electronics

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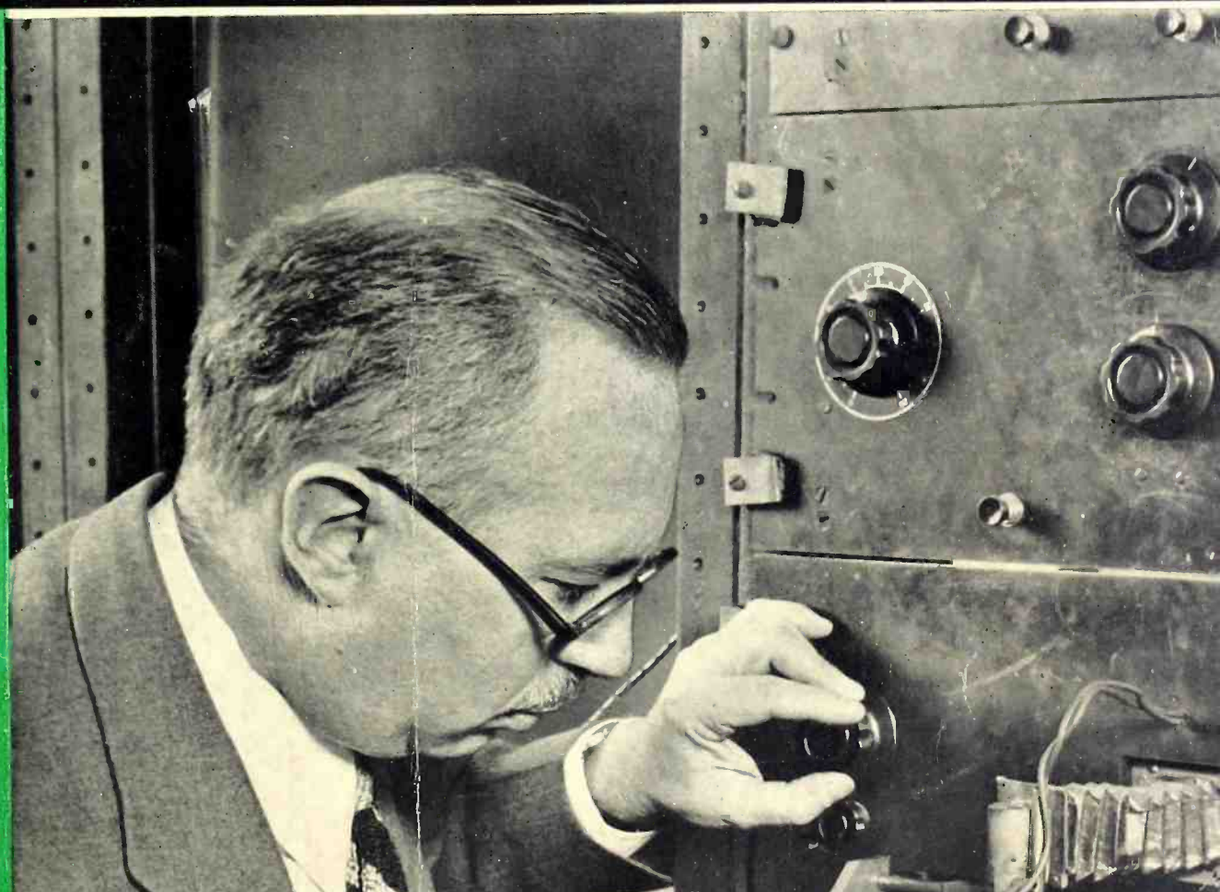


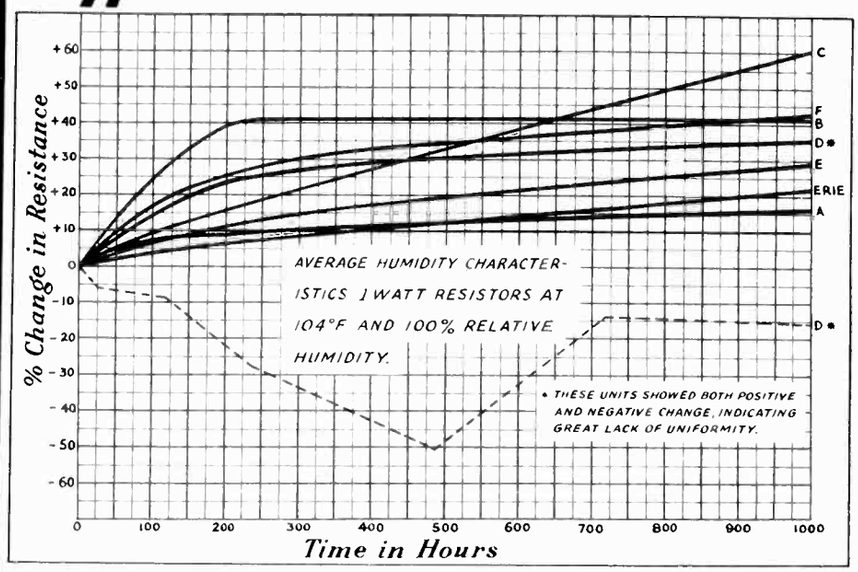
J.V.L. Hogan and his facsimile transmitter (See p.

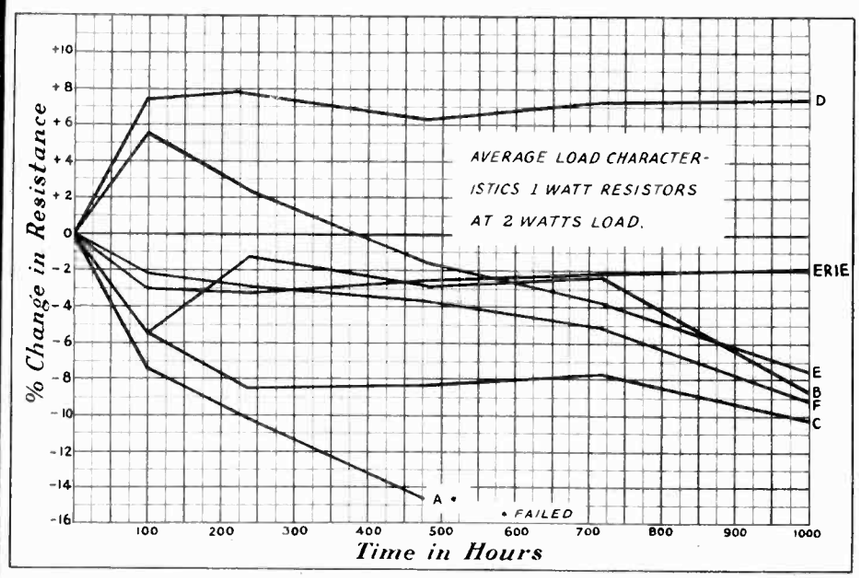
McGRAW-HILL PUBLISHING COMPANY, INC.

Price 35 Cents

NOVEMBER 1934

Two More Proofs of BALANCED PERFORMANCE of ERIE RESISTORS





The second of a series of advertisements dealing with the balanced performance of Erie Resistors. Watch for number three.

Take a few minutes to study these load and humidity test charts. They show two more reasons why Erie Resistors are the *only* make that gives all-round performance that is so essential to efficient set operation.

Note, for example, that Resistors "A" have a slightly lower humidity change than the Erie Resistors tested. But see their relative positions in the load test chart — Resistors "A" have the highest change in resistance value of the seven competitive makes, while the Erie Resistors maintain their uniformly superior position.

Last month we showed the same comparative results in two other characteristics — voltage coefficient and temperature coefficient.

It is because of the lack of uniformity in the various characteristics of many makes of resistors that we say "Check Everything" before you approve or buy *any* resistors.

ERIE RESISTOR CORPORATION

ERIE, PA.

Factories in ERIE, PA.-TORONTO, CANADA - LONDON, ENG.

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electronics

O. H. CALDWELL
Editor
KEITH HENNEY
Managing Editor
DONALD FINK

McGRAW-HILL PUBLISHING COMPANY, INC.

New York, November, 1934

Radio interference must go!

Rochester convention IRE to initiate corrective campaign

FALL meetings of the IRE at Rochester, N. Y., have been notable in the past, and have attracted wide attention among radio engineers.

But the sessions scheduled for Rochester, November 12, 13 and 14, promise even greater influence on the future of radio in America. For at this coming Rochester convention will be launched the RMA-IRE campaign to eliminate radio interference on both the broadcast and short-wave channels.

Conceived by W. R. G. Baker, director of engineering for RMA, and Virgil Graham, tireless worker for industry betterment in both RMA and IRE, these initiators have now enlisted the aid of Dr. Alfred N. Goldsmith to serve as chairman of the new RMA committee on radio interference, which will act as the spearhead of the coming campaign.

DR. GOLDSMITH and his associates recognize that this problem of radio interference can be solved by no oppressive overnight methods. They see ahead a long campaign of research and education, directed at, as well as aided by the radio and electrical manufacturing industries, the automobile manufacturers, the electrical utilities, and the general public. It may take five years to make an appreciable dent in present interference conditions, and almost a generation before the last offending appliances are retired from service. But meanwhile Dr. Goldsmith's committee will try to see to it that appliances produced from now on are of non-interfering types. The committee plans also to apply the principles of "enlightened self-interest" to the task of eradicating interference sources on 1935 automobiles, and on electrical circuits, public and private.

CEASELESS vigilance will be the price of an interference-free ether. Every home in America will eventually feel the benefits of the campaign to be started at Rochester during the meetings of November 12-14.

FACSIMILE—"THE HOME

Day of printed home "radio newspaper," with headlines, cartoons, display ads and radio programs comes nearer

BROADCASTING had scarcely got started, before radio men began asking themselves what other use or uses could be made of the radio waves to furnish *other* services to the home. And now, after some years of experimentation, we seem to be entering upon a new period of *visual broadcasting,* when it will be possible to scatter across the countryside, to homes in cities and hamlets, printed pages and pictures, delivered with the speed of light—facsimile.

Thus "the radio printing press in the home," may soon be a reality, paralleling the commercial use already made of the same facsimile methods by the great newspaper and communication groups, for transmitting by radio or wire pictures and documents, complete in every detail, and almost indistinguishable from the original.

In principle, facsimile is familiar to most radio men. The page to be transmitted is first scanned by a photocell, which is carried back and forth in successive rows or "lines," and responds to the dark and light areas which it traverses, with corresponding electrical impulses. These impulses are then amplified and transmitted as a series of signals which when received can be used to interrupt or modulate the marking of a stylus, pen or jet similarly moving across the page at the receiving station, and so by a progressive accumulation of lines, producing a reproduction of the original.

Facsimile is already in wide commercial use. Pictures are now regularly transmitted across the Atlantic and across the continent. Weather maps are delivered to ships at sea. Exact copies of newspapers, headlines and all, can be laid down on the decks of ocean liners. Paris fashions can be sketched and sent winging to all America. X-ray shadowgraphs can be radioed for the consultation of foreign specialists. Criminals' photographs and finger-prints can be broadcast to the police of the civilized world.

Facsimile prints the morning paper

And so enters the engaging picture of what might happen if the apparatus for receiving such photographic facsimile can be made simple and inexpensive enough for use in the average home. The project first received serious consideration in its home aspects only a few years ago, at the time when the newspapers, stung by broadcasting's diversion of advertising revenue, started to take radio programs out of their columns. Of course broadcasting needs a printed advance-sheet or program, and the means of providing this was all ready, in the facsimile apparatus developed primarily for commercial purposes.

And as the picture unfolded, it was realized that if the broadcasters were to deliver their programs to their audiences by facsimile, they might as well include news, and headlines, and display ads, and cartoons, opening up another large avenue of income.

So in one form the vision ahead for facsimile in the

Charles J. Young of Camden, N. J., and his "lawnmower" facsimile reproducer, which uses carbon-paper as the printing medium

RADIO PRINTING-PRESS"

Work of R. H. Ranger, Captain Fulton, J. V. L. Hogan and C. J. Young. Trend toward simplification of printers

home is something like this. All evening, let us say, the Joneses have been listening to the musical offerings of their radio set. Bedtime comes, and time to turn off the radio music. But instead the switch on the radio set is simply turned to a position marked "Newspaper" which cuts out the loud speaker and hooks up the facsimile reproducer—the "radio printing press." And then, while the Joneses are sleeping, their radio set with its facsimile attachment is silently printing away, unrolling page after page of news matter, pictures, cartoons, display ads with big type, and everything. So that when Papa Jones comes to breakfast in the morning, there, by the radio set, is a complete little newspaper, headlines, cartoons, ads and all. Such a radio newspaper would not be subject to the hours of delay for printing and delivery. Most morning papers now have to close at midnight, to catch their mails and truck schedules; the radio-facsimile paper could take "hot news" up until a few minutes of the close of the facsimile period at say 6 a.m.

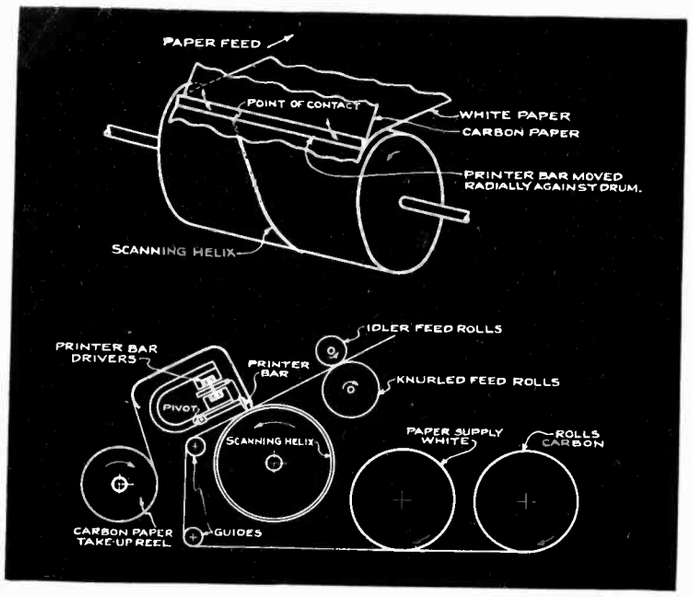
Broadcast vs. short-wave channels for facsimile

Such use of the broadcast channels between 1 a.m. and 6 a.m. for facsimile, seems almost ideal utilization of facilities otherwise wasted and idle during that period. Millions of dollars of investment in broadcasting transmitters stand idle during these early morning hours daily. The channels in the ether are mostly empty during those hours. And millions of listeners' sets stand mute and silent. Facsimile then is a way to put these idle facilities to use during the hours most of us are asleep, transmitting a cumulative service which is ready for our attention when we awake. The facsimile printer need merely be connected into the broadcast receiver in place of the usual loudspeaker, and the millions of radio sets now in homes could be converted into "home radio printing presses" for facsimile reception.

Other advocates of facsimile see it as a special service of its own, not to be interpolated into the broadcast channels, but occupying special short-wave channels of its own, which would enable it to render a full twenty-four-hour service. They see facsimile delivering graphic information, pictures, maps, sketches, news photos, cartoons, anything, into the home all day long—with possibly an accompanying sound channel which would serve to explain and interpret the pictures as they appear. With such a separate facsimile channel, the newspaper would not be limited to a morning edition, but could be expanded into a sort of continuous news bulletin, sandwiched in between illustrative and pictorial matter.

There is a legend that the conception of facsimile started when Owen D. Young, talking with E. F. W. Alexanderson, and greatly impressed by a long complex radio message that had just come from abroad, asked with an enigmatic smile: "Well, if you can send all that across the Atlantic, why can't you send the front page of the *New York Times* itself across, in one zip?"

John V. L. Hogan of New York, and his "radio pen." The fountain stylus, carrying ink, draws lines rapidly across the paper



Printing mechanism of the Young-RCA facsimile receiver

Whereupon Dr. Alexanderson assigned his assistant, Captain Richard H. Ranger to the task, and by 1924 Ranger had a pen-type facsimile system invented, and by 1928 was transmitting weather-maps to ships at sea, and sending pictures across the Atlantic. Other jet and photographic types of facsimile apparatus were developed by Ranger, who continued in the field until 1930.

The Charles J. Young "lawnmower" printer

Further work in perfecting facsimile apparatus for the RCA interests was taken up by Charles J. Young, research engineer at Camden, and son of Owen D. Young. Mr. Young's "lawnmower" facsimile reproducer, using carbon paper as the means of inking, is now one of the most promising systems, since it eliminates all preparation of the paper, or the use of inks or jets.

Carbon paper was suggested in early facsimile experiments as a simple and direct printing agent, but the stylus which was used to produce the marks caused considerable difficulty. In the new system developed by C. J. Young for the RCA Victor Company, the stylus has been supplanted by a roller-and-printing-bar arrangement. The roller contains a single spiral of piano wire imbedded in and raised slightly above its surface. This wire presses through a layer of carbon paper and printing paper against a printing bar which lies parallel to the axis of the roller. As the roller is rotated, the point of contact between it and the printing bar travels in a straight line across the paper, and simultaneously the pressure exerted by the printing bar on the paper is varied by a magnetic drive controlled by the incoming facsimile signal. The line printed by the varying pressure constitutes one line of the image, and as the paper and carbon are moved slowly during the printing process, adjacent lines are printed parallel to one another and the image is built up. Variations in shade are produced by variations in pressure, and as a result half-tone images can be reproduced almost as easily as black-and-white.

In the transmitter the picture or message is placed on a roller and rotated underneath a photocell scanner which picks up the variation in light and shade in a series of closely spaced parallel lines. The amplifiers which take the output of the photocell impress the current variations on an audio frequency carrier, of a frequency in the neighborhood of 3,000 cycles per second. This tone output is then transmitted over radio or wire lines in the usual manner.

At the recorder, the printing helix (the piano-wire spiral) is rotated synchronously with the transmitting apparatus. The synchronization is provided by power system connections, if both transmitter and receiver can be operated from the same system. Otherwise temperature-controlled tuning fork oscillators are used to control both receiver and transmitter independently, a regulation accurate to one part in 100,000 being possible by this means. The paper, of standard $8\frac{1}{2}$ inch width, is fed over the printing helix at a rate of 1.2 inches per minute. The carbon paper is fed somewhat slower

TOLERANCE is an enlightened attitude of mind which can listen to contrary-minded opinions without anger and, though it may seek to resist them, does not desire to throttle them. Intolerance is produced by any one of a number of clouded states of mind, of which five are outstanding — fear, fanaticism, laziness, ignorance, and selfishness.

Fear and its child, jealousy, playing upon ignorance, are behind the main prejudices which get written into our history textbooks and pollute the minds of our children. If we had always been cleverer than the British in the Revolution and there had been no Bunker Hill and occupation of New York and Philadelphia and no help from Lafayette and no burning of the National Capital in the War of 1812, we would have been taught to believe that the redcoats were brave fellows. We might even have conceded to the British an occasional gleam of a sense of humor. And, if the Confederate generals had been a little stupid in the Civil War and blundered occasionally, our history books would have forgiven the South a little sooner.

popular symbols of intolerance were the pillow-case and the burning cross. This year the badge of intolerance is the colored shirt. New "shirt" organizations are springing up every month, groups claiming their hundreds of thousands of members, training at night in barns and vacant lots, and banded together in the name of a better and purer America. We have the Brown Shirts with their headquarters in New York, the Silver Shirts emanating from North Carolina, the White Shirts of Tennessee, the White Legion of Alabama, the Gray Shirts of Glens Falls, and the Khaki Shirts of Pennsylvania. To these actual wearers of fraternal shirts, Mr. Travis Hoke in his useful pamphlet adds a new peril, the as-yet-unorganized Dress Shirts (*Shirts*, American Civil Liberties Union, 100 Fifth Avenue, New York City, June, 1934, 15 cents).

As long as the various Rainbow Shirts who represent the angry prejudices of the herd do not find superior intellectual leadership, the nation is safe. It is when the Boiled Shirt fraternizes with the Rainbow Shirt, when an intellectual assumes direction of the frustrated

How the home radio newspaper of the future will appear. A sample of type text received on the Young "lawnmower" receiver

than this in order to economize its use. The printing helix rotates at a synchronous speed of 120 revolutions per minute, producing one line for each revolution. The picture has, therefore, one hundred lines per linear inch, a degree of detail quite sufficient for half-tone reproduction.

Transmission at this speed is possible when wire lines are used, or when strong signals are available in a clear radio channel. This speed corresponds to a message speed (assuming single-spaced typewritten material) of 100 words per minute, or a full letter size sheet in eight minutes.

The receiving circuit which feeds the signal to the magnetic drive of the printing bar consists of a detector-rectifier which rectifies the tone-modulations received from the transmitter, a filter which converts the rectified tone to d-c pulses, and a d-c push-pull output stage which amplifies these pulses and applies them to the magnetic control.

