COMMUNICATIONS

including

TELEVISION ENGINEERING


SCROLL OF HONOR

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Lee de Forest

· Ph.D., D.Sc., D.Eng. ·

Inventor of the Audion · · · Father of the Modern Radio Art
Pioneer in Wireless Telegraphy · Pioneer in Sound on Film
Pioneer in Radiotelephony · · · Inventor of the Radio Knife
Father of Radio Broadcasting · Early worker in Short Wave Therapy
· Primeval Friend of the Radio Amateur ·

Every Transmitting Station of any class: Every Receiving Station: Every Listener and Viewer in the Home · Transoceanic Radiotelephony Transcontinental Telephony; · Every Public Address System and other uses of the principle of Amplification: all owe their existence to him.

Given by his confreres on this Twenty Second day of September, 1939, at the Celebration of De Forest Day at the New York World's Fair.

William J. McGonigle — Pres. Veteran Wireless Operators Association

Raymond A. Heising — Pres. Institute of Radio Engineers

PRES. American Institute

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OCTOBER

1939

aluminum construction
light weight

completely self contained
fast set up

easy accessibility

standard batteries-long life

3 standard tubes

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COLLINS NEW 12 Z REMOTE
Has Plenty On The Ball

It's football time again and to help you do a better pick-up job, here is Collins new 12Z. Many operators will be trudging stadium steps again, but instead of carting a van load of equipment, the smart operator will be able to take two steps at a time with his light-weight 12Z.

Inherent Collins quality assures him of the utmost reliability and fidelity. He knows that with the 12Z he can do a studio job anywhere. A shrewd happy man, indeed, is our hero with his new shiny Collins 12Z Remote Amplifier. We say shrewd, because he knows the 12Z is more amplifier for the money than he can buy anywhere else.

COLLINS RADIO COMPANY

CEDAR RAPIDS, IOWA   NEW YORK, N. Y: 11 WEST 42 STREET

COMMUNICATIONS

OCTOBER 1939

Including Television Engineering, Radio Engineering, Communication & Broadcast Engineering, The Broadcast Engineer.
Registered U. S. Patent Office
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VOLUME 19
NUMBER 10

RAY D. RETTENMEYER
Editor

• Editorial Comment •

THE 1939 Rochester Fall Meeting will be held at the Sagamore Hotel, Rochester, N. Y., on November 13, 14 and 15. Sponsored jointly by the Institute of Radio Engineers and the Radio Manufacturers Association, this convention promises to be of considerable importance. For details, turn to page 12.

ALSO of special interest in this issue is the Annual Purchasing Directory which appears on page 25. We believe the information contained in this directory will be of value to executives, engineers and purchasing agents in the field. Comments will be welcomed.

DURING the past few weeks the various tube manufacturers have cleaned house. They have established what appears to be a sound and simple price structure based upon manufacturing costs, distributor net prices and suggested list prices. The new setup should have a very definite stabilizing effect. Perhaps other parts manufacturers could well follow their example.

THE joint RMA-NAB radio campaign which started to function early this year seems to be progressing nicely. Working closely with the Radio Service Men of America and securing the aid of the various broadcast stations the campaign is performing a real service to the industry.

CONSIDERABLE experimental work has been done towards equalizing ordinary telephone lines to permit them to carry the wide band of frequencies necessary for television transmission. At least one experimental television pickup has been handled in this way with fair results. If these experiments prove successful, much will have been done towards the solution of one of television's biggest problems—distribution.

• Contents •

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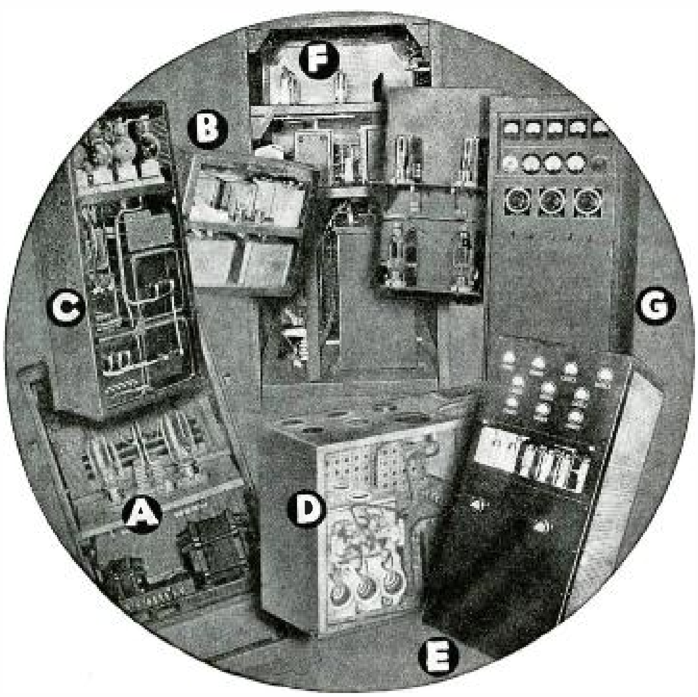
UTC TRANSFORMERS *for every purpose*

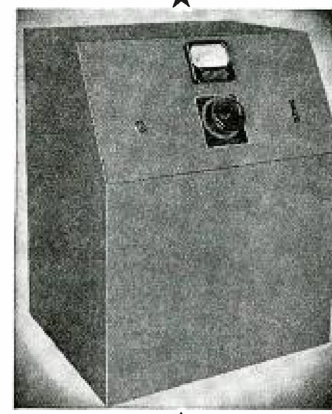
INDUSTRIAL RECTIFIERS

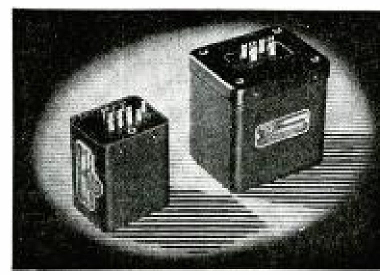
Tube and disc type rectifiers are the ideal means for converting A.C. to D.C. They are noise and maintenance free and more efficient than rotating equipment. UTC rectifiers are designed to customers' specifications, and are inexpensive, whether in large quantities or single lots. Write for quotations on equipment for your needs.

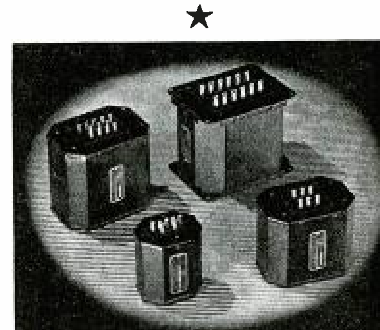


UTC industrial rectifiers are available from 1 volt to 250,000 volts and from 1 watt to 250 Kw. Typical units are illustrated above.

A—For physiotherapy and medical equipment.
B—For filament supply.
C—5 Kw. 220 V. supply.
D—3-phase 220 V. supply.
E—5 Kw. high voltage supply.
F—20 Kw. high voltage supply.
G—Variable voltage laboratory unit.







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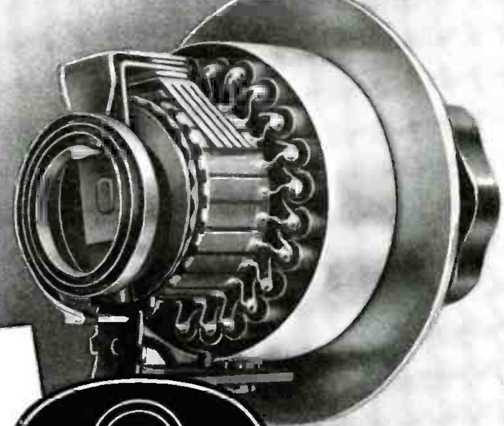

KGU

"THE VOICE OF HAWAII"

DED MAY, 1922 ◆ ◆ 2500 WATTS ◆ 750 KILOCYCLES. N. B. C. MEMB

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HONOLULU
HAWAII

M. A. MULRONY
MANAGER

September 19, 1939

International Resistance Company
401 North Broad Street
Philadelphia, Pa.

Gentlemen:

Station KGU has been using your type A 21 ladder type attenuators for the past nine months in its remote control equipment and studio amplifier feeder.

For the past ten years we have been trying to obtain a satisfactory feeder for low level mixing service. At long last we are satisfied with the type A 21 attenuator supplied by your firm. These attenuators are the answer to our problem. In our climate, mixing the low noise levels is aggravated due to the hum always present. We have always had difficulty to obtain quiet mixer attenuators until we tried out one of your commutator contact units. Our repeat orders all through this year indicate the continued proof of satisfaction obtained at Station KGU.

We are sure that many other radio stations have been looking for a satisfactory low level mixing attenuator, and their attention should be called to your instrument.

Very truly yours,

Advertiser Publishing Co., Ltd.

M. A. Mulrony

MAM

IRC

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Type A-21, 20-Step

ATTENUATOR

Low noise levels are maintained in service as a result of the unique, molded motor commutator-type switch; a multi-finger beryllium copper contact; a flat clockspring connector; Insulated Metallized and Wire Wound Resistors, and other exclusive IRC features. Either potentiometer or ladder networks available in 20 steps with or without detent dial or knob. Because of size limitations IRC also supplies a conventional, stud-type Attenuator for 30-step requirements, known as IRC Type B-31. A spiral spring connector in each arm of bridged "T" eliminates two wiping contacts and makes possible a maintained low noise level of —150 DB. Write for Catalogs 5 and 5-A.

INTERNATIONAL RESISTANCE CO.

415 N. Broad Street, Philadelphia, Pa.

AUTOMATIC TIME AND WEATHER SYSTEMS

By LEWIS WINNER

Market Research Engineer

*Miss Time of Sweden**

IT is strikingly strange that so important a factor in our daily program as *Time* . . . and its close ally . . . *Weather* . . . have received such feeble attention, until comparatively recently. That probably appears to be paradoxical, realizing the importance of these two veteran friends. But only with advent of progressive communication and electrical engineering and modern advertising, have *Time* and *Weather* publicly become such amazing attention holders. Today you can look at a sign, turn in on the radio, or better yet, call up on the telephone and receive accurate information, any time of the 24-hour day. Of course, it is true that this unique telephone service is not available everywhere, but *Time* will march on, and it won't be long, as they say.

In telling time, two methods are used. One, of course, is the simple direct microphone method, where the operator or announcer simply looks at a special synchronous clock, and reads off the time into a transmitter. The other is the intriguing automatic method, providing time of day service through the facilities of recorded film operated by any one of several ingenious devices.

Oddly enough, this uncanny automatic system was first conceived in that famous city . . Stockholm, in Sweden . . where there are more telephones per person than anywhere else in the world. The date . . . early in 1934 . . . and the place . . . the engineering laboratory of the L. M. Ericsson company.

The Ericsson system employs a photoelectrically prepared film disc mounted between two glass plates, rotated slowly by a controlled motor; an optical system with its photoelectric cells and beam of light, actuated by eccentric cams, and operated by gears through the same motor that rotates the film discs. Lifting up the receiver automatically actuates a relay device that opens the time announcement circuit, and feeds the recorded message to the line into the receiver. This announcement is broken up into hours, minutes and even seconds.

The intervening years have seen a host of remarkable engineering strides in this device, and as shown in Figs. 1, 2 and 3, today it is even more uncanny in its reliability, accuracy and quality of reproduction. So popular has it become that close to 20,000 people call every day to ask for the time. Remembering that there are only 125,000 subscribers in this city of Stockholm, it is quite apparent that the percentage of interest is quite high. It is further interesting to note that in the city of Warsaw, where there are only 55,000 subscribers, the daily rate is nearly 30,000 calls for *Time*.

One of the unusual features of this device is the film disc, using concentric bands. It is possible with this concentric method to provide a comparatively long series of messages on this disc which is

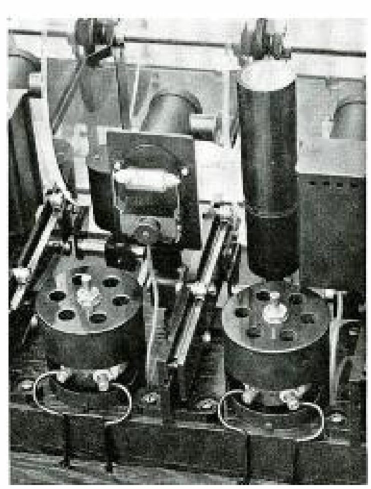


Fig. 1. Closeup of Ericsson Automatic Talking Machine with film (in glass plates), photocell, beam projector.

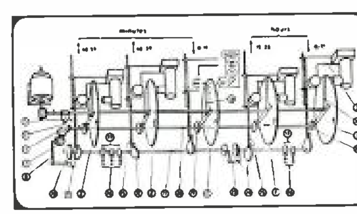


Fig. 2. Circuit diagram of the Ericsson Automatic Time Telling Machine.

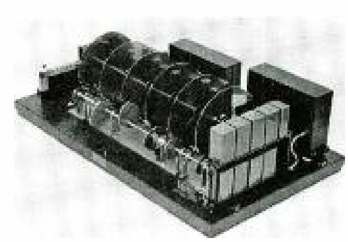


Fig. 3 The Ericsson Automatic Weather Forecasting Machine.

**Miss Time's voice is heard on recordings used in Ericsson units.*

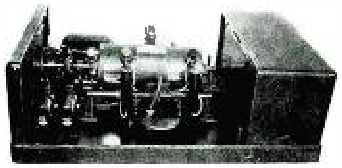


Fig. 4. The Polish Automatic Time Telling Machine.

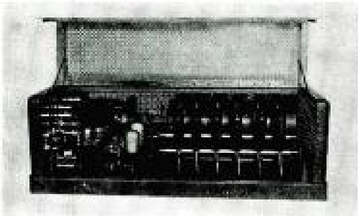


Fig. 5. The Polish Automatic Weather Forecasting Machine

only some 6" in diameter. To operate or to transcribe these messages, the optical system moves from the outer edge in and back again for the repeats. The time device uses five of these discs, but of course this can be extended to include many more for additional time messages or special data that may be of interest to the listener, such as advertising, about which more will be said later.

As many as 150 patrons may call in at one time, with an equal level of volume available for every one. This is made possible by the use of a low impedance output operating out of a high gain resistance coupled audio amplifier connected to a parallel operated telephone circuit. Like a direct controlled device, it is not possible to break into a section of an announcement after you have dialed your number. Instead you hear the beginning and end of the message several times, just as you do when you call the direct operator. A time disconnect relay that disconnects the amplifier during the moment that the dialing is being completed, affords this service.

As stated previously, it is possible to extend the number of film discs to afford additional messages. This has been done with the machine that provides *Weather* service. In this instance, of course, no clock is used, but the same timing principle is used. Six discs, with their special weather reports recorded thereon, are used. The specific messages desired are available by turning large drum dials, that appear through the front of the cabinet. On these drum dials are numbers, each of which corresponds to a specific weather condition. When the drum is turned, that portion of the film with the specific weather report desired, appears before the optical system, and when you call in for your report, it is this message that you hear.

A typical weather report would entail the turning of dial A, for the day of week and part of the day, viz. . . . Monday morning. Then the next would be adjusted for the direction of wind, viz., N NE. This is followed by the dial that affords us the strength of the wind. Then we have the type of weather, that is, if it will rain or snow. On the next drum we are able to turn to miscellaneous phrasing as . . . "Later on" . . . or "Next Day." And finally we have the forecast, as . . . "Clearing Skies" or "Increasing Cloudiness." There are 180 different classifications of data available, thus affording a multitude of combinations.

So popular has this service been that as many as 23,000 calls a day have been recorded. And during specific seasons when certain sports are in vogue, this increases many times. And speaking of certain sports, this machine has also been equipped with discs that provide information on conditions at mountain tops for skiing, one of the most popular sports in Sweden and other countries in this region. In addition information on the temperature of bathing pools, direction of wind, waves, tides, is also available in many cities. For fishermen, other data are also supplied. Thus it is quite evident that these devices have proven themselves most effective servants of Mr. and Mrs. Public, and have correspondingly served to amplify the prominence of *Time* and *Weather*.

Polish Time and Weather Systems

A few years after the introduction of the Swedish systems for *Time* and *Weather,* T. Korn, a brilliant young engineer of Warsaw, Poland, conceived another method permitting the automatic transmission of *Time* and *Weather* reports. He chose to use a rotating cylinder, on the surface of which was carried a recorded film, with its hours and minutes, or weather forecasts. This film is lighted by a thin beam of light, which is reflected by the mirrored surface of the drum. This, in turn, is modulated by the sound recorded on the film, and then on to the photo cell, the output of which is fed into a regular telephone amplifier, and finally into the trunk line. This mirrored drum is encased in a metal housing, and driven slowly by a synchronous motor. The photo cells and optical system peering through transparent shield openings on the rotating drum are shifted by eccentric cams, controlled by gear to the synchronous motor that revolves the large drum.

On one side is the hour shifting device, and on the other side is the minute section, split into two divisions. A resistance coupled audio amplifier is also employed, in a rather high gain circuit.

Utilizing the same pattern of design is the *Weather* machine, except that here six cells are used in conjunction with different portions of the complete weather forecast. The changes in forecast are controlled by a push button arrangement, corresponding to specific data required.

American Systems

A short time after the introduction of the Ericsson system, J. L. Franklin, of Atlanta, Georgia, announced his method of telling *Time* by an automatic device. And here again we have the reflected light principle used. In this instance, the bottoms of grooves, on a metallic cylinder, carrying strips of transparent film record, are chromium plated, offering a very highly reflected surface. When non-metallic cylinders are used,

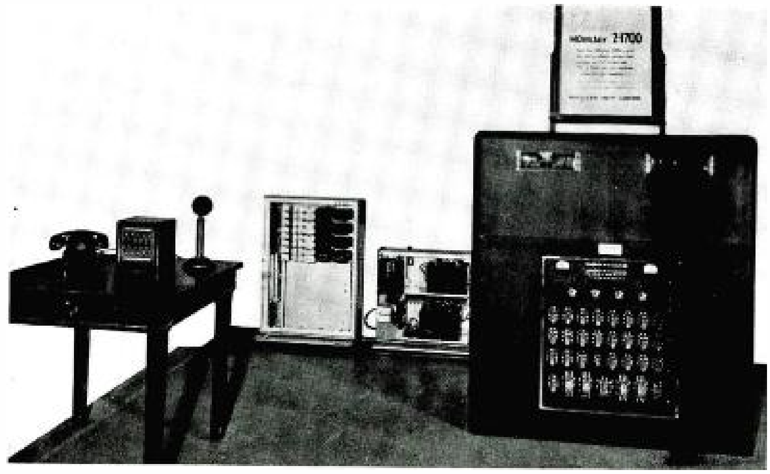


Fig. 6. The J. L Franklin Automatic Time Telling installation. Note the emergency hand set equipment at the left. The time devices are mounted atop the large cabinet at the right.

then ribbons of chromium plated metal may be used. The optical system used here is mounted on top of the film casing. The beam of light thrown is reflected into the photo cells.

Two cylinders are used. One is the hour cylinder, with twelve spiral grooves, resembling a twelve-thread screw. The minute cylinder with sixty grooves carries the recorded film in each of its sixty slots. These cylinders are actuated by eccentric cams controlled by a synchronous motor.

The time device is mounted in an attractive metal casing, beneath which is housed the amplifying system. Beneath this unit is the mercury switch compartment.

In view of the grooved design of the film cylinders, an unusual degree of film-change flexibility is afforded. Thus it is entirely possible to change sections of the drum quite rapidly, which is excellent in those instances where special messages are to be included and interchanged.

And speaking of special messages, we come to an interesting use to which this American device has been put by many advertising firms. For instance, the First National Bank in St. Louis installed one at the beginning of the year and within a period of two weeks nearly 605,000 calls were put through for time alone, which is certainly an inspiring percentage of interest in *Time*. It must be remembered that there are only 125,000 subscribers in St. Louis. Another installation in Montclair, New Jersey, has also proven the popularity of *Time* with everyone. To promote the interest in the service this device affords, extensive advertising campaign has been instituted in newspapers, billboards, car cards and direct mail.

Since, of course, this private installation must serve the community twenty-four hours a day, it naturally must be checked frequently. To this end, special service engineers have been selected to keep a steady eye on their operation. In some instances, the installations have been made in radio and electrical stores, and in radio stations, as in the case of station WEEI in New Haven. The servicing of these instruments is within the scope of the alert radio service man, with his kit of modern testing and mechanical equipment. And incidentally here is a new industry for the service man to study seriously, for with increased interest being shown everywhere in the automatic devices of this nature by the public and sponsors, it will not be long before there will be an enthusiastic demand for him. What should he know? The fundamental principles of sound coupled with a thorough knowledge of amplifiers, synchronous motors, and essentials of mechanics.

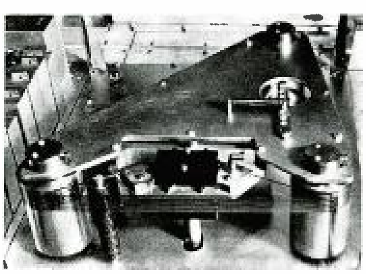


Fig. 7. The Talking Steel Tape installation at the New York Telephone Company.

