
JULY • 1944
electronics
A McGRAW-HILL PUBLICATION

electronics

JULY • 1944

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CHANGE OF ADDRESS

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Director of Circulation:
Please change my address on Electronics

From ....

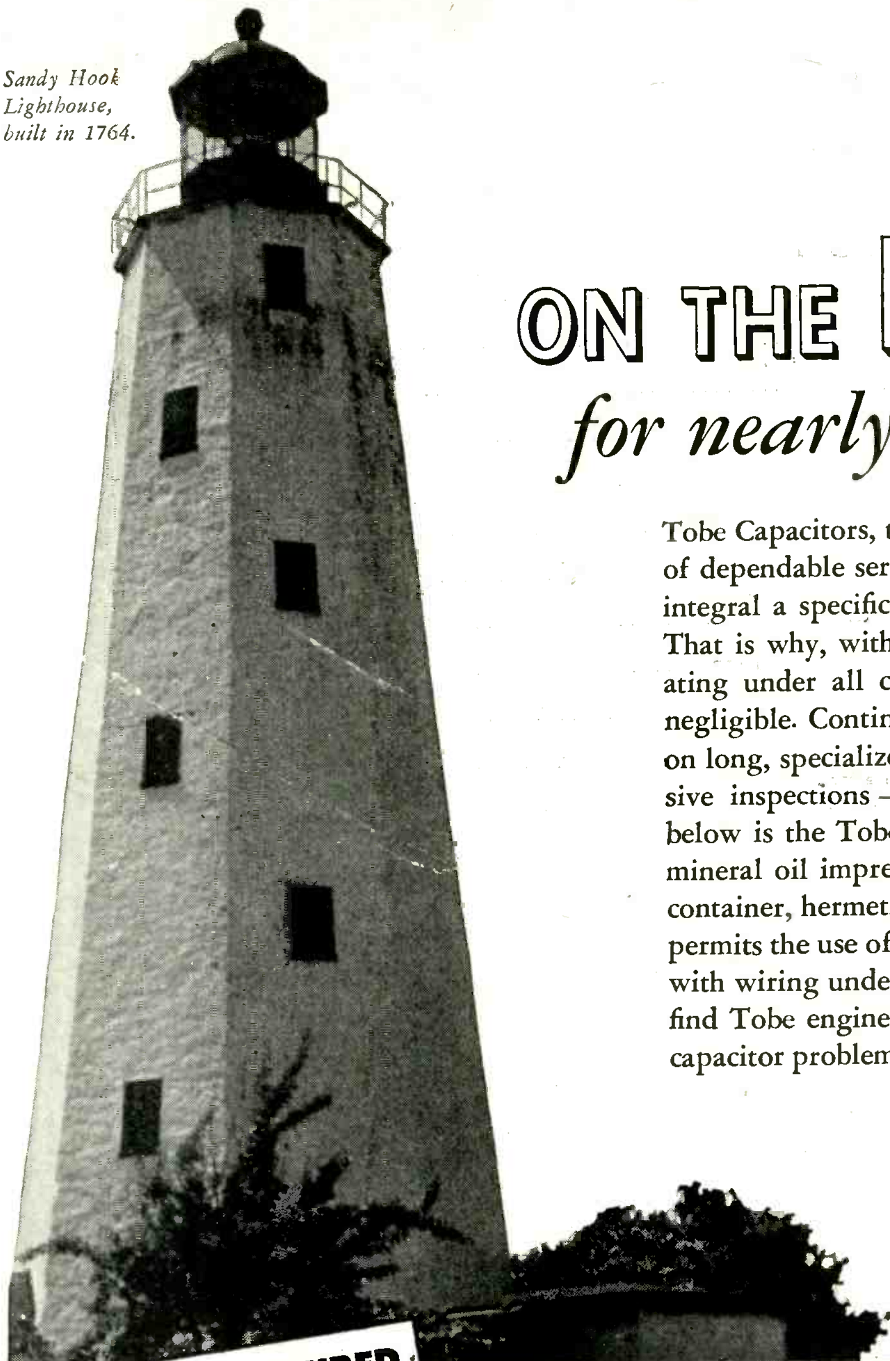
....

To ....

....

Signed ....

Sandy Hook Lighthouse, built in 1764.



ON THE BEAM—

for nearly two centuries

Tobe Capacitors, too, are "on the beam"—giving years of dependable service . . . for, at Tobe, *long life* is as integral a specification as the dimensions themselves. That is why, with millions of Tobe Capacitors operating under all conditions, "returns" are practically negligible. Continuation of this enviable record rests on long, specialized manufacturing experience—intensive inspections — and constant research. Illustrated below is the Tobe OM-Capacitor. This capacitor is a mineral oil impregnated unit in a streamlined drawn container, hermetically sealed. The hold-down bracket permits the use of either inverted or upright terminals, with wiring underneath or on top of chassis. You will find Tobe engineers ready to cooperate on your own capacitor problems. Why not inquire now?

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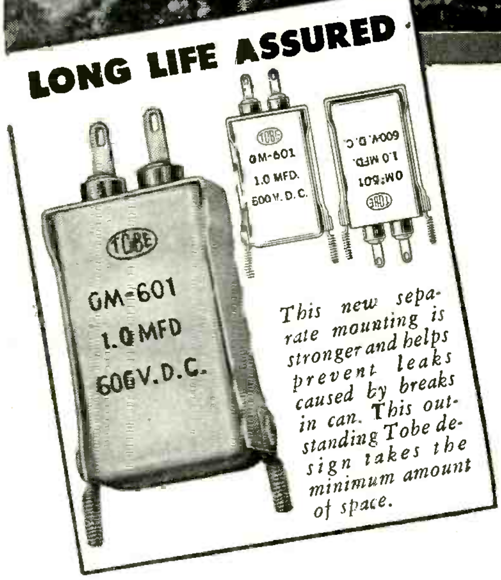


SPECIFICATIONS

OM-CAPACITORS

TYPE	OM-*
RATINGS	.05 to 2.0 mfd. 600 V. D. C. .05 mfd. to 1.0 mfd. 1,000 V. D. C.
STANDARD CAPACITY TOLERANCE	20%**
TEST VOLTAGE	Twice D. C. rating
GROUND TEST	2,500 Volts D. C.
OPERATING TEMPERATURE	-55° F to 185° F
SHUNT RESISTANCE	.05 to 0.1 mfd. 20,000 megohms .25 to 0.5 mfd. 12,000 megohms 1.0 to 2.0 mfd. 12,000 megohms
POWER FACTOR	At 1,000 cycles—.002 to .005
CONTAINER SIZE	Width ⅝", length 1$\frac{5}{16}$", height 2¼"
MOUNTING HOLE CENTERS	1½"

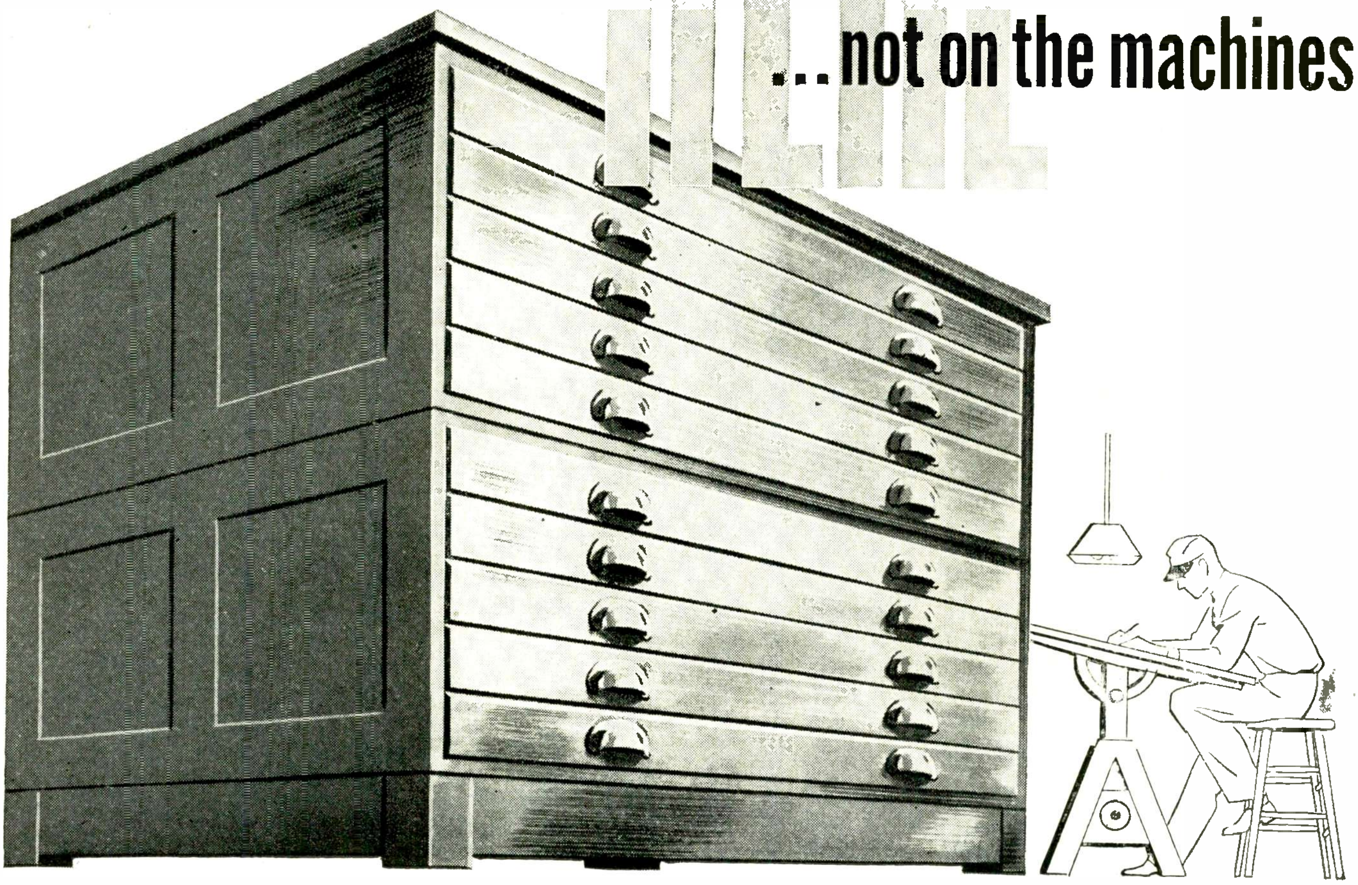
MIDGET OM-CAPACITORS

TYPE	OMM-*
RATINGS	.05, .1 and 2 x .05 600 V. D. C. .05 x .1 1000 V. D. C.
STANDARD CAPACITY TOLERANCE	20%**
GROUND TEST	2,500 V. D. C.
OPERATING TEMPERATURES	-55° F to 185° F
SHUNT RESISTANCE	20,000 megohms
POWER FACTOR	At 1,000 cycles—.0075
CONTAINER SIZE	Width ⅝", length 1$\frac{5}{16}$", height 1$\frac{11}{64}$"
MOUNTING HOLE CENTERS	1½"

*Data sheets showing complete code number for units having a specific capacitance value and voltage rating available on request. **Other tolerances available.