Fluctuations due to fading have been largely overcome by the use of properly designed automatic volume control circuits. In fact this system has been used to transmit weather maps to ships at sea, and during several months of operation it was found that reception was reliable on well over 95 per cent of the transmissions. One map, sent from Rocky Point, was received on board ship lying in harbor at Havre, France. Electrical loading machinery used on the docks close by caused such interference that even slow code transmissions were very difficult to copy by ear. The facsimile receiver, however, produced an intelligible, if somewhat streaked, map under these conditions. This fact has indicated to Mr. Young that facsimile methods will permit the reception of transmitted intelligence through interference which is heavier by far than the signal itself.

One of the European pioneers of facsimile, who has been sending pictures over wires since 1908, moved his laboratory to America a few years ago, and is now producing transmitted pictures of surpassing artistic quality, resembling rotogravure. This is Dr. Otho Fulton, who at 344 Madison Avenue, New York City, has developed his well-known electrolytic facsimile reproducer into new continuous-printing and portable models.

Capt. Fulton's electrolytic "home printing press"

In its latest form, this Fultograph home printing press will deliver 8-by-10-inch pages of specially prepared paper, completely printed, every six minutes. The paper comes in rolls and is impregnated with an iodine compound. Under the electrolytic action of current flowing through the stylus electrode, iodine is freed in the form of dark brown marks, producing a beautiful rotogravure effect, with half-tones due to the varying current intensities of the incoming picture signal. Unlike the wet process required with his earlier machines, Captain Fulton now uses the paper dry, but to secure the electrolytic effect, the paper is automatically moistened just before it reaches the stylus position.

The paper comes from a continuous roll, and the machine cuts sheets from this, wraps them around the recording cylinder, and then drops them into a basket when finished printing. Each sheet to be printed upon must be wrapped around the cylinder and then rotated with it, while the electrode stylus is fed along the cylinder by a lead-screw, very much in the manner of the old cylinder-type phonographs.

Rough synchronization is effected by driving the reproducer by a synchronous motor running on the 60-cycle power supply in step with the transmitter cylinder. But each line of the picture, as drawn, is also synchronized separately by a starting impulse or signal, which starts the cylinder after its brief stop at the end of the preceding line. Captain Fulton has experimented with pictures with lines numbering from 60 to 120 per inch.

Captain Otho Fulton with one of his portable facsimile printers, which can also be used for transmitting written messages

HOME FACSIMILE SYSTEMS

OTHO FULTON—"Fultograph"

Sepia-colored solid and half-tone images recorded by a stylus on moistened, chemically treated paper by electrolytic action. One sheet (8½ by 11 inches) printed at a time, one sheet in six minutes, with automatic reloading. Detail: 60 lines to the inch. Probable retail cost $50. Operates from modern radio receiver. Suitable for reproduction of text, cartoon, and half-tone images comparable in quality and appearance with rotogravure.

J. V. L. HOGAN—"Radio pen"

Black and white images recorded in ink by magnetic pen on a continuous roll of paper, image three inches wide. Detail: 60 lines per inch. Probable retail cost: $35. Operates on output of any modern receiver. Suitable for reproduction of cartoons and type at a rate of 40 words per minute. System installed at station WTMJ, Milwaukee, and W2XDR, Long Island City, N. Y.

C. J. YOUNG—"Lawnmower" recorder

Black-and-white or half-tone images recorded from carbon paper on continuous roll of paper, 8½ inches wide, by a helix-and-bar system. Detail: 100 lines per inch. Operates from d.c. push-pull amplifier. Suitable for continuous reproduction of text, cartoons, and half-tone images at a rate of 100 words per minute. System being developed by RCA Victor Company.

but believes that about 80 lines per inch is best adapted for his future receivers.

The Fulton home printer is adapted to be plugged into any home radio set, in place of the loud-speaker, although Captain Fulton believes that facsimile belongs on the short-wave channels, for full-time service. He estimates that his home reproducer can be manufactured to retail at $25 to $50. A well-known radio manufacturer is now beginning the commercial production of some of these facsimile reproducers, and a metropolitan station is considering beginning a facsimile program.

Captain Fulton has also developed a portable facsimile receiver, complete in carrying case and weighing about ten pounds. The motor can be either electric, or spring-drive for use in airplanes, trucks, etc. By the use of an ingenious metallic conducting paper and insulating ink, this portable receiver can also be used as a message sender. No photo-cell is then used, but the message to be sent is written with the insulating ink on the metallic paper and then revolved under the stylus ordinarily used as the receiving electrode. As the ink interrupts the circuit, a facsimile signal is transmitted which can be received by other instruments in the usual way.

Sixty-line "Radio Pen" of J. V. L. Hogan

A direct-inking scheme of home facsimile has been developed by J. V. L. Hogan and Horace J. Miller under the name "Radio Pen." This system does not reproduce half-tones, that is, the pictures are black and white with no intermediate degrees of shading, but the entire system is simple and direct. At the transmitter the original drawing or type is placed on a strip of white paper and fed under a photocell scanner. The optical system of this scanner is moved over the original drawing by a quick-return mechanism driven by a synchronous motor at a rate of one hundred strokes per minute. During the quick return no picture signals are transmitted; synchronizing and framing signals occupy this interval so that the maximum use is made of the available time. The paper is fed on a roller at a constant rate of $1\frac{2}{3}$ inches per minute, so that 60 lines of the image are scanned per linear inch of the drawing.

The signal frequency which results has a fundamental somewhere in neighborhood of 200 cycles per second, but harmonics as high as the third are important for good quality and must be amplified faithfully. This signal frequency with harmonics is then impressed on a sub-carrier of 2,400 cycles per second, chosen because it is a frequency to which nearly all home radio receivers will respond with good efficiency. This 2,400 cycle modulated sub-carrier is then in turn impressed on the radio frequency carrier (2,050 kc. in the case of station W2XDR from which facsimile broadcasts are occasionally sent by Mr. Hogan and his associates).

At the receiving end any type of home radio receiver capable of operating a dynamic loudspeaker is used to detect and amplify the incoming signal. The output tube (or tubes) may be of any type from 71-A's to 47's. The audio frequency signal (the modulated 2,400 cycle note) is taken from the receiver across the primary terminals of the output transformer and led to the facsimile unit.

This unit contains a motor synchronized with the motor used in the transmitter by means of power system connections or by a synchronizing signal sent while the scanner is making its return motion. The motor drives a four inch roll of paper (at a rate of $1\frac{2}{3}$ inches per minute) underneath a magnetically controlled ink-pen. This pen is moved by the same motor in a reciprocal motion across the paper, in a three-inch stroke. During the slower (left-to-right) motion the pen inks the paper in accordance with the received signal, and as each line is produced, the facsimile image appears directly on the paper. The magnetic and mechanical design of this pen is one of the most difficult achievements of the entire system. The pen will respond to impulses as high as 600 cycles per second (the third harmonic of the 200 cycle signal frequency) but it must of course be non-resonant to any of the received signal frequencies. A special ink is required to produce satisfactory results.

The facsimile receiving unit is being developed as an accessory to the present type of radio receiver, and it is planned to manufacture the receiving unit for the cost of a good dynamic loudspeaker, say $35.

Pictures like this, in a rich rotogravure brown, are received on the Fulton "home printing press"

WTMJ, Milwaukee, experimenting with Radio Pen

A bandwidth of 6 kc. is entirely sufficient for the transmission of facsimile signals of this type, over which a message may be transmitted in facsimile at a rate of forty words per minute. Developments now in the experimental stage indicate that a seven inch wide roll of paper, and a six inch stroke may be used with a message speed of sixty words per minute.

The Hogan "Radio Pen" has been installed in a 1,000 watt transmitter by station WTMJ of the *Milwaukee Journal*. A demonstration of its possibilities was held recently for business men and dealers in that city, and a department store has provided space for a display to the public. No immediate commercialization is planned, but the officials of WTMJ are anxious to gauge the public reaction to home facsimile, and to iron out the technical and commercial problems which obstruct its introduction to the home. So far the public interest has been encouraging, and it is quite possible that WTMJ will inaugurate a public facsimile service when its acceptance seems certain.

High-fidelity program circuits

By J. B. EPPERSON
Chief Engineer, WNOX, Inc.

DURING the past few months a great amount of interest has been shown on the subject of high fidelity. This article deals with fidelity standards in wire program circuits, and describes briefly some of the properties of program circuits and corrective equalizers.

A program circuit might be defined as any communication circuit which is used for conveying broadcast program material from one point to another. To this category belong the long lines used for interconnecting the stations of the various networks, and the local lines which are used either for linking remote pick-up points with the studio or the studio with the transmitter. It is with the local lines that this paper is principally concerned.

With respect to their frequency characteristics, these wire line facilities may be divided into three groups and classified as follows: high fidelity, medium fidelity, and low fidelity. The high fidelity type should be capable of passing a band of frequencies between 50 and 8000 cycles with no greater variation than 2 db.,[1] the medium fidelity type a band of frequencies between 100 and 5000 cycles with no greater variation than 2 db., and the low fidelity type will include those lines whose frequency characteristics fall below the medium fidelity standards.

Characteristics of the line

The frequency attenuation of a wire circuit depends largely upon its distributed inductance, capacity, and resistance. Of these three factors, the capacity predominates and causes the circuit to have a negative reactive component as well as an attenuation factor which rises progressively with frequency and line length. The curve in Fig. 1 shows the manner in which the attenuation varies with frequency for standard cable sections of one and five miles in length. For the attenuation of lines of other lengths, multiply the length of the line in miles by the factor read from the curve for one mile. From these curves, it is seen that where cable circuits are used for high quality broadcast program circuits, some form of frequency compensation or equalization must be employed. Standard cable and open wire circuits will therefore have to be placed in the low fidelity group unless they are short in length, or unless their frequency characteristics have been corrected by suitably designed compensating circuits.

Practically all wire circuits available for use in metropolitan areas are made up of non-loaded standard cable sections. This cable contains paired circuits which are made up of No. 19 A.W.G. having 88 ohms of metallic resistance, and 0.060 μf mutual capacitance per mile.

Since the telephone line has a negative reactive component, the equalizer must be designed to have a positive reactive component so that at any of the frequencies encountered, the negative component of the line and the positive component of the equalizer are complementary. In this manner the equalizer impedance will decrease with a decrease in frequency at exactly the same rate as the effective capacity reactance of the line decreases with an increase of frequency and thus keep the overall loss constant.

The parallel resonant circuit has properties which readily adapt it for use in equalizing short cable circuits. At resonance it acts as a pure resistance of a high value depending upon the relation of circuit reactance to resistance. This characteristic, to the equalizer, brings about a maximum impedance and a minimum loss to the line at the circuit resonant frequency. At frequencies below resonance the parallel circuit is inductive thereby bringing about the desired positive reactive component to the equalizer. At frequencies above resonance, the parallel circuit is capacitive and to the equalizer, provides a desirable cut off point just above the resonant frequency. The parallel circuit has a selectivity which is determined largely by its L/C ratio and circuit Q. Therefore, by adding resistance, the resonant frequency characteristic may be broadened. In the equalizer, this fact is made use of to provide a simple variable attenuator for the low frequencies.

WITH THE ADVENT of high fidelity receivers, broadcast stations must be vitally interested in maintaining higher operating standards. In this respect, the local program circuits are among the many items for major consideration.

Figure 2 represents the parallel or shunt type equalizer which is connected at the receiving end of the line to be equalized. The coil L and condenser C are connected in parallel to form the resonant circuit. This circuit, in turn, is connected in series with the resistor R. The terminals 1 and 2 are bridged across the line preceding other equipment.

Equalizer design

In the design of equalizer circuits, the values of L and C should be chosen so that the parallel circuit is inductive to the highest frequency which is to be passed. This means that the LC circuit must have a resonant point which is slightly above the highest frequency to be passed. With the parallel resonant circuit correctly designed, R may be adjusted to bring about the correct attenuation for lines of different lengths. As the line length and capacity

are increased, R must be decreased. The lower frequencies are thus attenuated in a manner which compensates for the attenuation of the higher frequencies by the line itself.

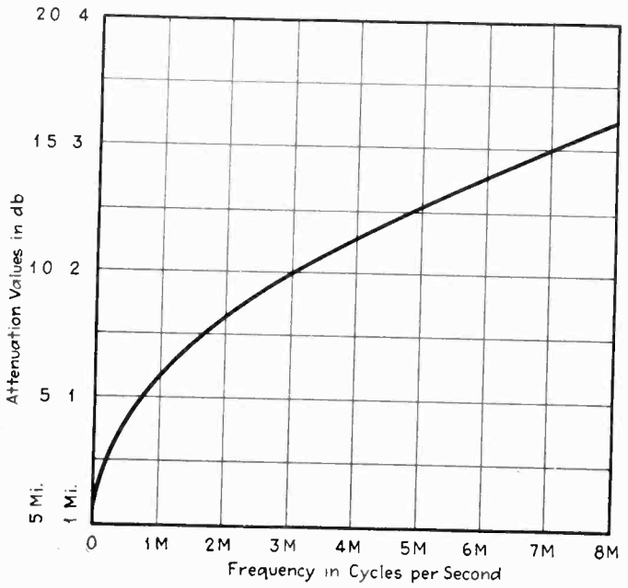


Fig. 1—Non-loaded standard cable characteristics

In Figs. 2A and 2B, typical values of equalizer constants are shown for correcting the frequency characteristics of short cable circuits up to 5000 and 8000 cycles respectively. The 5000 cycle type has values of L and C such as to make the resonant frequency approximately 5489 cycles. Likewise, the 8000 cycle type is made resonant to approximately 8400 cycles. For each circuit, the cut off point is determined by the resonant frequency.

The local telephone company usually designates 2 db. (above 0.06 watts) as the maximum volume level at which programs may be transmitted over their circuits so that cross talk and inductive noises will not become an objectional factor. Since the overall drop in an equalized line of 1000 cycles is approximately three times that of an unequalized line, it is usually unsatisfactory to use a single equalizer on lines of more than ten miles in length. For longer lines, the large amount of amplification required at the studio end causes stray noises to become objectional. Unless they are unusually free from noise, lines greater than approximately ten miles in length should be divided into two sections which are independently equalized and separated by a line amplifier. Two equalizers are also often required where an open wire meets a cable, or where there is a junction of two circuits which have widely different charactristics.

Where cable circuits are used for program circuits, a center cable pair should be specified to lessen the chances for inductive interference. The center pairs are less susceptible to induction noises because they are in capacity balance; that is, they have the same capacity with respect to each other, to the remaining cable pairs, and to the lead sheath.

Line equalization process

Most stations, for their remote pick-ups, lease lines from the local telephone company. The lines can be purchased in either an equalized or an unequalized state but, since the unequalized lines are lower in cost, they are more often employed. Where the unequalized lines are purchased, the necessary equalization is usually applied by the station engineers. Some of the regional and local stations even use the lines as they are taken without any attempt at equalization. For high quality audio transmission this practice should be discontinued, and a suitably designed equalizing network placed on the studio relay rack as standard equipment. It is not necessary to install separate equalizers for each remote line. Many stations have found a satisfactory solution in the use of one equalizer connected in a position where it may be made common to any of the remote lines. The equalizer settings are predetermined and posted near the panel so that a quick adjustment can be made for each line.

For determining the proper equalizer settings, the services of a good audio oscillator will be found indispensable. Sine wave tones of constant level from 50 to 5000 or 8000 cycles are sent from the remote end of the line and measured at the receiving end of the line by a suitable output meter designed to work across the 500 ohm line. The equalizer, which is of course bridged across the line at the studio end, is adjusted until the received level is the same for each incoming frequency.

For the station engineer who does not own an audio oscillator, constant note records are available at a nominal cost. These records have a frequency range from 46 to 5000 cycles, and are recorded at a speed of 78 r.p.m. Caution must be observed in the use of these records however, since the recorded level varies with frequency

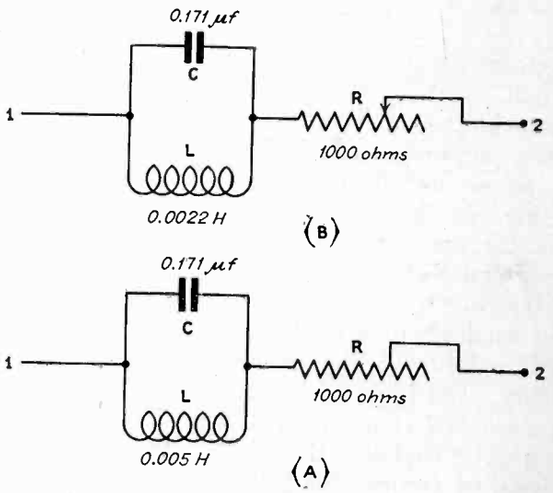


Fig. 2—Equalizer of parallel or shunt type

and phonograph pickups vary widely in their output levels. For use at the remote end of the line, a good portable turntable and motor should be employed. The phonograph pickup should feed into a remote amplifier, and the output of the amplifier which feeds the line should have some form of level indicator attached. As each frequency is reproduced, the amplifier gain control is adjusted so that the output level is held constant.

The manufacturers of standard equalizing equipment usually furnish a curve with each instrument in which the transmission equivalent at 1000 cycles is plotted against the equalizer resistance setting in ohms. The transmission equivalent for any particular line can be obtained from the local telephone company with sufficient accuracy to make an approximate equalization possible by merely taking the equalizer setting from the curve.

1. 2 db. limit applies to program circuit only. Ballantine, in Proc. I. R. E., May 1934, proposes a 5 db. limit for overall variation.

RELATIONS IN THE RECEIVING TUBE FAMILY

A list of seventy tube-types, arranged by cathode voltage and intended use. Tubes having equivalent characteristics (except cathode voltage and current) are indicated by appropriate marks.

Typical operating characteristics:
E_b = plate volts
E_c = grid bias volts
i_b = plate milliamperes
r_p = plate resistance ohms
S_m = mutual conductance micromhos

= means exact equivalent (except heater voltage and current) including socket connections.
≒ means approximate equivalent
≠ means not equivalent; ◣ heater types

2.0-, 2.5-, 6.3-volt series

Cathode voltage: 2.0 | 2.5 | 6.3

Triodes (det.-amp.)

30 ≠ 27 ≒ 37		
E_b = 180	250	250
E_c = -13.5	-21.0	-18.0
i_b = 3.1	5.2	7.5
r_p = 10,300	9250	8400
S_m = 900	975	1100

56 = 76	
250	250
-13.5	-13.5
5.0	5.0
9500	9500
1450	1450

R.F. tetrodes

32 ≠ 24-A ≒ 36		
180	180	180
-3.0	-3.0	-3.0
1.7	4.0	3.1
1.2 megs	0.6 megs	0.5 megs
650	1050	1050

R.F. pentodes

	57 = 6C6	
	250	250
	-3.0	-3.0
	2.0	2.0
	1.5 megs	1.5 megs
	1225	1225

		77
		250
		-3.0
		2.3
		1.5 megs
		1250

Variable-mu tetrode

	35	
	180	
	-3.0	
	6.3	
	0.3 megs	
	1020	

Variable-mu pentodes

34 ≠ 58 = 6D6		
180	250	250
-3.0	-3.0	-3.0
2.8	8.2	8.2
1.0 meg.	0.8 meg.	0.8 meg.
620	1600	1600

		78
		250
		-3.0
		7.0
		0.8 meg.
		1450

		39-44
		250
		-3.0
		5.8
		1.0 meg.
		1050

Power triodes

31 ≠ 2A3		
180	250	
-30.0	-45.0	
12.3	60	
3600	800	
1050	5250	

		45
		250
		-50.0
		34.0
		1610
		2175

Power tetrodes

49 ≠ 46	
135	250
-20.0	-33.0
6.0	22.0
4175	2380
1125	2350

Power pentodes

33 ←≒→ 6A4		
180		180
-18.0		-12.0
22.0		22.0
55,000		45,000
1700		2200

	2A5 = 42	
	250	250
	-16.5	-16.5
	34.0	34.0
	100,000	100,000
	2200	2200

	47 ≠ 41	
	250	250
	-16.5	-18.0
	31.0	32.0
	60,000	68,000
	2500	2200

		38
		250
		-25.0
		22.0
		100,000
		1200

59 ≠ 89	
250	250
-18.0	-25.0
35.0	32.0
40,000	70,000
2500	1800

Diode triodes

2A6 = 75	
250	250
-1.35	-1.35
0.4	0.4
91,000	91,000
1100	1100

55 = 85	
250	250
-20.0	-20.0
8.0	8.0
7500	7500
1100	1100

Diode pentode

Used as r.f. amp.