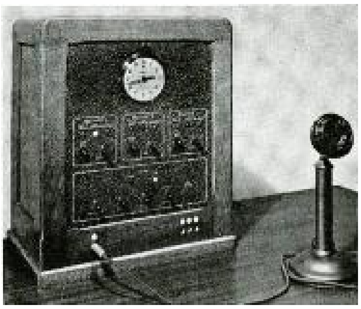


Fig. 8. Closeup of the control turret by which the operator records weather forecasts.

It must be remembered, too, that although these systems are now being used for wired circuits, they can eventually be transformed for use in radio systems, public-address work, and many other forms of wire and radio communications requiring a series of duplicated messages.

Semi-Automatic Systems

In addition to these automatic methods of telling *Time* and *Weather,* there are the semi-automatic methods, requiring constant "personal" transmission, and personal recording several times a day.

The constant "personal" transmissions used for *Time* are in effect semi-automatic in view of the automatic time indicators required, and specially developed for this work. For instance, at the New York Telephone Exchange there is a time announcement turret, which is actually a dual unit with two clock units is a time indicator, driven emergency. On the face of each of the clock units are a time indicator, driven by alternating current of regulated frequency. This records time in fifteen-second steps. In addition to this clock are three lights . . . white, green and red.

At a predetermined interval, before each quarter minute change in the time indicator, a green signal on the turret lights and the operator receives an audible tone in her head receiver to warn her to begin her announcement. . . . "When you hear the signal, the time will be two-five and three-quarters." This is followed, exactly at the time announced by a time signal. The green signal lights and the announcement tone is heard in the operator's head receiver only when one or more subscribers are connected to the time bureau. This connection is indicated by a white light, so that the white light, the green light and the audible signal, the annoucement and finally the time signal follow each other. Thus the operators or announcers, of which there are seventy and specially trained, serve to complete the cycle of automatic service. Included on the turret are volume indicators, that enable the operator to check her voice level constantly.

I mentioned a moment ago that the frequency of the current fed to the time indicators was regulated. This is performed by a frequency-standard method, established by a "crystal clock" at the Bell Labs. This "crystal" is our old friend . . . quartz. We know that thin wafers that may be cut from quartz will have a natural state of vibration, depending on their size; and when inserted in a suitable circuit, they will control the rate of electric vibrations to an accuracy of one part in a million. Four such crystals, confined in a time vault at the Bell Labs., have been independently operated and checking each other continuously for more than ten years. Even though the frequency of the current driving the clocks at the Time Bureau is regulated by this time standard, the clocks are also checked by special radio apparatus at the Bureau with the familiar and reliable time signals from the Naval Observatory at Washington, D. C.

While we are at the New York Telephone Company, let us drop in to see how they forecast the *Weather* reports. Here again we have a semi-automatic method, calling for the services of an announcer, only several times a day, however. And they use, our veteran standby of automatic recording . . . a

(*Continued on page 14*)

Fig. 9. (Top) The Film Talking Tape Editing equipment. Both a visual and aural means of checking the tape are provided.

Fig. 10. (Bottom) Miller Filmtape.

Designing Steatite Die Pressed Ceramics

Die for making steatite part.

By W. L. SCOVILLE

American Lava Corp.

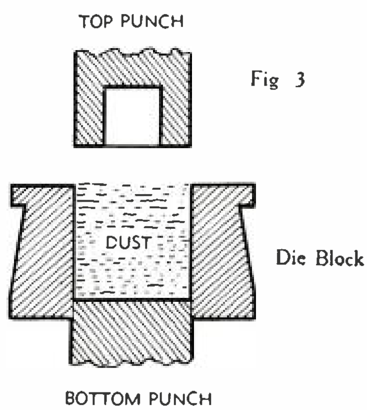
THE radio parts and electrical appliance manufacturers form a branch of a rapidly growing industry which is today pulsing with the new blood of television and improvements in radio technique.

These manufacturers design, purchase and use an infinite quantity and variety of ceramic insulators which are supplied by the porcelain industry and by manufacturers of steatite insulation. Since the manufacture of steatite insulation is a relatively young industry, it is true that its methods and problems of manufacture are not well known by the users of its product.

To correct this condition, information bulletins have for some time been issued to the trade and it is to shed further light that this article is written. When the users of steatite insulators more generally understand how these insulators are fashioned, they can eliminate a great deal of re-designing and, in the long run, obtain a better design more cheaply and quickly.

The steatite insulation manufacturing industry does not lend itself to standardization or the stocking of catalogued parts, for the simple reason that improvements in the apparatus void old designs and new developments require new ones. Thus, the greater part of their output is tailor-made to customers' specifications.

For more than a half-century, insulators have been machined out of blocks of steatite just as such nuggets are taken from the earth. Today, however, as the volume of business demands something much faster, the steatite is pulverized, mixed with fluxes and various binders and pressed or extruded under pressure to obtain the desired shape. In this way thousands of insulators may be formed in the time necessary to machine one insulator from the natural stone.



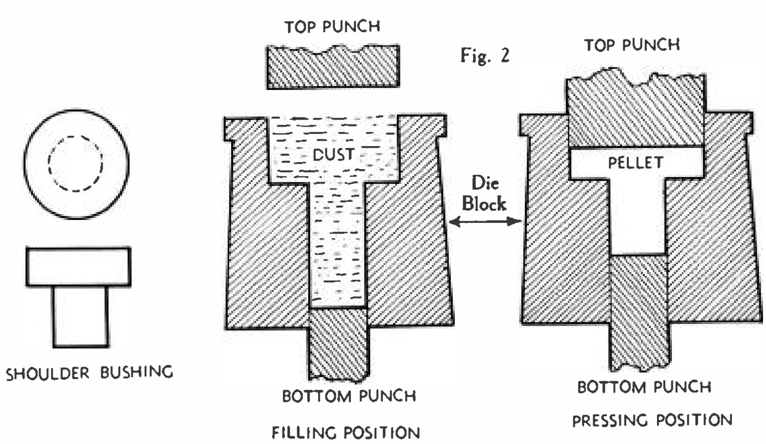
The process of extruding is simply forcing the moist pulverized steatite through a shaped orifice or die and breaking it off in long sticks for drying. Short measured lengths are then cut from these sticks and after further machining (if required) are ready for the kiln. This method of manufacture lends itself to tubes and long pieces of constant cross-section.

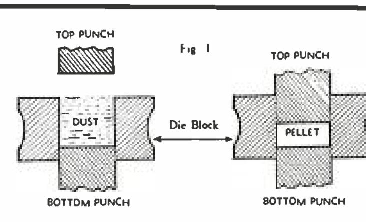
The process of pressing consists of shaping the pulverized steatite under pressure in a die or mold. Since, in die pressing, the molded object is ejected from the press ready for firing and can be pressed with considerable speed, it follows that pressing is, within limits, the cheapest method of manufacture.

If the prospective purchaser is considering a ceramic that is adaptable to the pressing method, it behooves him to make its design as simple as possible (according to the supplier's idea of simplicity) for the following reasons:

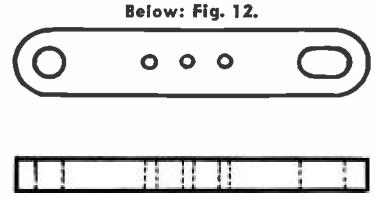
(1) The cost of the die or mold will be less.
(2) The ware can be pressed at a higher rate of speed.
(3) The pressing operation will require less high-priced supervision.
(4) The ceramic can be pressed complete and will need no machine work after pressing.
(5) The supplier will have less rejections in his own plant due to breakage, etc.

The simplest design for pressing is





Below: Fig. 12.



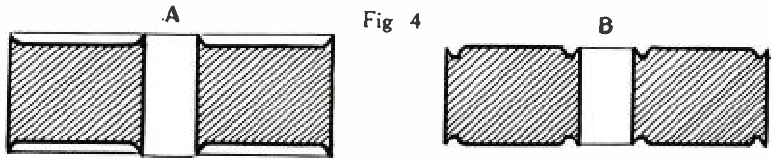
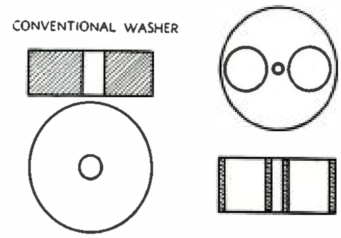


Fig 4

MADE FROM WORN UNPROFILED DIE

MADE FROM WORN PROFILED DIE



Above: Fig. 6.

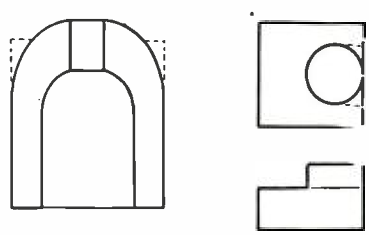
a pellet shaped like an ordinary checker. Here, the die consists of a stationary block and a movable top and bottom punch. These die parts are shown below in the filling and in the pressing positions. The pellet compresses to about half the volume of dust taken for it.

Theoretically, a cross-shaped piece would be just as easily pressed, but the die will cost much more. Holes may be added, which are formed by stationary pins running up through the bottom punch and into the top punch.

In short, then, any piece of uniform thickness, no matter how intricate its outline, can be pressed with a simple die consisting of a block, two punches and a pin for every hole. It should be remembered, however, that these intricate shapes require more delicate handling throughout processing and will cost correspondingly more.

The shoulder bushing shown in Fig. 2 is easily pressed, but the die is more complex than the one shown in Fig. 1. The problem that presents itself here is that the bushing has two thicknesses—through the flange and through the entire length and each thickness requires a height of fill approximately double itself. Herein lies the basic difference between dry pressing, as in the steatite industry, and wet pressing as in the porcelain industry. The raw material of the porcelain manufacturers, being about fifty per cent clay with a moisture content of twelve to eighteen per cent, is very plastic and will flow under pressure into the various cavities of the die; consequently, porcelain dies are much simpler in construction as they fill for the entire piece as a whole and not for the various thicknesses. The porcelain manufacturer might press this bushing

Fig. 7



upside down and form the shank by flowing the material up into a cavity in the top punch. (See Fig. 3.)

In the dry pressing of the steatite industry the material has a negligible flow; consequently, almost every level on the ceramic requires its own separate die part; both punches may be split into two or more separate parts which move in relation to each other, and the block may have a movable sleeve in it. However, slight bosses and indentations can be formed on the ceramic by forming their patterns in reverse on the punch faces, but it would be difficult to put down a rule limiting their height or depth.

The designing, draftsmanship, fabrication, and maintenance of the many hundreds of dies that the steatite ceramic manufacturer keeps in his plant for the service of his customers is a large and highly specialized branch of the industry. The greater part of them are designed to fashion ceramics to very close tolerances and the very nature of their use demands that their various parts fit very tightly together. The finest die steels are used and the various die parts are machined and polished to a high degree of accuracy.

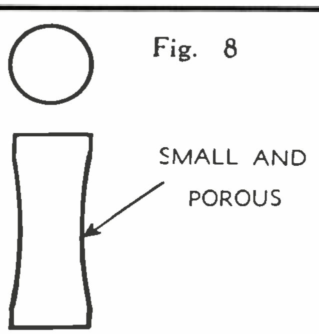
With this insight into the working of the steatite industry's pressing dies, it is hoped that the following rules for the economical design of pressed ceramics will be more understandable than heretofore.

(1) Give the supplier full information as to size of parts that fit into or around the ceramic. If the supplier knows just how the ceramic is to be used, he can check the customer's design for economy and will know what features of the ceramic will need the most careful attention in production. Whenever possible, the supplier should be furnished with a sample assembly so that this idea can be furthered. The usual procedure of designing a ceramic to fit an assembly should be reversed when at all practicable and the assembly designed around the actual ceramic insulator; usually the metal stamping dies are cheaper than the steatite-pressing dies and can be altered more easily.

(2) Always allow as liberal tolerances as possible. The pressed pellets, during

(Continued on page 12)

Fig. 8



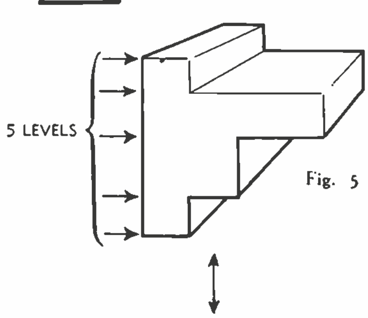


Fig. 5

In Fig. 5 vertical arrow shows direction of pressing.

Fig. 11. The counter-bored tapped hole can be furnished more economically.

Fig. 9

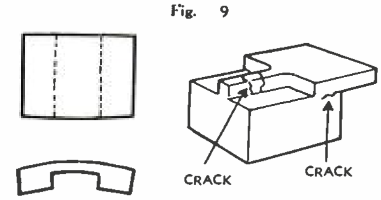


Fig. 10

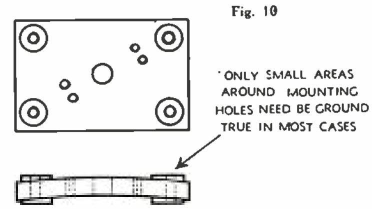
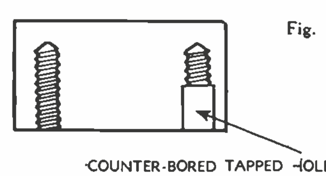


Fig. 11



PROGRAM OF ROCHESTER FALL MEETING

THE 1939 Rochester Fall Meeting is to be held at the Sagamore Hotel, Rochester, N. Y., on November 13, 14 and 15. This gathering, sponsored jointly by the Institute of Radio Engineers and the Radio Manufacturers Association, promises to be of considerable importance. The tentative program is as follows:

PROGRAM

Monday, November 13.

8:30 A. M. Registration.
9:00 A. M. Inspection of Exhibits.
9:30 A. M. Technical Session:
"Spectral Response of Phototube to New Illuminants," A. M. Glover, RCA Mfg. Co., Radiotron Division.
"Observations on Coverage with Frequency Modulated Waves," Paul A. De Mars, Yankee Network.
"A Noise Meter for Television Frequencies," C. J. Franks, Microvolts, Incorporated.
12:30 P. M. Group Luncheon — Main Dining Room.
2:00 P. M. Technical Session:
"Circuit Consideration of Superheterodyne Converter Tubes," C. R. Hammond and E. Kohler, Jr., Ken-Rad Tube & Lamp Corporation.
"The Use of Cascade Circuits with Staggered Parameters for Obtaining Ideal Filter Characteristics," V. D. Landon, RCA Mfg. Co., Victor Division.
4:00 P. M. Inspection of Exhibits.
Meeting—IRE Electronics Committee—Parlor C.
Meeting—RMA Committee on Broadcast Receivers—Green Room A.
6:30 P. M. Group Dinner—Main Dining Room.
7:30 P. M. Inspection of Exhibits.
8:00 P. M. Technical Session:
"What Do We Do Next?," Kenneth Jarvis, Consulting Engineer.

Tuesday, November 14.

8:30 A. M. Registration.
9:00 A. M. Inspection of Exhibits.
9:30 A. M. Technical Session:
"Annual Message of RMA Director of Engineering," W. R. G. Baker.
"A Survey of Standard Signal Generators," E. Karplus, General Radio Company.
"Compensation of Vacuum Tube Input Capacitance Variation by Bias Potential Control," John F. Farrington, Hazeltine Service Corporation.
12:30 P. M. Group Luncheon — Main Dining Room.
2:00 P. M. Technical Session:
"Some Factors Governing Choice of Lenses for Television Cameras," H. B. DeVore and Harley Iams, RCA Manufacturing Co., Radiotron Division.
"A Demonstration of Audio-Frequency Testing with Square Waves," L. B. Arguimbau, General Radio Company.
"Vacuum Tube Life Probability Versus Consumer Satisfaction," Henry Parker, Rogers Radio Tubes, Ltd.
4:00 P. M. Inspection of Exhibits.
Meeting—RMA Committee on Vacuum Tubes—Parlor A.
6:30 P. M. Fall Meeting Dinner (Stag)—Rochester Club.
Toastmaster—A. N. Goldsmith.
Speaker—H. B. Richmond.
Subject—RMA-IRE Cooperation.

Wednesday, November 15.

9:00 A. M. Inspection of Exhibits.
9:30 A. M. Technical Session:
"The Gradation of Television Pictures," H. E. Kallmann.
"Tubes for High Frequency Amplification in Receivers," M. A. Acheson and W. P. Mueller, Hygrade Sylvania Corporation.
11:15 A. M. Inspection Trip:
Stromberg-Carlson Frequency Modulated Wave Station, Rochester Gas and Electric Building (next door to Sagamore Hotel).
12:30 P. M. Group Luncheon — Main Dining Room.
2:00 P. M. Technical Session:
"Television Receiving Antennas," Stanford Goldman, General Electric Company.
"Progress in Development of Instruments for Measuring Radio Noise," C. M. Burrill, RCA Mfg. Co., Camden, N. J.
"Summary of the Significance of the Papers Delivered at This Meeting," D. D. Israel, Emerson Phonograph & Radio Corporation.
4:00 P. M. Exhibits Close.
Meeting—RMA Committee on Television—Green Room A.
Meeting—RMA Committee on Sound Equipment—Parlor A.

STEATITE CERAMICS—Continued from page 11

firing, will shrink from two to sixteen per cent (according to the "body" selected) and it requires very close supervision to make an entire order of them shrink to the certain percentage allowed for in the die. It may seem paradoxical that the ceramic manufacturer boasts of his ability to hold exacting tolerances and then asks for broad tolerances, but it boils down to this: the supplier can furnish ceramics to close tolerances, but when they are more restrictive than ordinary commercial tolerances, he must resort to costly individual gauging. Another factor that argues loudly for broad tolerances is the wearing of the dies: the supplier's different mixes are all abrasive—some highly so—and they eat into the exposed faces of the die.

(3) Give the supplier license to bevel any edge of the ceramic that he deems advisable. As the die parts wear, the material will crowd into the resulting crevice between punch and block and form a fin or flash on the ceramic. When a bevel is allowed the supplier will profile his punch faces and the ceramic will be neater and the dies last longer. The die with the profile punch face will press more pellets before it starts to fin and even then the fin is not objectionable as it does not extend beyond the flat surface. (See Fig. 4-B.)

(4) When bosses, counterbores or depressions are necessary they should be kept as low or shallow as possible and their walls should be tapered about three degrees. If their height or depth is kept small in proportion to their size, they can be pressed without extra movable die parts; the taper is to allow them to turn loose from the punch.

(5) Keep the number of different levels at a minimum. (See Fig. 5.)

In general each level requires a movable die part of its own which adds to both the die and pressing cost.

(6) Holes or depressions should have a substantial wall between themselves and between them and the edge of the ceramic. The thin walls in Fig. 6 would require a fragile die. The pellets would be difficult to form and the ceramic would tend to crack at thin sections.

(7) Avoid designs that necessitate dies of weak construction—very small pins, feather-edges on the die parts, etc. Fig. 7 shows some ceramics which would require feather-edges. The dotted lines show how the shape could be changed to strengthen the die.

(8) Avoid holes in the ceramic not parallel to the axis of pressing. Side or pull pins cannot be used and such holes must be drilled into the pellets individually after pressing.

(9) Ceramics should not be too long—in direction of pressing—in proportion to the area of cross-section. Since all pellets are pressed from only two sides (top and bottom) an extremely long piece will have a soft spot in the center which will fire small and porous. See Fig. 8.

(10) Thin sections, no matter where, should be avoided. They tend to crack, warp, or blister and they make the size of the ceramic hard to control. (Fig. 9.)

(11) If, in the application of a ceramic, it is to be bolted between pieces of metal so that any warpage would tend to break it, the supplier can furnish bosses which are too small to reflect the warpage, yet will withstand the clamping pressure. If a high degree of flatness is imperative, then the ceramic may have to be ground flat after firing. This is expensive and the areas to be ground should be kept at a minimum. Fig. 10 shows a plate designed for economical grinding.

(12) The threads of a tapped hole, of course, cannot be pressed so tapped holes require individual tapping after pressing. The pressed pellets crumble

(Continued on page 14)

VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

W. J. McGONIGLE, President — RCA Building, 30 Rockefeller Plaza, New York, N. Y. — H. H. PARKER, Secretary

LEE DE FOREST DAY

LEE DE FOREST Day was celebrated at the New York World's Fair on Friday, September 22, 1939, with pomp and ceremony commensurate with the outstanding contributions to a better civilization of the scientist it honored—spoken of by the President of the Institute of Radio Engineers (and we do not quote directly but in substance): "The greatest inventor since Thomas A. Edison and one of America's leading radio scientists"—Dr. Lee de Forest, inventor of the audion and 'Father of Broadcasting,' who has to his credit over three hundred patents.

A complete and comprehensive program was arranged for the "Day" and we regret that space limitations prohibit a complete report. We record a brief outline of the Day's events.

The group of distinguished guests assembled at the Biltmore Hotel in the morning and proceeded by motorcade—in Lincoln cars furnished through the courtesy of the Ford Motor Company—with a police motorcycle escort furnished through the courtesy of the Chief Inspector of the New York Police Department and the good offices of the Superintendent of Communisations, Inspector Gerald Morris—to the Boulevard Gate of the World's Fair and thence directly to Perylon Hall, where Dr. de Forest and party were officially greeted by Mr. Julius Holmes, Chief of Protocol for the Fair, and the party witnessed Dr. de Forest signing the Distinguished Guests book, which contained the signatures of the King and Queen of England and others, thence by motorcycle to the Ford Exposition.

