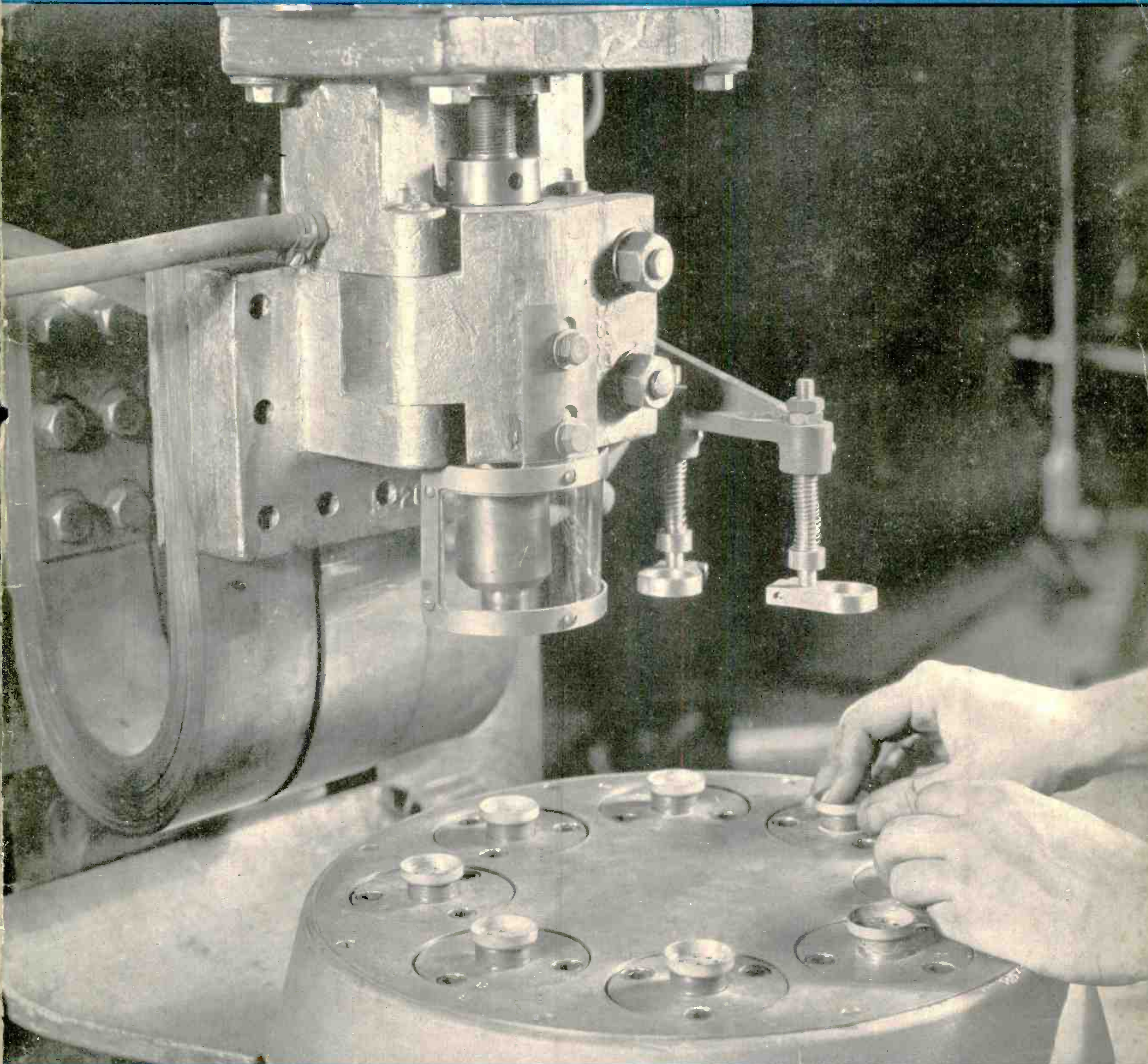
electronics

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



McGRAW-HILL
PUBLISHING COMPANY, INC.

SEPTEMBER 1935

Price 50 Cents

AMPERITE *Velocity* MICROPHONES

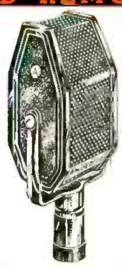
A COMPLETE LINE—FILLING EVERY BROADCASTING NEED!

FOR STUDIOS - MODELS SR80 & SR80-H

Model SR-80. Easiest way to improve any installation. Perfect fidelity. No background noises. No resonant peaks. Can be placed up to 2000 feet from amplifier without any appreciable loss. Frequency response 30 to 10,000 C.P.S. Output, –64 db. (open line). Hand-hammered ribbon is not affected by even a 40-mile gale. Not affected by temperature, pressure, or humidity. Completely shielded. Elastic coupling absorbs shocks and vibrations.

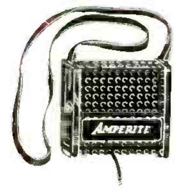
NEW! High Level Model SR80-H. Unusual brilliancy and definition. Eliminates input transformer with its losses and inductive hum. Requires 15 db. less overall amplification than low impedance type. Excellent for both studio and remote. This microphone is high enough in impedance (2000 ohms) to operate directly into grid—but not high enough to introduce serious losses in lines up to 50'. Longer lines can be used with low capacity R.F. Cable.

FOR ANNOUNCING AND REMOTE



Model RB-M. New Super-flux Nickel Aluminum Magnets are used . . . magnets more powerful than even 36% Cobalt . . . Since this microphone has no peaks, it gives perfectly life-like reproduction (not mechanical) and does not tire the listener. Eliminates acoustic feedback in P.A. Work. NEW! High Level Model RB-H Eliminates separate pre-amp. (Output impedance, 2000 ohms.)

FOR "SPOT" BROADCASTING 7-POINT, Jr.



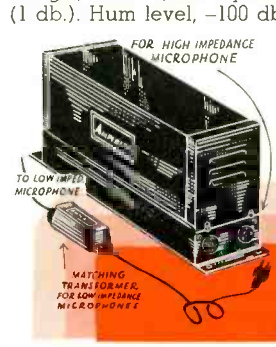
THE LITTLE VELOCITY WITH UNIFORM OUTPUT

Output uniform with speaker's head at any angle Output level practically equal to large velocity. Frequency response 60-7500 cycles. Reproduction lifelike Eliminates audience noises Transformer included within microphone case. Rugged construction New chrome aluminum magnets used Weighs only 8 ounces Size $2\frac{1}{4}$ x $1\frac{1}{4}$ x $1\frac{7}{8}$ High Level Model available (Model 7J-H)

A-C PRE-AMPLIFIER and LINE AMPLIFIER

THOROUGHLY SHIELDED & GUARANTEED HUMLESS

Another great Amperite value included in FREE TRIAL offer. Frequency range, 30 - 14,000 cycles (1 db.). Hum level, –100 db.



STANDS

The very latest in construction and appearance Rugged Smooth operating Complete line of floor stands. Desk and banquet stands. Portable stand which unfolds to extra sturdy floor stand. Chrome or gunmetal finish. Write for Bulletin S.

FREE TRIAL

Broadcasters are invited to conduct a TWO WEEKS' FREE TRIAL of our microphones. No deposit. No obligation whatever. All we ask is that you make the test exhaustive. Then decide whether you want to keep the microphone or return it. Even if you are not in the market, feel free to make the test for future reference. Behind this FREE TRIAL offer is the conviction that Amperite offers the finest microphones available today, regardless of price. High fidelity reproduction of speech and music. . . . Perfect Definition of instruments in ensemble work. . . . Dependability . . Ruggedness . . . All these qualities are guaranteed!

NEW!
Illustrated Catalogue Sheets.
Write for them now.

VELOCITY AMPERITE MICROPHONES

AMPERITE Company 561 BROADWAY NEW YORK

Cable Address: Alkem, New York

ELECTRONICS, September, 1935. Vol. 8, No. 9. Published monthly, price 50c. a copy. Subscription rates—United States, $5.00 a year. Latin America, $5.00 a year. Canada, including duty, $5.50 a year. All other countries, $6.00 a year or 24 shillings. Entered as second-class matter April 4, 1930, at Post Office at New York, N. Y., under the Act of March 3rd, 1879. Printed in U. S. A. Cable address "McGrawhill, New York." Member of A.B.P. Member of A.B.C. Copyright 1935 by McGraw-Hill Publishing Co., Inc., 330 West 42d Street, New York, N. Y. Printed by The Schweinler Press, N. Y.

Branch Offices: 520 North Michigan Ave., Chicago; 883 Mission St., San Francisco; Aldwych House, Aldwych, London, W. C. 2; Washington; Philadelphia; Cleveland; Detroit; St. Louis; Boston; Greenville, S. C. James H. McGraw, Chairman of the Board; Malcolm Muir, President; James H. McGraw, Jr., Executive Vice-President; Howard Ehrlich, Vice-President; B. R. Putnam, Treasurer, D. C. McGraw, Secretary.

ELECTRONICS

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

HOWARD EHRLICH
Vice President

KEITH HENNEY
Editor

DONALD G. FINK
Associate Editor

H. W. MATEER
Manager

Volume 8 Number 9

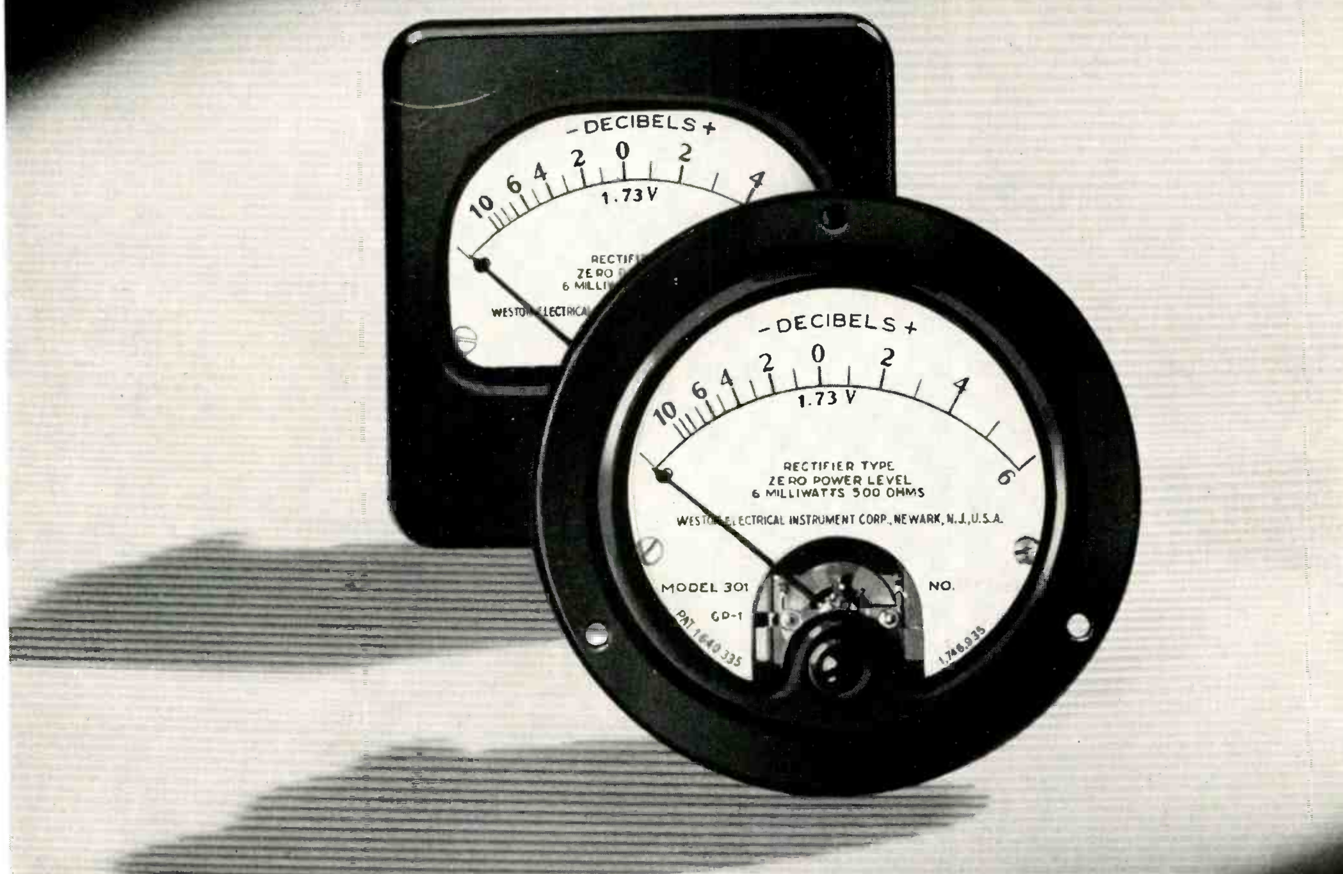
CONTENTS

September 1935

DEPARTMENTS

Unvarying UNIFORMITY OF RESPONSE

WESTON DB indicators



"Controlled pointer action" . . . is the way sound engineers compliment the unvarying response of Weston DB indicators. Skillful engineering, and years of experience in the manufacture of DB meters, accounts for this uniformity. Also, it explains the widespread use of Weston DB indicators by communication engineers, companies manufacturing monitoring control, and amateur broadcasters . . . *everywhere*. The line consists of three types . . . High Speed—Low Speed—and General Purpose . . . to meet all requirements. Full details are available in bulletin form . . . Weston Electrical Instrument Corporation, 618 Frelinghuysen Avenue, Newark, New Jersey.

WESTON *Instruments*

In the interest of well designed radios we offer suggestion

No. 6 "BOHEMIAN"

WITH a "Bohemian" disdain for the conventional, modern designers frequently combine forms with widely different precedents into unified designs of real beauty. In the Radio Receiver above, the base is a frank adaptation of an oriental flat arch and the cabinet a severely plain, smooth-surfaced, round-edged box. The geometrical pattern of the grille is reminiscent of the "Kalligraphen Ornamente" found on Bohemian glass of the early 18th Century. It also bears some resemblance to the perforated metal work of Prof. Hoffman of Vienna.

Both base and grille are of ebony black Bakelite Molded, and the cabinet is a rich blue-green of the same material. The completed cabinet design is distinguished and unusual. As almost everyone possesses an innate sense of beauty this "Bohemian" design would have superior sales appeal.

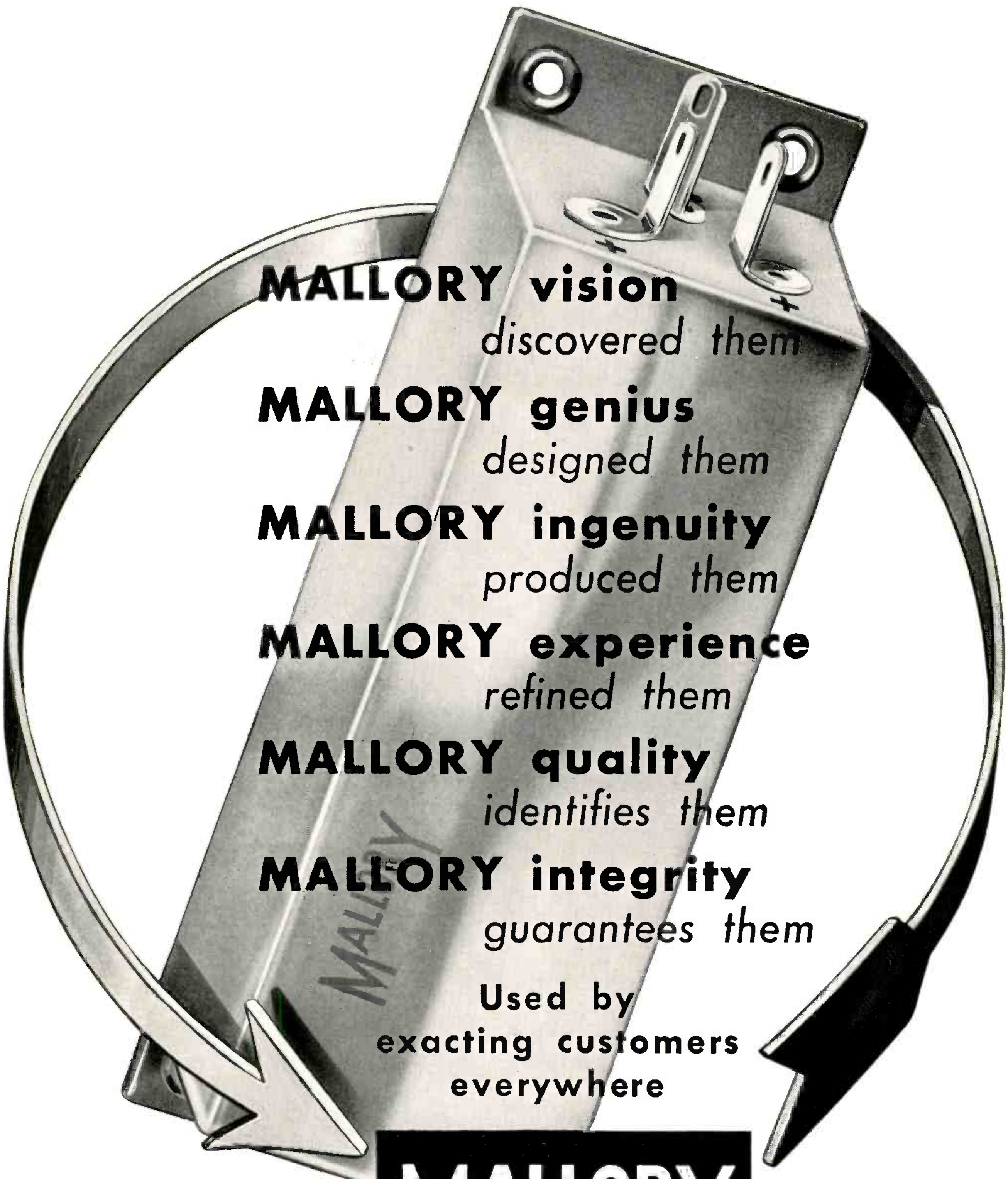
We invite radio manufacturers and designers to enlist our cooperation in exploring the original design possibilities inherent in Bakelite Materials. These are practically unlimited because of the adaptability of Bakelite Molded to the economical reproduction of a wide variety of forms, and of the variety of colors available. May we also suggest that you write for our 48-page illustrated booklet 13M, "Bakelite Molded."

BAKELITE CORPORATION, 247 Park Avenue, New York, N.Y. . . . . 43 East Ohio Street, Chicago, Ill.
BAKELITE CORPORATION OF CANADA, LIMITED, 163 Dufferin Street, Toronto, Ontario, Canada

BAKELITE

REGISTERED U.S. PAT. OFF.

THE MATERIAL OF A THOUSAND USES



MALLORY

DRY ELECTROLYTIC CAPACITORS

FOR RADIO AND INDUSTRIAL FIELDS . . . DEMANDED BY THOSE WHO INSIST ON THE BEST

P. R. MALLORY & CO., INC. INDIANAPOLIS, INDIANA

CABLE ADDRESS — PELMALLO

ELECTRONICS

SEPTEMBER
1935

KEITH HENNEY
Editor

Crosstalk

▶ IN YOUR HANDS . . . With this issue of *Electronics*, the editors present their answer to the pleas of many of the paper's readers. The articles are longer; there is, we hope, the feeling that the articles have been permitted to run their natural length—not poured in a mold a little too tight for the metal; they are better illustrated, with cuts large enough to use without eyestrain. There are more articles—the field is better covered. The departments, always of continuing value in a usable magazine, have been expanded, and their scope increased. Changes in format and typography will be discerned by the accustomed reader—changes intended to make the paper easier to read and better to look at. In the matter of layout and typography Mr. Harry Phillips and Mr. Joseph Holland, both members of the McGraw-Hill staff, have been of unmeasured aid.

In placing this new *Electronics* in your hands, the editors invite your comments, suggestions, and criticisms.

▶ WITH REGRET . . . It is with genuine regret that the editors announce the resignation of Dr. O. H. Caldwell, first editor of the magazine. The qualities that made "O. H." so well known in the radio industry, that have kept him in the publishing business for twenty-five years, will be missed by the present staff.

▶ DRAMA . . . In this issue is a story of how radio is aiding the construction of a bridge, dreamed of for a generation by West Coasters, a bridge to cross San Francisco Bay. It is a typical example of the approaching large-scale uses to which 5-10 meter waves can be put. Already building contractors are using transceivers, compact send-receive units, instead of running miles of wire about a large steel or concrete structure. Utilities are planning networks of short wave stations along their rights of way to be turned on and off and modulated by carrier to inform cruising repair cars to be on their way.

▶ IMAGINARY ONLY . . . It is interesting—and discouraging—to find that one of the most useful suggestions ever made has, as usual, been entirely neglected by technical writers. We refer to paragraph 3 of the introduction to F. M. Colebrook's notable work, "Alternating Currents and Transients" (McGraw-Hill, 1925).

Mr. Colebrook explained in detail his aversion to the loose usage of the vector operator "j". It has been and still is defined as being *equal* to $\sqrt{-1}$. This definition is confusing to the young student meeting rotating vectors for the first time. His conception of $\sqrt{-1}$ is that it belongs in the realms of Einsteiniana, something which few can understand. Eventually the idea sinks in—is it possible that modern teachers are guilty of purposely making a subject difficult, as was charged by Sylvanus Thompson in the delightfully impious "Calculus Made Easy?"

Why, then, not always define this operator for what it actually is? Calling it $\sqrt{-1}$ does not define it; saying that it is equal to $\sqrt{-1}$ is confusing, if for no other reason than that no one knows what $\sqrt{-1}$ is. Can we not always define it as Colebrook suggests: An operator having a certain effect, i.e., a 90 degree rotation, on any vector with which it is associated?

▶ BEAM TUBES . . . With the introduction of the 6E5 electron beam tube, still another agency has been made available to electronics engineers. This miniature cathode ray tube opens up another vision, that of a new sort of control. In this tube a beam of electrons strikes a fluorescent screen so that one may see where the electrons go as they are deflected by a control electrode which may be the side rods holding the screen, putting to use parts of tube structure which heretofore have been mere nuisances. In addition the *visible* agency of fluorescence offers distinctly new possibilities. We predict many future applications of this type, as yet unimagined.

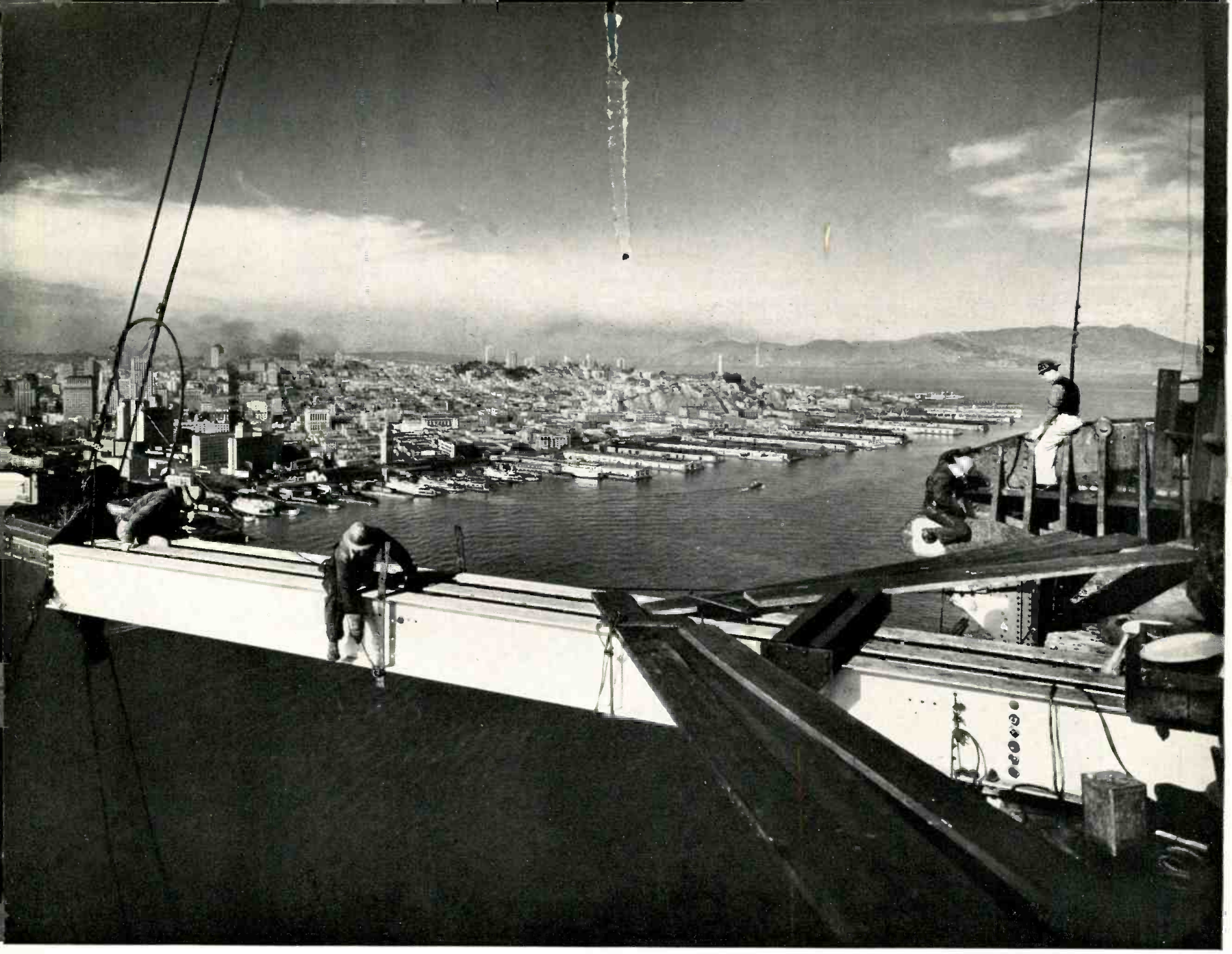
▶ CHEAP PARTS . . . The following letter prompted by a previous editorial is printed here because it raises a real question:

"I read your editorial on 'Cheap parts' in the July issue with considerable appreciation. You have hit a vital spot in modern set construction.

"In the service of radios we find that by far the most failures (aside from tube trouble) are due to electrolytic condensers. It would appear that such condensers, even though of initially ample voltage rating, always age, and sooner or later fail. This is not the case with paper condensers. Many sets in this vicinity have been operating for upward of ten years without failure of paper condensers. Electrolytics may go bad within a few months. Accordingly we use only paper (and mica) dielectric condensers on all replacement work here.

"The greatest source of trouble in auto radios, similarly, is failure of the vibrating type of rectifier. Even systems using a tube for high-voltage rectification eventually go bad, while the inverter-rectifier type generally does not last more than a year. Is it possible that manufacturers really do not understand the nature of the transients developed in such cases and the aging of contacts and springs, or do you suppose it is just another case of economic necessity? In any case, no such trouble has been observed here in sets using motor-generator power supplies.

"Reversion to the older systems in just the two instances given above would, I am sure, give infinitely greater customer-satisfaction, and prove a real economic boon to the manufacturers."



Waves Over 'Frisco

Radio, on five to seven meter channels, is guiding the construction of the $8\frac{1}{4}$-mile, 75-million dollar project over San Francisco Bay. The bridge will have two decks, carry six lanes of traffic, 16,000 cars per hour

Building Bridges by Radio

In the great San Francisco-Oakland bridge project, ultra high frequency radio communication keeps engineers and contractors in touch with isolated and mobile units—a dramatic example of the efficacy of quasi-optical frequencies

D. REGINALD TIBBETTS
Consulting Communications Engineer
Designer of System
Berkeley, California

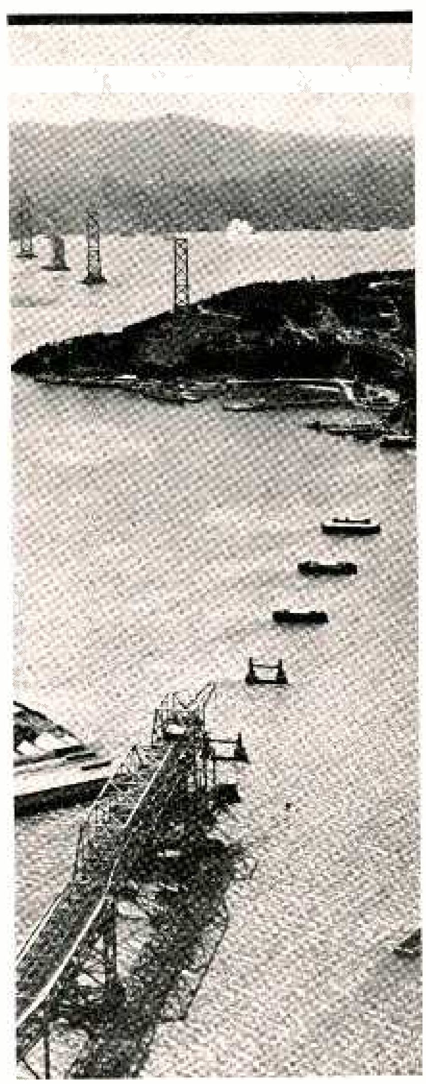
DURING the latter months of 1932, the plans and general design for the San Francisco-Oakland Bay Bridge, on San Francisco Bay were well developed. Bid forms were prepared, a loan assured from the Federal RFC and bids called for. In March, 1933, bids were opened and the Director of Public Works of the State of California, Earl Lee Kelly, awarded the contracts to the low bidders. On July 9th, 1933, actual construction work was started.

The engineers of this bridge, to be one of the largest ever built, had solved engineering problems never before confronted by bridge engineers. Yet there was one problem which was not fully worked out. How were they to communicate with one another while directing work which was to proceed simultaneously on a dozen different fronts? It was imperative to have instant, dependable communication with boats and mobile marine equipment, and with twenty-five isolated piers far out in the bay.

It was decided to use radiotelephone equipment operating on wavelengths of from five to seven meters.

Such receivers and transmitters can be made very small in size and can use compact antenna equipment, an item of necessity on small craft. Such equipment can be made quite low in initial cost. Simplicity is easily possible. Standardized and flexible short wave equipment can prevent interruptions. A rapid replacement of complete units is easily possible. Any trouble centers around a limited area. No underwater cables need present difficult location and repair problems.

At the present time there are thirty-four complete transmitters and receivers in use. The equipment is used on four channels by Chief Engineer C. H. Purcell and his State Bridge engineers, in active charge of the work, and by three principal contractors. Two of these contractors are engaged in the construction of the many isolated off-shore piers. The other contractor holds the contract for the delivery of concrete. Nothing but radiotelephone equipment could have solved the problem of concrete delivery. Twelve barges are equipped with concrete mixing

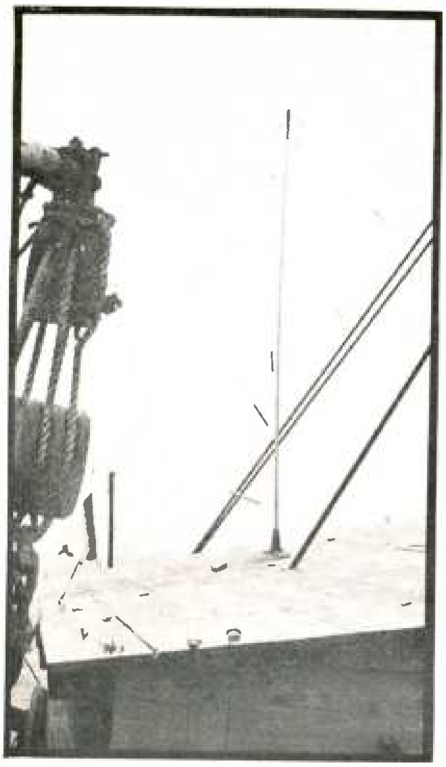


machinery. The idea is to load materials for the concrete, tow the barge to the isolated pier and then mix the materials for the delivery. To have this program operate efficiently with no waiting between barges and a minimum of standby expense for tugs it was necessary to dispatch each barge so that it would arrive just as the preceding barge finished pouring. With radiotelephone equipment at the loading wharf and portable sets for the barges, this traffic can be regulated to the minute. In addition, the equipment is available in case of accident and to secure aid in case of breakdown.

Many varied and interesting problems presented themselves to the communication engineer in the design and application of the equipment. In the first place consideration of the fact was given that the equipment would be placed in the hands of men, who would be devoid of radio knowledge or experience. The equipment to them would be like a regular telephone instrument. In addition, the idea is new and to be a success must be foolproof to secure recognition of experienced men in the construction field. Its worth must be proven over a long period of time and under the severest of operating conditions.

To show the extent to which simplicity was required, the incident of the worker trying to answer through the calling loud speaker when a microphone was in plain sight, is typical.

The equipment installed uses a-c power when available. At other locations a single six-volt storage battery is used with several blocks of B batteries for plate potential. At certain key locations, even though a-c power is available, automatic change-over to battery operation is provided. A relay in the primary of the power transformer holds the filament and plate connections on from the rectified source. At the instant

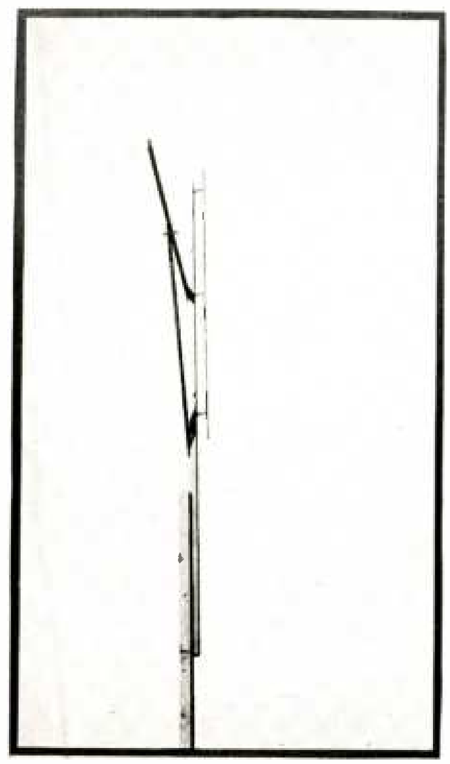


Guyed antenna on Anchor-Derrick barge

the power fails, the relay connects the filaments to a storage battery, which has been on float from a trickle charger, switches the plate potential to a bank of stand-by B batteries. The set will operate on this stand-by in less than one-tenth of a second from the time of power failure and will remain in operation for a period of over one hundred hours.

To attain simplicity, it was decided to use selective simplex. If full duplex had been used, two antennas would be required at each set location, one for transmitting and one for receiving presenting a space problem on the small marine craft. A receiving antenna in close proximity to a transmitting radiator might present reflection problems and unwanted directional effects. Two channels would be required for full duplex and since four systems are in use, it was thought better to use the four frequencies allocated for private individual systems operating on a selective simplex basis. Thus any stations on the same frequency could call and be heard by any other on this same channel without any wavelength adjustments.

The system operating for the contractor of the west bay piers, being the shortest in distance of communication, was placed on the highest frequency, 63,000 kc. The next longest was that operating for the contractor building the east bay piers. This channel was given an assignment of 61,000 kc. After some time of use, additional interest in the amateur five meter band between 56,000 and 60,000 kc., gave considerable interference to this channel. The interference was caused by lack of stability and knowledge of frequency positions by the amateurs rather than by any wilful acts. It was decided to move this channel to 38,600 kc. and give the amateur

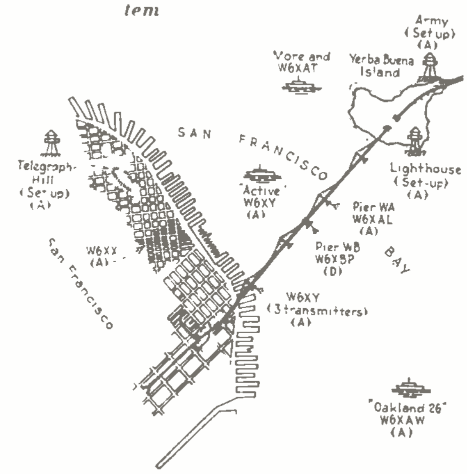


Radiator on isolated pier in the Bay

stations, licensed, "bootleg," and otherwise, all the room desired.

The controls on the sets consist of a switch to change from transmit to receive, an a-f volume control and a receiver tuning dial. The dial was provided to take care of noise that might be encountered, possible blocking of the detector when two stations were in communication, and any drift in the transmitter frequencies. There is a built-in loud speaker with its privacy switch. Reception is always present in the handset receiver when the set is in receiving position. To secure local privacy, a small switch below the loud speaker is

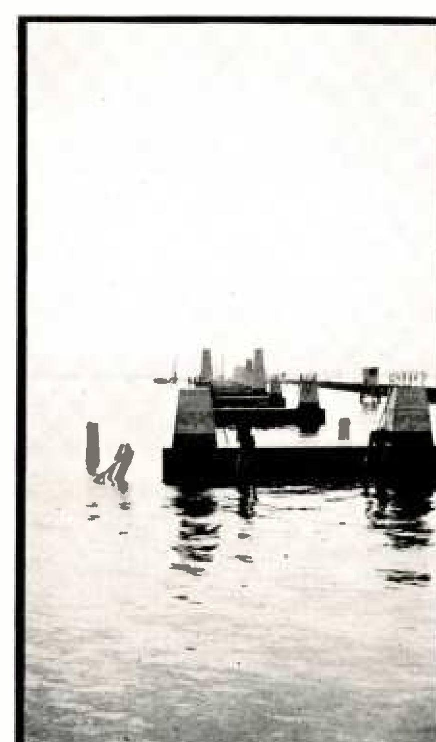
Eleven hundred conversations per day per channel take place over this system

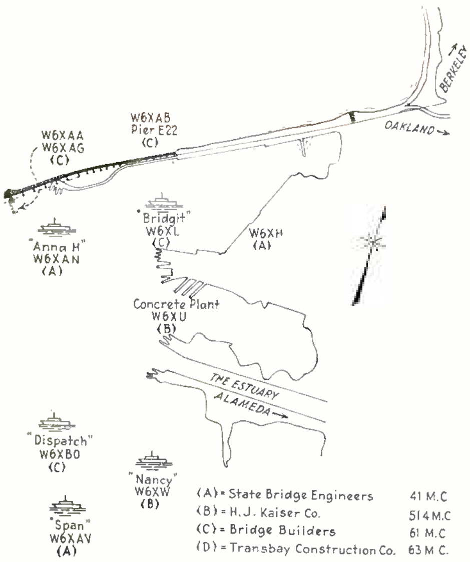


thrown to open the speaker lead.

The receivers use a super-regenerative detector. This type of detector has proved extremely sensitive and has a wide acceptance band so necessary when receiving signals from a modulated oscillator. Since all detectors of this type are subject to re-radiation which would interfere with communication between other stations, a single stage of semi-tuned r-f amplification was provided. This r-f stage also acts as an automatic volume control, so

Typical pier units to which communication is necessary

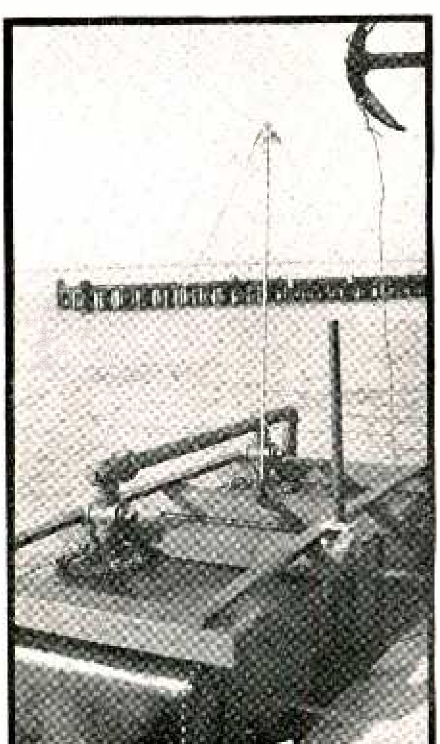




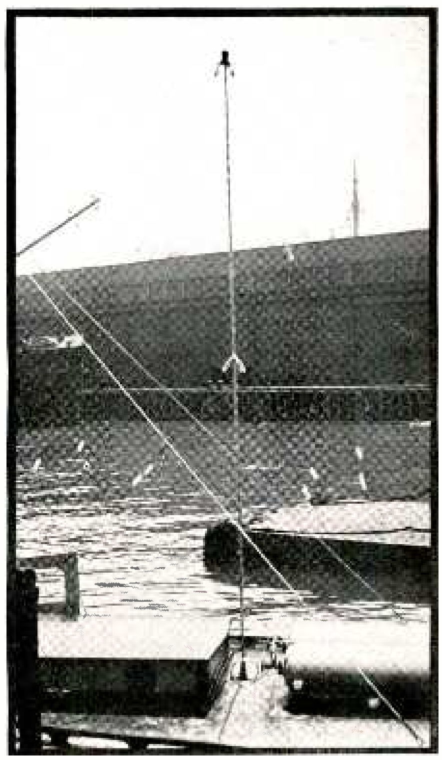
that nearly all signals are received by the detector at the same level. Finally, two a-f stages are used, the first raising the level to a satisfactory value for the handset receiver and the second giving still more output for the loud speaker. In very noisy locations, the modulator is utilized as a third audio stage to drive an eight inch permanent-magnet loud speaker to a full ten watts.