2B7 = 6B7	
250	250
-3.0	-3.0
9.0	9.0
650,000	650,000
1125	1125

Triode pentode

		6F7
		250
		-3.0
		6.5
		850,000
		1100

Electron-coupled oscillators

1A6 ≠ 2A7 = 6A7		
180	250	250
-3.0	-3.0	-3.0
1.3	3.5	3.5
500,000	360,000	360,000
300	520	520

1C6
180
-3.0
1.5
750,000
325

Twin amplifiers

19 ≠ 53 ≒6A6≒79			
135	250	250	250
-3.0	0	0	0
4.0	14	14	10.5
—	—	—	—
—	—	—	*

Rectifiers

	82 ≠84(6Z4)	
	500	350
	—	—
	125	50
	—	—
	—	—

		1-V
		350
		—
		50
		—
		—

* Different socket connections

1.5-, 3.3-, and 5.0-volt series

Cathode voltage: 1.5 | 3.3 | 5.0

Triodes

26 ≠ 99 ≠ 01-A		
180	90	135
-14.5	-4.5	-9.0
6.2	2.5	3.0
7300	15,500	10,000
1150	425	800

		112-A
		180
		-13.5
		7.7
		4700
		1800

		40
		180
		-3.0
		0.2
		150,000
		200

R.F. tetrode

	22	
	135	
	-1.5	
	3.7	
	325,000	
	500	

Detector

		00-A
		45
		—
		1.5
		30,000
		666

Power Triodes

	20	
	135	
	-22.5	
	6.5	
	6300	
	525	

		71-A
		180
		-43.0
		20
		1750
		1700

Rectifiers

		5Z3
		500
		—
		250
		—

		80
		550
		—
		135
		—

		83
		500
		—
		250
		—

1.1-, 7.5- and 12.6-volt types

Cathode voltage: 1.1 | 7.5 | 12.6

11 ≠ 10 ≠12Z3		
*135	425	(rect.)
-10.5	-39.0	250
3.0	18.0	—
15,000	5000	60
440	1600	—

12 ≠ 50	
135	450
-10.5	-84.0
3.0	55.0
15000	1800
440	2100

	81
	(rect.)
	700
	—
	85
	—

25-, and 30-volt types

Cathode voltage: 25 | 30

43 ≠ 48	
135	125
-20.0	-20.0
34	56
35000	—
2300	3900

25Z5
125
—
100
—
—

1A6 ≒ 1C6
1C6 ≒ 1A6
2A3
2A5 { = 42, ≒ 41
2A6 = 75
2A7 = 6A7
2B7 = 6B7

6A4 ≒ 33
6A7 = 2A7
6B7 = 2B7
6C6 { = 57, ≒ 77
6D6 = 58
6F7
-00-A

01-A
10
11
12
19
20
22

24-A ≒ 36
26
27 ≒ 37
30
31
32
33 ≒ 6A4

34
35
36 ≒ 24-A
37 ≒ 27
38
39-44
40

41 ≒ 42, 2A5
42 { = 2A5, ≒ 41
43
45
46
47
48

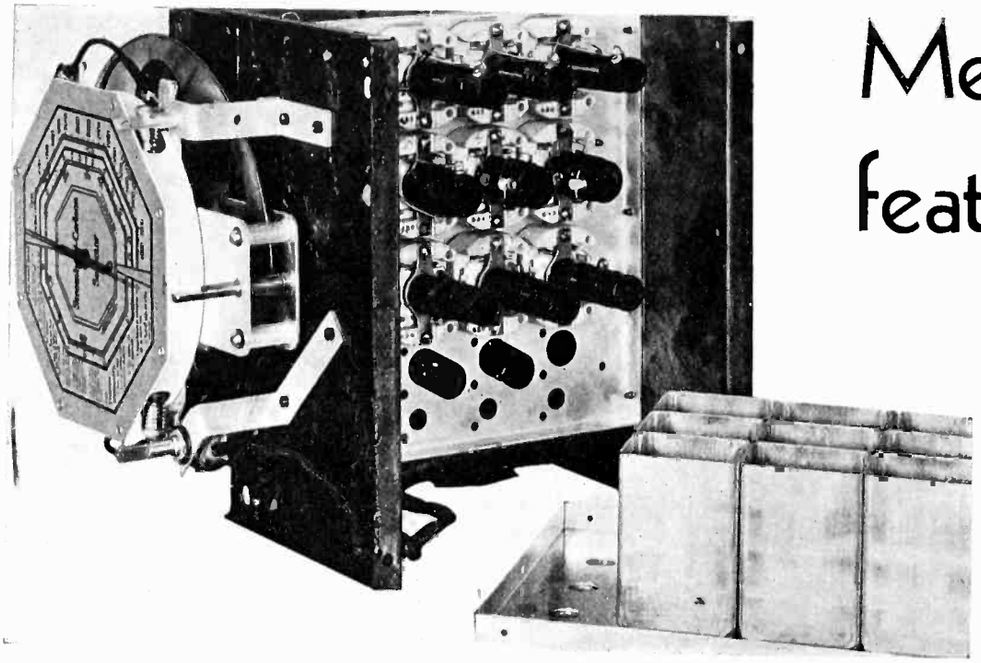
49
50
53
55 = 85
56 = 76
57 { = 6C6, ≒ 77
58 { = 6D6, ≒ 78

59
71-A
75 = 2A6
76 = 56
77 ≒ 6C6, 57
78 ≒ 6D6, 58
79

85 = 55
89
99
112-A
5Z3
12Z3
25Z5

1-V
80
81
82
83
84

electronics, November 1934



Mechanical features of the season's radio sets

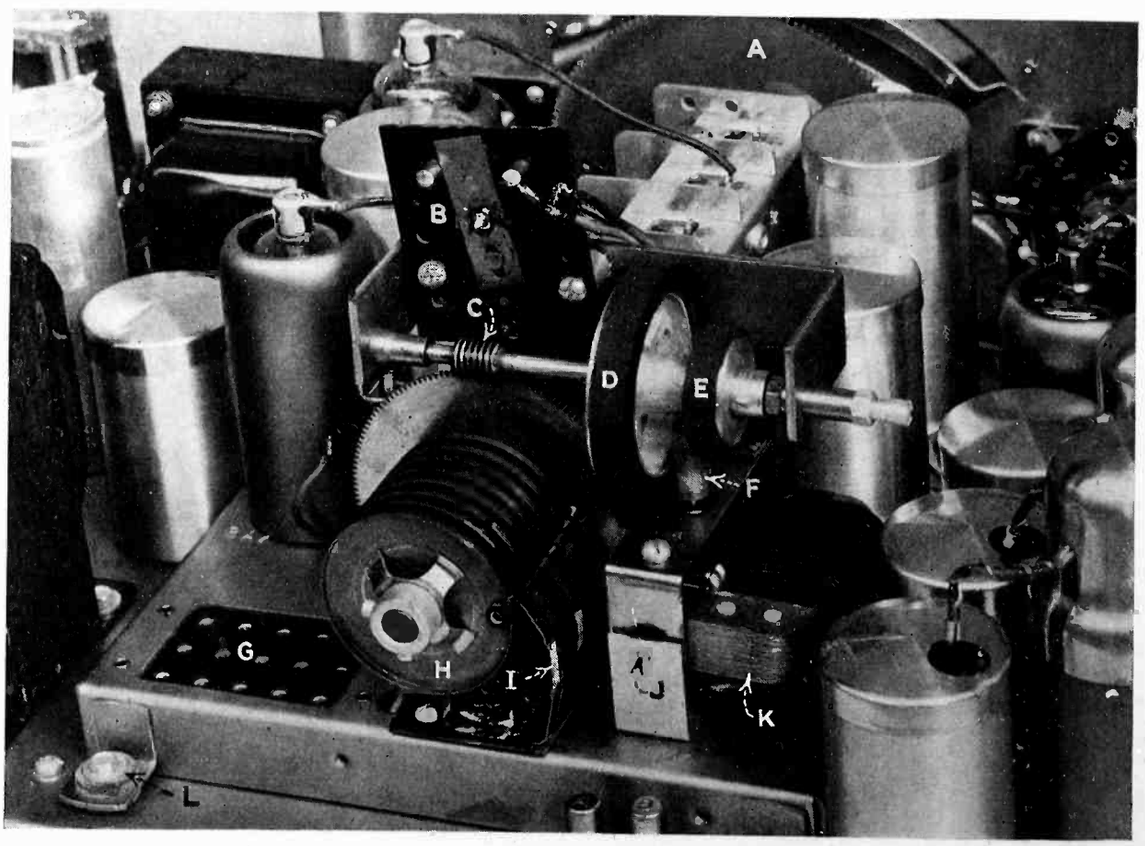
ALTHOUGH the praise that is due the mechanical engineers for their share in the success of the radio industry is largely unsung, no one doubts the importance of their work.

The discovery that an r-f amplifier could be switched from one band of coils to another, each covering a distinct and perhaps restricted range of channels, was most important. At once it became possible to have truly all-wave sets, and the rapid introduction of receivers covering higher and higher frequencies attests to the electrical development that has been necessary.

Proper assembly of the many coils for such complicated receivers has been under rather constant change, each new model showing signs that mechanical engineers have been at work. Selector switches for proper connection of three sets of coils for each band covered have contributed much to the success of all-wave reception. Shielding has been no small problem and cheap methods of keeping electrical fields where they belong have required consistent mechanical ingenuity.

Early models covering the higher frequencies had rather crude methods of changing the vernier ratio of the tuning dial. Recent receivers show marked improvement in this mechanical feature. In the RCA Victor model shown the normal 10-to-1 vernier is changed to a 50-to-1 vernier ratio by pulling the knob out away from the cabinet. On Philco models the ratios are 8-to-1 and 80-to-1. The accomplishment of these changes has required neat mechanical designs.

Backlash and lost motion in transmitting the motion of the tuning knob to the variable condensers—once a bugaboo—are no longer important though disappointing



Above — Stromberg-Carlson chassis of all-wave receiver with method of shielding the bank of coils with but one can assembly —a neat method of saving operations

Right—Details of Atwater Kent Tune-O-Matic receiver. Lettering of the various components is explained in the text

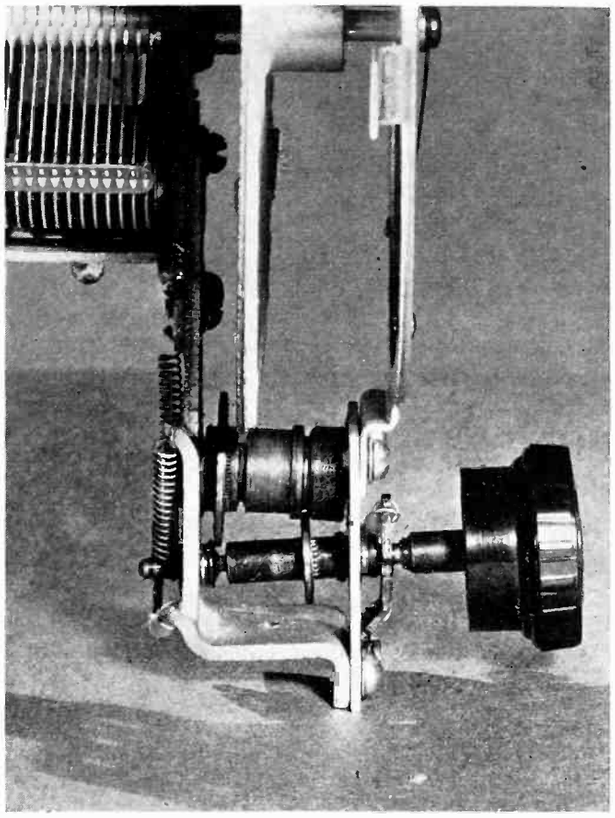
factors again by the work of mechanical engineers.

Introduction of Atwater Kent's Tune-O-Matic model is being watched with considerable interest as a trend. In the tuning motor of this interesting receiver, the direction of rotation is constant, i.e., the shaft does not reverse in order to move the variable condensers in the opposite direction. Instead an ingenious method of reversal is employed. The motor shaft runs between two rubber-tired wheels, one large and one small. Normally the shaft rests against the small wheel. The resulting motion drives the condensers in the direction of 540 to 1600 kc. The motor, however, is pivoted so that it can be tipped and when so moved it rests against the larger wheel which rotates the condenser in the opposite direction. This mechanism may be seen in the photograph.

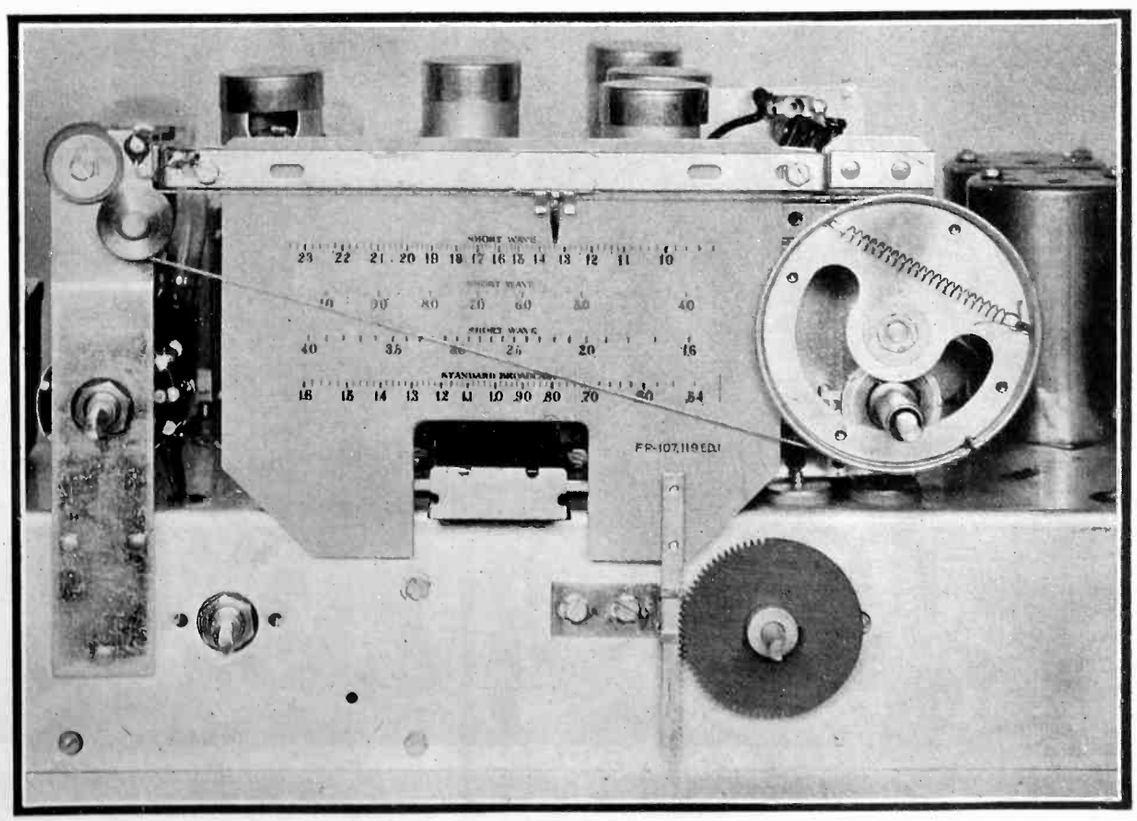
The current for operating the solenoid which tips the motor is controlled by a switch which opens at 1600 kc. and closes at 540 kc. This switch, in turn, is operated by a cam on the variable condenser shaft.

The shaft of the condenser is extended in the rear, and on this extension are mounted 8 adjustable discs, each with an insulated sector on the rim. These are the station selector and "off" discs. There are, therefore, 7 stations which can be automatically tuned in at any one of the 15 minute periods throughout the 24 hour day. The dealer or service man adjusts the position of these discs on the shaft so that the insulated sector is under a contact arm (of which there are of course 8).

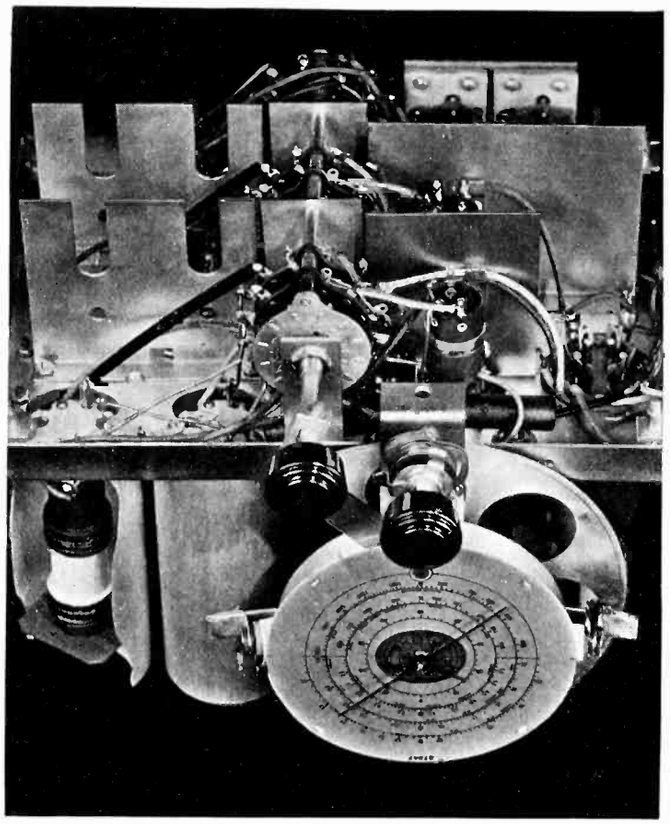
The actual process of tuning in a station is as follows: Suppose the set is cold and that 3:00 p.m. is the time chosen by the owner to listen to some particular program. At this time the electric circuit to the solenoid and the motor is completed, the solenoid tipping the motor so that its shaft contacts the large wheel. The variable condenser is turned to the frequency of the desired station. When this point is reached a high-impedance relay is cut into the motor circuit which so reduces the current that the motor stops; then the solenoid throws the motor so that the small wheel is in contact with the motor shaft, thus acting as a brake on the motor. The relay has connected the 110 volt circuit through the receiver by this time so that the tubes have warmed up and the set begins to function.



One version (Pilot) of the changing vernier ratio of the tuning system. In this case the tuning knob has a lateral movement to bring into play one of two sets of friction drives



Mechanism for moving vertically the wave band chart and for moving horizontally the tuning indicator. This photo of a United American Bosch chassis is a beautiful example of the mechanical design entering into modern receivers



The "magic brain" of RCA Victor, interesting because of its layout of the three sections of the wave band changing switch. When the coils for the various wave bands are connected to r-f stages and oscillator, an automatic indicator shows the user exactly which band he is tuning through

The eighth selector disc is the "off" disc and thus if the owner wishes the set to be shut off at the completion of the 3:00 to 3:15 program he plugs the "off" disc into the 3:15 jack so that the receiver is automatically turned to the 1600 kc. position where it is automatically shut off. Current is taken by the set only when in operation except that required by the electric clock.

In the photograph of the Tune-O-Matic receiver the lettering identifying the various portions of the mechanism may be identified as follows: A, manual condenser drive gear. B, reverse switch to change direction of tuning condenser motion. C, automatic tuning worm gear. D and E, large and small rubber-tired wheels. F, motor drive nib. G, socket for clock assembly plug. H, station selector discs. I, contact fingers. J, pivot on which motor rests. K, tuning motor. L, top deck sprung on soft rubber.

Airplane dials

The preponderance of tuning dials of this general type was most marked at the Madison Square Garden show in New York in late September. All manufacturers, however, have not gone to this decorative feature. Philco is an outstanding example. Those who have not adopted this type of dial feel that it tends to give the radio a mechanical appearance. It is also true that with the average-sized dial the scale length is small compared to that possible with the horizontal band type. Thus the stations are more crowded together. This is overcome, to some extent, by the use of a second hand on the airplane type dial which travels at a lower rate of speed. For example in a certain RCA Victor model the width of the 49-meter band is approximately $\frac{5}{16}$ inch on the larger dial. The second hand, however, travels about half way around its circle (arbitrarily divided into 100 divisions) to cover this band.

Men working at progressive chassis assembly in the Emerson plant. Here preliminary work is carried out so that sets may pass the operators at about one-minute intervals

Automatic line-measuring equipment

of the German broadcast system

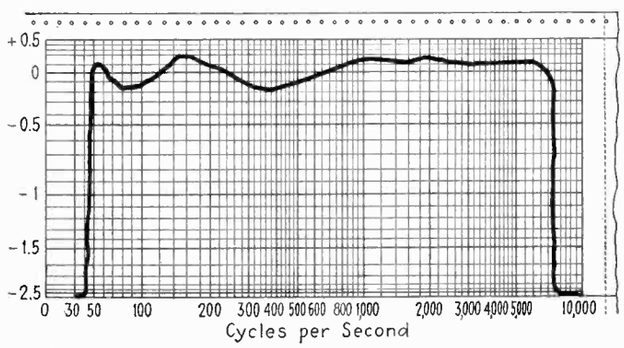
By R. W. P. LEONHARDT

IN RADIO broadcasting, the sounds which are received by the microphone and converted into electrical oscillations are always conveyed over wires to the transmitter. Running commentary broadcasts sometimes are an exception, as in this case small short-wave transmitters are occasionally used for bridging a short distance. The transmission lines are not necessarily short connections merely running from the studio to the transmitter in the same building or in the vicinity, but they have often to bridge very great distances, which may exceed the normal radiating range of a large transmitter.