Mr. Fred Black, Director of Expositions for the Ford Motor Company, with Mr. Ralph de Zayas of the Ford Public Relations Staff, were hosts to the party at a delightful luncheon in the Lounge of the Ford pavilion. A half-hour broadcast from the luncheon over WMCA and the Inter-city network was participated in by Dr. de Forest; Major Mack Horton, his first assistant; Madame Eugenia Farrar, the first woman to sing over the radio—she sang for Doc way back in 1907; Dr. Orestes H. Caldwell, Editor of *Radio Today* and one of the first Federal Radio Commissioners; Dorothy Hall, radio amateur W2IXY who communicated with Pitcairn Island when many others failed; R. A. Heising, President of the Institute of Radio Engineers, who paid high tribute to Doc's accomplishments; and our President, who acted as Toastmaster. Immediately following the half-hour broadcast a fifteen minute program by Vaughn de Leath over WOR and the Mutual Broadcasting System network with Dr. de Forest as guest was broadcast from the luncheon. Vaughn de Leath was present with her entire company—her program was a commercial—to pay tribute to Dr. de Forest. She originally broadcast for the first time from a station run by Doc back in 1919 and acquired the title "Original Radio Girl." Also present at the luncheon were: E. F. W. Alexanderson, inventor of the high-frequency alternator; Dr. Frank Conrad, first manager of KDKA, back in 1920; Harold P. Westman, Secretary of the Institute of Radio Engineers, who did such a good job of disposing of tickets for the dinner; Arthur Lynch, Managing Director of W2USA Radio Club—the World's Fair's outstanding amateur radio station; Dean Gleason Archer, President of the Suffolk University and author of an outstanding history of "RADIO"; Mrs. de Forest and their young daughter, Marilyn; Mrs. McGonigle; Charles de Forest, Doc's brother, and others prominent in the radio field.

The next stop was the RCA Exhibit, where the Messrs. Almonte, D'Agostino and Campbell played host. Doc was televised, interviewed, photographed with the giant vacuum tube at the front of the Building and with the entire party in the RCA Lounge and then witnessed a special demonstration of Television.

Then to the Westinghouse Exhibit, where Dr. de Forest addressed the members of the radio clubs of the high schools of New York under the auspices of the American Institute of the City of New York. Doc was photographed with Robert Barkey, winner of our Association's Marconi Memorial Scholarship, and was asked many technical questions by the radio-minded youngsters. Dr. Shelton of New York University and Trustee of the American Institute greeted Doc with the executives of the Westinghouse Exhibit.

Then a dash over to the Italian Building for photographs of Dr. de Forest at the plaque of Marconi which adorns the front of that Building.

Then as guests of Maurice Olivier, Commissioner General of the French Pavilion, Dr. de Forest and party were escorted through the scientific portion of the Pavilion and later to the beautiful lounge of the Pavilion, where champagne and wine were served and a special broadcast from Paris by the President of the French Academy was heard on the public-address system paying tribute to Dr. de Forest for his great achievements.

A short intermission during which some dressed for the Jubilee "De Forest Day" Dinner at the swank Sulgrave Club in Merrie England Village.

The Dinner party included all those at the luncheon, and among others present were: J. R. Poppele, Chief Engineer of WOR and Radio Quality Group, Inc., through whose generosity we had an excellent public address system; Clark Rodimon and David Houghton of ARRL headquarters staff; K. T. Hill, Director of the Hudson Division ARRL; Samuel Darby, Jr., prominent patent attorney; David Sarnoff, President RCA; E. K. Cohan, Technical Director CBS, and party; Dr. Kolster, inventor of the Radio Compass; Wm. J. Barkley, General Sales Manager Collins Radio Company; Wm. E. Beakes, President Tropical Radio Telegraph Company; Capt. Verleger, skipper of the Admiral Byrd expedition ships; O. B. Hanson, V. P. and Chief Engineer of NBC; C. B. Cooper, one of Doc's first assistants, and Frank Butler, another early assistant of de Forest's; J. Henry Hallberg, prominent inventor, and now engaged in short

Wm. J. McGonigle presenting Scroll to Dr. deForest.

wave therapy research; Ray Jefferson, President of Jefferson-Travis Radio Manufacturing Company; Horton H. Heath, Manager of RCA's Department of Information; H. H. Beverage, well known antenna designer and inventor; Fred Muller, a past President of our Association; Robert T. Pollock, President of the American Institute of Science; and let's not forget George H. Clark, who did so much to assure the success of "de Forest Day," and of course our faithful treasurer, "Bill" Simon.

Dr. de Forest was greeted by the assembled guests, who stood and cheered him until requested to be seated. It must have been one of the most thrilling moments of Doc's long and colorful career. The tribute was spontaneous and sincere.

A feature of the Dinner was the presentation of a "Scroll of Honor" to Dr. de Forest by our President. The presentation and Dr. de Forest's splendid address in reply were broadcast over the combined facilities of the Mutual Broadcasting System and the National Broadcasting Company.

The "Scroll" outlining some of Dr. de Forest's accomplishments was signed—for our Association and the professional wireless operators, past and present, by our President; for the Radio Engineers by the President of IRE; for the Electrical Engineers by the President of AIEE; for the Radio Clubs by the President of the Radio Club of America; for the Science Groups in High Schools by the President of the American Institute of Science; for the Medical Profession by the President of the American Medical Association; for the Motion Picture Engineers by the President of the Society of Motion Picture Engineers; for Doc's college Engineering Society by the President of the Yale Engineering Association; for the amateurs by the President of ARRL; for the Broadcasting Industry by the President of the National Association of Broadcasters, and for his Alma Mater by the President Emeritus of Yale University, Dr. Angell, who gave Dr. de Forest his Ph.D.

"Lee de Forest Day" at the New York World's Fair was a worthy tribute to a most deserving scientist and humanitarian. DR. DE FOREST, WE SALUTE YOU."

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STEATITE CERAMICS

(*Continued from page* 12)

somewhat in the tapping operation, especially with fine pitches, so as large and coarse a thread as possible should be chosen. If the screw must enter the ceramic quite a distance it would be advisable to counterbore a fraction of the hole so that any variation in firing shrinkage, and its accompanying variation in pitch, will still allow the screw to enter. See Fig. 11. Holes tapped into a ceramic perpendicular to the pressing axis will invariably fire out oval shaped (obviously unsatisfactory) because all ceramics shrink different amounts in the two directions. This phenomenon of directional shrinkage is due to the fact that the pellets are necessarily compressed in one direction only and adds to the manufacturer's troubles in more ways than the one just mentioned.

(13) If the center-to-center distance between two holes must be held to a prohibitively close tolerance, the customer can make one of the holes oblong, allow more tolerance, and still have the ceramic fit snugly over the two mounting pins. See Fig. 12.

In conclusion, let it be stated that the radio parts and electrical appliance manufacturer should design his ceramic with an eye on the probable shape of the die that it will need. Then if he will broaden his tolerances to the utmost and tell the supplier all he possibly can of the ceramic's intended assembly or application, he will have done all in his power to insure a low price and quick delivery in the purchase of his insulators. On top of this he should welcome all suggestions toward redesign of the ceramic by the supplier.

The supplier, fashioning ware with a rather temperamental combination of materials for an exacting trade, has this viewpoint: he knows that intelligent design of his ceramic ware will enable him to manufacture it more economically, effecting smaller production losses, and making possible lower selling prices, which in turn will increase his volume of business.

• • •

TIME AND WEATHER

(*Continued from page* 9)

steel tape. I say "veteran," for truly it represents one of our first methods of successful recording for commercial purposes, although there is hardly a comparison in the results obtained today as against yesterday.

It will be remembered that the Dane . . . Poulsen . . . introduced magnetic steel wire recording as far back as 1900 . . . at this time for copying high speed arc system signals. Since suitable amplifiers were not available then, the quality was bad; but nevertheless there was proof that here was method of recording that was to be considered. In 1924, Dr. Stille, a German engineer, began a thorough study and search of the possibilities of this form of recording, and soon he found that steel tape offered better recording possibilities than wire. He developed an electromagnetic system, resulting in a reduction of wave form distortion. Years brought on other developments, until the steel tape became suitable for broadcasting purposes, the first evidences of which came to light in 1932 when the British Broadcasting System transmitted the Christmas Day speech of the his late Majesty King George V by this method. Today, it is successfully used in a number of recording methods, one of which is the public information service by telephone companies and others engaged in the dissemination of duplicated data.

In the New York Telephone system, a moving belt of steel tape, about 30 feet long, passes across the poles of an electro-magnet, at a rate of about a foot a second. Speech currents produce a varying magnetism on the tape.

The quality and uniformity of the tape guide the results of the system. Tungsten magnet steel is offtimes the choice of most, providing a minimum of magnetic aging. It is possible with this tape to "erase" a message at will. This, of course, is most important at such an installation as that at New York Telephone studios, where as one weather report is recorded on one tape, it is "wiped" off the next tape, and made ready for the next recording. This "erasing" is done with the same machine that records. In other words, the tape rides through the recording magnet and "erasing" magnet. To "erase," it is only necessary to increase the magnetic field, that neutralizes the heavy magnetic field, and "erases" the message.

The messages impressed on the tape vary from 25 to 38 words, with a level of 33 words as an average. The messages must not take over 25 seconds, and operators are trained to talk at this rate. If more than 25 seconds are consumed during the recording, the message must be erased. To enable the operator to watch this speed, she watches a clock with a second hand, and two signal lights which flash a warning if the volume of her voice is too high or too low.

At the present writing three of these talking tape machines are in use. Thus far the calls for this information have been varying from 30,000 to 50,000 a day . . . certainly a strong indication as to the popularity of this service. The service inaugurated on April 8 of this year in the New York area is now also being tried out in Hightstown, New Jersey, to supply information to the farmers on crops and market conditions. The messages take about three minutes and are varied as many times a day as the situation warrants.

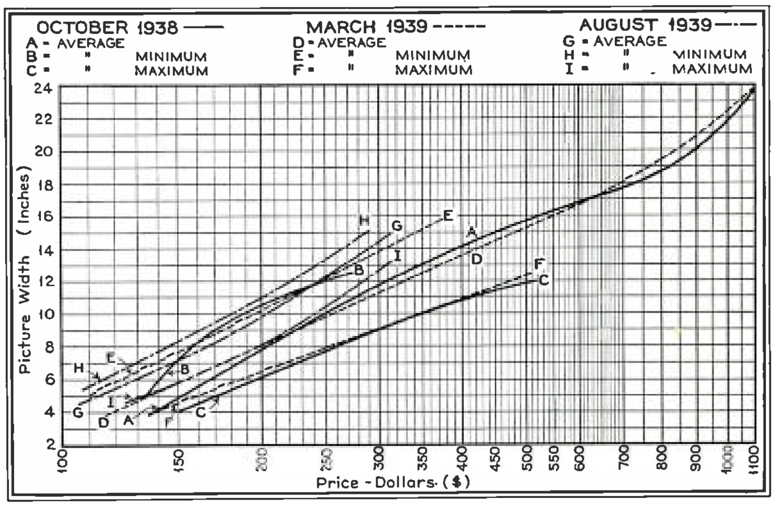
Film Tape Recording

Still another form of tape recording exists. This is the film tape . . . not the photographic film tape . . . but the mechanographic film tape, as developed by James A. Miller in cooperation with the Philips Company of Eindhoven, Holland. Used in this system is a special film, 7 millimeters in width, with a coating of clear material on the base, over which is an extremely thin layer of opaque material, approximately 2 microns thick. A specially prepared sapphire cutting tool is employed. The edges of this tool form an oblique angle with the surface of the film, cutting a hill and dale sound

(*Continued on page* 39)

TELEVISION ENGINEERING

Registered U. S. Patent Office



A curve showing the trend of European television receiver prices. It will be noted that there is a distinct trend towards reduced costs.

TELEVISION ECONOMICS

Part IX

By
Dr. ALFRED N. GOLDSMITH
Consulting Industrial Engineer

I-10 Projection Electronic Receivers

BEFORE describing the projection-tube receiver, it may be instructive by contrast to consider the inconvenience or commercial impracticability of producing large pictures by electronic means in cathode-ray tubes the screens of which are directly viewed. In one case this problem was attacked by "major force." A 31-inch demountable cathode-ray tube was made of arc-welded steel and was 4½ feet long. Such a tube has an end force due to air pressure of the order of 5 tons. Accordingly the viewing end was made of pyrex glass convex outward, 31 inches in diameter and 2 inches thick! The tube was made gas tight by gum-rubber gaskets which were placed between the glass and the metal and in the metal flanges. Exhaustion of the tube to a millionth of a millimeter of mercury required 48 hours. The fluorescent screen was deposited on a flat piece of glass, 0.75-millimeter thick, and fastened internally to the tube walls. This arrangement gave straight picture edges and less halation in the picture.

In this particular tube, 150 volts negative were required on the gun grid for beam-current cutoff. A beam current of 1.1 milliampere with 10,000 volts on the second anode gave a picture brightness, in the highlights, of 40 candles per square foot (126 foot-lamberts). To produce a brightness of 40 candles per square foot over the entire screen surface, a beam current of 6 milliamperes at 10,000 volts was required. At the same voltage with only 2 milliamperes beam current, a brightness of 14.6 candles per square foot (46 foot-lamberts) was obtained. The corresponding picture was therefore extremely bright and fully usable in a daylit room. Nevertheless such an arrangement is interesting only scientifically in view of the bulk and weight of the tube and certain operating considerations.

Accordingly the practical production of large-screen pictures has been attacked by the use of so-called projection tubes. These are tubes producing a sufficiently bright image, so that after optical projection and enlargement thereof, the resulting picture still has an adequate brightness. Under development in this direction are tubes using the thermal effect. For example, the electronic beam may fall upon a grid of fine tungsten wires or the like, producing incandescence and self-luminous images. There are also under development tubes using an "image-storage" method whereby the image persists at all points during approximately one scanning.

The fluorescent projection tube is at present time the only commercially available type. These tubes differ from the usual receiver kinescope in a number of respects. The anode voltage rises to tens of thousands of volts and the tube circuits require special protection. The fluorescent material is operated substantially at saturation. The color of the image is less important than in direct viewing. Adequate tube life presents a greater problem. The anode coating in the tube must not flake off, and may be either colloidal graphite or deposited platinum. The tube window, for smaller size screens, must be an optical flat. Extreme care in gun design and construction is necessary to produce a minute screen spot, particularly considering that the image may be as small as 1½ x 2 inches (although one present tendency is toward larger screens for the original image). Avoidance of defocusing of the spot when deflected, and of spherical aberration is necessary, particularly considering the high magnification of the original image. In general magnetic deflection is used, together with a magnetic beam-focusing system of special design.

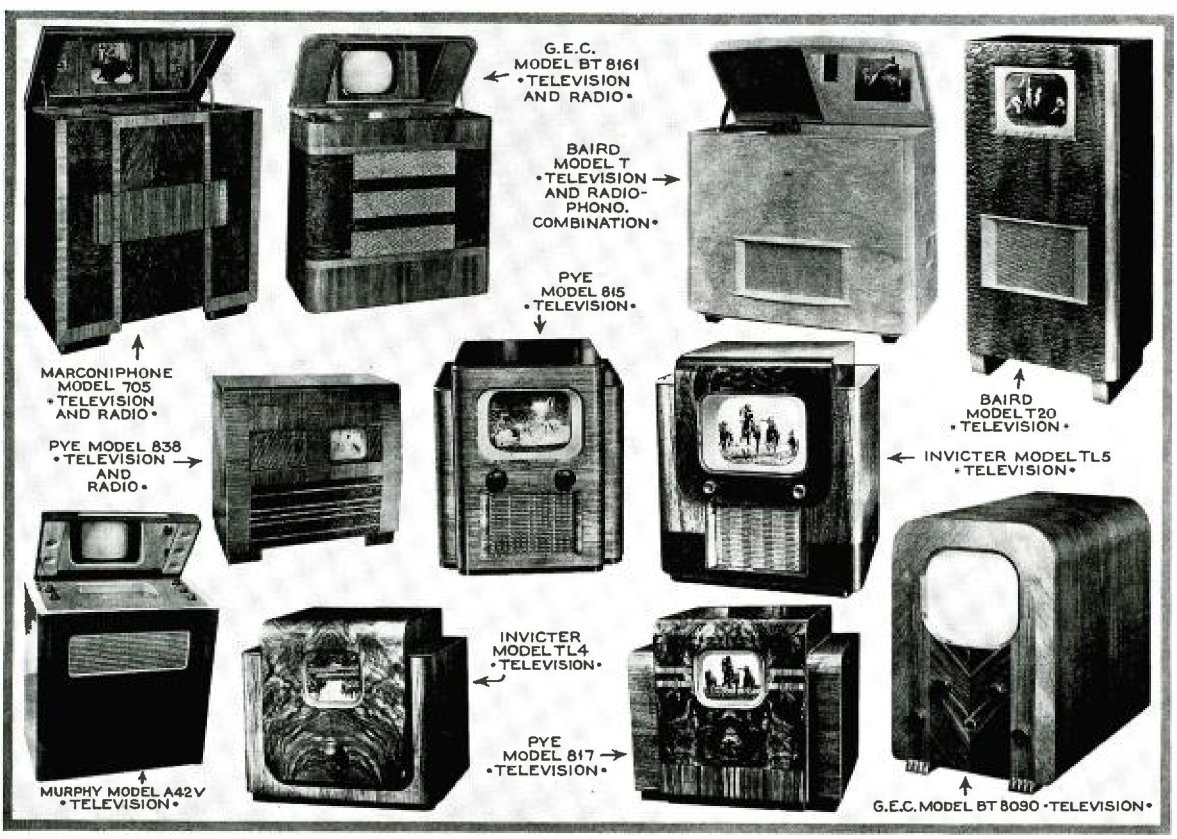
The heavy-duty performance of fluorescent materials determines the design of projection kinescopes. The light output from a fluorescent screen reaches saturation with increasing current density either because of reduction of output due to the heating of the screen or because every luminescent element is already excited. Cooling of the screen therefore reduces the saturation effect. The various fluorescent substances have somewhat different behavior. Thus zinc-beryllium orthosilicate gives a luminous output linearly proportional to beam current up to about 10 microamperes per square centimeter. Zinc sulfide and calcium tungstate have a higher saturation current of about 100 microamperes per square centimeter. It should be remembered that these are *average* current densities. The scanning-spot current density, corresponding to an average current density of a few microamperes per square centimeter, rises to amperes per square centimeter.

In practice, it has been found better to increase the output of the screen by increasing the anode voltage (at any rate up to 10 or 20 kilovolts) rather than by increasing the beam current. An increase of current also constitutes a difficulty in holding a small scanning-spot size.