A SMALL PART IN VICTORY TODAY...A BIG PART IN INDUSTRY TOMORROW

Your originals belong HERE ...not on the machines



PENCIL originals are precious, but even when they are new they often give unsatisfactory shop prints. When they are handled, they wear and blur. Prints made from them get cloudier still.

So use your pencil originals only once—to make PHOTACT Prints with *ink-intense* lines on PHOTACT Tracing Paper or Cloth.

Then make all the blueprints, blue or blackline prints or brownprint negatives you need from your PHOTACT Prints. They will be more legible than any made from the average pencil original.

For full information, write on your letterhead to PHOTACT Department, Keuffel & Esser Co., Hoboken, N. J.

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WESTINGHOUSE ELECTRONIC TUBES . . . . DOING A JOB ON

This cab no longer

THESE WESTINGHOUSE TUBES NOW AVAILABLE IN LIMITED QUANTITIES

WL-195	Pliotron	WL-632A	Thyratron	WL-681/686	Ignitron
WL-196	Pliotron	WL-651/656	Ignitron	WL-710	Ballast Tube
WL-463	Pliotron	WL-652/657	Ignitron	WL-788	Ballast Tube
KU-610	Thyratron	WL-655/658	Ignitron	WL-857B	Phanotron
KU-627	Thyratron	WL-672	Thyratron	WL-892	Pliotron
KU-628	Thyratron	KU-676	Thyratron	WL-895	Pliotron
KU-629	Thyratron	WL-677	Thyratron	WL-896	Ballast Tube

EVERY FRONT, IN EVERY BATTLE, IN EVERY WAR INDUSTRY

waits at 3 A.M...

A certain type of Westinghouse Electronic Tube was urgently needed in England. Every night, as the last lot came off the test rack at our Bloomfield Plant, we had a cab waiting, ready to rush it to the airport for bomber ferry across the Atlantic. Today, things are different. Engineering ingenuity and a vast program of plant expansion have multiplied Westinghouse Electronic Tube production 30 times. We've trained 28 new workers for each one formerly employed, expanded floor space 20 times. And now we're not only meeting time and quality musts on all Government contracts—we're also continuing to supply the heavy demands of war industry.

Your nearest Westinghouse Office or Distributor will be glad to receive your inquiries for Westinghouse Tubes. Westinghouse Electric & Manufacturing Company, Bloomfield, N. J.

Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

Quality Controlled ELECTRONIC TUBES

WESTINGHOUSE PRESENTS JOHN CHARLES THOMAS • SUNDAY 2:30 EWT., N.B.C. ★ TOP OF THE EVENING • MON. WED. FRI. 10:15 EWT., BLUE NET.


TORQUE
Hammarlund precision variable capacitors have just the right amount of TORQUE, to permit smooth and accurate adjustment. You don't have to fight rough and jumpy action when you tune with Hammarlund variables.
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SMALLEST PAPER CAPACITOR - - -
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TYPE P5N
TYPE P4N
FEATURES
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2. Non-Inductive.
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4. Very high leakage Resistance.
5. Fine Power-Factor.
6. Range from 20 MMFD to .25 MFD. From 150 volts to 600 volts.
7. Types P4N, P5N for 100% humidity operation.
8. Types P4, P5 for 95% humidity operation.
Samples and price list on Request
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BUY EXTRA WAR BONDS . . .
. . . 'Til THE WAR IS OVER.
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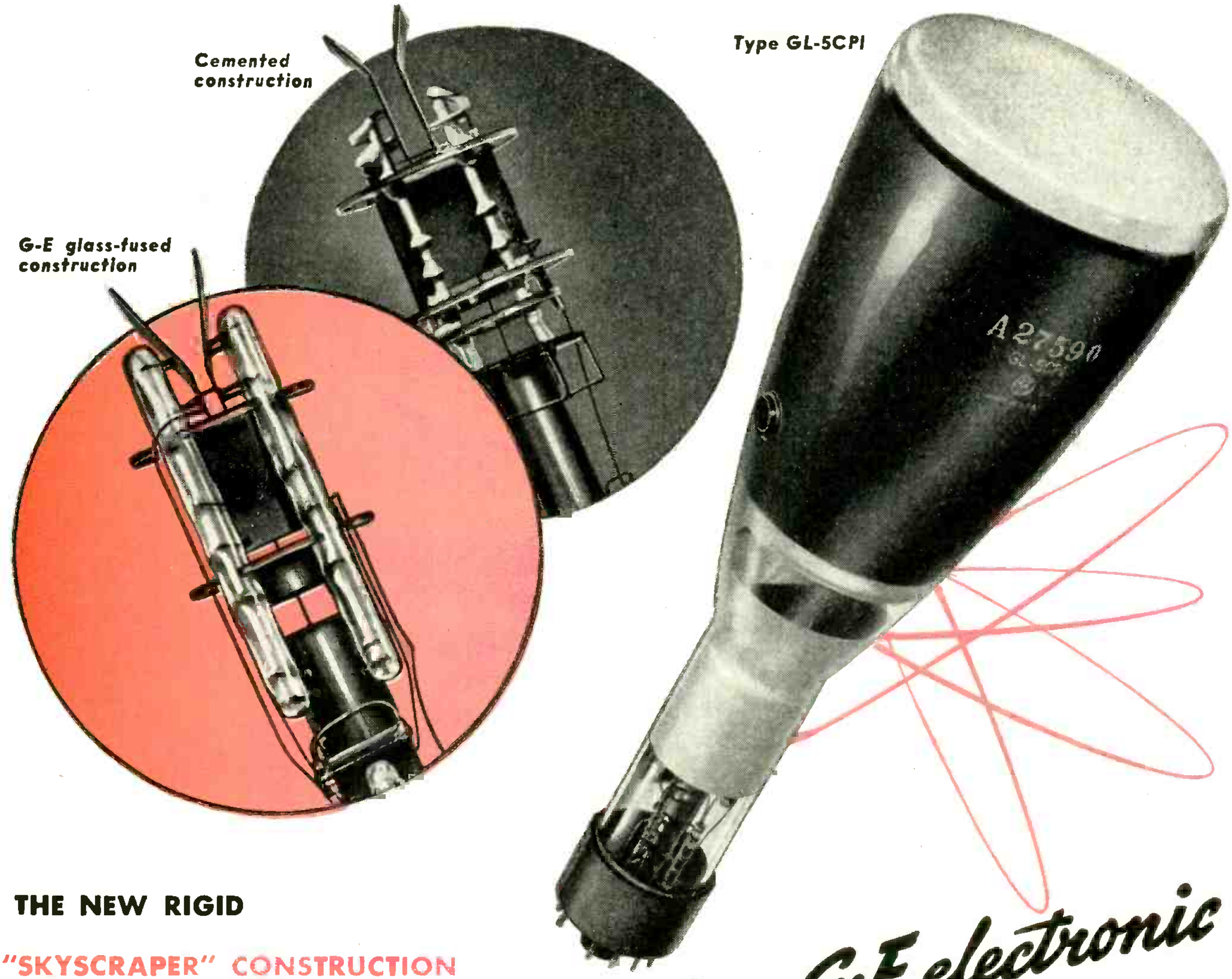


THE NEW RIGID "SKYSCRAPER" CONSTRUCTION OF G-E CATHODE-RAY TUBES KEEPS THE ELECTRON GUN SHOOTING STRAIGHT

another G·E electronic **FIRST!**

GENERAL ELECTRIC originated the unique type of "skyscraper" construction which today is used in all G-E cathode-ray tubes. Here the electron gun, which is the heart of the tube, is mounted *rigidly* so it will position the electron beam accurately throughout the life of the tube.

In this G-E "skyscraper" construction, supporting arms are *welded* to the gun assembly, then solidly fused into uprights of strong, clear glass. No cemented construction! No rough, porous or soluble insulating materials to pick up, during assembly, particles of metal that contribute to leakage; or to retain gases that detract from the performance and life of the tube! No cemented parts to become loose in the process of cleaning or under vibration in service! . . . Instead, hard mirror-smooth glass that can be thoroughly cleaned of all contamination before the tube is sealed!

WRITE for descriptive literature on G-E cathode-ray tubes. We will be glad to help you in solving your application problems. *Electronics Department, General Electric, Schenectady, N. Y.*

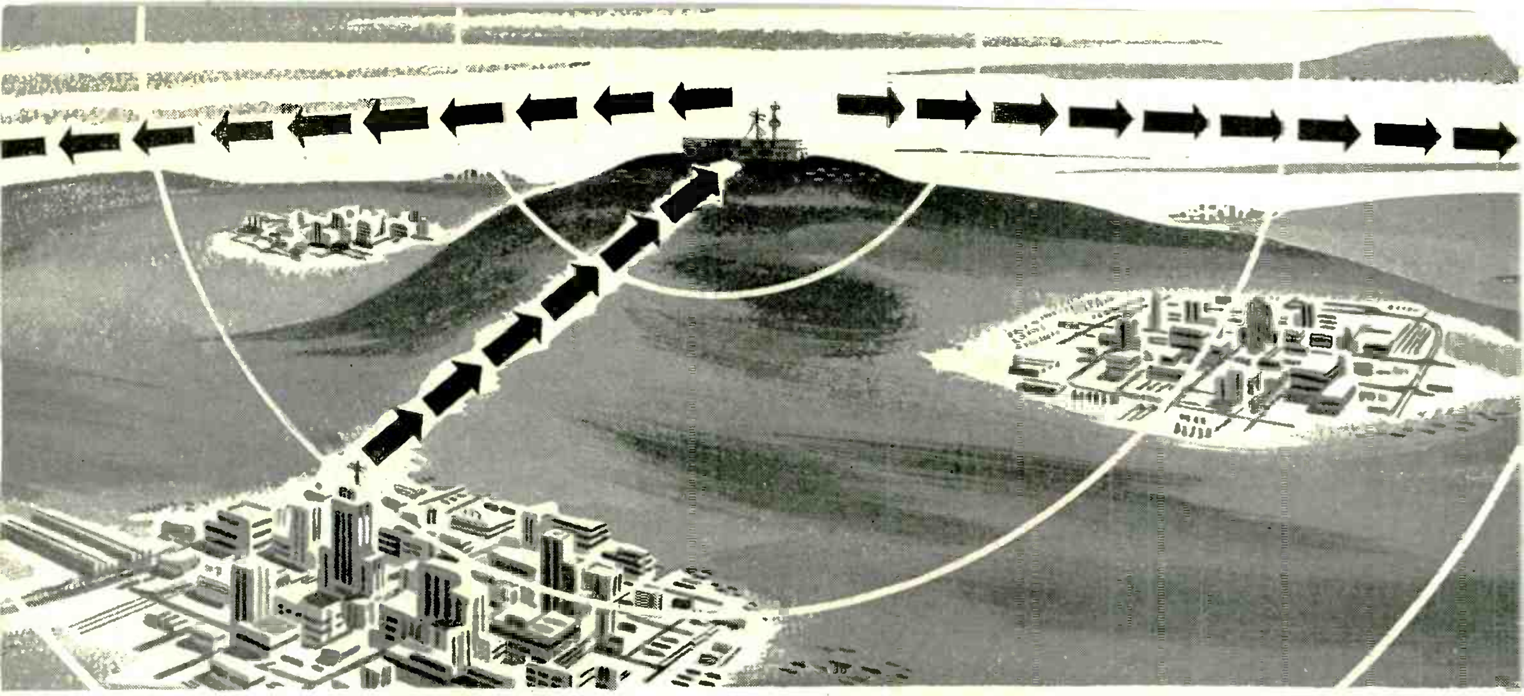
G-E TUBES ARE FIRST IN INDUSTRY, TOO! The G-E phototube, or "electric eye," for instance, performs amazing tasks of counting, sorting, grading, maintaining precise register in printing, detecting flaws in sheet metal, actuating safety devices, and many other functions.