As overhead lines are very much exposed to the hazard of interference, underground trunk cables are exclusively used in Germany as being the most reliable and least sensitive channel of communication. Contrasted with many other countries where it was necessary for this purpose to lay special cable, Germany had from the outset a great advantage in this respect as all trunk cables in Germany possess central quads; i.e., four cores located in the middle of the cable which are mutually insulated from each other and screened by a separate lead sheathing from the other cores. These four conductors, originally intended for measuring purposes and special services, are not subjected to any disturbing influences; in particular, the cross-talk attenuation of the other cable cores relative to four lines is very high. These cores have been arranged for radio transmission.

These cable cores have a cut-off frequency of about 9,500 cycles, new cables possessing a cut-off frequency of roughly 11,500 cycles. For an undistorted transmission, it is important that the line attenuation be the same at all frequencies, and that with very long transmission lines the various velocities of propagation be equalized. The cable lines are improved in sections by repeaters. The various attenuation values are simultaneously equalized in the repeaters with the result that a practically undistorted frequency range of from 50 to 6,400 cycles can be transmitted with the older types of cables and of from 30 to 8,000 cycles with modern types.

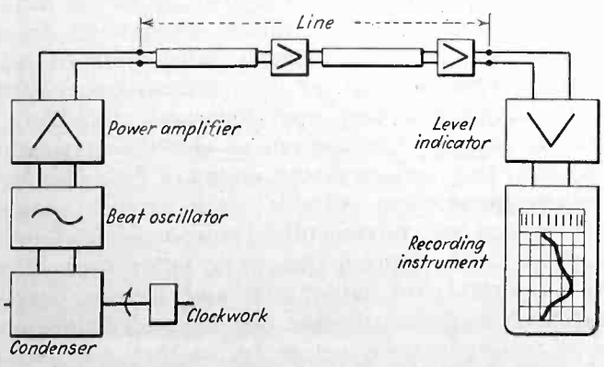
It is important with respect to layout and replacement of parts, that all main amplifiers for the radio transmission system, be of the same kind; in Germany, therefore, they are so devised as to correct a long-distance cable section of 72.5 km. (45 miles) long (average length). Should a repeater section not attain this normal length, an artificial line is inserted to give the cable electrical values of normal length. If the length of a repeater section exceeds the normal, the normal attenuation is again established by means of the surplus amplification at disposal in the repeater. For local lines (cable), the German Postal Authorities have standardized the normal length at 10 kilometers and use local extension lines which can be altered in levels of 2 kilometers as supplementary members.



Sample of curve recorded by transmision level recorder

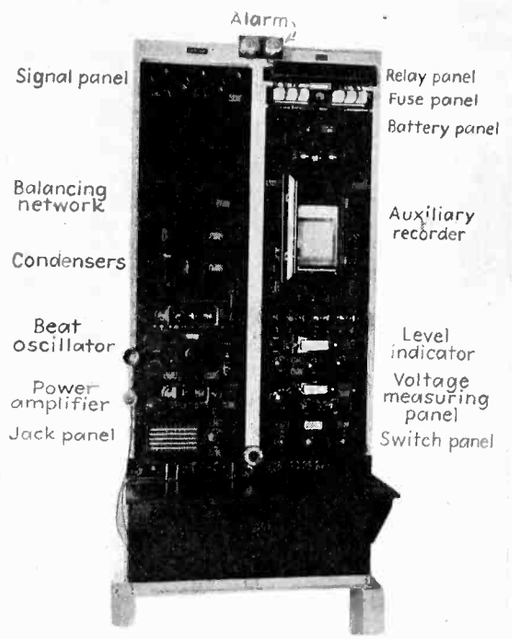
The necessary efficiency of transmission is safeguarded by various kinds of auxiliary equipments. At the transmitting and receiving ends, equalizing devices again suppress the distortion of the local line. When distributing over several lines, the auxiliary amplifiers have the purpose of producing the requisite electrical input for the respective line. Auxiliary equalizing devices and temperature attenuation compensators for the transmission lines are also connected in circuit to ensure the most exact correction of the transmitting lines between the individual repeater stations as well as between these and the junction stations.

In a standard repeater section 72.5 km. long, an additional attenuation distortion of roughly 0.1 neper (one neper = 0.115 decibel) occurs with a frequency



Block diagram of transmission level recorder

range of about 50 to 6,000 cycles at a temperature fluctuation of 10 deg. C. Accordingly, apart from the net attenuation between summer and winter, it is possible for a line of, say, 10 repeater sections (725 km.) long, to experience an alteration in attenuation of more than 2 nepers in the range from the lowest to the highest transmitting frequency. Since much greater transmission distances are already in use, it is essential



Rack with level recorder equipment

to incorporate equalizing connections. These are temperature attenuation compensators in the form of variable artificial lines. System correction of the lines is undertaken at +20 deg. C. The additional attenuation distortion occurring at +10 deg. C. and at 0 deg. C. is then obviated in service, by a corresponding adjustment of the temperature attenuation compensators.

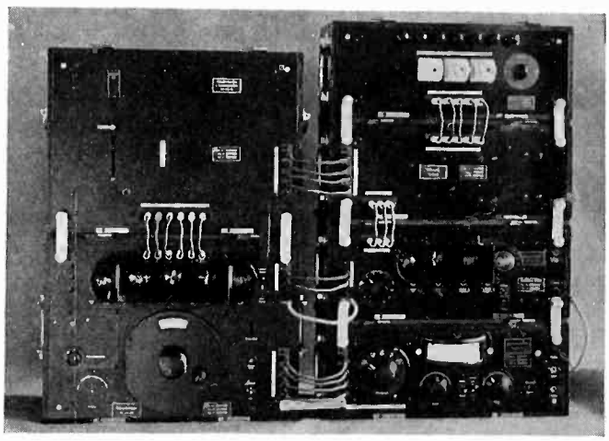
Automatic measuring and supervisory equipment

The extensive system such as outlined must always operate reliably. It is therefore continually supervised and often checked by measurements. The measuring and supervisory apparatus necessary to this end form inseparable components of the entire plant. Of prime importance is the measurement of the effective attenuation and of the transmission level (measure for the magnitude of voltage), the normal value (zero level) of which is 0.775 volts. The simplest measuring method is one whereby a large number of frequencies, extending over the entire range of transmission, is agreed upon between the participating terminal stations, measurements being then effected in succession with these frequencies. This method, however, entails much loss of time, particularly when it extends over the wide transmission range of radio transmission lines. Endeavours were therefore made, especially for long-distance radio lines, to supplement the earlier apparatus in such a manner that the transmission of measuring frequencies and their measurement takes place automatically. This aim has been realized by the development of automatic measuring and supervisory apparatus.

Frequencies of from 30 to 10,000 cycles are automatically transmitted and received in a continuous sequence with modern measuring apparatus. An automatic apparatus of this kind was demonstrated by Siemens & Halske in 1931 on the occasion of the convention of the C.C.I. (Comité Consultatif International des Communications Téléphoniques à grande Distance) at Prague. In the full meeting of the C.C.I. which followed, the technical presuppositions necessary for such measurements were framed, so that these measurements could be carried out uniformly, and, for long-distance transmissions, co-jointly, in the following manner.

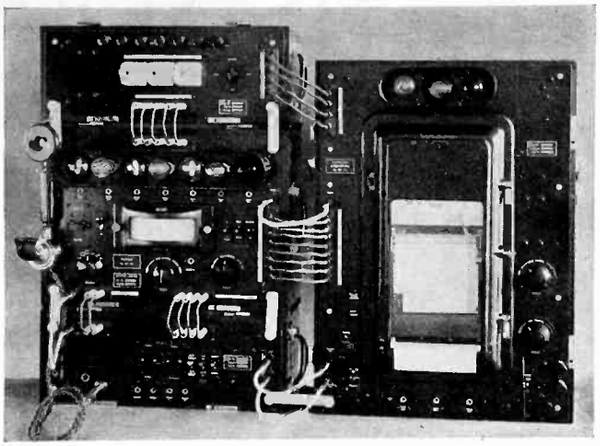
If a long-distance radio cable network has been interconnected for broadcasting, the level or attenuation measurement is effected prior to transmitting. At the outgoing point is a measuring transmitting equipment (beat oscillator with additional power amplifier), the transmitting frequency of which is altered steadily from 0 to 10,000 cycles by means of a rotary condenser driven by a clockwork. The actual measuring apparatus (a transmission level measuring set with a recording instrument) is connected to the other end of the transmission line. Here, the magnitudes of the incoming voltages are recorded on a chart on which the frequency is marked on the abscissa and the voltage (in nepers) on the ordinate. The action of the transmitting and receiving equipments is automatically caused to coincide so accurately that the frequency read off the chart at any instant always coincides with the transmission frequency.

The level recorders are installed at the most important points of the transmission plant, e.g. in the studio, at the distribution points of the cable lines (junction stations) and at the transmitters. In the case of the transmitting stations, the transmitted measuring fre-



Transmission portion of Siemens & Halske portable transmission level recorder

quencies can either be tapped off direct at the end of the long-distance line for the level recorder or following their transmission to the transmitter, so that the frequency process of the latter can then either be included in the measurement or determined separately. In such case, the measuring frequencies must first of all be separated from the carrier by rectification. With a view to simple and easy operation and attendance, all accessories for level measurement and the apparatus at the transmitting and receiving ends are either united in stationary racks or in portable cases, in such a manner that they can be conveniently transported and quickly assembled for measurements. The latter type is especially important for laboratory and testing purposes, as attenuation measurements can be undertaken on all network configurations—in so far as they are four-pole —with the level recording equipment. The recording



Receiving part of portable level recorder

of an entire measuring curve including calibration only takes four minutes.

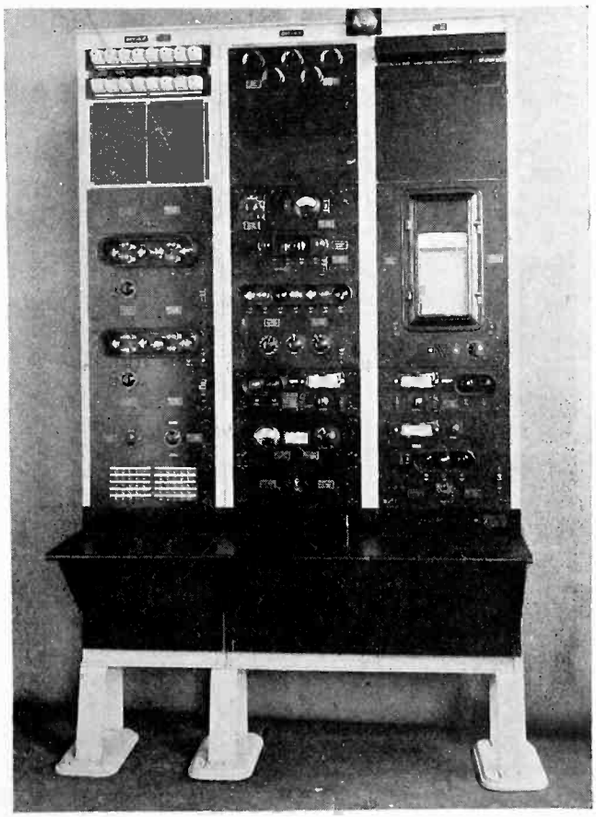
Apart from the level recorder, yet another supervising apparatus, the equipment set for measuring the non-linear distortion performs signal service at the transmitter. The coefficient of non-linear distortion is the ratio of the effective value of all the harmonics to the fundamental oscillation. It must not exceed certain values otherwise it will have a disturbing effect. The device for measuring the non-linear distortion permits of determining those factors in the range of 0.1 to 100 per cent at frequencies of from 50 to 5000 cycles. This measuring equipment is united together with the necessary auxiliary apparatus, such as auxiliary condenser, rectifying voltmeter and a current filter on a rack.

Besides these measuring apparatus, which are intended for testing or measuring the transmitting plant *prior* to a broadcast, there are also equipments for supervision *during* broadcasting. The difference in the volume of sound between music and speech broadcasts is very great so that extreme care has to be taken that the amplifiers are not overmodulated by an excessive voltage amplitude, but also that the softer passages are not drowned by the line noises which are always present to some extent. It is also expedient to measure these interference noises of the lines immediately. An efficient monitoring equipment, consisting of amplifier and loudspeaker is equally necessary for supervisory purposes. With this equipment, all faults occurring during transmission, such as interference noises, cross-talk on the lines, faulty connections, unauthorized interference, etc., can be recognized opportunely, so that an immediate counter-measure can be taken. Measuring and supervisory equipments of this kind are installed at the most important points of the line (junction stations and transmitter) and here incorporated in a supervising rack. The intermediate stations only contain monitoring loudspeaker systems for checking and for rapidly limiting faults which arise.

To prevent overmodulation and insufficient modulation, the voltage amplitudes travelling over the line during transmission, are continuously supervised by a maximum and minimum voltmeter. Prior to a transmission, it is usual to predetermine which relation is to be maintained between the maximum and minimum voltages. Certain regulators are adjusted accordingly, and the supervising official has then only to see that the pointer on the minimum voltmeter does not return to a red section, and that the pointer of the maximum meter does not deflect too often into a section also characterized in red. In principle, these measuring apparatuses are impulse meters, i.e., tube voltmeters which also correctly indicate a voltage impulse of but short duration by means of sensitive moving coil instruments. These indicated values can also be recorded chronologically with the aid of an ink recorder.

For service supervision at the transmitter, the same supervising apparatus is supplemented by a measuring rectifier and a modulation meter. The measuring rectifier in turn also permits the transmitter to come within the scope of supervision. The modulation meter corresponds in principle to the maximum impulse meter, but in addition has an auxiliary tube which can be calibrated to a constant amplification so that the energy input of the lower level ahead of the terminal amplifier can be measured. The measuring range of the modulation meter is adjusted by means of a potentiometer in such a manner that the commencement of the red section on the scale indicates the voltage which prevails behind the terminal amplifier when the transmitter is modulated to a maximum. During transmission, therefore, the pointer must not, or very rarely, touch the red section. Slight, momentary overmodulations are hardly noticeable. Service interferences of a mechanical kind, as for instance due to a burning out of a tube heating filament are indicated by acoustic or optical signals.

The described measuring and supervising stations practically form one unit with the transmitter terminal amplifier at this point. All measuring apparatus, including those belonging to the level recorder, can be connected selectively to the incoming or outgoing side of the transmitter or to the end of the line. A second set of all indicating instruments of these measuring and supervising apparatus can be accommodated on the switchdesk of the transmitter and, for the convenience of the control official, be united together with the other apparatus for supervising the transmitter.



Supervising and terminal amplifier racks used at transmitter

INDUSTRIAL ELECTRONIC-

New group takes up commercial problems of co-ordination of production and sales

CO-OPERATION in the field of industrial electronic tubes is now being practically effected by the new sub-division of the National Electrical Manufacturers Association known as the Industrial Electronic-Tube Section.

Still in its first year of organization, the new Electronic-Tube Section of NEMA has laid out for itself an ambitious program for correcting trade practices, standardizing tube features and bases, and codifying specifications and definitions, and is now proceeding with this plan for betterment of its industry, working both among its own members and with the Washington authorities.

Included within the scope of the Section are vacuum and gas-filled electronic tubes, and light-sensitive devices having functions similar to such tubes (such as photo-voltaic cells) for non-radio applications and other uses of electronic tubes for non-radio purposes; electronic tubes for industrial purposes.

Exceptions are tubes used in radio receivers, transmitters, wire communication, sound and/or picture-recording or reproduction or television; electrotherapeutic devices such as sun-lamps, X-ray units and vapor lamps, and electronic devices used as a light source.

DR. H. A. JONES
Chairman Industrial Electronic Tube Section NEMA

Officers and committees

Dr. H. A. Jones of the General Electric Company, Schenectady, N. Y., is chairman of the Electronic-Tube Section of NEMA, and D. V. Edwards, of Electrons, Inc., 127 Sussex Avenue, Newark, N. J., is secretary.

Engineering committee, Dayton Ulrey, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., chairman; William C. White, General Electric Company, Schenectady, N. Y., secretary; D. T. Schultz, Raytheon Production Corporation, Newton, Mass. D. V. Edwards, Electrons, Inc., Newark, N. J.; D. F. Schmit, RCA-Radiotron, Harrison, N. J., and V. O. Allen, Hygrade-Sylvania Corporation, Emporium, Pa.

Membership Committee, V. G. Rydberg, Westinghouse Lamp Company, chairman; L. F. Bockoven, Western Electric Company; C. A. Rice, Hygrade Sylvania Corporation.

Supplementary Code Committee, A. H. Castor, Radiotron Co., Harrison, N. J.; D. V. Edwards, Electrons, Inc.; L. R. Harness, Westinghouse Electric & Manufacturing Company.

Selling conditions to be studied

The board of governors of NEMA has provided that the new Industrial Electronic-Tube Section be allocated with respect to its Supervisory Agency under the NEMA Code, in the already-established "Specialties" classification, along with the existing sections already operating thereunder:

Small rectifier, ignition and battery-testing equipment section;

Specialty transformer section;

Small fixed-capacitor section.

The Supervisory Agency of this group or classification is the committee made up of one representative from each section in the classification. As now constituted, the Supervisory Agency committee comprises A. E. Tregenza of the Jefferson Electric Company, Chicago; K. W. Nel-

DR. DAYTON ULREY
Chairman Engineering Committee

WILLIAM C. WHITE
Secretary Engineering Committee

TUBE SECTION, NEMA

Engineering Committee will draw uniform definitions and tube-base specifications

V. G. RYDBERG
Chairman Membership Committee

son of the General Electric Company, Bridgeport, Conn., and Dr. Jones of the Electronic-Tube Section. While officially operating as a committee, each representative actually handles personally the affairs relating to his own section, except in cases where an issue involving his own company is concerned, in which case the representative withdraws, and the other members of the Supervisory Agency committee administer in his stead.

Section scope does not include apparatus

If a price call is made this call will place in the hands of the Section officials a complete picture of conditions in the industrial-tube field today, prices, terms, types, etc. This call will be limited wholly to the tubes themselves, and will not include any apparatus in which the tubes are incorporated or used, since such apparatus falls outside of the scope of the Electronic-Tube Section.

Most important in the program of the Section is the work that is being undertaken by the Engineering Committee, under the direction of Dr. Dayton Ulrey, chairman, and W. C. White, secretary. Physical standards for tube construction will be drawn up; already work is far progressed on a new and improved standard base for industrial tubes which provides better and stronger contacts and eliminates the use of improper tubes of somewhat similar characteristics, licensed only for radio use.

A. H. CASTOR
Chairman Supplementary Code Committee

Definitions and terms will also be drawn up by the engineering committee, applying to industrial tube products. Considerable confusion has existed in the nomenclature and ratings in this field, and it is the purpose of the engineering committee to draw up definitions which all co-operating manufacturers can meet.

MARCONI ON . . . MICRO-WAVES FOR DEPENDABLE SHORT-DISTANCE COMMUNICATION

"Although I have succeeded in receiving waves of 60 centimeters at 258 kilometers, which was in that case eight times the optical range, my later investigations on the propagation of these waves have brought to light not only their own well-known erratic behavior, but also a definite seasonal effect which so far limits their commercial use to about the optical range.

"Within that optical range we can say definitely that micro-waves can be employed advantageously for short-distance inter-island and island-continental communications as well as overland, in spite of even complete visual obstruction."

—Marchese Guglielmo Marconi in a transatlantic broadcast from station 2RO, Rome, addressed to American listeners October 29

Electron-tube voltage control for photometry

By F. E. KILPATRICK, *Electrical Testing Laboratories* and CARL P. BERNHARDT, *N. Y. Engineer, Westinghouse Electric & Manufacturing Company*

AN IMPORTANT requirement for accurate results in the art of photometry (if the similar-circuit photometer or its equivalent is not used) is a source of constant voltage. The light output (lumens) of a tungsten filament lamp varies approximately as the 3.6 power of the voltage, so that even a small fluctuation in voltage is considerably magnified in respect to light output. For good work the voltage must attain a constant value instantaneously after the lamp load is applied in order that precise readings of current and light output may be made.

The usual source of voltage available for photometric work has been the storage battery. Generators have been used in photometric work of lesser precision but almost exclusively it has been necessary to employ a separate generator for each photometer. The principal disadvantage of the sources of supply which have been used in the past lies in the fact that large loads cannot be applied without causing an appreciable drop in voltage, seriously affecting other photometers operating from the same source. With the storage battery the voltage does not recover, while with a mechanically regulated generator recovery is slow.