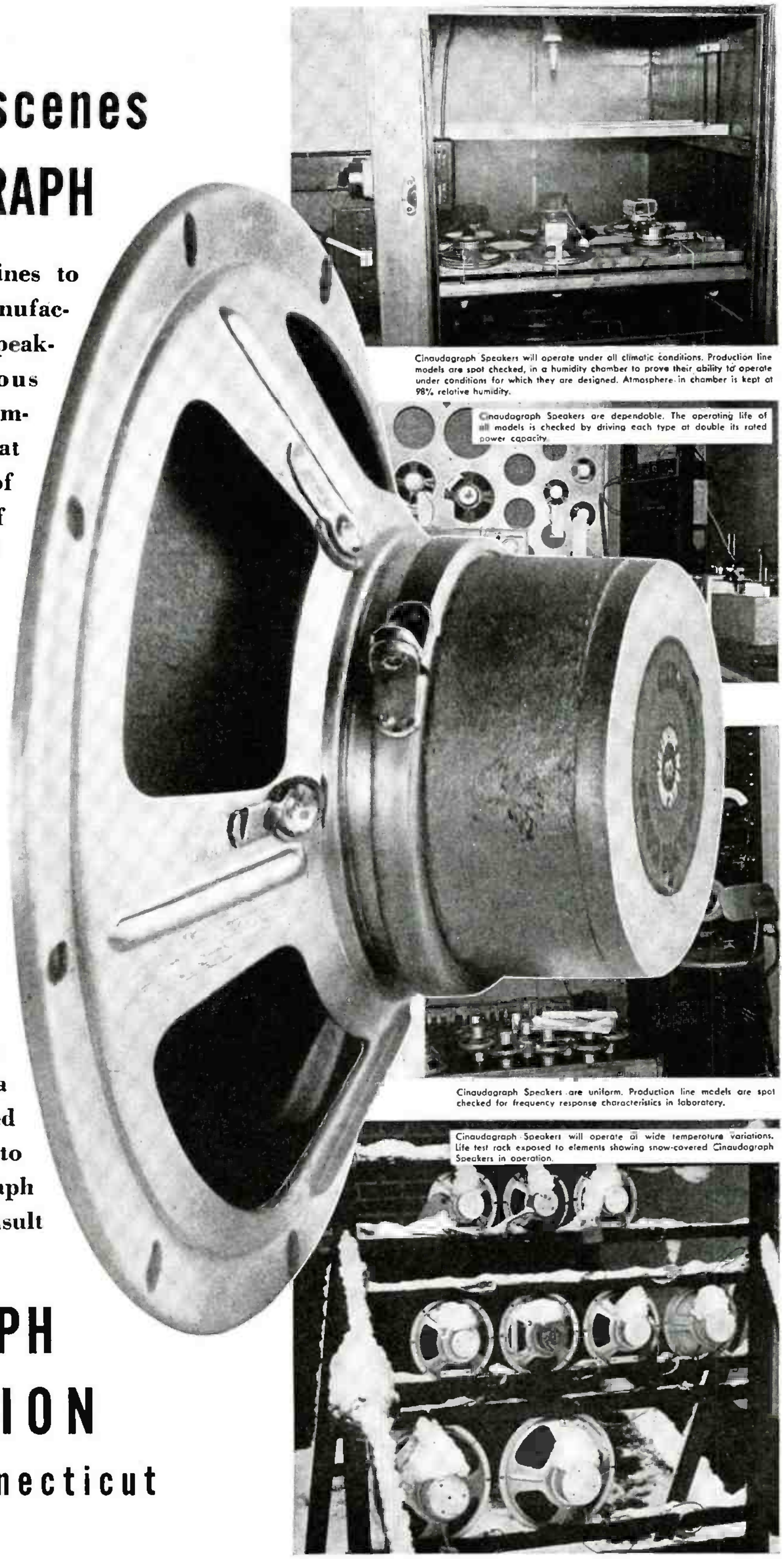
The light output from the phosphors varies as a certain power of the electron energy at the screen (e.g., in kilovolts). For willemite, this power or exponent is less than 2, for zinc sulfides it is equal to 2, and for calcium tungstate or a fused layer of willemite it is greater than 2. The limiting potential for willemite was found by one investigator to be 6-10 kv. depending on the mode of preparation and exhaust. The zinc sulfides were stated to limit at 6-9 kv., and calcium tungstate at 5 kv. Considerably higher values than these have, however, been found useful in recent commercial practice. It may be added that the thickness of coating of the phosphors affects the limiting voltage, the heavier coatings corresponding to the higher limits.

Before considering specific projection tubes, it should be noted that the motion-picture engineers have proposed a desirable screen brightness in theatres) of 7-14 (with an average of 11) foot-lamberts or 2.2-4.4 (with an average of 3.5) candles per square foot (together with the sometimes suggested use as a temporary practice, of about 2.5-5 foot-lamberts or 0.8-1.6 candles per square foot). It is likely that the lower values here mentioned would not be satisfactory for large-screen pictures in the home in view of the necessity for an acceptable general lighting level.

In one American projection tube, with a 1½ x 2 inch picture, 10,000 volts were used on the last anode. The electron current at the cathode was 1.0-1.5 milliampere, but the beam current at the screen was 0.4 milliampere. Zinc orthosilicate of carefully controlled crystalline structure was used as the phosphor. The scanning spot was 0.005-inch in effective diameter. The general screen brightness was found to be 280 candles per square inch (12,700 foot-lamberts)! The picture was projected by a f:1.5 lens, and the resulting high-lights on an 18 x 24-inch picture had a brightness of 1.9 foot-lamberts (0.6 candle per square foot). These values are rather low compared with the above recommended screen brightness for theaters. Nevertheless, it was claimed that a visible and even enjoy-



A group of European television receivers and "vision" units.



Showing the variation in television receiver cabinet design of various European sets.

able picture 8 by 11 feet could be produced in a darkened room! In a similar case, the focal length of the lens was 120 millimeters, its distance from the tube 130 millimeters, and its distance from the projection screen 4.6 feet. The screen was evidently of the "specular" variety since it was stated to be a 480-per cent reflective screen. Such screens give a bright image, but there is a tendency toward a glare spot in the center of the screen or wherever the source is in effect partly reflected in the screen. Furthermore, the brightness of the image from such screens rapidly falls off as they are viewed at increasingly oblique angles, which limits the number and location of persons who can conveniently view the program. Inasmuch as performance claims should be made with comparable screens, for example, with reference to a perfectly diffusing screen as a standard of comparison, some specific standards for screen brightness should be accepted by the industry to prevent subsequent misunderstandings and confusion.

The life of the projection tube mentioned above was stated to be satisfactory, and the lighting efficiency was reduced only 27% after 1200 hours of operation at 10,000 volts and 0.2 milliampere at the screen.

The experience of a European organization in this field indicates that, for fluorescent screens deposited directly on glass, final anode voltages up to 45,000 volts are practical, although special fluorescent materials are necessary to endure such bombardment, and adequate conductivity as well as sufficient secondary emission is necessary for the fluorescent screen.

Metal sheets carrying fluorescent materials may be used as screens up to 80,000 volts or more. Because of the oblique scanning, the electron optics on the one hand and the glass blowing on the other present notable problems. Nevertheless such screens are desirable when more than 50 watts power is applied to the screen. Air or water cooling of the screen has been found to be simpler for the type having a metal support.

The luminous efficiency of the tubes falls markedly as the anode voltage increases. Thus, at 6,000 volts the efficiency may be 5 candles per watt, while at 20,000 volts it is about 3 candles per watt, and at 40,000 volts it has dropped to approximately 2 candles per watt. Nevertheless the higher voltages are useful because they permit more satisfactory focusing and further, an increase in anode voltage permits an increase in the surface brightness of the screen even though the luminous efficiency as a whole has dropped.

The optical systems used for large-screen projection are generally lenses of the highest available speed corrected for spherical aberration and to a certain extent, for other usual errors. It has not yet been determined definitely just how far the lens designer is economically justified in complicating the lens system in order to get extreme refinement of image quality, particularly considering that the large-screen picture must be viewed at a distance and at best cannot be of finer detail than the original fluorescent image. Experience up to the present has indicated increasing difficulty in maintaining definition as picture size is increased. Further, there is greater likelihood of inter-line flicker with nearby viewing of large pictures.

In a particular European projection-tube receiver, a 14 by 16 inch picture was produced with 15,000 volts on the anode. The fluorescent material was deposited on a flat end of the tube. Magnetic deflection was used. For a picture 5.4 x 6.4 feet, a projection lens of focal length of 160 millimeters and speed of f:1.8 was used. In another projection tube, electrostatic focussing was employed with 25,000 volts on the anode and a guaranteed 2,000-hour life.

In still another European projection-tube receiver, the original picture was 2 inches wide and was produced with a spot which was claimed to be only 0.0005-inch in diameter with 25,000 volts on the anode. The projected picture was 15 x 18 inches in size. In this type of equipment, it has been frequent usage to place the projection tube in its own individual chassis.

A recent European projection receiver gives a picture 14½ by 18 inches which was stated by the maker to be the largest size desirable for the home. The picture on the 4-inch tube is 1.6 inch by 2 inches, and is produced on a concave end of the tube having a radius of curvature of approximately 9 inches. The image color is a light yellow green, and synthetic willemite is used. Spot size for good definition should be about 0.001 inch. Beam current may rise to 50 or 75 microamperes when 25,000 volts are applied to the final anode. The cathode-ray beam power is 20 watts, with a maximum of about 30 watts; and 76 lumens are thus produced corresponding to an illumination of 3,150 foot candles on the fluorescent screen, or a screen intensity of 34.4 candle power. The fluorescent screen is protected against overload by relays actuated by the deflection circuits, and having a delay in operation of about 1/5th second which is sufficient to prevent damage to the screen material and yet enables economic relay design. The life of the projection tubes is claimed to be well in excess of 700 hours.

A f:1.9 projection lens is used and the picture is projected on a flat etched glass translucent screen, the etched surface being protected from contamination and injury by enclosure between sheets of glass. Damping devices are applied to the screen raising and lowering mechanism to prevent excessive jarring or damage to the screen. An economic projection lens is used, and slight pincushion distortion caused by the curved screen is optically corrected by slightly curving or flexing the back-silvered mirror mounted in the lid of the receiver, this being done by means of set screws in the centers of the four edges of the mirror. The mirror is made of plain glass nor more than 2 or 3 mm. thick and can be bent about 3 mm. to produce the desired correction. The screen illumination for the projected image is about 13 foot candles (although it is not known whether this corresponds to incident light or to a transmitted brightness of about 6 foot lamberts). It is stated that the usual direct-vision cathode-ray tube products a maximum illumination of about 18.6 foot lamberts.

As stated previously the trend in projection tubes for major exhibition purposes is toward the higher anode voltages, even up to 50,000 volts and beyond. In a recent and striking demonstration of large-screen television in a theatre in Europe, a 16-inch-diameter projection tube was used in which the 6-inch-wide picture was produced on a separate flat screen. The beam constants were 45,000 volts and 300-400 microamperes with a stated normal screen power of 18 watts. A projection lens of the highest available speed and a focal length of 14 inches was used to project a picture no less than 12 x 15 feet in size with an illumination of 10 lux. (This would be approximately 1 foot-candle on the screen and perhaps a screen brightness of 0.8 foot-lambert or 0.25 candle per square foot, which is rather below the motion-picture-theater screen-brightness range).

In another European theater television receiver and projector a picture 12′ x 16′ in size was produced. The final anode voltage in the projection tube is 50,000 volts, with a peak current of approximately 4 milliamperes. A luminous efficiency of approximately 4 lumens per watt is claimed. Heat dissipation from the fluorescent screen requires oil cooling. Assuming a reasonable efficiency of the optical system, in terms of the ratio of fluorescent-screen brightness to projection-screen brightness, with due regard for the magnification and other optical factors which are involved, it may be estimated that the final screen brightness falls below 0.5 foot lambert. In a totally darkened projection room, the effect of this brightness on a large screen is not unsatisfactory in the present state of the art, but is obviously inadequate for future theatre conditions.

Another television picture 39 by 39 inches, with an illumination of 100 lux (about 9.3 foot-candles) was produced in Europe by a tube running at 60,000-80,000 volts and 3 milliamperes, the fluorescent screen being composed of special zinc-sulfide crytsals.

Carrying this work further, pictures 10 x 12 feet in size were produced from a kinescope with a screen size of 4 x 5 inches or more. The projection lens had an approximate 10-inch clear aperture. The viewing screen gave full brightness within a narrow angle (about 50 degrees) and then fell off rapidly. The increase in brightness in the desired directions was notable. This screen was made up of about 2,000,000 small lenticular elements mounted in a slightly visible lattice of groups of elements about 6 x 6 inches in size. The lenses or mirror surfaces are invisible to the audience, and it was stated that within the selected audience space, the picture showed a constant brightness.

Advanced design in a European projection-tube gun is claimed to have resulted in a spot of less than 0.004″ diameter with a beam current of 1 ma., corresponding to a current density above 10 amperes per square centimeter!

As also illustrative of European practice, the image in a projection tube 3.2 x 4 inches in size, produced with 40,000 volts on the final anode, was projected by an f:1.4 lens. It is to be noted that projection lens speeds have been raised to the highest practical point in these television theater projectors. In another form of European theater projector, the screen in the kinescope consists of fluorescent material on a metal sheet. It is mounted obliquely relative to the scanning beam which therefore requires keystoned (electrically corrected) scanning. A projection lens of focal length between 10 and 14 inches and of speed between f:1.6 and f:1.8 is used for projection. Two complete projector units are available, and are maintained continuously in operation, although only one tube image is projected at any given time. The projection lens can be slid in front of either of the available tube images. A high-voltage rectifier is provided capable of furnishing 10 milliamperes at 60,000 volts. It normally suppplies between 36,000 and 45,000 volts and between 300 and 400 microamperes to the scanning beam (averaging 10 or 15 watts). The total electrical consumption is 2 kilowatts. The high-voltage assembly, including the smoothing condensers, is enclosed in an oil-filled tank. Special care is taken to secure high-fidelity sound reproduction, the system frequency characteristic being flat up to the speaker coil to plus or minus 4 db. between 30 and 20,000 cycles.

Using an arc illuminant in a mechanico-optical receiver embodying a light-storage element, there was produced a picture about 10 by 12 feet in size with an illumination of nearly 3 foot-candles, corresponding to an unusually substantial light flux to the screen. No voltages above 500 volts are used. The throw is only 20 feet, thus permitting installation of the projector on the stage. The supersonic light control requires between 30 and 40 watts for its control. The 49 tubes used in the receiver are not larger than those in an ordinary broadcast receiver. For illumination, a modified Hall and Connolly high-intensity arc is used. The positive carbon is 11 mm. in diameter and will run 55 minutes. A new carbon can then be fed into the holding jaws during operation, with a break of less than 5 seconds. This permits the full use of the copper-coated negative carbon, which is 10 mm. in diameter and runs for 90 minutes. Alternatively, twin arcs can be supplied permitting continuous operation. The rear projection screen which is used is of wide diffusing angle, and is claimed to have only a small loss of light. It is made by spraying a non-inflammable material on a sheet of plate glass having the proper surface, the material being peeled off when dry and then tightly stretched on a frame. Thus the screen material is impressed with the proper surface for the purpose. Pictures up to 15 x 20 feet are claimed to be commercially producible by the latest equipment of this type.

An analysis of the foregoing and similar data indicates the following average or typical performance ranges for projection-tube equipment of modern types. For home receivers producing pictures in the range 18-24 inches wide, the screen illumination is about 3-10 foot-candles, the screen lumens 8-20, and the screen brightness about 2-8 foot-lamberts (0.6-2.6 candles per square foot) or less, depending on screen type. For large theater screens from 6 to 15 feet wide, screen illumination from about 1 to 3 foot-candles is obtained, with screen lumens in the range from about 100 to 300, the screen brightness being approximately 1.3-4 foot-lamberts (0.4-1.3 candles per square foot), which brightness range will require upward extension to be fully satisfactory.

I-11 Converter-type Receivers

It has been proposed from time to time that the sound accompanying the television program be produced by a regular broadcasting receiver of the present type having a certain short-wave band against which, by heterodyning, the sound transmitted on the u-h-f carrier could be reproduced. Measures of this sort may be commercially expedient, but are probably temporary.

It has also been proposed that separate picture-receiver units be produced, or even kinescopes in cabinets with a minimum of associated circuits, the units being designed for convenient placement relative to the audience and irrespective of the main receiver to which they would be cable-connected. This arrangement is analogous broadly to separate loud-speakers for a sound receiver. In one specific case, a separate video unit was produced operating from the video output of the second detector. This unit separated the synchronizing signals, generated the deflection voltages and amplified them for electrostatic deflection, modulated the kinescope grid, and contained the necessary power supply. The units contained 10 tubes and a kinescope, together with about 90 components. Such an arrangement enables individual reception, or several audience groups. It is competitive with the table or chair-side television receiver, but the choice between these is not only economic but also a matter of personal preference.

I-12 Chair-side Receivers

Except for reduction in size of the kinescope and maximum compactness of the chasses, all within a compact cabinet, this type of receiver does not essentially differ from the console receiver. Table receivers may be used beside a chair for convenient viewing. Alternatively, the chair-side receiver may be so arranged that the looker glances obliquely downward in a natural direction at the tilted screen. There is room for considerable ingenuity in the devising of the most convenient forms of individual-viewing television receivers, and particularly in the lower priced ranges.

I-13 Portable Television Units

Perhaps the most extreme form of individualized receiver which can be imagined was one in which the kinescope and a telephone receiver were included in a single compact unit weighing only 2 lbs. The telephone receiver fitted naturally against the ear, and the 1 by 1½-inch picture was then directly viewed, the whole assembly somewhat resembling an enlarged telephone handset (though, of course, with no telephone transmitter). The reduced size of picture in this case, and the inconvenience of holding an object of such weight against and in front of the head for any length of time, may relegate this instrument to the novelty or specialty class except perhaps for two-way telephone-television communications. Even in this field, unobstructed viewing of the speaker or subscriber will likely prove necessary at each end of the circuit.

I-14 Audio or Sound Receiver

The advent of television in the uhf. band affords a unique opportunity to the radio engineer speedily to make radical improvements in the audio service without conflict with existing practices. It may be mentioned that one European television-telephone receiver has been designed to pass no less than 40 kc. for the audio side-bands, thus permitting reproduction of all audible sounds, subject to adequate loudspeaker quality. Obviously it would be an economic and technical error not to introduce substantial improvements into the audio portion of the television service at its inception, and of course at intervals thereafter. As previously stated, it is proposed to pre-emphasize the higher audio frequencies, thus increasing fidelity and reducing the effect of interfering noise. The sound tone control in the television receiver must accordingly have an adequate range to cover the various forms of audio characteristics which may be encountered. Various further improvements in sound reproduction such as auditory perspective or stereosonic reception may be introduced if desired at later dates. The available frequency range for such services within the television channels will probably be found to be adequate.

It has been thought by some that there would be a necessarily close relationship between the loudness of the reproduced sound and the picture size (that is, apparent distance of the sound source within the picture, as well as the size of the picture itself). While it is true that approaching visible sources of sound in the picture should become louder and change somewhat in tone quality as they approach, general experience in sound-motion-picture theaters shows that any *exact* correspondence in this repects is unnecessary. It appears that there is fairly wide aural tolerance in such matters. Further, the change in loudness required for different sizes of picture is not very considerable or critical to a troublesome degree.

I-15 Adjunct Services

It is unlikely that television broadcasting will run throughout all the available hours, at least for some time to come. This indicates the possible economic desirability of auxiliary services within the u-h-f band. Further, the higher cost of the television receiver justifies making it available in some way as many hours per day as the owner may reasonably desire.

Television service is of course most important in the evening hours, firstly because the audience is at a maximum at these times, and secondly because the reduced room illumination makes viewing more convenient. The early morning hours and the late evening hours seem particularly suited to audio broadcasting as well as facsimile broadcasting.

The auxiliary u-h-f audio-broadcasting programs, without television-picture transmission, may be particularly satisfactory during certain of the daylight hours when, for example, the housewife at work prefers not to be immobilized before a television receiver. If this practice becomes general, means for operating the television receiver economically for audio programs only will be desirable. As indicated, facsimile programs in the u-h-f range offers an interesting additional service. The existing medium-wave and short-wave sound broadcasting services may also be made available on the television receiver at a relatively small additional cost. The electric phonograph is a useful and frequently desirable addition to the receiver assembly. These various added elements may greatly enhance the usefulness of the assembly.

When the necessary distance separation between television stations on the same frequency, in different cities, with avoidance of interference has been determined, it will be possible more systematically to allocate the necessary frequencies for the various adjunct services mentioned above in such fashion as to avoid inter-city interference. These problems merit early attention since it is important that the television receiver shall be an article of maximum attractiveness, use, and utility from the beginning.

I-16 Receiver Commercial Considerations

The first question arising in connection with television receiver sales is: "What is a television receiver?" The present tendency is to regard a television receiver as one containing *both* picture and sound receivers, and to distinguish the video portion only as a "picture receiver." Further, how many "tubes" are there in a television receiver? Shall the kinescope be included in this number (considering that its analog, the loudspeaker, is not included in the number of tubes in the sound receiver, but on the other hand considering that the kinescope *is* a vacuum tube)? Shall there be standard sizes of kinescopes and shall these, in turn, correspond to standard picture sizes? There may be a tendency on the part of some to describe picture sizes optimistically. Perhaps the best single designation would be the width of the rectangular picture, measured with normal viewing along the central horizontal line. The extent of rounding of the corners of the picture should also be specified. Appropriate terminology for those television receivers enabling as well either medium-frequency or short-wave broadcasting reception should be determined. In these connections it is important that whatever practices are proposed shall be such as to be both natural and acceptable to the public so that they may win wide support. Strained or unnatural terminology, even if brief and desirable, will not win public support nor yet enforcement by regulatory ordinances or the decisions of the courts.

In a standardized type of receiver in one of the European countries, representing modern practice, the picture size, on a tube with a rectangular screen end, is 7.7 by 9 inches. The zinc-cadmium-sulfide screen produces between 4 and 5 candles per watt. The final anode voltage is 6,000 with a peak current of 150 microamperes, and a peak power of about 0.9 watt, producing a peak illumination of about 4.5 candles. The average brightness is approximately 0.01 candles per square centimeter, and it is stated that the apparent brightness of the screen is therefore nearly 30 foot lamberts, permitting convenient observation in a fairly well illuminated room. The screen color is selected towards the red-orange-yellow range rather than toward the blue-green range.

In Europe, the public has shown considerable interest in the actual size of the picture, the trend being noticeably toward the larger picture sizes. Otherwise stated, the purchaser tends to buy a receiver with as large a picture as is permitted by his financial limitations. In the accompanying graph the range of European television-receiver retail prices, and of the relationship between prices and picture sizes are given. The first of these corresponds to conditions in October, 1938, and the second to March, 1939. There is little difference between them beyond a slight price decrease for sets providing pictures less than 6 inches wide. Examination of these data indicate that the smallest size of picture now under consideration is about 4 inches wide, and the largest size for home receivers is 24 inches wide. Judging from the corresponding number of models on the market, the most popular (or most available) sizes of receivers give pictures 8 or 10 inches wide. However, even after two years of television program service, there was still an unusually wide range of prices for receivers giving a particular picture size.