The receiver uses the least practicable number of tubes, these being the r-f stage, super-regenerative detector and two or three stages of audio frequency amplification.

Antenna on "A"-frame derrick barge



The transmitter is the simplest possible to stay within frequency stability requirements. Push-pull self-excited oscillators are used with a very high l/c ratio. The modulation levels are kept at a moderate percentage and since most of the sets are never turned off, a good operating temperature stability is reached. The oscillator tube is of the twin-triode type. Modulation is secured by the use of another twin-triode in Class B and the last audio stage of the receiver which is utilized as driver, its grids being excited directly by a high quality single button handset microphone.



Half-wave rod on 32-foot inspection cruiser "Moreland"

The antennas used are half-wave verticals using 600 ohm matched impedance transmission lines. A few quarter-wave antennas are used on portable sets for convenience and compactness. Where possible, directional antennas are used to concentrate the signals and to prevent interference to other services using the same frequencies. The antennas are placed as high as possible to overcome shadow effects that might be caused by nearby objects and by shipping operations in the bay. Yerba Buena Island, through which the tunnel section of the bridge passes, is directly in line between several stations. However, the power used, nearly ten watts, overcomes this obstacle in the path although some very queer cases of distortion to the radiation pattern are noted.

Unit in use on isolated barge in Bay

All stations are licensed by the FCC operating under the exceptions of Rule 320 as a communication aid during the construction of the San Francisco-Oakland Bay Bridge. All who use the equipment hold Radiotelephone Third Class licenses or better. The stations are licensed as Special Experimental in the Experimental Service.

The San Francisco-Oakland Bay Bridge Construction Radiotelephone System is showing that an extensive ultra-high frequency radiotelephone network can be operated in a limited construction area of the marine type very successfully with as good reliability, and at a much lower initial and final cost, than any other possible means.

The system is carrying very heavy loads and recent counts show that over eleven hundred separate conversations are being handled over but one of the four channels in a twenty-four hour period.

Tubes Enter

Mass production in heavy industry annealing, welding operations; will

R. A. POWERS

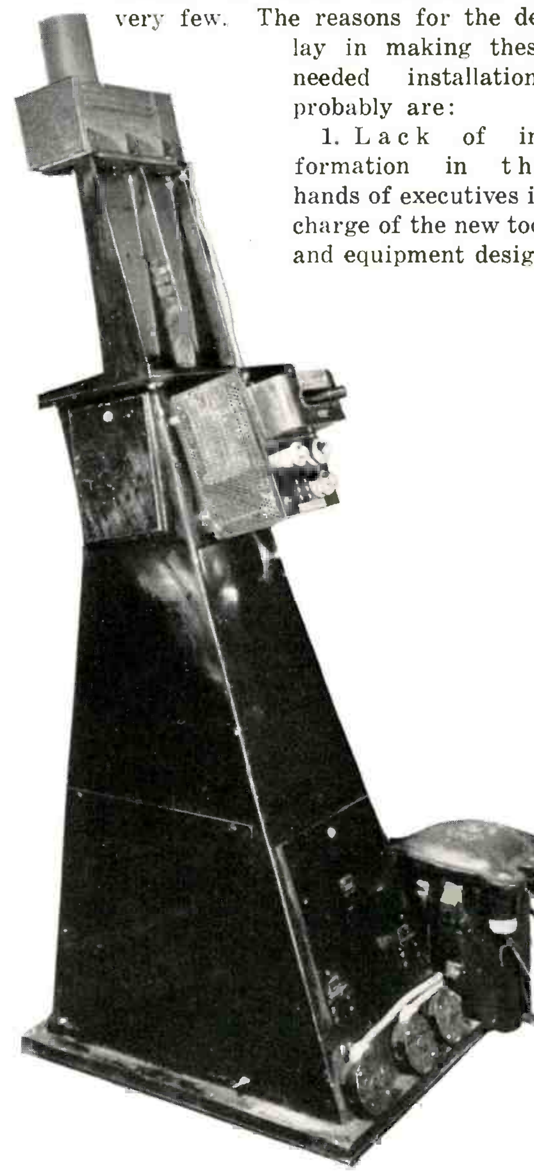
Electronic Control Corporation
Detroit, Michigan

PISTON PIN INSPECTOR

Checking phototube device with master piston pin, ground and lapped to a ten-millionth inch to make sure that the block supporting the pins to be inspected has not worn. Right—vacuum arc housed at the top; starting switch at rear

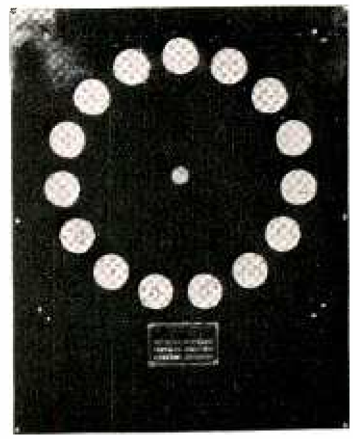
IN THE automobile industry there has been an ever-increasing demand for electron tubes to speed production, lower costs of production, and to assure a more uniform and better finished product. But the number of actual installations is very few. The reasons for the delay in making these needed installations probably are:

1. Lack of information in the hands of executives in charge of the new tool and equipment design



the Automobile Plant

discovers that electrons in motion will control heating sort piston pins at 9,000 per day; test wheel spokes



of tube progress, tube uses and the near future possibilities.

2. The thought of many of these executives that a simple and inexpensive light relay will solve all problems from color matching to measuring to one-thousandth of an inch without additional optical systems or other equipment. Disappointment follows when they learn that this is usually impossible, and as a result they return to the older methods as used in the past, and without electron tubes.

While it is true that an ordinary simple light relay will count articles, protect punch press operators and do other odd jobs, it must not be overlooked that these jobs have been done mechanically in the past, and as the mechanical equipment works to the satisfaction of the factory management, the possible sales of a standard light relay unit are very limited at present.

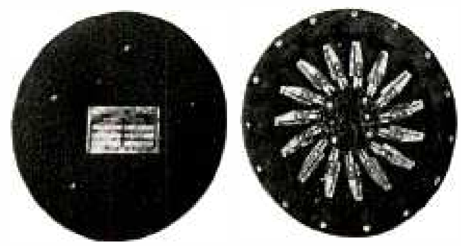
Some of the more recent installations of the phototube and associated electronic equipment in automobile and parts production are very interesting and illustrate what tubes can do.

Resistance type of heating for heat treating or annealing small articles quickly has always been of interest to the automobile industry, because time and money are saved; but there have been very few installations because of the complete lack of suitable control. In resistance heating the article or piece to be heated is held firmly in automatic dies or chucks, these dies being the two electrodes of a low-voltage, high-amperage circuit (secondary of a spot welder transformer 150 kva., for example). As soon as the current is applied, the article becomes the resistance in the circuit, and rapidly heats. To insure maximum speed in this production heating, the transformer is so designed as to supply ample current to melt quickly the article if the current is not cut off when the correct temperature is reached. An electronic time delay, while accurate, does not insure uniform heating of each article. An accumulation of scale or dirt on the dies may make it necessary to use a longer heating time for one article as compared with another.

While it is evident that the phototube and associated equipment are the answer to this problem, there are several considerations in the selection of the light relay unit. First, the unit for temperature control must be more sensitive to small changes in light values than any unit obtainable on the open market. Second, the light relay for temperature control duty must *not* be affected by solar changes; because there is not one practical shop man who would tolerate equipment which had to be adjusted for operation at night as against bright sunny days. Above all, the control must be accurate and stable.

The action of the resistance heater used in heat treating or hardening the tip of the valve stem, as shown in the accompanying photograph, is very interesting in operation. This installation actually shows the user a saving over the former methods with gas and oxygen, and the phototube control fulfills the outlined requirements.

The operator places the valve stem between the two dies, which are then brought up against it by an air cylinder adjusted for a suitable pressure. As soon as the dies have located the work, the heating current is turned on, and the tip of the valve stem heats rapidly. When heated to the correct color, the phototube relay opens the heating current, and one-tenth second later the dies automatically spring open, and the valve drops out, either into a quenching tank for oil hardening, or into a pan for air hardening. The entire operation requires less than five seconds, and a uniform job results.



Fixture for testing welds on a 15-spoke automobile wheel

This same type of heating, and accurate control with the phototube will soon be used for annealing the shank of Pitman arm balls for the steering mechanism of the car, for upsetting the ends of drag links, and other vital parts of the automobile, where rapid accurate heat treating or annealing operations are necessary. Many of these installations are now being made.

Where less accurate control of the temperature is required electronic time delays are suitable, and less costly. The resistance heater for pre-heating the end of small bolt or spindle, before the desired shape is pressed or forged on the heated end, is a typical example where electronic time delays perform with entire satisfaction. In this type of an installation the article or section of the piece is brought up to forging temperature, automatically rejected from the dies, and falls into a trough which feeds the punch press for the forging operation. Here temperature variations of plus or minus fifty degrees from the specified temperature do not affect the finished product.

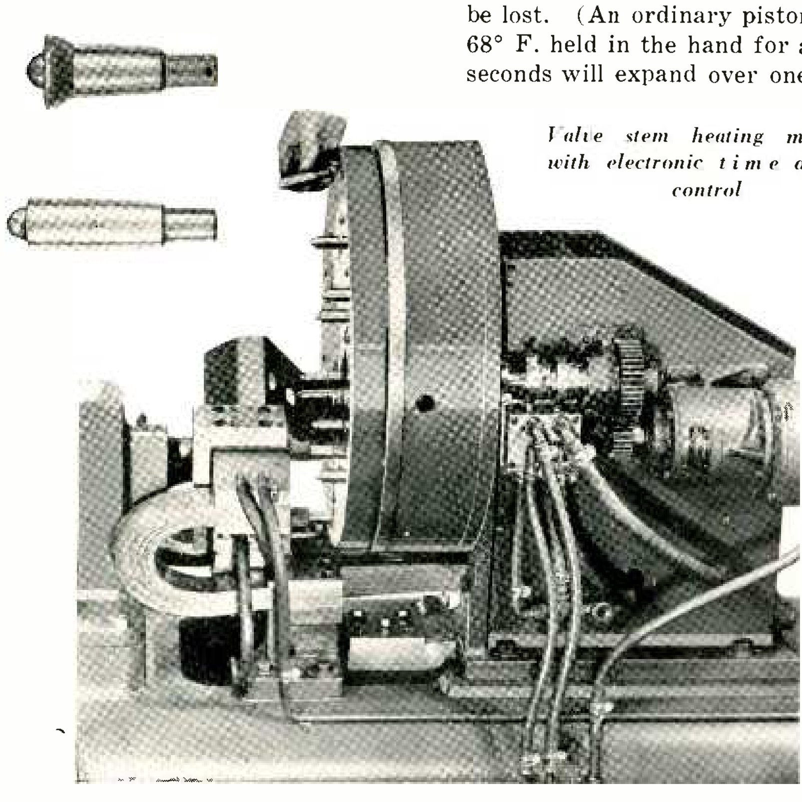
The operation of this machine is interesting. The operator feeds the small pieces into a series of automatic dies which revolve on a table.

As each die reaches the point of contact for heating, it automatically locks up on the work, and the heating electrode comes down, heating it for an adjusted period of time controlled by the electronic time delay. The dies automatically open and eject the piece into the trough. Production is about one thousand pieces per hour.

Now that electronic control of resistance heating is available we may expect to see even larger billets of steel heated for forging in this manner. This type of heating will result in drastic savings not only in fuel but also in rebuilding of the present furnaces.

In the automobile industry there has been an increasing demand for rapid, accurate measuring and inspection of the parts for the finished automobile. The required accuracy has increased with the increasing production of cars. These two increases have presented no small problem to the gage and instrument makers who supply the actual producers of the cars with their measuring equipment. Many new electrical and mechanical gages have come upon the market, but in all cases these gages have some frictional contact with the article being measured.

Naturally, when ten to fifteen thousand pieces are being measured per day, per gage, not only frictional contact becomes worn, but also the movement within the gages; with the resulting loss in accuracy, loss in time to readjust the gages; and even a greater financial loss when these inaccurately checked parts reach the final assembly on the car, and are placed in the field.



Valve stem heating machine with electronic time delay control

Wrist Pin Inspection

Probably there is not one part on the car that is held as close to required measurements as the piston pin, or wrist pin.

To overcome the wear and loss of accuracy there seems but one answer, to measure these parts with a beam of light. Yet, where measurements to one-half of a tenth of a thousandth of an inch are required, an optical problem presents itself. In the piston pin measuring device described here, one-tenth of a thousandth of an inch change in diameter, causes a shadow movement of about three-fourths of an inch. Roughly speaking, the optical magnification is of the order of 7,500 to 1; and because the intensity of the light falls off by the square of the magnification a fairly sensitive light relay is required. It naturally goes without saying that when measuring to one-tenth of a thousandth of an inch, a small amount of light must be used as the original source, because any excessive heat generated by this source would cause expansion of the article, and all accuracy would be lost. (An ordinary piston pin, at 68° F. held in the hand for about 25 seconds will expand over one-tenth.)

Starting with a small source of light, and losing greatly by optical magnification, the human eye is out of the question for rapid reading of the resulting measurements by shadow. The phototube is the answer to the detection of the small change between light and shadow as the piston pin increases or decreases in diameter.

To give the reader some idea of the problems encountered in the design and construction of such an automatic measuring machine where speed and accuracy are required, it might be well to mention that the upper half casting of this machine, which houses all the optical parts, source of light, the resting block for the work, etc., was first normalized to relieve any internal strains. After being completely machined, the casting was brought up to 180° F., and from there down to 32° F. the optical axis was checked every ten degrees. Naturally, some distortion was noted; but this was corrected by removing some of the webb, and adding to others; until the completed casting was as near perfect as possible.

The lamp is kept at a considerable distance from the article being measured. While very inefficient, any heat generated by the light will travel fairly uniformly throughout the upper half casting. The lamp house itself is entirely insulated from the castings.

In the operation of the machine, the piston pin, or other work comes to rest on the V block, the contact surfaces of the V block being fitted with tungsten carbide inserts to reduce wear to minimum. An image of the lamp filament is focussed on the center line or diameter of the piston pin. The projection system is then brought in focus with the diameter, which is brightly illuminated by the filament image, and a shadow of the piston pin is projected to the lower part of the machine, where it is picked up by the cylindrical mirror. The cylindrical mirror projects the light back to the phototubes, and as the piston pin increases or decreases the shadow moves to eclipse the various cells.

A secondary relay circuit sorts and grades according to piston pin diameters as follows:

Diameter .85909 inch or smaller is undersized and scraped.

Diameter .8591 to .85919 is the

small pin, and is so graded.

Diameter .8592 to .85929 is the standard pin, and is so graded.

Diameter .8593 to .85939 is the large pin, and is so graded.

Diameter .8594 or larger is oversized, and is returned to be relapped.

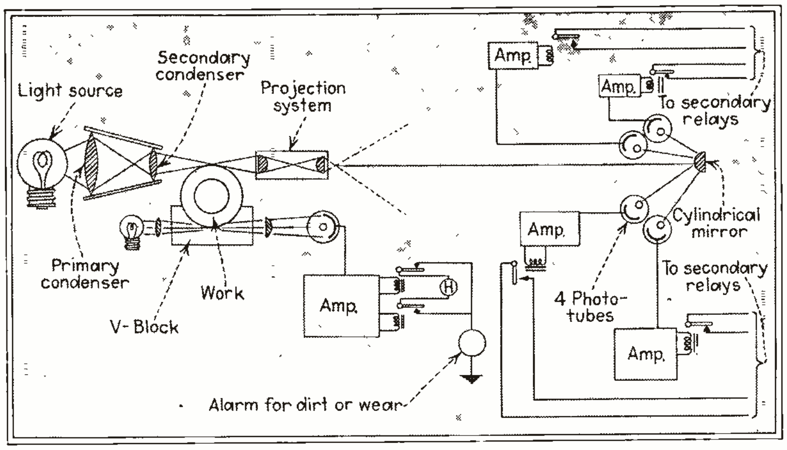
It will be noticed from the above dimensions that a very critical change-over point from one size to the next is necessary. This change-over occurs on less than one-tenth of a tenth of a thousandth of an inch. The machine described here, sorts the *small* pins into one container, the *standard* into another, and the large into still another. The reason for these various sizes is that the piston pin bearing in the connecting rod naturally varies slightly, and to obtain a correct selective fit it is necessary to have the pin very accurately graded. The oversized pins are refinished, and remeasured. The undersized pins are scrapped.

If the piston pin being measured is undersized all four cells are illuminated and the four second relays are all energized; if the pin is small, one cell is shadowed, three illuminated; if the pin is standard, two cells are shadowed, and one illuminated; and if the piston pin is oversized, all the cells are shadowed.

While this small machine will work with only one cell, the output of its amplifier is connected to four sensitive relays adjusted to open and close in their respective order according to the amount of the cathode area illuminated and the portion shadowed; nevertheless the adjustments are too critical, and rapid replacements in event of failure are impossible.

The use of four phototubes and four amplifiers with four primary or sensitive relays allows immediate replacements of a complete amplifier chassis at time of a tube failure; adjustments are not critical, and operation is foolproof. The same general outlay as used in this machine may be used for any number of measuring and grading operations, where speed and accuracy are necessary.

Phototubes are used to control the cut-off of clay used in making the porcelain insulator for sparkplugs; to control automatic spray painting of carburetor air cleaners; to automatically load conveyors, and in many other divisions, of the automobile industry.



Optical system for wrist or piston ring sorting using four phototubes, four amplifiers and appropriate relays

A good example of electrical-mechanical equipment is a fixture for testing the welds of a fifteen-spoke automobile wheel. Each spoke of the wheel is given a severe blow by a pre-adjusted and pre-loaded spring operated hammer. The small deflection of the spoke is the indication of a poor weld. This small deflection, through amplification, closes an electrically locked relay, which controls the fifteen pilot lamps, each representing a spoke of the wheel. The use of amplification allows very close adjustment of contacts and insures reliable test of the wheel.

To insure uniform quiet of roller bearing assemblies, each bearing in one factory is tested for noise level. The bearing is placed on a stand, where it is driven at various speeds. Microphones are placed at noise output points around the bearing, each microphone being connected to individual amplifiers. The output meters of these amplifiers are marked for "go" and "no go." The operator looks at the various output meters, and if two of the meters indicate "go" and one "no go," it is sometimes possible to locate the immediate source of noise in the assembly and the completed bearing is returned to the production line for readjustment.

Transmission assemblies and rear axle assemblies are checked in the same manner. The elimination of the human ear results in a more uniform finished product.

While color matching of interior automobile body trim, body paint, and plating have been covered before in *Electronics*, a new color matching problem recently solved with the phototube is of interest. The safety divisions of the various automobile plants have sample lenses, or goggles, to be used in various welding divisions of the factories. These samples are submitted to the supplier who usually imports the colored glass from foreign countries. It is his job to supply the lenses for replacement as close to the color of sample submitted as possible. In the past the sample as submitted was placed on an illuminated ground glass screen, and the human eye was responsible for matching a thousand or more replacement lenses to this sample. Because of eye fatigue the match was very poor. A phototube device today does the job more accurately, and with greater speed. This same device is being used by safety departments to match the right lens with the left lens. This accurate matching of the two lenses results in greater efficiency from the men wearing the goggles.

Cathode ray oscillographs are used to determine condition of operation of two or three cycle welds as used on hydromatic body welding machines, when they are being set up for a production program. Oscillographs are used to determine accurately the firing condition in the engine cylinder, when newly designed cylinder heads are being tested. The cathode ray tube and associated equipment has proved very valuable in analyzing body rumble frequency, the source and means to dampen this noise.

In the future more tubes will be used; but only after the engineers in charge of production, tool and fixture design, and inspection become familiar with what can be done for them.

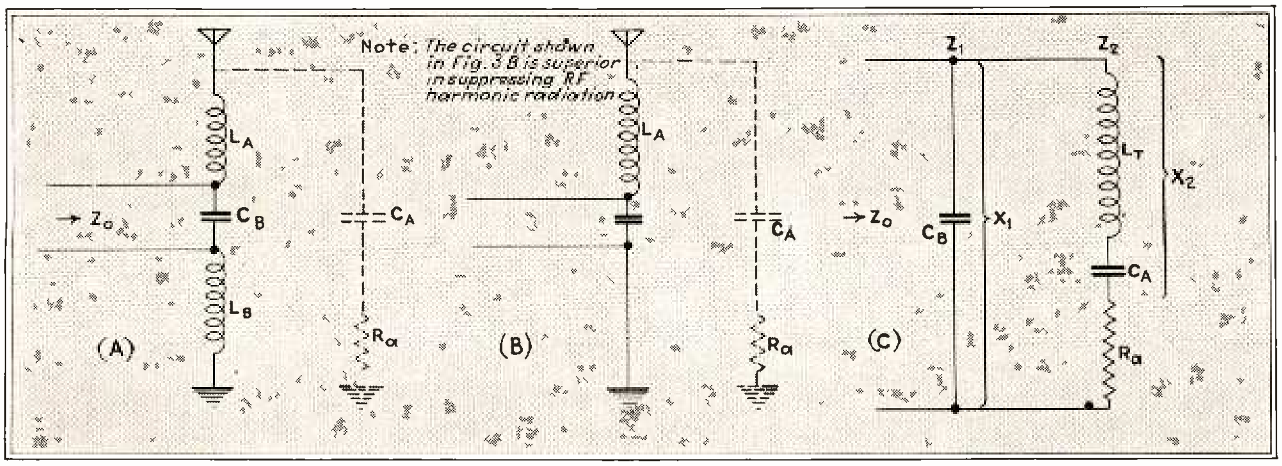


Fig. 3—Transmission line terminations. (C) is the equivalent of (A) and (B)

Formula 10 shows that unless Z_o exceeds the value of R_a an effective resistance equivalent to the characteristic impedance of the line cannot be secured. In Fig. 6 are shown curves relating to values of X_1 required for terminating a given transmission line of characteristic impedance Z_o coupled to an antenna system having a resistance R_a.

When low impedance lines are used, such as the concentric tube type, the termination shown in Fig. 4A. is useful since it affords a condition where correct termination may occur in the form of an effective resistance even though R_a equals or exceeds Z_o.

In Fig. 4B. is shown a transmission line termination in the form of a tank circuit. The tank condenser C_B across the line is selected so as to provide a suitable kva. ratio of the tank circuit with respect to the kw. transferred to the antenna circuit. This kva./kw. ratio is normally about 10 and should never be less than 2.

From formula (10) above, applied to the equivalent circuit Fig. 4B

$$X_1 = \frac{Z_0^2 R_e}{\pm \sqrt{R_e Z_0 - R_e}}$$

$$X_1^2 = \frac{Z_0^2 R_e}{(Z_0 - R_e)}$$

from which

$$R_e = \frac{X_1^2 Z_0}{Z_0^2 + X_1^2} \qquad (11)$$

where R_e in this case is the effective value of resistance reflected into the tank circuit from the antenna circuit.

The value of R_e in this case can be readily calculated[3] from the formula

$$R_e = \frac{\omega^2 M^2 R_a}{(R_a^2 + X_a^2)} \qquad (12)$$

where the inherent resistance of the tank circuit is negligible

M = Mutual inductance between L_A and L_B

X_a = Reactance of antenna circuit

R_a = Resistance of antenna circuit.

For a condition of effective reristance termination the value of X_a approaches zero with the antenna tuned to resonance and may be neglected.

$$\text{Therefore } \frac{\omega^2 M^2}{R_a} = \frac{X_1^2 Z_0}{Z_0^2 + X_1^2}$$

$$\text{or } M = \sqrt{\frac{X_1^2 Z_0 R_a}{\omega^2 (Z_0^2 + X_1^2)}}$$

In Fig. 7 are shown values of M required for a transmission line having a characteristic impedance of 400, 500 and 600 ohms and a line termination capacitor or between 0.001 and 0.004 μf. The transmitter frequency was assumed as 670 kc. and the antenna resistance 30, 70 and 140 ohms. In the design of a tank circuit termination for a given line the value of C_B across the line is selected so as to provide a proper kva. in the tank circuit with respect to the power transferred to the antenna circuit this kva./kw. ratio is normally about 10.

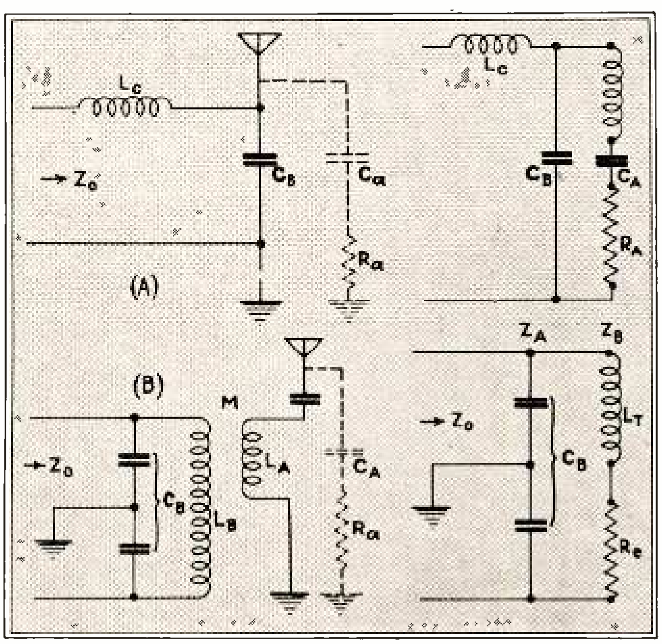


Fig. 4—Termination (A) when $R_a \geq Z_o$ and its equivalent. At (B) is a tank circuit termination

The usual procedure in adjusting a transmission line termination for a condition of no wave reflection on the line is as follows:

1. The number of coupling turns are calculated so as to give the proper value of M. With the tank circuit open, the antenna is tuned

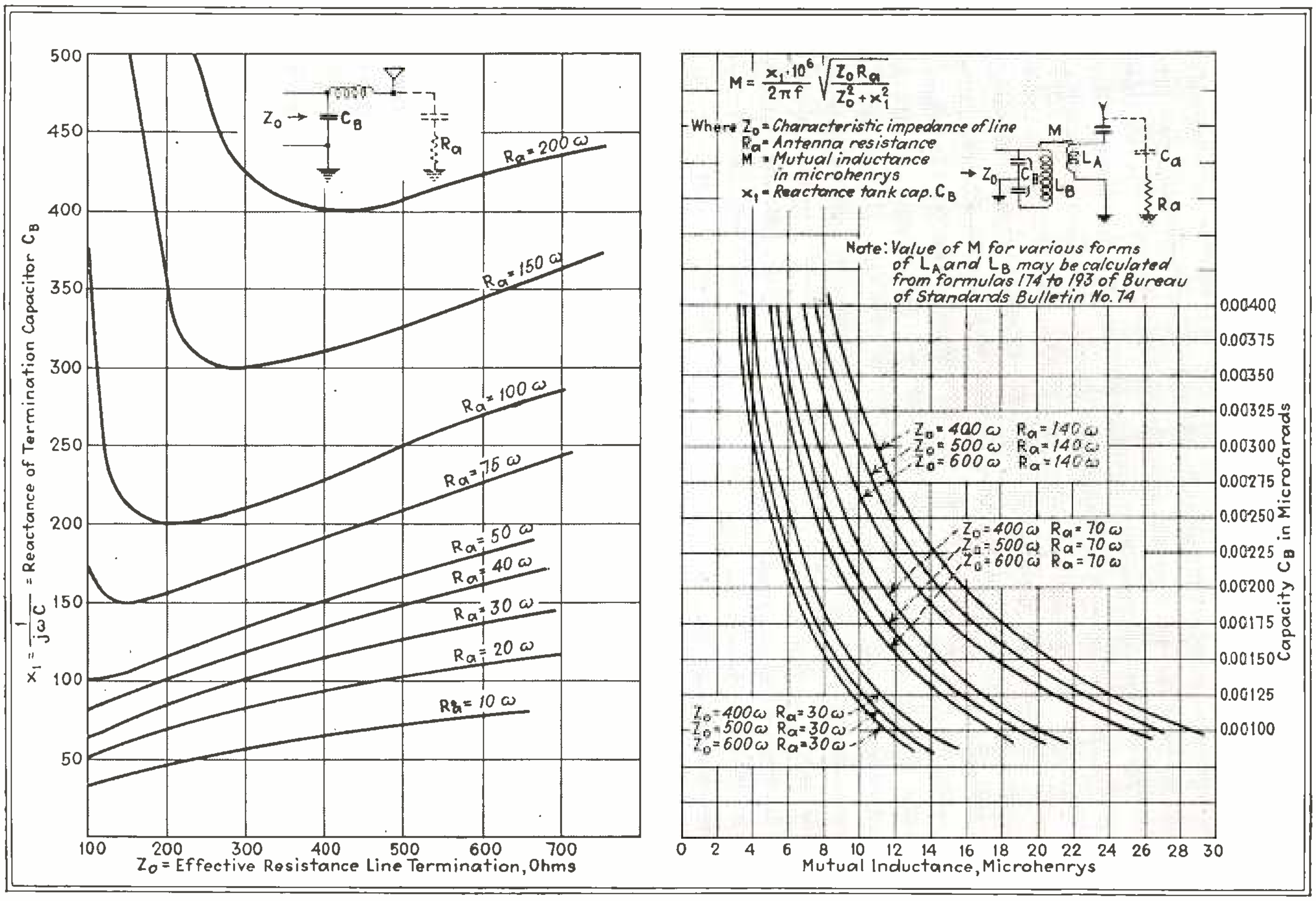


Fig. 5—Termination capacity required to afford an effective resistance termination of a line, Zo, to an antenna Ra. At right, relation between M and C_B for various values of Zo and Ra at 670 kc.

to exact resonance with the transmitter frequency by means of an external oscillator unit loosely coupled to the antenna circuit.

2. The tank circuit is now connected into the circuit and tuned to resonance. This is indicated by a condition where the current in the antenna circuit becomes a minimum.

3. The transmission line is then connected across the tank circuit without making any changes in previous adjustments.

4. Correct termination may be checked by measuring the transmission line currents at the ends and quarter wave points along the line by means of suitable meters. When proper termination has been effected the transmission line currents will be identical at all points along the line.

[1]"Suppressor of Transmitter Harmonics," by C. G. Dietsch, Electronics, June, 1933.

[2]"Artificial Electric Lines," A. E. Kennelly, page 24, McGraw-Hill Book Co., 1917.

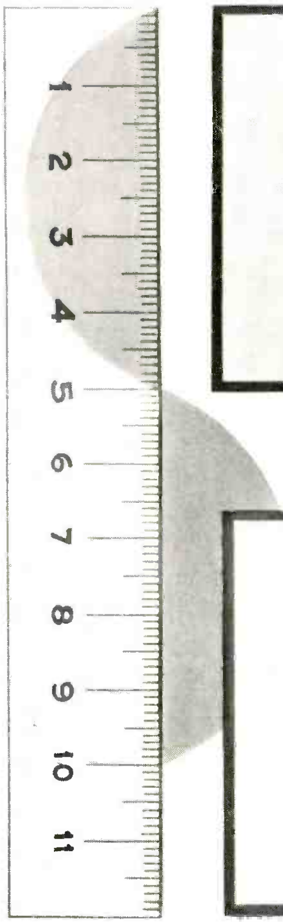
[3]"Electric Oscillations and Electric Waves," G. W. Pierce, page 159, McGraw-Hill Book Co.

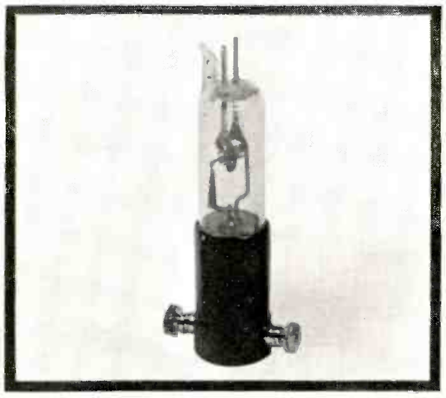
EDITOR'S NOTE: This material was prepared by Mr. Dietsch for the Second Edition of the Radio Engineering Handbook, now in preparation.

Measuring terminal impedances of lines and antennas

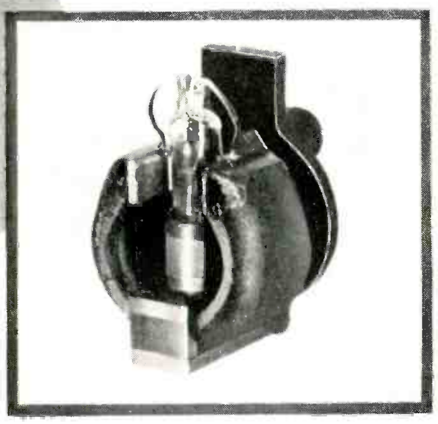
Microwaves To Detect Aircraft

Telefunken firm in Berlin reveals details of ten centimeter "mystery ray" system capable of locating position of aircraft through fog, smoke, and clouds. Rumor indicates that U. S. and Italian armies are experimenting with similar system, declared to revolutionize war tactics

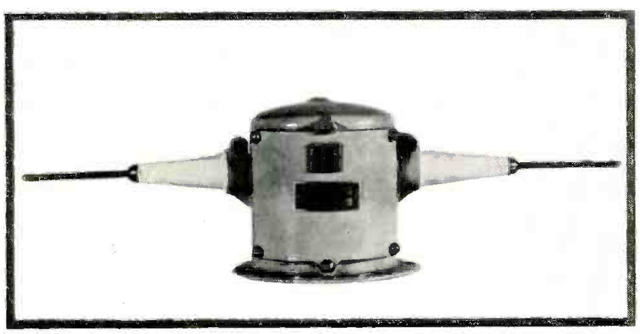




Split-magnetron tube used in microwave transmitter, shown above one-half actual size

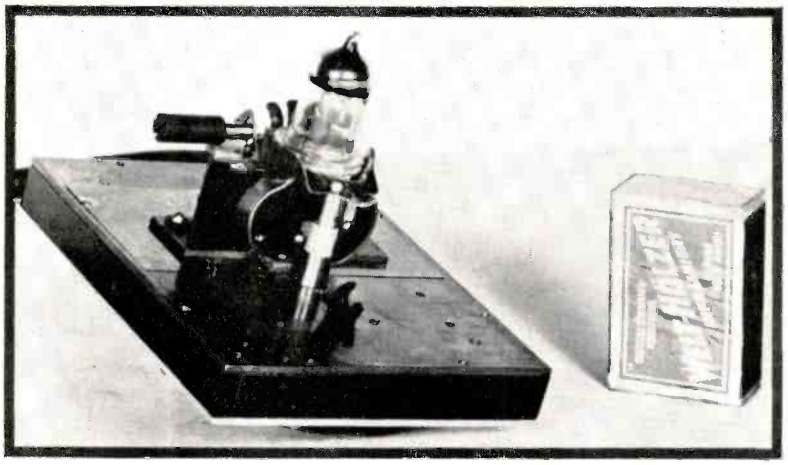


Magnetron in place inside permanent magnet, which also acts as a tuning inductance. Ten centimeter waves, shown actual size above to left, are generated directly in this device

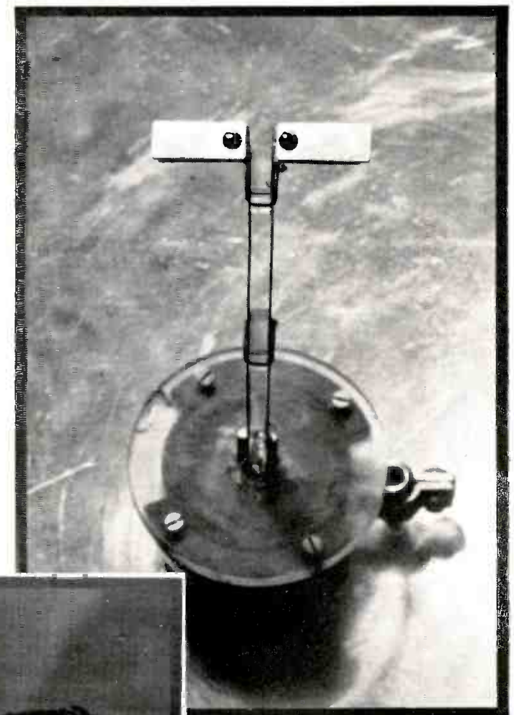


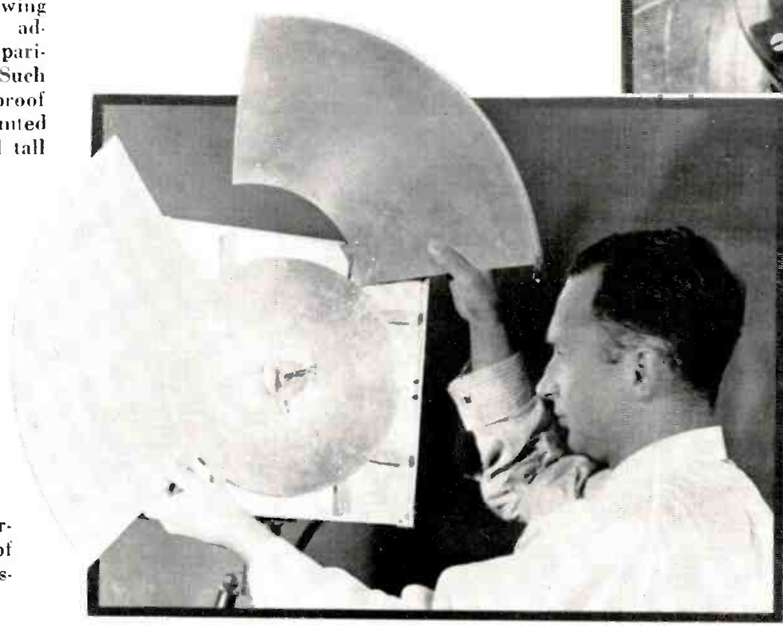
The transmitter proper containing the magnetron generator and di-pole radiators. The transmitter, mounted on a pole, is shown to the right. The vanes behind the di-pole determine the direction of the transmitted beam

Directional beams, 5 to 15 cm. in wavelength, are sent upward at a fixed angle from a large group of transmitters. After reflection from the hidden airplane, they are received by a similar group of receivers. The reception pattern reveals the position



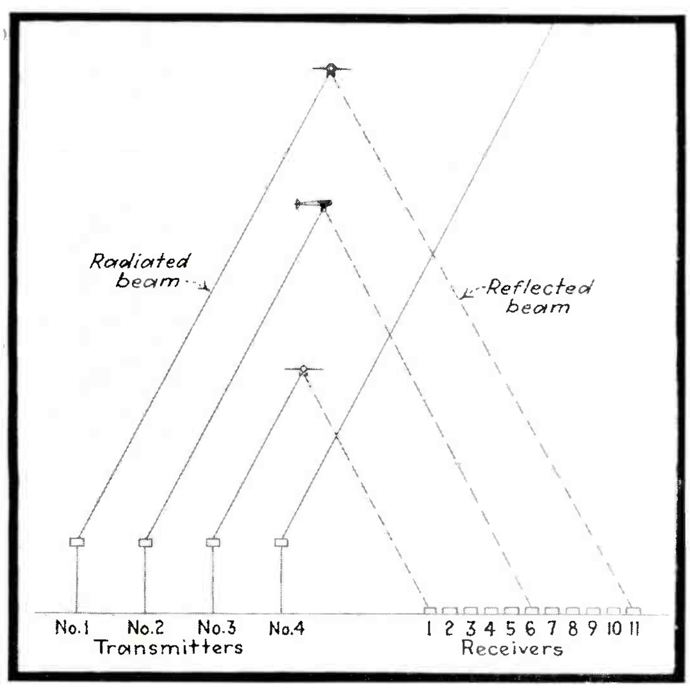
Above, receiver, showing tuning inductance and adjustable capacity in comparison with matchbox. Such receivers, in weather-proof iron boxes, are to be mounted atop church towers and tall buildings





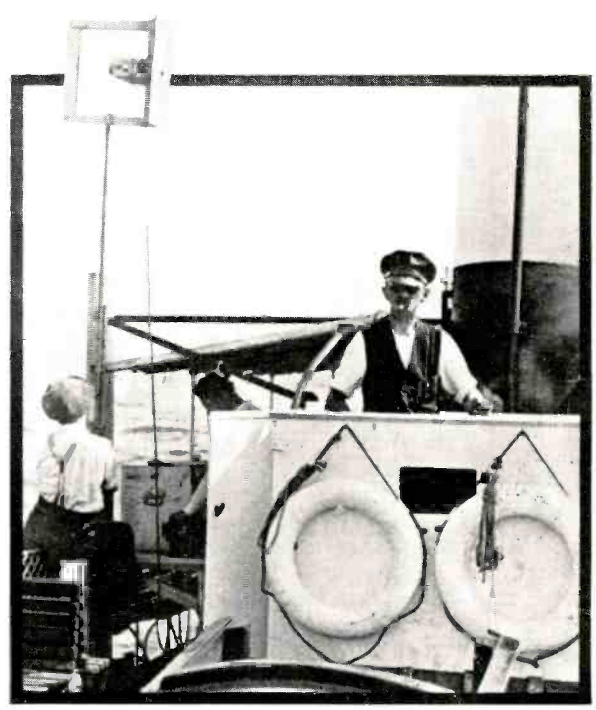
Above and to left, a portable di-pole transmitter. The quartz-insulated di-pole, shown above, radiates the ten centimeter waves

Right: Demountable mirror for concentration of waves in portable transmitter



Above, diagram showing location of transmitters and receivers in relation to aircraft. Each transmitter has its individual code signal, so that the received beam can be identified and located accurately

Microwaves for marine use, used in guiding a tug boat into harbor. The same apparatus and principles are used as in aircraft detection

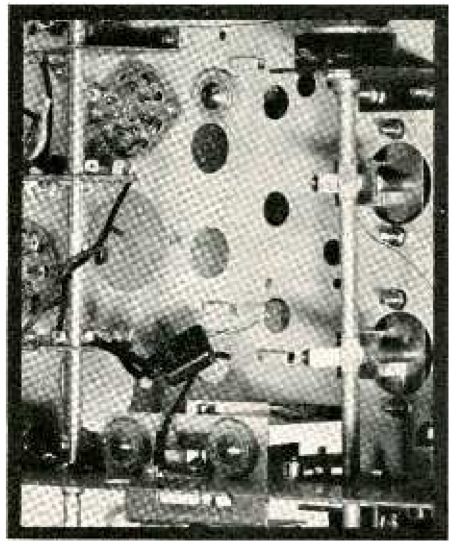


What's New in Radio for 1936?