● *Tune in* "The World Today" *every evening except Sunday at 6:45 E.W.T. over CBS. On Sunday listen to the G-E* "All Girl Orchestra" *at 10 P. M. E.W.T. over NBC.*

G. E. HAS MADE MORE BASIC ELECTRONIC-TUBE DEVELOPMENTS THAN ANY OTHER MANUFACTURER

GENERAL ELECTRIC

161-C5



S-T Directional Relay Antenna

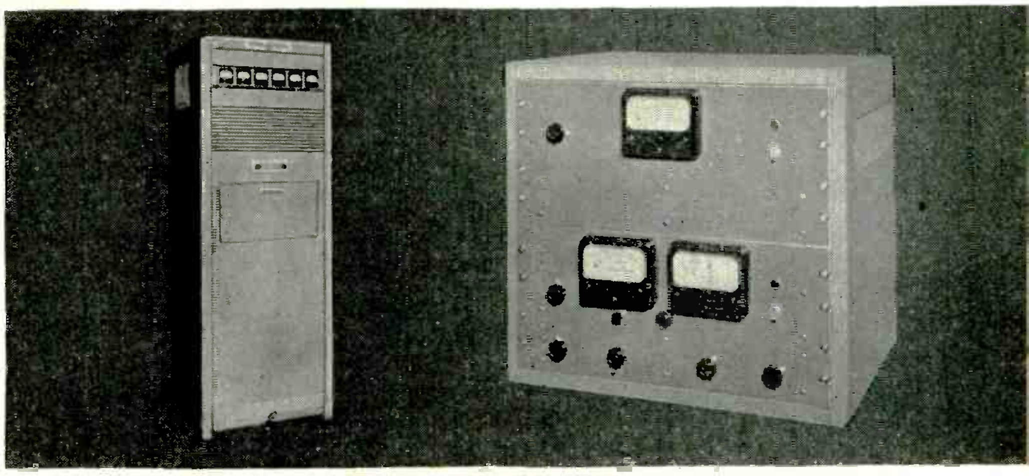
FM Broadcast Antenna

160-C9

Locate your transmitter for maximum coverage

Locate your studio for maximum convenience

Bridge the gap without wires



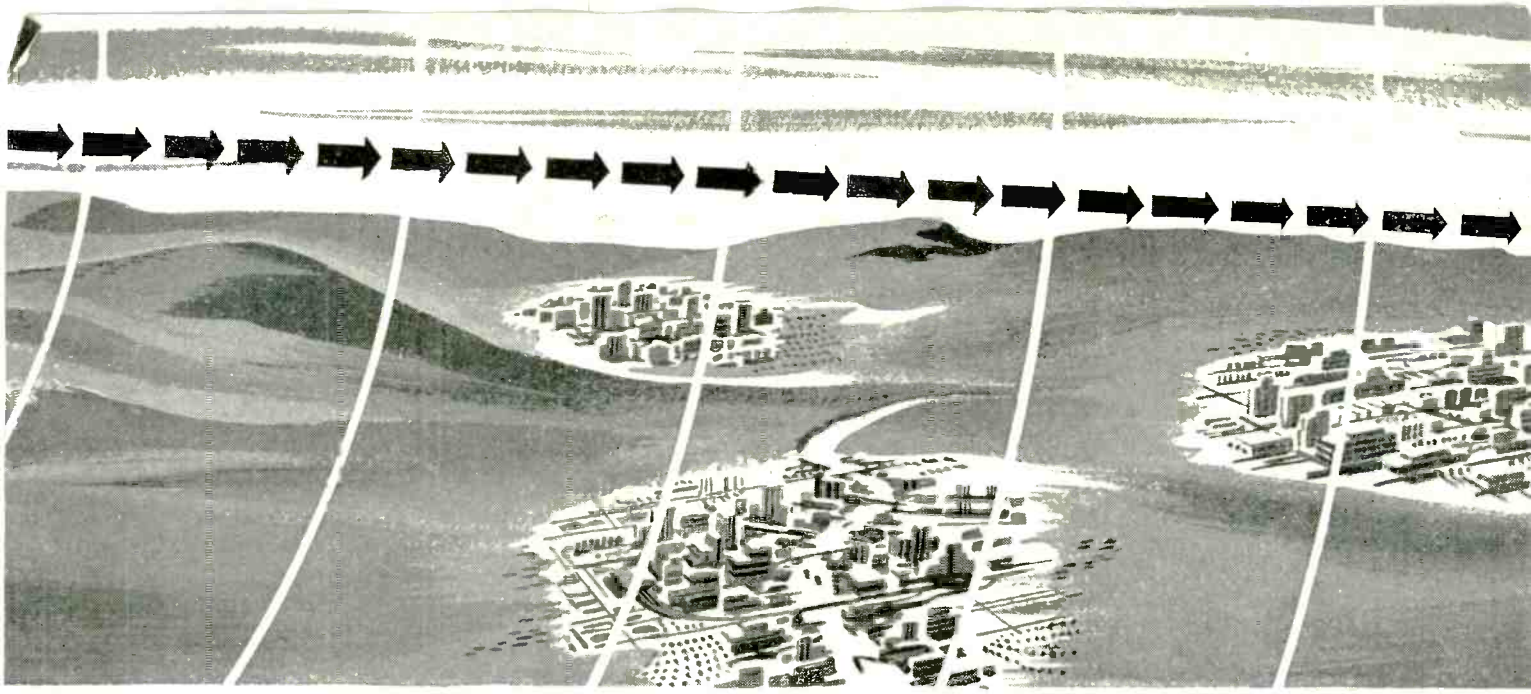
S-T Relay Transmitter (25-watt)

Station Monitor and Converter

• *Tune in General Electric's "The World Today" and hear the news from the men who see it happen, every evening except Sunday at 6:45 E.W.T. over CBS network. On Sunday evening listen to the G-E "All Girl Orchestra" at 10 E.W.T. over NBC.*

STATION AND STUDIO EQUIPMENT • TRANSMITTERS • ELECTRONIC

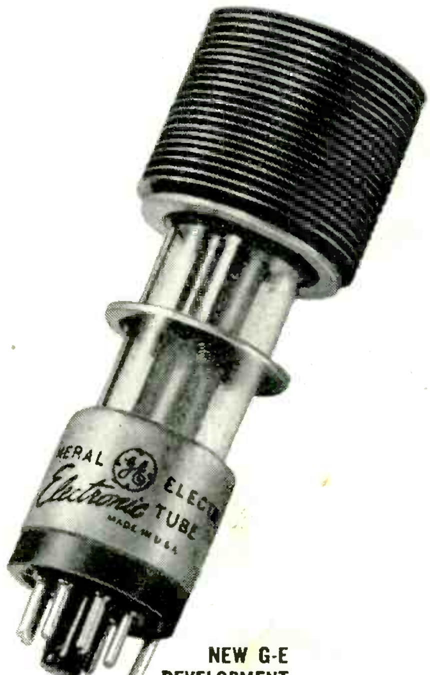
GENERAL ELECTRIC



THROUGH proved performance in the six already established relay systems, G-E *S-T* (studio-to-transmitter) relay equipment offers a practical method by which you can reliably and economically relay your FM programs from studio to transmitter.

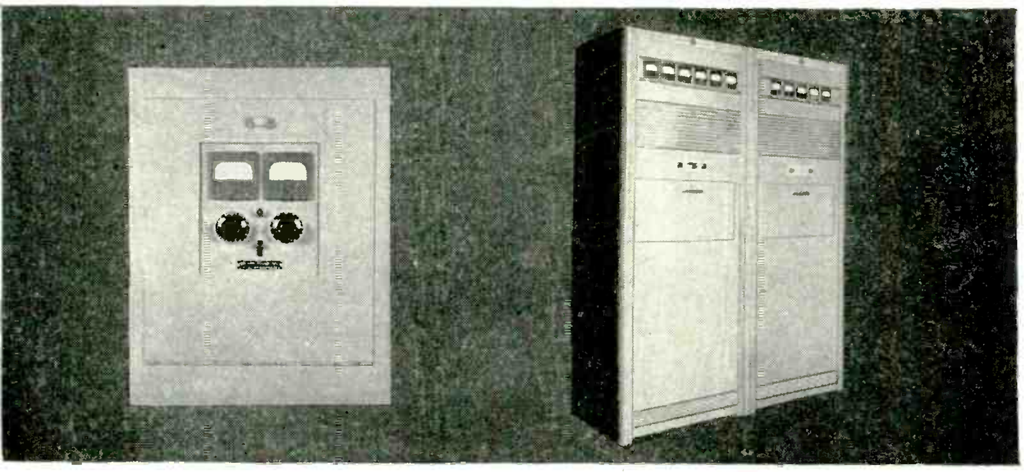
Extremely high fidelity, low noise level and a virtual absence of distortion are additional advantages of this exclusive G-E equipment. Completely dependable, too! Rain, sleet, floods or windstorms have no effect on this unique system "without wires." Distance is not a problem, for G-E *S-T* equipment is now reliably functioning up to airline distances of as much as 110 miles.

The G-E *S-T* relay transmitter is of the economical low-power rating of 25 watts. The G-E directional *S-T* relay antenna beams the signals to a receiving antenna of the same type at your G-E broadcast transmitter location. The total power gain of this system is 100. Thence, with full fidelity and further power gain, the programs go out over your service area through the easily tuned G-E circular broadcast antenna. . . . G-E *S-T* equipment is low in initial cost and economical to operate. Write for details, and information. Our engineers will be glad to discuss your problems with you. *Section 3-D, Electronics Department, General Electric, Schenectady, N. Y.*



NEW G-E DEVELOPMENT

The G-E disk-seal tube, an ultra-modern transmitting type, makes possible radio relaying of FM and television programs at very high frequencies. It will be used in post-war studio-to-transmitter and network relays.



S-T Receiver | *FM Broadcast Transmitter (1000-watt. Others 250-watt to 50-kw)*

50 FM STATIONS ARE ON THE AIR—157 APPLICATIONS ARE PENDING

Now is the time to plan your FM station. The "G-E Equipment Reservation Plan" enables you to obtain a post-war priority and early delivery on equipment. Send for it and descriptive literature on FM—today.