Also shown in the graph are the corresponding television-receiver retail prices in late August, 1939. It is to be noted that the range of prices for a given size picture has been narrowed and, on the average, reduced. Thus a picture 10 inches wide was produced by earlier receivers costing between $190 and $450, with an average probably not far from $300. The later receivers have a corresponding price range between $190 and $230, with an average around $210. Receivers with pictures 12 inches wide (from a 15-inch kinescope), also are more numerous than previously.

The receiver cost is found to rise less rapidly than the picture area. It should be remembered, however, that these European prices (translated into dollars) do not necessarily give any definite indication of suitable corresponding American prices. There has always been some disparity between American and European prices of comparable radio equipment since the scale of production and the methods of manufacture in the two cases may be quite different, since the transmission standards are somewhat dissimilar, and since there is as yet no assurance that standards of picture quality (that is, criteria of picture acceptability) in the two instances will be identical.

An analysis of picture size in a group of American television receivers in the late Spring of 1939 indicates an average picture width of 7½" with a minimum of 4" and a maximum of 10". The price range of these receivers lay between $190 and $600. Crudely expressed, the price of these receivers was at the rate of about $50-$60 per inch of picture width.

It is possible that certain component portions or assemblies in the television receivers in a given manufacturer's "line" may be constructed as identical and in large quantities, thus making them interchangeably useful throughout the line. This applies particularly at first to audio and phonograph parts. In that case, receiver costs may be correspondingly reduced. However, it is likely that such economies will be feasible only to a limited extent in the early stages of television commercialization.

I-17 Receiver Test and Servicing

The cost of any receiver to the customer may be made to include the cost of certain extra and desirable services, and probably this should be done at least in the early stages of television commercialization. Thus, it may include the cost of a preliminary survey of the receiver location to determine whether the service which the customer will receive will be satisfactory. It may include as well a guarantee of receiver operation for some specified period of time. Also included might be the service of installing the receiver, or even the servicing of the receiver on a contract basis for some specific period after its installation. In special cases, the cost of locating sources of interference and, if possible, eliminating them may be involved. These are serious economic problems in view of the complexity of receiver circuits, the necessity for survey and installation, and the need for systematic inspection and servicing. Apparently an educational campaign will be required to convince the public of the desirability of purchasing not only a television receiver but adequate *service* during and after its installation.

The television service man must of necessity come closer to being an engineer than the audio service man. The receiver circuits and adjustments are complicated, test equipment is elaborate and relatively more costly, and cut-and-try methods are unlikely to do other than damage to the receiver and its operation. The systematic training of television service men is therefore important and fortunately is begining on an apparently correct basis. Despite thorough training of the service men, it is likely enough that a larger percentage of television receiver major repairs will be made in the factory than in the shop, and again of minor repairs in the shop rather than in the home.

In regard to servicing, experience in one European country has indicated that it is desirable to have a number of local service stations rather than to attempt to service a large area from one central point. Traveling time and expense is thus reduced, although it must be added that the "load factor" of the staff may be also reduced and the total cost of test equipment increased.

Material for testing the receiver in actual operation requires test chart or program transmission since, in general, the service man can hardly be expected to have a miniature television transmitter of high quality available. Service in the home, as against removal of the equipment to the shop also present a problem in view of the bulk and weight of the equipment on the one hand versus the inconvenience on the other hand to the owner resulting from repeated service visits.

One experienced television manufacturing representative in Europe has estimated that the maintenance cost of a television receiver may well approximate $50 per year—a figure which is made up of tube replacements, service calls, one possible major breakdown in a transformer or the like, and possibly one developed defect in the loudspeaker. Such a figure seems high and should be substantially reducible by care in the original inspection and later use of the set.

The equipment necessary for testing and servicing receivers is not standardized, but may advantageously include some of the following apparatus:

A sweep oscillator, used in conjunction with an oscillograph, has been found useful in tests of circuit alignment, band width, and selectivity measurements. Such oscillators are also convenient in factory receiver tests and circuit alignment, as well as in the study of i-f-amplifier performance and circuit relationship (e.g., operation of the a-v-c system). Thirty complete sweep cycles per second are convenient, the width of the sweep being about 5 mc, and the range of frequencies being variable throughout the usual i-f range from 8 to 13 mc or beyond. A typical oscillator of this sort contains a few tubes and about 50 component parts.

Beat-frequency oscillators are applicable to the measurement of the frequency and phase characteristics of the v-f amplifiers. A practically constant output voltage of several volts rms is desirable over the range from a few tens of kc to about 8 mc.

The general performance of the receiver can be determined with actual iconoscope or monoscope transmission if this is available, although for full tests a generator capable of producing the standard American signals will be required. For simpler and less costly test installations, square-wave or vertical-bar generators, or even ordinary signal generators may be used. In one form of square-wave generator, there were produced such waves of 20-volt amplitude, peak-to-peak, in the frequency range from 3 to 60 cycles in at least 6 steps. Adjustment was provided for control of the symmetry of the wave form up to the highest available frequency. There could also be generated at the same amplitude, square waves between 60 and 17,000 cycles. In addition, a group of 3 waves, with an adjustable phase relationship between them was available. These waves were a 3-volt 100-kc square wave, a 50-volt 100-kc sine wave, and a 50-volt 10-mc sine wave (the actual phase adjustment being available on the two sine waves).

As previously indicated, a precision cathode-ray oscillograph with a viewing screen of adequate size, and with circuits enabling the exact measurement of phase delays is required. Such an oscillograph also permits study of the shape of the synchronizing signals, and the accuracy of operation of the circuits wherein the video and synchronizing signals are separated.

In the testing of receivers, it is necessary to give consideration to at least two factors. In the first place, the signal attenuation of the receiver should increase almost linearly from nearly zero at 0.75 mc above the video carrier frequency to practically infinity at about 0.75 mc below the video carrier. In the second place, any resulting picture errors are then due to the receiver, provided a vestigial sideband transmitter meeting the RMA specifications is used,, or providing a double-side-band transmitter is used which is operating normally as indicated by a simple diode-detector monitor.

The operation of the high-voltage supply in the receiver requires an available dc. voltmeter reading to 10,000 volts or more, and preferably with a resistance of at least 10,000 ohms per volt.

I-18 Color Television

The omission of an economic or technical analysis of this field at the present time is justified by its relatively rudimentary state of commercial development (as to picture size, detail, brightness, and color fidelity), by its comparatively great complexity as to circuits, optics and equipment, by the required channel width (which, for reasonably adequate color reproduction, must be at least three times as great as for black-and-white picture transmission), by the resulting high cost of the transmitter and receiver, and by the greatly enhanced program costs resulting from the necessity of controlling color of sets, properties, costumes, and make-up as well as the adaptation of these factors to the mood of the corresponding action. In view of the preceding, color-television broadcasting to the home need not be regarded among present-day economically desirable prospects according to any existing and demonstrated methods, although it may find some application in due course in specialized fields such as theater television.

J. PROGRAM COST ELEMENTS

As is well known, programs may originate from a personal performance or from film. In effect on the audience there is relatively little difference in the corresponding productions except that film programs offer greater flexibility through retakes and editing, whereas direct pick-ups enable continuous and complex action shown at the instant of occurrence. An idea of the magnitude of the program problem may be obtained from the following. One large Europeon television station has in excess of 300 employees assigned to television only. In America, a television analyst has stated that the production of a direct television program, one hour daily throughout the year, would cost $1,000,000 annually. Obviously, careful and controlled program budgeting, with maximum realized entertainment value per dollar is an essential factor in successful television broadcasting. In the following, the program cost elements will be considered largely in accordance with present-day motion-picture procedure although it is clear that major economies, short cuts, and simplifications, with the elimination or pruning of all but strictly essential elements, will be necessary to adapt motion-picture proceedure to television needs.

J-1 Story

Television will be insatiable for good story material. Its producers will search through literature in general, including novels and dramatic production, old and current magazines, and any other available sources of story material. They may well be forced into the training of large writer groups from whom may be drawn a few qualified and successful playwrights. Their problems will not be lessened by the fact that most motion-picture producers will reserve all television rights to their film productions. Even musical material, while most plentiful and capable of occasional repetition, will require special technique to make it palatable to the television audience. Nor will the ever-looming possibility of censorship add to the peace of mind of the television producer.

It is not possible to list the wide variety of subjects ranging from the humorous to the tragic which may form a part of television programs. In Europe the following list includes some of the program topics which have been used, and it may be added that practically as wide a variety as this has already been tried in American experimental broadcasts together with other types not here listed. The programs in one European country included: descriptive talks, dramas and playlets, historical re-enactments, newsreels, cartoonists in action, puppet shows, musical recitals, operas, musical comedies, band presentations, dancing lessons, ballet and other dances, revues, variety shows, cabaret performances, card games (e.g. bridge), demonstrations of a wide variety of scientific or other types, work of a veterinary surgeon, viewing of pictures from art galleries, fashion parades, cooking lessons, the raising of flowers, full-scale demonstration of fire-fighting, the study of an enlarged model showing how artificial glass eyes are made, architectural models, scientific apparatus and its use, activities of the river police, definition bees (presumably resembling American information quizzes), demonstration of barrage balloons, demonstration of two-way television-telephone communication, instruction in use of television receiver, visits to the children's ward in a hospital, representation of the history of the railroads over a hundred years, descriptions of "sea monsters," and outside broadcasts of such sporting events as skating, boat races, dinghy sailing, soccer, wrestling, boxing, hockey, golf, fencing, horsemanship, skiing, and tennis. In that country, during 1938, slightly less than 1,000 hours of entertainment (and 300 hours of dealer demonstration material from film) were broadcast. Of the program, about 25% was drama, 18% films (particularly including newsreels and cartoons), 6% talks, and the remainder various types of light or topical programs.

J-2 Treatment

After the story has been accepted as suitable for production, it is usually turned into a picturable form as a short story, with some included dialogue. The highlights of the action are stressed; and care is taken to modify or build up into picture form any dull or minor elements found in the story. The treatment required for television will undoubtedly differ from that normally used for motion pictures. Usually it will be simpler, and the number of scenes or locations may be reduced. Much ingenuity can profitably be applied to indicate off-stage action by implication rather than presentation.

J-3 Script

Once the treatment is regarded as

(*Continued on page* 39)

The *Yardstick* for measuring CONDENSER QUALITY

What It Does . . .

CAPACITY BRIDGE

Measures capacity 100 mmfd. (or .0001 mfd.) to 100 mfd., in 6 ranges; leakage; power factor to 50%, etc., of condensers *under actual working conditions.*

RESISTANCE BRIDGE

Measures resistance values of resistors and electrical equipment and circuits. 10 ohms to 1 megohm in 5 ranges.

INSULATION RESISTANCE

Measures this important factor in condensers and other devices. Meter is calibrated directly in megohms. Reads up to 10,000 megohms.

VACUUM-TUBE VOLTMETER

Consists of amplifier stage and grid-leak. May be used externally.

MILLIVOLTMETER

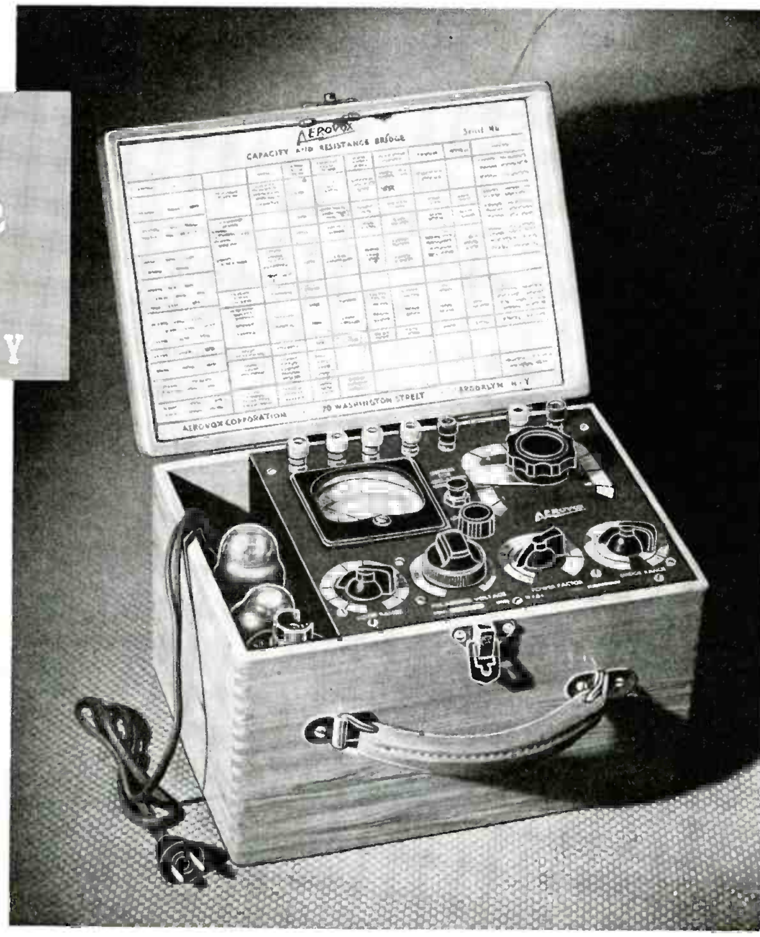
Meter terminals brought out directly. Range: 60 mv. at 60 ohms. Can be used with external shunts.

MILLIAMMETER

Meter can be read in milliamperes. 0-6 ma., 0-60 ma. May be used externally.

VARIABLE POWER SUPPLY

Available directly at terminals. 15 to 600 volts continuously variable over entire range.



AEROVOX BRIDGE

● Designed to provide servicemen with more critical means of appraising condenser quality and performance, this instrument has been bought by many engineers, laboratories, manufacturers. Widely accepted as standard test equipment, it is simply irresistible at the *net cost of only* $35.75. Note versatility as partially listed here. Check with all other popular-priced capacity and resistance bridges. Examine the Manual included with each instrument (50c. per copy, bought separately). Then . . .

Ask to See It . . .

Your local AEROVOX jobber can show you this instrument. Examine it critically. Check its many features at first hand. Ask for latest descriptive bulletin. Or write us direct.

AEROVOX CORPORATION

New Bedford, Mass.

Sales Offices in All Principal Cities

Purchasing Directory

The following pages contain information which we believe will be of assistance and value to all executives, engineers and purchasing agents in the radio, television and allied communication industries.

The companies listed are recognized sources of supply whose products and services have acquired a highly commendable reputation.

In presenting this data COMMUNICATIONS assumes no responsibility for omissions. We have attempted to supply comprehensive and accurate information in a usable form. Any omissions are unintentional and should be called to our attention.

Acoustic Material and Treatment

Armstrong Cork Products Co., Lancaster, Pa.
Celotex Co., Chicago, Ill.
ELECTRICAL RESEARCH PRODUCTS, INC., 195 Broadway, New York City.
Insulite Co., Minneapolis, Minn.
International Balsa Corp., Jersey City, N. J.
Johns-Manville Co., New York City.
National Gypsum Co., Buffalo, N. Y.
Northwest Magnesite Co., Pittsburgh, Pa.
Union Fibre Co., Winona, Minn.
Upson Co., Lockport, N. Y.
U. S. Gypsum Co., Chicago, Ill.

Amplifiers, P-A and Sound Equipment

Amplifier Co. of America, N. Y. C.—amplifiers, sound systems.
AUDIO DEVELOPMENT CO., 123 Bryant Ave., N. Minneapolis, Minn.—amplifiers, hearing aids.
Audio Products Co., Burbank, Calif.—amplifiers, speech-input equipment.
Banks Mfg. Co., Chicago, Ill.—intercommunicating systems.
Bell Sound Systems, Inc., Columbus, Ohio—p-a and inter-communicating systems.
BURSTEIN-APPLEBEE, 1012 McGee St., Kansas City, Mo.—amplifiers and p-a equipment.
COLLINS RADIO CO., 2920 First Ave., Cedar Rapids, Iowa—amplifiers, speech-input equipment.
COMMUNICATION EQUIP. & ENG. CO., 504 N. Parkside Ave., Chicago, Ill.—amplifiers.
Daniel Electrical Labs., New York City—amplifiers.
Electro-Acoustic Products Co., Fort Wayne, Ind.—amplifiers.
Electronic Design Corp., Chicago, Ill.—amplifiers, p-a systems.
Erwood Sound Equipment Co., Chicago, Ill.—p-a systems.
FAIRCHILD AERIAL CAMERA CORP., 88-06 Van Wyck Blvd., Jamaica, N. Y.—amplifiers.
GATES RADIO & SUPPLY CO., Quincy, Ill.—amplifiers, speech-input equipment.
LANSING MFG. CO., 6900 McKinley Ave., Los Angeles, Calif.—sound systems.
John Meck Industries, Chicago, Ill.—amplifiers.
MILLION RADIO & TELEVISION, 685 W. Ohio St., Chicago, Ill.—sound systems.
Morlen Electric Co., Inc., New York City—amplifiers, p-a equipment.
Operadio Mfg. Co., St. Charles, Ill.—sound equipment.
Philco Radio & Television Corp., Philadelphia, Pa.—amplifiers, intercommunicating systems.
RCA MANUFACTURING CO., INC., Camden, N. J.—amplifiers, p-a & intercommunicating systems.
Radio-Electronic Eng. Co., Warren, Pa.—sound and intercommunicating equipment.
Radio Receptor Co., Inc., 251 W. 19 St., New York City—sound equipment.
RADIOTONE, INC., 7356 Melrose Ave., Hollywood, Calif.—amplifiers.
RADIO WIRE TELEVISION, INC., 100 Sixth Ave., New York City—sound systems, amplifiers.
Radolek Co., Chicago, Ill.—amplifiers.
Raytheon Mfg. Co., Waltham, Mass.—amplifiers.
Remler Co., Ltd., San Francisco, Calif.—amplifiers & intercommunicating systems.
Sound Products, Hollywood, Calif.—p-a systems.
Sound Projects Co., Chicago, Ill.—amplifiers, p-a systems.
Sound Systems, Inc., Cleveland, Ohio—amplifiers.
Stromberg-Carlson Tel. Mfg. Co., Rochester, N. Y.—sound equipment, amplifiers.
SUNDT ENGINEERING CO., 4757 Ravenswood Ave., Chicago, Ill.—p-a equipment.
TELEVISO CO., 337-345 N. Pulaski Rd., Chicago, Ill.—p-a systems.
THORDARSON ELEC. MFG. CO., 500 W. Huron St., Chicago, Ill.—amplifiers.
TRANSFORMER CORP. OF AMERICA, 69 Wooster St., New York City—amplifiers, p-a equipment, intercommunicating systems.
UNITED TRANSFORMER CORP., 150 Varick St., New York City—amplifiers.
UNIVERSAL MICROPHONE CO., LTD., Inglewood, Calif.—intercommunicating systems.
THE WEBSTER CO., 5622 Bloomingdale Ave., Chicago, Ill.—sound and intercommunicating systems, amplifiers.
Webster Electric Co., Racine, Wisc.—amplifiers.
WESTERN ELECTRIC CO., 195 Broadway, New York City—p-a equipment.
WILCOX ELECTRIC CO., 4014 State Line, Kansas City, Kan.—amplifiers, p-a equipment.

Antennas—Transmitting, Antenna Erection, Antenna Arrays, Television Receiving Antennas

American Bridge Co., Pittsburgh, Pa.—antenna towers.
Andrea Radio Corp., Woodside, L. I., N. Y.—television receiving antennas.
Bendix Radio Corp., Baltimore, Md.—antenna arrays.
BLAW-KNOX CO., Pittsburgh, Pa.—vertical radiators.
L. S. BRACH MFG. CO., Newark, N. J.—television receiving antennas.
CONSOLIDATED WIRE & ASSOC. CORPS., 522 S. Peoria St., Chicago, Ill.—television receiving antennas.
General Electric Co., Schenectady, N. Y.—tower-lighting chokes.
Hartenstine-Zane Co., Inc., New York City—antenna installation.
International Derrick & Equip. Co., Columbus, Ohio—vertical radiators.
J. Nat. Johnson & Co., Inc., Chicago, Ill.—installation.
LEHIGH STRUCTURAL STEEL CO., 17 Battery Pl., New York City—vertical radiators.
JOHN E. LINGO & SON, INC., 28 St. & Buren Ave., Camden, N. J.—vertical radiators.
RCA MANUFACTURING CO., INC., Camden, N. J.—antenna surveys, antennas, antenna erection antenna arrays, television antennas.
The Radiart Corp., Cleveland, Ohio—television receiving antennas.
Radio Receptor Co., New York City—directional array phasing.
Technical Appliance Corp., N. Y. C.—television receiving antennas.
Truscon Steel Co., Youngstown, Ohio—vertical radiators.
Washington Institute of Technology, Washington, D. C.—directional antennas and exciter systems.