Add metal tubes, variable band-width for higher fidelity, bass compensation, volume expansion, automatic tuning—result: radio lives up to its reputation of producing something new each season for engineers to build, for listeners to buy

EACH year, along about the first of February, the engineer responsible for radio receiver design racks his brain for new and worthwhile features to incorporate in the new line of sets for the coming season. Seldom is a new development used widely in the first season of its appearance, it is found in only one or two models at first, then gradually is generally adopted as its worth is proved.

New devices arrive either from the set maker's own laboratory or emanate from the Hazeltine or RCA License Laboratories. The engineers also study carefully the technical periodicals in search of new circuits, new parts, new designs, both in this country and abroad. Of the new developments which may appear scarce in February, some will be dropped and others drastically modified, as design of the new models goes forward. Nevertheless by July there are always many new features to be found in the receivers displayed so proudly to distributors and the current year is no exception. By September these sets are in production.

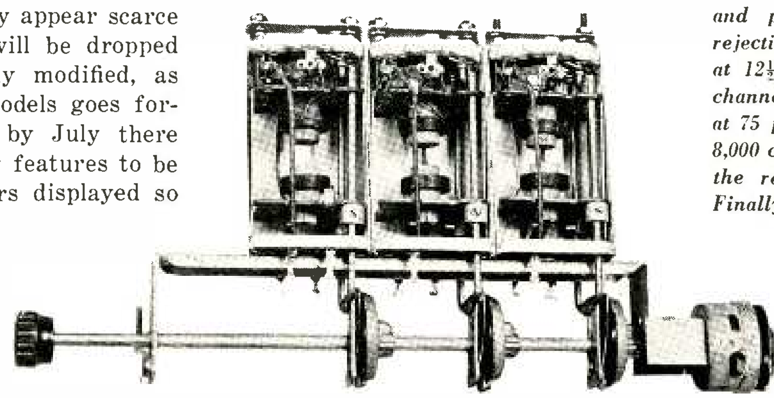


Zenith i-f expander. Note the rack and pinion. On sharp position, rejection ratio of set is 10,000 times at 12½ kc. over the carrier. The channel broadens gradually until at 75 per cent rotation, it is flat to 8,000 cycles. Further rotation raises the response above 3,000 cycles. Finally both low and high notes are boosted

Metal Tubes

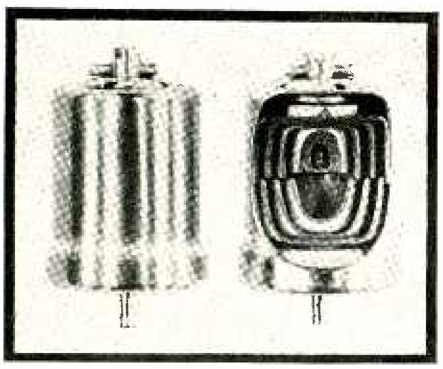
New tubes have always offered opportunity to the receiver engineer for new circuits and new mechanical layouts. This year there is a whole new line of tubes, some with new characteristics, all with new appearance and shape and a metal envelope. There are also tubes with glass envelopes whose characteristics and bases are like the metal tubes, and others with a glass envelope surrounded by a metal shield.

In the trend toward high fidelity, involving extension of the audio range toward the low and the high frequencies, reduction of harmonic distortion, increased available power output, and improvement in speaker characteristics, one of the essentials is control of the i-f bandwidth.



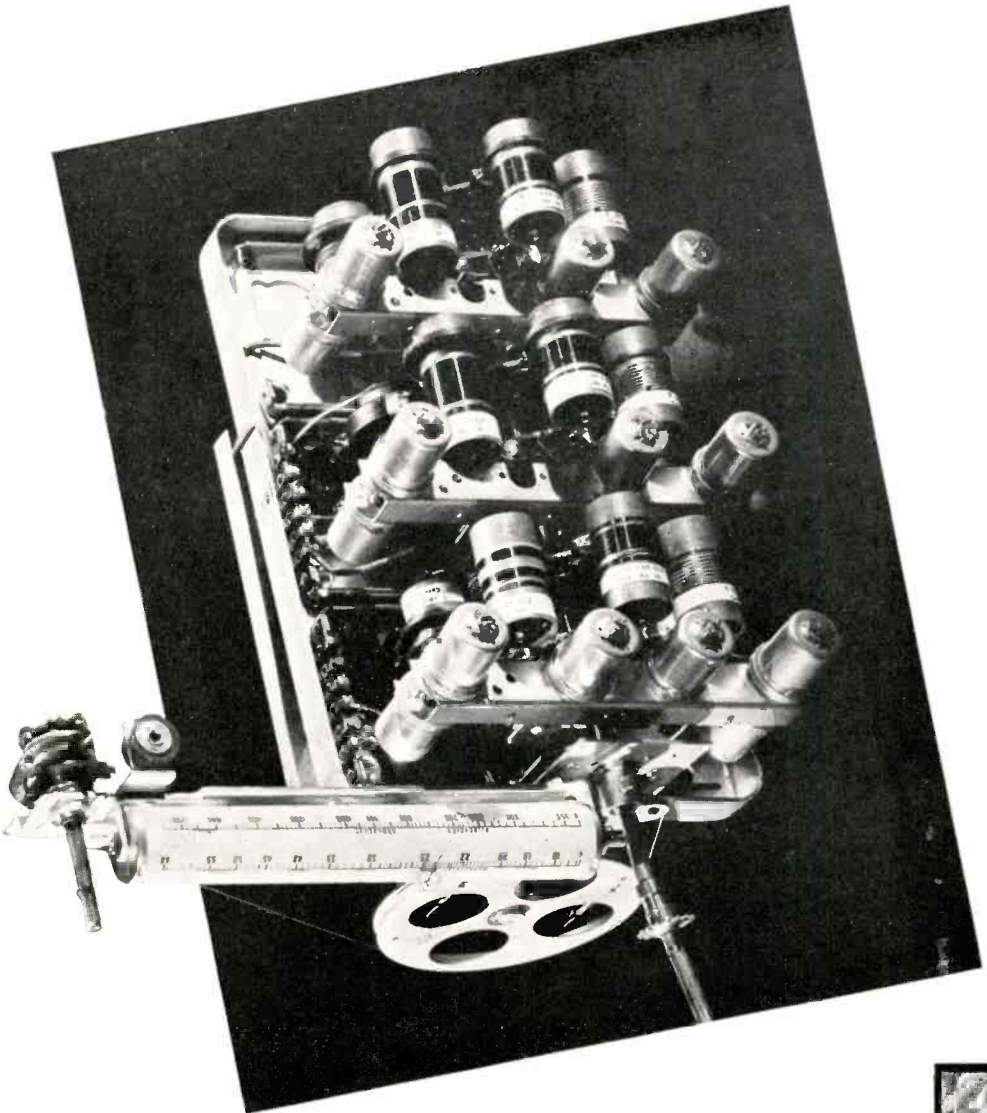
Philco band-widening system

During the past season two or three manufacturers, among them Philco and Stromberg-Carlson, met the problem of selectivity versus high frequency reproduction by the use of variable bandwidth controls. The listener could, by means of this control, make his receiver exceptionally selective or capable of responding to high a-f sidebands. With former receivers of fixed i-f bandwidth, a fidelity characteristic down only 5 db at 3500 or 4000 cycles combined with a bandwidth of not over 35 kc at 1000 times input was felt to be very good indeed. With variable bandwidth control, the bandwidth may be only 20 kc at 1000 times input in the narrow band position and in the wide-band position the response may extend to 6000, 8000, 10,000 or even 16,000 cycles. Most manufacturers have felt that adequate reproduction was secured with response down 5 db at 7000 cycles, but in a few instances the reproduction of frequencies up to 16,000 cycles (Scott) has been felt desirable.



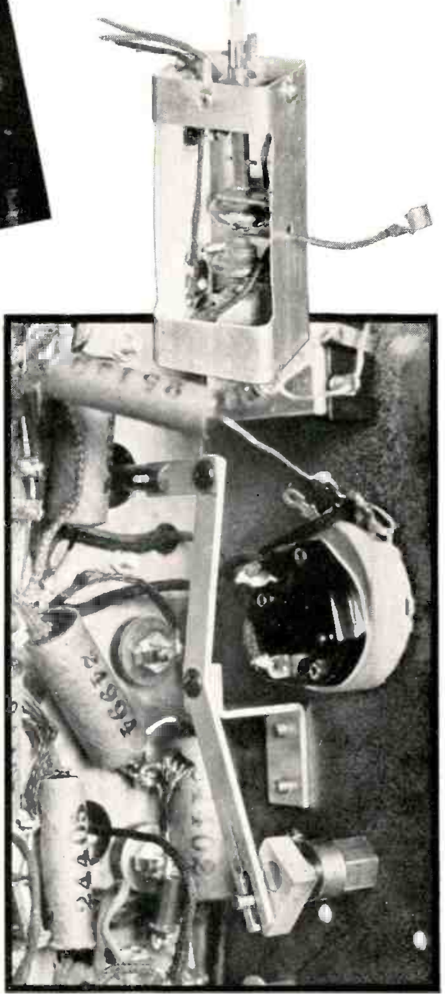
GE Permaliner — totally enclosed air dielectric trimmer. Adjustment by rotating screw on top of the unit, moving the upper group of cups

Extension of the range much beyond 8000 cycles requires decrease in selectivity of the r-f stages at the



Philco high-fidelity speaker

Sentry Box—slide-rule tuning scale, GE high spots. Rugged, stable arrangement of r-f coils, switches and associated parts. Complete tuning scale visible, other ranges out of sight until needed



Stromberg-Carlson band widener—simple, mechanical method of increasing the coupling between i-f windings to spread out the response characteristic. Insert—one of the i-f coils

low frequency end of the broadcast band, addition of a sharp band-elimination filter to take out the 10-kc beat between adjacent carriers, and extremely good audio and speaker design; accordingly the typical receiver has been made to respond only to frequencies up to about 7,500 cycles.

Several different methods of varying the coupling of the i-f transformer have been used. Among the most common are the following:

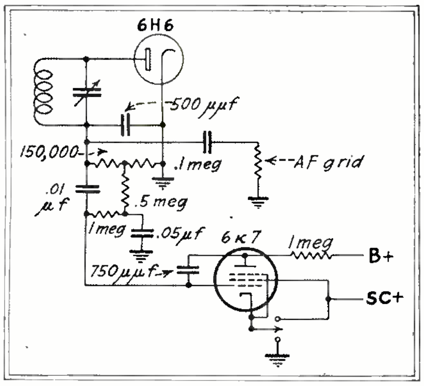
1. Variation of mutual inductance by sliding one coil of the transformer in relation to the other.
2. Inclusion of the required mutual inductance in small separate coils with rotatable coupling as in a variometer.
3. Variation of coupling by means of a third tuned, coupled circuit in which a variable resistance is included.
4. "Staggering" the tuning of the circuits by small variable condensers.

The most common method is that of sliding coils; many ingenious mechanical means for accomplishing the required motion have been designed.

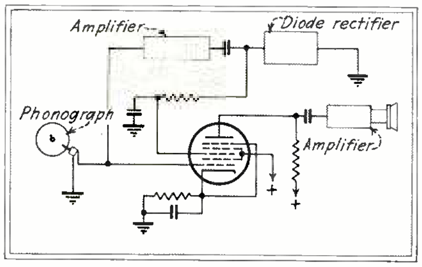
High Fidelity Tricks

Zenith and Philco (and probably others, too) are using fixed bias for the power stages of their better receivers to increase output and to lower distortion. General Electric has a neat method of solving the demand for high fidelity. In the 20-tube model the entire superheterodyne system is eliminated when the listener desires the best of the better programs. The receiver becomes a single-stage t.r.f. set with diode detector and a double a-f system, one channel feeding two low-frequency speakers, the other a special high-frequency speaker (exclusive with GE) with wide horizontal distribution at even the highest frequencies.

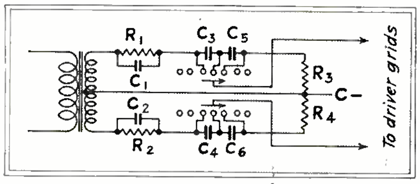
On the selective condition, a frequency changer, double-channel i-f



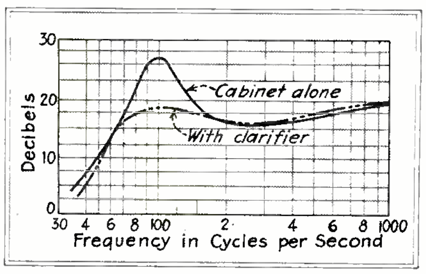
Fada automatic tone control



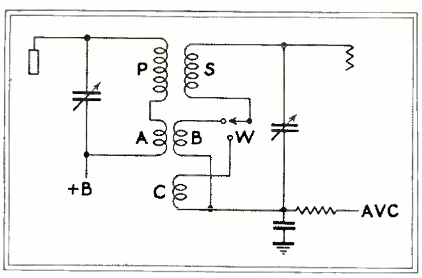
Volume expander of RCA Victor



Bass augmentation scheme of Scott



Effect of acoustic clarifiers



"Third dimensional tone"—Fairbanks-Morse. Loosely coupled i-f coils; in series with primary is A, a few per cent of inductance of P. On top of A is B of same inductance; C of similar inductance is spaced slightly from B. Switch W puts C in series with S, set is 3 kc. wide at two times input; 20 kc. wide at 1,000 times. Switch W connected to B, coils are overcoupled; set is 16 kc. wide at 2 times; 35 kc. at 1,000 times input

amplifier and a.v.c. system are inserted between r-f stage and detector, and the high-frequency speaker is shorted.

Zenith has been aided by the engineering staff of Jensen in designing its high-fidelity models. Two speakers are used.

Philco has invented "acoustic clarifiers" as aids to better fidelity. These are resonant cones, (they look like loud speakers without driving mechanism) which vibrate at their natural period but are damped by a special material. These clarifiers are placed on the baffle around the loud speaker, two on the same horizontal line as the speaker, and one below it. They complete the baffle at all frequencies other than the resonant frequency of the device. At this frequency they absorb energy and damp out this particular frequency. The resonant frequency is chosen to coincide with cabinet resonance.

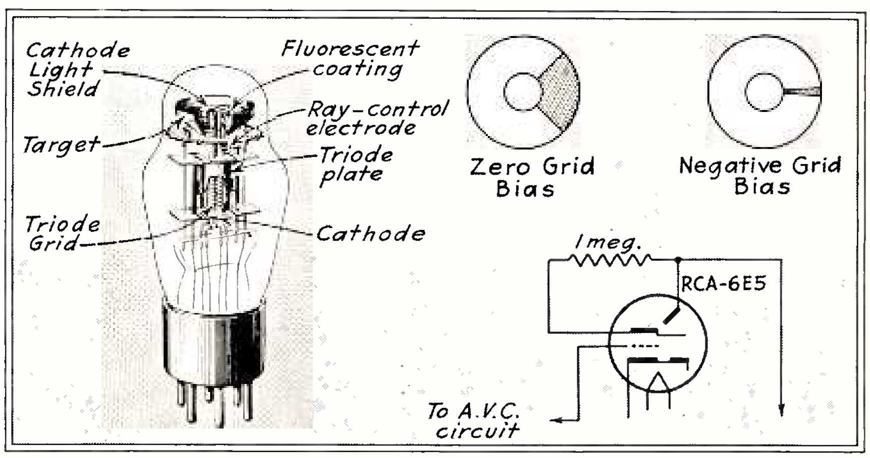
I-F Trimmers

Wide-band i-f systems have resulted in more care being given to trimmers, as a change of alignment results not only in decreased sensitivity and shift in tuning, as was the case on narrow-band systems, but also in lack of symmetry of response to upper and lower sidebands with consequent distortion. Sideband symmetry requires that any tendency to regeneration be eliminated, an amount which would not be noticed on a narrow-band i.f. giving perceptible assymmetry when the band is wide. These requirements have led to use of lower inductances and higher capacities and air trimmers.

Another development toward high fidelity reception which has come into general use on one or more models of many manufacturers this season is a control for augmenting the bass response. In the past, tone compensation has been applied to the volume control but current practice favors a separate control for the bass, since the amount of bass for most natural and pleasing reproducion is affected not only by volume level but also by the type of program, a musical program often requiring augmentation of the bass whereas speech very seldom does.

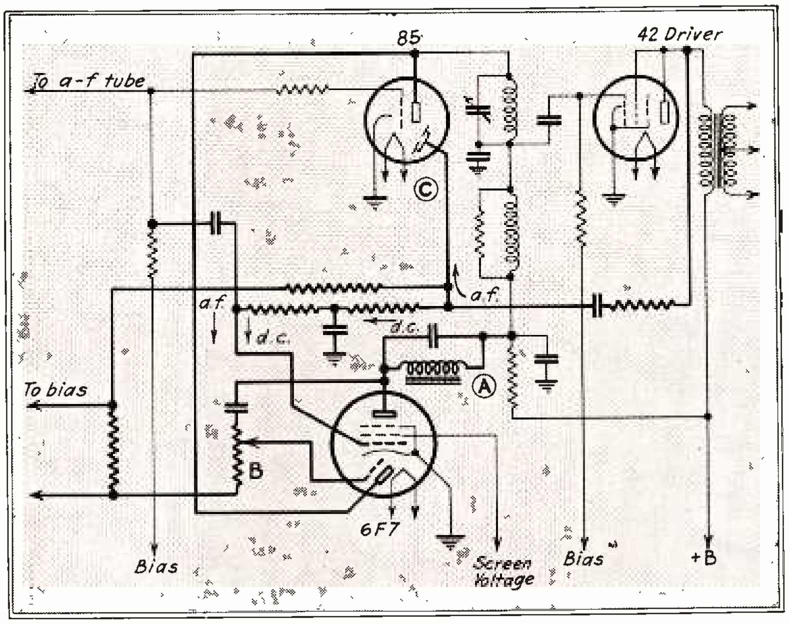
Bass Augmentation

There have been many circuits for accomplishing control of the bass, most of which employ a three or four position switch that increases bass response at maximum in some circuits 4 db, in other circuits as much as 10 db. An ingenious circuit for bass augmentation is used in the Scott high-fidelity receiver. It provides fixed augmentation of the high frequencies and adjustable augmentation or attenuation of the bass. The fidelity adjustment is provided in the grid circuit of the pushpull driver stage. The capacities C_1 and C_2 shunted around resistors R_1 and R_2 adjacent to the transformer winding bypass the high frequencies but attenuate the middle and low frequencies. The bass adjustment is accomplished by the two switches, the arm of each being connected to one of the grids. There are five positions, the arm shorting three contacts in each position. When the switches are in the extreme left position C_3, C_5 and R_3 are in series between one grid and ground (C—) and C_4, C_6 and



Details of the 6E5, cathode stream indicator tube

R_4 in series between the other grid and ground, thus providing a higher impedance in the grid circuit for the bass than for higher frequencies. The augmentation is about 8 db in this position. On position further right C_3 and C_4 are short circuited providing less bass augmentation. With the switches in the center, the condensers are short circuited producing neither augmentation nor attenuation of the bass. The next position to the right of the center shorts C_5 and C_6 and connects the grids between C_3 and R_3 and C_4 and R_4 respectively, decreasing the bass response. In the extreme right position two condensers are in series with each grid producing maximum bass attentuation.



Philco bass booster—connected across first a-f stage. 6F7 used as pentode first stage, triode as second stage amplifier. Coupling between is tuned circuit A. B permits customer to adjust gain. Amplification of 10 times over normal bass is secured. To prevent too much bass, diode element is loaded across 42 output driver. Rectified voltage tend to overbias the bass booster when studio bears too heavily on Wayne King-like programs

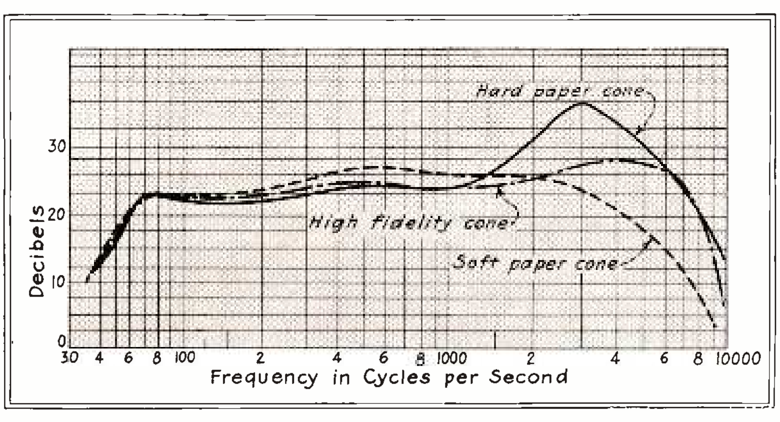
Tuning Indicator

A cathode-ray tube in each receiver! Even a few months ago the proposal would have sounded visionary but with the announcement of the 6E5 it has become a reality. This tube is used as a tuning indicator, the width of shadow band on the flourescent screen indicating departure from resonance. The tube consists of two parts, a triode portion which acts as a d-c amplifier, and a cathode-ray portion which causes the screen to flouresce. The cathode is common to both portions and the electrode controlling the width of electron beam is connected to the triode plate within the tube. As the receiver is tuned to resonance the a.v.c. voltage increases, applying increasing bias to the triode grid of the 6E5. Increased triode bias, in turn, lowers the plate current of the triode position which raises the potential of the beam control electrode so that its effect of casting a shadow on the fluorescent screen is lessened. The 6E5 thus is a tuning indicator which is at the same time sensitive, quick acting, and perfectly damped.

The 6L7 tube permits of a simplified circuit for volume expansion which promises to find increasing usefulness. The application to a phonograph amplifier (RCA-Victor) is shown, where the signal from the pickup is applied to grid 1 of the 6L7 and also through an amplifier to a diode rectifier. The d.c. from the diode varies the bias on grid 3 of the 6L7. At low signal voltage the bias of No. 3 grid is high, increasing signal applied to the diode decreases the bias resulting in greater gain through the 6L7. Thus the range of volume is expanded so that the reproduction has more nearly the volume range of the original before monitoring. If the signal on grid 1 is kept small the use of separate grids for signal and bias application results in change of gain with negligible distortion.

Noise Suppression

A carrier-operated noise suppressor of a type different from those previously used is the type used in Fada receivers this season. A switch is provided so that the device may be used at will. When the cathode is connected to ground the 6K7 becomes operative with a gain of 200 or more. To obtain this gain the screen is at approximately 10 volts because of the 1 megohm plate resistor. Under this high gain condition the 750 $\mu\mu f$ capacity between grid and plate appears as a 0.15 μf condenser in series with a 5000 ohm resistor between grid and cathode, effectively decreasing the audio signal, consisting principally of noise components at the low carrier values, so there is no noise output. As the carrier increases the 6K7 rapidly reaches cutoff, due to rectified carrier from 6H6 being applied to its grid, when its audio shunting effect is negligible, thus giving full output.



Characteristics of Philco high-fidelity speaker

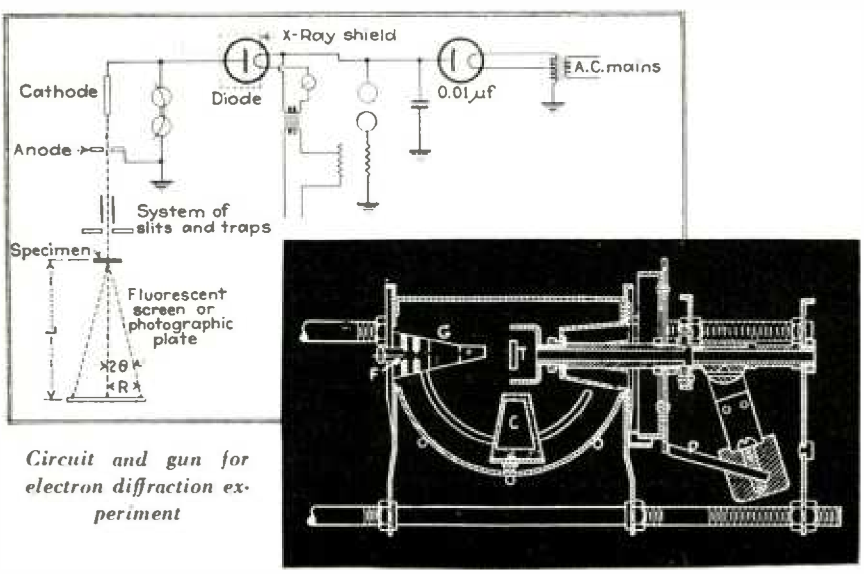
Diffraction of Electrons

. . . protons, and positrons forms a new research tool useful for measuring corrosion, calibrating electrometers to 380 kv. and pressure gages to 4×10^{-11} mm.; studying molecular structure; investigation of thin films, oils, photographic film

C. J. PHILLIPS
Physical Laboratory
Corning Glass Works

THE amazing pace of modern scientific research is brilliantly exemplified by the results of recent work on the diffraction of electrons, protons, positrons, atoms, and molecules. Since the appearance, some three and one-half years ago, of a paper[1] similar in content to this, there have been many improvements in equipment and technique, and many experimental discoveries which promise wide industrial application. Electron diffraction has been used for the investigation of the structure of thin films and surface layers of metals, metallic oxides, oils, lacquers, and fibres. It gives invaluable information in connection with the manufacture of light-sensitive cells, vacuum tubes, and photographic film, as well as in the study of the mechanisms of lubrication and corrosion.

It is well known that X-rays can be used to investigate crystal structure simply because the wave-lengths of these waves are comparable in magnitude with the spacings of atomic planes in crystal lattices. In 1924 Prince Louis de Broglie proposed to extend the huge domain of waves to embrace matter itself. Great advantages would accrue by postulating that all material particles—and, in particular, electrons—have properties analogous to those of a train of waves. This view is the basis of "wave mechanics," and predicts that electrons should exhibit diffraction effects with crystals similar to those observed with X-rays. Thus, a beam of electrons of uniform energy is regarded as analogous to a train of waves. For electrons accelerated by ordinary voltages—say, 100 to 100,000 volts—the wave-lengths are comparable with those of X-rays. When such a wave train passes through matter, each atom becomes the source of a scattered wavelet of amplitude roughly proportional to the atomic number. As in the optical or X-ray case, these wavelets interfere with one another and with the original wave, forming an interference pattern, varying in intensity from point to point.



Circuit and gun for electron diffraction experiment

This new tool differs from the X-ray case in several ways. The scattering per atom is about 10^7 times as strong, corresponding to the far greater stopping and scattering power of matter for the electrons. Consequently, exposure times are much less: seconds or less instead of hours. Moreover, medium-speed electrons penetrate matter only 10^{-6} cm. or less, thus revealing surface peculiarities which would be camouflaged by the excess of internal matter were X-rays used.

When a given substance is bombarded with low-speed electrons the results are quite different from and more complicated than when high speeds are employed. This is in part because of the extreme sensitivity of slow electrons to surface impurities, and in part because the substance has, in effect, a refractive index which becomes considerably greater than unity for such electrons. The results may also be classified according to whether they arise from (a) Transmission through very thin films (10^{-6} cm.) of the material, or (b) "Reflection" at grazing incidence from the surface of the material. A further classification is now possible, since diffraction has been observed with solids, liquids, and gases.

The first test of de Broglie's hypothesis was made by Davisson and Germer[2] using slow electrons (about 100 volts) "reflected" from the face of a nickel crystal. Agreement with theory has now been secured over the whole range from 50 to 10^6 volts.

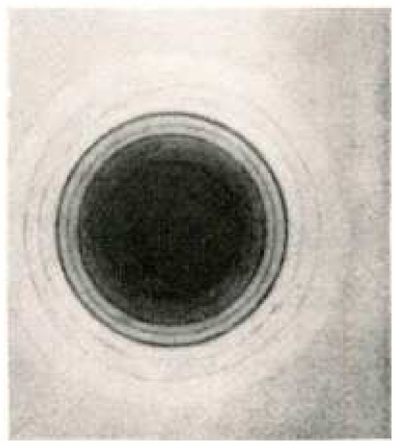
Transmission Experiments

Various diffraction cameras[3] are similar in principle but differ in detail.[4] Finch and Quarrell used a saturated diode in the general circuit shown.

The transmission method is the simpler of the two. The angle be-

DRS. DAVISSON *and* GERMER *of the Bell Telephone Laboratories who first demonstrated that electrons have wave-like properties*

Pattern secured from transmission of electrons through film about 10^{-6} cm. thick



Pattern from transmission of electrons (25 kv.) through thin film of silica glass (from Maxwell and Mosley)

tween the incident and the diffracted beam can be denoted by 2 θ in the circuit diagram. Then θ denotes the glancing angle made by the incident and the diffracted beams with the reflecting net planes. The angles involved are all small, so we can apply Bragg's law in the form

$$m\lambda = 2d \sin \theta = d \tan 2\theta = \frac{dR}{L}.$$

Here m is the spectral order and d the spacing of the crystal planes, or, in terms of accelerating voltage,

$$\frac{12.25\, mL}{d} = RV^{\frac{1}{2}}.$$

As the voltage is varied the radius of a given diffraction ring varies so that the product of the radius and the square root of the voltage remains constant. For extremely fast electrons a relativity correction must be applied.

The usual method of electron diffraction determination of lattice constants involves substitution of the values of R, V, and L in the equation above. Until recently the lattice constants could not be determined to better than 2.5%, since sphere gap voltmeters involve about a 5.0% error. Some recent cameras have shutters so designed that the plate can be exposed in two independent halves, the specimen carrier holding two specimens. One of these is a substance whose constants have been determined by precise X-ray analysis. Data for the other specimen is obtained by comparison and interpolation. The accuracy is as great as that with X-rays.

G. P. Thomson[4] and his co-workers have done work of this kind on thin foils of celluloid, Au, Ag, Pt, Fe, and Pb, using voltages from 20 to 65 kv. Rupp,[5] using voltages from 120 to 320, extended the results to include Al, Cr, Cu, Ni, Sn, and Zn. The rings are continuous, indicating the presence of many crystals oriented at random in the foil.

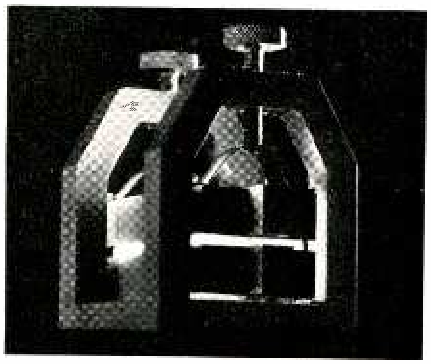
Reflection Experiments

The semi-circular rings observed in reflection experiments are similar to those obtained by transmission, rather more than half lying in the shadow of the specimen. These rings result from electrons which pass through minute crystalline projections on the surface. If the surface becomes oxidized, for example, the pattern changes to that characteristic of the oxide. (See also Gates[6] and Thomson.[7]) Dixit[8] showed that silver mirrors are improved by holding them in the fumes of aqua regia because they become coated with Ag_2O. Many other compounds have been found in this way, but often they can be identified only by comparison with the pattern of the substance with which they are suspected to be identical. Such comparisons are often made by powdering a thin film of the substance on celluloid and then securing a transmission pattern.

The sharpness of the diffraction rings is a valuable index of the size of the crystals causing them. In this connection the patterns offer several clues. If the crystal size becomes less than about 10^{-6} cm, the crystals act like gratings of very low resolving power and the rings become diffuse. In additon, unless the thickness in the direction of the beam is greater than 10^{-5} cm the atoms along the beam will not interfere completely. The ordinary pattern due to a three-dimensional crystal is then replaced by a "crossed grating" pattern due almost entirely to the atoms in the plane normal to the beam. Since 10^{-5} cm is greater than the average penetration of the electrons, patterns of this type are found with rough etched crystals. On the other hand, the ring pattern is obtained from smooth cleavage faces *provided the crystal structure is perfect.* This last proviso is important because it allows for an estimate of the degree of surface regularity. For example, for diamond the patterns indicate regularity over at least 2×10^{-5} cm, whereas for rocksalt the region is much less and depends greatly on the surface preparation. Finally, the Kikuchi[9] lines afford an estimate of the perfection of the crystal orientation.

The electron diffraction method has already yielded important information concerning the processes of crystal growth and of crystallization. Kirchner[10] evaporated minute quantities of various salts on celluloid films. Transmission patterns showed that the first crystals formed were very small but continued to grow even at room temperature and then to gradually orient themselves. Jenkins[11] found that oxide films lifted off molten lead, zinc, and bismuth often showed pronounced orientation—usually one axis is almost exactly parallel to the plane of the film. Originally these oxides were in the form of small patches on the metal surface, oriented with one axis normal to the surface, but otherwise at random. When the metal—lead, for example—solidified, it formed a few large crystals; the oxide patches meanwhile turned round into parallelism and so formed a single thin crystal. Trillat[12] has observed the growth of thin metal films into single crystals, under heat treatment.

EDGE-CLAMPED CRYSTAL



This 700-kc quartz crystal is clamped at the edges for preventing lateral motion and consequent frequency shift, a development of the Bell Telephone Laboratories

A few other instances of the utility of the electron diffraction method will be mentioned. The amorphous layer on the surface of polished metals, discovered microscopically by Sir George Beilby, has been confirmed.[13] Finch[14] showed that only after repeated trials could a foreign metal be deposited on these polished surfaces. Apparently the added metal at first was rapidly dissolved by the amorphous layer. Research of quite different character has been prosecuted by Jenkins[15] on graphite, by Murison on grease layers, and by Nelson on various hydrocarbons. Bruni and Natta investigated the structure of rubber. This work is particularly interesting because X-ray examination yields photographs similar to those for liquids, a crystalline structure being revealed only if the rubber is stretched or frozen. Electron diffraction, however, shows that even when unstretched the rubber really has an oriented, quasi-crystalline structure. A diffraction pattern obtained by Maxwell and Mosley[16] is shown. The films were obtained by blowing the glass into a bubble, after which hydrofluoric acid was used for further reduction in thickness. This appears to be the first systematic work of this kind done on glass.

Work With Gases and Vapors

The diffraction of electrons by a gas can be applied to the analysis of complicated structural relationships in molecules. The method consists essentially in allowing a very fine stream of electrons of uniform velocity to intersect a gas stream, the

[*Continued on page 308*]

BIBLIOGRAPHY:

[1]Phillips, Electronics, page 84, March 1932. [2]Davisson and Germer, Phys. Rev., *30*, 707 (1927). [3]For diffraction cameras see Germer, Rev. Sci. Insts., *6*, 138 (1935). Thomson and Frazer, Proc. Roy. Soc., *A128*, 641 (1930)., Phillips, Physics, *2*, 48 (1932)., Trendelenburg and Wieland, Wiss. Veröff. Siemens Konzern, *13*, 41 (1934); Trendelenburg and Franz, same, *13*, 48 (1934)., de Laszlo, Proc. Roy. Soc., *A146*, 672 (1934)., Burgers and Basart, Physica, *1*, 543 (1934)., Finch and Quarrell, Proc. Phys. Soc. London, *46*, 148 (1934)., Darbyshire and Cooper, J. Sci. Inst., *12*, 10 (1935)., [4]Thomson, Proc. Roy. Soc., *A117*, 600 (1928). [5]Rupp, Ann. Physik, *85*, 981 (1928). [6]Cates, Trans. Farad. Soc., *39*, 817 (1933). [7]Thomson, Proc. Roy. Soc., *A128*, 649 (1930). [8]Dixit, Phil. Mag., *16*, 1049 (1933). [9]Kikuchi, Jap. J. Phys., *5*, 87 (1928). [10]Kirchner, Z. Phys., *76*, 576 (1932). [11]Jenkins, Proc. Phys. Soc., *47*, 1 (1934). [12]Trillat and Hirsch, J. Phys., *3*, 185 (1932). [13]Darbyshire and Dixit, Phil. Mag., *16*, 961 (1932)., French, Proc. Roy. Soc., *A140*, 637 (1933); Raether, Z. Phys., *86*, 82 (1933).

[14]Finch, Quarrell, and Roebuck, Proc. Roy. Soc., *A145*, 676 (1934). [15]Jenkins, Phil. Mag., *17*, 457 (1934)., Murison, Phil. Mag., *17*, 201 (1934)., Nelson, Phys. Rev., *44*, 717 (1933)., Bruni and Natta, Accad. Lincei, Atti. *19*, 536 (1934). [16]Maxwell and Mosley, (abstract), Phys. Rev., *47*, 330 (1935). [17]Wierl, Ann. Phys., *8*, 521 (1931); *13*, 453 (1932)., Brockway and Pauling, Proc. Nat. Acad. Sci., *19*, 68 (1933)., de Laszlo, Proc. Roy. Soc., *A146*, 672 (1934)., Hendricks, Maxwell, Moseley and Jefferson, J. Chem. Phys., *1*, 549 (1933).

[18]Johnson, J. Frank. Inst., *206*, 301 (1928). [19]Dempster, Phys. Rev., *30*, 644 (1927). [20]Rupp, Zeits. f. Physik, *92*, 485 (1934); *93*, 278 (1935). [21] Veszi, Zeits. f. Phys. Chem., *B11*, 211 (1930). [22]Estermann and Stern, Zeits. f. Physik, *61*, 95 (1930). [23]Zabel, Phys. Rev., *42*, 218 (1932). [24]Coper, Fromer and Zocher, Zeits. f. Elektrochem., *37*, 571 (1931). [25]Johnson and Starkey, Proc. Roy. Soc., *A140*, 126 (1933). [26]Guillemin, J. Frank. Inst., *219*, 73 (1935).

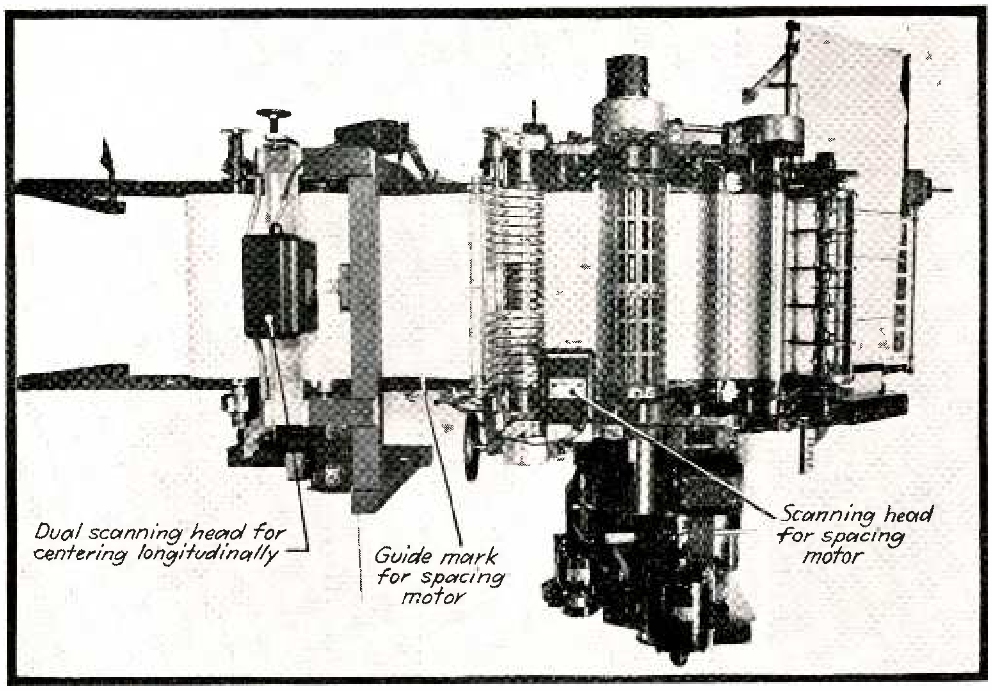
GENERAL REFERENCES

Phillips, C. J., "The New Wave Atom, Elusive and Mysterious," Scientific American, pages 14-17, January 1933.