TUBES • ANTENNAS • RECEIVERS

FM—television—AM

See G.E. for all three!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AAC
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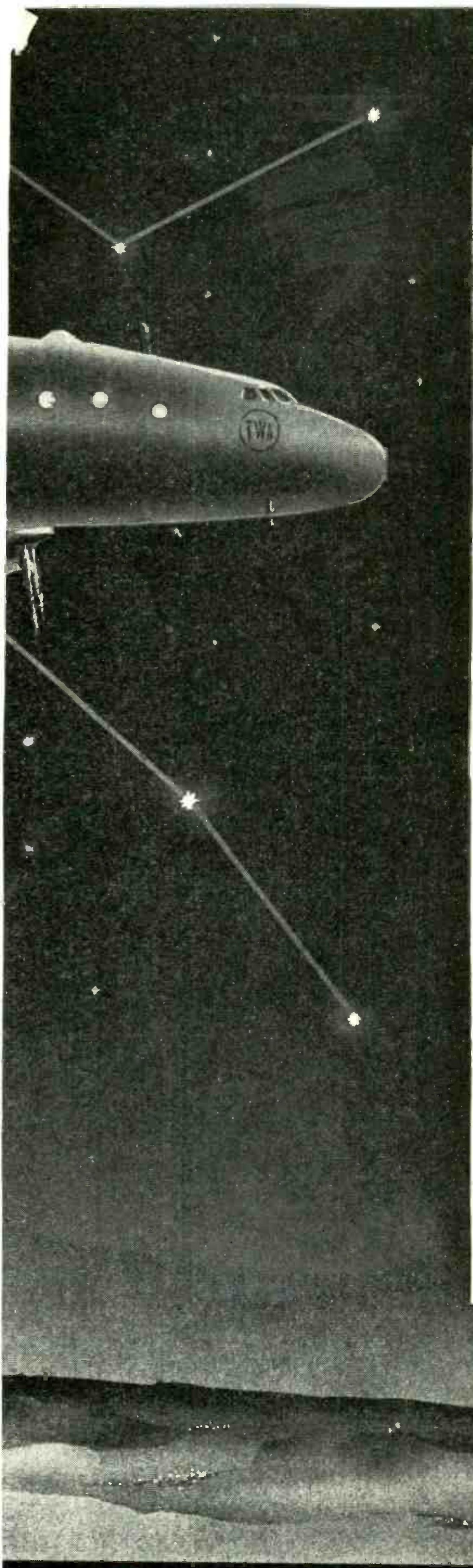

A Constellation is composed of many Stars

THERE'S a new constellation in the skies, a star of stars...a new master of the heavens. This great ship, conceived by TWA...built by Lockheed, holds a mighty promise, a promise of tremendous developments in peacetime air transport. We are proud to share in its record-breaking glory and in its promise... proud that AAC Hydraulic Controls are among the many stars which make up this Constellation. These precision units are another mark of AAC leadership in Engineered Power Controls...in the air, on land, and on the sea.

(P-74)

POWER CONTROLS DIVISION

BURBANK, CALIFORNIA

ACCESSORIES CORPORATION

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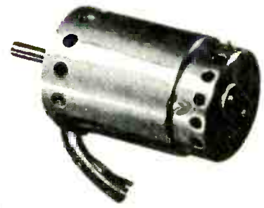
EAD

SPECIALIZED FRACTIONAL H. P. MOTORS

MODEL J31A

(for high ambient temperatures)

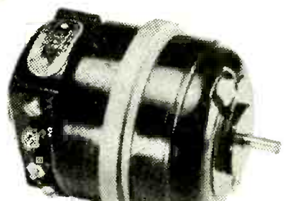
400 Cycles, 115 Volts. 1/100 H.P. Weight 15 oz. Diameter $1\frac{15}{16}$". Length $2\frac{29}{32}$".



MODEL J31

(for general applications)

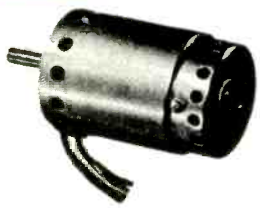
400 Cycles, 115 Volts, 1/50 H.P. Weight 15 oz. Diameter $1\frac{15}{16}$". Length $2\frac{29}{32}$".



MODELS J36 AND J36A

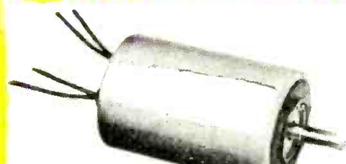
Voltage Generator, Weight 20 oz. Length 3". Diameter $2\frac{1}{4}$". Output voltage is linear with speed to within $\pm 1\%$ and voltages are equal with $\pm 1\%$ of rotation.

J36—From Zero to 5000 R.P.M.
J36A—under 200 R.P.M.



MODEL J31B

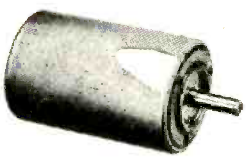
400 to 1200 Cycles variable frequency 115 Volts. 15 oz. Diameter $1\frac{15}{16}$". Length $2\frac{29}{32}$".



MODELS J49 AND J49A

115 Volts, 1/250 H.P. Weight 16 oz. Diameter $1\frac{3}{4}$". Length $2\frac{11}{16}$".

J49—60 Cycles
J49A—400 Cycles



MODEL J61

28 Volts D.C. Torque unit. Developes 5 oz. in. throughout 90° swing. Diameter $1\frac{3}{4}$". Length $2\frac{11}{16}$".

CENTRIFUGAL BLOWER UNITS

MODEL J-50 BLOWER UNIT

60 CYCLES 115 VOLTS

Delivers 10 cu. ft. per minute of free air. Weight 21.5 oz. Overall diameter $3\frac{11}{16}$". Overall length $4\frac{1}{16}$".

MODEL J51—400 CYCLES, 115 VOLTS. Delivers 22 cu. ft. per min. of free air. Weight: 21.5 oz., Diameter $3\frac{11}{16}$", Length $4\frac{9}{32}$".

MODEL J52—400 TO 1200 CYCLES VARIABLE FREQUENCY. 115 Volts. Delivers 17 cu. ft. per min. of free air. Diameter $3\frac{11}{16}$". Length $4\frac{1}{16}$".

MODEL J53—28 VOLTS D.C. Delivers 22 C.F.M.

MODEL J54 (Midget)—60 CYCLES, 115 VOLTS Delivers 6 C.F.M.

MODEL J55 (Midget)—400 CYCLES, 115 VOLTS. Delivers 13 C.F.M.

EASTERN AIR DEVICES, INC.
An Affiliate of The Fred Goat Co., Inc., Est. 1893
585 DEAN STREET, BROOKLYN 17, N. Y.

GOOD NEWS FOR TELEVISION!

Since National Union established new production records on cathode-ray tubes—the dream of low-cost television for the average post-war home has taken a long step toward fulfillment.

Consider the fact that National Union has succeeded in raising its cathode-ray tube production to a volume many times greater than the combined pre-war C-R tube output of the entire industry! To achieve such a production miracle required, of course, completely new techniques, new mechanical aids to operators, new quality control measures. But above all, it required imagination and technical capacity to cut loose from the long prevalent conception that the manufacture of cathode-ray tubes was strictly a laboratory project. N. U. engineers proved that these laboratory techniques *could* be adapted to high speed streamline mass production. And, it is significant that N. U. C-R tubes have acquired at the same time an international quality reputation, with special distinction for their superior fluorescent screens.

In the post-war expansion of television, as in other applications of electronic tubes for home and industry, National Union achievements in engineering and production have set new horizons. Remember to *count on* National Union.

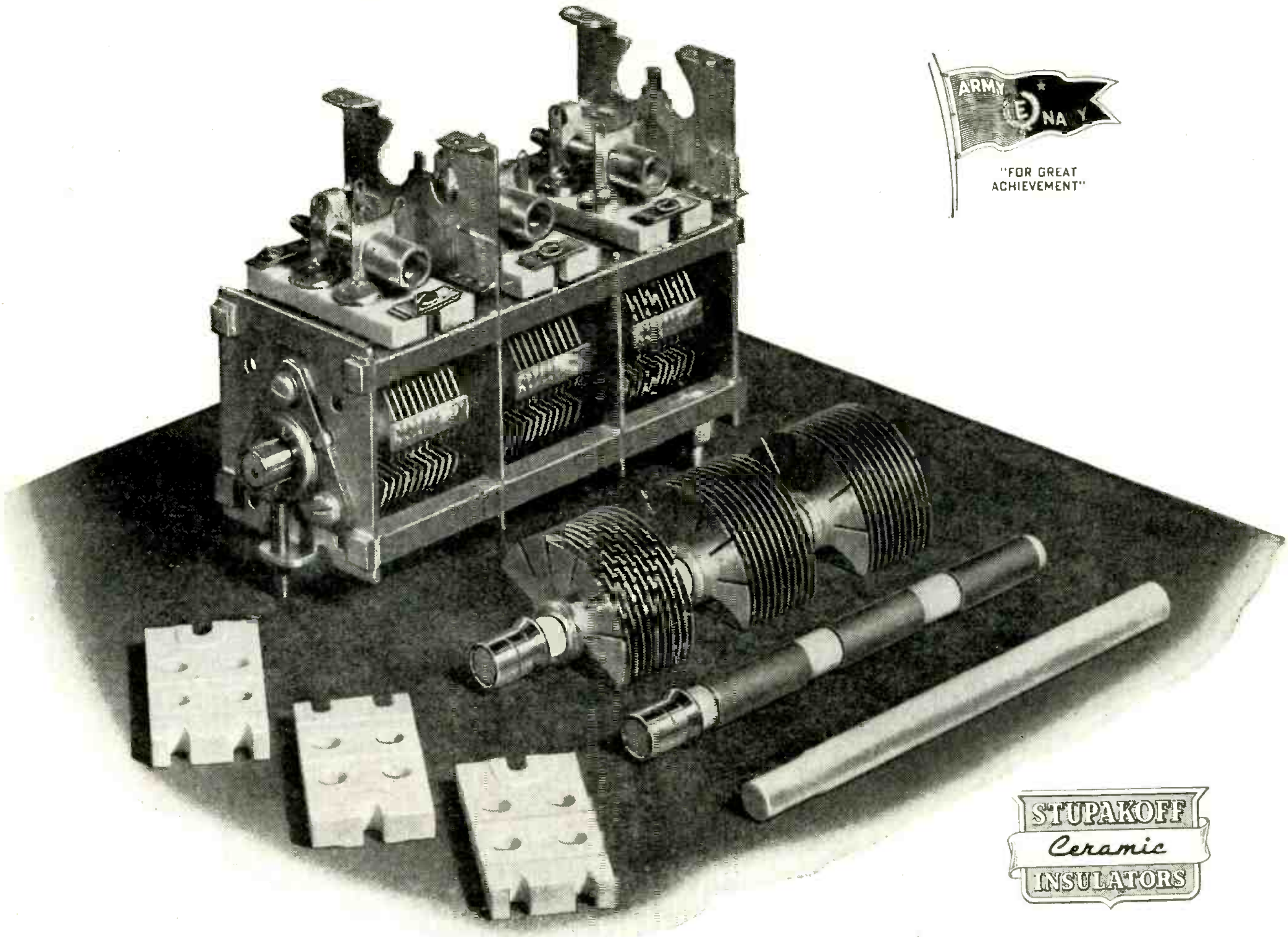
NATIONAL UNION RADIO CORPORATION, NEWARK, N. J.
Factories: Newark and Maplewood, N. J.; Lansdale and Robesonia, Pa.

