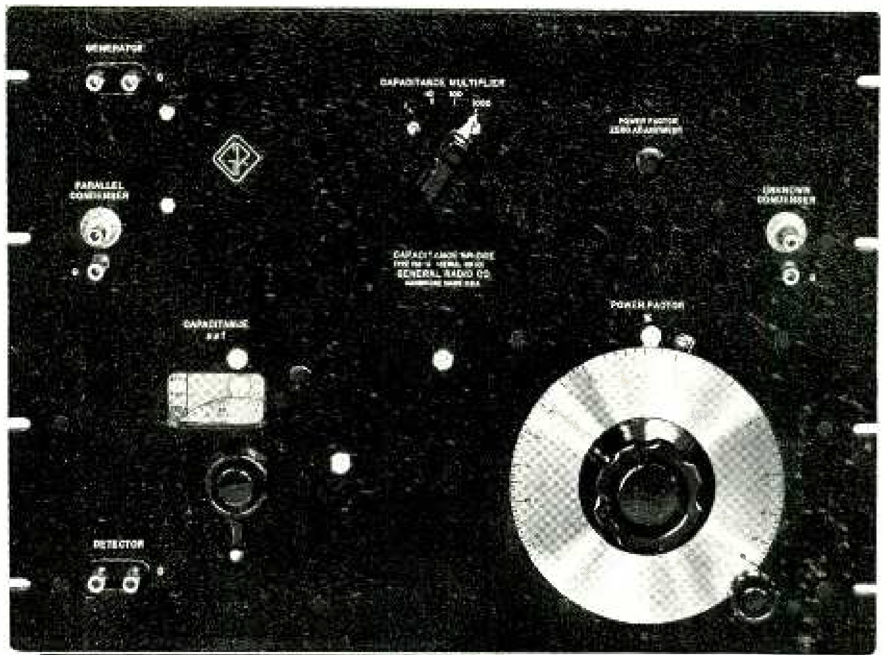

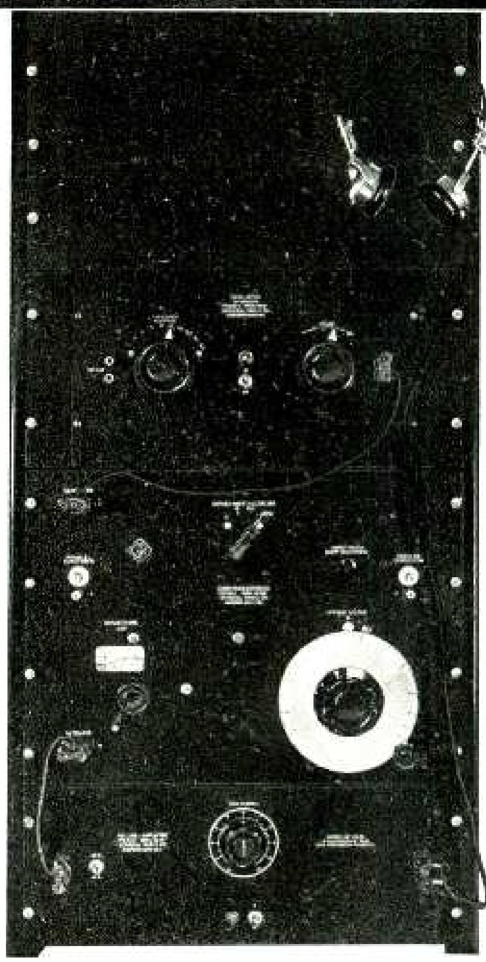

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