Thomson, G. P., "The Wave Mechanics of Free Electrons," McGraw-Hill, New York, 1930.

Mark and Wierl, "Die Experimentalen und Theoretischen Grundlagen der Elektronenheugung," Borntrager, 1931.

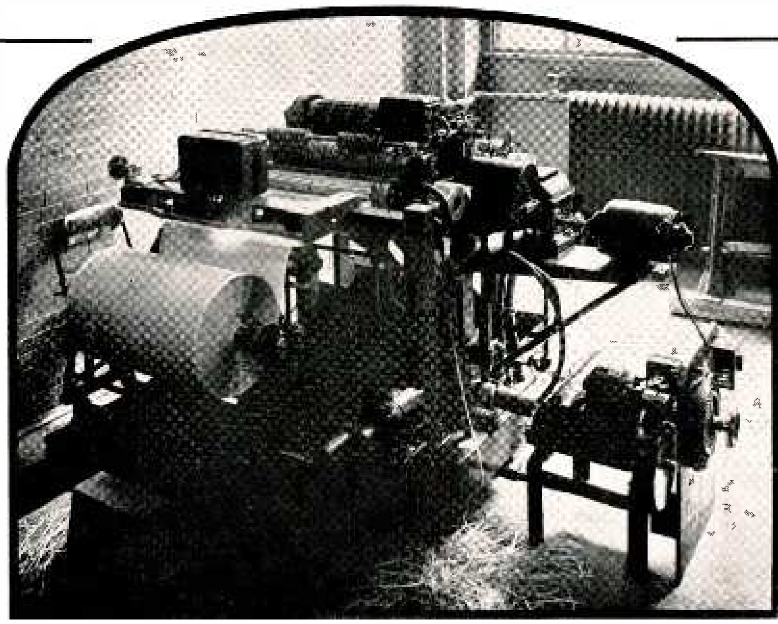
Thomson, G. P., "Electron Diffraction as a Method of Research," Nature, pages 492-495, March 30, 1935.



Looking down on the stamp perforator with its photo-electric guides. From the roll at the left. the continuous sheet of stamps is fed through the perforating cylinders

Phototubes Perforate U.S. Stamps

Philatelists demand accurately centered postage stamps—Uncle Sam applies new art to guide perforating machines



The new photo-electric perforater in the Bureau of Engraving and Printing. The photo-celscanning heads appear as the two black boxes sitting above the perforating rolls

LEONARD CHURCH
Washington Correspondent

THE perforation of sheets of postage stamps is an operation requiring a high degree of mechanical precision. It is a problem which is complicated, rather than simplified, by the very superior quality of printing which Uncle Sam insists on doing. The intaglio process of printing is used, which requires the introduction of as much as 35 per cent moisture (by weight) into the paper in a sequence of operations which include: The initial wetting of the paper, the printing of the stamps, the drying of the paper, its gumming, another drying interval, and finally the winding of the finished stamps in rolls 18½ inch wide, each roll containing 720,000 "subjects."

The white space between these stamp "subjects" is approximately 7/64 inch, and provides the track within which, to avoid mutilation and consequent rejection of the stamps, the perforations, 3/64 inch in diameter, must be held.

Before the application of the phototubes to the task, the control of the perforating machine depended wholly upon the skill of the operators in making individual mechanical adjustments of both longitudinal and lateral positioning of the perfora-

[*Continued on page 295*]

Television Transmitters Planned

P. T. Farnsworth tells press at Philadelphia demonstration that three 7-meter transmitters are under way. 20 kw. stations to have 30-mile range

On July 30, before an audience composed of members of the newspaper press and radio editors, Philo T. Farnsworth of Farnsworth Television, Inc. of Philadelphia, demonstrated the latest advances in his system of television. The demonstration consisted of a half-hour program of film and direct pick-up subjects, consisting of Mickey Mouse cartoons, sections of musical comedy and, for the direct pick-up, an orchestra and vaudeville performance.

Transmission was accomplished by two means: wire and radio. The wire transmission was sent over a short wire circuit having a frequency band width of approximately two megacycles, while the radio was sent from a 15 watt transmitter on approximately 40 megacycles over a distance of about 50 ft., to a standard receiver mounted in a console. This latter receiver contained both sound and sight equipment with a conventional 7-in. cathode ray tube for creating the image. The receiving end of the wire line transmission consisted of a special receiver and a very large cathode ray tube (14 in.

Above, R. A. Rutherford of Farnsworth staff shows image dissector used in film transmitter. At left, Philo Farnsworth and his television-sound console. The large tube at the upper left produces a 10 by 12 inch black and white image

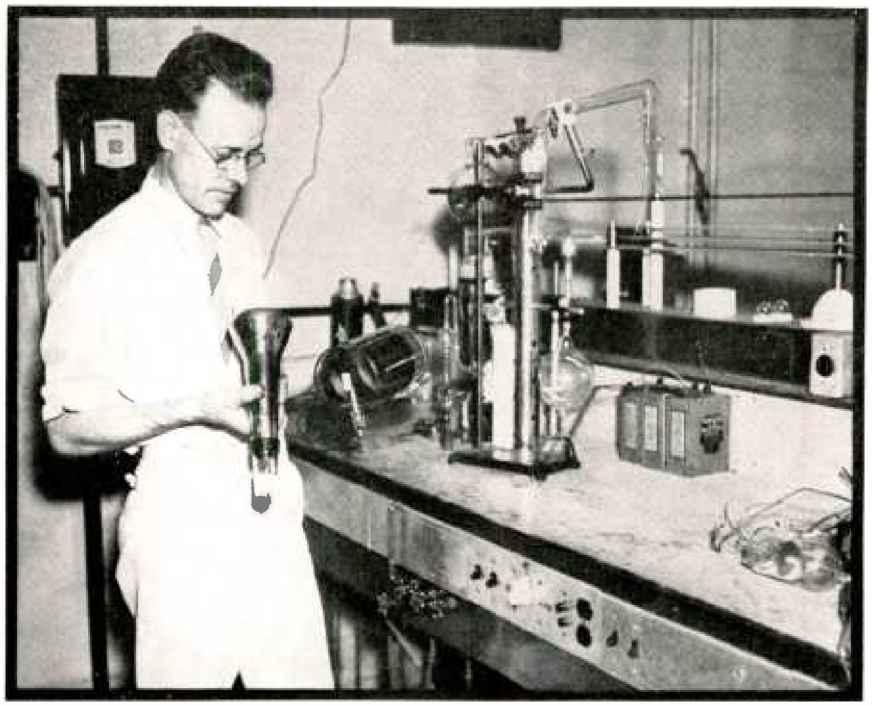
in diameter). The fluorescent coating on this latter tube consisted of compounds of calcium, zinc, chlorine, tungsten and silicon, and produced a brilliant image in black and white, with a very faint pinkish cast. The pictures were sent at a rate of 24 complete images per second, interlaced two-to-one, i.e., a scanning frequency of 48 per second. The picture was transmitted at 240 lines.

The result of the demonstration convinced the observers that a considerable improvement has been made during the past year by Mr. Farnsworth in his apparatus. The film pick-up, particularly, was of a very high order of excellence, and was the equal to the average home-movie in detail, brilliance and contrast.

In announcing his plans for the future, Mr. Farnsworth revealed that he has undertaken to build three television transmitters. The first, which is now under construction in San Francisco, has a power of 10 kw., which may eventually be increased to 20 kw. A 20 kw. station is to be installed in the laboratory of the Farnsworth Company in Chestnut Hill, Philadelphia, and a third transmitter will be installed later in New York City. These transmitters are of unusual design, in that they make use of the Farnsworth multipactor tube, a cold cathode electron multiplier (see ELECTRONICS, August, 1934, p. 242). According to Mr. Farnsworth, a single tube of this type is capable of delivering an output of 10 kw. of useful energy in the ultra high frequency range, and a water-cooled type of this tube is now in development for this purpose. Two tubes operating in push-pull will supply 20 kw. output for the proposed transmitters.

A master-oscillator power-amplifier type of transmitter is to be used. The oscillator is a small electron multiplier tube operating at approximately 20 megacycles, which is followed by a frequency doubler stage and a final amplifier. Modulation will be applied to the final amplifier if audio frequency equipment capable of delivering 1 kw. of power at television frequencies can be developed, the 1 kw. being sufficient to completely modulate the 20 kw. output. If this is not possible, modulation will be applied through the stage preceding the final amplifier.

Various commercial agreements have been undertaken by the Farnsworth interests in relation to patents held by the company. Philco Radio & Television Co. of Philadelphia has been licensed under these patents for the manufacture of television receiving equipment. Heintz & Kaufmann have similarly been licensed for the manufacture of transmitting equipment, and reciprocal license agreements have been contracted with the Baird Television interests of Great Britain.



Mr. Farnsworth with two pick-up devices. The image dissector in his left hand produces an electron picture from the visual image focussed on it

Perforation

[*Continued from page 293*]

tors. However, with a paper speed through the machine of 255 feet per minute, equivalent to the perforating of 60,000 stamps a minute, the mutilation factor has remained an appreciable one, despite the highest skill on the part of the operators.

For the experimental machine now in operation in the Bureau of Engraving and Printing in Washington, the stamp rolls come with register marks printed on the web. One set of marks, to control the cross perforations, appears on the outside margin, there being one such register mark for each sheet of 400 stamps. Another series of marks, to control the longitudinal perforations, is printed down the center of the web.

On the perforating machine, one phototube is located so as to scan the marginal register marks, each one of which represents one revolution of the cross-perforating cylinder. The perforator is driven by a constant-speed motor and the gearing so arranged as to transmit approximately 101 per cent of the normal speed directly to the cross-perforating cylinder. This, of course, necessitates a variable speed arrangement and a series of differential gearings to increase or decrease the speed of the perforator unit. With the web always driven at a constant speed, the phototube control, through a spacing motor, makes momentary changes in the speed of the perforating cylinder. Simultaneously, the variable-speed transmission speeds up or slows down correspondingly to supplement the correction momentarily introduced by the spacing motor. The error in the web of the paper is a cumulative factor, frequently amounting to as much as 4/64 inch per sheet of 400 stamps.

The longitudinal perforations are controlled by a dual scanning head, which watches both sides of the series of center register marks. Variations laterally are transmitted to a pilot motor which moves the stamp web to right or left the necessary amount of the correction, held —except for abrupt changes—within an accuracy of plus or minus 1/100 inch. Independent mechanical adjustments of the longitudinal perforators, to take care of an uneven contraction of the web along the outer rows of stamps, is through a group of 22 wheels, each one of which can be moved separately from the others while the machine is in operation.

Views and Reviews

New books for the shelves of engineers in the electronics field: *Practical Radio Communication, Engineering Radiography,* and *Photoelectric Cells*

Practical Radio Communication

By Arthur R. Nilson and J. L. Hornung. *McGraw-Hill Book Company, 1935. 754 pages, 434 illustrations, end papers, tables, appendices, etc. Price $5.00.*

This large volume is aimed at the operating technician, the man who must handle apparatus whether it be broadcast control equipment, a marine installation, aviation, police or other mobile unit. The theory of the book is that the man who knows most about the equipment is best able to hold down the job. The designing engineer will naturally get his mathematical equations and derivations from one of the classic radio texts, but for an up-to-the-minute description of modern receivers, transmitters, antennas and power supply apparatus this new radio book is eminently worth while.

One may be inclined to quarrel with the preface which states that "radio has found its stride, its technique is quite settled." This reviewer is willing to place a bet that the authors will be amazed to find how out-of-date their book is before two years have gone by. (A most discouraging way radio books have!) Furthermore, the first paragraph of the first chapter states that "the precise nature of electricity is as undefined today as it was when electrical effects were first noticed centuries ago"—a statement which might give pause to a great number of serious scientists of this as well as of other ages.

There is a great quantity of material in this 750-page book. Many methods of measurement are indicated, many design formulas are cited, many practical problems are worked out and others left for the reader to puzzle his brain over.

Engineering Radiography

By V. E. Pullin, C.B.E., *Director of Radiological Research, Research Department, Woolwich, England. G. Bell & Sons, Ltd., London. (135 plus VII pages; price 45 shillings.)*

This book, beautifully printed and bound, written by one of the foremost authorities on the subject of X-ray practice, is intended to cover the practical applications of X-ray examination to engineering, i.e., the examination of castings, forgings, welds, by the use of X-ray and radium illumination. The book was written for the engineer and contains no material on the theory of X-ray formation, the subject being wisely confined to those matters which the engineer must understand in making and interpreting X-ray photographs. More than 250 photographs and diagrams are included in the book, including many interesting comparisons between X-ray pictures which reveal faults, shown beside pictures of the specimens themselves, cut open to show the faults.

The author opens with a general chapter on the principles of radiographic examination in which the possibilities and limitations of the method are emphasized. This is followed by chapters on apparatus and on the technique of taking radiographs. The major part of the book is taken up with the chapter on the interpretation of engineering radiographs, which is, of course, the most difficult aspect of the subject. The remainder of the book is taken up with the discussion of the special problems of radiographing welds and the use of radium (gamma rays).

Photoelectric Cells

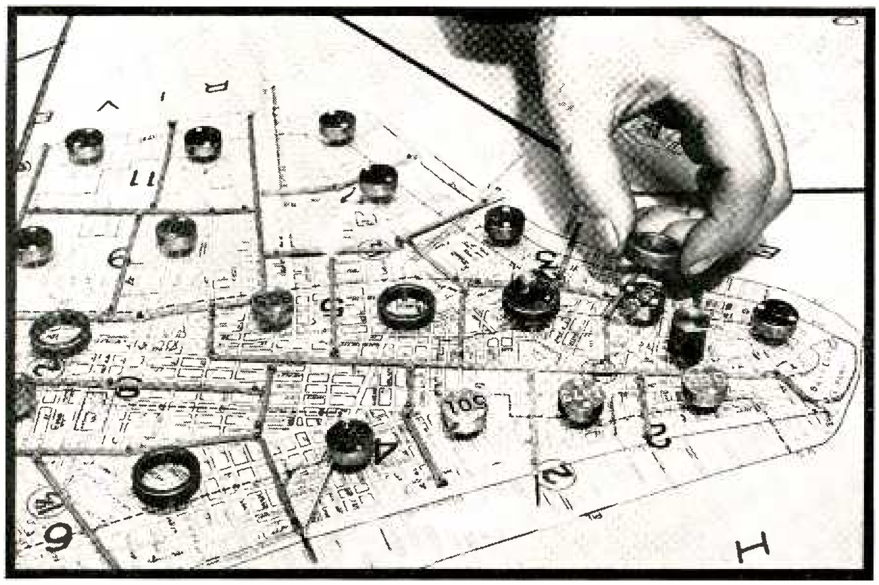
By Norman Robert Campbell and Dorothy Ritchie. *Third edition. Isaac Pitman & Sons, 219 pages, 69 illustrations. Price $3.75.*

The first edition of this useful book came out in 1929. The third edition is now available, an interesting commentary on the rapidity with which the photoelectric art changes. Since the first edition was published the entire realm of using phototubes for purposes other than sound motion pictures or as laboratory devices has developed. The general and industrial public has become aware of the potentialities of a beam of light.

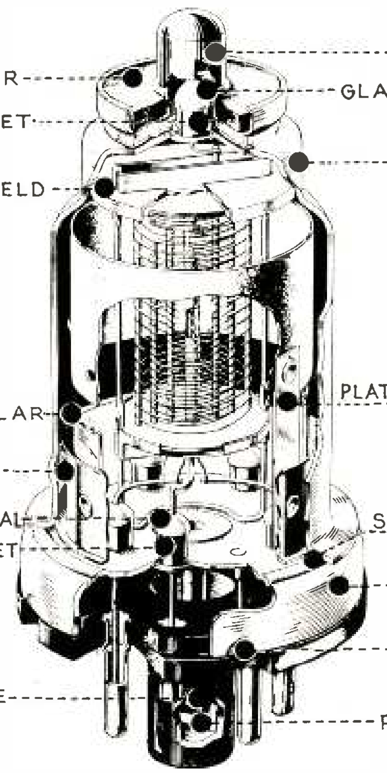
In this edition the authors have taken advantage of the fact that several other books on the subject have appered, some on the tubes themselves, and others on applications. They have confined their interest almost entirely to the phenomena underlying the phototube.

There is a chapter each on rectifier cells and conductivity cells. The "inner" and "outer" photoelectric effects are described in detail. Amplifier and other circuits to be used with light-sensitive tubes are described. The electronics expert will find this a most useful book.

KEEPING TABS ON NEW YORK POLICE CARS



Brass markers on this map of Manhattan indicate the position and condition of each radio-equipped police car in New York. A ring over the car marker indicates repairs needed. The marker on edge indicates car is being oiled. When a car answers a call, its marker is turned over so that the white numerals show; black numerals indicate the car is ready for service



Making Metal Tubes

Progressive photographs made in RCA Radiotron plant of the intricate processes entering the construction of radio's newest creator of obsolescence. Base diagrams, complete average operating characteristics, production figures, substitute tubes

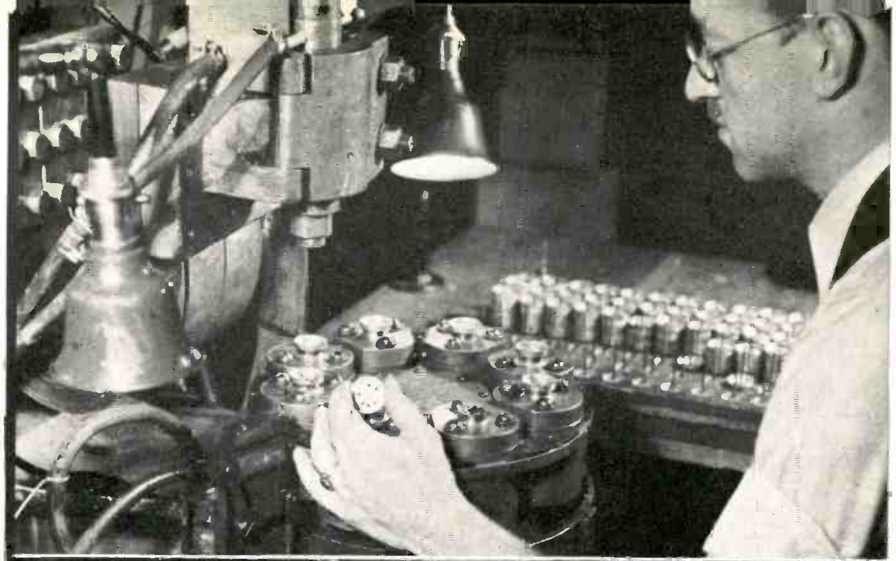
ALTERNATING current receivers, dynamic loud speakers, metal tubes—nothing in the radio industry has come along with such power to "date" radios. Predicted by the announcement in *Electronics* of Fernico, given definite warning by the General Electric all-metal power tubes, finally hinted at editorially, nevertheless their definite showing in New York in April seems to have come as a distinct surprise and shock to a major portion of the industry. And yet in August production on these totally different tubes, made by different manufacturing processes, of different materials is running in the order of over 2,000,000 tubes a month. Shrinkage is reported to be high, production difficulties still persist, set manufacturers worry because of small deliveries, portions of the industry worry about whether the tubes will ultimately cause trouble in service—but in spite of all these minor ailments, the vast majority of 1936 receivers will employ metal tubes, designed by G.E.

Several other tube series have appeared, each with an existence that is problematical. They are the Arcturus metaglass tubes, glass envelopes with octal bases exactly like those used on the metal tubes, the Triad metal-shielded tubes which are "non-breakable, fully shielded, metal tubes in which a newly developed glass is used for maintaining the vacuum." Similar tubes are available from Hytron, Republic and from several of the manuafcturers who are making interim tubes until they get the bugs ironed out of the metal tube machinery. These tubes, all of which use the new base may find permanent places in the receiver business, or they may pass out completely. Time alone will tell.

On the following pages will be found a step-by-step photographic story showing the construction of one of the typical metal tubes. Following these photos, made for *Electronics'* readers in the Radiotron plant at Harrison, New Jersey, will be found the average operating characteristics, the base diagrams, and a full page chart giving the comparisons of the new tubes and their nearest prototypes in the older glass envelopes. Metaglass, and metal-shielded tubes of the types employing more or less glass in the envelope and seals have characteristics which make them replaceable with the glass tube series. Several of the well known manufacturers use these tubes in preference to the metal lines. Others use some glass and some metal tubes.

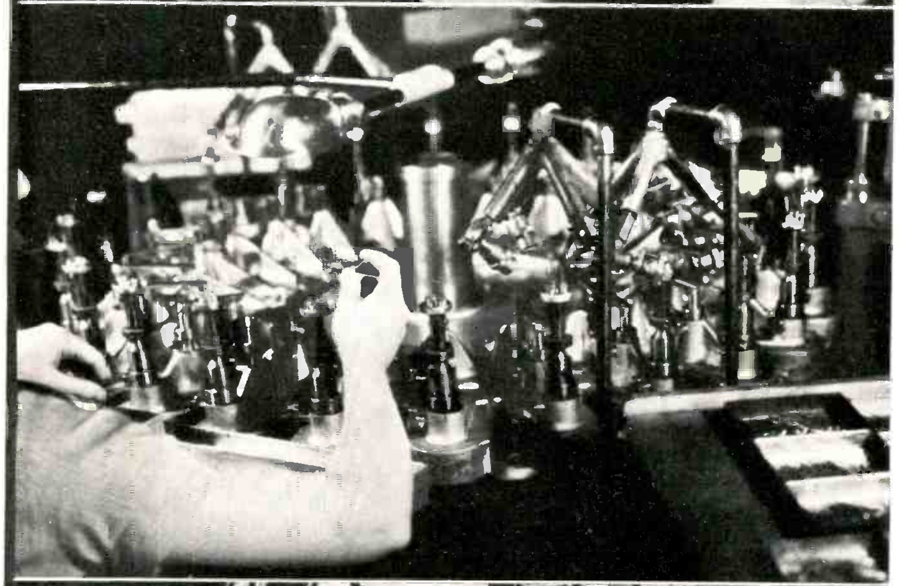
The front cover photograph of the thyratron controlled welding equipment used for joining metal shell to the header was taken in the plant of Tung-Sol.

Making Metal Tubes



1

The header (in operator's hand) is the stamped and perforated foundation of the tube. Metal eyelets of Fernico, inserted in the perforations, are welded to the header in this first assembly operation

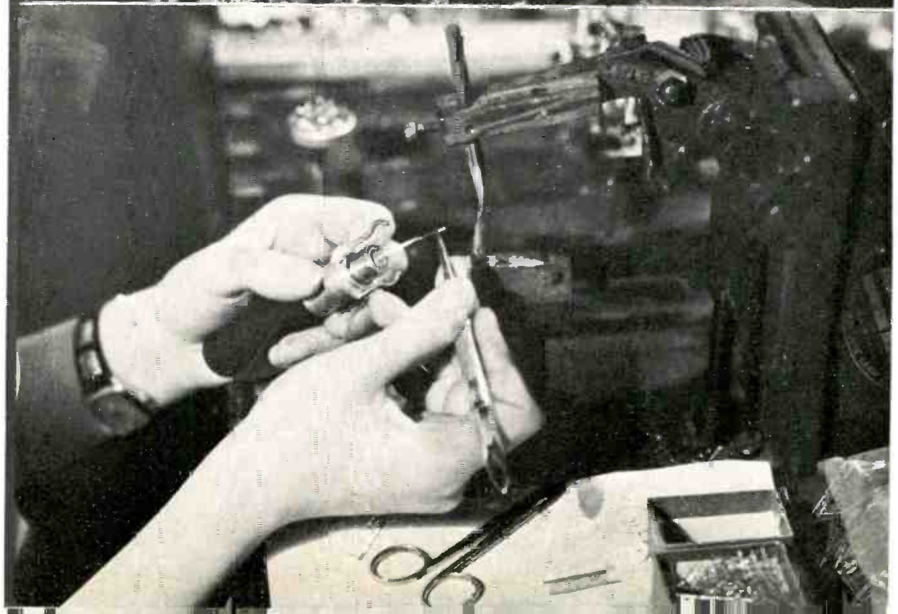


2

Glass-beaded lead wires are then inserted in the header eyelets, and the assembly is carried through gas flames which melt the glass beads, forming a permanent air tight seal between glass and metal

3

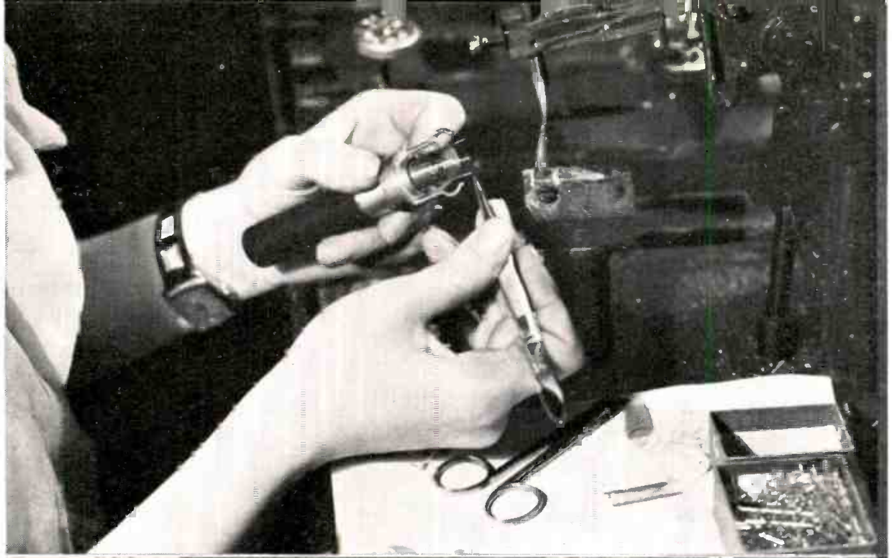
The metal exhaust tubulation, through which the tube is pumped out, is then welded to the header. A thyratron-controlled power welder performs this operation, after which the assembly is ready for the element structure



4

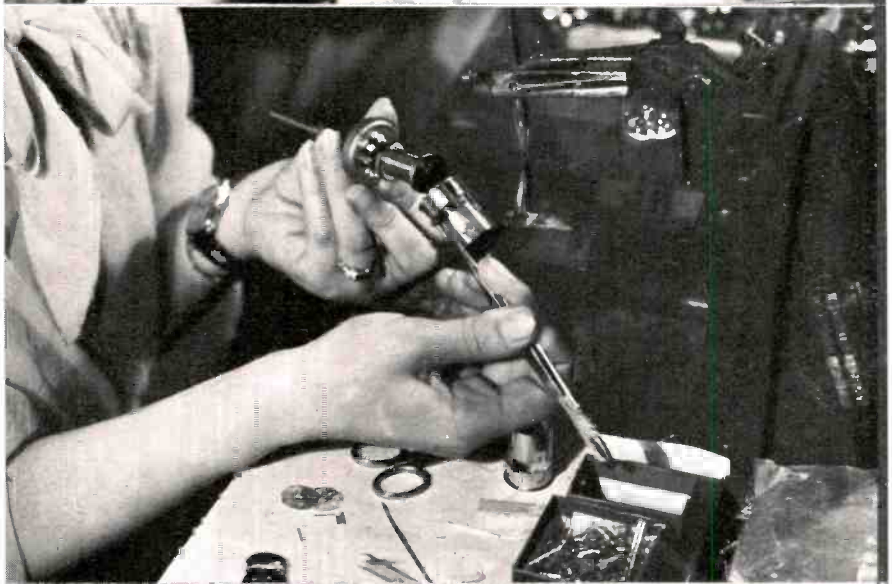
The element structure is assembled by means of a jig, shown in use here by the operator who is inserting a cathode sleeve. Necessary welding operations are performed by the small spot welder shown behind the jig

Making Metal Tubes



5

Assembling a grid on the mount. The jig used for assembly of the elements serves not only as a mounting tool, but also as an accurate gauge for maintaining the proper separations between the elements

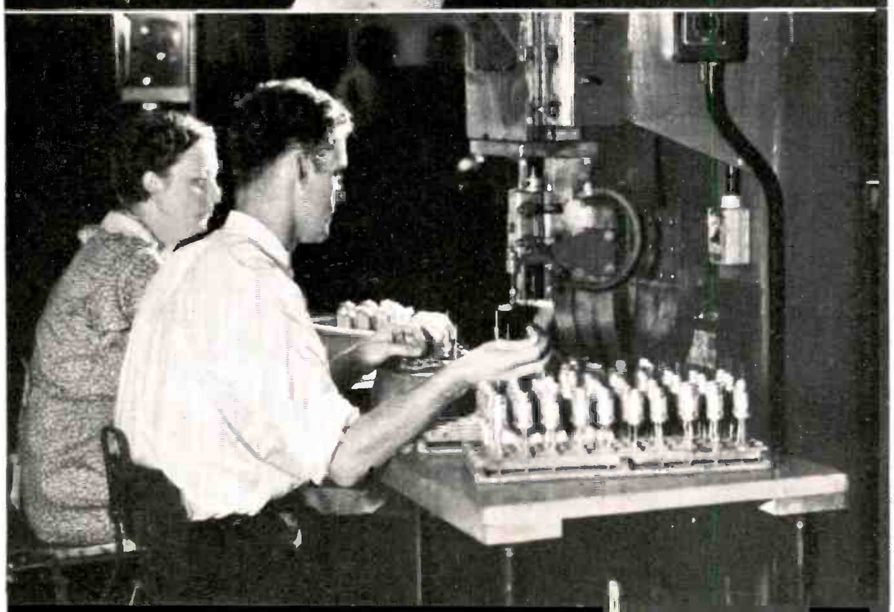


6

Fitting the plate over the assembly. The plate unit consists of the plate itself, attached to a flanged collar by means of mica support strips. The collar is welded to the header in a later operation

7

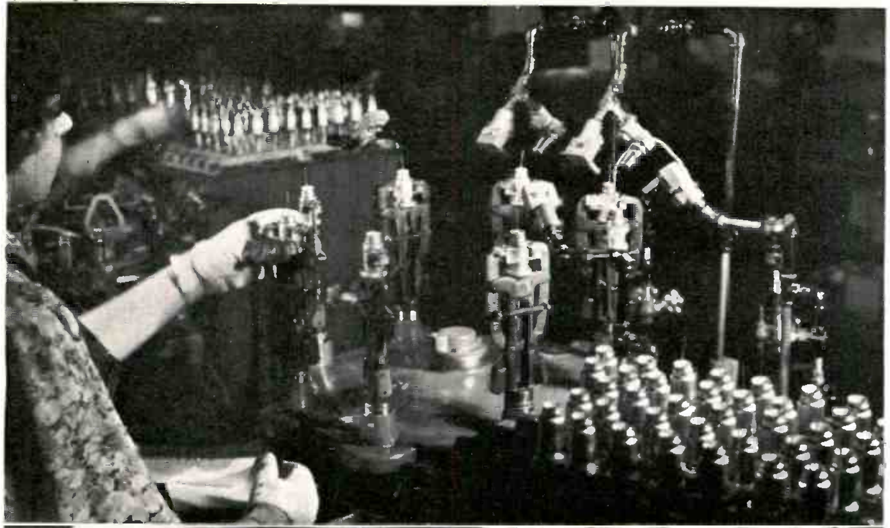
The outer metal shell, stamped with the type number, is then fitted over the completed element structure. The grid lead, which protrudes through the top, is provided later with a glass bead



8

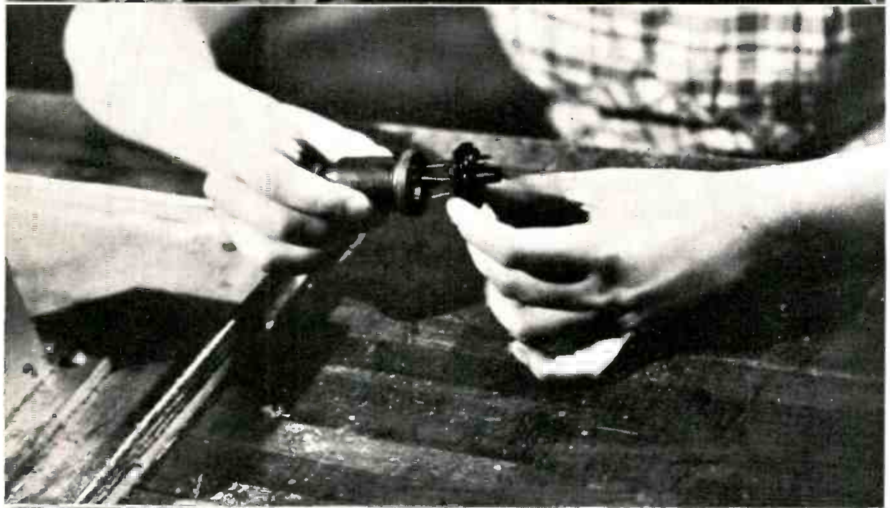
A welding current of 75,000 amperes is then used in this machine to weld the metal shell to the header, forming the all-important air-tight joint. Except for sealing the grid lead the tube is ready for pumping

Making Metal Tubes



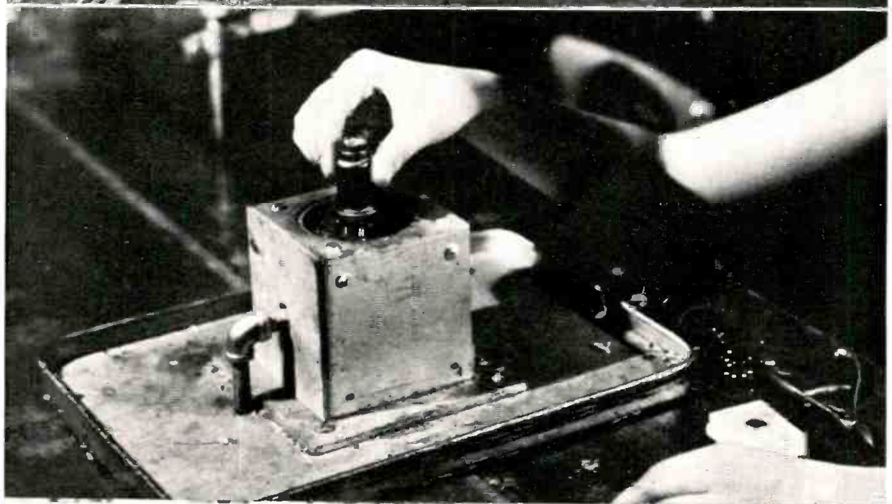
9

Sealing in the grid-cap lead. Gas fires melt a small glass bead down around the cap lead wire and the eyelet in the top of the metal shell, thus closing the last seal before pumping



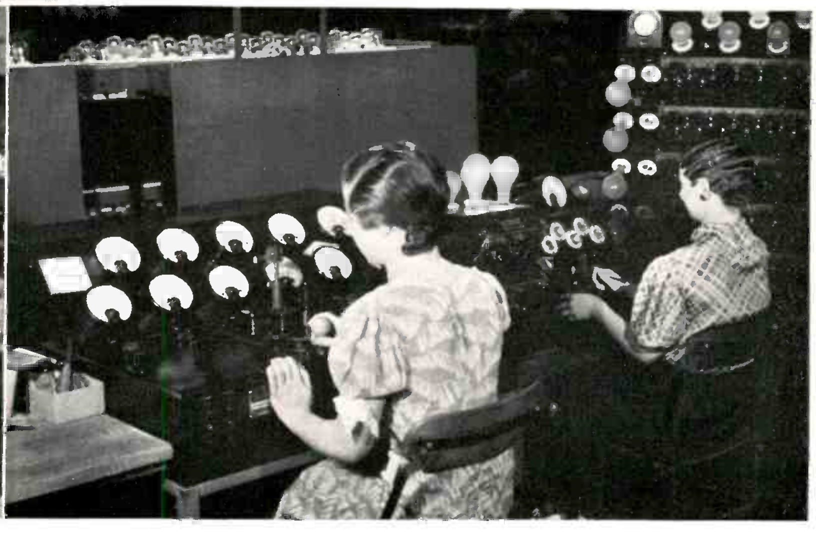
10

After pumping, the exhaust tube is welded, and the tube is fitted with its octal base, as shown here. Greater skill on the part of the operators is necessary to perform this operation quickly and accurately



11

Soldering leads to the base pins. When the leads have been trimmed, they are dipped in molten solder. This is virtually the only operation which has been carried over from the glass-tube manufacturing technique

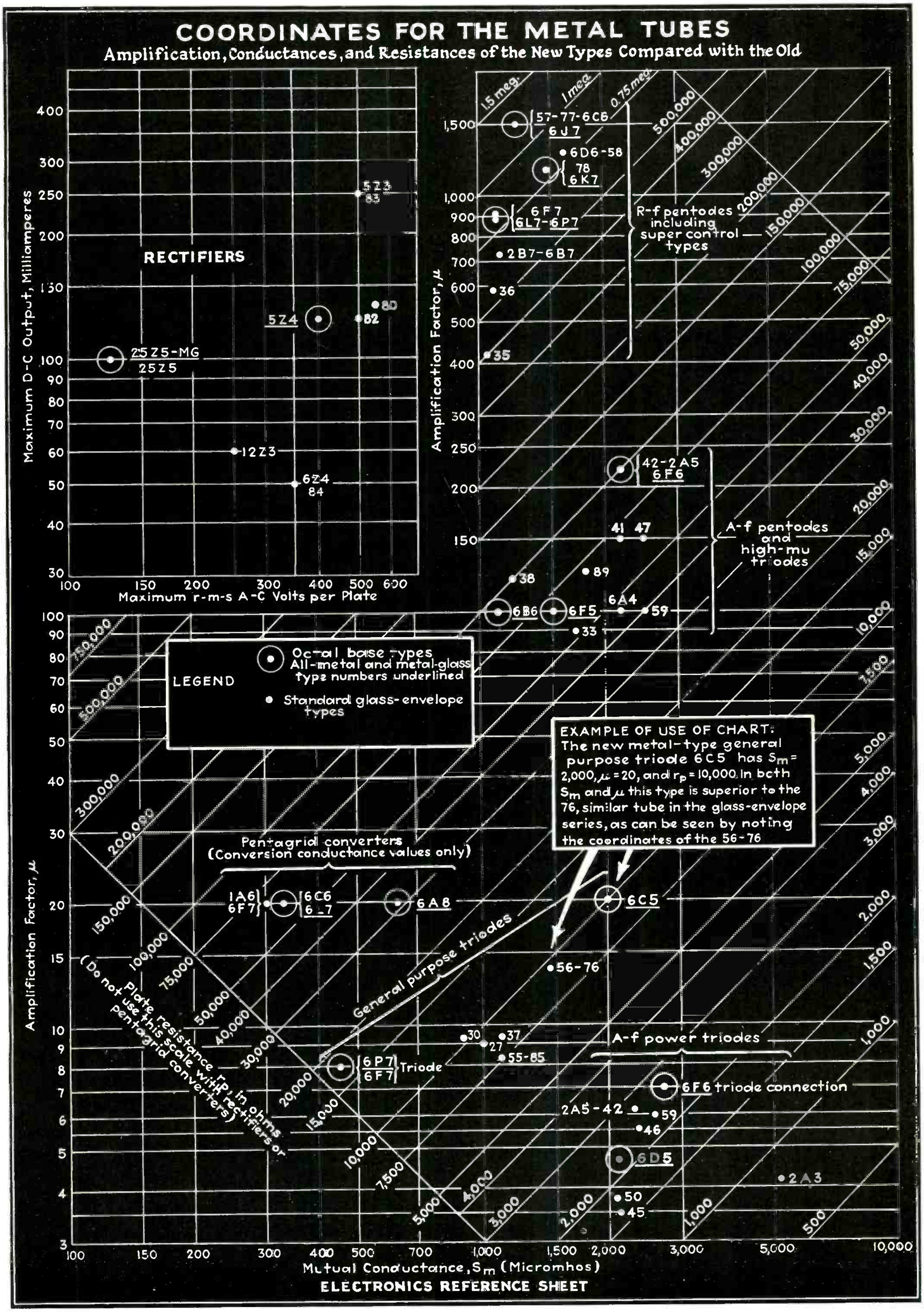


12

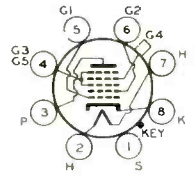
Seasoning the tubes. Before final inspection, the tubes are placed on a seasoning rack where they are operated for a length of time sufficient to stabilize their characteristics

13

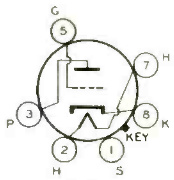
Electrical testing. Following the seasoning schedule, the tubes are given many tests, such as checks for emission, gas, noise, shorts and cathode current. Painting and reinspection completes the tube.