NATIONAL UNION
RADIO AND ELECTRONIC TUBES

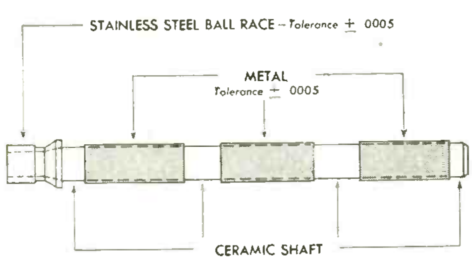
Transmitting, Cathode Ray, Receiving, Special Purpose Tubes • Condensers • Volume Controls • Photo Electric Cells • Panel Lamps • Flashlight Bulbs

The Trend is to . . .

CERAMIC-METAL SUB ASSEMBLIES



Condenser Courtesy of General Instrument Corporation



ILLUSTRATED is a "precision condenser" equipped with Stupakoff insulators and metallized ceramic sub-assembly.

This metallized ceramic rotor shaft is only one of many extremely accurate sub-assemblies produced by Stupakoff.

Correctly engineered, laboratory perfected and converted to large scale production, such parts offer optimum electrical and mechanical characteristics.

Use our experience to solve your special problems. Write, wire or phone—our engineering and production facilities are ready to serve you promptly.

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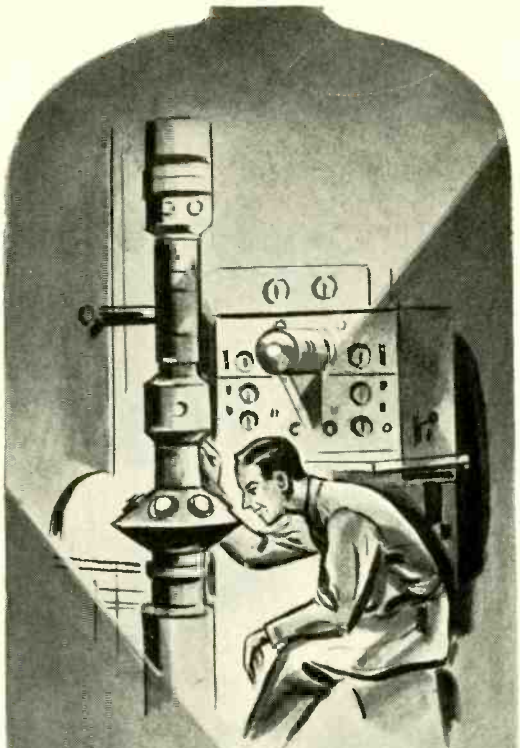
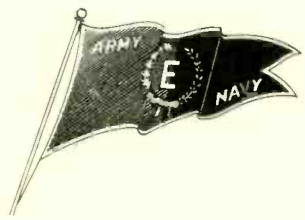
Products for the World of Electronics

STUPAKOFF CERAMIC AND MANUFACTURING CO., LATROBE, PA.


Working Today...
to Smooth the Path of Flight Tomorrow
Only imagination now limits the extent to which new electronic communication developments will serve to smooth the path of future flight. Amazing applications of electronics to air communications have already brought new methods of aircraft control to aid our gallant airmen in war. Advancements to come will bring the greatest safety, convenience and economy in aviation the world has ever known! Air Communications, Inc. is proud to be a recognized member of the industry that is constantly working toward that goal.
Today many precision-built Air Communications products are serving a fighting America. Equipment that calls for almost unbelievable accuracy, some parts of which must be perfect to 1/10,000th of an inch, is continually rolling off our assembly lines. Our engineers are busy designing other important devices to aid aviation now and in the future.
After victory, our complete facilities will be utilized to further the advancement of air communications. In the meantime, our cooperative engineering is available to help you solve your engineering problems of the future.
Designing, Engineering and Building for Victory...and for the Future
AIR COMMUNICATIONS, INC.
KANSAS CITY 8, MISSOURI
Keep Buying
WAR BONDS
For Victory





E-E Electronic Vacuum Tubes..

..lenses for visioneering!

The versatility of the science of electronics is best exemplified in the field of optical endeavor. Colossal telescopes and powerful microscopes had extended human vision to the limits of the capability of the rays of light themselves. It seemed the ultimate had been reached. Then came electronics. Brilliant minds and tireless researchers wrought new miracles. Today, Television, the X-Ray and the Electronic Microscope bring new horizons into focus, with the challenging promise of better things to come.

The Engineering Department of ELECTRONIC ENTERPRISES offers complete collaboration in the solution of your present or post-war electronic problems. For information on E-E power transmitting and rectifying vacuum tubes, write for the new E-E data book. No obligation will be incurred.

Illustration of Type 371-B Half Wave High Vacuum Rectifier Peak Inverse Voltage 25,000 Peak Plate Current 1.5 Amp.

ELECTRONIC ENTERPRISES, INC.

GENERAL OFFICES: 65-67 SEVENTH AVENUE, NEWARK, 4, N. J.
EXPORT DIVISION: 25 WARREN STREET, NEW YORK, 7, NEW YORK
CABLE ADDRESS: SIMONTRICE NEWYORK

ELECTRONIC e ENTERPRISES

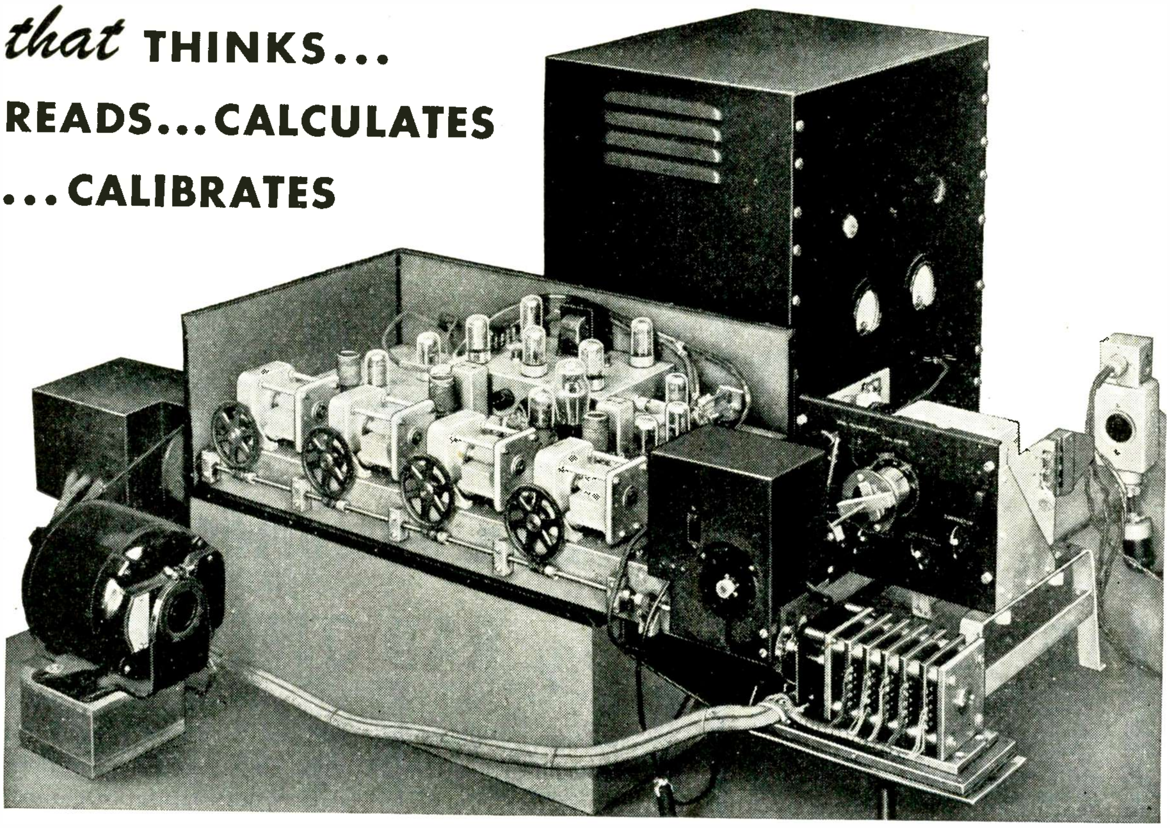
Electronic Wizardry

Philco Engineers Create a "Master Mind"

that **THINKS...**

READS...CALCULATES

...CALIBRATES



AMONG PHILCO'S many contributions to the war effort was the creation of the electronic "master mind" pictured here. Last year alone, it saved 144,000 man-hours of labor and, with other economies, reduced the cost of one type of radio equipment to the Government by $1,170,000.

Perfected only after many months of exhaustive research and development by Philco engineering ingenuity, this device replaced a tedious and intricate hand calibrating operation, which was slow and subject to human error. Employing 126 tubes, the Philco *"Master Mind"* can "think," calibrate, calculate, and record dial readings many times faster than any human being—at a great saving of time and without danger of error.

Another example of Philco research and engineering "know-how" which, while fulfilling emergency war needs, promises important peacetime applications in industry after Victory!

PHILCO

CORPORATION

FASTEN ALUMINUM WITH ALUMINUM

Send for this new catalog . . . it's Free

Standard aluminum fastening devices, manufactured by Alcoa in various alloys of Alcoa Aluminum, meet the rigid requirements of the many industries assembling aluminum products. A high degree of precision is maintained. They contribute security, light weight, ease of handling, fine appearance and corrosion resistance.