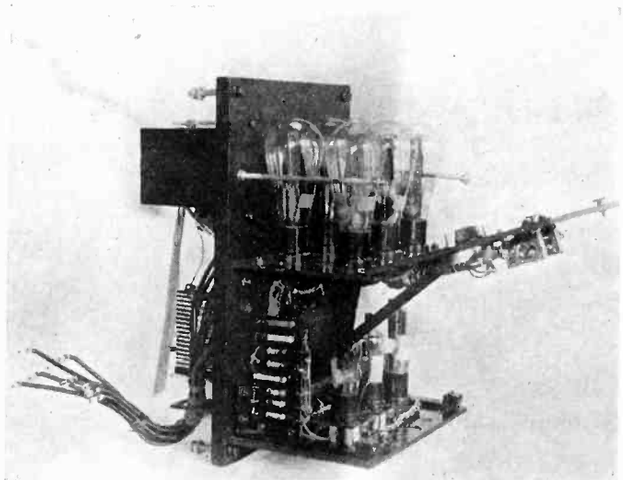


Figure 1—Electronic voltage regulator with covers removed.

It seemed desirable to investigate the possibilities of the new thermionic voltage regulator for use in this photometric work. The apparatus chosen was the Westinghouse type DT electronic voltage regulator shown in Fig. 1 and supplemented by a 1½ kw. pilot exciter direct connected to the main source of supply for the photometer which is a 20 kw. 125-volt motor generator set. While this set was considerably larger than would normally be required for this work it was hoped that this source of supply could be used for not only one but several photometers at the same time, as guarantees of regulation were in the order of two-tenths of one per cent with recovery time for load changes within a few cycles, which were practical because of the constancy of the load.

This direct-current electronic voltage regulator referring to Fig. 2 operates as follows:

The voltage adjusting potentiometer terminating at points 5 and 6 is connected to the armature of the 20 kw. d-c load generator. A 90 volt B battery is connected to oppose the voltage between the adjustable arm of this potentiometer and the positive terminal of the common generator and potentiometer connection. Under normal conditions this voltage difference is of the order of 2 volts and is impressed upon the grid of the first DRJ-571 amplifier tube. The first amplifier tube is resistance coupled to a similar tube whose output is used to control the grid voltage of the RJ-563 tubes. These six high current, high vacuum tubes are connected in parallel to supply from the 400 volt tube exciter field current to the 20 kw. generator. The required voltage for the operation of the two DRJ-571 amplifier tubes is obtained from a full wave rectifier tube and its associated filter circuit and voltage divider. All filaments of the tubes used are energized from a 110 volt, 60 cycle single phase supply.

Since the regulator varied the generator field current directly no anti-hunting means was necessary, this being only required if the regulator were supplying excitation to an exciter whose armature delivered the generator field current.

Operation of the circuit

A clear conception of the operation of the regulator may be had by assuming that the generator load is increased with the usual accompanying drop in regulated voltage. The effect of this voltage drop is to decrease the negative bias on the grid of the first amplifier, with consequent increase in tube plate current. Due to the resistance coupling between the amplifier tubes Nos. 1 and 2 the plate current of the second tube will decrease thus decreasing the negative bias or grid voltage applied to the RJ-563 tube. Since the field of the 20 Kw. generator is connected in series with the plates of the RJ-563 tubes and the 400 volt supply the field current is correspondingly increased with a resulting rise in generator voltage to normal. Under conditions where the regulated voltage increases momentarily due to a change in load the regulator action is exactly the opposite to that just described.

The normal field current of this 20 Kw. generator at the maximum load at which it will be used is 1.9 amp. Since the electronic voltage regulator is designed to deliver a maximum of 0.9 amp. field current, a manually controlled field rheostat was connected in parallel with the regulator as shown. Thus the generator field cur-

rent is the sum of the current through the manually controlled field rheostat circuit and the automatically varying regulator current. This use of the field rheostat is desirable since it permits reducing the field current which must be supplied by the RJ-563 tubes with a consequent increase of tube life. Under normal conditions the tube life expectancy is of the order of 2500 hours even in this exacting type of service.

Six adjustments are conveniently located on the panels for controlling the generator voltage. (1) the a-c switch on the regulator panel controls the 60 cycle a-c supply to the "B eliminator" and filaments of the various tubes. (2) The d-c switch on the regulator panel connects the plate current of the six power tubes to the generator field in parallel with the field rheostat and in series with the 400 volt d-c source of supply. (3) The voltage adjusting potentiometer knob on the panel permits raising or lowering the regulated voltage as desired. (4) The pilot generator field rheostat controls the voltage of the 400 volt d-c source. (5) The generator field rheostat, which is in parallel with the regulator and (6) The selector switch which places the operation of the set either under automatic control with the regulator or under manual field rheostat control with the regulator disconnected.

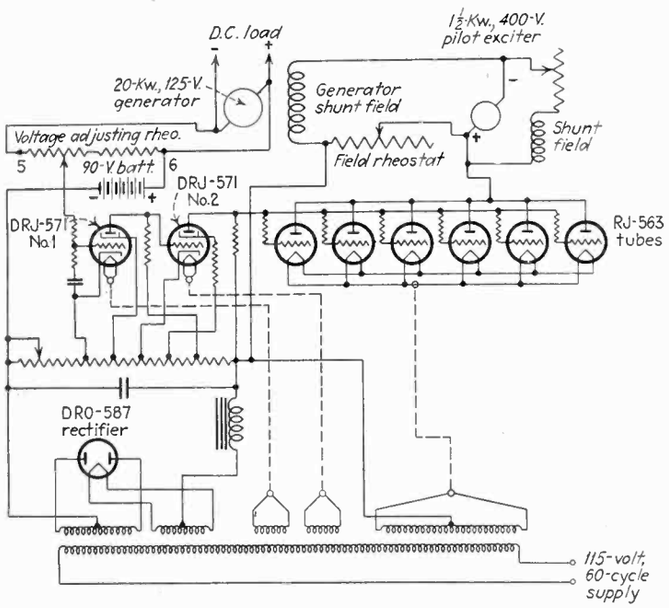


Figure 2—Diagram of connections for accurate voltage regulation.

After installation the regulator was adjusted so that the 20 kw. generator delivered 140 volts. This voltage was supplied to two photometric spheres, in each of which was inserted a 1000 watt, 120 volt lamp. The voltage was adjusted to exactly 120 volts in each sphere by individual adjustable series resistors and one operator was asked to connect and disconnect the 1000 watt lamp from the source of supply. Observations on a laboratory standard voltmeter connected to the second sphere showed only a very slight flicker of the pointer, and at no time did the voltage drift from exactly 120 volts. This was considered quite satisfactory for this type of work, being far superior to the lead storage battery source of supply from the standpoint of recovery, in that more than one photometer could be fed from the regulated generator. Since the installation of the regulator at Electrical Testing Laboratories as many as four photometers have been connected to this source of supply at the same time and operated independently. From the standpoint of regulation the supply voltage has been found to be all that could be desired. Thus another avenue of useful application has been opened by the electronic tube.

▲

A new job for electron tubes

AT THE Electrical Testing Laboratories high vacuum tubes have solved a major problem of incandescent lamp testing—the need for a constant source of voltage

▼

THE NEW WORLD OF NEW THINGS AHEAD—

It is my impression that we are on the eve of things of an entirely different nature.

It is not what we know that is so important. It is what we do not know. Most of what we know can be found in libraries, in the minds of people and in processes as they exist today. But we have no conception of what a small percentage this is of what there is yet to know.

—CHARLES F. KETTERING
Vice-President, General Motors

HIGH LIGHTS ON ELECTRONIC

Traffic volume analyzed by photo-cells

DURING THE PAST year Professors B. D. Greenshields of Dennison University, and R. S. Swinton of the University of Michigan, have been using photocell controlled cameras for analyzing traffic conditions on roads and streets near Ann Arbor.

In one form of the apparatus a small moving-picture camera is set up by the roadside, its operation controlled by a photo-electric cell, or "eye," which is sensitive to changes in light. Across the road, and focused on the eye, is a small mirror. When a passing car breaks the beam of light from the mirror, it affects the eye, which in turn automatically causes one picture to be snapped and a new film to be moved into readiness. Sixteen pictures a second may be taken if necessary.

Pictures thus made are thrown on a screen marked with vertical parallel lines. Simple calculations enable observers to tell the speed of a car, time lost in decelerating and accelerating, and the number of cars using a road or intersection. At the latter points it also shows the reasons for automobile congestion and pedestrian behavior.

"Our photo-cell equipment," reports Professor Swinton, "is arranged for use with a 6-volt storage battery, and B batteries to supply the higher voltage. It operates successfully with the light deflected by a mirror, but our projection device will not send a powerful enough beam to operate at a distance greater than 24 feet in daylight, using six volts and thirty-two candle power. We should like something that would throw a beam sixty feet or better so that we could sweep a forty-foot roadway and stay well back from the traffic. A relay at the camera, which may be as much as 300 feet back from the road, operates a solenoid through a 6-volt storage battery.

"We have placed the beam rather low on the radiator of the car so that it sweeps the full length of the car with a single interruption. Occasionally, however, one gets an additional record of the trunk on the back of the car. This makes no difference in our photographic record, but does cause error with our counting device. Calibration of the device by driving a car back and forth in front of the camera at known speeds seems to give a very satisfactory curve."

✦

Neon sign changer on dirigible

BY MEANS of remote-controlled relay contactors, operating in the high-voltage neon-tube circuits, novel letter changing effects are obtained on neon-sign letter boxes on dirigible balloons built by the Goodyear Tire and Rubber Company, Akron, Ohio. In this way changing advertising signs can be carried on the sides of the big bags, spelling out different letters and words, as the dirigibles fly over cities.

Tubular neon units are arranged to make up standard "letter boxes" providing for the forming of any letters or numbers. Short-circuiting magnetic contactors are then installed at the junction points, between the tubes, as many as 350 midget contactors being used on a single blimp. By operating these remote-control relays, any desired letter can be switched on at will. H. Webster Krum is the design engineer for the Goodyear airship operations department.

✦

Electronic voltage regulators in power plants

ELECTRONIC VOLTAGE regulators are being installed on power systems to replace mechanical regulators, according to recent engineering discussions before the A.I.E.E. Transition from mechanical to electronic regulators is taking place and, may more and more supplant machine exciters within the range in which the excitation requirements of generators do not exceed tube capacities. A limited number of direct-excitation-type electronic voltage regulators is in service, the largest installation supplying and controlling the excitation of a 15,000-kva. synchronous condenser. The full load excitation is 560 amp. at 135 volts.

Philip Sporn reported that the 15,000-kva. electronic regulator installation cited was frankly experimental when put in, but 35,000 hours of experience has shown it to be at least the equal of mechanical regulators. One of the Thyratron tubes gave a life of 17,800 hours, the average of all tubes being about 15,000 hours. The American Gas & Electric system has four of these electronic voltage regulators. E. E. George said reliability is imperative because one failure will vitiate the confidence of the operating staffs in them and make difficult a fair opportunity to take advantage of the more refined regulation afforded.

✦

Tooth-paste tubes checked by photo-cells

PHOTO-CELLS PLAY an important role in the new toothpaste tube-filling machines just installed in the Hillside, N. J., plant of the Bristol-Myers Company. The Arthur Colton Company of Detroit, Mich., developed these filling outfits for the makers of Ipana.

GAS-TANK AVIATION LIGHTS P.E.-CONTROLLED

Here is a picture of the gas container of the Syracuse Lighting Company, recently described in *Electronics*, as photo-electrically controlled. The lamps come on automatically at dusk

DEVICES IN INDUSTRY + +

The following operations are performed by the new unit: Cardboard boxes containing empty collapsible tubes, four abreast, are fed into the machine on a moving belt. A set of four plungers automatically picks up four tubes and places them on the machine proper within holes in a moving metal band. Next, an automatic register device operated by photo-cell places the lithographed legend on the tube in exact line with the closing device, which closes, crimps, and numbers each tube.

Operation of the photo-cell depends upon light focused on a yellow line in the center of a black lithographed band at the extremity of each tube. This black band with the yellow line in the center is in register with the lithographed legend on the tubes, and is applied during a single lithographing operation. By controlling rotary motion, through enormous amplification, each tube is rotated until the yellow line faces the light. Then the rotating motion stops, and a long line of tubes which before were placed in any position whatsoever, is all straightened out, right side out, by the electric eye.

✦

Photo-cell guard against suicides and sleepwalking

DR. MORTIMER RAYNOR, medical director of famous Bloomingdale Hospital, near New York, directs attention to the usefulness of the photo-cell or other similar device for detecting movements of nervous patients intent upon self-destruction. Sometimes the nurse or attendant is called away to another part of the ward, and the insane person takes advantage of this absence to slip quietly out of bed. Dr. Raynor suggests that if a beam of light or ultra-violet rays could be adjusted just above the patient, any movement or attempt to get out of bed, could be made to ring an alarm. Experiments in this direction are now being carried on.

Meanwhile Dr. E. E. Free, of New York, reports experiences in Europe in preventing sleepwalking by means of photo-cell beams.

This safeguard for sleepwalkers, tying them to bed with intangible and almost invisible light beams, instead of ropes or strips or bedclothes," explains Dr. Free, "has been devised by a British manufacturer of photo-electric cells and similar devices. One or more beams of dim blue or red light are directed across the bed from special lamps and reflectors like miniature searchlights. These beams enter one or more light-sensitive cells, which give an electric current so long as the light beam enters them. If anything interrupts the light beam, even for a small fraction of a second, the electric signal ceases. This stoppage may be made to sound an alarm or to work any other kind of electric apparatus.

"When the sleeper retires this light-beam system is switched on. If then the sleeper gets out of bed or even sits up in bed, his body must cut one or more of the light beams passing across the bed. This casts a shadow on the light-sensitive cell, stops for an instant the electric current from this device and sounds whatever kind of alarm has been provided. In hospitals the device is suggested to watch over restless or delirious patients not attended continually by a nurse. Any move of the patient to get out of bed instantly flashes a signal to the nurse in charge of the ward. For sleepwalkers who want to break their habit or to guard against hurting themselves, the alarm may be arranged to ring a bell if the sleeper arises and thus to wake him.

Detects metal particles in food manufacture

ANYONE CARRYING a gun when entering the exhibit of the Electric Light and Power Industry on the second floor of the Electrical Building at the Chicago World's Fair, would have had it readily detected.

In one section of this large exhibit space was located a metal detector, similar to that which is just being introduced in police departments for the location of concealed weapons on criminals when they are arrested.

This machine signals if the person standing before it has any metal concealed about his person—a knife, keys, and even the smallest of objects.

Industrial plants use these machines for the location of foreign metal particles in their product. For instance, candy factories have found them invaluable in locating small bits of metal that might be gathered by the mixture during process of manufacture, thus allowing greater speeds of production without fear of accidental contamination.

MAGNETIC EFFECT OF CAR OPENS GARAGE DOOR

In this novel garage-door opener of the Tiffin (Ohio) Electro-Mechanical Company a poised compass needle, housed in non-magnetic casing and buried in the roadway, is deflected by the steel mass of the car. On approach of the car, the needle swings around, intercepting a photo-cell beam which, through relays, opens the door

A single tube beat-frequency oscillator

By LEON PODOLSKY and EUGENE McBRIDE

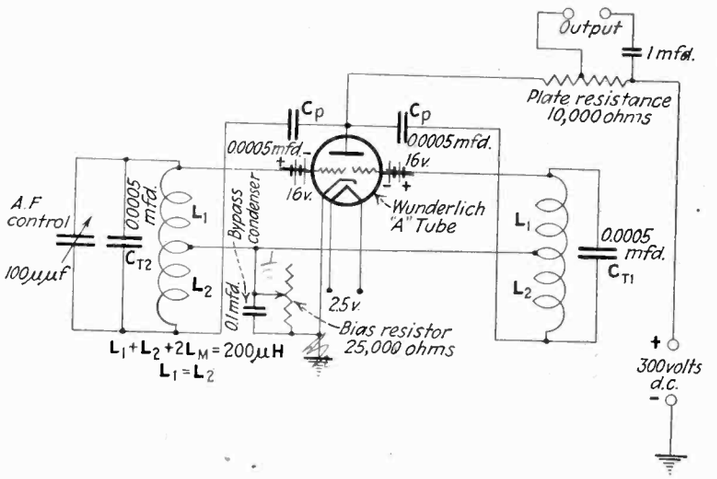
Engineering Department, Wirt Company.

THE need for a simple, cheap, and readily portable variable audio frequency oscillator, of the beat-frequency type, which would have frequency stability substantially independent of voltage or temperature fluctuations has long been felt in many small laboratories where the cost of a larger beat oscillator has not been justified, or where many such oscillators are required for test or experimental work.

In the common beat frequency oscillator where two radio frequencies are generated in separate circuits and the two mixed in a detector to produce the audio beat the resultant audio frequency is dependent directly on the stability of the radio frequency oscillators. Variations of tube voltages may not be the same in both radio frequency oscillators, causing some variations in their frequency. Even if the two radio frequency oscillators are driven from the same power supply, the parameters of the two circuits and their tubes are rarely exactly the same and fluctuations of voltages cause the oscillators to drift at different rates and possibly in different directions of frequency. Likewise, fluctuations in temperature affecting the resistance of the tuned circuits and other circuit parameters rarely cause fluctuations of equal magnitude in the two radio frequency oscillators. All of these factors mitigate against audio frequency stability from a beat frequency oscillator, and yet for nearly all types of variable audio frequency work such an oscillator is desirable due to the wide frequency range and ease of manipulation possible without the use of large inductances or capacities.

The authors attempted in their experimental work to keep the desirable wide frequency range and relatively small circuit constants of the beat frequency oscillator, and at the same time eliminate the use of separate radio frequency oscillator tubes and a separate mixer tube in order to reduce the number of tubes and circuits susceptible to voltage or temperature fluctuations to a minimum. It was found possible to keep all the desirable flexibility of the beat oscillator and to make the audio frequency practically independent of both voltage and temperature by combining the functions of the two radio frequency oscillators and the mixer in a single tube.

This was accomplished by the use of a tube (Wunderlich, type A) having a single cathode and plate structure, but with two exactly symmetrical grids. Two plate stabilized Hartley oscillators were employed to generate the fixed and variable radio frequencies. Each radio frequency oscillator circuit employed the common plate of the tube and one of the two symmetrical grids. The circuit diagram is shown in the figure. Since the two radio frequency oscillators employ the same plate circuit



Circuit diagram of the oscillator. A Wunderlich type A tube is used

two radio frequency current components exist in this plate circuit, different in frequency by an amount dependent on the tuning of the variable oscillator circuit. The two radio frequency components are effectively mixed in this plate circuit and the beat note, which is the difference of the two radio frequencies, appears as an audio frequency current in the output coupling device.

As is shown the two radio frequency oscillator circuits employ the common cathode electron stream and the common plate and consequently both oscillators are dependent on exactly the same filament and plate voltages, and furthermore they both have the same grid and plate resistance, each dependent on the same conditions.

It is seen that since both oscillator circuits have exactly the same tube parameters and are dependent on the same driving voltage, that any fluctuations in voltage which might cause changes in the tube or circuit parameters which could result in radio frequency changes will affect both oscillator circuits in exactly the same manner and magnitude. Consequently, any changes in the radio frequency of one of the oscillator circuits must

THE USE of a double-purpose tube having two symmetrical grids has made possible a simple beat-frequency oscillator of unusually stable frequency and output level. Such an oscillator, because of its wide, continuous range and simplicity of construction, should find use wherever audio frequency measurements are made

be accompanied by a change of the same magnitude and direction in the other circuit. The resultant beat note between the two radio frequencies will be essentially constant and independent of the magnitude of this drift.

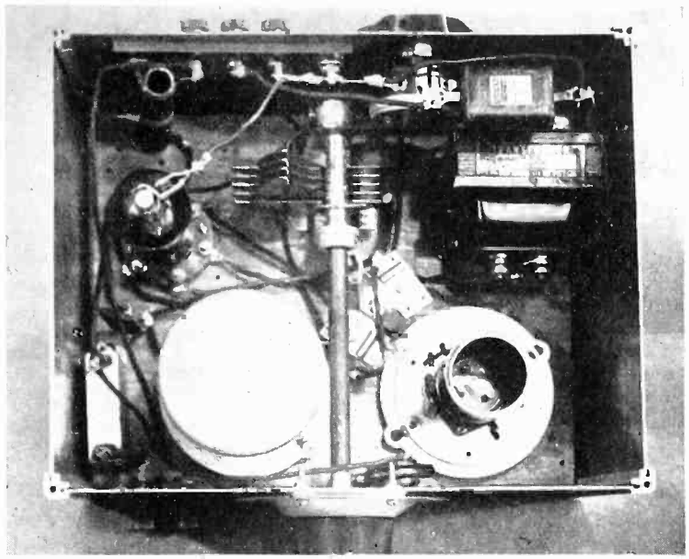
For example: Consider that one radio frequency oscillator is tuned to 500 K.C. and the other to 501 K.C., giving a resultant audio frequency of 1000 cycles. If the plate voltage drifts so as to cause a 1% change in the radio frequencies the new radio frequencies will be 495 K.C. and 495.99 K.C. respectively. The difference in frequency is 990 cycles which is only 1% change in the resultant audio frequency. It is thus seen that the audio frequency of this single tube beat frequency oscillator will be maintained practically constant throughout a range of conditions which would render that of the three circuit beat oscillator totally impractical.