COORDINATES FOR THE METAL TUBES
Amplification, Conductances, and Resistances of the New Types Compared with the Old
RECTIFIERS
Maximum D-C Output, Milliamperes
Maximum r-m-s A-C Volts per Plate
5Z3
83
5Z4
80
82
25Z5-MG
25Z5
12Z3
6Z4
84
Amplification Factor, μ
57-77-6C6
6J7
6D6-58
78
6K7
6F7
6L7-6P7
2B7-6B7
36
35
R-f pentodes including super control types
42-2A5
6F6
41
47
A-f pentodes and high-mu triodes
38
89
6B6
6F5
6A4
59
33
LEGEND
Octal base types All-metal and metal-glass type numbers underlined
Standard glass-envelope types
EXAMPLE OF USE OF CHART: The new metal-type general purpose triode 6C5 has Sm = 2,000, μ = 20, and rp = 10,000. In both Sm and μ this type is superior to the 76, similar tube in the glass-envelope series, as can be seen by noting the coordinates of the 56-76
Pentagrid converters (Conversion conductance values only)
1A6
6F7
6C6
6A8
6C5
General purpose triodes
56-76
Plate resistance rp, in ohms (Do not use this scale with rectifiers or pentagrid converters)
30
37
27
55-85
6P7
6F7
Triode
A-f power triodes
6F6 triode connection
2A5-42
59
46
6D5
2A3
50
45
Mutual Conductance, Sm (Micromhos)
ELECTRONICS REFERENCE SHEET

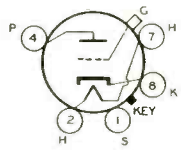
Metal Tube Base Diagrams



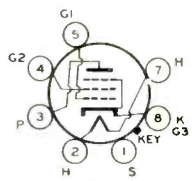
6A8



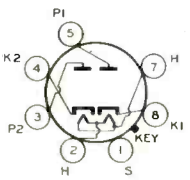
6C5



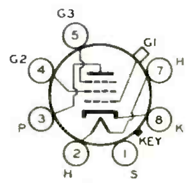
6F5



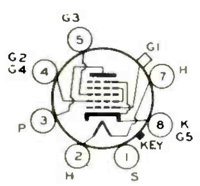
6F6



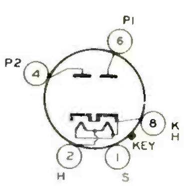
6H6



6J7
6K7

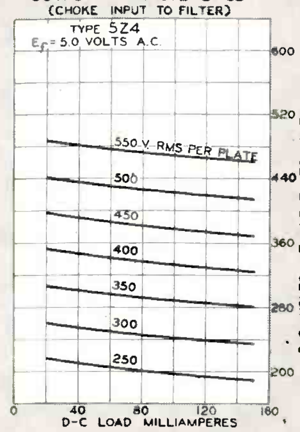


6L7

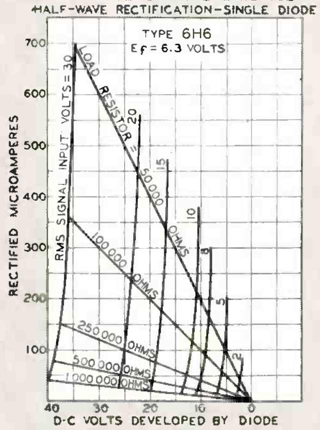


5Z4

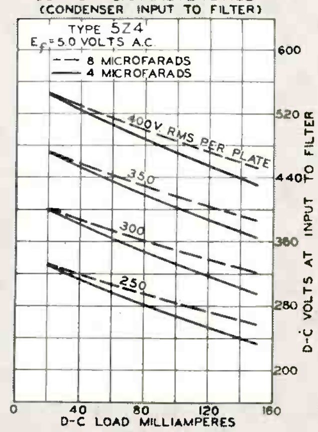
OUTPUT CHARACTERISTICS
(CHOKE INPUT TO FILTER)



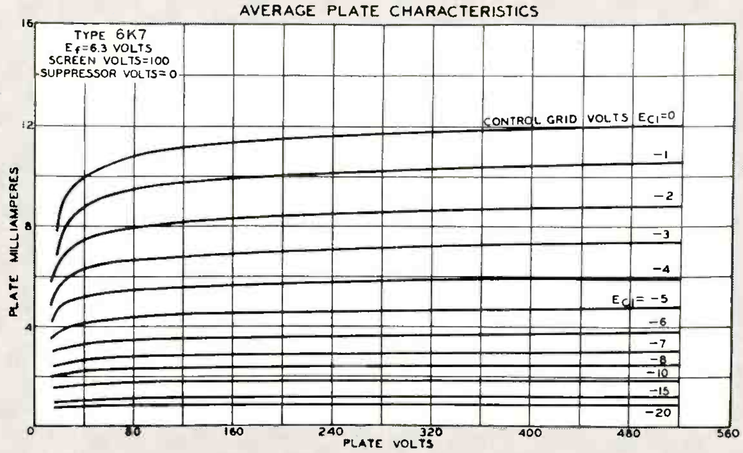
AVERAGE CHARACTERISTICS
HALF-WAVE RECTIFICATION-SINGLE DIODE



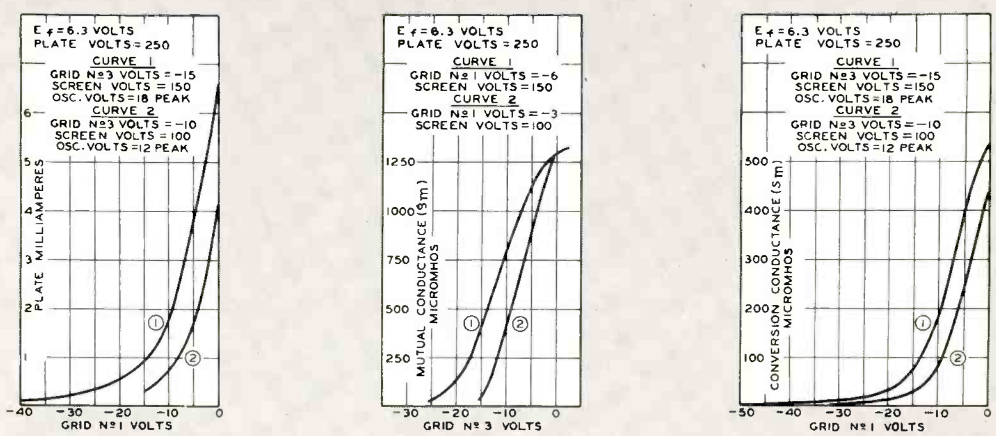
OUTPUT CHARACTERISTICS
(CONDENSER INPUT TO FILTER)



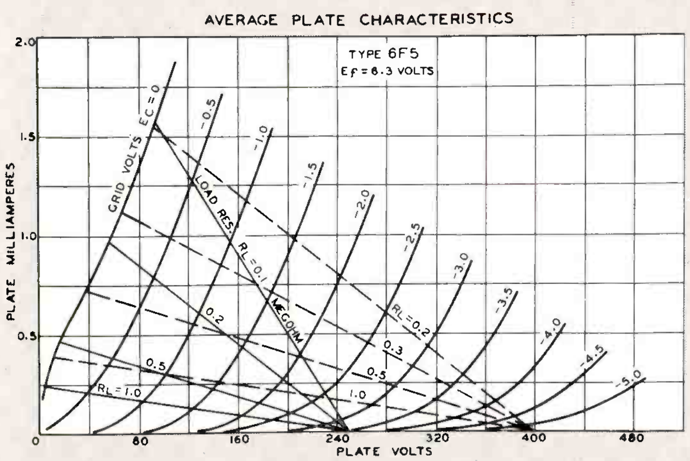
AVERAGE PLATE CHARACTERISTICS

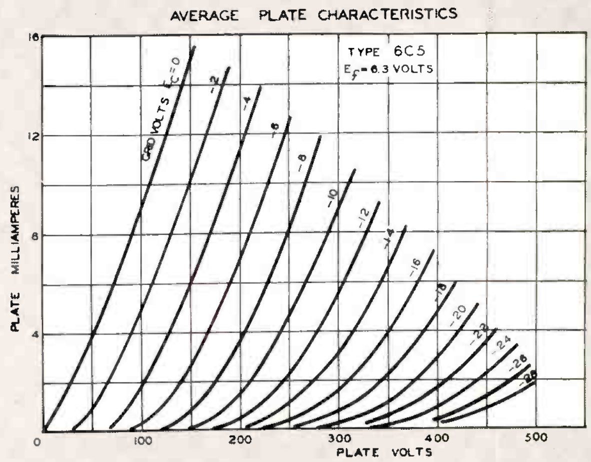


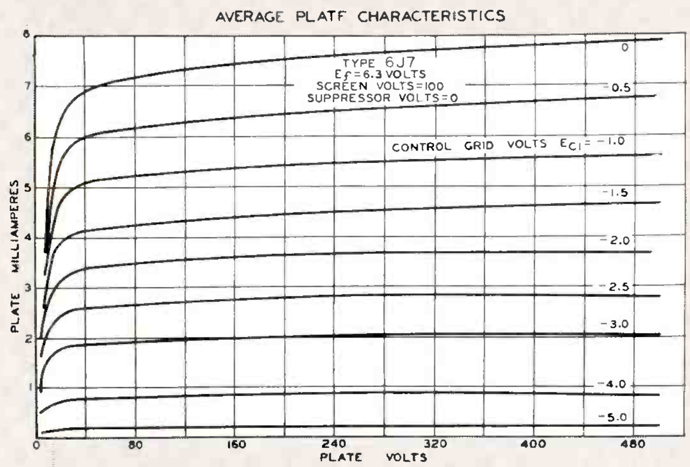
AVERAGE CHARACTERISTICS FOR TYPE 6L7

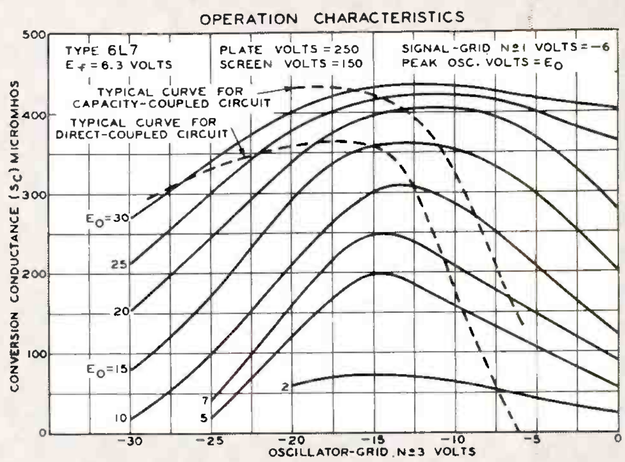


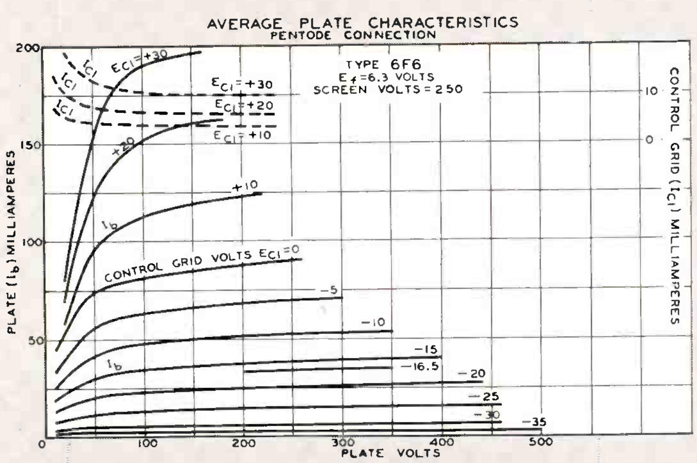
and Characteristics ▸ ▸ ▸

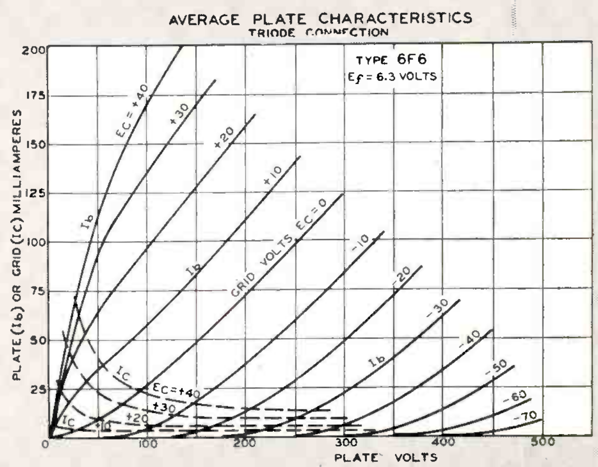












TUBES AT WORK

. . . Practical applications of electron tubes and circuits in the fields of communication, industrial control, and laboratory science

Three Useful Tube Circuits

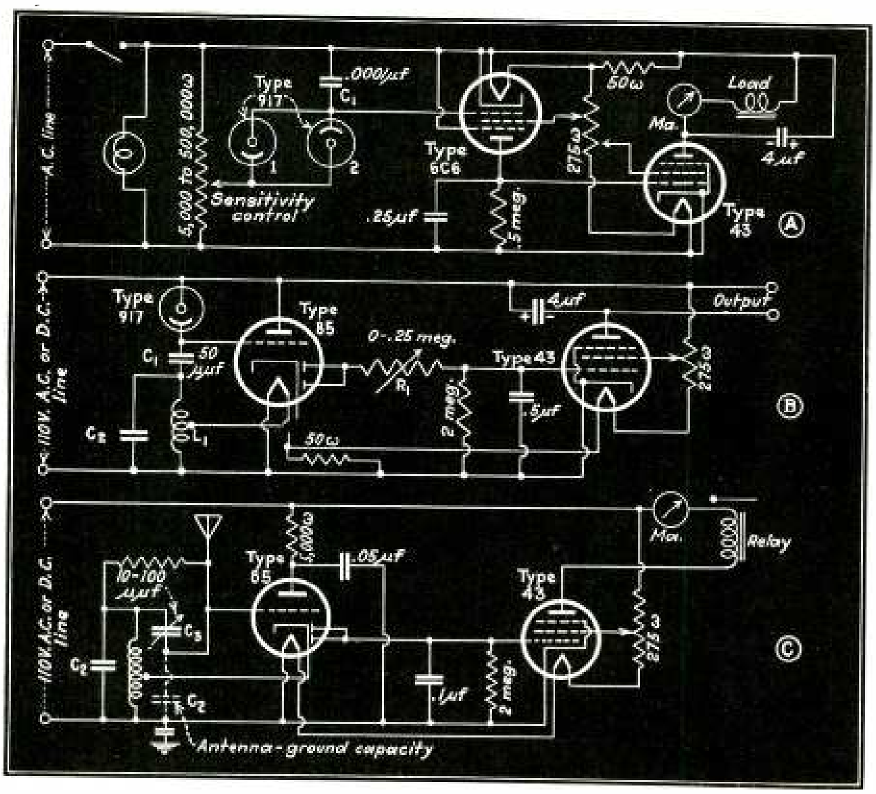
UNDER the title, "Miscellaneous Applications of Vacuum Tubes," F. H. Shepard, Jr., of RCA's Research & Development Laboratory, described before the Radio Club of America, some time ago, the circuits shown in the accompanying figure. Although these circuits have been circulated to a limited audience, through the Proceedings of the Radio Club of America, the editors feel that they are of unique interest in showing how simple commercial tubes and equipment may be adapted for use directly on an a-c line for a variety of control purposes. Accordingly, they are reprinted here.

The circuit shown at *A* in the figure, a light-ratio indicator circuit, is designed to indicate the ratio of the light falling on the two photo cells. Since this ratio is independent of the absolute value of the light, the device is independent of change in light intensity. By the use of filters it is possible to use this circuit for color matching with considerable success. As indicated, the circuit works directly from a 110-volt a-c line, and consists solely of standard tubes, resistances and condensers. When the light on the two photo cells is unequal, condenser C_1 charges until the current through the cells is equal; this change of d-c voltage on the condenser is amplified and used to operate the relay or other load. The amplifier shown is a d-c amplifier which operates directly from an a-c supply voltage.

The circuit shown in *B* is a relaxation-type photo current amplifier, of use in the measurement of slow light variations. This circuit operates directly from 110-volt a-c or d-c lines, and has extreme sensitivity. The type 85 tube is in an oscillator circuit which builds up a negative charge on its grid and thus blocks oscillation. This charge is allowed to leak off through the photo cell until the oscillation can begin again. The time between each pulse of oscillation is controlled by the time constant of the photo tube in conjunction with the condenser C_1, there being a linear relation between the frequency of relaxation and the light on the photo tube. The double diode sections of the 85 tube rectify the oscillation pulses and feed them to a type 43 tube which in turn controls the output load.

The circuit shown at *C* is a capacity-operated relay, for use in so-called space control devices. The type 85 tube in this circuit acts as an oscillator whose feed-back is controlled by the capacity of a small antenna to ground. As this capacity is varied by the presence of, say, the body capacity of the operator, amplitude of oscillation increases. The diode section of the tube develops a voltage equal to the peak oscillator voltage, and this peak voltage is fed to an output tube which controls the relay. In the demonstration a person holding his hand about 5 ft. away from the antenna could cause a variation of 2 or 3 milliammeters in the output by wiggling his forefinger.

The three circuits given above represent extremely ingenious use of standard equipment for operation on 110-volt lines without auxiliary equipment. They can no doubt be put to many other uses than are suggested here.



Three circuits for performing control functions, designed to operate directly from 110 volt lines

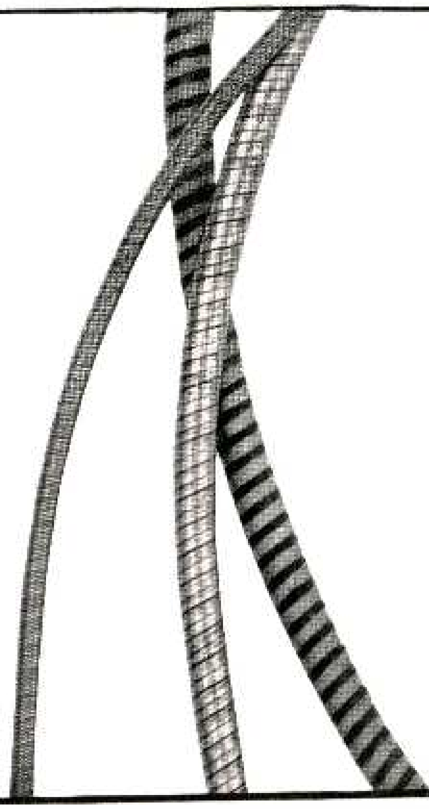
Thyratron Motor Used in Fan Drive

ELECTRONIC commutation of large electric motors was developed by General Electric engineers several months ago. and described before the A.I.E.E. last January. Now it appears that the application of such a thyratron motor in a 400-hp. installation has been made by the American Gas & Electric Co., New York. The application was made in this case to an induced-draft fan drive in a generating station. In such fan systems variable speed control is essential if high efficiency is to be maintained. Electronic control of commutation has resulted in a-c speed control which is comparable to the speed control obtainable in a shunt d-c motor.

Photo-Tube Regulates Store Lighting

PHOTO-ELECTRIC control of the illumination level in a men's clothing store has been instituted at Wallach Brothers, a Fifth Avenue haberdashery in New York. Three 200-watt lamps are provided in each ceiling fixture, each fitted with diffusing vanes for distributing the light evenly throughout the store. Photo-cell control units are installed in the walls and pillars of the store, and are so connected that they can operate two of the lamps in each fixture. The third lamp burns constantly.

Can you use this **smaller diameter flexible shaft** *on your auto radios?*



Shown above are actual size views of the .130″ shaft and the smaller casing with enlarged end and with flanged end. While the casing body is smaller than the No. 170A1, the ends, whether enlarged or flanged, are held to the same dimensions. Hence no change in design is necessary to use the smaller casing. For panel installations the No. 147A2 (galvanized finish) casing is recommended. For steering column controls, casing No. 147A1 (Parkerized finish) is usually supplied.

Like most auto radio manufacturers, you are probably using our .150″ diameter (No. 150L53) flexible shaft and its companion small outside diameter casing (No. 170A1) which we originated and developed for remote control of auto radios.

Now—it may be possible for you to use our latest development—a shaft of even smaller diameter, the .130″ (No. 130R33) remote control shaft, and smaller casing (No. 147A1) to match.

This smaller shaft and casing will provide most satisfactory results where the installation is less than two feet in length. For longer lengths, higher gear ratios are recommended.

There is economy, of course, in the use of this smaller diameter material, and also an even neater appearance.

WRITE for details of the .130″ shaft and companion casing. If you would like to have samples, we'll be glad to furnish them on request.

The S. S. WHITE Dental Mfg. Co. INDUSTRIAL DIVISION

Knickerbocker Building, New York, N. Y.

FLEXIBLE SHAFTS for POWER DRIVES, REMOTE CONTROLS and COUPLINGS

The photo-cell relays operate at two levels of illumination. When the daylight is strong, two lights are turned out in each fixture, but when the light falls to a somewhat lower value one of the lights goes on, and at still lower levels of illumination all three lights are turned on. An average general illumination of about 20 footcandles is thus constantly maintained regardless of external light conditions.

Chemical Materials Used In Television Apparatus

FLUORESCENT compounds, anode-focussing materials, and photo-sensitive substances are of special interest to those developing television, oscillographic, and other cathode-ray devices for both experimental and commercial purposes.

Studies on the image brilliance and the screen texture of cathode-ray tubes or kinescopes have called attention to the need for fluorescent powders that will produce a maximum luminosity, have a sufficient lag for image transition without appreciable flicker, and exhibit no after-glow for higher line images. Fine, free-flowing salts like the fluoride, sulphate or tungstate of calcium, as well as the sulphides and silicates of zinc and magnesium, have been used with some success. A synthetic zinc orthosilicate phosphor, highly resistant to burning by the electron beam, has been used where a short time-lag is required. Zinc sulphide will give a green color most suitable for visual work, while calcium tungstate produces the blue tone applicable to photographic studies.

Before applying the fluorescent chemicals to the glass tube envelopes, one removes any possible contaminating substances. Suitable binders for the powders include the silicates of potassium and sodium. These may be applied by a soft brush of suitable dimensions and should dry partially before carefully blowing on the fluorescent materials with a fine air stream.

Despite the efficiency of certain materials from the standpoint of luminosity the images may be further intensified by reducing light reflection within the tube, using for this purpose an aqueous suspension of colloidal graphite such as Acheson's "Aquadag." This material being highly conductive, conveniently serves as a ray-focussing or second anode. Not only are graphite films non-reflecting and conductive, but they are highly resistant to oxidation, will acquire "getter" characteristics when baked, and are chemically inert. These particles being of colloidal dimensions and possessing unusual adsorption powers, make unnecessary the use of binding agents. Colloidal graphite in water forms films which adhere to metal as well as to glass, thus insuring a homogeneous and tenacious layer, a good contact with lead-in wires and a coating for electron gun elements.

A simple combination of funnel, or aspirator bottle and air-vent, is employed for applying graphite to the interior of the tube following its careful cleansing with an oxidizing agent like chromic acid. Rotary motion in the case of the funnel method or change of height of the aspirator bottle for the second case enables one to control the areas covered by solution. For regulating the thickness of the deposited films, one dilutes with distilled water the concentrated graphite preparation as commercially sold. The treated envelopes are then dried with warm air and later baked at 450° C. in order to eliminate occluded moisture and decompose any protective colloid substances present.

Finally, the scanning screens or mosaics of such devices as the Zworykin iconoscope are produced by a direct evaporation in vacuo of an alkali metal on a signal plate of mica or of vitreous enamel. Such an evaporated film, likely to be very thin and non-continuous, consists of a conglomeration of minute spots or globules that are uniformly distributed and isolated one from another. The same effect may be more accurately produced by ruling the mosaic from a continuous metallic film by a ruling machine. The present technique utilizes a very large number of minute silver globules, each of which is photo-sensitized by caesium through a special process. Other mosaics consist of aluminum wires with a thin insulating layer of aluminum oxide covered by a conducting film of silver.

The above materials applicable to the optical and electrical functions of television apparatus are now commercially available for both laboratory and industrial use.

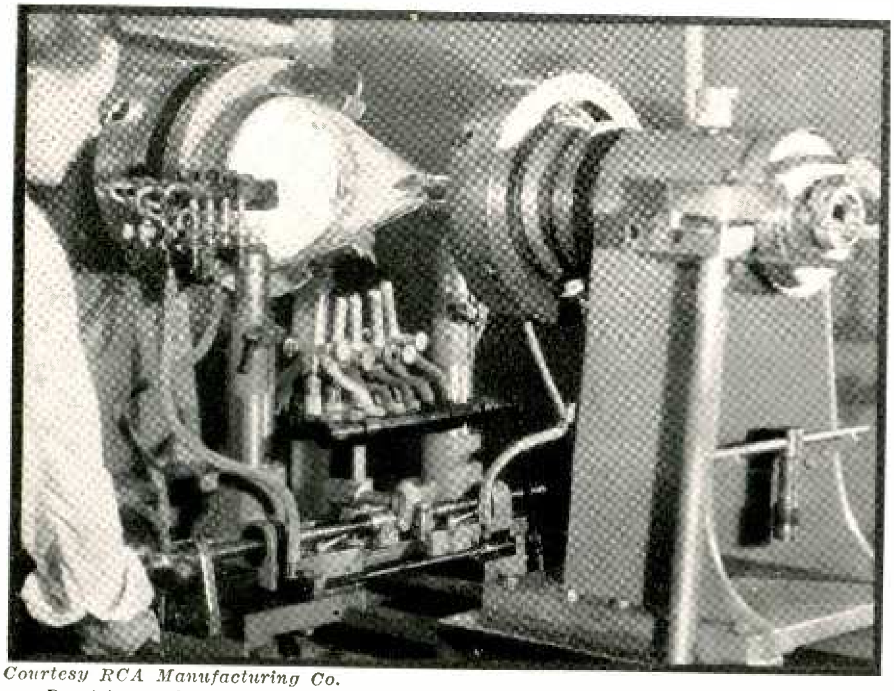
Editor's Note: In connection with the above discussion on chemical compounds in television, we are printing here a translation supplied through the kindness of Messrs. Pfaltz and Bauer, Inc., from a report made by the E. de Haen Works, Manufacturers of industrial and fine chemicals in Germany, concerning the difficulties in the use of fluorescent compounds for television use:

1. Not quite perfect purity of the glass; even purification with chrome sulphuric acid is not always sufficient. Hydrofluoric acid seems to be better for cleaning the bulbs.

2. Traces of gas on the inside glass walls; sediment on these walls which may have formed from the cathode mass, or sediment on these walls which may have formed from impurities coming out of the vacuum pump, which sometimes occur even when working with liquid air.

3. Use of incorrect or impure binders.

4. Dust. This is the worst enemy of the television compounds. In applying the television colors to the bulbs it is necessary to work in an absolutely dust-free room, and it must be seen to that not even the slightest particles of dust get into the television compounds when they are put into the bulbs.



Courtesy RCA Manufacturing Co.

Precision lathe for fusing deflecting electrodes into the glass side wall of a cathode ray tube. Three sets of fires melt and fashion the glass of the large bulb

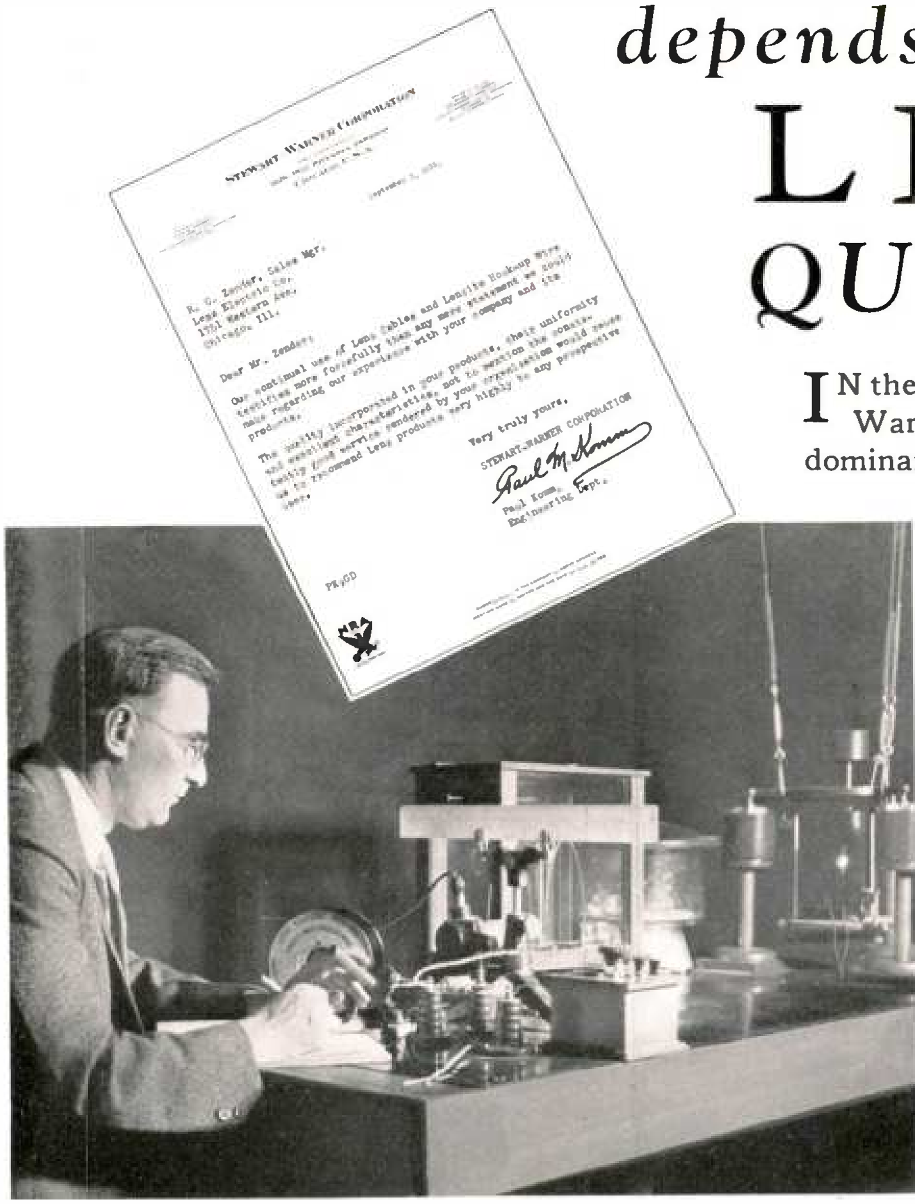
WTMJ Prepares Four-Stage Pickup for Golf Broadcast

IN CONNECTION with the Wisconsin State Amateur Golf Tournament held recently at the Pine Hill Country Club, 60 miles from Milwaukee, engineers of WTMJ had three short-wave transmitters in readiness. The first, a one-watt pack transmitter weighing 14 lb.,

STEWART-WARNER

depends on

LENZ QUALITY



IN the manufacture of Stewart-Warner Radios, the predominant idea is quality. Under the close scrutiny of Mr. Paul Komm only the best materials are selected for incorporation into Stewart-Warner's fine receivers. It is significant that Lenzite Hook-Up Wire and Lenz Cables are used in Stewart-Warner Receivers.

LENZ R. F. Circuit Hook-Up Wire

—selected by leading manufacturers for its outstanding Dielectric Characteristics.

At 70° F. 50% RH.

- **Power Factor**—One-half of one per cent at 25 meters (12 megacycles) completely immersed in mercury.
- **Phase Angle**—18 degrees and seven minutes.
- **Insulation Resistance**—83.000 megohms per foot at 400 volts D.C. completely immersed in mercury.
- **Capacity**—(to ground) 22 MMF. per foot at 25 meters (12 magacycles).
- **AC voltage Breakdown**—1600 volts per foot, completely immersed in mercury.

At 120° F. 90% RH.

- **Power Factor**—1% at 25 meters (12 megacycles) completely immersed in mercury.
- **Capacity** (to ground)—28 MMF. per foot at 25 meters (12 megacycles).
- **Moisture Absorption**—less than 1% by weight.

LENZ

ESTABLISHED 1904

LENZ ELECTRIC MANUFACTURING CO.

1751 NORTH WESTERN AVENUE, CHICAGO, ILL.

LENZ ELECTRIC MFG. COMPANY
1751 N. Western Ave., Chicago. Ill.
Gentlemen:
Please send me FREE 10-foot sample of Lenz R.F. Circuit Hook-Up Wire.

Size .... Solid ☐ Stranded ☐
Name ....
Company .... Dept. ....
Address ....
City .... State ....

and operating on 86 megacycles, was available for the sports announcer to carry with him to the greens. The second was a portable mobile short-wave transmitter operating on 40.6 megacycles with a power output of 5 watts. This transmitter, installed in a small coupe, was driven over the golf course, following the play. The third transmitter, a semi-portable 7½-watt transmitter, was set up on the porch of the clubhouse, and transmitted with 7½-watt power on a frequency of 2,102 kilocycles. A short-wave receiver set up in a ball park three and one-half miles away, in the city of Sheboygan, picked up the transmission from this latter transmitter and relayed it over wire lines 60 miles to the main transmitter of WTMJ. In addition, radio communication was maintained between the clubhouse and the car on the course for control purposes.

During the play it was found unnecessary to use the pack transmitter, since the microphone used with the automobile transmitter was equipped with a 50-ft. extension cord, so that the announcer was able to walk to the green easily. A regular automobile receiver was used in the coupe to receive the signals of WTMJ on the regular frequency of 620 kilocycles, thus providing a final check on the entire transmission. This complicated system of rebroadcasting equipment was made necessary by the fact that the one telephone line from the city of Sheboygan to the clubhouse was not available for broadcast purposes. Considering the difficulties under which the broadcast was carried out, the quality of the transmission was excellent.

Canada Installs Short Wave Receiver for British Programs

THE CANADIAN RADIO BROADCASTING COMMISSION has installed a central receiving station near Ottawa to pick up programs of the British Broadcasting Corporation for retransmission to the Canadian audience. Heretofore the Commission has been using the transatlantic radio telephone service for its overseas features, which, because of its high cost, greatly limited the possibilities of European retransmission in Canada.

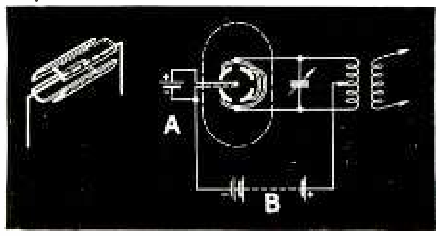
The new station occupies a 30-acre site 10 miles west of Ottawa, the location having been chosen because of its freedom from interference. Two aerials, 1,000 ft. apart, are used for signal pickup. The aerials, installed at right angles to the oncoming wave, exert a volume control action, since the fading of short wave signals rarely occurs at both aerials at once. The lead-in system consists of a concentric transmission line, filled with nitrogen gas at a pressure of 100 lb. per sq.in.

Two complete receiving units are used, one connected to each aerial, with a mixer which combines the outputs of both. This system, commonly called the diversity system of short wave reception, has been used successfully in transatlantic telephone and telegraph systems.

Because of the difference in time between Great Britain and Canada, it is inconvenient for Canadian listeners to hear British programs direct, since the evening programs in Great Britain arrive in the afternoon in Canada. To overcome this difficulty, electrical records known as "blattnerphone" recordings are made of the British programs when they occur, and are then rebroadcast later in the evening.

Microwave Transmitter

ON PAGES 284 and 285 of this issue is described a German system of using microwaves for aircraft detection. The circuit diagram below shows the general connections of the transmitter which generate the 10 cm. waves in this system. The A-battery lights the filament cathode, while the B-battery



is connected through the tuning inductance to the split anode. The magnetic field around the tube causes the electrons leaving the cathode to perform circular orbits inside the cylindrical anode structure. The changes in potential induced thereby in the anode structure cause the oscillations to be maintained in the tuned circuit.

Diffraction

[*Continued from page 292*]

diffracted electrons being recorded on a photographic plate. Structure investigations are made by comparing the relative intensity distribution curve, calculated for a definite model, with the observed angular intensity curve. This offers the advantage, over the crystal method, that the molecule is studied free from the effect of its neighbors and of the restraining crystal lattice. Much progress has been made in determining interatomic distances, because the observed patterns depend on interference between wavelets scattered by atoms *in the same molecule*. Work of this kind has been done by Wierl[17] and others.

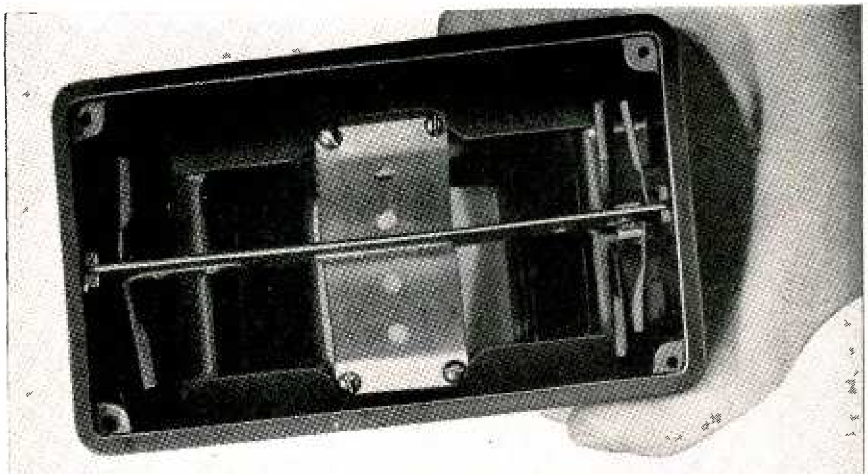
Soon after the demonstration of electron diffraction it was found that atoms and protons behave in much the same way. Johnson[18] found it possible, despite many experimental difficulties, to study the reflection of atomic hydrogen from cleavage surfaces of calcite, sylvite, and rocksalt, and from natural faces of quartz. Others have extended the field to include helium, mercury, and cadmium atoms. A. J. Dempster[19] showed that diffraction patterns could be obtained by reflecting protons from crystal surfaces. Rupp[20] made the interesting discovery that when positrons and negatrons electrons were passed through the same gold and aluminum films, the negatrons gave the usual rings, while positrons showed a continuous scattering.

As is the case with atoms and electrons, the de Broglie wavelengths associated with molecules also are in the X-ray region, so that rays of molecules incident on crystal surfaces show diffraction phenomena. In all cases there is considerable diffuse reflection along with the definitely directed reflection. Veszi[21] has shown that this is partly because the molecules are adsorbed and then re-evaporated 10^{-4} to 10^{-5} seconds later. When beams of He and H_2 were reflected from LiF, Stern[22] and his co-workers found conclusive evidence of diffraction from a surface *cross*-grating, the grating space being the distance between rows of *like* ions. Later, Zabel[23] diffracted He, Ne, and A from NaCl surfaces cleaved in *dry* air or *dry* hydrogen, and found patterns due to rows of adjacent *unlike* ions. But when small amounts of moisture were present there was evidence of a spacing twice as great, just as Stern found for LiF! Coper, Frommer and Zocher[24] studied the surface layers produced by rays of metal atoms and metallic salt molecules. Johnson and Starkey[25] produced thin layers of Hg atoms mixed with carefully controlled amounts of H_2, O_2, A, and CO_2. They then studied the conductivity of these adsorbed films. Many other applications of this interesting technique are given in a paper by Guillemin[26].

This admittedly incomplete account of the diffraction of material particles should at least serve to indicate the type of problem which can be attacked by this method. Many of these problems fall within the field of industrial applications of electronics.

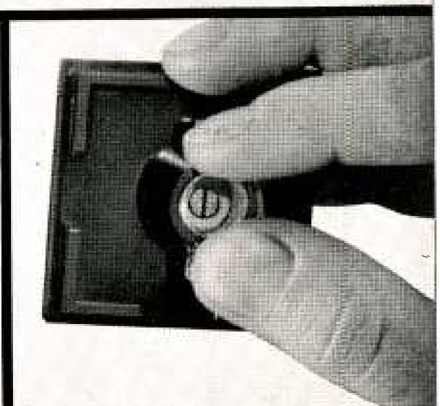
HOW to Avoid Costly Inserts

—Get benefits shown by these typical plastic assemblies



Notable economy effected by using Type "U" and Type "Z" Self-tapping Screws instead of inserts for securing contacts and covers to Bakelite case of knife sharpener.

Elimination of inserts by Type "U" Self-tapping Screws for securing parts to molded smoking set speeded up molding by 30% and assembly by 100%.



2½ cents a unit saved by Type "Z" Self-Tapping Screw replacing insert for attaching lamp receptacle to Bakelite base.

SCORES of assemblies like these are being made faster, cheaper and stronger since metal inserts were abandoned and Parker-Kalon Hardened Self-tapping Screws adopted for fastenings. Every day electrical manufacturers are proving that these unique Screws that form a strong thread in a plain hole are the long-wanted means of removing complications and expense in plastic molding and assembly departments.

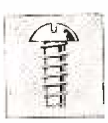
Applied in one simple operation, these Screws are bound to lower costs. No other method of making strong fastenings is so easy, fast, and economical. Inserts are costly and slow up molding work. To tap holes in the material for machine screws wastes time and labor, and often means breakage of expensive taps and scrapped parts. Where wood screws or machine screws are forced in, poor fastenings lead to expensive failures and complaints.

Not only do Hardened Self-tapping Screws effect economy, but they also make better fastenings. Tests show they *hold more securely than do machine screws in inserts or tapped holes.* Attach a brief description of your assembly to the coupon and we will furnish proper samples, free, for a trial of this better, cheaper method.

PARKER-KALON CORPORATION, 198 Varick Street, New York

Where and How to use:-

Type "Z" Hardened Self-tapping Sheet Metal Screws



For joining and making fastenings to sheet metal up to six gauge; aluminum, die castings, Bakelite, etc. Simply turn Screw into drilled, pierced, molded hole. It forms a thread in the material as it is turned in. Can be removed and replaced.