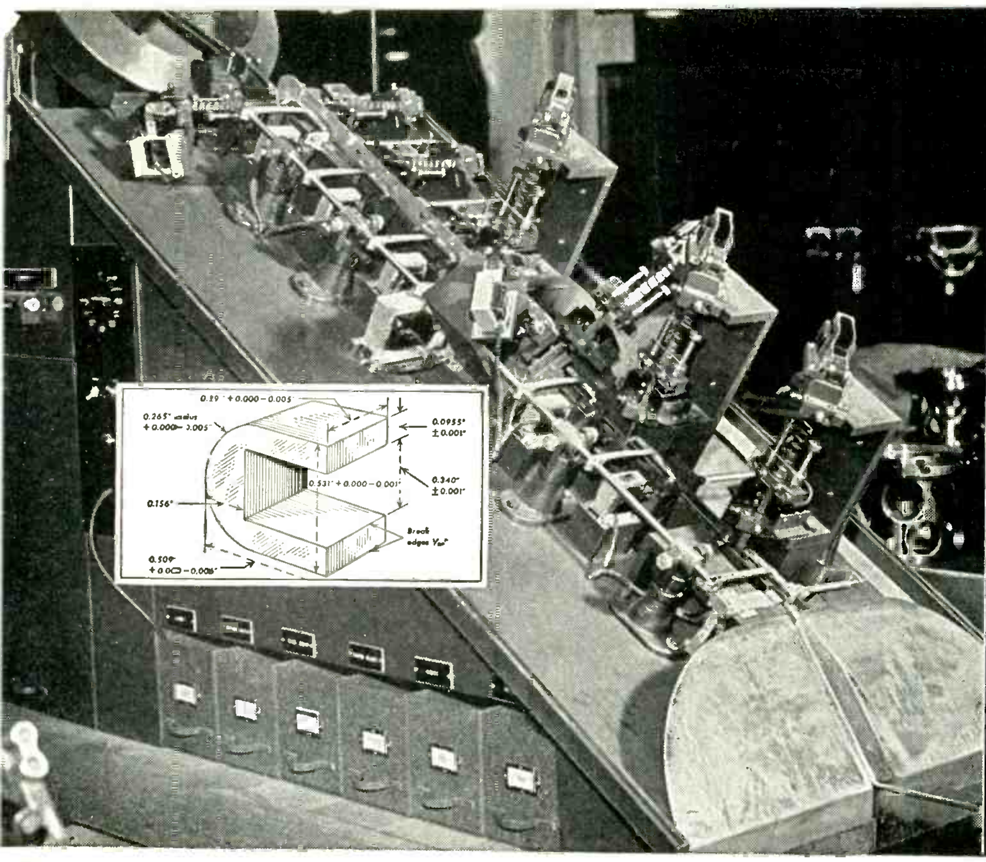
Strong aluminum alloy screws, bolts, nuts and rivets make dependable fastening devices; witness the aircraft using millions of them daily. Include these items in your designs and gain the security which comes from fastening aluminum with aluminum, and the economies obtained by standardization.

Alcoa *standard* screw products are now available in all needed types, sizes and finishes. "Stock" items are carried in warehouse stocks, strategically located throughout the country, by all authorized Alcoa distributors. Where special parts are required, manufacturing facilities are available for producing them.

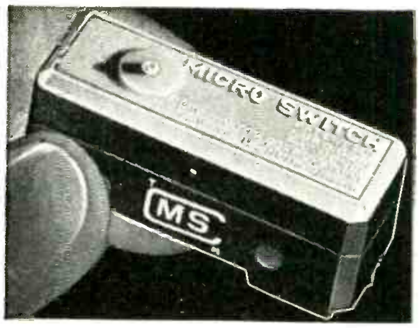
For a copy of this new catalog, write ALUMINUM COMPANY OF AMERICA, 2136 Gulf Building, Pittsburgh 19, Pennsylvania.

ALCOA ALUMINUM

REG. T. M.



HAMILTON STANDARD PROPELLERS Rely on 14 MICRO SWITCHES to Check 602 DIMENSIONS PER MINUTE



The basic Micro Switch is a thumb-size, feather-light, plastic enclosed, precision, snap-acting switch, Underwriters' listed and rated at 1200 V.A. at 125 to 460 volts a-c. Capacity on d-c depends on load characteristics. Accurate repeat performance is experienced over millions of operations. A wide variety of basic switches and actuators meets requirements varying from high vibration resistance to sensitivity in response to operating force and motion as low as 2/1000 Oz. In. Many types of metal housings are available.

★

Hamilton Standard Propellers of East Hartford, Conn., division of United Aircraft Corporation, rely on 14 Micro Switches to accurately check the seven dimensions of their tiny blade retainers to tolerances as close as .0005″.

Hand inspection with conventional gauges took from one to three minutes for each of the small U-shaped parts. In conjunction with General Control Company, of Cambridge, Mass., Hamilton engineers devised the "Gage-O-Matic" machine shown here which accurately and automatically checks all seven dimensions at the rate of 86 pieces per minute . . . 602 precise checkings each minute.

The Micro Switch equipped "Gage-O-Matic" machine uses two Micro Switches at each of seven stations through which the parts are passed automatically. The Micro Switches energize solenoids to either discard the piece or pass it for the next measurement. Pieces which pass all seven tests arrive in the "OK" drawer. Those which have been discarded, go to their respective drawers, depending upon the defect.

This use of Micro Switch by Hamilton Standard Propellers is just one example of the way in which this tiny, accurate, dependable, snap-acting electric switch is enabling all industry to do old jobs better . . . often to accomplish results not possible with earlier types of switches.

New products now being designed will make use of the wide range of characteristics which can be built into basic Micro Switches and the thousands of combinations of switches with special housings and actuators. Send for the Micro Switch Catalog No. 60 today.

Send for Catalog No. 70 if you are interested in Micro Switches for Aircraft.

*Let's All Back the Attack—
Buy EXTRA War Bonds*

Micro Switch Corporation, Freeport, Ill.

Branches: 43 E. Ohio St., Chicago (11) • 4900 Euclid Ave., Cleveland (3)
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The trademark MICRO SWITCH is our property and identifies switches made by Micro Switch Corporation

MICRO (MS) SWITCH

TRADE MARK

Made Only By Micro Switch Corporation . . . Freeport, Illinois, U. S. A.

ANNOUNCING

The New HOLTZER-CABOT Electronic Insulation Resistance Tester

Hand Generator — eliminates batteries and external power supply. Delivers 500 Volts D.C. testing voltage regardless of the direction in which crank is turned.

Visual Indication of Correct Testing Voltage — Two indicator buttons light up when generator is delivering correct testing voltage assuring accurate readings.

Electronic Voltage Regulation — assures uniform testing voltage over a wide range of crank speeds.

Guard Circuit — eliminates surface leakage from affecting measurements.

Light Weight — a self-contained, portable unit — ready-to-use in the laboratory, plant or out in the field. Weighs only three pounds.

Wide Range — 0 to 100 megohms. Scale markings spaced for easy accurate reading.

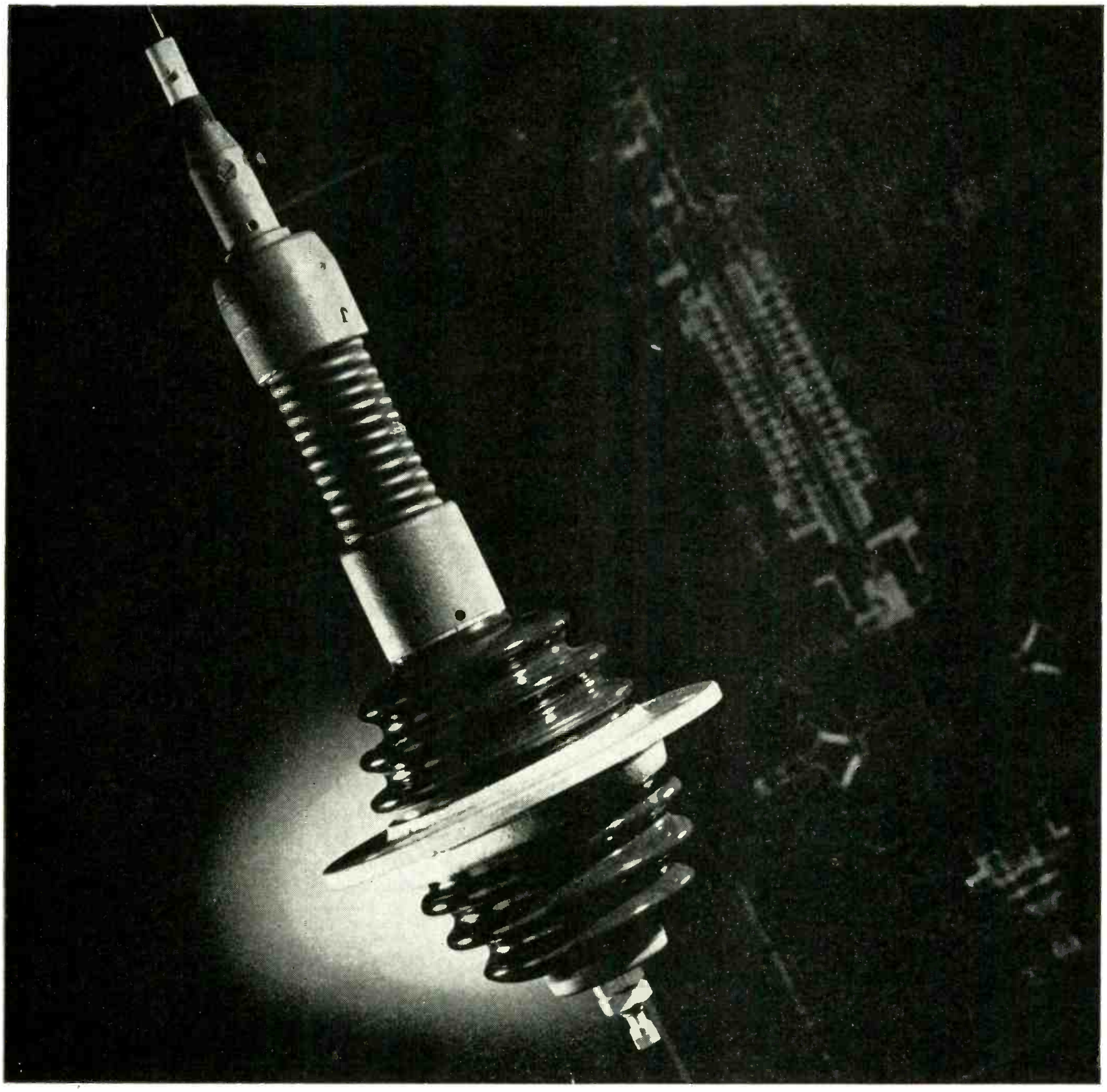
The new Holtzer-Cabot insulation resistance tester is a precision-built unit specifically designed for insulation resistance testing of all types of electrical equipment. A self-contained testing package, it is ready to use anywhere.

Because it generates its own power through the hand crank generator, users are always assured of 500 Volts D. C. . . . there are no weak batteries to contend with. Simple and easy to use by practically any engineer or maintenance man.

Protect your equipment from insulation failures and avoid possible production delays, shut-downs, and costly repairs. Use a Holtzer-Cabot insulation resistance tester for periodic tests on *all* equipment. Write for bulletin, today.

The HOLTZER-CABOT ELECTRIC COMPANY

400 Stuart Street, Boston 17, Massachusetts



LAPP-DESIGNED, LAPP-BUILT—TO DO A SPECIFIC JOB

This is an antenna base insulator for use on a communications center transmitter. It is one of several Lapp designs for transmitter and receiver mast bases for military vehicular radio—on jeeps, halftracks, tanks and other rolling equipment.

Whether or not this special-purpose gadget has application to anything you build or propose to build, there's a moral in it for you. In this case, as in hundreds of others, an original and impractical design was modified by Lapp engineers—to provide a part that meets all electrical and mechanical requirements, and that Lapp can build economically and efficiently.