The frequency of one of the tuned circuits can be shown to be:

$$f = \frac{1}{2\pi\sqrt{2C(L_1 + M)}}$$

where the symbols are those given in the circuit diagram. By making $C_p = C_{T1}$ and by making the coefficient of coupling between L_1 and L_2 zero, a condition of maximum frequency stability relative to voltage changes is obtained, and the proper phase relation between the two high-frequency components is maintained, resulting in maximum audio output. The condenser C_p is inserted for the purpose of rendering the frequency independent of the battery voltage, by making the oscillating frequency equal to the resonant frequency of the equivalent tuned circuit.

It follows that if the battery voltage were to vary, the frequency will remain constant, since it is only determined by the circuit elements external to the vacuum tube. Regarding a varying load resistance it will be remembered that the load R_L was assumed to be in parallel with the tube resistance R_p. Then the combination of the resistances can be considered as a single resistance. Thus, the same adjustment which causes the frequency to be independent of battery voltages, also renders the frequency independent of a variable load impedance, providing this impedance is a resistance and is connected in parallel with the plate resistance of the tube.



Fewer parts and greater stability are features of this useful oscillator

In conclusion, the following facts concerning this new type of beat frequency oscillator are of interest: The fundamental radio frequencies are eliminated from the audio output system without the use of filters. The oscillator is a compact and inexpensive source of variable audio frequencies covering the entire audio range and having excellent stability in comparison with modern beat frequency oscillators of considerably greater cost.

NEW BOOKS FOR USERS OF ELECTRON TUBES

Electrical measurements in theory and application

By Arthur W. Smith, Professor of Physics, University of Michigan. Third edition. McGraw-Hill Book Company, New York. (413 pages; price $3.00.)

THIS BOOK, intended as a combination text and laboratory manual for students having a year of college physics, has been one of the standard treatments of the subject for many years. The latest edition has been rewritten in parts and brought up to date. The chapters include definitions and units used in electrical measurements, the methods of measuring current and voltage by meters, potentiometers, bridges, and the measurement of power, in d-c circuits. The section on alternating current practice is introduced by a chapter on the vacuum tube and its use as a source of the oscillating current used in a-c measurements.

Magnetic circuits, and measurements of flux and induced voltage, including tests on magnetic materials, are treated at length, as are methods of measuring inductance, capacity and frequency. One section of great value is the discussion of the derivation of and relations between the various electric units, based on the electro-magnetic theory, which fills the last two chapters of the book. This section will be welcomed by the many students who find this aspect of electrical theory difficult to understand.

Servicing superheterodynes

By John F. Rider, New York. (277 pages, 94 illustrations and appendix. Price $1.00)

THE POSITION OF the writer in the field of radio service is well and favorably known and when, from time to time, his books appear, always related to this subject, they are well received. This particular book is now in its fourth printing. It is really a revised edition, containing a considerable quantity of material on modern superheterodynes. The actual service portion is confined to one chapter, but there is a chapter on test oscillators.

All such matters as amplified AVC, QAVC, image suppression, diode demodulators, an appendix showing the intermediate frequencies used by modern receivers and much more that was unknown when the first printings of the book were made will be found discussed and explained. Such matters as receiver sensitivity (in microvolts per meter), the necessary image ratios for good reception, the input voltages to diode rectifiers and other quantitative data will not be found here; the service man need know primarily why the circuit works and what to do about it if it does not.

+ + NOTES ON ELECTRON

Photoelectric density comparator for analyzing spectrograms

A NEW density comparator, an instrument designed for accurate and rapid quantitative spectrographic analysis, has been developed by engineers of the Bausch and Lomb Co. It is built as an accessory instrument to any spectrograph. The intensities of spectrum lines are measured by photoelectric means and the results read directly from a scale. For work involving the measurement of but a few selected lines, which is the usual case in quantitative spectrography, it surpasses the recording types of micro-photometers in rapidity and in providing, at unusually low cost, an instrument which accurately measures intensities. It is free from the personal equation of the operator and the effects of fatigue, which limit the accuracy of measurements made with visual photometers. Computations can be made at once without waiting for the development of a photographic paper or film. It may be used for plates taken with any size, type, or make of spectrograph.

The complete equipment consists of a projection system, a photocell for reception, a voltage regulator, and a sensitive galvanometer mounted on a Julius Suspension. The current for the standard unit is 110 volt, 60 cycle. Provision is made for other voltages and frequencies. The illuminator is located inside the housing of the instrument and consists of a 200 watt monoplane filament lamp equipped with a reflector, and is focusable.

Since the measurements to be made are directly dependent upon intensity of illumination, compensation for variations in line voltage is provided for by a regulating transformer which delivers a constant voltage (115) alternating current to the lamp even though the power line voltage varies from 105 to 130 volts.

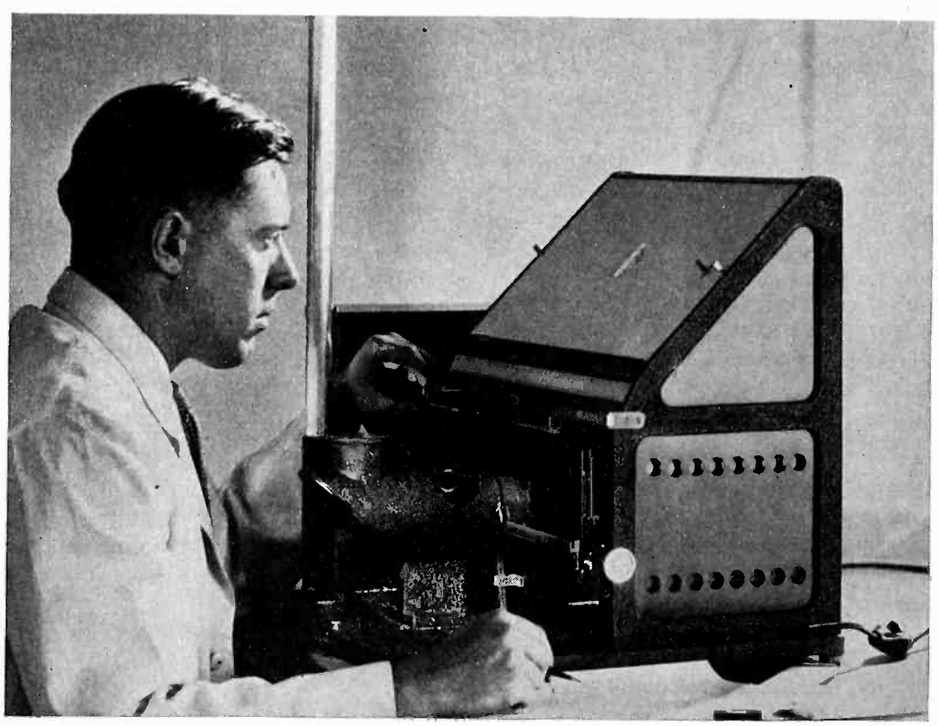
The spectrum plate is mounted on a mechanical stage carried by a horizontal guide on the front of the instrument directly between the illuminating chamber and the projection lenses. Both horizontal and vertical adjustments are provided. A condensing lens system with a heat absorbing filter is mounted between the light source and the plate and provides adequate and even illumination over an area about 1 inch square. The projection lens system is focusable, and with the aid of two mirrors, one of which is adjustable, throws a magnified image of the illuminated area onto the large inclined white screen. Double imagery is avoided by the use of first surface mirrors.

The projected image is bright enough to be visible in a lighted room. This arrangement permits easy selection of a desired line by its position relative to the adjacent lines of the spectrum. The light from the projected beam passes through a narrow vertical slit in the inclined screen and falls directly upon the photocell constituting the first element of the receptor system.

The receptor system consists of a single Weston Photronic cell mounted behind the narrow slit on the screen, upon which the light beam falls. The current actuates a reflecting galvanometer of high sensitivity. The galvanometer is provided with a suitable damping resistance to make it dead-beat.

The galvanometer can be used only when supported in such a way that its mirror is perfectly steady, even though the room or building is subject to heavy vibration. This usually necessitates the use of a suspended support so designed that vibrations are absorbed before they can reach the instrument. For this purpose there is an accessory to the instrument, the Brevoort Modification of the Julius Suspension.

To obtain the expression for the density of a line two readings are necessary. The first reading is made through the clear spectrum background adjacent to the line. The second reading is made after the projected image of the spectrum line or area in question has been positioned exactly upon the slit in front of the photocell. The ratio of these two readings is the expression for the density of the line or area.



Photoelectric instrument for comparing the density of the lines in the photographic plates of spectrographic analysis

Ferrocart and its applications

BY J. V. FILL

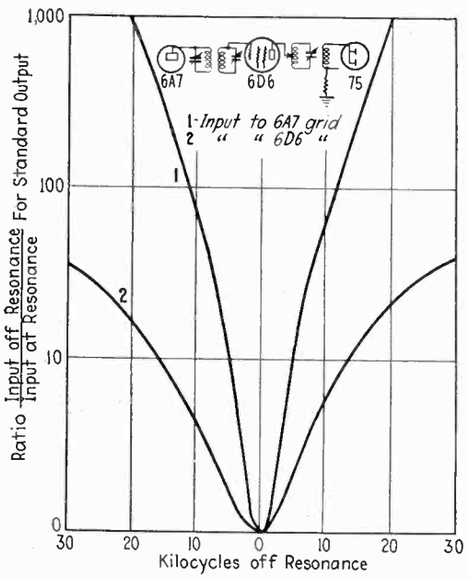
RADIO ENGINEERS are familar with the fact that increasing the permeability of a transformer core, providing the losses in the core are sufficiently low, will greatly enhance the efficiency of the coil. Because less wire is required for a given inductance, thereby lowering the resistance, and distributed capacity, giving the coil a lower power factor (higher Q), and at the same time reducing the size of the coil considerably.

At radio frequencies, losses become of great importance, as they increase as the square of the frequency. The following problem then presented itself: to make a core with sufficiently high "usable permeability" and at the same time maintain a minimum of losses. If the product is to be used commercially, it must combine these factors with uniformity as to permeability, physical dimensions and losses.

It remained for Hans Vogt, a pioneer in sound films, to perfect an iron core material having these characteristics.

TUBES AND CIRCUITS + +

This he called Ferrocart, and in its original form, as the name implies, it was made of iron and paper. By means of an insulating medium of high quality paper separating each layer of insulated iron particles, the eddy current and hysteresis losses are reduced to a low figure, enabling the material to be used at practically all radio frequencies with improvement in selectivity, sensitivity, and a reduction in coil size.



Selectivity characteristic of typical Ferrocart 456-kc. transformer, universal wound type

Recently an additional product has been commercially perfected which is being moulded into any desired shape, capable of machining, and which is mechanically solid and thermally stable up to 150° C., and has the above mentioned desirable electrical characteristics.

Tests show that the uniformity may be definitely kept within the following limits: permeability and electrical characteristics 2%; stability, dimensions and losses 5%. While E-I cores may be used with good success for carrier and intermediate frequencies, the design that adapts itself to American practice most readily, is the small round core on which is wound a universal litz coil, of the order of 1 mh. for 456 kc. This core is put directly in the winding jig, has a small hole in the center and is first covered with an insulating sleeve of high dielectric before the winding is started. The curves on a typical coil shown here were made by Radio Frequency Laboratories, Inc., Boonton, N. J.

The Q of the above mentioned type coil of 1 mh or thereabouts, measured in air, is of the order of 180. Contrasted with the best 4 section air core coil of similar dimensions, this value of Q is about 40% higher. Over the usual run of coils used in I-F transformers, these small Ferrocart coils will show an increase in Q of over 2 times.

The E-I core is somewhat more expensive to make and does not easily lend itself to quantity production as the round core does, but it has the advantage of offering a further reduction in the stray field surrounding the coil, and is somewhat more compact. This type of assembly is proving very valuable in the construction of extremely compact receivers such as are used in aircraft and mobile work. Two such E-I coils, when coupled together, depend on their small leakage field and may be placed close together, resulting in a very compact design. Such a unit may be readily adjusted for resonance by varying the air gap between the E and the I, resulting in a 20 per cent change in inductance in most cases. This, of course, obviates need for trimming condensers, there being two small fixed condensers to maintain the proper LC ratio connected across primary and secondary. The two adjustment screws are connected to their respective I's, making alignment a very easy proposition.

Among the many features of transformers using Ferrocart coils is the possibility of varying the band width for different degrees of reception. This may be accomplished by small variations in couplings effected by a lever attached to one of the coils.

Ferrocart is useful in carrier-current telephony, enabling very compact coils to be constructed. Tests show that the transmitter and receiver may be housed in one box instead of in two separate units, thus simplifying connections and making more economical and space-saving design. Another use is in choke coils for insertion in the ac-line of a radio receiver, thereby reducing the line noise without affecting the line voltage.

The characteristics of Ferrocart are:

Laminated		Moulded
3.8	Specific weight	4.7
10-12	Permeability	13.9

The above permeability figures are measured in a ringe core. Further development work is being done in designing coils for antenna coupling systems. These comprise the coventional type of antenna transformer and anti-noise systems to improve the signal to noise ratio due to the high transfer of signal energy into the first tube. This feature is important for automobile radio receivers, where an insufficient antenna is used and the noise level is inherently high. In addition a considerable reduction in size of the conventional air core antenna coil is realized.

Directional antenna for new KYW at Philadelphia

A FOUR-TOWER directional antenna array is being erected for the new KYW at Philadelphia, with the intention of directing the maximum signal toward Philadelphia and Allentown, and a minimum in other directions. In addition to its directional feature, the four-tower system is used to minimize the sky wave, thus reducing inter-station interference and fading. Nearly a ton of copper is used for the ground system, in the form of special cages suspended ten feet above the ground around the 235 foot towers.

+

190 kc. surge converts copper strap into tubing

A 50,000 AMPERE, 100,000 volt surge of radio frequency current was recently used by Westinghouse engineers to convert a piece of copper strap into a piece of seamed tubing. Current at 190 kc. was sent through a thick soft copper strap, one inch wide and 1/32nd inch thick by transformer action, the strap acting as the secondary of the transformer. The interaction of the flux and the current combined with the skin effect of high frequency caused a motor action to act on the copper at its edges, with the resulting curling of the strap.

Copper strap twisted into a cylinder by the action of a radio frequency current, shown by W. G. Roman of the Westinghouse high voltage laboratories

electronics

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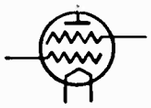


Business is better in radio

A SUBSTANTIAL increase in radio sales is indicated by the U. S. Treasury reports of excise taxes collected on radio sets and tubes. For the nine months ending September 30, 1934, the five-per-cent excise tax on radio totaled $2,209,400, an increase of 48.6 per cent over the similar nine-month period of 1933, during which collections were $1,487,124.

Radio excise tax collections during August, 1934, were $229,681.76 as compared with $125,865.08 during August, 1933. The official government figures of September collections register another large increase. During September, 1934, the radio excise tax collections were $305,291.91, as against $147,930.49 in September, 1933.

Canada goes ahead

CANADA is also sharing this radio prosperity. Radio receiving sets are turned out by Toronto factories at approximately double the levels of a year ago. It now appears certain that Canadian production of 112,273 sets, valued at $4,401,313 in 1933, will be considerably surpassed by the 1934 output. For the first half of 1934, radio receiving sets sold in Canada numbered 58,000, compared with 22,250 in the first half of 1933. Total value of the sets in the 1934 period was $2,165,000, as against $527,000. Average value per set was $37, against $28 last year. About 8,000 of this year's six months' sales were automobile sets.

A challenge to components makers

INTRODUCTION of the "acorn" tubes (see *Electronics,* September, 1934, p. 282) is an immediate challenge to manufacturers of parts. There is a market for an exceedingly small radio, vest-pocket in size, perhaps. But in the past set designers have felt nothing could be done because the essential elements, the tubes, were so large. That day is past.

Such components as variable condensers, coils, headphones and loud speakers, resistors must be reduced in size if they are to appear in the ultra-midgets. There is much room for research here for new high capacity condenser dielectrics, for resistance materials of greater heat tolerance, for new emission surfaces to decrease the power required by the tubes, for compact long-life batteries.

Such parts need not be cheaper or more fragile; they might be sturdier because of small size and perhaps more expensive—they need only be smaller.

Radio—the new news agency

NATURALLY the newspaper publishers stand a little aghast and uncomprehending, in considering why they should share their news, collected at great expense, with the radio broadcasters for advance dissemination to the listeners. The publishers' objections are thoroughly reasonable from their standpoint. News is property, valuable property, which must be merchandised while it is fresh. And naturally the newspapers want to protect their own channels of distribution.

But what the newspaper men do not seem to realize is that a new means of disseminating news has overtaken their own slower processes of printing-press, train, truck, and delivery boy. News can now go to the home *directly* and *with the speed of light.* Viewed as a multiplier and spreader of information, radio and facsimile are as far ahead of the printing press, as the modern newspaper perfecting press is ahead of Franklin's early hand-press. Shortly facsimile printers will be producing little newspapers in the home, as clear and sharp as those coming from the press. The public will demand news over these faster

agencies, aural and visual, whether that news comes from the older newspaper sources or from new news-gathering organizations. The newspapers are suddenly finding their vast plant investment overtaken by technological obsolescence. It is up to them now to make the best deal they can, with the new conqueror of time and space. For radio has the upper hand.

Radio "music rooms" for the home

THE home radio set reaches its due dignity as a musical instrument in the new Philco "music room" settings in Radio City, New York. There, for the first time, radio is being displayed as an integral part of the decorative scheme of a fine home. In the past the radio set has usually merely been inserted into the living room. Now with the aid of leading interior decorators the radio instrument is being used as the focal point for a series of beautiful music rooms.

Five representative "music rooms" are on display, the creations respectively of Elsie de Wolfe, Alavoine, French, Contempora, and Stair & Andrew. Each presents a different conception of a music room, ranging from Eighteenth Century French to Modern. The exhibition is sponsored by the National Alliance of Art and Industry, and grew out of the efforts initiated by this forward-looking group, in co-operation with the editors of *Electronics* and *Radio Retailing*, beginning in March, 1933, to bring more artistic design into the outward appearance of radio cabinets.

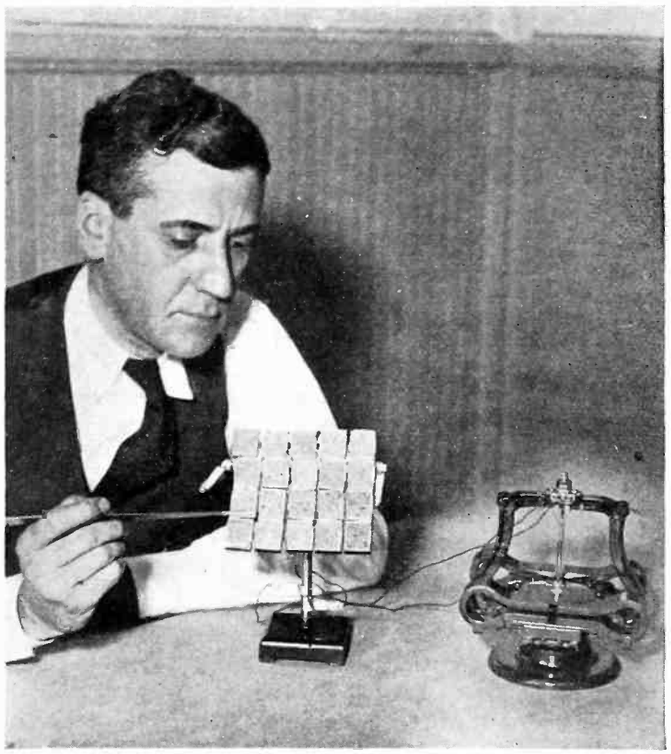
Sturdy industrial tubes

A VALUABLE psychological factor is introduced by the new all-metal industrial tubes. The new tubes "look like" pieces of industrial electrical equipment.

No glass is visible. The metal envelope is strapped and bolted firmly to the panel board. And the current is led into and out of the new tubes not by pin-and-socket contacts of radio memory—but over heavy flexible leads, ending in massive lugs that can be screwed down tight, to the satisfaction of the most hard-boiled service engineer. At last the electronic tube looks like—and is built like—a piece of industrial apparatus.

This new tube construction removes some of the most serious drawbacks that have delayed industrial electronic progress.

SUNSHINE RUNS THIS MOTOR



J. Thomas Rhamstine of Detroit has connected a group of his self-generating barrier-plane photo-cells to operate a small motor on energy from daylight. The motor resistance is 60 ohms and it will run on ½ milliampere

▲ ▲

HENRY FORD ON OVER-PRODUCTION

Most people think nowadays of surplus as an evil. It is said to break the market. It drives down prices. Therefore, they say, the surplus should be destroyed, and the future production of the commodity strictly limited.

This view, I think, is short-sighted and mistaken. The surplus is really a blessing in disguise. It places pressure on the ingenuity of man to discover new uses for the commodity. Once those new uses are discovered, the apparent surplus adds to the wealth and comfort of human life.