Type "U" Hardened Metallic Drive Screws

This type of Self-tapping Screw is used for making permanent fastenings to iron, brass and aluminum castings, steel, Bakelite, Durez, etc. Hammer Screw into a drilled or molded hole. It forms a thread in material as it is driven.

PARKER-KALON
HARDENED
Self-tapping Screws
PAT. IN U.S. AND FOREIGN COUNTRIES

FREE SAMPLES FOR TRIAL

Parker-Kalon Corp 198 Varick Street, New York

Send samples of Self-tapping Screws suitable for the fastening described on attached sheet.

Name ....

Company ....

Address ....

Parker-Kalon Products are sold only through recognized distributors

THE ELECTRON ART

. . . A digest of new advances in electronic theory and practice as reported in the technical press here and abroad

IN THE NEWS

THE Royal Society of England has conferred the honor of foreign membership upon Dr. Irving Langmuir, associate director of the G. E. Research Laboratory at Schenectady. Dr. Langmuir is one of eight Americans who hold foreign membership in this British scientific society which is limited to 50 persons throughout the world.

SAID Emperor Haile Selassie of Ethiopia: "We are building radio stations so that Ethiopia can participate in the intellectual life of the rest of the world. Any threat of war from Italy would interfere with this work, on which we wish to spend our whole time and energy."

IN announcing permission to construct the million-cycle coaxial cable between New York and Philadelphia, the members of the Federal Communications Commission said: "The Commission is of the opinion that the petitioners cannot monopolize the experimental advantages, features and uses of the coaxial cable to the disadvantage, exclusion and detriment of other parties." A. T. & T., builders of the cable, had petitioned for the right to use the cable exclusively for the development of television patents, whereas the Commission ruled that the experiments should be encouraged for "the public welfare and in the public interest."

THE New York Police Department is conducting tests with a view to installing two-way ultra-high frequency equipment for police radio system. Although details are not officially available, it is understood that transmission from headquarters to the cars would take place on conventional wave lengths, while transmission from cars to headquarters would take place on the ultra-high frequencies, with receivers located within the transmitting distance of each car, throughout the city, and connected with headquarters by wire line. Such a system would overcome the objectionable features of high frequency equipment, such as dead spots and short range.

THE first two-way police system in Ohio will be installed this summer in the city of Hamilton, the equipment to be of the ultra-high frequency type, similar to the system now in use at Boston, Mass.

THE Radio Corporation of America, in announcing a net income of $671,000, after expenses, for the second quarter of the year, stated that this figure represented an increase of approximately $135,000 over the corresponding quarter of last year. The complete report for the six months ended June 30 reveals the fact that the $300,000 allowed for amortization of patents was less than 1 per cent of the $39,000,000 gross income from all operations. It is interesting to note that during the same period the provision for Federal income tax was almost double that allowed for amortization of patents.

THE T.R.I. Reports, the monthly bulletin of the Television Research Institute, New York, contains accounts of many television programs sent over European stations, particularly in Berlin and London. A recent program entitled "Skyline," broadcast over the London sight-sound transmitter, consisted of a visual and aural tour of New York's interesting sections, interspersed with appropriate dance routines set to popular music.

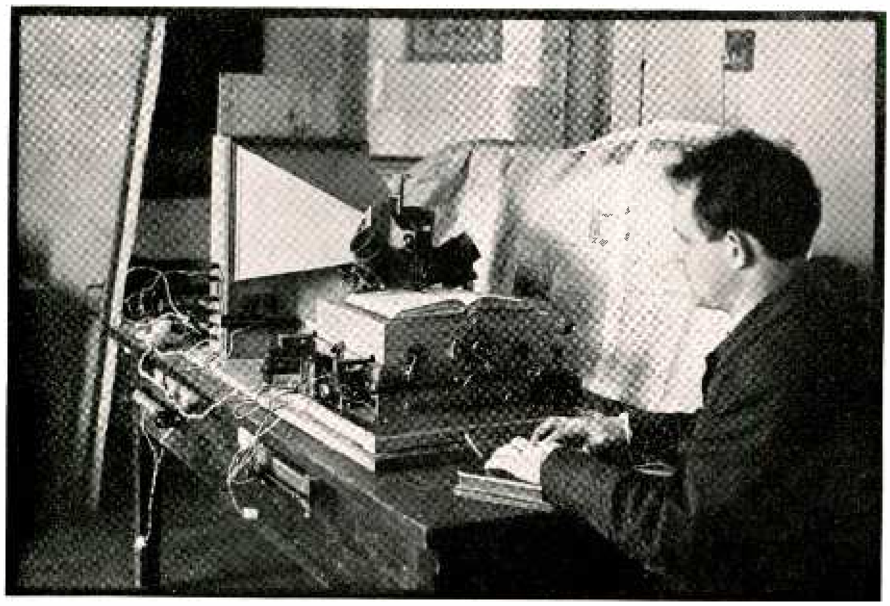
DOCTOR William Otis Hotchkiss, president of the Michigan College of Mining & Technology for the past ten years, has been elected president of the Rensselaer Polytechnic Institute, to succeed the late Dr. Palmer Chamberlain Ricketts.

SAID R.C.A.'s president, David Sarnoff, in a recent address: "Radio's willingness to adopt new things transcends the efforts of any other industry in the world, and in this willingness to discard quickly the present for the new, this eagerness to adopt new developments, lies the reason for its remarkable progress in such a short period of time. . . . You may be sure that we in the radio industry are cognizant of the steady increase in the demand of our people for the better things of life. In the research laboratories of the R.C.A. marked progress is being made in the development of television, of facsimile, which will ultimately provide new products and services, that should add to the nation's prosperity, help to increase employment, and advance the forward march of our cultural development."

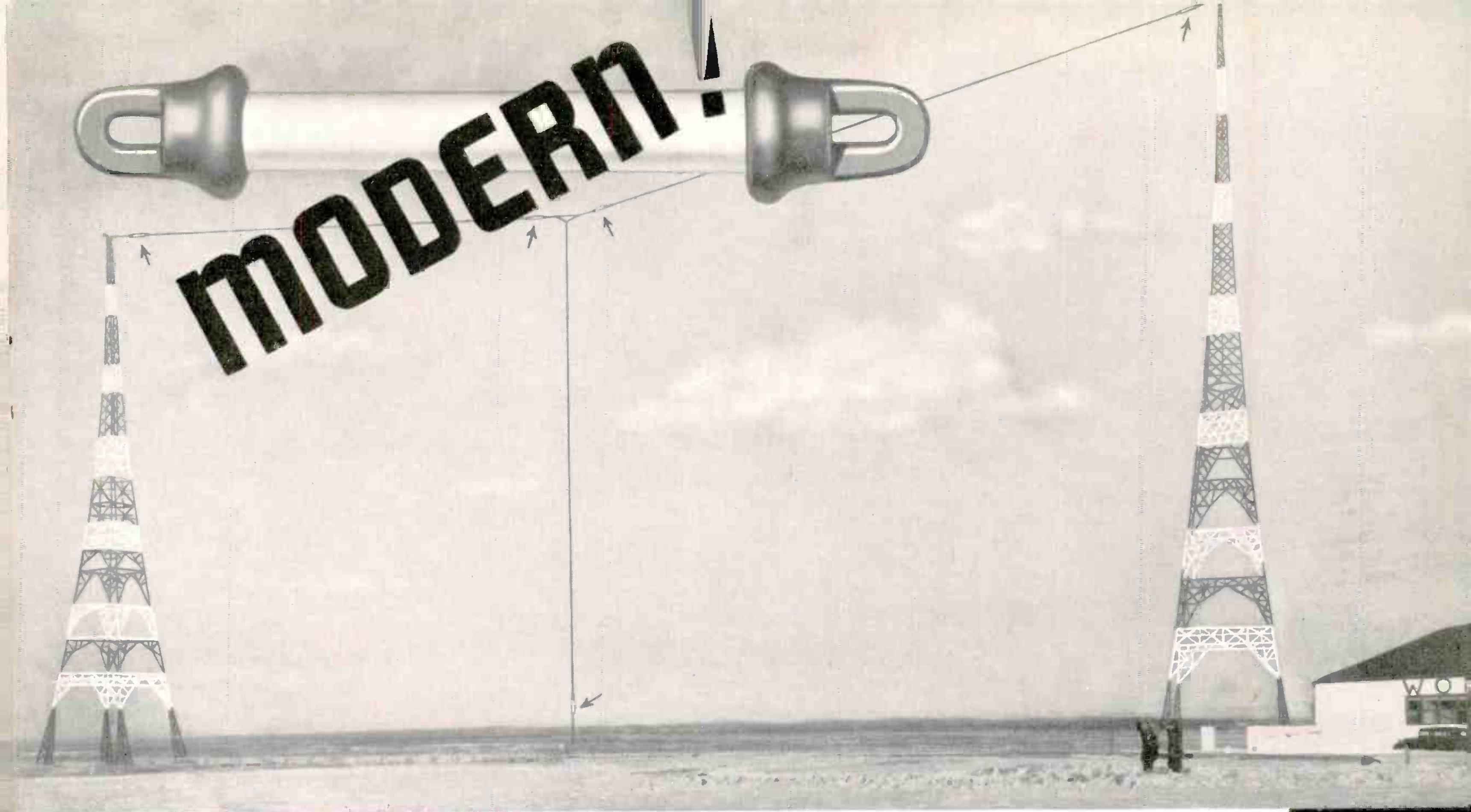
PATENT suits have been brought by the Aerovox Corporation against several manufacturers of dry electrolytic condensers for infringement of patents.

REPORTS that five meter communication between amateur stations of low power has been accomplished over dis-

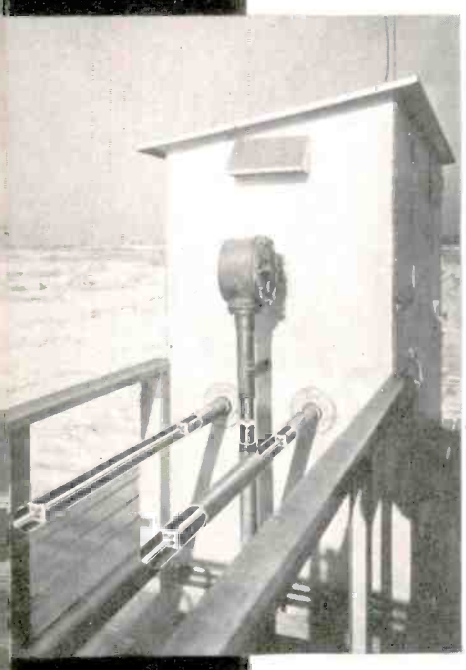
PHOTOTUBE "TRANSLATES" BOOKS FOR BLIND READERS



This device enables blind persons to read any book. A phototube slowly scans each line, the impulses being transmitted to a special desk, where the blind person interprets them by his sense of touch. The device was developed by the Ukrainian physicist, A. G. Goldman



Panorama of WOR 50 K.W. Broadcast Station



ISOLANTITE PLAYS AN IMPORTANT ROLE IN THE MODERN BROADCAST TRANSMITTER.

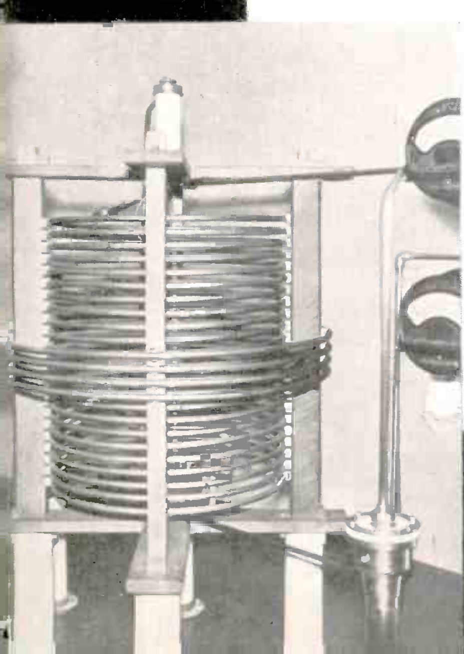
The 50 K.W. Transmitter recently built by Western Electric for Station WOR employs ISOLANTITE liberally.

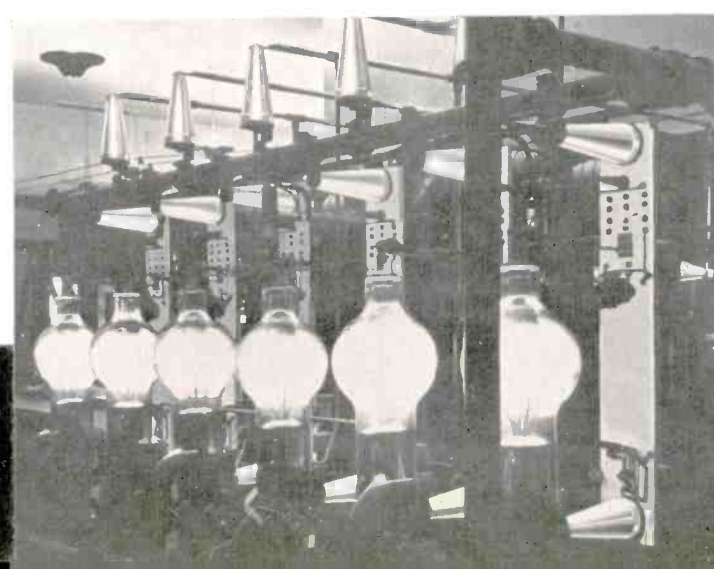
In this up-to-date station are strain insulators, concentric transmission line spacers and end seals, stand-offs, switches, shafts, inductance supports, power and rectifier tube supports, condenser cases, pedestals and many other parts of ISOLANTITE.

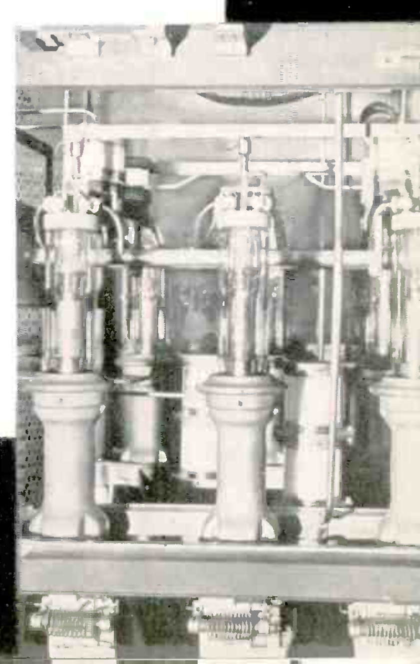
To improve your equipment, specify ISOLANTITE insulation. *Isolantite Inc., 233 Broadway, New York, N. Y. Factory at Belleville, N. J.*

Represented by GRAYBAR ELECTRIC CO.

Isolantite
CERAMIC INSULATORS







tances as great as 900 miles have been made by the American Radio Relay League at Hartford, Conn. The contacts are usually of short duration and are characterized by very rapid fading. Two-way conversations by radiophone on this frequency have been reported between Chicago and New York; confirmation of these transmissions has been made by the League amateurs. Experimenters in this frequency band have noticed a marked improvement in the dx conditions during the past two months, a condition which may be explained by sun spots or other cosmic activity.

IN the 28 megocycle band (10 meters) distances as great as from the United States to Australia have been covered consistently, and it is expected that it is possible for one amateur station to contact all continents of the globe on this frequency without difficulty, if conditions continue to improve.

The Article of the Month

"On Superregeneration of an Ultra-Short-Wave Receiver,"

By Hikosaburo Ataka, published in the Proceedings of the I.R.E., August, 1935, pages 841-884.

EDITOR'S NOTE:
From time to time, the editors will publish in "The Electron Art" abstracts of articles which they believe are of unusual value and timely interest. The purpose of the abstracts is to present in digested form the assumptions, theories, experimental methods, results and conclusions of the original work, for the benefit of the overworked engineer who has not the time (and perhaps not the patience) to wade through the original presentation. Although every effort will be made to be accurate, it is recommended that the reader use these abstracts as guides rather than as the final authority in each case, since it is only in the original article that a full understanding of the author's work may be obtained.

THE current in the tank circuit of a superregenerative receiver operated at an ultra-high frequency, may be evaluated by considering the tank circuit shown in Fig. 1-a. The resistance of the circuit and the negative resistance introduced by the ultra-high frequency oscillation are neglected with respect to R_m, the maximum magnitude of the negative resistance introduced by the quenching voltage of frequency $P/2\pi$, since this approximation is very nearly satisfied when no signal is present. The author sets up the differential equation for this circuit and solves it by means of many interesting mathematical devices, all of which are more or less completely given in the original paper.

The solution of the equation indicates that there are two general types

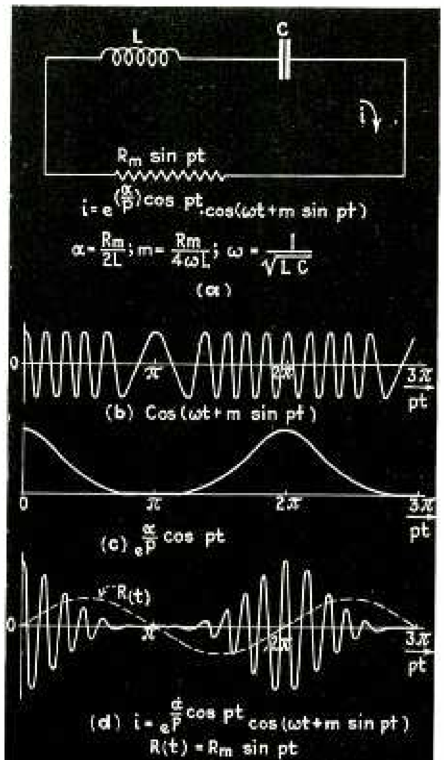


FIG. 1

of current which may be expected: a stable solution which indicates an oscillatory current, modulated or periodically suppressed by the quenching voltage; and an unstable solution, in which the ultra-high frequency oscillation is completely suppressed by the quenching voltage. The mathematical analysis indicates that the higher the quenching frequency, and the greater the amplitude of the quenching voltage, the more likely will this unstable condition occur, which theory is substantiated by the experimental results obtained. Under the assumption $\omega >> p$ the stable solution (on which the practical operation of these receivers depends) is given by the equation given in Fig. 1-a.

The component currents expressed by this equation are plotted in Figs. 1-b to 1-d. Fig. 1-d shows the oscillatory current in the circuit in its phase relation to the change in the negative resistance offered by the quenching voltage.

It will be noticed in Fig. 1-d that the oscillation appears to be suppressed in the valleys between each burst of oscillation. In theory the amplitude of the current is suppressed only at a single instant, but in practice the oscillation is completely suppressed over a considerable portion of the complete period.

To check this theory, the circuit diagram shown in Fig. 2-a was employed. As will be seen, the high frequency oscillation voltage was coupled to one set of plates of the cathode ray tube, while the quenching frequency voltage was coupled to the other set, the result being a Lissajou figure which would indicate the relative amplitudes and phases of these two voltages. The stability of oscillation was checked experimentally with the results shown in Fig. 2-b, in which the stable and unstable (partially suppressed and completely suppressed, respectively) conditions of the circuit are shown. This diagram substantiates the theory that the higher the quenching frequency and the higher the amplitude of the quenching voltage, the more unstable the oscillation.

In studying the relation between the quenching voltage and high frequency current, many Lissajou figures were taken, a typical representative of which is shown in Fig. 2-c, in which the horizontal and vertical displacements represent the amplitudes of the voltages indicated. The heavy black spot at the extreme right of this diagram was apparent only when the rushing noise typical of superregenerative receivers was apparent, which fact gives a clue to the mechanism of the noise. The transformation of the Lissajou figure into rectangular coordinates is shown in Fig. 2-d. This diagram indicates that the oscillatory voltage begins when the quenching voltage has nearly its maximum value, shows a sharp increase to maximum value, following an exponential rise and then a more gradual falling-off, following a sinusoidal curve. The oscillation is completely suppressed for the rest of the period, and the process is repeated

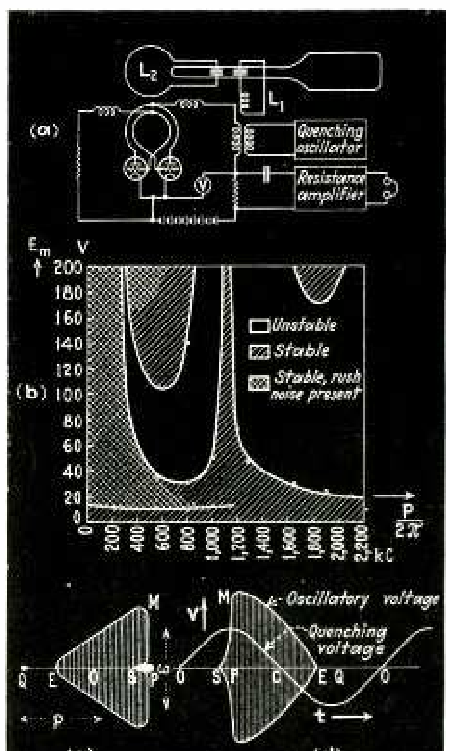


FIG. 2

again when the quenching voltage again nearly reaches its positive maximum.

The cathode ray diagrams indicate that the start of the oscillatory voltage

occurs at a somewhat irregular interval, when no signal voltage is present, and these irregularities are only noticed when the receiver is displaying the characteristic rushing noise. The

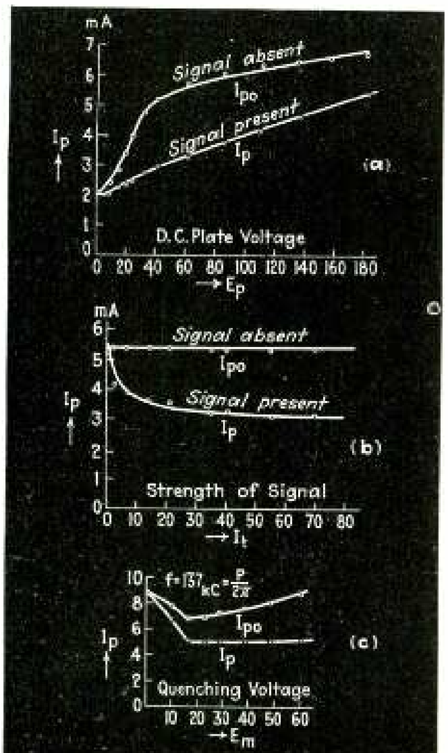


FIG. 3

author advances the theory that the oscillation cannot start until a certain instantaneous value of voltage is reached, and that this instantaneous value is composed of random voltages such as those from thermal agitation, shot effect, flicker effect, etc. When no signal is present these random effects initiate the oscillatory voltage. As a result, the characteristic noise is considered to be caused by the irregular electromotive forces which initiate the oscillation. In the presence of a signal voltage, the characteristic noise of the receiver is largely suppressed, to a degree depending upon the strength of the signal. This effect, called by the author the Uda phenomenon, is investigated by noting the changes in plate current which occur when a signal is impressed upon the circuit. The plate current is seen to decrease with the presence of a signal, while the grid current increases, the changes being maximum when the receiver is tuned to resonance with the incoming wave. At the same time the oscillatory current increases. These effects are explained by the fact that the oscillation of the receiver is then reinforced by the signal, resulting in an increased grid current, an increased grid bias, and a resulting decrease of plate current.

To study further the synchronization between ultra-short-wave oscillators a receiver and transmitter were set up and cathode ray Lissajou figures taken for varying signal strength. It was found that as the signal became stronger the characteristic noise was suppressed, and the heavy spot to the right of the Lissajou figure disappeared. The oscillation started at an earlier time, the greater the intensity of the signal. Under these conditions the oscillation is initiated now by the signal wave rather than by thermal and other random effects, and that as a result the oscillation, being of regular aspect, does not give rise to the characteristic noise. It was found also that the *amplitude of the oscillatory current remained almost constant, regardless of the intensity of the signal.*

The concluding part of the paper is taken up with an examination of the amplification afforded by superregenerative circuits. By comparing the plate current values which occurred with and without the signal being present, for different values of quenching voltage and frequency, the sensitivity of the receiver as a function of quenching voltage and frequency was investigated, sensitivity being measured by the difference in the plate current. It was found that a quenching frequency of from 130 to 200 kc. produced the optimum sensitivity. By a similar comparison of plate current with or without signal, the effect of direct plate voltage was investigated. The maximum sensitivity occurred at a voltage of approximately 50 volts. For higher plate voltages a strong oscillatory state occurs and the sensitivity decreases gradually, while on the lower plate voltages the receiver gradually reaches an unstable condition. The diagrams given in Fig. 3 indicate the changes in current for these various effects, the vertical separation between the curves being a measure of the sensitivity for that abscissa value.

The mechanism of amplification, according to the theory advanced by the author, can be seen from Fig. 4. The shaded area represents a product of voltage times time, which is proportional to the strength of the signal. The mean value of this shaded area averaged over the entire cycle is proportional to the detected signal current. Evidently this detected current

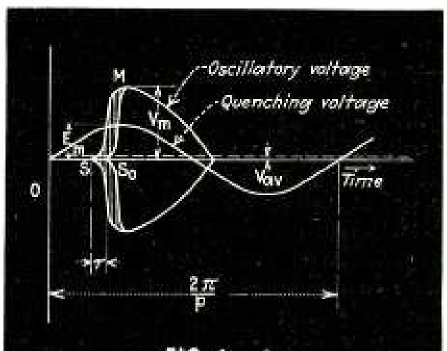


FIG. 4

can be increased by decreasing the period (that is, increasing the quenching frequency), by increasing the maximum value of oscillatory voltage (which may be accomplished by increasing the quenching voltage), and by lengthening the time over which the shaded area occurs. The signal has this last desired effect, but does not change the maximum oscillatory voltage or the quenching frequency. Increased sensitivity may be obtained by increasing the quenching voltage and the quenching frequency, provided, however, that the increases are not too great, since then the oscillation becomes unstable and the oscillatory current is completely suppressed. Therefore, an optimum value, both of quenching voltage and oscillatory voltage, can be found at which the receiver sensitivity is a maximum.

The author makes the following concluding statements which should be of interest to designers of superregenerative equipment: First, the characteristic noise which appears with the reception of weak signals may be reduced by the proper design of the vacuum tube so that the random effects which cause the noise are of small amplitude. The poor selectivity of the receiver cannot be improved to any great degree inasmuch as it results from the large number of component frequencies which are produced by the quenching action. The sensitivity of the receiver may be increased by the choice of optimum values of quenching voltage and quenching frequency, both of which are relatively high. Proper choice of these quantities will also decrease the characteristic noise and improve the selectivity.

This reviewer believes that the experimental methods outlined are applicable to the direct measurement of the amplification afforded at different values of circuit parameters and voltages, and might be used by designers for checking the relative suitability of various circuit designs.—D.G.F.

Japanese Research

THE FIRST NUMBER of Volume 5 of "Report of Radio Research in Japan" published by the National Research Council of Japan, Imperial Academy House, Veno Park, Tokyo, contains a description of an experimental shortwave field strength measuring set for outdoors, in an article by K. Ohno on "Japan-Europe wireless communication tests with a short wave transmitting aerial curtain hung between two iron towers, each 250 meters high," the curtain consisting of 8 rows of four pieces of wire 18.9 m. long, the rows being spaced 19.2 m. apart, intended for 7,820 kc. S. Hamada, M.So and T. Shimizu write on the "Development of some special vacuum tubes," including all-metal tubes and various types of pentodes for use as modulated rf amplifiers or oscillators, all made by the Research Laboratory, Tokyo Electric Company. Reports on the intercomparison of requency standards in Japan and the measurements of ionosphere heights in Japan from September, 1933 to April, 1934 conclude the number.

Use Textolite Laminated

THE coil form is the most critical factor in a short-wave radio circuit. Low dielectric losses at all degrees of humidity and a negligible change in power-factor are essential. Accuracy and permanence of dimensions are also important in order that tne required inductance may be exact.

Textolite Grades No. 2008 and 2009 have been developed specially to meet these requirements. The General Manufacturing Company, Chicago, uses Textolite exclusively for the insulation of all its coil forms because it demands the highest standard of quality, which Textolite offers. You can profit by specifying Textolite for parts requiring low dielectric losses, low moisture absorption, high surface resistivity, and ease of fabrication.

For quick and dependable service on Textolite laminated materials and fabricated parts, write to our nearest distributor: **General Laminated Products, Inc., 233 Spring Street, New York City, General Laminated Products, Inc., of Illinois, 1308 N. Halsted Street, Chicago,** or write to Plastics Department, General Electric, West Lynn, Mass.

942-34

GENERAL ELECTRIC

PERIODICALS OF THE WORLD

A list of electrical, physical and general publications of interest to readers on electronic subjects, with their abbreviations and editorial office addresses.

Acad. Polonaise Sci. et Lettres, Bull.—Bulletin International de l'Académie des Sciences et des Lettres. Gebethner et Wolff, Rynek Gl., Cracovie, Poland.

A.C.E.C.—Ateliers de Constructions Electriques de Charleroi, Route de Philippeville, Charleroi, Belgium.

Acoustical Soc. of America, J.—Journal of the Acoustical Society of America, 919, N. Michigan Ave., Chicago.

A.E.G. Mitt—A.E.G. Mitteilungen. Das Literarishe Büro der AEG, Friedrich-Karl-Ufer 2/4, Berlin, N.W.40.

Am. Acad., Proc.—Proceedings of the American Academy of Arts and Sciences. 28, Newbury St., Boston.

Am. Electrochem. Soc., Trans.—Transactions of the American Electrochemical Society. Columbia Univ., New York.

Am. Illum. Eng. Soc., Trans.—Transactions of the American Illuminating Engineering Society. Mt. Royal, and Guilford Aves., Baltimore, Md.

Am. J. Sci.—American Journal of Science. New Haven, Connecticut.

Ann. d. Physik.—Annalen der Physik. B. v. Ammon, Salomonstrasse 18B, Leipzig. Germany.

Ann. de Physique—Annales de Physique. Masson et Cie, Libraries de l'Academie de Médecine, 120, Boulevard St. Germain, Paris (VI^e).

Ann. Soc. Sci. de Bruxelles—Annales de la Société Scientifique de Bruxelles. 2, Rue de Manège, Louvain, Belgium.

Annales des P.T.T.—Annales des Postes, Télégraphes et Téléphones, Librairie de l'Enseignement Technique, 3, Rue Thénard, Paris, (5^e).

Arch. des Sciences — Archives des Sciences Physiques et Naturelles, Institut de Physique de l'Université, Geneva, Switzerland.

Arch. f. Elektrot—Archiv für Elektrotechnik. J. Springer, Linkstrasse 23-24, Berlin, W.9.

Arkiv f. Mat., Astron., och Fysik. Stockholm—Arkiv för Matematik, Astronomi, och Fysik. Almqvist & Wiksells Boktryckeri-A.-B., Stockholm; Wheldon & Wesley, Ltd., 2, 3 and 4, Arthur Street, London, W.C.2.

A.S.E.A., J.—ASEA Journal. Allmanna Svenska Elektriska A.B., Westeras, Sweden, and 5, Chancery Lane, London, W.C.2.

Assoc. Ing. El. Liége, Bull.—Bulletin de l'Association des Ingénieurs Electricians sortis de l'Institut Electrotechnique Montefiore, 31, Rue-Gilles, Liége Belgium.

Assoc. Suisse Elect. Bull.—Association Suisse des Electriciens Bulletin. Secretariat General de l'A.S.E. et de l'U.C.S., Seefeldstrasse 301, Zürich 8, Switzerland.

Bell System Techn. J.—Bell System Technical Journal. American Telephone & Telegraph Co., 195 Broadway, New York.

Brit. J. of Radiology—The British Institute of Radiology. 32 Welbeck Street, London, W.1.

Bureau of Standards, Circ. and Misc. Publ.—Publications of the Bureau of Standards. Superintendent of Documents, Gov. Printing Off., Washington, D. C.

Bureau of Standards, J. of Research—Bureau of Standards. Journal of Research. Superintendent of Documents, Gov. Printing Office, Washington, D. C.

Cambridge Phil. Soc., Proc.—Proceedings of the Cambridge Philosophical Society. Cambridge Univ. Press, Fetter Lane, London, E.C.4.

Canad. J. of Research—Canadian Journal of Research. National Research Council of Canada, Ottawa, Canada.

Comptes Rendus — Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Gauthier-Villars et Cie, Quai des Grands-Augustins 55, Paris (6^e).

Dept. Sci. and Indust. Research, Publ.—Publications of the Department of Scientific and Industrial Research. 16, Old Queen Street, London, S.W.1.

El Rev.—The Electrical Review. 4, Ludgate Hill, London, E.C.4.

El Rly. Bus and Tram J.—The Electric Railway Bus and Tram Journal. Avenue Chambers, Vernon Place, Southampton Row, London, W.C.1.

El. Times—The Electrical Times. Sardinia House, Kingsway, London, W.C.2.

El. World—Electrical World. McGraw-Hill Publishing Co., Inc., 330 West 42nd St., New York.

Elect. Communication—Electrical Communication. International Standard Electric Corporation. 67 Broad St., New York; and Connaught House, Aldwych, London, W.C.2.

Elect. Engineering — Electrical Engineering. Journal of the American Institute of Electrical Engineers, 33 W. 39th St., New York.

Elect. J.—The Electric Journal, 530 Fernando St., Pittsburgh, Pa.

Electrician—The Electrician. Bouverie House, 154 Fleet St., London, E.C.4.

Electrot. Laborat. Tokyo, Japan, Circ.—Circulars of the Electrotechnical Laboratory, Ministry of Communications, Tokyo, Japan.

Electrot. Laborat. Tokyo, Japan, Researches—Researches of the Electrotechnical Laboratory, Ministry of Communications, Tokyo, Japan.

Elek. Betrieb—REA Der Elektrische Betrieb. Georg Siemens, Kurfürstenstrasse 8, Berlin, W. 57.

E.N.T.—Elektrische Nachrichten-Technik. J. Springer, Linkstrasse 23-24, Berlin, W. 9.

Elek. im. Bergbau—Elektrizität im Bergbau. R. Oldenbourg, Glückstrasse 8, Munich, Germany.

E. u. M.—Elektrotechnik u. Maschinenbau. Theobaldgasse 12, Wien 6, Austria.

E.T.Z. — Elektrotechnische Zeitschrift. J. Springer, Linkstrasse 23-24, Berlin, W.9.

Elettrotecnica — L'Elettrotecnica. Giornale ed Atti dell' Associazione Elettrotecnica Italiana. Via S Paolo 10, Milan (103), Italy.

Engineer—The Engineer. 28 Essex St., Strand, London, W.C.2.

Engineering—Engineering. 35 and 36. Bedford St., Strand, London, W.C.2.

Experimental Wireless (Now Wireless Engineer)—Wireless Engineer and Experimental Wireless. Dorset House, Tudor St., London, E.C.4.

Faculty of Sci., Tokyo, J. — Journal of the Faculty of Science, Tokyo. The Imperial University of Tokyo, Japan.

Faraday Soc., Trans. — Transactions of the Faraday Society. Gurney & Jackson, 33 Paternoster Row, London, E.C.4.

Frank. Inst., J.—Journal of the Franklin Institute. The Franklin Institute of the State of Pennsylvania, 15 So. Seventh St., Philadelphia, Pa.

Gen. El. Rev.—General Electric Review. The General Electric Co., Schenectady, N. Y.

Hokkaido Imp. Univ., Eng. Mem.—Memoirs of the Faculty of Engineering, Hokkaido Imperial University, Sapporo, Japan.

Illum. Eng., London—The Illuminating Engineer. The Journal of Good Lighting. 32 Victoria St., London, S.W.1.

Imp. Acad. Tokyo, Proc.—Proceedings of the Imperial Academy of Tokyo. Ueno Park, Tokyo, Japan.

Indian Journ. Phys.—Indian Journal of Physics and Proceedings of the Indian Association for the Cultivation of Science. 210 Bow-Bazar St., Calcutta, India.

Ingegnere—L'Ingegnere. Rivista Tecnica Sindacato Nazionale Fascista Ingegneri, Via Vivaio 17, Milan (113), Italy.

I.E.E., Japan, J.—Journal of the Institution of Electrical Engineers of Japan, Denki-Gakkwai, No. 3, 1-Chome, Yûraku-chô, Kôjimachi-ku, Tokyo, Japan.

I.E.E., J.—Journal of the Institution of Electrical Engineers, Savoy Pl., Victoria Embankment, London, W.C.2.

I.E.E., Students' J.—Students' Quarterly Journal. The Institution of Electrical Engineers, Savoy Pl., Victoria Embankment, London, W.C.2.

Inst. Eng. Australia, J.—Journal of the Institution of Engineers, Australia, Science House, Gloucester and Essex Streets, Sydney, New South Wales, Australia.

Inst. Post Office El. Eng., Papers—The Institution of Post Office Electrical Engineers, Selected Papers. General Post Office, Alder House, London, E.C.1.

I.R.E., Proc.—Proceedings of the Institute of Radio Engineers, 330 West 42nd St., New York.

J. de Physique et le Radium — Journal de Physique et le Radium. 12, Place de Laborde, Paris (VIII^e).

J. Math. Phys., Mass. Inst. of Technology — Journal of Mathematics and Physics, Massachusetts Institute of Technology, Cambridge, Mass.

Journ. Sci. Instruments—Journal of Scientific Instruments. The Cambridge University Press, Fetter Lane, London, E.C.4.

Journ. Télégraph—Journal Télégraphique. Bureau International de l'Union Télégraphique, Berne, Switzerland.

Junior Inst. Eng., J.—Journal of the Junior Institution of Engineers. 39 Victoria Street, Westminster, London, S.W.1.

Kyoto Coll. Eng., Mem.—Memoirs of the Kyoto Imperial University College of Engineering. Maruzen Co., Ltd., Tokyo, Japan.

Kyoto Coll. Sci., Mem.—Memoirs of the College of Science. Kyoto Imperial University. Maruzen Co., Ltd., Tokyo, Japan.

Kyushu Univ. Coll. Eng., Mem.—Memoirs of the College of Engineering, Kyushu Imperial University, Fukuoka, Japan.

M.V. Gazette — Metropolitan-Vickers Gazette. Metropolitan-Vickers Electrical Co., Ltd., Trafford Park, Manchester, England.

Nat. Acad. Sci., Proc.—Proceedings of the National Academy of Sciences. The Home Secretary, Constitution Ave. and 21st St., Washington, D. C.

National Research Council, Bull.—Bulletin of the National Research Council. Publication Office, National Research Council, Constitution Ave. and 21st St., Washington, D. C.

Nature—Nature. MacMillan & Co., Ltd., St. Martin's Street, London, W.C.2.

Onde Elec.—L'Onde Electrique. Société des Amis de la T.S.F., 40, Rue de Seine, Paris.

Phil. Mag.—The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science. Taylor & Francis, Red Lion Court, Fleet St., London, E.C.4.

Phys. Rev. — The Physical Review. Univ. of Minnesota, Minneapolis, Minn.

Phys. Soc., Proc.—Proceedings of the Physical Society of London. 1, Lowther Gardens, Exhibition Road, London, S.W.7.

Phys. Math. Soc. Japan, Proc.—Proceedings of the Physico-Mathematical Society of Japan. Faculty of Science, Tokyo Imperial University, Tokyo, Japan.

Phys. Zeits.—Physikalische Zeitschrift. S. Hirzel, Königstrasse 2, Leipzig, C1, Germany.

Physics—Physics. The American Physical Society. Univ. of Minnesota, Minneapolis, Minn.

Pont. Accad. Sci., N. Lincei, Atti.—Atti della Pontificia Accademia della Scienze-I Nuovi Lincei. Casina Pio IV. Cittá del Vaticano, Italy.

Pont. Accad. Sci., N. Lincei, Mem.—Memoria della Pontificia Accademia della Scienze-I Nuovi Lincei. Casina Pio IV. Cittá del Vaticano, Italy.

P.O.E.E.J. — The Post Office Electrical Engineers' Journal. Electrical Review, Ltd., 4, Ludgate Hill, London, E.C.4.

Power — Power. McGraw-Hill Publishing Co., Inc., 330 West 42nd St., New York.

Radio Research, Japan, Reports — Reports of Radio Researches and Works in Japan. The National Research Council of Japan, Tokyo, Japan.

R.G.E.—Revue Générale de l'Electricité. 12, Place de Laborde, Paris (VIII^e).

Rev. Modern Physics — Reviews of Modern Physics. The American Physical Society. Univ. of Minnesota, Minneapolis, Minn.

Rev. Sci. Instruments — Review of Scientific Instruments. The Optical Society of America, 450-454, Ahnaip St., Menasha, Wis.

Roy. Inst., Proc.—Proceedings of the Royal Institution of Great Britain. 21 Albemarle St., London, W.1.

Roy. Irish Acad., Proc. — Proceedings of the Royal Irish Academy. 19 Dawson St., Dublin, Ireland.

Roy. Soc., Phil. Trans.—Philosophical Transactions of the Royal Society of London. Harrison & Sons, Ltd., 44-47 St. Martin's Lane, London, W.C.2.