Lapp engineering talent and Lapp production methods are such that we can say, "If it's an assembly that can be made of porcelain or steatite and metal parts, tell us what the requirements are and how you think it might be made; Lapp will tell you how it can best be made—and will make it." Our right to that claim has been proved over and over in military electronic production; it's going to be a competitive advantage to smart post-war electronic producers. *Lapp Insulator Co., Inc., LeRoy, N. Y.*

Lapp

ARMY E NAVY

"When we think of the OD3/VR-150, we think of HYTRON"

This enthusiastic comment by an expediter for one of the largest electronic equipment manufacturers, is typical. Engineers and purchasing agents everywhere are automatically associating Hytron with the OD3/VR-150. Since the tube was not originated by Hytron (Hytron was called upon to manufacture the tube to help satisfy a mushrooming demand), the reason must lie in Hytron's ability to do a better job.

WHY THE HYTRON OD3/VR-150 IS PREFERRED

1 CAREFUL ENGINEERING DESIGN — Hytron re-design, among other improvements, resulted in the addition of a new starting electrode which permits a uniformly lower starting voltage.

2 RIGID PRODUCTION CONTROL — Handling and dimensioning of internal parts during pre-processing and assembly are extremely painstaking.

3 TIGHTER FACTORY SPECIFICATIONS — For example, the minimum required starting voltage is 180 volts. Average starting voltage of the Hytron OD3/VR-150 is less than 160 volts.

4 CONTINUOUS ENGINEERING CONTROL OF QUALITY — In over 15 months, there have been no Government rejections of lots submitted for inspection.

5 MASS PRODUCTION — This apparently simple tube is in fact difficult to produce. Yet Hytron is manufacturing it at a rate sufficient to meet on schedule the growing demands of both new and old customers.

MORAL: You too should specify the Hytron OD3/VR-150 (and OC3/VR-105).

OD3/VR-150 AND VR-150-30 COMPARED

Frequently engineers ask how the OD3 and VR-150-30 differ. The maximum regulation limit for the VR-150-30 was 5.5 volts from 5 ma. to 30 ma. The OD3 has a maximum regulation limit of 4 volts from 5 ma. to 30 ma. Viewed another way, the current range is expanded to 40 ma., with the original maximum voltage regulation limit of 5.5 volts. The OD3/VR-150 is in short an improved replacement which supersedes the VR-150-30; it has the advantages of the increased 40 ma. max. rating.*

** The OC3/VR-105 also has ratings up to 40 ma. max.; it supersedes and is a replacement for the VR-105-30.*

OD3/VR-150 CHARACTERISTICS

Type	Glow Discharge Voltage Regulator
Maximum Overall Length	4-1/8″
Maximum Diameter	1-9/16″
Bulb	ST-12
Base	Small Shell Octal 6-Pin

Average Operating Conditions

Starting Supply Voltage	180 min. d.c. v.
Operating Voltage (approx.)	150 d.c. v.
Operating Current	5 min. d.c. ma. 40 max. d.c. ma.
Regulation = (E_{40}—E_5)	3.5 d.c. v.

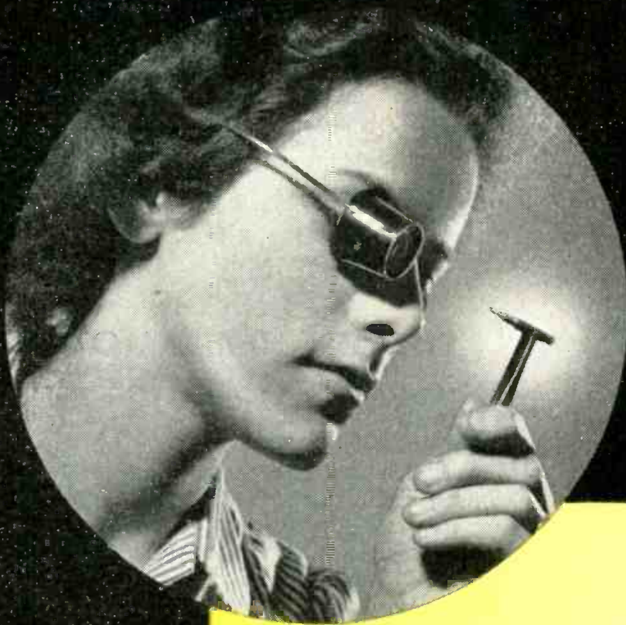
OLDEST EXCLUSIVE MANUFACTURER OF RADIO RECEIVING TUBES

HYTRON CORPORATION ELECTRONIC AND RADIO TUBES

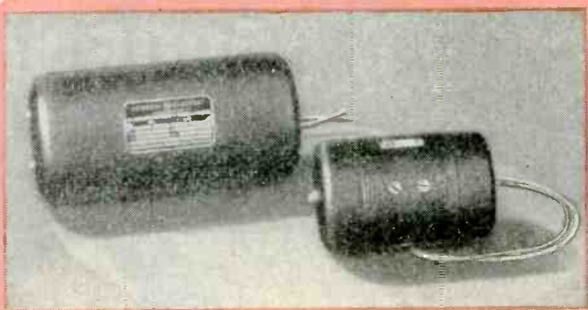
SALEM AND NEWBURYPORT, MASS.

HYTRON RADIO TUBES

BUY ANOTHER WAR BOND



2 power sources

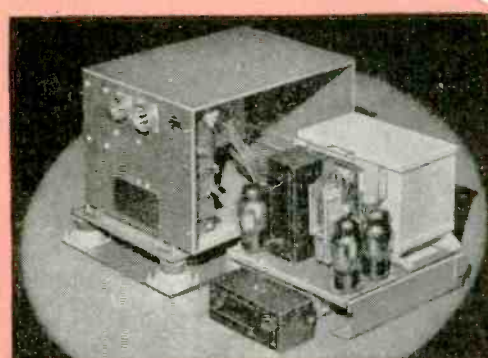


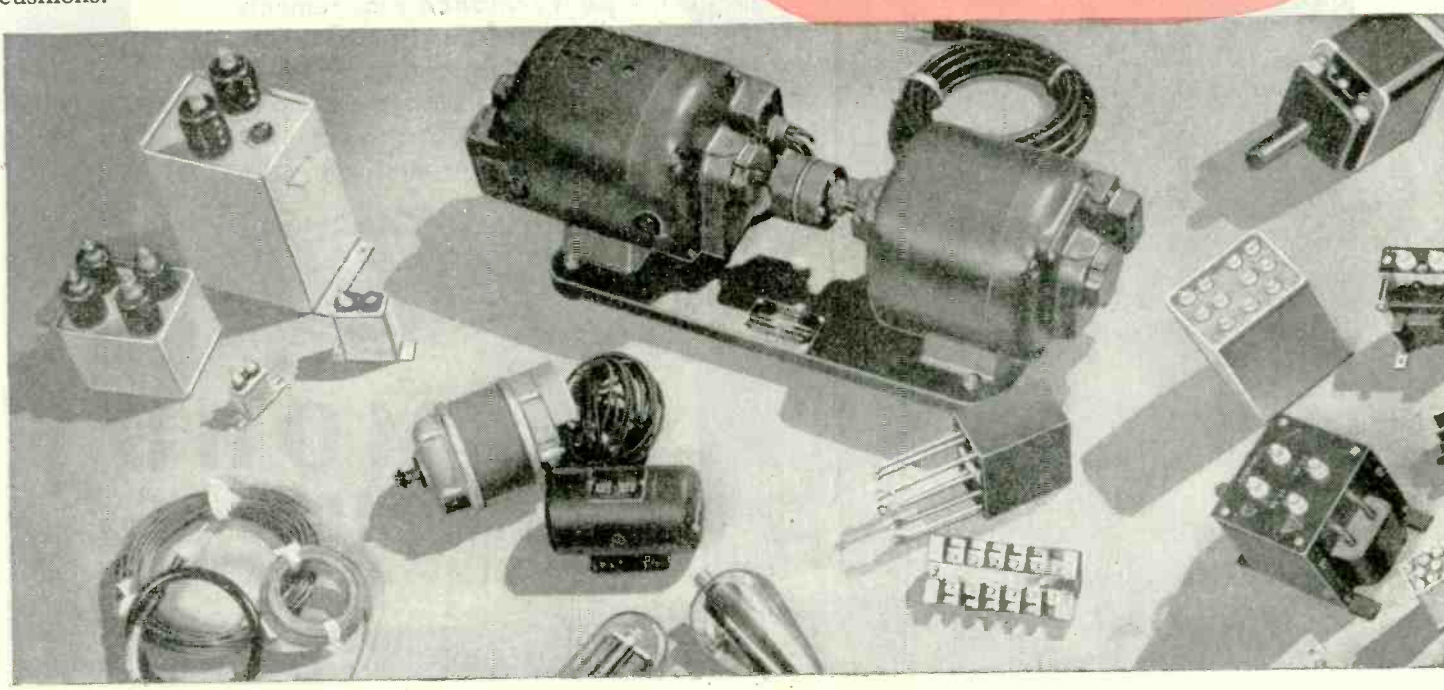
THE G-E DYNAMOTOR

Designed to deliver high output from small frame size, G-E dynamotors have earned a reputation for thoroughly dependable service under adverse conditions. Compactly constructed and light in weight, these units are available in outputs of 15 to 350 watts intermittent (15 to 200 continuous) and with output voltages ranging up to 1500 volts d-c when operated on a 12- or 24-volt battery source. Weights range from 3 to 31 lb. These dynamotors are specially designed to minimize objectionable a-c ripple and consequent need for radio filtering.

THE G-E INVERTER TRANSFORMER

Custom-designed for individual applications, G-E inverter transformers are compact and light in weight. They are specially designed for low internal heating, are quiet and efficient in operation, and readily interchangeable with correspondingly rated dynamotors. They can be designed for operation on a 6-, 12-, or 24-volt battery source, to supply wide range of output voltages—either a-c or d-c. Where conditions require, these units can be made dust-tight and can be shockmounted on rubber cushions.





to choose from...