HENRY FORD

A REVIEW OF THE ELECTRONIC ART HERE AND ABROAD

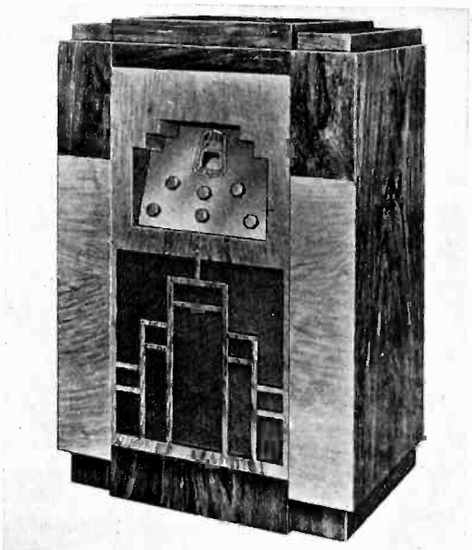
British high-fidelity receiver goes America one better

PROVIDING A FLAT audio response from 40 to 12,000 cycles per second, a new high fidelity receiver of advanced design has been announced by a prominent British manufacturer. The set, which retails at 85 guineas (about $425), contains an automatic record changer with piezo-electric phonograph pick-up. Two loudspeakers are used, one a moving coil type, the other a high frequency unit.

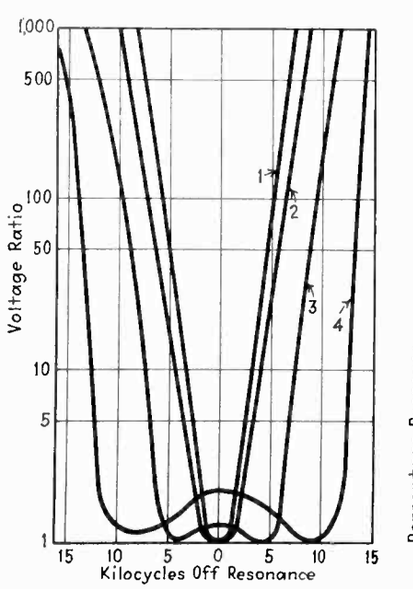
Continuous control of the selectivity of the receiver is provided by varying the coupling between the band-pass coils in the six i.f. tuned circuits. The band received may be varied from the full 24 kc. required for 12,000-cycle audio response to hair-width selectivity, depending upon the conditions under which the set must operate.

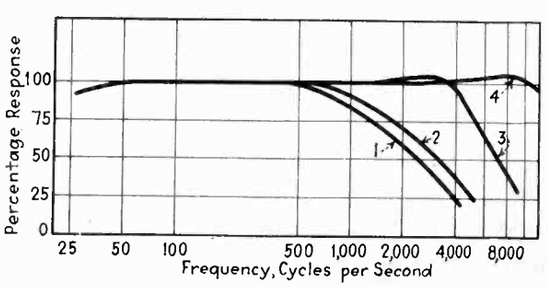
An unusual and useful feature of the set is a "whistle filter" set at 9 kc., the separation between European broadcasting stations. The selectivity control cuts out this filter when the receiver is set for reception above 9000 cycles per second, but allows it to remain in the circuit for all lower values. This filter removes much of the interstation chatter interference. The selectivity control also removes the high frequency loudspeaker from the circuit when it is in its most selective condition. All of these functions are controlled from the single knob of the selectivity control. The performance curves are given in the illustration.

Additional features more familiar to American practice are also provided, such as visual tuning, delayed a.v.c., and inter-carrier noise suppression. An additional noise suppression control is provided which allows the user to vary continuously the sensitivity of the receiver from its maximum value (one microvolt sensitivity) to a position just capable of receiving the strongest signals. Resistance-capacity coupling is used in the audio stages, the last of which provides, single-ended, the six watts to the speaker. The two European wavebands are provided, i.e. 190 to 570 meters, and 800 to 2,000 meters. Eight tubes are used, including the rectifier.



High fidelity receiver manufactured by the Birmingham Sound Reproducers, Ltd. of Old Hill, Staffordshire, England, which provides an audio frequency from 40 to 12,000 cycles





Performance curves of the British high fidelity receiver, shown for four settings of the selectivity control. The frequency range corresponding to the selectivity settings is given in the left hand curve

Imports of electronic equipment

THE BUREAU OF FOREIGN AND DOMESTIC COMMERCE announces that during the month of August, 1934, the following imports of equipment in the electron tube field were made: Radio apparatus and parts, $3,027; X-ray tubes (mostly from Holland), $3,008.

Berlin radio show

MANUFACTURERS EXHIBITING at the annual Berlin show were agreeably surprised at the business turn-over according to reports. Nearly all reported doing more business than in 1933 at the same annual show. Of the 300,000 visitors, 100,000 came from outside the city. 5,000 dealers were in attendance.

In Germany a successful attempt seems to have been made to combat the frequent announcement of new models. In fact the sales of sets at the show were distinctly higher and the reason advanced is the fact that one can now buy a receiver without the certainty that it will be obsolete within a year.

So busy are German factories as the result of sales at the Berlin show that most of them are running well behind orders. Thus it appears that, if the seasonal peak can be maintained, the manufacturing capacity is less than necessary instead of greater as in the United States.

The number of subscribers to the federal radio broadcasting service totaled 5,440,466 on September 1, 1934, or an increase of 82,647 over the preceding month. Of these subscribers, 428,836 were freed from payment of the monthly service fees collected by the German Post Office; and of these 294,460 were unemployed persons.

New broadcast stations abroad

THE NEW LaNacion station in Buenos Aires, said to be the most powerful in South America, will soon be put into operation. This station will replace the equipment operated for several years by this newspaper under the call letters LR6. The equipment is largely of German (Telefunken) origin. Six tubes of 50 kw. capacity each will be used to provide an antenna power of 50 kw.

The Columbian Congress has been requested to appropriate an additional

750,000 pesos for the Ministry of Education for developing a program of rural public instruction using sound and visual educational methods. The appropriation (if voted) would be expended as follows: one 30,000 peso transmitter and 1,000 receivers to cost 30 pesos each. 150,000 pesos for 500 gasoline-driven power sets to generate the energy for the radio receivers; 55,000 pesos for 50 portable film-projecting machines; 28,000 pesos for purchase of raw and finished film; and 100,000 pesos for the acquisition of 200 rural libraries.

In France a new 200 kw. station will use a pylon antenna 200 meters high. The cost will be 2,642,000 francs.

New magazine devoted to the art of radio tube

ARTICLES on tubes which hitherto appeared in the *Telefunken Zeitung*, the quarterly house organ of the Telefunken Company, will in the future be published in a separate magazine, *Die Telefunken Röhre* (The Telefunken Tube), under the editorship of Professor H. Rukop, well known for his work on the propagation of radio waves.

The July and September numbers have already appeared. As announced in the foreword, they bring scientific and technical articles on high vacuum, gas and vapor discharge tubes by members of the staff, to inform engineers, scientists or manufacturers of the actual state of the tube art, the proper use and choice of the tubes, or the impending changes in tube and receiver design. The well illustrated magazine is at present distributed free of charge to persons applying for it.

It is known that in Germany the manufacture of radio tubes is in the hands of two companies, Telefunken and Valvo, both producing by agreement the same receiving tubes. Thus the articles may be said to reflect the ideas and endeavors of the entire German radio tube industry.

Output tube problems

[W. KLEEN, Telefunken Laboratory.] The most striking difference between triodes and pentodes is that the $I_p - E_p$ characteristics, plotted for a regular series of grid voltages, for instance zero, minus 10, minus 20 volts, etc. show in the case of triodes a strong bend at low plate currents according to the 3/2 power law, whereas the characteristics for pentodes are strongly curved at low plate voltage, but in the opposite sense, and the relation between plate current and plate voltages cannot be expressed by a simple power law. Directly-heated tubes give more evenly spaced and more nearly straight characteristics than indirectly heated tubes, because the indirectly heated tube has an emitter of relatively large diameter and the space charge occupies at low voltage an appreciable fraction of the cathode-grid distance.

For faithful reproduction a load line across the operating point (a line whose slope or tangent is equal to minus $1/R$) should be divided by the characteristic curves into parts of equal length. This happens when the characteristics are not only straight lines, but parallel to one another, two conditions never completely satisfied in reality. In some cases (triodes) the requirements are more nearly met with by a load line parallel to the voltage axis (slope equal to zero, open circuit, constant amplification) than by lines belonging to the same plate voltage (short circuit condition).

Pentodes incline toward the other extreme, the mutual conductance is constant for zero load; or, more accurately, in the case of directly heated pentodes the divisions on the short circuited load line decrease on going to a higher grid bias, in the case of indirectly heated pentodes the lengths are greatest for medium biases. (The reverse applies to indirectly heated triodes). But even though the characteristics may be curved, faithful reproduction is still possible for a certain range of loads since in the case of pentodes the slope of the characteristics decreases with increasing grid bias. Load lines may thus be drawn which give nearly equal lengths between the different curves. If the load line giving most faithful reproduction corresponds to a resistance equal to the internal resistance R_p of the tube, the tube also gives at the same time its highest output as determined by the highest plate voltage, current and grid swing.

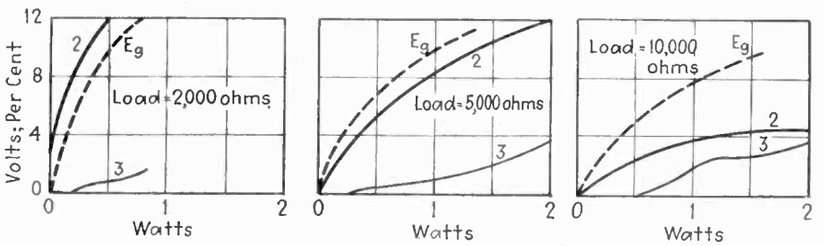
The load represented by the loudspeaker is, of course, not constant; it is low at low frequencies, increases slowly as 1,000 cycles is approached and grows more rapidly beyond this point. A rough value of linear distortion may be gained by considering the variation of the output with a change in the output resistance.

$$\text{Power output} = \frac{\mu^2 e_g^2 R}{(R_p + R)^2}$$

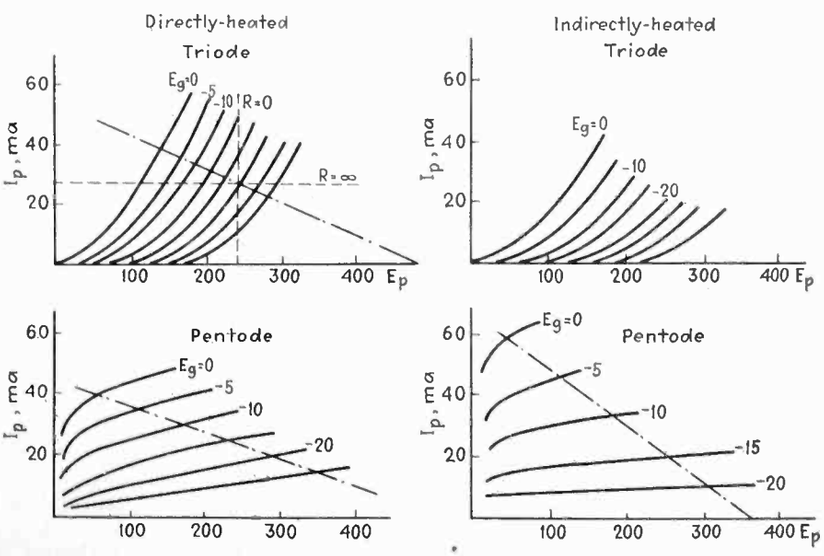
$$= \frac{R/R_p}{(R/R_p + 1)^2} \frac{\mu^2 e_g^2}{R_p} = \frac{R_p/R}{(R_p/R + 1)^2} \frac{\mu^2 e_g^2}{R_p}$$

The ratios R_p/R and R/R_p are interchangeable in the fractions used.

The production of harmonics may be determined from the same $I_p - E_p$ diagrams or from $I_p - E_g$ diagrams. Five values of the plate current are needed, i_1 the highest plate current used in practice, with the highest positive swing of the grid, i_2 the current with



First and second harmonic for various grid swings in heater-type pentode, plate and screen volts = 250; Ip = 24 ma.



Ep-Ip curves showing differences between triodes and pentodes and heater versus filament type tubes

half this swing, i_3 the current at the operating point, i_4 the current obtained with half of the lowest negative grid swing and i_5 the current with the most negative grid potential. When the characteristics are expressed as a series of powers of the grid voltage g

$$i = a + b_g + c_g^2 + d_g^3 + e_g^4$$

the amplitude C_1 of the fundamental, C_2 of the first overtone, C_3 of the second, etc. is

$$C_1 = \frac{1}{3}(i_1 + i_2 - i_4 - i_5)$$

$$C_2 = \frac{1}{4}(-i_1 + 2i_3 - i_5)$$

$$C_3 = \frac{1}{6}(-i_1 + 2i_2 - 2i_4 + i_5)$$

$$C_4 = \frac{1}{12}(i_1 - 4i_2 + 6i_3 - 4i_4 + i_5)$$

The triode amplifier is characterized by the difference in amplitude which it produces between the positive and negative half of the wave, resulting in a strong first overtone, while the pentode is characterized by the flattening of the wave at top and bottom giving rise to a prominent third harmonic with full grid swing. When the load is smaller than the d-c resistance of the pentode at which value the output is highest the second harmonic is stronger than the third. The third harmonic is less disagreeable to the ear than the first overtone.—*Telefunken-Röhre* No. 2: 58-72. 1934. *El N. T.* 11. No. 8: 293-297, 1934.

Prevention of repeat points

[R. Rechnitzler.] The simplest method of producing a beat frequency i, namely multiplication according to the formula

$$2 \cos l \cos s = \cos (l - s) + \cos (l + s) = \cos (s - l) + \cos (s + l),$$

gives the sum as well as the difference frequency of the local frequency l and the signal frequency s. If the frequency i used for amplification be kept at 400 kc., and the incoming s is 500 kc., the intermediate frequency is obtained either with the local oscillator set at $(s - l) = 500 - 400 = 100$ kc. or with $l = 900$, while for $s = 1{,}500$, the intermediate frequency is obtained with $l - 1{,}100$ as the difference between s and l, or with $l - 1{,}900$ as l—s. In using the higher local frequencies, the frequency has only to be changed from 900 to 1,900 to cover the broadcast band; in using the lower values it must be varied from 100 to 1,100, a much wider range. A high l is therefore of advantage and is less likely to create interference (1,900 kc.)

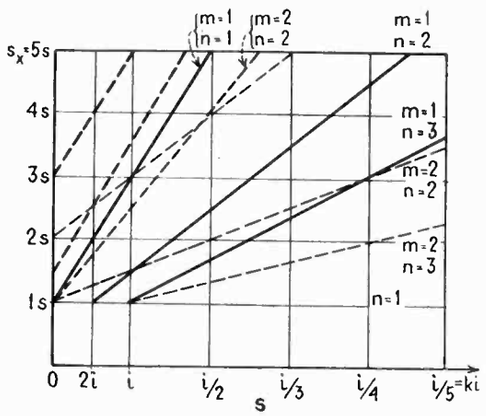
On the other hand, once l has been adjusted to the proper value, 200 kc., for instance, the same intermediate frequency is produced by two different signal frequencies $s_1 - l$ and $s_2 - l$, for instance 800 and 1,200, provided that s_1 and s_2 are $2i$ cycles apart. In reality there are even more images since s as well as l have harmonics so that i can be produced as the sum or the difference of multiples of l and s, that is, as

$$n \times l \pm m \times s_x = \pm i$$

Considering only the difference, all the possible s_x interfere with the desired s when

$$\frac{s_x}{s} = \frac{n(i + k) \mp k}{m}$$

where k is the ratio of i to s. The value of m can be kept small, that is equal to one, by good selectivity.



Repeat points and interference s_x of super tuned to s (expressed as a fraction of i) for various harmonics m of local oscillator and n of carrier

Since the two most important images are separated by $2i$, it is advisable to make $500 + 2i$ larger than the upper range (1,500) of the receiver, or i larger than 400 kc. or 500 kc.

When there is no trouble from other transmitters, that is when $s_x/s = 1$, and $k = i/s$ happens to be equal to $(m - n)$ $(n \mp 1)$, then the equation becomes

$$s = \frac{(n \mp 1)\, i}{m - n}$$

so that the signal is received in multiple so to speak. For instance, for $n = 1$ and $m = 2$, the formula gives $s = 2i$. The local frequency itself is $3i$, the second harmonic of the sender equal to $4i$, and the fundamental s as well as the harmonic $2s$, produce the same frequency i, the first as $(3i - 2i)$, the second as $(4i - 3i)$. Before the set is tuned, l is slightly higher and a beat note is produced between $(l + x) - 2i$ and $4i - (l + x)$. A similar effect occurs when the signal frequency is one-half the intermediate frequency. The only remedy would be to have $i/2$ outside the range of the receiver, that is below about 250 kc., but such a choice does not avoid the main mirror image. High grade receivers use one frequency i for getting selectivity and another for amplification.—*Funkt. Monatsh.* No. 9: 337-341. 1934.

French radio show

In Europe as in America the annual radio shows attract large crowds of potential purchasers. The 11th annual show in Paris covered a total of 8,000 square meters and wares from 210 exhibitors were on view. The attendance was estimated as betwen 190,000 and 200,000 compared to 160,000 in 1933.

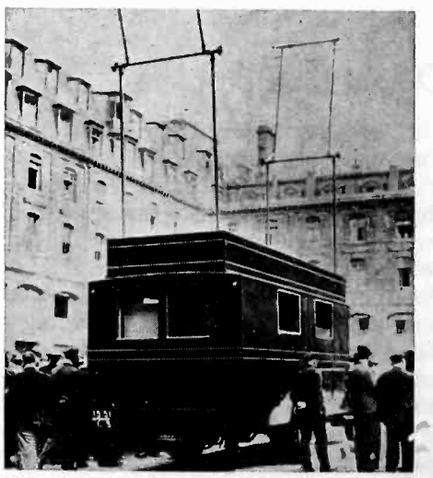
The most popular model was a 5-tube superheterodyne selling at 1,500 francs. Prices ranged from 310 francs to 7,500 francs, the former for a 4-tube set and the latter for a 11-tube radio-phonograph. Most of the larger companies presented 6 or 7 models. Nearly all sets have a.v.c., and dual volume and tone controls, by which is meant, probably, tone-compensated volume control.

American tubes continue to sell well in France—but the French are discovering that replacement sales are not as good as they would desire. Tubes in France, as in America, have high efficiency and long life leading to a poor replacement business.

Auto-radio has not taken hold in France; chiefly because of the low ampere-hour batteries used in cars, and because of the high prices.

Of all sets sold in France 60 per cent are imported and of this quantity, 40 per cent are of American make. Prices are lower than last year by approximately 10 per cent. Quality is somewhat better. Manufacturers are giving approximately 25 per cent of the new set's value as trade-in for old receivers.

PARIS POLICE RADIO



Fifteen seconds after this traveling headquarters pulls up its aerial unfolds

+ NEW PRODUCTS

THE MANUFACTURERS OFFER

Velocity type studio microphone

A NEW velocity microphone (Model SR-80) has been especially designed for studio work by Amperite Corp., 561

Broadway, New York City. Its frequency range is 30 to 14,000 cycles. While enclosed diaphragms or ribbons tend to have a cavity resonance as well as to limit the frequency range, the open construction of the SR-80 prevents cut offs at either high or low frequencies.

The duraluminum ribbon is hand hammered down to .00015 inch thickness to insure maximum sensitivity. A nickel alloy (permalloy) core transformer preserves the output and frequency range of the free ribbon.

Magnetic shielding prevents the pick up of inductive noises. An elastic coupling between the microphone and stand absorbs all shocks and mechanical vibrations. Since temperature, humidity, or age have no effect on the Velocity Microphone, the service problem is largely eliminated.

Because of the wider area of coverage, the SR-80 can be used to replace several diaphragm type microphones in studio work. The "dead" angle of the microphone is useful in giving instructions to the performers while "on the air."—*Electronics.*

✦

Sturdy metal-to-glass seal

A NEW metal-to-glass seal has been developed by the Research Laboratory of the General Electric Company, Schenectady, N. Y., which, because of the certainty with which tight and reliable joints can be made between glass and the alloy called Fernico, has opened up many possibilities in the development of various classes of vacuum tubes and other devices wherein leading-in wires or conducting parts must pass through gas-tight insulating seals or themselves form part of a gas-tight chamber.

Fernico can be machined, forged, punched, drawn, stamped, soldered, copper-brazed, and welded with a facility equal to that with which these operations can be performed on a high-grade nickel-iron.