Roy. Soc., Proc.—Proceedings of the Royal Society of London. Harrison & Sons, Ltd., 44-47 St. Martin's Lane. London, W.C.2.

Roy. Techn. Coll. Glasgow, J.—Journal of the Royal Technical College, Glasgow. Robert Anderson & Sons, Ltd., 142 West Nile St., Glasgow, C.1, Scotland.

Science—Science. Official Organ of the American Association for the Advancement of Science. The Science Press, Grand Central Terminal, New York.

Siemens Zeits—Siemens Zeitschrift. Siemens-Schuckertwerke Aktiengesellschaft, Verwaltungsgebäude, Berlin-Siemenstadt, Germany.

Soc. Belge Elect., Bull. — Bulletin de la Société Belge des Electriciens.

Soc. Franç. Elect., Bull.—Bulletin de la Société Française des Electriciens. 12 and 14, Rue de Staël, Paris.

S. African I.E.E., Trans.—Transactions of the South African Institute of Electrical Engineers. Kelvin House, 100 Fox St., Johannesburg, S. Africa.

Terr. Mag.—Terrestrial Magnetism and Atmospheric Electricity. The Ruter Press, 420 Plum St., Cincinnati, Ohio.

T.F.T.—Telegraphen-und-Fernsprech-Technik. R. Dietze. Regensburgerstrasse 12A, Berlin, W.50.

Tijds. Nederland Radiogenootschap—Tijdschrift van het Nederlandsch Radiogenootschap. 11A Elzentlaan, Eindhoven, Holland.

Tohoku Univ., Sci. or Technol. Reports—Scientific or Technology Reports of the Tohoku Imperial University. Maruzen Co., Ltd., Sendai, Japan.

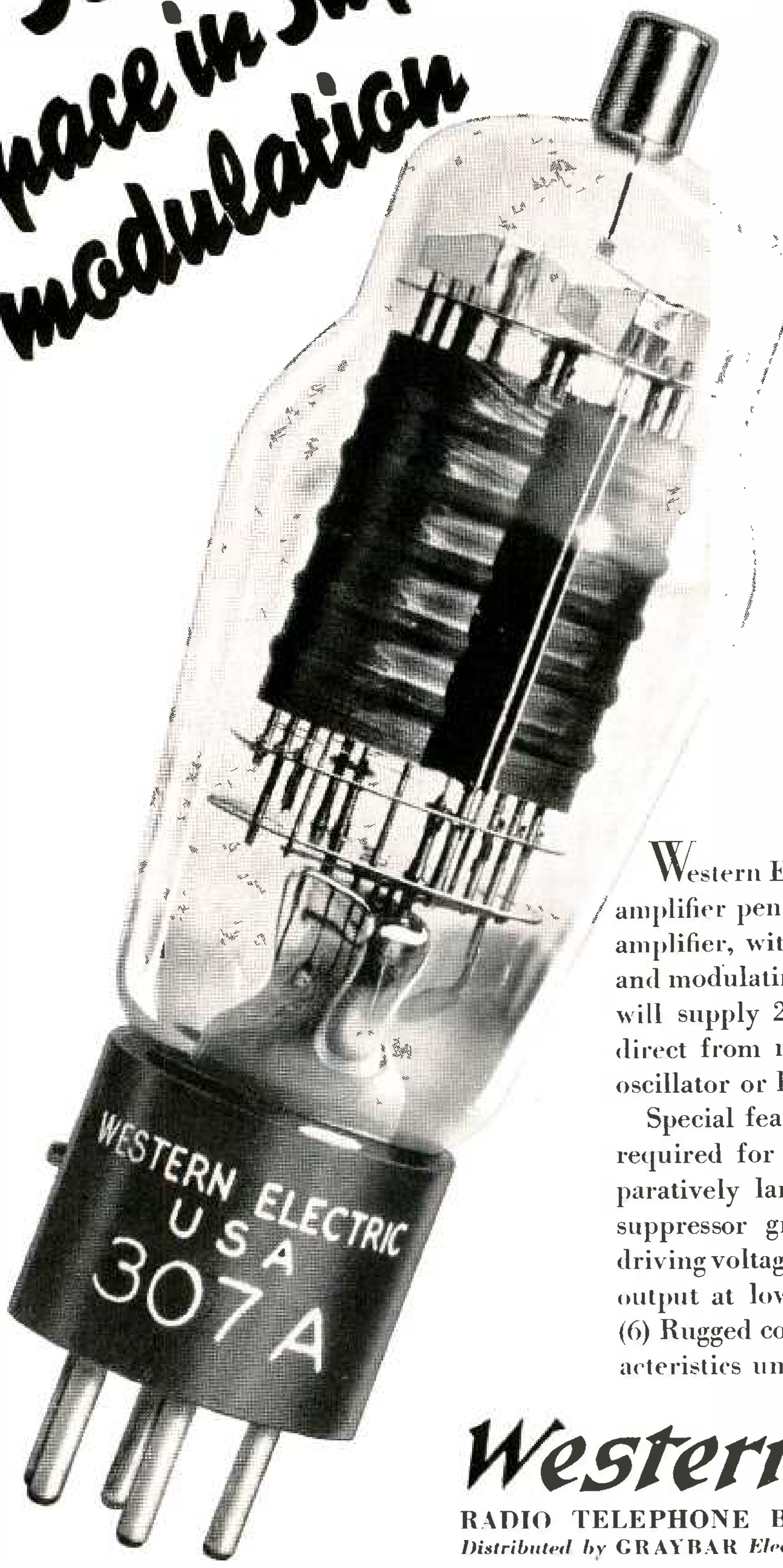
V.D.I.—Zeitschrift des Vereines Deutscher Ingenieure. V.D.I.-Verlag, G.m.b.H., Dorotheenstrasse 40, Berlin, N.W.7.

Washington Acad. Sci., J. — Journal of the Washington Academy of Sciences. Mt. Royal and Guilford Aves., Baltimore, Md.

Wireless Engineer—Wireless Engineer and Experimental Wireless. Dorset House, Tudor St., London, E.C.4.

Wireless World and Radio Rev.—Wireless World and Radio Review. Dorset House, Tudor St., London, E.C.4.

Setting the pace in Suppressor modulation



Characteristics of the 307A

Filament Voltage	5.5 Volts
Filament Current	1.0 Ampere
Maximum D. C. Plate Voltage	500 Volts
Maximum D. C. Plate Current	
Continuous, Class C Telephony	45 Milliamperes
Intermittent, Class C Telegraphy	60 Milliamperes
Maximum Plate Dissipation .	15 Watts
Maximum Screen-Grid Voltage	250 Volts
Mutual Conductance for Plate Current of 45 Milliamperes (Approx.)	4,000 Micromhos
Control-Grid to Plate Capacitance	0.55 $\mu\mu$f.
Input Capacitance	15 $\mu\mu$f.
Output Capacitance . . .	12 $\mu\mu$f.

Typical Operating Conditions

	Class C Telephony	Class C Telegraphy *Key Down*
D. C. Plate Voltage	500	500 Volts
Screen Resistor .	14,000	14,000 Ohms
D. C. Screen Voltage (Approx.)	200	250 Volts
D. C. Control-Grid Voltage	−35	−35 Volts
D. C. Suppressor-Grid Voltage . . .	−50	0 Volts
Peak R. F. Control-Grid Voltage . . .	50	50 Volts
Peak A. F. Suppressor-Grid Voltage . . .	50	0 Volts
D. C. Plate Current .	40	52 Milliamperes
D. C. Screen-Grid Current	21	18 Milliamperes
Peak Power Output .	24	17 Watts
Carrier Power Output	6	– Watts

Western Electric's new 307A is a filamentary power amplifier pentode. It is outstanding as a modulating amplifier, with carrier input applied to control grid and modulating voltage applied to suppressor grid. It will supply 24 watts peak output with modulation direct from microphone. Suitable also for use as an oscillator or high frequency power amplifier.

Special features: (1) Small suppressor grid swing required for essentially 100% modulation, (2) Comparatively large modulated output without driving suppressor grid positive, (3) Small high frequency driving voltage required, (4) Comparatively high power output at low supply voltage, (5) Quick warm up, (6) Rugged construction, yielding uniformity of characteristics under the most trying conditions.

Western Electric

RADIO TELEPHONE BROADCASTING EQUIPMENT

Distributed by GRAYBAR *Electric Co.* *In Canada: Northern Electric Co., Ltd.*

MANUFACTURING REVIEW

. . . Devoted to the products of the radio and allied industries, to the men who develop, produce, and merchandise them, and to the plants in which they are made

THE Manufacturing Review, successor to the New Products Section which formerly occupied these pages, is intended to perform an increased service to those readers whose primary interest is the manufacturing end of the radio and allied industries. Although the space will be devoted primarily to new products, it is intended also to include news of the men in the industry, and of the plants they operate in producing these new products. Sales and advertising managers are invited, therefore, to submit not only announcements of their new products and catalogs but of the doings of the men in their organization. Descriptions of manufacturing processes, gadgets and pet kinks will likewise be considered for publication, the sole criterion being their usefulness to the industry at large.

Attention is directed to the first item in the New Products Section of these pages. This material is in reality a miniature article, including the curves and technical data on a new microphone, whose development is representative of extraordinary activity in this particular field. The editors will be glad to consider similar data on any new product, for use in these columns.

Names and Places

Hill Appointed Export Manager of Shure Microphone: S. M. Shure, president of Shure Bros. Co., Chicago, announces the organization of an export department and the appointment of Mr. John C. Hill as export manager. The Shure microphone line will be merchandised through wholesale importers or direct to the customer in cases where no importer has been appointed. Correspondence concerning export of the Shure line may be addressed to Mr. Hill in care of the company at 215 West Huron St., Chicago.

Empire Appoints Gallaas Sales Engineer: The Empire Sheet & Tin Plate Co. of Mansfield, Ohio, has appointed Mr. George L. Gallaas to the position of sales engineer in the Electrical Sheet Department. Mr. Gallaas is a graduate of the University of Minnesota, in the class of 1926, and was affiliated with the Ideal Electric Manufacturing Co., as design engineer, sales engineer, and manager of the synchronous motor department.

Radiart Issues Auto-Radio Instruction: The Radiart Corp. of Cleveland, manufacturers of vibrators for auto radios, has announced a complete six months course of instruction for service men in the theory, design and practical servicing of automobile radio receivers. The course will cover all phases of auto radio including power supply, antennas, and interference from electric sources in the car.

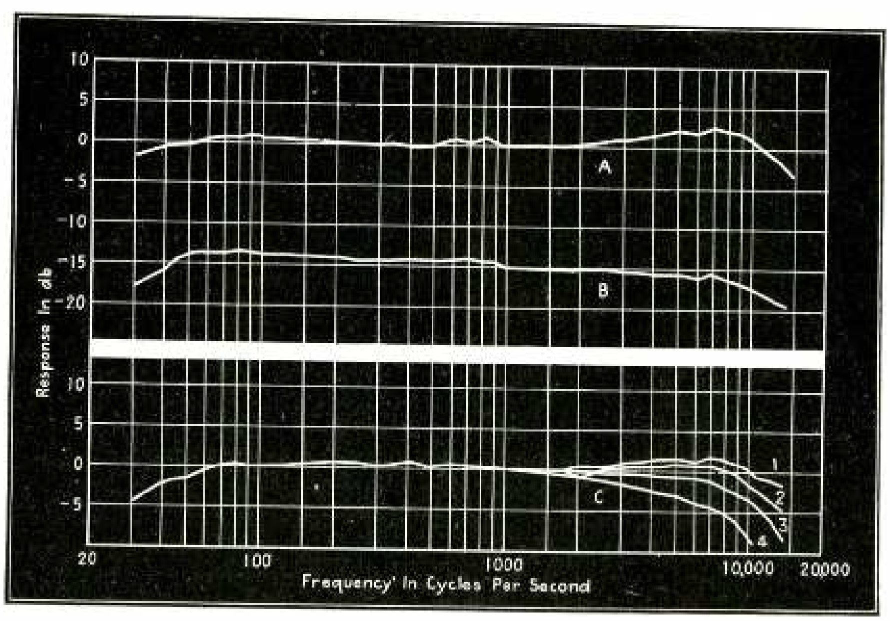
Ferranti Electric Announces Audio Component Service: The laboratory of Ferranti Electric, Inc., 130 W. 42nd St., New York, N. Y., has announced the services of a well-equipped staff of engineers for the manufacture of high fidelity audio components, on short notice. The announcement states that the engineers available are familiar with the properties and behavior of silicon steels and high permeability alloys and are in a position to undertake special and complicated problems in this line.

New Products

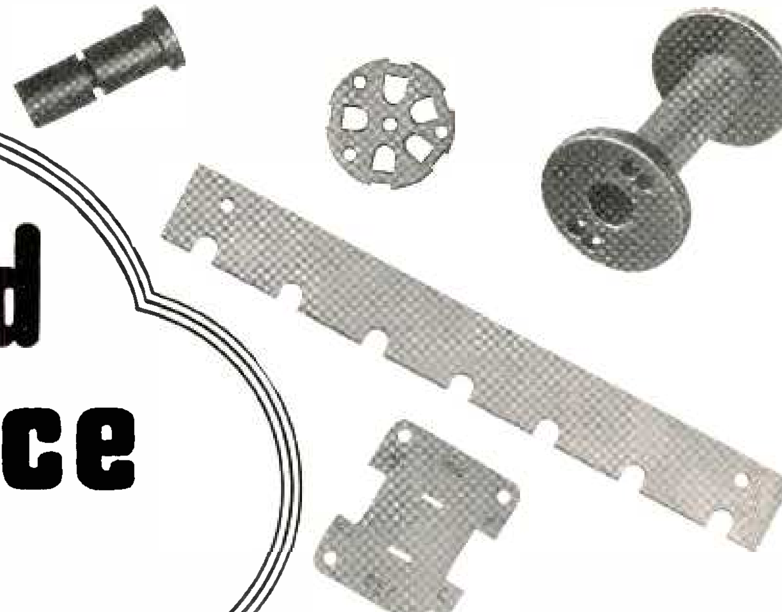
A New High Impedance Velocity Microphone

A HIGH IMPEDANCE velocity microphone has been considered impractical by most microphone engineers. The reasons, of course, have been the limitation of the length of the line, distortion due to the attenuation of the higher frequencies, and an attenuation which varies with different line lengths.

Like many seeming impossibilities, this problem has been worked out in a new microphone developed by the Amperite Corporation. And what seems more strange, the higher frequencies are its forte. It has a brilliancy and definition which, it is



(A) Audio response of the new Amperite HHV microphone, contrasted with (B), the relative response of a low impedance type. (C) shows the effect of adding cable 1—no cable, 2—25', 3—50', 4—100'



Good Service on GOOD INSULATION!

A LOCATION near the center of industry and ample equipment for manufacturing and machining to dimensions, enables Formica to provide excellent service on a high quality, dependable phenolic insulation.

Since 1913 the Formica organization has been specializing on just one product, and a competent laboratory has worked out adaptations of the material for every ordinary use.

We can meet your requirements; ship promptly, and provide a material that will stand every test.

The next time you need phenolic sheet get in touch with us.

Have you a copy of the Catalog booklet, "What Formica Is." It tells what grade to order for the purpose in hand.

THE FORMICA INSULATION CO.
4638 Spring Grove Ave., Cincinnati, Ohio

FORMICA

said, renders the reproduction more life-like than ever attained in any other type of microphone. Its slightly rising high frequency response (see Figure) contributes to this result.

Contrary to expectations, the advantages of the HIV (High Impedance Velocity) proved greater than anticipated. Enumerating them:

1. Elimination of the input transformer.

Eliminating the main source of inductive hum and transformer losses. The greatest source of hum is the input transformer of the amplifier which through its inductive relation to power transformers, motors, or a-c lines picks up a considerable amount of noise or a-c ripple. In order to remedy this, it is necessary to shield and separate the components of the pre-amplifier and amplifier.

2. Higher output from the microphone itself.

It can be stated roughly that the energy delivered to the first vacuum tube of the amplifier is from 10 db to 15 db higher than that obtained with the best low impedance velocity microphone and matching transformer available today. This increased ratio of signal to circuit noises makes the microphone ideally suited for remote broadcast work. In addition, the absence of the input transformer makes possible the construction of very compact a-c operated line amplifiers.

3. Approximately 5 db more output on frequencies above 8,000 cycles.

The lower frequencies are uniformly reproduced without peaks down to 30 cycles. By increasing the primary turns of the microphone transformer, the lower frequencies can also be increased without affecting the higher frequencies. In other words, with either the high or low impedance velocity microphone, increased lows can be obtained without sacrificing the higher frequencies by increased primary impedance.

The small mass of the ribbon (.00012 in. thick) accounts for the excellent definition of the velocity microphone—the increased high frequencies for the brilliancy of the high impedance type.

With ordinary low capacity cable ($\frac{1}{8}$ in. between wire and shield) the HIV microphone lead can be any length up to 100 ft. Probably ninety per cent of the microphone installations do not require a longer cable. In such cases, the HIV is advantageous. Where longer lines are required, either r-f cable should be used or the low impedance velocity (25, 50, or 200 ohms). Like the low impedance velocity, the HIV reproduces the entire audible range without peaks, is free from background noises, rugged, and is not affected by temperature, altitude, or moisture. Where long cable lengths are not required, its high output, excellent low frequency response combined with its brilliancy and definition at the higher frequencies make it an important advance in microphone design.—*Electronics.*

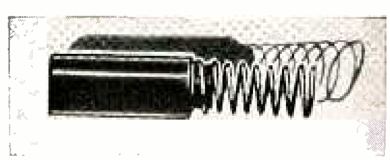
New Micamold Capacitors and Resistors

Two new lines have been announced by the Micamold Radio Corporation, 1087 Flushing Ave., Brooklyn, N. Y. The type 340 condensers are molded paper condensers permanently sealed in molded plastic, and are claimed to have a life of more than double that

of high grade cardboard tubular units. They are impervious to moisture and are fully color coded. The type 800 molded wire wound resistors units are small wire-wound resistors, molded in plastic and having small bulk. The resistors have a rating of 1 watt, are impervious to moisture, have strong lead wires which cannot pull out and are fully color coded.—*Electronics.*

Suppressor for Ford V-8 Distributor

A special suppressor resistor, developed by the Continental Carbon. Inc., 13900 Lorain Avenue, Cleveland, Ohio, is designed for quieting the radio disturbance which originates in the distributor of Ford V-8 cars. This



suppressor is made in the shape of the brush-contact in the ignition coil circuit of a Ford V-8 distributor and replaces this brush-contact. The resistance thus introduced in the ignition circuit has the effect of damping the oscillatory discharge without appreciably weakening the intensity of the spark. Only one suppressor of this type is required in a car in addition to the regular spark plug suppressors. Retail list price is 30c.—*Electronics.*

Crystal Pickup

Licensed under the patents of the Brush Development Co., the Astatic Microphone Laboratory, Inc., Youngstown, Ohio, announces a new astatic crystal pickup for reproduction from disk records. These pickups which are of the high fidelity type have the following advantages, according to the manufacturer: light weight; one-third of the conventional magnetic pickup; bass response; the high impedance of the element at low frequency permits it to reproduce the weak low frequency components of commercial records; uniform response, with no pronounced peaks throughout the audio range; and light pressure on the record which results in longer record life. Type S-8 pickup has an 8-in. radius from swivel to needle, while the type S-12 has a 12-in. radius. Standard finish is black crackled varnish with chromium plated fittings.—*Electronics.*

Compact Aircraft Transmitter

An unusually compact radio transmitter, intended primarily for the small privately-owned airplane and suitable also for harbor craft has been designed by Bell Telephone Labora-

tories for the Western Electric Company. Complete with shock-proof mounting, it weighs about 11 pounds and is only 8$\frac{1}{2}$ by 9$\frac{1}{2}$ by 6$\frac{1}{2}$ inches in size.

The transmitter operates over the frequency range between 2 and 7 megacycles and offers three types of transmission — voice, tone telegraphy with complete modulation and an output of 5 watts, and continuous wave telegraphy with an output of 15 watts.

Only two vacuum tubes are employed in the transmitter. Both are of the same type, a recently developed power pentode tube (Western Electric No. 307A). The first tube acts as the crystal controlled oscillator. The second acts as either an amplifier, a modulating amplifier or a modulating amplifier and voice frequency oscillator, depending on the type of transmission being employed.

Used in conjunction with the new two-band, 11 pound double duty receiver, this transmitter equips the small plane for two-way communication with apparatus of the same standard as that used on the nation's major airlines. The weight of the complete transmitter and receiver installed, with dynamotor power supply, is about 46 pounds.—*Electronics.*

Resistance Indicator

PRIMARILY DESIGNED to enable radio servicemen and amateurs to determine resistance values for best results in any circuit, the IRC Resistance Indicator has been introduced by the International Resistance Company. This resistance indicator is 7½ in. long, and is built in the form of a calibrated variable wire wound resistor. Two scales, 0 to 10,000 ohms and 10,000 to 100,000 ohms, permit accurate readings from 100 to 100,000 ohms. This range may be extended indefinitely by the addition of fixed resistors in series.

A ball bearing spring-cushioned slider running along a rod at the top makes it possible to tap off any desired resistance value or voltage.

In determining resistance values in radio work, the indicator may be used either in conjunction with a voltmeter or "by ear." It is only necessary to disconnect the resistor under test and insert the indicator. Then, with the radio receiver tuned to a station, vary the adjustable slider until the voltmeter (connected across the circuit) reads the correct voltage recommended by the set manufacturer. The IRC indicator is protected from accidental overloads by a readily renewable fuse. The list price is $4.50.—*Electronics.*

Communication Type Crystal Microphone

A NEW DIAPHRAGM-TYPE crystal microphone, specially designed for communications service in airways, police, commercial and amateur radiophone systems, has recently been announced by Shure Brothers Company, 215 West Huron Street, Chicago. The new model is known as the 70S, and is furnished with a convenient desk mount and two-conductor shielded cable.

It is well known that low-frequency speech components, with their high peak amplitudes, establish the overload level of the speech-input and modulator, yet they contribute very little to the intelligibility of the signal. The response in the 70S microphone increases linearly a total of 20 db in progressing from 60 to 2,000 cycles, is substantially uniform from 2,000 to above 4,000 cycles, followed by gradual cut-off. The rising characteristic attenuates the low "overload" frequencies and results in clear speech with effective side-band power double or more than usually obtained from the transmitter. The list price, complete with integral desk mount finished in rubber-black japan, and shielded cable, is $25.—*Electronics.*

Power Output Tube Type 6B5

A NEW POWER output tube has recently been announced by the Triad Manufacturing Co., Pawtucket, Rhode Island. The tube will deliver four watts at 5% harmonic distortion, with a signal input voltage of 15 volts, in class A operation, for which it is designed. The tube operates from 6.3 volts at 0.8 amp. for the filament, with a plate supply voltage of 300 maximum and a maximum plate current of 45 milliamperes. The load impedance is 7,000 ohms. The tube is in reality two tubes in one, having two plates. No bias is required for class A service, which eliminates the need of self-bias resistors and by-pass condensers. The tube is the same in physical appearance as the 42 having an ST-14 bulb and a large six-prong base.—*Electronics.*

Weston Markets New Tube Checker

A MODERN-TUBE CHECKER which represents a striking departure from former types, in external appearance, electrical and mechanical design, and in convenience to the user, has just been placed on the market by the Weston Electrical Instrument Corporation, Newark, New Jersey. The tester has socket mountings covering all pin combinations for glass and metal tubes now commercially available, with provision for combinations which may be introduced in the future.

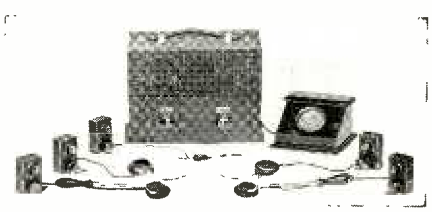
The circuit assembly of the new unit incorporates a fundamental advance in testing tubes on the basis of total emission, in that three separate loads, one for general purpose tubes, one for battery types and one for diodes, are available as required at the throw of a switch. Thus, total emission tests for each type of tube may be obtained on a specific load basis and without possibility of damage to the tube structure itself.

A complete inter-element neon short test, carried out while the tube is hot in the socket used for emission readings, is made simply by throwing the "short-test" switch previous to the regular test operation.

A self-contained transformer supplies all necessary potential from a 105 to 130-volt a.c. line. The line voltage adjustment on the center panel, operating in conjunction with a direct meter reading, is connected through a toggle switch to permit a check on line-voltage at any time while a tube is under test.—*Electronics.*

Trimm Group Hearing Aid

A COMPLETE group hearing aid for installation in churches and theatres for the benefit of those whose hearing is poor, has been announced by the Trimm Radio Manufacturing Company, 1528 Armitage Avenue, Chicago, Illinois.



The instrument is composed of a specially designed amplifying unit, high fidelity microphone, outlet boxes containing individual volume controls and phone jacks, Trimm featherweight earphones and Bone Conduction units. Every part is electrically matched, giving reproduction of sound and tone quality not heretofore found in instruments of this kind.—*Electronics.*

Quartz Crystal

A NEW TYPE of quartz crystal for frequency control, having a cut known as the LD-2 has been developed by the Bliley Electric Co., Erie, Pennsylvania. According to the manufacturer the frequency drift of these crystals is two-thirds less than that of the common X-cut crystal; the drift is guaranteed to be less than 8 cycles in a million per degree centigrade. An improved holder which is permanently sealed is supplied with each crystal. The crystal cuts for the range between 30 and 200 meters, to an accuracy within .03% are supplied complete with holder for $4.80, retail price.—*Electronics.*

New Rheostat Design

A NEW and improved design has been announced by the Ward Leonard Electric Co., Mount Vernon, New York, in their line of field rheostats. Features of the design are as follows:

The construction employs a pressed steel plate, which forms a rigid base, durable but light in weight. The resistance element to which the contacts are welded, is enveloped in a fused-on vitreous enamel. The steel shaft turns in a graphitized bronze bearing burnished to close tolerances assuring a good running fit. All parts are keyed and locked into slots milled across each end of the shaft. This construction eliminates the use of set screws. Any effort to turn the shaft past the end of travel causes no strain on the bearing or contact drive arm, as the stop is on the driving side of the plate.

The functions of current carrying and contact pressure are entirely separate. A rigid, hard copper contact arm is held against the contacts by means of a large heat treated coil spring. The contact arm is double ended, giving a balanced construction with almost 360 degrees travel.

Spacings and creepage distances meet all requirements for 600 volt service. All rheostats are listed as standard by the National Board of Fire Underwriters.—*Electronics*.

●

Porcelain Enamel: The Porcelain Enamel & Manufacturing Co. of Baltimore, Md., have announced a new porcelain enamel suitable for finishing both cast and sheet iron pieces in the same color, whereas previous enamels have resulted in a yellow cast when used on cast iron.

Electric Timer: The Tork Clock Co., Inc., Mt. Vernon, N. Y., has announced the Tymit, a 24-hour electric time control suitable for turning radio sets or other electrical appliances on and off, at predetermined times.

Private Telephone System: The Miles Reproducer Co., 244 W. 23rd St., New York, announce a private intercommunication system consisting of microphone and receiver with battery case, for portable use and for use in offices.

Flux for Brazing: The Handy & Harman Co., 82 Fulton St., New York City, announce Handy Flux, a flux especially designed for low temperature brazing, priced from $1.25 to $1.50 per pound, depending upon the quantity ordered.

Probing Light: The Thordarson Electric Manufacturing Co., 500 West Huron St., Chicago, Ill., announces a probing light for illuminating the interior of radio receiving cabinets and automobile instrument panels while installing and repairing these units, retailing at a price of $1.50, and using a standard radio pilot bulb.

Noise Filter: The Automatic Electrical Devices Co. of Cincinnati, Ohio, announces the Filterad, a plug-in device for use between the supply circuit and the offending switch, motor or other unit, for reducing interference from such sources.

Total Time Meter: The Westinghouse Company of East Pittsburgh, Pa., announces the total time meter, suitable for totalizing the running or idle time on electrically operated machinery of all kinds including high power transmission vacuum tubes. The registering mechanism registers for approximately 400 days before repeating.

Portable Grinder: Chicago Wheel & Mfg. Co., 1110 West Monroe St., Chicago, announces the de luxe Hand-ee grinder, a portable (12 oz. weight), high-speed grinding tool suitable for cleaning switches and contact points, cam segments and the like.

Balanced Line Filter: Arthur H. Lynch, Inc., 227 Fulton St., New York City, announce a balanced line filter for power circuits, which it is said uses the same principle as the balanced lead-in now common in noise-reducing antennas.

●

TRADE LITERATURE

THE following catalogs, trade literature, and other manufacturers' bulletins have recently been received:

✦ **Alloy:** "Lost Art or New Art?" a bulletin describing the technical properties of Mallory metal No. 3. The P. R. Mallory & Co., Inc., Indianapolis, Ind.

✦ **Resistances and Resistance Products:** The 1935 general catalog of the Muter Co., 1255 South Michigan Ave., Chicago, Ill. A description of replacement resistors for radio receivers, together with resistance devices, interference filters, tuning selectors, switches and the like. Issued July 1, 1935.

✦ **Piezo-Electric Devices:** Brush Piezo Electric Devices, a catalog of the Brush Development Co., E. 40th St. & Perkins Ave., Cleveland, Ohio. Data sheets on the use of bimorph elements and sound cells for microphones, headphone and tweeter speakers.

✦ **Electric Cable:** Advance in Cable Design, a catalog of the General Cable Corp., 420 Lexington Ave., New York City. Describing advances in the design of power cables, paper insulated, or compact cross section.

✦ **Metal Forming and Stamping:** Bulletin No. 12 of the F. R. Zierick Manufacturing Co., 385 Gerard Ave., New York, N. Y. A pamphlet describing dies, automatic stamping and wire forms, cadmium or nickel plated, suitable for use in radio production.

✦ **Vacuum Tube Manufacturing Machinery:** Three catalogs issued by the Eisler Engineering Co., 750 So. 13th St., Newark, N. J. Catalog P entitled "High Vacuum Pumps" describing mechanical oil pumps of various sizes, to be used in pumping vacuum tubes and neon tubes. Catalog 35-W "Electric Spot and Butt Welding Machines," for assembling the elements of vacuum and neon tubes, and catalog 35-M "Neon Sign Machinery," including all classes of equipment for glass blowing, pumping, bombarding and filling neon tubes.

✦ **Zinc Metal:** A catalog entitled "Design for Profit," issued by the New Jersey Zinc Co., 160 Front St., New York. Containing suggestions and information for the use of zinc alloys in die castings of various sorts.

✦ **Tungsten Depositing:** Data from the Tungsten Electro Deposit Corporation, Barr Building, Washington, D. C., describing the electrodeposition of tungsten with suggested uses in the radio industry.

✦ **Uses of Nickel:** Volume 13, No. 1 of Inco, house organ of the International Nickel Co., 67 Wall St., New York City.

✦ **Spot Welders:** Ace Spot Welder, a circular describing equipment manufactured by the Pier Equipment Manufacturing Co., Benton Harbor, Mich., describing the No. 40 electric spot welder.

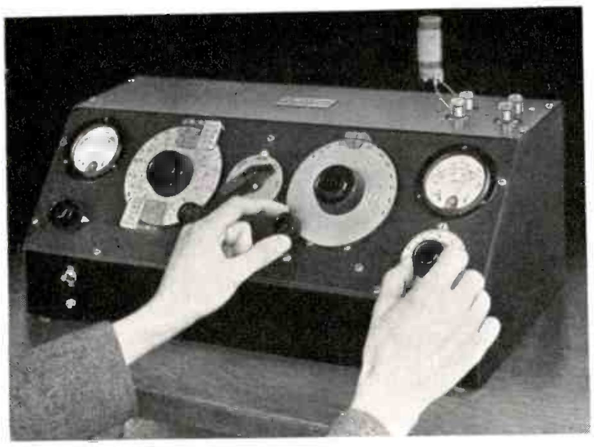
✦ **Seamless Tubing:** A pamphlet from the Summerill Tubing Co., Bridgeport, Montgomery Co., Pa., describing uses for seamless steel tubing in the radio and other industries.

✦ **Svea Metal:** Bulletin No. 16, Sveaonics issued by the Swedish Iron & Steel Corp., 17 Battery Pl., New York City, containing complete physical, chemical and electrical properties of Svea Metal.

✦ **Radio Transmitters:** Western Electric 400-watt Radio Transmission Equipment, a catalog describing the transmitter and rectifier for use in aircraft or ground stations, capable of being tuned by a dial system.

The "Q" METER
TYPE 100-A

. . . for high speed, accurate measurement of COILS, CONDENSERS, RESISTORS and other COMPONENTS at radio frequencies.

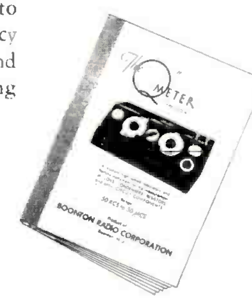


The "Q" Meter is in wide and constant use by most of the leading manufacturers of receivers, coils, condensers, vacuum tubes, etc. Price $445.00 F.O.B. Boonton, N. J.

This modern high speed instrument furnishes the means of measuring and designing efficient coils, condensers, and other components over a wide range of radio frequencies.

Every engineer wants one of these completely contained instruments for measuring "Q"; every progressive radio manufacturer needs the Q-Meter to reduce production costs to a point where he can successfully meet competition.

Write for full details and specifications of this outstanding contribution to the field of radio frequency measuring equipment. Send for 4-page bulletin giving complete information.



BOONTON RADIO CORPORATION
Boonton, New Jersey

HAMMARLUND

Trimming, Padding and I. F. Tuning CONDENSERS

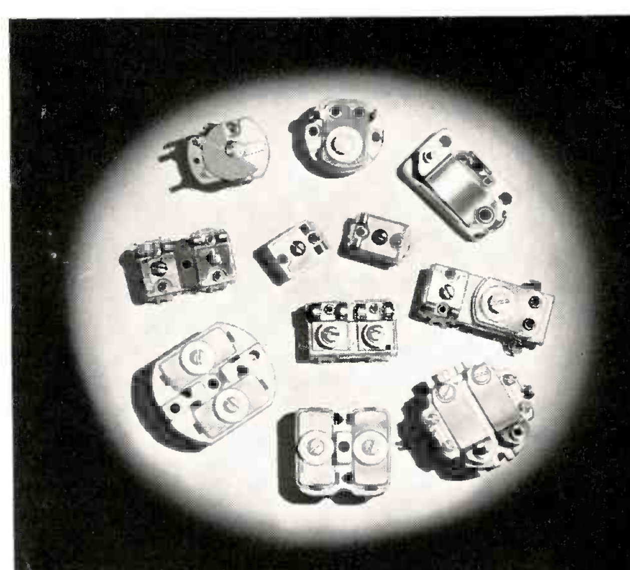
A MOST complete line of small adjustable condensers—the result of ten years of specialization on the exacting requirements of the radio industry.

Isolantite or Bakelite bases; air or mica dielectric; phosphor bronze spring plates; brass, self-aligning adjusting screws; in a large variety of sizes, shapes and ratings. Actual minimums are lower and actual maximums are higher than stated ratings. Individually tested for capacity range, power factor and for breakdown at 500 volts DC.

Special models made to specifications.

If you want condenser *quality* at interesting prices, put your problems up to HAMMARLUND.

For Better Radio
Hammarlund
PRECISION
PRODUCTS



See the Difference Good Design Makes

Write Dept. E-9 for Complete Catalog.
Send specifications for quotation on special designs.

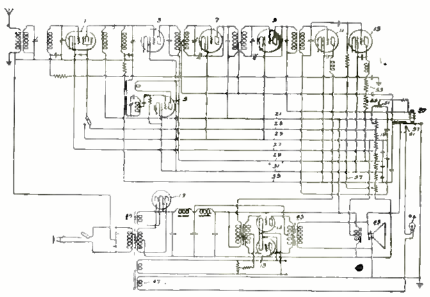
HAMMARLUND MFG. CO.
424-438 W. 33rd St., New York

PATENTS REVIEW

. . . Patents indicate trends . . . Next year's circuits and applications may be discovered by following U. S. and British inventions

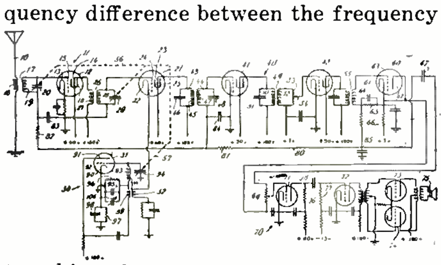
Volume control. In a diversity system only so many of the antennas are used at any one time as are necessary to keep the energy supplied to the receiver at a predetermined desirable value. H. O. Peterson, R.C.A. No. 2,004,128. See also J. B. Moore, No. 2,004,126.

Visual indicator. In a receiving system, combination of tuning means for the selection of signals, a means for translating the signals into audible sounds and a visual indicating means. The circuit is adjusted so that only signals above a certain minimum



strength are permitted to actuate the visual indicator. At the same time the sound translating apparatus is preventing from indicating and responding to incoming signals of less than the predetermined amplitude during the tuning operation. W. R. Koch, R.C.A. No. 2,007,399.

Superheterodyne circuit. An oscillator in which the anode is coupled to the grid circuit both capacitively and magnetically to produce oscillations, the capacity coupling comprising a condenser in the cathode circuit in common to the grid and anode circuit, the variable condenser of the selecting system being oscillated in conjunction with the variable condenser of the oscillator grid circuit by a unicontrol arrangement. The two condensers are so related that there is a fixed frequency difference between the frequency



to which the selective circuit is tuned, and the frequency to which the oscillator is tuned. W. A. MacDonald, Hazeltine Corp. No. 2,007,253.

Tuning circuit. An interstage system comprising tuned inductances and a uni-control tuning system. B. Trevor, R.C.A. No. 2,006,526.

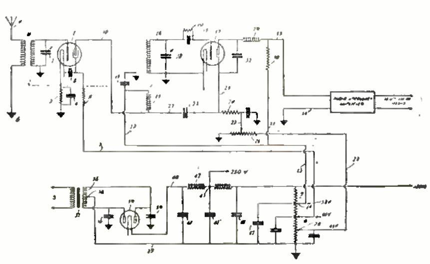
U. S. Patents

Radio Circuits

Radio frequency distribution system. A two-wire grounded transmission line, means for applying radio frequency voltage across one end of the line, a source of plate voltage connected across the line and a radio receiver connected to the line at a point remote from the plate voltage source. In an extension receiver unit, the plate voltage is derived from a transmission line which also provides suitable grid bias for the amplifier and detector stages. A. R. Hopkins, R.C.A. No. 2,006,994.

Direction finding system. A system to be used on aircraft to direct a beam of energy in the desired direction from the aircraft, comprising pairs of dipole radiators arranged at an angle with respect to each other and to a horizontal plane when the craft is on an even keel and a linear reflector parallel with each radiator. A. A. Linsell, R.C.A. No. 2,007,654.

Short wave receiver. A regenerative circuit in which the regenerative feedback is controlled by varying the screen



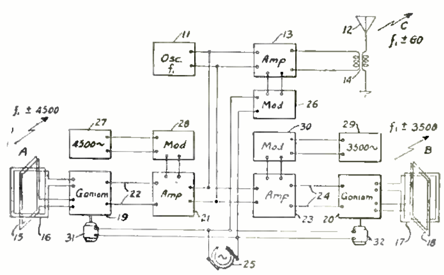
potential of a screen grid tube. David Grimes, R.C.A. No. 2,006,803.

Direction finding system. Means for determining direction of signals propagated through the earth's crust, comprising several detective devices arranged in quadrants on the earth's crust. A. M. Nicolson, Communication Patents, Inc. No. 2,007,211.

Radio broadcasting. Method of broadcasting whereby a radio wave is modulated by current from an announcer microphone circuit and from an auxiliary microphone circuit. The volume of the current in the auxiliary microphone is controlled in accordance with and in response to the volume of the current in the announcer microphone; the control is delayed for a short interval of time. W. A. Mueller, United Research Corp. No. 2,008,082.

Radio receiver tester. A continuity and capacity tester for testing radio receiving and transmitting sets. F. E. Wenger, Bluffton, Ohio. No. 2,007,992.

Direction finder. System involving several directive antennas for synchronously rotating the fields radiating



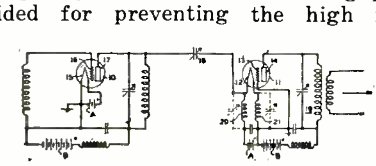
from them, etc., for determining radio position. L. R. Philpott, WE&M Co. No. 2,008,401.

Steering control. Automatic steering control apparatus for maintaining a vehicle on a desired course. T. E. Brockstedt, Washington Institute of Technology, Inc. No. 2,004,460.

Altimeter. Two self-excited oscillating circuits arranged to produce a beat note, means for automatically varying the resonant frequency of one of the circuits in accordance with the distance of the aircraft from ground. H. Junkers and Heinrich Wigge, Germany. No. 2,004,662.

Modulated transmitter. An amplitude modulated signal coupled to two differential circuits one oscillating above the carrier and the other slightly below the carrier, means coupled with the source for diverting a portion of energy and transforming its phase in quadratic relationship to the original phase, etc. Henri Chireix, Paris, France. No. 2,009,880.