Ceramics & Insulators

AMERICAN LAVA CORP., Cherokee Blvd. & Mfgr's. Rd., Chattanooga, Tenn.—ceramic, steatite and porcelain insulators.
Corning Glass Works, Corning, N. Y.—glass insulators.
HENRY L. CROWLEY & CO., 1 Central Ave., West Orange, N. J.—ceramic insulators.
Electronic Mechanics, Inc., New York City—mycalex insulators.
General Ceramics, 30 Rockefeller Plaza, New York City.
ISOLANTITE, INC., 233 Broadway, New York City—ceramic insulators of all types.
LAPP INSULATOR CO., INC., LeRoy, N. Y.—porcelain insulators of all types.
Locke Insulator Corp., Baltimore, Md.—porcelain insulators.
Owens-Illinois Glass Co., Toledo, Ohio—glass insulators.
MICA INSULATOR CO., 200 Varick St., New York City—mica insulators.
Mycalex Corp. of America, New York City—mycalex insulators.
Stupakoff Laboratories, Inc., Pittsburgh, Pa.—ceramic insulators.

Coils and Coil Machinery, Iron Cores

ALADDIN RADIO INDUSTRIES, INC., 466 W. Superior St., Chicago, Ill.—coils.
Burlington Labs., Inc., Chicago, Ill.—coils.
The Cleveland Container Co., Cleveland, Ohio—coil forms.
Coils, Inc., Providence, R. I.—coils.
CONSOLIDATED WIRE & ASSOC. CORPS., 522 S. Peoria St., Chicago, Ill.—coils.
HENRY L. CROWLEY & CO., INC., 1 Central Ave., W. Orange, N. J.—r-f and i-f cores
Dean W. Davis & Co., Inc., Chicago, Ill.—coils.
DX Radio Products Co., Chicago, Ill.—coils.
FERROCART CORP. OF AMERICA, Hastings-on-Hudson, N. Y.—r-f and i-f cores.
Greyhound Equipment Co., Brooklyn, N. Y.—coils.
GUARDIAN ELECTRIC MFG. CO., 1625 W. Walnut St., Chicago, Ill.—coils.
GUTHMAN & CO., INC., EDWIN I., 400 S. Peoria St., Chicago, Ill.—coils.
Halldorson Co., The, Chicago, Ill.—coils.
HAMMARLUND MFG. CO., 424 W. 33 St., New York City—coils.
Meissner Mfg. Co., Mt. Carmel, Ill.—coils.
J. W. Miller & Co., Los Angeles, Calif.—coils.
The Muter Co., Chicago, Ill.—coils.
F. W. Sickles Co., Springfield, Mass.—coils.
Teleradio Engineering Corp., New York City—coils.
UNITED TRANSFORMER CORP., 150 Varick St., New York City—coils.
Universal Winding Co., Providence, R. I.—coil winding machines.

Condensers—Fixed

AEROVOX CORP., New Bedford, Mass.
American Condenser Corp., Chicago, Ill.
ARISTON LAB., INC., 4045 Diversey Ave., Chicago, Ill.
CENTRALAB, 900 E. Keefe Ave., Milwaukee, Wisc.
CONSOLIDATED WIRE & ASSOC. CORPS., 522 S. Peoria St., Chicago, Ill.
Continental Carbon, Inc., 13900 Lorain Ave., Cleveland, Ohio.
CORNELL-DUBILIER ELEC. CORP., South Plainfield, N. J.
HENRY L. CROWLEY & CO., INC., 1 Central Ave., W. Orange, N. J.
Curtis Condenser Corp., Cleveland, Ohio.

TOBE DEUTSCHMANN CORP., Canton, Mass.
Dumont Electric Co., Inc., New York City.
Erie Resistor Corp., Erie, Pa.
HEINTZ & KAUFMAN, LTD., S. San Francisco, Calif.—compressed nitrogen condensers.
Illinois Condenser Co., Chicago, Ill.
LAPP INSULATOR CO., INC., Le Roy, N. Y.—gas filled condensers.
The Magnavox Co., Inc., Fort Wayne, Ind.
P. R. MALLORY & CO., INC., 3029 E. Washington St., Indianapolis, Ind.
Micamold Radio Corp., Brooklyn, N. Y.
J. W. Miller & Co., Los Angeles, Calif.
Morrill & Morrill, New York City.
The Muter Co., Chicago, Ill.
NATIONAL UNION RADIO CORP., 57 State St., Newark, N. J.
Sangamo Electric Co., Springfield, Ill.
The F. W. Sickles Co., Springfield, Mass.
SOLAR MFG. CORP., Bayonne, N. J.
Sprague Specialties, Inc., North Adams, Mass.

Condensers—Variable

The Allen D. Cardwell Mfg. Corp., Brooklyn, N. Y.
General Instrument Co., Elizabeth, N. J.
GENERAL RADIO CO., 30 State St., Cambridge, Mass.
GUTHMAN & CO. INC., EDWIN I., 400 S. Peoria St., Chicago, Ill.
HAMMARLUND MFG. CO., INC., 424 W. 33 St., New York City.
E. F. Johnson Co., Waseca, Minn.
James Millen Mfg. Co., Inc., Malden, Mass.
National Co., Inc., Malden, Mass.
Radio Condenser Co., Camden, N. J.
Reliance Die & Stamping Co., Chicago, Ill.

Crystals, Crystal Holders, Etc.

BLILEY ELECTRIC CO., Union Station Bldg., Erie, Pa.
William W. L. Burnett Lab., San Diego, Calif.
Commercial Radio Equipment Co., Kansas City, Mo.
Fridgen Crystal Labs., Bellefonte, Pa.
Hipower Crystal Co., Chicago, Ill.
Hollister Crystal Co., Merriman, Kansas.
G. C. HUNT & SONS, Carlisle, Pa.
Peterson Radio Co., Council Bluffs, Iowa.
Precision Piezo Service, Baton Rouge, La.
Premier Crystal Labs., Inc., New York City.
SCIENTIFIC RADIO SERVICE, 124 Jackson Ave., University Park, Md.
STANDARD PIEZO CO., Box 164, Carlisle, Pa. monitors, meters.
THE VALPEY CRYSTALS, Box 321, Holliston, Mass.

Frequency Measuring & Monitoring Equipment & Services

Bendix Radio Corp., Baltimore, Md.—frequency monitors, meters.
William W. L. Burnett Lab., San Diego, Calif.—service.
Commercial Radio Equipment Co., Kansas City, Mo.—frequency monitors.
Donnelley Monitoring Service, Lake Bluff, Ill.
DOOLITTLE & FALKNOR, INC., 7421 S. Loomis Blvd., Chicago, Ill.—frequency monitors.
GENERAL RADIO CO., 30 State St., Cambridge, Mass.—frequency standards, meters and monitors.
LAMPKIN LABS., Bradentown, Fla.—frequency meter.
Fred M. Link Co., New York City—frequency monitors.
Peterkin Radio Labs., Detroit, Mich.—frequency measurements.
Premier Crystal Labs., Inc., New York City—frequency meters.
RCA COMMUNICATIONS, INC., 66 Broad St., New York City—frequency measuring service.
RCA MANUFACTURING CO., INC., Camden, N. J.—frequency measuring & monitoring equipment.
STANDARD PIEZO CO., 126 Cedar St., Carlisle, Pa.—frequency meters, monitors, measuring service.
Washington Institute of Technology, Washington, D. C.—frequency monitoring.
WESTERN ELECTRIC CO., 195 Broadway, New York City—frequency monitors.

Fuses

Jefferson Electric Co., Bellwood, Ill.
LITTELFUSE, INC., 4757 Ravenswood Ave., Chicago, Ill.

Insulation—Molded and Laminated Plastics

American Insulator Corp., New Freedom, Pa.—molders.
Auburn Button Works, Inc., Auburn, N. Y.—molders.
BAKELITE CORPORATION, 247 Park Ave., New York City.
Boonton Molding Co., Boonton, N. J.—molders.
Brandywine Fibre Products Co., Wilmington, Del.—laminated.
Chicago Molded Products Corp., Chicago, Ill.—molders.
Continental Diamond Fibre Co., Newark, Del.—laminated.
Harry Davies Molding Co., Chicago, Ill.—molders.
Durez Plastics & Chemicals. Inc., N. Tonawanda. N. Y.
Erie Resistor Corp., Erie, Pa.—molders.
Formica Insulation Co., Cincinnati, Ohio.—laminated.
Franklin Fibre-Lamitex Corp., Wilmington, Del.—laminated.
General Electric Co., Schenectady, N. Y.—laminated.
MICA INSULATOR CO., 200 Varick St., New York City.—laminated.
Mitchell-Rand Insulation Co., Inc., New York City.
Nat'l Vulcanized Fibre Co., Wilmington, Del.—laminated.
Resinox Corp., Terre Haute, Ind.
THE RICHARDSON CO., 278 Lake St., Melrose Park, Ill.—molders, laminated.
Synthane Corporation. Oaks, Pa.—laminated.
TAYLOR FIBRE CO., Norristown, Pa.—laminated.
Wilmington Fibre Specialty Co., Wilmington, Del.

Laboratory and Test Equipment

AEROVOX CORP., New Bedford, Mass.—condenser and resistor bridge, noise analyzer, L-C checker.
ACME ELECTRIC & MFG. CO., Cuba N. Y.—insulation breakdown testers.
AMERICAN TRANSFORMER CO., 175 Emmet St., Newark, N. J.—transformer testing sets.
Victor J. Andrew, Chicago, Ill.—r-f ammeters, antenna impedance measuring sets.
Approved Technical Apparatus Co., N. Y. C.—tube and set testers, volt-ohm-milliammeters.
BALLANTINE LABORATORIES, Boonton, N. J.—electronic voltmeter sound measuring equipment.
ALFRED W. BARBER, 35-33 172nd St., Flushing, N. Y.—impedance meters.
Bendix Radio Corp., Baltimore, Md.—field intensity meters, tube and set testers.
BOONTON RADIO CORP., Boonton, N. J.—Q-meter, QX-checker, converter test oscillator, b-f generator.
THE BRUSH DEVELOPMENT CO., 3311 Perkins Ave.. Cleveland, Ohio—galvanometers.
BURTON-ROGERS CO., 857 Boylston St., Boston, Mass.—meters.
CLOUGH-BRENGLE CO., 5501 Broadway. Chicago, Ill.—signal generators, b-f oscillators, oscillographs, microvolters, frequency modulators, tube and set testers, v-t voltmeters, condenser & resistor bridges, decibel meters, etc.
THE DAVEN CO., 158 Summit St., Newark, N. J.—output meters, volume indicators, transmission measuring sets, gain sets.
Dayco Radio Corp., Dayton, Ohio—tube & set testers, oscillators, oscilloscopes.
TOBE DEUTSCHMANN CORP., Canton, Mass.—condenser & resistor testers, a-f graphic recorder.
DOOLITTLE & FALKNOR, INC., 7421 S. Loomis Blvd., Chicago, Ill.—field-intensity meter, frequency monitors.
ALLEN B. DUMONT LABS., INC., 2 Main Ave., Passaic, N. J.—cathode-ray oscillographs, television test equipment.
The Esterline-Angus Co., Indianapolis, Ind.—graphic recording instruments.
Federal Telegraph Co., Newark, N. J.—field-strength meter.
FERRANTI ELECTRIC, INC., 30 Rockefeller Plaza, New York City—electrostatic voltmeters.
FERRIS INSTRUMENT CORP., Boonton, N. J.—signal generators, microvolters, radio noise and field-strength meters, r-f calibrators.
General Electric Co., Schenectady, N. Y.—cathode-ray oscilloscopes, meters.
GENERAL RADIO CO., 30 State St., Cambridge, Mass.—heterodyne frequency meters, frequency monitors. stroboscopes, sound-level meters, standard signal generators, bridges, meters, oscillators.
Hewlett-Packard Co., Palo Alto, Calif.—oscillators.

The Hickok Elec. Inst. Co., Cleveland, Ohio—meters, cathode-ray oscillographs, v-t voltmeters, tube & set testers, signal generators.
Industrial Instruments, Inc., Jersey City, N. J.—conductivity bridge, insulation tester, etc.
Jones-Orme Co., St. Paul, Minn.—oscillators, oscillographs, signal generator.
LAMPKIN LABORATORIES, Bradenton, Florida—micrometer frequency meter.
Leeds & Northrup Co., Philadelphia, Pa.—bridges, galvanometers, etc.
LEPEL HIGH FREQUENCY LABS., 39 W. 60th St., New York City.—vacuum tester.
MICROVOLTS, INC., Boonton, N. J.—precision test equipment.
WILLIAM MILLER CORP., 11 W. State St., Pasadena, Calif.—galvanometers, special acoustical, geophysical & vibration recording equipment.
MILLION RADIO & TELEVISION, 685 W. Ohio St., Chicago, Ill.—tube testers, v-t voltmeters, multimeters, signal generators.
MONARCH MFG. CO., 3341 Belmont Ave., Chicago, Ill.—signal generators, multivibrators, output meters, inductance & capacity bridges, v.t. voltmeters, db meters, gainsets, distortion-factor meters.
The Muter Co., Chicago, Ill.—resistance bridges, decade boxes.
Precision Apparatus Co., Brooklyn, N. Y.—tube testers, signal generators, multi-range meters.
RCA MANUFACTURING CO., INC., Camden, N. J.—field-strength meters, frequency monitors, modulation monitors, cathode-ray oscillographs, b-f oscillators, meters, etc.
Radio City Products Co., Inc., New York City—tube & set testers. v-t voltmeters, signal generators.
Radio Engineering Labs., Inc., Long Island City, N. Y.—wavemeters.
Rawson Elec. Instrument Co., Cambridge, Mass.—ammeters, voltmeters, fluxmeters, multimeters, electrostatic voltmeters, etc.
Roller-Smith Co., Bethlehem, Pa.—indicating and graphic instruments.
Sensitive Research Instrument Corp., New York City—meters.
SHALLCROSS MFG. CO., Collingdale, Pa.—resistance and Wheatstone bridges, megohmeters, megohm voltmeters, milliohmeters, decade boxes.
SHURE BROTHERS, 225 W. Huron St., Chicago, Ill.—acoustic laboratory equipment.
SOLAR MFG. CORP., Bayonne, N. J.—capacitor analyzers.
Sound Apparatus Co., New York City—power-level recorder.
STANDARD PIEZO CO., 126 Cedar St., Carlisle, Pa.—frequency meters.
SUNDT ENGINEERING CO., 4757 Ravenswood Ave., Chicago, Ill.—neobeam oscilloscope.
Supreme Instrument Corp., Greenwood, Miss.—set and tube testers, multimeters, v-t voltmeters oscilloscopes, oscillators.
TECH LABORATORIES, 7 Lincoln St., Jersey City, N. J.—output meter volume indicators, special bridges.
TELEVISO CO., 337-45 N. Pulaski Rd., Chicago, Ill.—microvolters, b-f oscillators, v-t voltmeters, signal generators.
Triplett Electrical Instrument Co., Bluffton, Ohio.—measuring instruments, test equipment.
Triumph Mfg. Co., Chicago, Ill.—cathode-ray oscillographs, oscillators, signal generators, meters.
UNITED TRANSFORMER CORP., 150 Varick St., New York City—insulation test sets.
Universal Signal Appliances, New York City—automatic tape recorders.
WESTERN ELECTRIC CO., 195 Broadway, New York City—cathode-ray oscillographs, field-intensity meters, sound-level meters, phase monitors, volume indicators, etc.
Westinghouse Elec. & Mfg. Co., Pittsburgh, Pa.—instruments and meters.
WESTON ELECTRICAL INST. CORP., 614 Frelinghuysen Ave., Newark, N. J.—ohmmeters, voltmeters, oscillators, volt-ohm-milliammeters, power-level and output meters, etc.

Laminations and Stampings

Aluminum Goods Mfg. Co., Manitowoc, Wis.
The American Rolling Mill Co., Middletown, Ohio.
M. D. HUBBARD SPRING CO., 319 Central Ave., Pontiac, Mich.
Hunter Pressed Steel Co., Lansdale, Penn.
THOMAS & SKINNER STEEL PRODUCTS CO., 1120 E. 23 St., Indianapolis, Ind.
F. R. Zierick Mfg. Works, New York City.

Magnets

CINAUDAGRAPH CORP., Stamford, Conn.
Crucible Steel Co. of America, New York City.
GUARDIAN ELECT. MFG. CO., 1625 W. Walnut St., Chicago, Ill.—magnets.
Indiana Steel Products Co., Chicago, Ill.
Taylor Wharton Co., Highbridge, N. J.

THOMAS & SKINNER STEEL PRODUCTS CO., 1120 E. 23 St., Indianapolis, Ind.

Microphones, Microphone Stands, Cutting Heads, Pickups, and Accessories

AMERICAN MICROPHONE CO., INC., 1915 S. Western Ave., Los Angeles, Calif.—microphones, stands and accessories.
American Phenolic Corp., Chicago, Ill.—Microphone connectors.
AMPERITE COMPANY, 561 Broadway, New York City—microphones and stands, contact microphones.
ASTATIC MICROPHONE LAB., INC., 830 Market St., Youngstown, Ohio—microphones & accessories, pickups, recording heads, contact microphones.
Atlas Sound Corp., Brooklyn, N. Y.—stands.
AUDAK COMPANY, 500 Fifth Ave., New York City—pickups.
Beacon Microphone Co., Akron, Ohio.—microphones.
Bruno Laboratories, Inc., New York City, microphones, pickups.
THE BRUSH DEVELOPMENT CO., 3311 Perkins Ave., Cleveland, Ohio—microphones, microphone stands, pickups, record cutters, microphone cartridges.
CARRIER MICROPHONE CO., 439 S. La Brea Ave., Inglewood, Calif.—microphones.
Eastern Mike-Stand Co., Brooklyn, N. Y.—microphone stands.
ELECTRO-VOICE MFG. CO., INC., 1239 South Bend, Ave., South Bend, Ind.—microphones & stands.
FAIRCHILD AERIAL CAMERA CORP., Van Wyck Blvd., & Jamaica Ave., Jamaica, N. Y. pickups.
GARRARD SALES CORP., 296 Broadway, New York City—pickups.
GATES RADIO & SUPPLY CO., Quincy, Ill.—microphones.
M. A. Gerrett Corp., Milwaukee, Wis.—microphone stands.
LANSING MFG. CORP., 6900 McKinley Ave., Los Angeles, Calif.—pickups.
RCA MANUFACTURING CO., INC., Camden, N. J.—microphones, cutting heads, microphone stands, pickups.
RANGERTONE, INC., 201 Verona Ave., Newark, N. J.—recording heads.
Rek-O-Kut Corp., N. Y. C.—cutting heads.
SHURE BROTHERS, 225 W. Huron St., Chicago, Ill.—microphones & stands, pickups.
Sound Apparatus Co., New York City—recording & reproducing arms.
SOUTH BEND MICROPHONE CO., 1720 Mishawaka Ave., South Bend, Ind.—microphones.
TIBBETTS LABS., Camden, Me.—microphones.
Transducer Corp., New York City—microphones.
Trimm Radio Mfg. Co., Chicago, Ill.—microphone stands.
THE TURNER CO., Cedar Rapids, Iowa.—microphones.
Unit Reproducers Corp., Rochester, N. Y.—pickups.
UNIVERSAL MICROPHONE CO., LTD., Inglewood, Calif.—microphones, stands, accessories, cutting heads.
Webster Electric Co., Racine, Wisc.—pickups.
WESTERN ELECTRIC CO., 195 Broadway, New York City—microphones.

Power Supplies, Rectifiers, Voltage Regulators, Motors, Etc.

ACME ELECTRIC & MFG. CO., Cuba, N. Y.—voltage regulators.
The Alliance Mfg. Co., Alliance, Ohio—fractional horse power motors.
American Television & Radio Co., St. Paul, Minn.—vibrators, battery chargers.
AMERICAN TRANSFORMER CO., 175 Emmett St., Newark, N. J.—rectifiers, voltage regulators.
AMPEREX ELECTRONIC PRODUCTS, INC., 79 Washington St., Brooklyn, N. Y.—rectifiers (tube).
Amplifier Co. of America, N. Y. C.—voltage regulators.
THE BENWOOD LINZE CO., 1832 Washington Ave., St. Louis, Mo.—rectifiers, battery boosters, power units.
CARTER MOTOR CO, 1608 Milwaukee, Chicago, Ill.—dynamotors, genemotors, converters.
Cinema Eng. Co., Burbank, Calif.—rectifiers.
COLLINS RADIO CO., 2920 First Ave., Cedar Rapids, Iowa—power supplies.
CONTINENTAL ELECTRIC CO., 715 Hamilton Ave., Geneva, Ill.—mercury-vapor rectifiers.