The physical characteristic of Fernico which makes possible its successful fusion with glass, is its expansion curve, which coincides almost exactly with that of certain glasses. For this reason, no stresses are set up in either the glass or the alloy when cooling from the fusion temperature. This lack of initial internal stresses in the completed glass-Fernico seal makes the seal permanently tight and sturdy.—*Electronics.*

✦

New flexible rubber insulation

LAYTEX, A NEW rubber insulation, has been introduced by the United States Rubber Products, 1790 Broadway, New York. It is claimed that the new material is more flexible, has greater tensile and compression strength, higher dielectric strength and insulation resistance than any other flexible insulation known. The insulation is derived from latex, the milk of the rubber tree, and specially processed to remove all proteins, sugars and water solubles, substances which contribute to moisture susceptibility in the usual rubber insulation.

In applying the material to conductors, the conductor is run through a series of baths of the liquid, which is then solidified before the wire comes in contact with any mechanical support, thus avoiding mechanical defects from this cause. The stretch of the new material is 750 per cent, its tensile strength 5,000 pounds per square inch. Because of the method of applying the material to wire, a thinner coating may be applied equal in effectiveness to much heavier types of insulation.—*Electronics.*

Cathode-ray tube

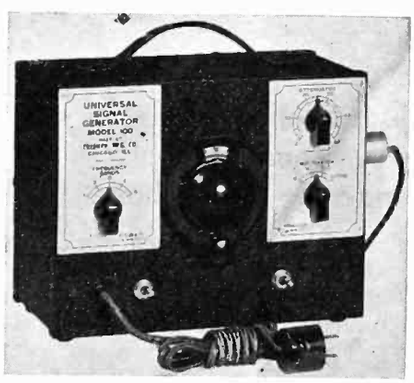
THE ALLEN B. DUMONT LABORATORIES, 542 Valley Road, Upper Montclair, N. J., announce a new cathode ray tube known as the 54-8-C or 94-8-C, being made in two sizes, respectively 5 in. and 9 in. These new tubes are designed to eliminate a number of the defects which occur in ordinary cathode-ray tubes. By a special design of the elements the threshold effect is eliminated, a more uniform pattern is obtained and the tube has a constant and higher impedance across the deflection plates as the voltage supplied to them varies.

The price on the above described tubes is $40 for the 5 in. and $85 for the 9 in.—*Electronics.*

✦

All-wave signal generator

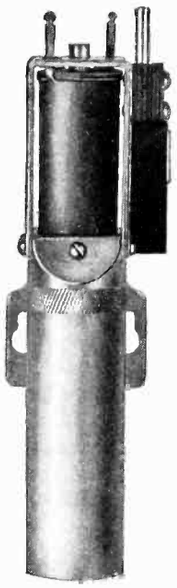
A UNIVERSAL signal generator providing an r.f. fundamental output from 100 kc. to 10,000 kc. has been developed by the Triumph Manufacturing Co., of 4017-19 West Lake Street, Chicago. Powered with 60 cycle, a-c current, and



completely self-contained in a cabinet 11½" by 10" by 9½", the unit weighs 12 pounds. A 400 cycle a.f. modulation is provided for any of the r.f. frequencies, while a four-step ladder attenuator provides the proper level for each testing use. Four ranges of output from practically zero to 50, 500, 5,000 or 50,000 microvolts are available. By the use of harmonics, frequencies as high as 50 megacycles may be obtained. The unit sells for $38.75 complete with tubes. —*Electronics.*

Dashpot delayed-action relay

AUTOMATIC ELECTRIC COMPANY, Chicago, has recently developed a new delayed-action relay which operates on alternating current without requiring a series condenser in its circuit. This relay is the oil-dashpot type, similar to



the direct current relay of the same series. The time delay interval between the closing of the coil circuit and the operation of the contacts can be varied from 5 seconds to 1½ minutes, by merely turning the outer dashpot cylinder. The release time of the relay is .010 second, and is non-adjustable. The relay can be furnished to operate on various voltages and frequencies and can be provided with a variety of contact combinations.—*Electronics.*

✦

High-fidelity "wave-equalized" condenser microphone

AFTER EXTENDED research work, Shure Brothers Company, "Microphone Headquarters," 215 West Huron Street, Chicago, announces the development of 43

Series "Wave-Equalized" High-Fidelity Condenser Microphones. The feature of these microphones is the complete absence of the usual cavity-resonance peak and the extension of high frequency response at least one full octave above the cut-off frequency of previously available practical condenser transmitters. Thus the 43 Series microphones provide "High-Fidelity" pickup, but retain the valuable feature of standard output level and low impedance, making it possible to use these instruments without increasing the gain of the existing speech-input equipment or making extensive wiring changes. Three models are available, including a standard "Bullet" model with integral two-stage amplifier, a desk-stand unit with remote amplifier, and a floor model with two stage amplifier in the base of a special stand.

	Per cent of octave range transmitted within 5 db.	
Instrument	Conventional Condenser Microphone	"Wave-Equalized" Condenser Microphone
Bass Viol	63	98
Snare Drum	66	90
Trombone	68	100
Piano	69	100
Male Voice	70	99
Female Voice	65	97
Clarinet	63	87
Violin	56	88
Hand Clapping	59	92

—*Electronics.*

✦

Coil winding machine

A COIL winding machine capable of winding four cross-wound wire-spaced coils simultaneously is offered by the Universal Winding Company of Boston, Massachusetts. The type of coils for which the machine may be used include intermediate frequency transformer coils, antenna loading coils, radio frequency chokes, and in fact any type of cross-wound coil. The winding speed is 600 to 650 r.p.m., which is developed from a ¼ to ⅓ hp. motor running at 1200 r.p.m. Any wire size from No. 30 to No. 38 B.&S. gauge may be used, and coils may be wound up to 1½ inch (width) by 6 inches (diameter) in size. The four coil winder will provide from three to four times as much output per machine as the single coil winder formerly used.—*Electronics.*

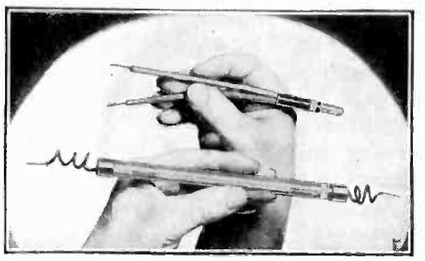
✦

Photocell relay

A PHOTOCELL RELAY for operation on 110 volt a.c. lighting circuits is offered by the Electronic Products Company, St. Charles, Illinois. In addition to terminals for the a.c. power four terminals are provided, for closed or open circuit operation. The size of the unit is 4 by 4 by 5 inches. The device is intended for installation by electricians or others without special training in electronic applications.—*Electronics.*

Voltage-operated neon fuses

UNDER THE name "Tattelite," the Littelfuse Laboratories of 4507 Ravenswood Ave., Chicago, Ill., announces a series of "tell-tale" fuses. Tattelites are neon discharge tubes having breakdown voltages of 100, 250, 500, 1,000, and 2,000 volts, which operate to shunt out the overload applied to the protected apparatus. Since the discharge is voltage-operated, the new fuses protect against excessive voltage, whereas the



usual fuse protects against excessive currents.

The uses to which the fuses may be put are: protection of voltmeters, insulation in ammeters, protection of transformers, condensers, and gaseous rectifiers; they may be used to leak off static charges in machinery and for lightning protection, as test instruments for indicating defective resistors and condensers, as radio frequency indicators, and the many other uses of the neon discharge tube. The full specifications of the line are contained in the catalog number 6 issued by the company. The list prices of the fuses run from $0.75 for the 100 volt model, to $4.00 for the 2,000 volt model.—*Electronics.*

✦

Reproducer for short-wave reception

WRIGHT-DECOSTER, INC., St. Paul, Minn., have developed their new model SW 429 especially for short-wave reception. This unit is extremely efficient, its sensitivity in the voice frequencies making it capable of bringing in weak signals that would be practically lost with an ordinary speaker. Following are its specifications:

Cone 10 inches; Outside measurement of cone bracket, 12⅛ inches; Depth 8¾ inches; Height 14 inches; Width 14 inches.

Voice coil impedance, 10 ohms at 400 cycles.

Standard voice-coil transformer 4,000 ohms.

Speakers operate on 110 to 115-volt, 50-60 AC current.

Weight, packed in carton, 21 lbs.

Price $40.25.—*Electronics.*

Beat frequency "Station Locators"

TWO NEW BEAT frequency station locators for use with short-wave broadcast receivers have been announced by the Arthur H. Lynch Co., 51 Vesey Street, New York City. The oscillators are of two types, one using a tube and the other tubeless. They operate on the beat frequency principle, whereby the incoming signal is caused to beat with the output of the oscillator so that an audible note is produced. This note appears at the loudspeaker whenever the carrier of a station is tuned in, and is a great aid in locating accurately the dial-position of the station. After tuning, the oscillator is turned off and the speech or music signal is received.

Either model can be used for reception of telegraph (code) signals, although the tube model produces signals easier to copy because of the higher note. The oscillators are connected by means of wafer adapters to the first r.f. tube in t.r.f. sets or to the first i.f. tube in superheterodynes. The list price of the tubeless model is $4.00, that of the tube-model (less tube) $6.00.—*Electronics.*

✦

Combination PA and remote amplifiers

FOR SIMULTANEOUS localized PA and remote broadcasts, the new Remler High Fidelity PAR-19 amplifier is a convenience which measurably improves transmission. Controlled by a single operator, PA amplification can be regulated to prevent feed-back during broadcast periods. The entire unit measures 18" x 19" x 8" and weighs only 85 lbs.

The public address power amplifier is a four-stage, push-pull resistance-coupled amplifier, using three type 6A6

tubes, two type 2A3 tubes, and one type 82 rectifier. The remote amplifier consists of a three-stage, push-pull amplifier using type 6A6 tubes.

A master gain control is provided for both public address and remote amplifiers, which enables the operator to secure any desired mixing combination and power level on either amplifier, independent of the setting of the other. Remler Company, Ltd., 2101 Bryant St., San Francisco, Calif.—*Electronics.*

✦

Ribbon-type portable B and C batteries

DRY BATTERIES of the B and C type are being manufactured in the form of a flexible ribbon by the Burgess Battery Company of Freeport, Illinois. No. B 19 F consists of 19 insulating tubes each containing one B size cell, the cells connected in series, and all the tubes permanently held together by thin ribbons woven between adjacent cells. This provides a 28½ volt battery with taps every 1½ volts, and weighs only 1½ pounds. The list price is $0.75. Type B 76 F likewise has 19 tubes but each contains four cells, and provides 114 volts in steps of 6 volts. This battery weighs six pounds and is priced at $2.35. Type Z 30 F contains 30 cells in 15 tubes, provides 45 volts, weighs one pound.

These batteries provide not only the advantage of many voltage taps but also compactness, light weight, and flexible form. They may be used as a belt about the body for portable radio use, or may be folded into an out-of-the-way place in portable or stationary apparatus.—*Electronics.*

✦

All-wave test oscillator and audio signal generator

ENGINEERS OF the Clough-Brengle Co., 1134 W. Austin Ave., Chicago, Illinois, have developed a new combination radio frequency and audio frequency signal generator. The radio frequency output on fundamental signals only, is continuously variable without any skips from 50 k.c. to 30 m.c. (6,000 to 10 meters).

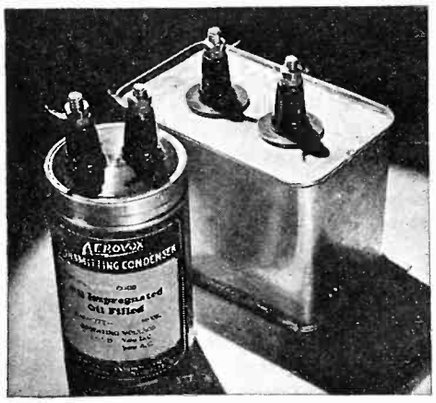
A panel snap switch gives the choice of an unmodulated r.f. signal, or 400 cycle modulation from the separate audio oscillator stage. The 400 cycle output of the audio oscillator is also available for making audio circuit tests.

A new type tuning dial has been developed, that provides full 25 inches of dial for each of the 6 frequency bands, divided into 400 divisions, each $\frac{1}{16}$ inch wide, making possible reading to 1/10 of 1% accuracy. Each instrument is hand calibrated with crystal oscillators. The Model OC, complete with three tubes, is priced at $29.94 net to dealers and servicemen. A descriptive bulletin is available on request.—*Electronics.*

Oil-filled transmitting condensers

DESIGNED FOR performance rather than price, a new line of oil-filled, oil-impregnated transmitting condensers is announced by the Aerovox Corporation, Brooklyn, N. Y.

The units are available in round and rectangular metal cans, in either case with high-tension insulator post terminals. Wound with pure linen paper instead of kraft or cheaper grades,



thereby guarding against deterioration even at high operating temperatures. Linen paper dielectric also provides necessary strength for tightly-wound sections. Finished sections are thoroughly impregnated in high-grade oil, placed in can and surrounded by protective oil bath not only for higher insulation value and long life, but also for proper expansion-contraction properties whereby an oil circulation is set up through the section for cooling purposes. Containers hermetically sealed for complete protection against moisture and leakage. Units are available in popular working voltages and capacities.—*Electronics.*

✦

Phototube relay

THE PHOTOTUBE division of the Miles Reproducer Co., Inc., 26 East 22nd Street, New York, announces three models of a light relay, for use on a.c., d.c., and on batteries. The a.c. type relay, uses one standard four-prong phototube and one type 37 heater type triode, and will respond to changes in light of only one-tenth of a candle power with consistency. All of the internal parts below the panel are impregnated with a non-hygroscopic insulating material which protects the wiring and circuit elements of the phototube and amplifier circuits. Three external connections provide the choice of open or closed circuit operation. The unit is compact, measuring only 3½ inches in diameter and 7 inches high. The list price is $67.50.—*Electronics.*

U. S. PATENTS

IN THE FIELD OF ELECTRONICS

Electron tube applications

Web control. A light sensitive method to prevent feeding of a web if the web breaks. John A. Hepperlen, G.E. Co. No. 1,975,577.

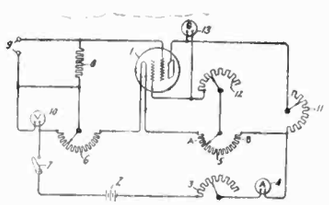
Regulator system. A dynamo-electric machine having a regulating field winding, a space discharge tube having a control grid and a compensating grid for controlling the excitation of the regulating field winding to maintain a characteristic of the machine constant. E. R. Morton, BTL Inc. No. 1,974,082.

Oscillation generator. Vacuum tube with a shield between cathode and anode having an orifice with a tuned vibratile shutter mounted to occult said orifice. P. F. Scofield, Heintz & Kaufman, Ltd. No. 1,958,071.

Tube tester. Method of using a-c on grid, plate and filament with a switch to change the voltage on grid and anode, and a meter to read the differential current. B. E. Lenehan, W. E. & M. Co. No. 1,958,895.

Mutual conductance measurement. The alternating current component of the plate current is rectified mechanically and read on an instrument calibrated in terms of mutual conductance. J. H. Miller, Jewell Electrical Instrument Co. No. 1,957,074.

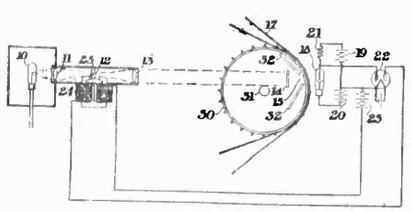
Measuring circuit. A vacuum-tube voltmeter with various forms of com-



pensation. F. J. Moles, G.E. Co. No. 1,969,518.

Sorting apparatus. Light sensitive means for sorting articles, involving conveyor belt, sorting chutes, photo-electric cells, etc. M. C. Hanson, Electric Sorting Machine Co., Grand Rapids. No. 1,973,206.

Photographic printing and exposure devices. The following patents to A. G. Denis of the Eastman Kodak Co. No. 1,973,468 to No. 1,973,470, inclusive, on photographic printing apparatus using



light sensitive means for automatically controlling exposure. See also No. 1,973,512, C. F. Smith, Eastman Kodak Co., for automatic control of exposure in contact printing.

Control system. A light sensitive control system having a motor which cuts off the light from a photo tube in accordance with a varying characteristic of the system. L. R. Runaldue, G.E. Co. No. 1,970,103. See also No. 1,971,191 to H. W. Lord, G.E. Co.

Sorting system. Electron tube method for detecting foreign substances having a high magnetic permeability. W. L. Miller, Winona, Minn. No. 1,973,414.

Deflation indicator. A device for comparing the air pressures in pneumatic tubes mounted on different wheels of a vehicle using light sensitive elements. G. B. Willcox, Saginaw, Mich. No. 1,974,906.

Control system. The relative intensity of light from a standard source and a variable source is utilized by means of light sensitive cell, an amplifier, etc., for control purposes. David C. Prince, G.E. Co. No. 1,976,461.

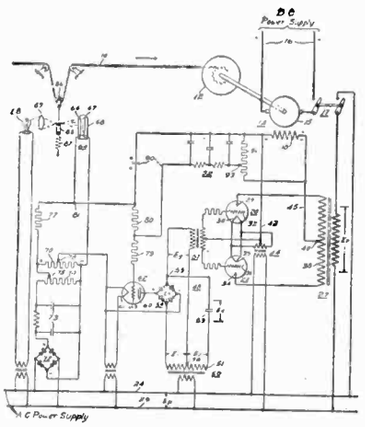
Motor control. Use of a cold-cathode discharge tube for controlling the acceleration of a motor by successive actuation of accelerating contactors. H. D. James, W.E.&M.Co. No. 1,976,614.

Remote control system. A follow-up system including light sensitive cell. B. A. Wittkuhns, Sperry Gyroscope Co., Inc. No. 1,976,648.

Stethoscope. An amplifying instrument for microphonic stethoscope comprising input terminals, several stages of amplification, etc. J. Weinstein, Brooklyn, N. Y. No. 1,976,707.

Motor control. A control system for an ironing machine. A means responsible to the electrical conductivity of the material being ironed, as controlled by its moisture content, for governing the speed varying means. R. S. Elberty, Jr., W.E. & M. Co. No. 1,976,487.

Regulating system. A device for regulating the tension of a strand being wound upon a reel. As the tension on the strand varies, more or less light is cut off from the light sensitive cell which

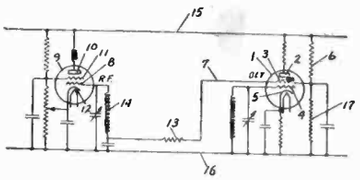


controls the winding tension. F. H. Gulliksen, W.E. & M. Co. No. 1,976,611.

Gravity indicator. Piezoelectric system for determining the value of gravity at any point. A. M. Nicolson, Communication Patents, Inc. No. 1,975,516.

Voltage regulator. A two-tube system for electric machines, comprising two voltages, one constant in value and the other varying in the same sense as the quantity to be regulated. N. A. J. Voorhoeve and F. H. de Jong, Philips. No. 1,972,806.

A-V-C system. A radio set having at least one tetrode and at least one preceding tube, an ungrounded connection between the screen grid of the tetrode and



the grid of the preceding set. L. F. Willging, Crosley Radio. No. 1,971,741.

Negative conductance. A circuit adapted to provide an adjustable negative conductance independent of frequency. Circuit consists of two tubes connected as follows. Between the anode of each tube and a load resistor is a battery with a positive potential toward the anode. The anode circuits are in push-pull. The grid of each tube is connected to the anode circuit of the other tube at the point where the load resistance connects to the negative terminal of the accessory plate voltage battery. Across the ends of the two load resistors are a pair of output terminals and a variable resistance. W. V. B. Roberts, R.C.A. No. 1,971,919.

Balancing telegraph circuits. Use of gaseous discharge tubes for balancing and testing duplex circuits. J. H. Hackenberg, W.U. Co. No. 1,954,624.

X-ray equipment. Installation for making short X-ray exposures using a tube with three elements, one a control electrode. Albert Couwers, Philips. No. 1,954,612.

Photographic printing. Light getting through negative controls printing time. C. M. Tuttle, H. E. White and J. W. McFarlane, Eastman Kodak. No. 1,954,338.

Phototube output control. Constant intensity beam directed at light-sensitive surface; maintaining a non-responsive area at the intersection of the axis of the light beam and the surface; and varying the area of the light sensitive surface affected by beam. V. A. Schoenberg, Niles Center, Ill. No. 1,954,329.

Electronic chronometer. Several glow discharge devices with voltages midway between ignition and extinction values, a moving contact connecting a low resistance successively in shunt to tubes, impressing temporarily the ignition voltage on tubes and an electronic relay in series with contact whereby the number of tubes ignited is controlled by proportional length of time the relay remains in circuit closing connection. A. B. Fuller, Eastman Kodak. No. 1,954,313.

Automatic battery charger. Use of 4-element tube for automatically charging battery when its potential falls below a value which prevents the tube from passing current. Alfred Wiessner, Siemens & Halske. No. 1,954,110.

Heating apparatus. Material is drawn between the electrodes of two condenser plates to which is applied a high frequency heating current. A. Meissner, G.E. Co. No. 1,954,678.