Radio amplifier. A system in which a cathode potential is varied at a high frequency rate with means being provided for preventing the high fre-



quency variation from affecting the cathode heating means. C. H. Suydam, International Communications Laboratories. No. 2,008,996.

Electron Tube Applications

Vehicle signal. A controlling device for roadway signalling system in which a pair of coils disposed in the roadway with their axes in alignment with each other and in the direction of movement of the vehicles over the roadway so that the passage of a magnetized vehicle over the roadway will affect the coils unequally to operate a galvanometer through means of a relay tube. C. A. Glock, Lynwood, Calif. No. 2,007,715.

Flashing apparatus. Use of a grid-controlled rectifier to charge and discharge a condenser intermittently. R. K. Gessford, WE&M Co. No. 2,006,-737.

Control mechanism. A light sensitive tube receives light from an electric lamp when each of several perforated discs is properly aligned with the other discs on a common shaft. A. S. Nelson, Hartford, Conn. No. 2,008,150.

Frequency control. Arrangement for producing oscillations of a constant frequency comprising a vibratory rod having a length equal to one-half the working wave length of mechanical vibration. S. B. Smith and C. J. F. Tweed, R.C.A. No. 2,008,263.

Remote control system. Apparatus for moving heavy objects from a small signal current comprising a repulsion motor, electron tube, etc. F. L. Moseley, Sperry Gyroscope Co. No. 2,008,364.

Color matcher. Means for projecting radiations on an article to be matched and the use of light sensitive tube having a response that varies in accordance with the variations in radiated flux impinging thereon, but is constant for variations in the wave length of the radiations. E. B. Wilson, WE&M Co. No. 2,008,410.

Illumination control. Operation of a luminous discharge tube by means of grid controlled electrifier. F. R. Elder, H. B. La Roque, G. E. Co. No. 2,008,494.

Electrometric determinations. Amplifier tubes are arranged in a grid circuit whereby the ratio of the current in one of the two pairs of electrodes in electrolytes is indicated. A. H. Davis, Jr., assigned to National Aniline & Chemical Co., Inc. No. 2,004,569.

Elevator control. Means for levelling an elevator by thermionic tubes. P. C. Keiper, Westinghouse Elevator Co. No. 2,000,703.

Follow-up system. A light sensitive tube having two anodes in a light or ray controlled follow-up system. Bruno Wittkuhns, Sperry Gyroscope Co. No. 1,999,646. See also 1,999,645 to Wittkuhns.

Speed control. Regulating means for rotating members using light responsive apparatus. A. N. Geyer, Seattle, Wash. No. 1,998,005.

Temperature measuring. Apparatus for indicating temperature variations of a work-piece, including the combination of a photometrically operated pyrometer and a movable light deflector constructed and arranged to transmit rays from different portions of a work-piece to the pyrometer. J. T. Nichols, Pittsburgh, Pa. No. 2,008,793.

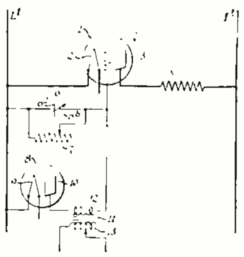
Control system. Use of an amplifier tube for controlling a machine in which a shaft is deflected proportionally to the pressure of the load thereon. J. H. Payne, G. E. Co. No. 2,001,543.

Apparatus for determining the force of gravity. Use of radio receiving devices adjacent to a sensitive pendulum. H. C. Hayes, Washington, D. C. No. 2,000,948.

Position control. Apparatus for controlling the position of a movable device in accordance with the position of movable primary element involving amplifier and rectifier tubes. H. L. Bernarde, WE&M Co. No. 2,005,884.

Automatic telephone message recorder. An amplifier with its input coupled to a telephone line, a translating device connected to the output of the amplifier, a recorder, etc. Method for automatically recording incoming messages on wax or other records. M. Keiser, assigned to Hixon-Keiser Patents Corp., New York. No. 2,005,-788. 16 claims, filed Feb. 18, 1933.

Power circuit. Regulating the flow of current through an electronic tube subjected to an alternating potential and having a control grid which consists in storing energy in a circuit during alternate half cycles and effecting and regulating the discharge of



this energy during the other half cycles to produce a transient voltage which is applied to the control electrode. Carroll Stansbury, Cutler-Hammer, Inc. No. 2,002,281.

Speed regulator. Use of rectifier tubes for controlling a rotating member whose speed is to be kept constant. L. H. Von Ohlsen, Safety Car Heating & Lighting Co. No. 2,001,557.

Ignition system. Polyphase currents, a load circuit, several parallel valves between each phase of the source and the load circuit, a make-alive electrode and a tube for controlling ignition. D. Silverman, WE&M Co. No. 2,005,875.

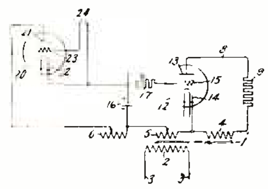
Power conversion. Patents to various members of the General Electric staff on electric control means, regulating system, power conversion, etc. Nos. 2,002,369; 2,002,371; 2,004,778; 2,006,-979; 2,008,512; 2,009,788; 2,009,833; 2,009,834.

Electric machine control. Patents Nos. 2,005,892 and 2,005,893 to F. H. Gulliksen, WE&M Co., and No. 2,003,-024 to C. P. West, WE&M Co. See also the following patents to the Bell Telephone Laboratories on methods of controlling the output of generators, speed and position regulating, etc. Nos. 1,998,104; 1,999,376; 1,999.377 and 2,003,457.

Electrostatic tube control. Patents to P. H. Craig, Invex Corp. Nos. 2,001,-836 to 2,001,838, inclusive, on the use of a tube with an external grid for power control.

Power control. The combination of an a-c supply circuit, alternating current load circuit, reactor for adjusting over a wide range the voltage supplied to the load involving a rectifier tube. F. G. Logan, Ward Leonard Electric Co. No. 2,003,945.

Time delay. Between the grid of a tube and the cathode is a capacitor. The negative bias is supplied to the grid, which bias is opposed by the



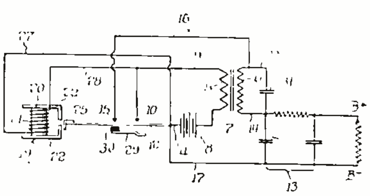
charge in the capacitor. The discharge of the capacitor is retarded so that an effective time delay is produced. W. D. Cockrell, G. E. Co. No. 2,003,992.

Light modulation. An a-c source, an electric vapor lamp including a cathode and several anodes, etc. W. F. Westendorp, G. E. Co. No. 2,009,826.

Register control. System for moving a strip of material in predetermined relationship with respect to markings thereon by a light sensitive means. W. R. King, G. E. Co. No. 2,002,374.

Instrument protection. In a signaling system, means for protecting an instrument responsive to signaling impulses from excessive voltages such as lightning discharges, comprising a shunt and an electrostatically controlled harmonic tube, non-responsive to signaling impulses but responsive to excessive voltages and operating to actuate the shunting device. C. F. Nelson, W. W. Tel. Co. No. 2,009,973.

A-c d-c system. Method of producing high voltage d-c from a low voltage



d-c source by means of a vibrator, rectifier, transformer, etc. E. L. Barrett, Utah Radio Products Co. No. 2,009,425.

Aeronautical device. A system for providing an artificial horizon for aircraft, involving reception of incoming radiant energy. H. I. Becker, G. E. Co. No. 2,009,832.

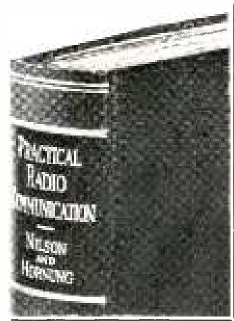
Distance and depth finder. Two patents to E. E. Turner, Submarine Signal Co., for determining depths or distances by the echo method. Nos. 2,009,-459 and 2,009,460.

Check up on your knowledge

of present-day radio operating equipment, methods, etc.

This new book provides a complete text in practical radio communication based on theoretical introduction, suitable for use by radio operators, technicians and engineers.

See this book for a balanced treatment of radio operating principles and practice that includes the latest in equipment, operation, etc., in broadcasting, marine, police, aeronautical, and amateur radio transmitting and receiving.



Just Published

Practical Radio Communication

Principles—Systems—Equipment—Operation

Including Short-wave and Ultra-short-wave Radio

By **Arthur R. Nilson,** Lieutenant (Technicist) (Communications) U. S. N. R. (Retired), and **J. L. Hornung,** Formerly Radio Instructor, Guggenheim School of Aeronautics, New York University. 754 pages, 6x9, 435 illustrations, flexible........................**$5.00**

THIS book covers the requirements for *all classes* of radio operator's license examinations; treats long, medium, short, and ultra-short-wave radio; includes *all classes* of radio stations—is in general a *complete text on practical radio communications.*

Use this book to prepare to pass government radio operator license examinations, ground yourself in essentials of technical and operating positions in police radio, broadcasting, aeronautical and marine radio, check up on your knowledge of developments and advances in equipment, methods, etc.

This book gives you

—full treatment of radio and electrical principles; delves deeply into radio application of alternating currents

—particular attention to broadcasting; practical description of Western Electric broadcast transmitter; information on studio acoustics and apparatus, control-room equipment and operation, etc.

—sections on ultra-short-wave radio equipments, of special interest to police operators

—radio-telegraphic and radio-telephonic treatment of aviation radio; aircraft transmitters, receivers; testing and maintenance

—marine medium-frequency equipment, high-frequency transmitters and receivers; Coast Guard low-power transmitters; direction finders; etc.

—power-supply apparatus; rectifiers; generators, etc.

Examine this new book for 10 days

McGRAW-HILL ON-APPROVAL COUPON

McGraw-Hill Book Co., 330 W. 42nd St., N. Y. C.

Send me for 10 days' examination, on approval Nilson and Hornung—Practical Radio Communication. In 10 days I will send $5.00 plus a few cents for postage and delivery, or return book postpaid. (We pay postage on orders accompanied by remittance.)

Name ....

Address ....

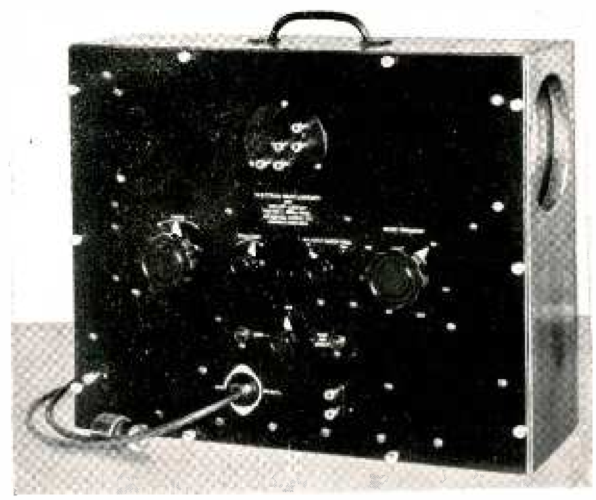
City and State ....

Position ....

Company ....L. 9-35

(Books sent on approval in U. S. and Canada only.)

STUDYING . . . WAVEFORM



THE **General Radio Type 687-A Electron Oscillograph** is particularly suited to the needs of the worker in the field of electronics in studies of all types of waveform.

The built-in sweep circuit locks in step with any recurrent waveform of audio frequency, providing a steady screen pattern for visual study, for measurement, and for photography. The sweep circuit has a range of *30* to *3,000* sweeps per second, permitting observation of frequencies up to *21,000* cycles or more.

The General Radio Electron Oscillograph is completely self-contained and portable. It is supplied with a **5-inch** fast-screen cathode-ray tube. Complete, ready to use, its price is $184.00 in the U. S. and Canada.

Let the engineering department of General Radio discuss with you the application of this or other cathode-ray equipment to your specific problems.

Write for a copy of **Circular P-100-E** *for a complete description of the Type 687-A Oscillograph.*

GENERAL RADIO COMPANY

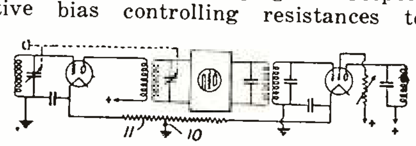
30 State Street Cambridge A, Massachusetts

TWENTY YEARS OF ELECTRICAL APPARATUS MANUFACTURE 1915 GR 1935

Feed-back circuit. In a pentode amplifier, negative feed-back of the voltage developed across the load circuit is used to reduce the apparent output impedance of the amplifier, while negative feed-back determined by the current in the load is used to increase the tube impedance. The first effect is applied to reduce harmonic distortion, while both effects are utilized when it is desirable that the amplifier work into a load of lower impedance than its own, the voltage feed-back in that case being made greater than the current feed-back. Current and voltage feed-back components are adjusted to bring the effective amplifier impedance into optimum relationship with the load impedance while maintaining a matched condition between the tube and the load. E&MI. No. 425,553.

High frequency amplifier. A single tube feeds a push-pull pair and the anode-cathode capacity of the first tube and the inductance between the anode and the mid-point of the output circuit are balanced by an impedance network between the cathode and the side of the output circuit. Balance is thereby secured for all working frequencies and the amplifier is stabilized and oscillations are prevented. British Thomson-Houston Co. No. 425,572.

Superheterodyne. In a super of the midget type having poor selectivity between the aerial and the first detector, means are provided for simultaneously increasing the gain of the I-F amplifier and reducing the gain or the input to the R-F amplifier. This may be done by ganging the respective bias controlling resistances to



move in opposite directions. The purpose is to enable interference due to two stations differing in frequency by about the intermediate frequency to be reduced. W. S. Barden, Marconi Co. No. 424,383.

Antenna system. An antenna system designed to provide good reception on long and short wave signals alternatively or simultaneously. Amy, Aceves & King, Inc. No. 424,239.

Directional system. The characteristic response of an inherently directive antenna is enhanced by the use of "directional reaction," which can be used to rotate the direction of maximum sensitivity. Marconi Co. No. 424,319.

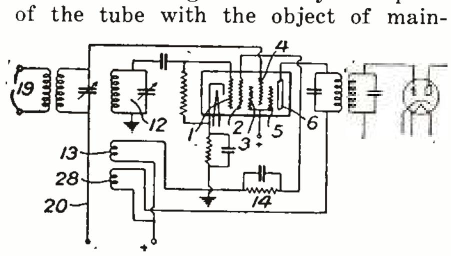
Iron core coil. An intermediate frequency band-pass filter having two inductance units with their condensers in a common casing has each of the inductances provided with a low-loss magnetic core of permeability 10-20. The inductance units are relatively movable for adjusting the coupling, or a movable screen is located between them for this purpose. H. Vogt. No. 423,861.

British Patents

Radio Circuits

Wired radio. Programs on different carrier frequencies are distributed over a power network, each amplifier output circuit comprises, in addition to a matching transformer circuits designed to reject the frequencies of the other channels and so prevent cross-modulation. A band-pass filter is used, the reactances of which are in part composed of the effective reactances of the rejector circuit, the leakage inductance of a transformer and the inductance of the network. Similarly, a low-pass filter is used to prevent harmonics generated in the amplifier from reaching the line. P. P. Eckersley. No. 423,673.

Oscillator-modulator. In a multi-grid type, the oscillation is sustained by energy fed back jointly by an intermediate anode-grid and by the plate of the tube with the object of main-



taining the oscillation at constant frequency and amplitude despite variations in the voltage of an outer grid. C. Travis, Marconi Co. No. 423,772.

High frequency receiver. A receiver for very short waves comprising a demodulator made up of a pair of tubes whose input electrodes are energized in phase opposition and also co-phasally by energy 90 deg. phase-shifted with respect to the component fed in phase opposition. The path energizing the tubes in phase opposition is made up of a high-frequency transformer with tuned primary and secondary windings with coupling and damping to give a flattened double peak response with a width equal to that of the band of frequencies to be demodulated. Marconi Co. No. 423,773.

Short-wave transmitter. A high-power short-wave transmitter comprises several tubes placed a half wavelength apart along a pair of leads, which are connected by coupling reactances at points midway between the tubes. The tubes may be arranged to oscillate by the Barkhousen-Kurz connection. Marconi Co. No. 424,455.

Beam transmission. In an overlap-beam system for assisting navigation, the median line which indicates the course to be taken is identified not by a modulated note but by the beat frequency between the waves used for the two beams. This frequency may be audible and received on an ordinary set, or it may be supersonic and effective only on a receiver tuned to that frequency, being secret otherwise. The two radiated frequencies are produced by a single transmitter, modulated with a frequency half that of the desired beat-frequency. The carrier is suppressed, and the two side bands are fed separately to each of the beam aerials. Telefunken. No. 424,612.

Frequency changer. In a multi-grid tube the received and local oscillations are applied to grids No. 1 and 3. An oscillatory circuit tuned to the desired intermediate frequency is connected between the grid 3 carrying the local oscillations and a fourth grid. A fifth screen grid prevents back coupling between the output and the tuned circuit mentioned above. The arrangement greatly increases the conversion conductance of the tube. Philips. No. 424,615.

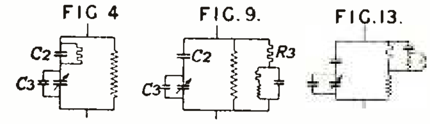
Directional antenna. The dimensions of an inverted-U aerial are chosen so that it receives or transmits most readily on a predetermined wavelength in one prescribed direction and has a minimum reception or radiation in another direction at an angle of less than 180 deg. to the first direction. E. C. Cork and E. L. White, Middlesex. No. 424,698.

Automatic volume control. A portion of the output from a carrier frequency amplifier is demodulated and applied to a low frequency amplifier while another portion is passed directly to the low-frequency amplifier which also acts as a carrier frequency amplifier, carrier frequency output being rectified to provide a-v-c potentials. E. K. Cole. No. 424,702.

Muting system. Muting and volume control voltages for a receiver embodying a-v-c are derived from a double-diode triode tube. J. S. Starrett. No. 424,711. Marconi Co.

Superheterodyne. As means for improving the constancy of the difference between natural frequencies of the re-

FIG 4 FIG. 9. FIG. 13.



ceiving circuit and the oscillator circuit with different settings of the common tuning dial of a superheterodyne receiver, resistance is added to the tuned oscillator circuit in various ways. Philips. No. 424,714.

Directional system. On shipboard a radio installation is intended to replace or supplement the ordinary signalling lights. To confine the radiated energy to the required sector of 90 deg., a series of energized aerials are backed by reflectors, and also by a reflector wall at least one wavelength long. This cuts off the back radiation and side lobes. For example, the side of the ship may serve as the reflecting wall. Telefunken. No. 424,747.

Time recorder. In a wireless receiver, apparatus for recording the time and/or the wavelength of reception. A Spiwak, Berlin. No. 424,910.

TRANSFORMERS

for Auto Amplification

Users of high-fidelity portable amplifiers will find that AmerTran Type OP Miniature transformers will solve many of their knottiest problems. Not only are these units small in size and of light weight, but they are also high quality parts which meet broadcast station specifications.

Frequency characteristics are uniform within ± 1 dB from 30 to 12,000 cycles and all types are self-shielded electromagnetically. Windings of all transformers are in carefully balanced sections with at least four leads brought to the terminal board from each coil. Send for Bulletin No. 1002.

AMERICAN TRANSFORMER CO.
180 Emmet St., Newark, N. J.

Speakers by

OXFORD

The new CHROMAVOX series

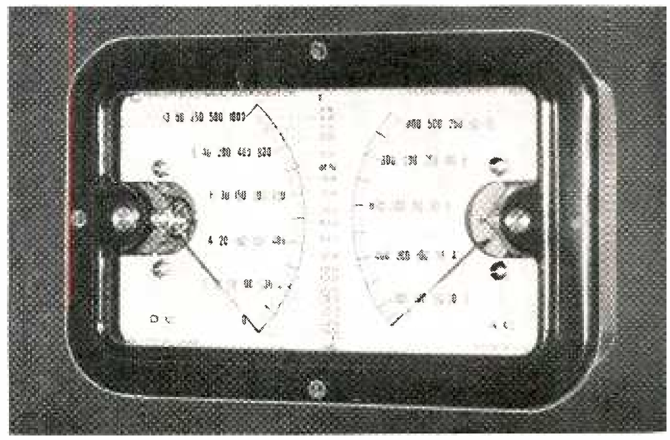
- unequalled purity of tone
- fullness of tone
- every instrument tested, guaranteed
- meets exacting engineering requirements
- wide line from which to choose
- prices uniformly fair

Write for illustrated Bulletin

Oxford Radio Corp.
Dept. H, 350 W. Huron St.
Chicago

ACCEPTED BY SOUND JUDGEMENT

The *NEW* TWIN



PRECISION WITHOUT EXTRAVAGANCE

IN ANY COMBINATION of AC or DC

A real advantage to engineers and designers—a most attractive face in the modern style. lending itself very readily to improving the appearance of any panel—yet occupying a minimum of space—and costs no more than two separate instruments.

The TRIPLETT Twin has the instrument scales side by side, thus permitting two distinct readings at a glance. It can be used to advantage in such applications as—to balance loads in three wire circuits, to detect line fluctuations when load readings are taken, to measure antennae and modulation current, to determine filament and plate voltages and in general where it is desired to obtain simultaneous readings on two instruments when connected in the same or separate circuits.

TRIPLETT manufactures a complete line of electrical instruments for radio, electrical and general industrial purposes—both standard and custom built. If you have an electrical instrument problem write to TRIPLETT.

TRIPLETT *Precision*
ELECTRICAL INSTRUMENTS

MAIL THIS COUPON FOR DETAILS

TRIPLETT ELECTRICAL INSTRUMENT CO.
Dept. E, Bluffton, Ohio, U. S. A.

Please send me at once—

—— More information on your Twin instrument

—— 1936 Catalogue

—— Information on (Specify) ....

NAME ....

ADDRESS ....

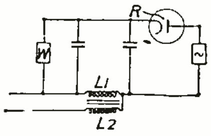
CITY ....STATE ....

Oscillation, generation, etc.

Modulating circuits. The modulating and high frequency stages of a modulation system have their cathodes connected together, the common cathode point being connected to ground through a resistive impedance permeable to direct current. By this means it is found that the anode current of one tube decreases as that of the other rises so that economy of high voltage current is effected; furthermore the characteristic of the oscillatory output has a straight slope from the origin so that 100 per cent modulation may be obtained with small distortion. Automatic volume control may be used to keep the operating point at its optimum position. Modulation is effected by varying the grid bias of the second tube. Marconi Co. No. 424,470.

Relaxation oscillator. A condenser charged through a screen grid tube is controlled so that deviation of the charging current curve from a straight line due to secondary electrons is removed. D. S. Loewe. No. 424,490.

Power supply. An arrangement for obtaining steady d-c from a source of pulsating current, for example, the output from a rectifier, the arrangement comprising a series choke, provision in which is made for obtaining a substantially steady voltage differing from the potential of either the main output terminals by tapping from the input side of the choke through a second choke which is inductively coupled to the first choke in such a manner that the pulsating current in the first choke introduces a compensating voltage ripple in the second choke. The load on the main filter circuit may be the plate circuit of an amplifier and



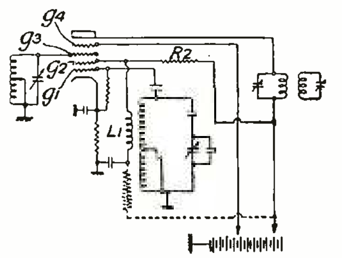
the potential derived through the second choke may be used as a grid biassing voltage. In this case the coupling between the two chokes may be such that a small ripple remains in the biassing voltage to be used to neutralize the effect of residual ripple in the plate supply. G. E. Co. No. 424,598.

Detector. Detection is performed on a falling part of the characteristic so that high frequency amplification is obtained by the reduction in damping of the input circuit due to the negative resistance effect. Pintsch, Berlin. No. 424,602.

Negative resistance oscillator. A magnetically-controlled oscillator of the split-anode type which has two or more pairs of anodes symmetrically arranged around a cathode with opposite anodes of each pair connected together and to the respective sides of the tuned output circuit. The circuit oscillates by virtue of negative resistance, and the present system enables oscillations to be produced at higher frequency than with the normal split-anode magnetron. Philips. No. 423,990.

Voltage supply. Current or voltage is supplied to an intermittently-operative short-wave oscillator from a condenser-relaxation oscillator. In applying the invention to magnetron oscillators, a relaxation oscillator is employed for supplying anode voltage and current for the magnetizing-coil. The supply system may also be employed for back-coupled oscillators or for a-f oscillators in which the oscillations may occupy only a small fraction of the supply cycle. No. 423,832.

Parasitic suppression. To suppress parasitic or eddy oscillations in the oscillator portion of a pentagrid or similar type of frequency changer tube, the inductance coupled to the anode



electrode of the oscillator is damped. This may be produced by utilizing a resistance in a high voltage circuit of the oscillator anode grid No. 2, which resistance is effectively in shunt with the coil, on the natural frequency of which the tube tends to oscillate. British Thomson-Houston. No. 423,995.

Glow tube oscillator. The condenser of a relaxation oscillator is charged from a d-c source through a glow discharge tube. The source feeds the glow discharge tube through a series resistance, preferably of the ferric-hydrogen type, and the tube supplies a constant voltage which charges the condenser through a variable resistance and inductance. In television use the same glow-discharge tube may feed two relaxation circuits, one generating the picture frequency and the other the line frequency. Loewe. No. 424,429.

Noise control. Positive bias is supplied to a high frequency amplifier. This bias is opposed by the voltage drop in a resistance in the anode circuit of the signal rectifier so that for very weak signals the set is quiet and for stronger signals the degree of amplification increases rapidly with the incoming signal strength. Telefunken. No. 424,779.

Modulation. For intermodulation between currents or voltages of different frequencies and for amplifying changes in steady currents or converting such changes into varying alternating currents, use is made of a tube having a non-linear amplification factor such as a variable-mu tube. The invention is applicable to the production of sum and difference frequencies, for example, in beat frequency oscillators. For the amplification of steady currents the output of a balance circuit is connected to an indicating instrument. W. L. Watton and L. H. Bell, National Physical Laboratory. No. 424.783.

Regeneration. A high frequency pentode is used between a high frequency amplifier and the detector, the screen circuit of the pentode containing an inductance of low value, coupled magnetically or through capacity to the tuned circuit. E. J. Pound and McMichael Radio. No. 424,965.

Saw-tooth oscillator. The object of this invention is to preserve the sharp peaks of the synchronizing pulses and to prevent triggering of the line frequency oscillator by the frame frequency oscillator. E&MI. No. 425,035.

Oscillator output control. The degree of oscillation of a back-coupled oscillator is controlled by rectified output voltage. L. E. Ryall, Middlesex. No. 425,308.

Gaseous modulation. Method of modulating radiation of very short waves by passing the wave through a region containing free electric charges, such as an ionized gas or electron discharge tube, the condition of which is varied by the modulating current. American readers will recognize this patent as relating to the demonstrations of very short wavelength transmission and reception carried out by Irving Wolff and his associates at RCA-Victor at various conventions, etc. E. G. Linder, Marconi Co. No. 425,571.

Television

Color system. Several cathode-ray tubes corresponding to the number of colors into which the view is analyzed are adapted to reproduce alternate lines of the image transmitted. British Thomson-Houston Co. No. 424,743.

Synchronizing signals. A series of impulses having the initial portions of the wave forms steep and of the same shape, the initial portions recurring at the line frequency while groups of one or more of the impulses are of longer duration than the remainder, these groups recurring at the image frequency. E&MI. No. 425,220.

Cathode ray system. A device of the type having deflecting means exterior to the envelope, such as a cathode-ray tube, comprises a shielding member surrounding a part or a whole of the device and integral with it, and means for deflecting the electron stream perpendicular to its direction which are fixed rigidly to the shield. In one form a metal shield surrounds a cathode-ray tube with an intermediate packing of felt, and carries at one end a cap which fits over the tube terminal. A ring with rubber facing clamps the tube permanently in position and surrounds the screen end. A centering electromagnet and a magnetic lens are mounted on sleeves which, after adjustment, are locked, for example, by soldering, so that they cannot be moved by the user. G. E. Co. No. 425,493.

PROFESSIONAL SERVICES

PROFESSIONAL ASSISTANCE

in the solving of your most difficult problems in the highly specialized field of electronic devices is offered by consultants whose cards appear on this page.

ASTATIC

S-TYPE CRYSTAL PICKUPS

HIGH FIDELITY!
ECONOMICAL!
PROFESSIONAL!
GUARANTEED!

LICENSED UNDER BRUSH DEVELOPMENT CO. PATENTS
See your jobber or write for literature.
ASTATIC MICROPHONE LAB., INC., YOUNGSTOWN, OHIO
"Pioneer Manufacturers of Quality Crystal Products"

200% Overload Without injury WITH

MICROHM MICA CARD RESISTORS

Our type "H" 40 watt Mica Card units, have been subjected, in laboratory tests, to loads up to 120 watts without injury. Size: 1¼" wide, 3¼" long by ⅛" thick. Their unique construction suggests many uses.

Write for further information and our new catalog.
PRECISION RESISTOR CO., 334 Badger Ave., Newark, N. J.

MICROHM
WIRE WOUND RESISTORS

AUDAX

trade mark

pick-ups . . .

"The standard by which others are judged and valued"

Made to suit every demand, from the humblest midget-combination to the HIGH FIDELITY—low needle-pressure requirements of fine transcriptions. AUDAX instruments are immune to humidity and summer heat. They are chosen on a PERFORMANCE basis, as equipment in most of the world's leading Radio Stations, Universities, Laboratories—in fact, wherever quality counts.

List
$9.50
to
$390.00
each

Special Recording Heads Made to Order

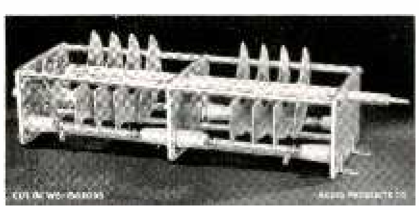
AUDAK COMPANY
500 Fifth Avenue, New York
"Creators of High Grade Electrical and Acoustical Apparatus Since 1915"

CUSTOM DESIGNING & MANUFACTURING

for the BROADCAST • SOUND AND ELECTRONIC FIELD

We Have Every Facility at Your Disposal and Welcome Inquiries on Your Special Work or Problems.

TYPE WS—1502035 TRANSMITTING CONDENSER



Shown is an example of our development for special applications. Designed for 15000 volt operation in high frequency transmitter. It may fit into your job. If not—we can build one that will. The WS-1502035 is 35 m.m.f. per section and sells for

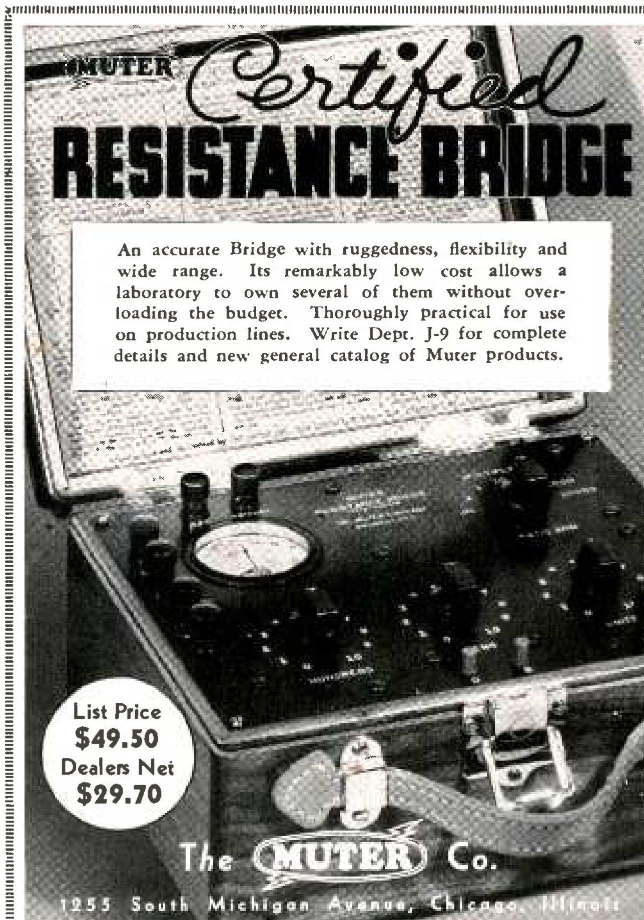
$15.00 NET Plus Postage
Shipping weight 9 pounds.

QUALITY PRODUCTS SINCE 1910

—AUDIO PRODUCTS CO.—
4189 W. Second St. A. J. EDGCOMB Los Angeles, Cal.

MUTER Certified RESISTANCE BRIDGE

An accurate Bridge with ruggedness, flexibility and wide range. Its remarkably low cost allows a laboratory to own several of them without overloading the budget. Thoroughly practical for use on production lines. Write Dept. J-9 for complete details and new general catalog of Muter products.



A TRIAL WILL CONVINCE YOU

30 Years' Experience
Insures Dependability

•

We Manufacture

PERMANENT MAGNETS
TOOLS and DIES
METAL STAMPINGS
LAMINATIONS

•

THOMAS & SKINNER STEEL PRODUCTS CO.

23d St. at Alvord — Indianapolis, Ind.

INDEX TO ADVERTISERS

This index is published as a convenience to the reader. Every care is taken to make it accurate but *Electronics* assumes no responsibility for errors or omissions.

Open This Door and You'll Close the Sale

Many a salesman who would like to go directly to the factory office finds himself shunted off to the purchasing agent. For in every company there are executives who "don't see salesmen,"—but who have a lot to say, *and say it*, when it comes to placing the order.

Where do they get their buying information? They get it by seeing "salesmen" after "salesmen" as they read through their business paper each week or each month. Of course, they don't give all these "salesmen" a hearing. But they do stop for those who have interesting messages. They do make a mental note to suggest so-and-so's product at the next meeting. Occasionally they tear out an advertisement to pass along to their colleagues, or to write for details.

And though they may not realize it, with each succeeding issue they are increasing their respect for the many products and companies presenting their cases in these pages.

* * * *

That's more than a pretty theory. A survey of 10,000 executives by Ernst & Ernst shows that 69 out of every 100 depend on business paper advertising for their buying information. McGraw-Hill Publications will help you reach these men in industry's 12 Major Markets—with a maximum of attention value, and with a minimum of waste circulation.

McGRAW-HILL PUBLICATIONS

McGraw-Hill Publishing Company, Inc., 330 West 42nd Street, New York, N. Y.

American Machinist
Aviation
Bus Transportation
Business Week
Chemical and Metallurgical Engineering
Coal Age
Construction Methods
Electrical Merchandising
Electrical West
Electrical World
Electronics
Engineering and Mining Journal
Engineering News-Record
Factory Management and Maintenance
Food Industries
Metal and Mineral Markets
Power
Product Engineering
Radio Retailing
Textile World
Transit Journal

POSITIONS WANTED

ELECTRICAL and communications engineer. Ten years' executive broadcast and telephone experience. Specialist in electrical control equipment. Four years electrical engineering, University education. Broadcast-telegraph licensee. Now employed. PW-74, Electronics, 520 No. Michigan Ave., Chicago, Ill.

MAN, aged 32, B.S., M.S. in electrical engineering, 10 years' varied experience in development of instruments, oscillographs, relay control devices, industrial application of small vacuum tubes, photo-cells, radio-frequency design, invention, etc. Best reasons for availability. Abundant references. PW-72, Electronics, 330 West 42d St., New York City.

TECHNICAL SECRETARY, Columbia graduate, travelled, linguist, excellent stenographer, complete command radio, electronic terminology, accustomed responsibilities. Best references. PW-73, Electronics, 330 West 42d St., New York City.

YOUNG MAN (21), high school education, with 9 years' varied experience in radio work, desires position as assistant to an engineer or research worker, either in a radio engineering or research laboratory. Please write to Henry J. Walczak, 49 Osgood St., Springfield, Mass.

"SEARCHLIGHT" RATES

Electronics

UNDISPLAYED:

Positions Wanted—5 cents a word, minimum charge—$1.00 an insertion.

Positions Vacant and other classifications—10 cents a word, minimum charge $2.00 an insertion. Allow 10 words for box address. No additional charge for forwarding replies.

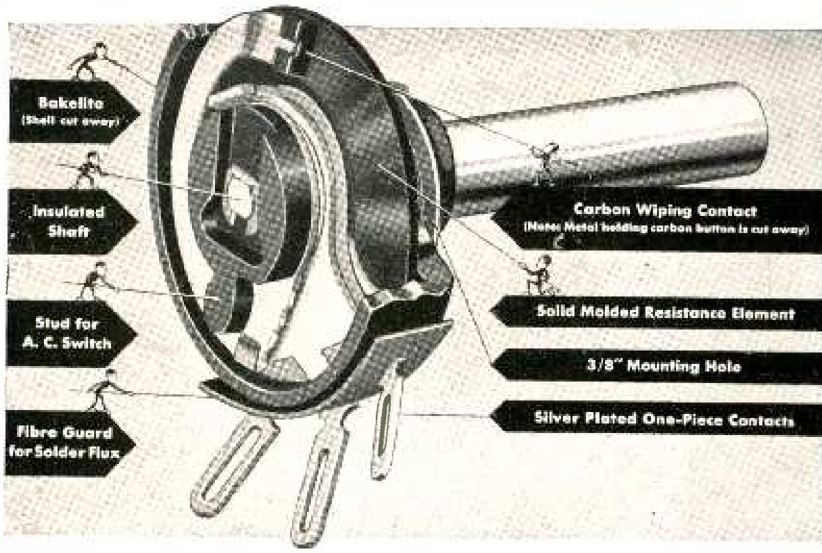
Discount of 10% for payment in advance on 4 consecutive insertions of undisplayed advertisements

Proposals—40 cents a line.

DISPLAYED:

Space is sold by the "inch," with 30 inches to a page (An "inch" measures approximately 1 inch high by 2¼ inches wide.) Rates are from $5.00 to $3.00 an inch, depending on the total space used.

0226



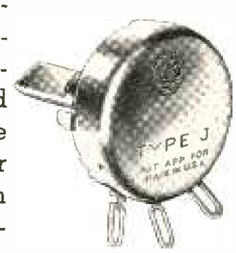
ALLEN-BRADLEY RADIO RESISTORS

the Choice of the World's Largest Radio Manufacturers

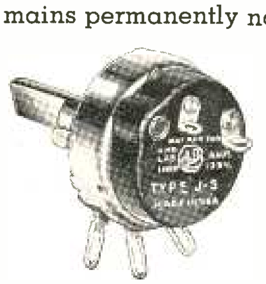
Severe Service Cannot Change Type J Bradleyometers

The solid molded resistor is homogeneous in cross section—it is not a film-type unit. In longitudinal section, the material is varied to suit specified resistance-rotation curves; after molding, the unit cannot change. Severe service cannot alter its performance. Long wear has no deteriorating effect on this molded resistor.

The small size of the Type J Bradleyometer—it is only 1 1/16" in diameter—makes it ideal for all radio receivers including midgets and auto-radio tuning heads. A fiber guard fitted over the silver-plated one-piece contacts effectively excludes solder flux. High humidity has no effect on Bradleyometer J, and the control remains permanently noiseless.



Type J Bradleyometer



Type JS Bradleyometer

The Type J Bradleyometer is made in two types: Type J is a volume control without line switch; Type JS has a built-in line switch actuated by the control knob. Both units are interchangeable with other types of volume controls built to R.M.A. standards. Therefore, every radio receiver can easily be improved by standardizing on these dependable and compact controls.

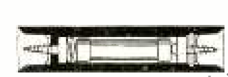
BRADLEYUNITS FIXED RESISTORS

These solid molded fixed resistors have an exceptionally low voltage coefficient. Moisture and age do not affect them. All manufacturing processes are under continuous laboratory control. Such uniformity of manufacture assures resistors that are quiet and dependable in radio receivers.

SUPPRESSORS

Allen-Bradley Suppressors do not "open circuit" in service; they do not "drop" in resistance and, therefore, fail as suppressors; they do not have a high voltage characteristic; they do not fail from exposure to oil and water; they do not break due to car or engine vibration. These resistors are enclosed in rugged, non-arcing bakelite casings.

Write for Allen-Bradley data.



ALLEN-BRADLEY 110 W Greenfield Ave., MILWAUKEE, WIS.

Here it is... RCA-803
A "HE-MAN" PENTODE

The RCA-803 fills a gap which has long existed in the transmitting tube line—the need for a really powerful transmitting pentode. Incorporating an electrical and mechanical design which assures the utmost reliability, the RCA-803 is ideally suited for such applications as: a suppressor-modulated 'phone transmitter; multi-band transmitters where neutralization would be troublesome; transmitters where the number of tubes is to be kept at a minimum.

The RCA-803 is available for immediate delivery. Write for technical information.

RCA

CHECK THESE FEATURES

- Dome Bulb
- Rugged Construction
- Precision Aligned Parts
- 125 Watts Plate Dissipation
- Carbon Plate
- 50 Watts Carrier Output *(Suppressor Modulated)*
- 200 Watts Output *(Class C Telegraphy)*
- Ceramic Base
- Superior Insulation
- Thoriated-Tungsten Filament
- Easily Excited
- No Neutralization
- List Price, $38.50

RCA RADIOTRONS

RCA RADIOTRON DIVISION

RCA MANUFACTURING CO., INC., CAMDEN, N. J.