Delco Appliance Div. Rochester, N. Y.
EICOR, INC., 515 S. Laflin St., Chicago, Ill.—dynamotors, converters.
EITEL-McCULLOUGH, INC., 798 San Mateo Ave., San Bruno, Calif.—rectifiers (tube).
Electric Specialty Co., Stamford, Conn.—generators, dynamotors, rotary converters.
Electronic Labs., Inc., Indianapolis, Ind.—polarity changers, power supplies & converters, vibrators.
Electronic Products, Los Angeles, Calif.—rectifiers (tube).
Electrons, Inc., Newark, N. J.—tube rectifiers.
Electro Products Labs., Chicago, Ill.—battery eliminators.
Federal Telegraph Co., Newark, N. J.—mercury-vapor rectifiers.
FERRANTI ELECTRIC, INC., 30 Rockefeller Plaza, New York City—rectifiers.
GATES RADIO & SUPPLY CO., Quincy, Ill.—power supplies.
General Electric Co., Schenectady, N. Y.—motor-generators, regulators.
HEINTZ & KAUFMAN, LTD., So. San Francisco, Calif.—rectifiers.
IDEAL COMMUTATOR DRESSER CO., 4025 Park Ave., Sycamore, Ill.—voltage regulators, motor maintenance equipment.
International Tel. & Tel. Corp., New York City—selenium rectifiers.
Janette Mfg. Co., Chicago, Ill.—motors, motor-generator sets, rotary converters.
KATO ENGINEERING CO., 530 N. Front St., Mankato, Minn.—motors, converters.
LEAR DEVELOPMENTS, INC., Roosevelt Field, Mineola, L. I., N. Y.—portable power supplies.
Fred M. Link Co., New York City—dynamotor and vibrator power units.
LITTELFUSE INC., 4757 Ravenswood Ave., Chicago, Ill.— surge protectors, arc suppressors.
P. R. MALLORY & CO., INC., 3029 E. Washington St., Indianapolis, Ind.—vibrators, dry disc rectifiers, battery chargers, grid bias cells, vibrapacks.
Meissner Mfg. Co., Mt. Carmel, Ill.—vibrators.
Oak Mfg. Co., Chicago, Ill.—vibrators.
D. W. ONAN & SONS, 43 Royalston Ave., Minneapolis, Minn.—electric generating plants.
PIONEER GEN-E-MOTOR CORP., 466 E. Superior St., Chicago, Ill.—dynamotors, genemotors, rotary converters.
The Radiart Corp., Cleveland, Ohio.—vibrators.
Raytheon Mfg. Co., Waltham, Mass.—voltage regulators, rectifiers, power supplies, battery chargers & eliminators.
Roller-Smith Co., Bethlehem, Pa.—voltage regulators.
SOLA ELECTRIC CO., 2525 Clybourn ave., Chicago, Ill.—voltage compensators.
Standard Electrical Products Co., St. Paul, Minn.—miniature motors.
TAYLOR TUBES, INC., 2341 Wabansia Ave., Chicago, Ill.—rectifiers (tube).
THORDARSON ELECT. MFG. CO., 500 W. Huron St., Chicago, Ill.—automatic voltage regulators.
UNITED ELECTRONICS CO., 42 Spring St., Newark, N. J.—mercury rectifier tubes.
UNITED TRANSFORMER CORP., 150 Varick St., New York City—rectifiers, voltage regulators.
UTAH RADIO PRODUCTS CO., 812 Orleans St., Chicago, Ill.—vibrators.
Ward Leonard Electric Co., Mt. Vernon, N. Y.—voltage regulators.
WESTERN ELECTRIC CO., 195 Broadway, New York City—rectifiers.
Westinghouse Electric & Mfg. Co., Bloomfield, N. J.—tube rectifiers.
Wirt Co., Philadelphia, Pa.—voltage regulators.

Recording Equipment, Discs, Etc.

Acoustic Consultants, Inc., New York City—magnetic tape recorders.
Harry Acton & Co., New York City—cutting & playback needles.
The Alliance Mfg. Co., Alliance, Ohio—motors & turntables.
Allied Phono. & Record Mfg. Co., Hollywood, Calif.—recording blanks.
ALLIED RECORDING PRODUCTS CO., 126 W. 46, New York City—recording equipment and needles.
David Bogen Co., Inc., New York City.—recording equipment.
THE BRUSH DEVELOPMENT CO., 3311 Perkins Ave., Cleveland, Ohio—magnetic steel tape recorders.
Cellutone Record & Mfg. Co., Los Angeles, Calif.—recording blanks, stylii. recording microscopes.
CINAUDAGRAPH CORP., Stamford, Conn.—tape recorders.
DUPLEX RECORDING DEVICES CO., 514 W. 36th St., New York City—recording equipment.
Electrical Industries Mfg. Co., Red Bank, N. J.—recording equipment.
ELECTRICAL RESEARCH PRODUCTS, INC., 195 Broadway, New York City—lateral and vertical recording and reproducing equipment.
Electronic Sound Labs., Inc., Hollywood, Calif.—recording equipment.
Electrovox Mfg. Co., New York City.—needles.
Emar Instrument Corp., New York City—recording & reproducing equalizers, monitoring systems.
FAIRCHILD AERIAL CAMERA CORP., 88-06 Van Wyck Blvd., & Jamaica Ave., Jamaica, L. I., N. Y.—portable and studio recorders.
Federal Recorder, New York City—recorders and discs.
GARRARD SALES CORP., 296 Broadway, New York City—phonograph motors & assemblies, record changers, turntables, needles.
GATES RADIO & SUPPLY CO., Quincy, Ill.—transcription equipment.
M. A. Gerrett Corp., Milwaukee, Wis.—needles.
LANSING MFG. CO., 6900 McKinley Ave., Los Angeles, Calif.—reproducers.
Mirror Record Corp., New York City—recording discs, needles.
Nash Radio Products Co., St. Louis, Mo.—record lube.
Permo Products Corp., Chicago, Ill.—needles.
Phonograph Needle Mfg. Co., Providence, R. I.
Poinsettia, Inc., Pitman, N. J.—recording equipment & supplies.
PRESTO RECORDING CORP., 242 W. 55 St., New York City—recording discs, recording & reproducing equipment, needles, turntables.
RCA MANUFACTURING CO., INC., Camden, N. J.—transcription equipment, needles, records.
Radio-Electronic Eng. Co., Warren, Pa.—recording equipment.
Radio Engineering & Mfg. Co., New York, N. Y.—turntables, transcription reproducers.
RADIOTONE, INC., 7356 Melrose Ave., Hollywood, Calif.—recorders, turntables, etc.
RANGERTONE, INC., 201 Verona Ave., Newark, N. J.—needles, electric chimes.
RECOTON CORP., 178 Prince St., New York City—needles.
Rek-O-Kut Corp., N. Y. C.—turntables, feed mechanisms.
Remler Co., Ltd., San Francisco, Calif.—transcription turntables.
Scully Machine Co., Bridgeport, Conn.—professional recorders.
Sound Apparatus Co., New York City—recording

& reproducing machines, disc material, needles, recording microscopes, motors, equalizers, filters, etc.
Sound Products, Hollywood, Calif.—record players.
Sound Systems, Inc., Cleveland, Ohio—turntables.
TRANSFORMER CORP. OF AMERICA, 69 Wooster St., New York City—recorders & reproducers.
UNIVERSAL MICROPHONE CO., LTD., Inglewood, Calif.—recording machines, discs, needles, etc.
Universal Signal Appliances, New York City—automatic tape recorders for code.
THE WEBSTER CO., 5622 Bloomingdale Ave., Chicago, Ill.—phonograph motors and assemblies.
WILCOX ELECTRIC CO., 4014 State Line, Kansas City, Kan.—recording amplifiers.
Wilcox-Gay Corp., Charlotte, Mich.—recorders.

Relays

Advance Electric Co., Los Angeles, Calif.
Allen-Bradley Co., Milwaukee, Wis.
Allied Control Co., Inc., New York City.
American Automatic Electric Sales Co., Chicago, Ill.
L. S. Brach Mfg. Co., Newark, N. J.
Cinema Engineering Co., Hollywood, Calif.
C. P. CLARE & CO., 4901 Lawrence Ave., Chicago, Ill.
Hugh H. Eby, Inc., Philadelphia, Pa.
GUARDIAN ELECTRIC CO., 1625 W. Walnut St., Chicago, Ill.
Leach Relay Co., Los Angeles, Calif.
Photoswitch, Inc., Cambridge, Mass.
Roller-Smith Co., Bethlehem, Pa.
Sigma Instruments, Inc., Belmont, Mass.
Standard Electric Products Co., St. Paul, Minn.
Struthers Dunn, Inc., Philadelphia, Pa.
United Cinephone Corp., Long Island City, N. Y.
Ward Leonard Electric Co., Mt. Vernon, N. Y.
WESTON ELECT. INST. CORP., 614 Frelinghuysen Ave., Newark, N. J.

Resistors, Attenuators, Controls, Etc.

AEROVOX CORP., New Bedford, Mass.—carbon resistors, fixed & adjustable wire-wound resistors.
Allen-Bradley Co., Milwaukee, Wis.—fixed and variable resistors.
AMPERITE CO., 561 Broadway, New York City—ballast tubes.
Atlas Resistor Co., New York City—wire-wound tubular resistors.
Audio Products Co., Burbank, Calif.—attenuators, controls.
The Carborundum Co., Niagara Falls, N. Y.—fixed resistors.
CENTRALAB, 900 E. Keefe Ave., Milwaukee, Wis.—fixed & variable resistors.
Champion Radio Works, Danvers, Mass.—ballast tubes.
Chicago Tel. Supply Co., Elkhart, Ind.—volume & tone controls.
Cinema Engineering Co., Burbank, Calif.—resistors, attenuators.
CLAROSTAT MFG. CO., INC., 285 N. 6 St., Brooklyn, N. Y.—volume & tone controls, fixed wire resistors, attenuators, T & L pads, p-a controls, resistor tubes.
COLLINS RADIO CO., 2920 First Ave., Cedar Rapids, Iowa—attenuators.
CONSOLIDATED WIRE & ASSOC. CORPS., 522 S. Peoria St., Chicago, Ill.—volume and tone controls, resistors.
Continental Carbon, Inc., Cleveland, Ohio—carbon and wire-wound resistors, suppressors.
THE DAVEN CO., 158 Summit St., Newark, N. J.—volume controls, attenuators, rheostats, resistances, potentiometers.
Electro Products Labs., Chicago, Ill.—pads.
Erie Resistor Corp., Erie, Pa.—carbon resistors.
FERRANTI ELECTRIC, INC., 30 Rockefeller Plaza, New York City—attenuators.
GENERAL RADIO CO., 30 State St., Cambridge, Mass.—resistors.
Hardwick, Hindle, Inc., Newark, N. J.—fixed & adjustable resistors, rheostats.
INTERNATIONAL RESISTANCE CO., 401 N. Broad St., Philadelphia, Pa.—metallized resistors, volume controls, attenuators, power rheostats, wire-wound resistors, precision resistors.
Lectrohm, Inc., Cicero, Ill.—fixed & variable enameled resistors, wire-wound resistors.
Leeds & Northrup Co., Philadelphia, Pa.—precision resistors, resistance standards.
P. R. MALLORY & CO., INC., 3029 E. Wash. St., Indianapolis, Ind.—volume control, rheostats, potentiometers, wire-wound resistors.
Micamold Radio Corp., Brooklyn, N. Y.—resistors, ballast tubes.
The Muter Co., Chicago, Ill.—resistors, plug-in resistors.
The Ohio carbon Co., Cleveland, Ohio—resistors.
OHMITE MANUFACTURING CO., 4835 W. Flournoy St., Chicago, Ill.—rheostats, resistors, precision resistors, line-cord resistors. T & L pads, dummy antennas.
PRECISION RESISTOR CO., 334 Badger Ave., Newark, N. J.—precision wire-wound resistors, potentiometers, power resistors.
Remler Co., Ltd., San Francisco, Calif.—attenuators.
SHALLCROSS MFG. CO., Collingdale, Pa.—wire-wound resistors, surge resistors.
Speer Carbon Co., St. Marys, Pa.—carbon & wire-wound resistors.
Sprague Products Co., N. Adams, Mass.—resistors.
Stackpole Carbon Co., St. Marys, Pa.—carbon resistors, volume & tone controls.
THE STATES CO., 19 New Park Ave., Hartford, Conn.—resistors.
TECH LABORATORIES, 7 Lincoln St., Jersey City, N. J.—attenuators, resistors, pads, decades.
UTAH RADIO PRODUCTS CO., 820 Orleans St., Chicago, Ill.—resistors, volume controls.
Ward Leonard Electric Co., Mt. Vernon, N. Y.—wire-wound resistors, rheostats.
S. S. White Dental Mfg. Co., The, New York City—molded resistors, flexible shafts.
Wirt Co., Philadelphia, Pa.—resistors.

Screws

American Screw Co., Providence, R. I.
Continental Screw Co., New Bedford, Mass.
Corbin Screw Corp., New Britain, Conn.
Elastic Stop Nut Corp., Elizabeth, N. J.
National Screw & Mfg. Co., Cleveland, Ohio.
Parker-Kalon Corp., New York City.
Russell, Burdsall & Ward Bolt & Nut Co., Port Chester, N. Y.
SHAKEPROOF LOCK WASHER CO., 2533 N. Keeler Ave., Chicago, Ill.

Sockets, Jacks, Plugs, Switches, Etc.

Alden Mfg. Co., Brockton, Mass.
Allied Control Co., Inc., N. Y. C.
American Phenolic Corp., Chicago, Ill.
American Radio Hardware Co., Inc., N. Y. C.
Barker & Williamson, Ardmore, Pa.—switches.
Bastian Brothers Co., Rochester, N. Y.
Birnbach Radio Corp., New York City.
Bud Radio, Inc., Cleveland, Ohio—sockets, jacks, plugs.
CENTRALAB, 900 E. Keefe Ave., Milwaukee, Wis.—wave change & tone switches.
Chicago Tel. Supply Co., Elkhart, Ind.—switches, jacks, plugs.
Cinch Mfg. Corp., Chicago, Ill.—sockets, plugs.
Cinema Eng. Co., Burbank, Calif.—cords plugs.
CONTINENTAL ELECTRIC CO., 715 Hamilton Ave., Geneva, Ill.—vacuum power switches.
THE DAVEN CO., 158 Summit St., Newark, N. J.—rotary switches.
Hugh H. Eby, Inc., Philadelphia, Pa.—sockets, plugs, switches, binding posts, terminal strips.
A. W. Franklin Mfg. Co., New York City—sockets, terminal strips.
GUARDIAN ELECT. MFG. CO., 1625 W. Walnut St., Chicago, Ill.—switches, plugs.
HAMMARLUND MFG. CO., 424 W. 33 St., New York City—sockets.
IDEAL COMMUTATOR DRESSER CO., 4025 Park Ave., Sycamore, Ill.—connectors.
Insuline Corp. of America, Long Island City—radio parts.
E. F. Johnson Co., Waseca, Minn.—sockets, plugs, jacks.
HOWARD B. JONES, 2300 Wabansia Ave., Chicago, Ill.—plugs, connectors, sockets, terminal panels, jacks.
P. R. MALLORY & CO., INC., 3029 E. Washington St., Indianapolis, Ind.—switches, plugs, jacks.
Meissner Mfg. Co., Mt. Carmel, Ill.—sockets, switches.
James Millen Mfg. Co., Inc., Malden, Mass.—sockets, connectors.
The Muter Co., Chicago, Ill.—switches.
Oak Manufacturing Co., Chicago, Ill.—switches, sockets.
OHMITE MANUFACTURING CO., 4835 W. Flournoy St., Chicago, Ill.—switches.
The Pyle-National Co., Chicago, Ill.—plugs.
RADIO WIRE TELEVISION, INC., 100 6th Ave., New York City—parts.
SHALLCROSS MFG. CO., Collingdale, Pa.—tap switches.
Struthers Dunn, Inc., Philadelphia, Pa.—limit switches.
TECH LABORATORIES, 7 Lincoln St., Jersey City, N. J.—switches.
Technical Devices Corp., Bloomfield, N. J.
Trimm Radio Mfg. Co., Chicago, Ill.—plugs.
UTAH RADIO PRODUCTS CO., 820 Orleans St., Chicago, Ill.—plugs, switches, jacks.
Wirt Co., Philadelphia, Pa.—switches.

Solder, Soldering Irons, Solder Pots, Etc.

L. S. Brach Mfg. Co., Newark, N. J.—solder, soldering irons.
Drake Elec. Works, Inc., Chicago, Ill.—soldering irons and solder pots.
Electric Soldering Iron Co., Deep River, Conn.—electric soldering irons, temperature control for welding irons.
GARDINER METAL CO., 4820 S. Campbell Ave., Chicago, Ill.—rosin and acid core solders—wire, bar.
IDEAL COMMUTATOR DRESSER CO., 4025 Park Ave., Sycamore, Ill.—electric soldering tools.
Kester Solder Co., Chicago, Ill.—solder.
Lectrohm, Inc., Cicero, Ill.—solder pots.
The Ruby Chemical Co., Columbus, Ohio—solder, soldering & tinning flux.
Sta-Warm Electric Co., Ravenna, Ohio—electric soldering irons, solder pots, wax pots and pouring heaters.
Struthers Dunn, Inc., Philadelphia, Pa.—melting pots, pouring ladles.

Speakers, Headphones, Horns, Etc.

Arlavox Mfg. Co., Chicago, Ill.—speakers.
Atlas Sound Corp., Brooklyn, N. Y.—speakers, speaker baffles, enclosures, speaker trumpets, supports and fixtures.
BRUSH DEVELOPMENT CO., 3311 Perkins Ave., Cleveland, Ohio—tweeters, headphones.
C. F. Cannon Co., Springwater, N. Y.—headphones.
Chicago Tel. Supply Co., Elkhart, Ind.—headphones.
CINAUDAGRAPH CORP., Stamford, Conn.—speakers, horns.
Fox Sound Equip. Corp., Toledo, Ohio—speakers.
A. G. HINTZE CO., 300 W. Adams St., Chicago, Ill.—grille cloth.
JENSEN RADIO MFG. CO., 6601 S. Laramie Ave., Chicago, Ill—speakers.
LANSING MFG. CO., 6900 McKinley Ave., Los Angeles, Calif.—radio, p-a and theatre speakers.
The Magnavox Co., Inc., Ft. Wayne, Ind.—speakers.
Operadio Mfg. Co., St. Charles, Ill.—speakers.
OXFORD-TARTAK RADIO CORP., 915 W. Van Buren St., Chicago, Ill.—speakers, horns baffles, field exciters, etc.
Quam-Nichols Co., Chicago, Ill.—speakers.
RCA MANUFACTURING CO., INC., Camden, N. J.—speakers, horns, headphones.
RACON ELEC. CO., INC., 52 E. 19 St., New York City—speakers, baffles, horns, tweeters, woofers, sound chambers.
The Rola Co., Cleveland, Ohio—speakers.
Trimm Radio Mfg. Co., Chicago, Ill.—headsets.
Unit Reproducers Mfg. Co., Rochester, N. Y.—speakers.
UNIVERSITY LABS., 195 Chrystie St., New York City.—speakers, horns, etc.
UTAH RADIO PRODUCTS CO., 820 Orleans St., Chicago, Ill.—speakers.
WESTERN ELECTRIC CO., 195 Broadway, New York City—speakers, horns, etc.
Wright-DeCoster, Inc., St. Paul, Minn.—speakers.

Transformers, Chokes, Reactors, Filters, Etc.

ACME ELEC. MFG. CO., Cuba, N. Y.—transformers.
AEROVOX CORP., New Bedford, Mass.—interference filters.
AMERICAN TRANSFORMER CO., 175 Emmet St., Newark, N. J.—All types of transformers, reactors, etc.
Anaconda Wire & Cable Corp., Muskegon, Mich.
AUDIO DEVELOPMENT CO., 123 Bryant Ave., N., Minneapolis, Minn.—transformers, filters.
Barker & Williamson, Ardmore, Pa.—transmitting inductances.
Chicago Transformer Corp., Chicago, Ill.—transformers.
COLLINS RADIO CO., 2920 1st Ave., Cedar Rapids, Iowa—equalizers.
CONTINENTAL CARBON, INC., 13900 Lorain Ave., Cleveland, Ohio—filters.
Coto-Coil Co., Inc., Providence, R. I.—chokes, inductors.
DAVEN CO., 158 Summit St., Newark, N. J.—equalizers.
Dean W. Davis & Co., Inc., Chicago—transformers.
TOBE DEUTSCHMANN CORP., Canton, Mass.—filters.
Dongan Elec. Mfg. Co., Detroit, Mich.—transformers, filters.
DOOLITTLE & FALKNOR, INC., 7421 S. Loomis Blvd., Chicago, Ill.—transformers, chokes, filters.
FERRANTI ELECTRIC, INC., 30 Rockefeller Plaza, New York City—transformers, reactors, equalizers, filters.
Franklin Transformer Mfg. Co., Minneapolis, Minn.—transformers, filters, reactors.
Freed Transformer Co., New York City—transformers.
GENERAL RADIO CO., 30 State St., Cambridge, Mass.—filters.
General Transformer Corp., Chicago, Ill.—transformers.
GUARDIAN ELECT. MFG. CO., 1625 W. Walnut St., Chicago, Ill.—reactors.
Robert M. Hadley Co., Newark, Del.—transformers.
The Halldorson Co., Chicago, Ill.—transformers, reactors.
HAMMARLUND MFG. CO., INC., 424 W. 33 St., New York City—transformers.
Jefferson Electric Co., Bellwood, Ill.—transformers, chokes.
E. F. Johnson Co., Waseca, Minn.—inductors.
Kenyon Transformer Co., Inc., New York City—transformers, reactors, chokes.
J. W. Miller Co., Los Angeles, Calif.—coils, chokes, filters.
OHMITE MANUFACTURING CO., 4835 W. Flournoy St., Chicago, Ill.—chokes.
Phelps Dodge Copper Prod. Corp., Los Angeles, Calif.—transformers.
RACON ELECTRIC CO., INC., 58 E. 19 St.—filters.
Raytheon Mfg. Co., Waltham, Mass.—transformers.
SOLA ELECTRIC CO., 2525 Clybourn Ave., Chicago, Ill.—transformers.
Standard Elect. Prod. Co., St. Paul, Minn.—transformers.
Standard Transformer Co., Chicago, Ill.—transformers, reactors.
Superior Electric Co., Bristol, Conn.—transformers.
TECH LABORATORIES, 7 Lincoln St., Jersey City, N. J.—equalizers.
THORDARSON ELECTRIC MFG. CO., 500 W. Huron St., Chicago, Ill.—transformers, chokes.
Transformer Engineering Corp., Cleveland, Ohio—transformers.
UNITED TRANSFORMER CORP., 150 Varick St., New York City—transformers, reactors, equalizers, filters.
UTAH RADIO PRODUCTS CO., 820 Orleans St., Chicago, Ill.—transformers.
Westinghouse Elec. & Mfg. Co., Pittsburgh, Pa.—transformers, reactors.
Whisk Laboratories, New York City—balancing and power filters.

Transmission Lines

American Phenolic Corp., Chicago, Ill.
Victor J. Andrew, Chicago, Ill.
Belden Mfg. Co., Chicago, Ill.
COLLINS RADIO CO., 2920 1st Ave., Cedar Rapids, Iowa.
Communication Products, Inc., Jersey City, N. J.
DOOLITTLE & FALKNOR, INC., 7421 S. Loomis Blvd., Chicago, Ill.
ISOLANTITE, INC., 233 Broadway, New York City.
E. F. Johnson Co., Waseca, Minn.
General Cable Corp., New York City.
Transducer Corp., New York City.
WESTERN ELECTRIC CO., 195 B'way, N.Y.C.

Transmitting Equipment—Broadcast, Television, Facsimile, Aeronautical, Marine, Police; Frequency - Modulated Equipment; High - Frequency Receivers and Associated Apparatus

Amplifier Co. of America, N. Y. C.—preamplifiers, commercial & broadcast transmitters.

Victor J. Andrew, Chicago, Ill.—custom built communication equipment.

Barker & Williamson, Ardmore, Pa.—transmitting inductances, band-switching devices, custom-built transmitters, etc.

Bendix Radio Corp., Baltimore, Md.—high-frequency transmitters, synchronizers, modulation monitors, etc.

Cinema Engineering Co., Burbank, Calif.—sound, communication equipment.

COLLINS RADIO CO., 2920 1st Ave., Cedar Rapids, Iowa—broadcast, aeronautical, marine and police transmitters; broadcast amplifiers and speech-input equipment; volume limiting amplifiers, line equalizers, etc.

Commercial Radio Equip. Co., Kansas City, Mo.—broadcast amplifiers, preamplifiers.

COMMUNICATION EQUIP. & ENG. CO., 504 N. Parkside Ave., Chicago, Ill.—Carrier telephone & telegraph equipment.

THE DAVEN CO., 158 Summit St., Newark, N. J.—speech-input control apparatus, mixer panels, line equalizers.

DOOLITTLE & FALKNOR, INC., 7421 S. Loomis Blvd., Chicago, Ill.—broadcast, aircraft, police transmitters, police receivers, special equipment to specifications, antenna coupling units.

ALLEN B. DUMONT LABS., INC., 2 Main Ave., Passaic, N. J.—television transmitting & receiving equipment.

Electronic Sound Labs., Inc., Hollywood, Calif.—radio transmitters.

Federal Telegraph Co., Newark, N. J.—transmitters.

FINCH TELECOMMUNICATIONS LABS., INC., Bendix Airport, Bendix, N. J.—facsimile transmitters and receivers.

GATES AMERICAN CORP., Quincy, Ill.—broadcast, airport and police transmitters; broadcast studio and remote equipment, limiting amplifiers.

General Electric Co., Schenectady, N. Y.—aircraft and police transmitters and receivers, high-frequency apparatus, f-m receivers.

GENERAL RADIO CO., 30 State St., Cambridge, Mass.—frequency and modulation monitors, power-level indicators, volume controls.

The Hallicrafters, Inc., Chicago, Ill.—communication receivers.

HAMMARLUND MFG. CO., 424 W. 33 St., New York City—communication receivers.

Harvey Radio Labs., Cambridge, Mass.—police radio systems, marine radio-telephone installations, airport ground stations, general communication equipment.

HEINTZ & KAUFMAN, LTD., San Francisco, Calif.—radio transmitters, special receivers.

Howard Radio Co., Chicago, Ill.—communication receivers.

Charles F. Jacobs, New York City—antenna spreaders, r-f feedline separators.

E. F. Johnson Co., Waseca, Minn.—"Q" antennas, antenna equipment, broadcast equipment.
LEAR DEVELOPMENTS, INC., Roosevelt Field, Mineola, L. I., N. Y.—aircraft transmitters, receivers, direction finders, ground stations, antenna reels, antenna insulators.
Fred M. Link Co., New York City—police transmitters, receivers; special radio products.
National Co., Inc., Malden, Mass.—communication receivers.
Par-Metal Products Corp., Long Island City, N. Y.—relay racks, rack and panel equipment.
RCA MANUFACTURING CO., INC., Camden, N. J.—broadcast transmitters, marine radio equipment, aviation and police radio, television equipment, facsimile equipment.
Radio Engineering Labs., Inc., Long Island City, N. Y.—police, aircraft, marine and fire radio equipment frequency-modulated transmitters.
Radio Frequency Labs., Inc., Boonton, N. J.—aircraft transmitters and receiving equipment, direction finders.
Radio Receptor Co., Inc., 251 W. 19 St., New York City—transmitters, aeronautical and marine radio equipment.
RADIO TRANSCEIVER LABS., 8627 115th St., Richmond Hill, N. Y.—high-frequency transmitters and receivers, u-h-f portable and pack transmitters and receivers.
Sound Products, Hollywood, Calif.—aircraft and police radio, ship radio-telephone transmitters.
TELEVISO CO., 341-57 N. Pulaski Rd., Chicago, Ill.—broadcast transmitters, blind-landing aids.
THORDARSON ELECT. MFG. CO., 500 W. Huron St., Chicago, Ill.—transmitter & peak limiting amplifier kits.
TRANSFORMER CORP. OF AMERICA, 69 Wooster St., New York City—speech-input equipment, modulation amplifiers.
Transmitter Equipment Mfg. Co., Inc., New York City—transmitters for broadcast, police, fire, marine and aviation services; police, fire, marine receivers.
WESTERN ELECTRIC CO., 195 Broadway, New York City—broadcast, police, marine and aviation radio equipment; speech-input units, amplifiers, etc.
Westinghouse Elec. & Mfg. Co., Baltimore, Md.—transmitting equipment.
RADIO WIRE TELEVISION, INC., 100 6th Ave., New York City—transmitting equipment.
WILCOX ELECTRIC CO., 4014 State Line, Kansas City, Kan.—airline and police radio equipment; broadcast amplifiers; speech-input equipment.

Tube Machinery

Distillation Products, Inc., Rochester, N. Y.—vacuum pumps.
EISLER ENGINEERING CO., 750 S. 13 St., Newark, N. J.—complete equipment for the production of radio and electronic tubes.
KAHLE ENGINEERING CORP., 941 De Mott St., North Bergen, N. J.

Tube Parts & Materials

Aluminum Goods Mfg. Co., Manitowoc, Wis.—tube shields, special stampings.
The American Brass Co., Waterbury, Conn.—tube parts.
American Electro Metal Corp., Lewiston, Me.—tube parts and materials.
AMERICAN LAVA CORP., Chattanooga, Tenn.—ceramic, steatite, porcelain tube parts.
Brandywine Fibre Products Co., Wilmington, Del.—spacers, ferrules, bushings, grommets from fibre.
CALLITE PRODUCTS CO., 542 39th St., Union City, N. J.—tungsten and molybdenum rods, sheets, wire, contacts, grids, coils, supports, etc.; fluorescent tubing and materials; precious metal contacts.
Corning Glass Works, Corning, N. Y.—glass.
HENRY L. CROWLEY CO., West Orange, N. J.—ceramic parts.
DeMuth Glass Works, Inc., Brooklyn, N. Y.—glass envelopes.
Driver-Harris Co., Harrison, N. J.—alloy wires.
WILBUR B. DRIVER CO., 150 Riverside Ave., Newark, N. J.—filament wire, carbonized plates for radio tubes.
Fansteel Metallurgical Corp., North Chicago, Ill—tube parts and materials.
GOAT RADIO TUBE PARTS, INC., 314 Dean St., Brooklyn, N. Y.—tube shields, parts; grid cap clips; stampings.
International Nickel Co., Inc., New York City—nickel, nickel alloys.
King Laboratories, Inc., Syracuse, N. Y.—getters.
LEPEL HIGH FREQUENCY LABS., 39 W. 60 St., New York City—tube parts.
J. W. Miller Co., Los Angeles, Calif.—grommets.
Newark Wire Cloth Co., Newark, N. J.—wire cloth.
PFALTZ & BAUER, INC., Empire State Bldg., New York City—fluorescent materials.
Speer Carbon Co., St. Marys, Pa.—graphite anodes.
Summerill Tubing Co., Bridgeport, Pa.—seamless tubing.

SUPERIOR TUBING CO., Norristown, Pa.—seamed and seamless tubing in various metals and alloys.
Swedish Iron & Steel Corp., New York City—metal in various forms for tube parts.

Tubes—Receiving, Transmitting, Photo-electric Cells, Cathode-Ray, Etc.

AMPEREX ELECTRONIC PRODUCTS, INC., 79 Washington St., Brooklyn, N. Y.—water and air-cooled transmitting.
Arcturus Radio Tube Co., Newark, N. J.—receiving.
Champion Radio Works, Inc., Danvers, Mass.—receiving.
CONTINENTAL ELECTRIC CO., Geneva, Ill.—photoelectric cells, mercury-vapor rectifiers.
ALLEN B. DUMONT LABS., INC., 2 Main Ave., Passaic, N. J.—cathode-ray.
EITEL-McCULLOUGH, INC., 798 San Mateo Ave., San Bruno, Calif.—transmitting.
Electronic Products, Los Angeles, Calif.—mercury-vapor, gaseous discharge and special vacuum.
Electrons, Inc., Newark, N. J.—tube rectifiers.
Federal Telegraph Co., Newark, N. J.—transmitting.
HEINTZ & KAUFMAN, LTD., S. San Francisco, Calif.—transmitting.
Hygrade-Sylvania Corp., New York City—receiving, cathode-ray.
Hytron Corp., Salem, Mass.—receiving.
Hytronic Labs. Div., Hytron Corp., Salem, Mass.—transmitting.
The Ken-Rad Tube & Lamp Corp., Owensboro, Ky.—receiving.
Dr. F. Loewenberg, New York City—photoelectric cells.
NATIONAL UNION RADIO CORP., 57 State St., Newark, N. J.—receiving, cathode-ray, photocells, panel and exciter lamps.
RCA MANUFACTURING CO., INC., Harrison, N. J.—transmitting, receiving, cathode-ray, photo-electric cells.
Raytheon Production Corp., Newton, Mass.—receiving.
TAYLOR TUBES, INC., 2341 Wabansia Ave., Chicago, Ill.—transmitting.
Triad Mfg. Co., Inc., Pawtucket, R. I.—receiving.
Tung-Sol Lamp Works, Inc., Newark, N. J.—receiving.
UNITED ELECTRONICS CO., 42 Spring St., Newark, N. J.—transmitting and industrial control.
VACUTRON, INC., 20 W. 22 St., New York City—tubes, industrial control devices.
WESTERN ELECTRIC CO., 195 Broadway, New York City—transmitting, cathode-ray.
Westinghouse Elect. & Mfg. Co., Bloomfield, N. J.—industrial electronic tubes, photocells.
WESTON ELECT. INST. CORP., 612 Frelinghuysen Ave., Newark, N. J.—photocells.

Tubing, Spaghetti: Varnished Cloth, Mica

Acme Wire Co., New Haven, Conn.—varnished cambric, silk, paper.
Bentley Harris Mfg. Co., Conshohocken, Pa.
WILLIAM BRAND & CO., 276 4th Ave., New York City—mica films, tubing and saturated sleeving, varnished cloth, paper and tape.
Insulation Manufacturers Corp., Chicago, Ill.—varnished tubing and saturated sleeving.
MICA INSULATOR CO., 200 Varick St., New York City—varnished cloth, mica.

Tubing—Paper

The Cleveland Container Co., Cleveland, Ohio.
PARAMOUNT PAPER TUBE CO., 801 Glasgow Ave., Chicago, Ill.
Precision Paper Tube Co., Chicago, Ill.

Tuning Controls, Dials, Knobs, Etc.

ALADDIN RADIO INDUSTRIES, INC., 466 W. Superior St., Chicago, Ill.—push-button tuners.
The Alliance Mfg. Co., Alliance, Ohio—push-button tuning motors.
Aluminum Goods Mfg. Co., Manitowoc, Wis.—dials.

American Emblem Co., Inc., Utica, N. Y.—dials, scales, escutcheons, nameplates.
Crowe Name Plate & Mfg. Co., Chicago, Ill.—dials, nameplates.
CENTRALAB, Milwaukee, Wis.
Harry Davies Molding Co., Chicago, Ill.—knobs, dials.
Delco Appliance Division, Rochester, N. Y.
Dial Light Co. of America, New York City—pilot lights, pilot-light sockets, jewel assemblies.
DRAKE MFG. CO., 1713 W. Hubbard St., Chicago, Ill.—dial and jewel light assemblies.
Dual Remote Control Co., Wayne, Mich.—remote controls.
A. W. Franklin Mfg. Co., New York City—push-button tuners.
Gordon Specialties Co., Chicago, Ill.—nameplates, dials.
GUARDIAN ELECT. MFG. CO., 1625 W. Walnut St., Chicago, Ill.—tuning controls.
LITTELFUSE, INC., 4757 Ravenswood Ave., Chicago, Ill.—pilot lights.
P. R. MALLORY & CO., INC., 3029 E. Washington St., Indianapolis, Ind.—station selector switches, dial and panel lights.
Meissner Mfg. Co., Mt. Carmel, Ill.—push-button units, dials, remote-control units.
J. W. Miller Co., Los Angeles, Calif.—dials.
The Muter Co., Chicago, Ill.—push-button selector switches.
NATIONAL UNION RADIO CORP., 57 State St., Newark, N. J.—radio panel lamps.
Oak Manufacturing Co., Chicago, Ill.—push-button units.
OHMITE MANUFACTURING CO., 4835 W. Flournoy St., Chicago, Ill.—dials and knobs.
Premier Crystal Labs., Inc., New York City—pilot-light indicators.
Sprague Specialties, Inc., N. Adams, Mass.—push-button units.
F. W. Stewart Mfg. Corp., Chicago, Ill—remote-control units.
Tung-Sol Lamp Works, Inc., Newark, N. J.—radio panel lamps.
UTAH RADIO PRODUCTS CO., 812 Orleans St., Chicago, Ill.—tuning motors.

Varnishes, Lacquers, Compounds, Waxes, Etc.

Acheson Colloids Corp., Port Huron, Mich.
BAKELITE CORPORATION, 247 Park Ave., New York City.
Candy & Co., Inc., Chicago, Ill.
E. I. Du Pont De Nemours & Co., Wilmington, Del.
Durez Plastics & Chemicals, Inc., N. Tonawanda, New York.
Insulation Manufacturers Corp., Chicago, Ill.
Maas & Waldstein, Newark, N. J.
MICA INSULATOR CO., 200 Varick St., New York City.
The Zapon Co., Stamford, Conn.
ZOPHAR MILLS, INC., 120 26th St., Brooklyn, N. Y.

Washers

M. D. HUBBARD SPRING CO., 319 Central Ave., Pontiac, Mich.
SHAKEPROOF LOCK WASHER CO., 2533 N. Keeler Ave., Chicago, Ill.
Thompson-Bremer & Co., Chicago, Ill.
Wrought Washer Mfg. Co., Milwaukee, Wis.

Wire—Antenna, Hook-Up, Magnet, Etc.

Acme Wire Co., New Haven, Conn.
Acorn Insulated Wire Co., N. Y. C.
Alpha Wire Corp., New York City.
American Electric Cable Co., Holyoke, Mass.
Anaconda Wire & Cable Co., Chicago, Ill.
Belden Mfg. Co., Chicago, Ill.
CONSOLIDATED WIRE & ASSOC. CORPS., 522 S. Peoria St., Chicago, Ill.
Cornish Wire Co., Inc., 15 Park Row, N. Y. C.
Crescent Insulated Wire & Cable Co., Trenton, N. J.
General Cable Corp., New York City.
HOLYOKE WIRE & CABLE CORP., 230 Main St., Holyoke, Mass.
LENZ ELECTRIC MFG. CO., 1751 N. Western Ave., Chicago, Ill.
Phelps Dodge Copper Products Corp., Los Angeles, Calif.
Wheeler Insulated Wire Co., Bridgeport, Conn.

Wire—Resistance

SIGMUND COHN, 44 Gold St., N. Y. C.
Driver-Harris Co., Harrison, N. J.
WILBUR B. DRIVER CO., 150 Riverside Ave., Newark, N. J.
HOLYOKE WIRE & CABLE CORP., 230 Main St., Holyoke, Mass.
Hoskins Mfg. Co., Detroit, Mich.

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ISBELL RETIRES

Arthur Isbell, Manager of the Commercial Department of R.C.A. Communications, at 66 Broad Street, New York, N. Y., retired on September 29 after thirty-seven years in radio work. During his career he saw the major development of the art from the days of the coherer and open spark gap, with distances of a hundred miles considered remarkable, to the marvels of today, with the vacuum tube ubiquitous in all forms of radio and sound engineering, and with distances already up to the limit of terrestrial geography.

Isbell worked for the de Forest Wireless Telegraph Company, the National Electric Signaling Company, the Massie Wireless Telegraph Company, the Wireless Telegraph Co., Ltd., of Hawaii, the United Wireless Company, the Marconi Wireless Telegraph Company of America, and the Radio Corporation of America. During the World War he was an Expert Radio Aid in the Bureau of Engineering, Navy Department, in full charge of settling all accounts between the Government and the various radio companies whose business was taken over by the Navy at the outbreak of the war.

TELEVISION ECONOMICS

(*Continued from page* 23)

adequate, it has been customary to produce the "shooting script" (which resembles a "prompt sheet"), this work being carried out by specially trained and experienced writers. All necessary "business" is here included in detail to minimize rehearsal time, and this is particularly desirable for television purposes. In motion-picture production, the scenes are "shot" in the most convenient or economical sequence principally from the viewpoint of stage facilities, actor availability, and utilization of sets, but in television with direct pick-up the scenes must necessarily be shot in their correct sequence. In one European country, the camera positions are worked out on a scale floor plan of the studio, on which are shown as well the sets, properties, and main camera angles. Tracking of cameras to new positions is also shown. Rehearsals are carried out with dummy cameras in small outside studios prior to the single dress rehearsal. Communication with the actors at rehearsal is by means of loudspeakers from the director's desk. A central position for the camera boom is generally selected such that the boom need not be moved during the play. In common with the motion picture, television broadcasters will face the problem of allowing sufficient time for audience laughter after comic situations—an always vexatious problem. It is common motion-picture practice to indicate in the script all camera angles but not to set them accurately since the camera men and director must be given leeway. Even greater flexibility may be desirable in this regard for television, although camera positions must be carefully rehearsed.

(*To be continued*)

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TIME AND WEATHER

(*Continued from page* 14)

track. Being done mechanically, the cut is clean, with the points of demarcation between the opaque and transparent portions being very sharply defined. The opaque portions have a very high density while the transparency of the clear portion is most uniform. With this special cutting device, it is possible to record up to 10,000 cycles per second, with a power consumption of only two watts.

Unique about this system is that, first, more than one track can be recorded on the same piece of film. Cutting and re-recording can be done from the original. It is not necessary to enter a dark-room to load the film magazines, since this is not a photographic process, and therefore light does not affect the film.

The film is wound on a metallic hub, and at a swift glance it has the appearance of several wax records piled up.

To play back, the film is fed through an optical system, at a speed of 60 feet a second, with the resultant impulses being fed into a quality amplifier.

The high fidelity characteristics of this system are most unusual. In playback tests, it was difficult to distinguish the recorded version from the live transmissions, by either the ear or meter test.

One popular radio station in the East is now using this system in an automatic announcing method . . . for station letters and location. Other similar projects are in the planning. With the many properties this film tape system offers, it is easy to see how effective a tool it will be for public services as *Weather* forecasting.

Wherever Mr. and Mrs. Public have had the good fortune to have *Time-Weather* and other public information services offered them, the utmost of enthusiasm has been shown. In fact, they have become so accustomed to this form of service that it has become part and parcel of their daily program.

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