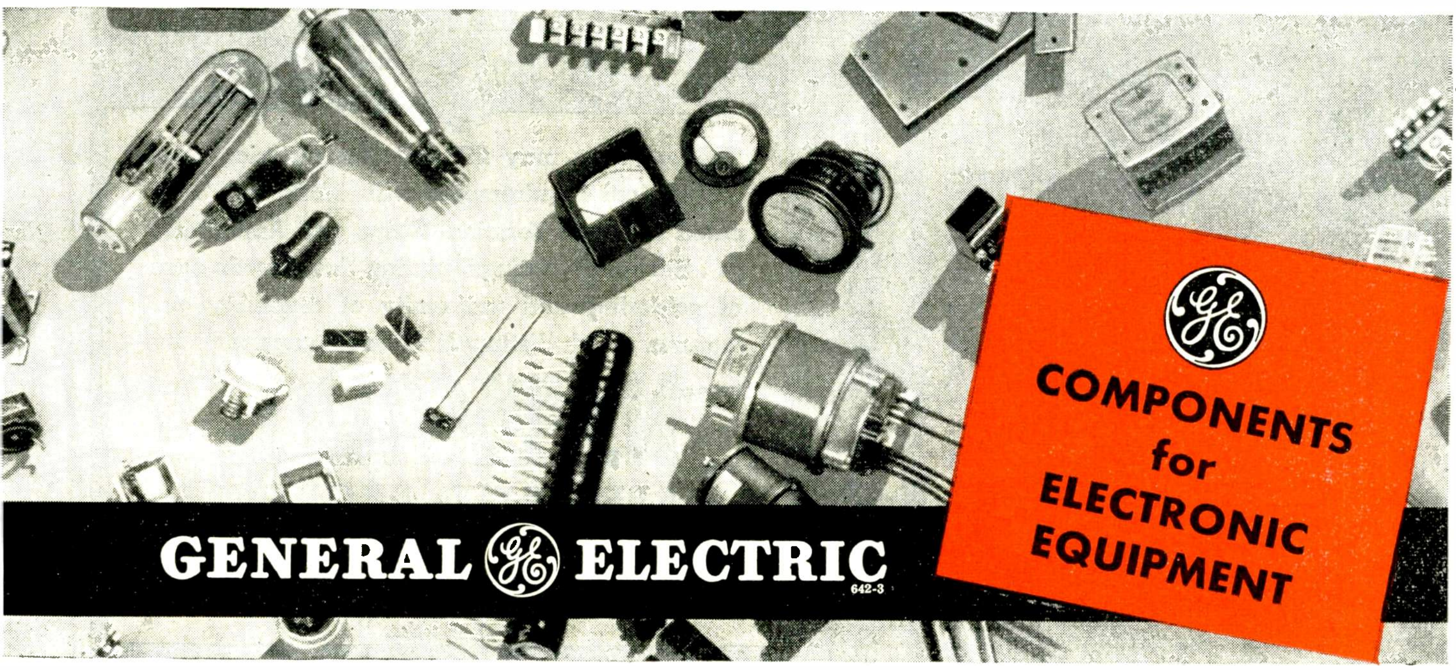
Another example of how the variety of G-E components enables you to choose your own method of accomplishing a desired result.

● If you have a problem involving a portable power supply for radio or allied electronic equipment, it will pay you to look into the merits of the dynamotor and inverter shown at the left. Similarly, if you have need for any of the many other components in the diversified G-E line, you can profit by discussing those needs with our engineers.

For every one of these G-E products has been worked out in close co-operation with designers in the electronic industries. All have been thoroughly tested—in our laboratories, in our customers' laboratories, and in laboratories operated by the Armed Services. More impressive still, many have been tested on the field of combat, where their dependability has proved a contributing factor in the success of a variety of radio and allied equipment.

Whether you are designing new electronic equipment or improving old designs, take advantage of the extensive line of G-E components and G-E electronic "know-how." Whatever your objectives, find out how G.E. can help you achieve them more simply or more economically. The G-E office near you will gladly furnish details. *General Electric, Schenectady 5, N. Y.*

Buy all the Bonds you can—and KEEP ALL YOU BUY




Versatility
IN TERMINAL ASSEMBLIES
The engineer may fill both his electrical and mechanical requirements with National Fabricated Products Terminal Strips and Assemblies . . . Secure mountings, plating that affords ease of soldering and uniformity of assembly are features which distinguish these components by
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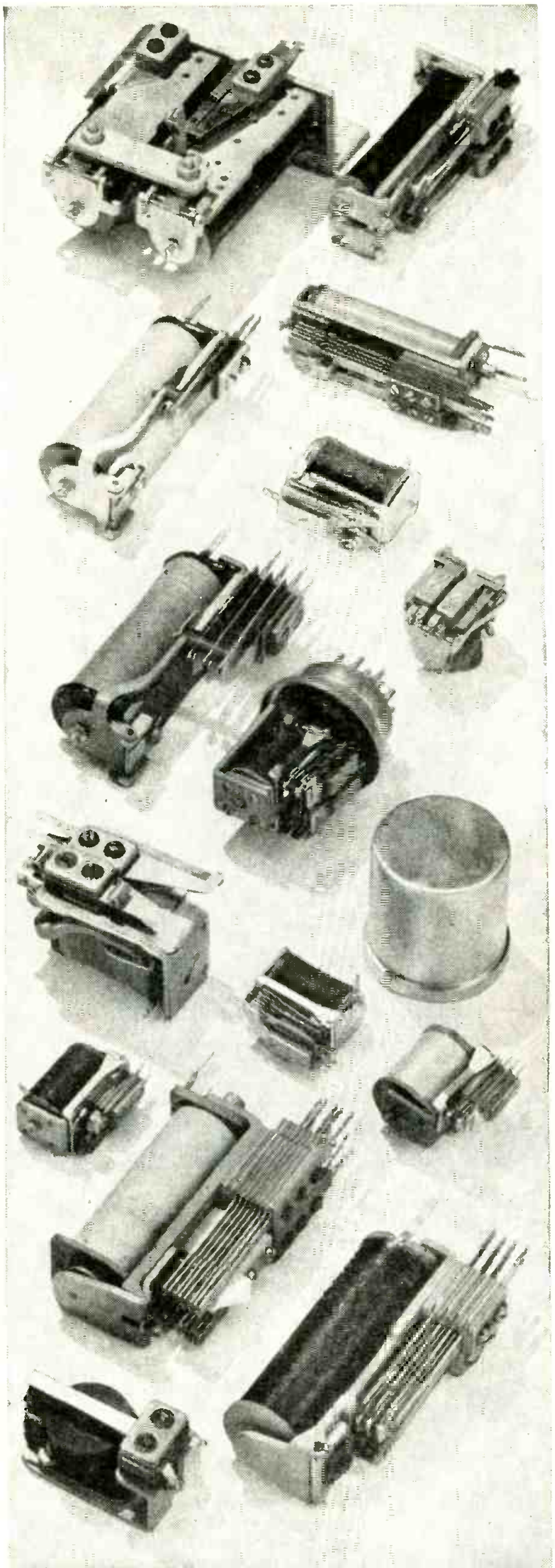
2650 WEST BELDEN AVENUE, CHICAGO 47, ILL.
Manufacturers of SOCKETS, TERMINAL ASSEMBLIES, JACKS AND CONNECTORS for use in every field of electronics.



BE SURE YOU HAVE THE RIGHT RELAY

The *right* relay, of course, is the one which will exactly fit your needs, and give you the longest, most dependable service at lowest cost. Here's how you can get it:

1. Write for the Automatic Electric catalog. It lists over forty basic types of relays, providing every combination needed for modern electrical control. All technical facts are clearly tabulated for your guidance.

2. If you want help in applying this information to your problem, call in our field engineer. He will be glad to put his experience to work for you.

Send today for your copy of the catalog—or simply ask our field engineer to bring one over.

Relays
AND OTHER CONTROL DEVICES
by AUTOMATIC ELECTRIC

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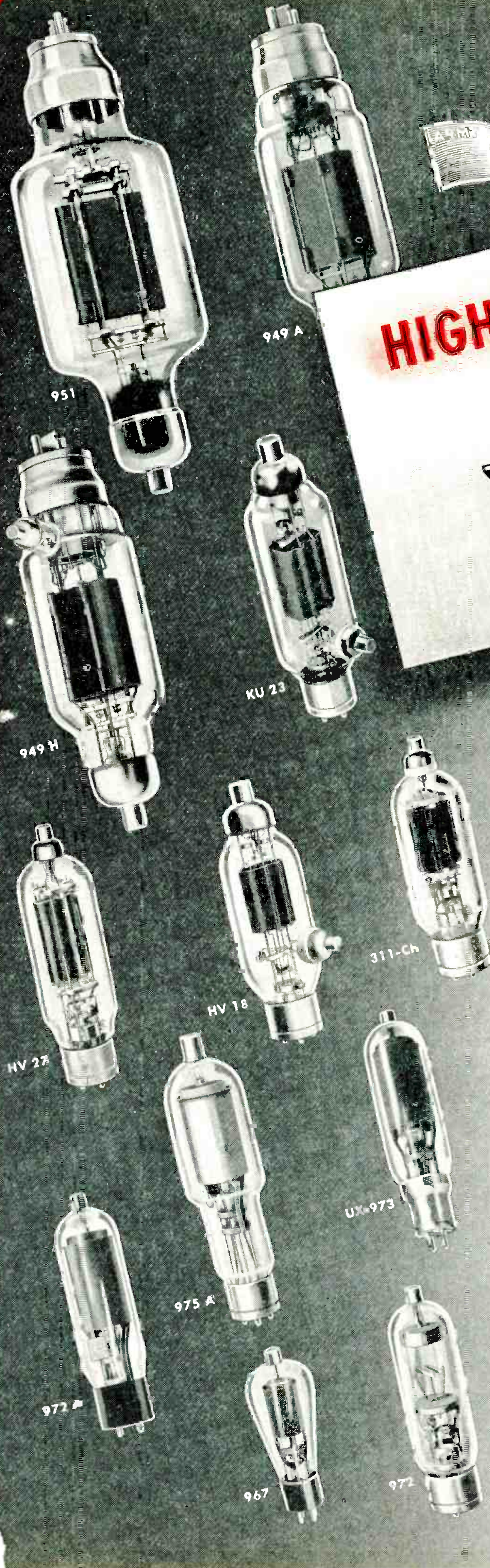

951
949 A
949 H
KU 23
HV 18
311-Ch
HV 27
UX-973
975 A
972 A
967
972

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ASSURES ONE STANDARD OF EXCELLENCE REGARDLESS OF QUANTITY

Unique production systems work side by side with a versatile engineering organization to build the utmost in efficiency into every TEMCO transmitter. Regardless of quantity, be it one, ten or a thousand units . . . every TEMCO-built transmitter receives the benefit of superb construction and engineering design.

Your expert eye will easily recognize the marks of finer craftsmanship evident in these TEMCO-built products, although only one special Power tube Life test rack was built in contrast to hundreds of these 150GS transmitters.

Delivered from the same production lines, all were endowed with every advantage of TEMCO'S advanced engineering skill.

Whether you need but one or many units of a particular design put TEMCO production flexibility to work for you. Write for a copy of our newest illustrated catalog.

TRANSMITTER EQUIPMENT MFG. CO., INC.
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TEMCO

RADIO COMMUNICATION EQUIPMENT

an eye to the future

The electronic engineer is an important part of the war effort, and his day has too few hours for him. His highly vital, specialized training and knowledge are utilized to the utmost in devising new electronic equipment to keep up with and anticipate the many demands of the modern warfare.

Despite those many work-filled hours, the electronic engineer still finds time, here and there, to dream of the future and plan for the day when his skill will be turned to peacetime pursuits. He has wonderful plans for tomorrow: Ideas for a better and more comfortable life. Today, however, he is working to guarantee tomorrow.

Raytheon is proud of its engineers and the job they are doing . . . and Raytheon is proud to have a part in the vitally important role that advanced electronic tubes and equipment are playing in the Allied Nations' drive for Victory. In the peace to come, Raytheon's advanced research and technique will assure Raytheon's continued leadership in the electronic era.

RAYTHEON

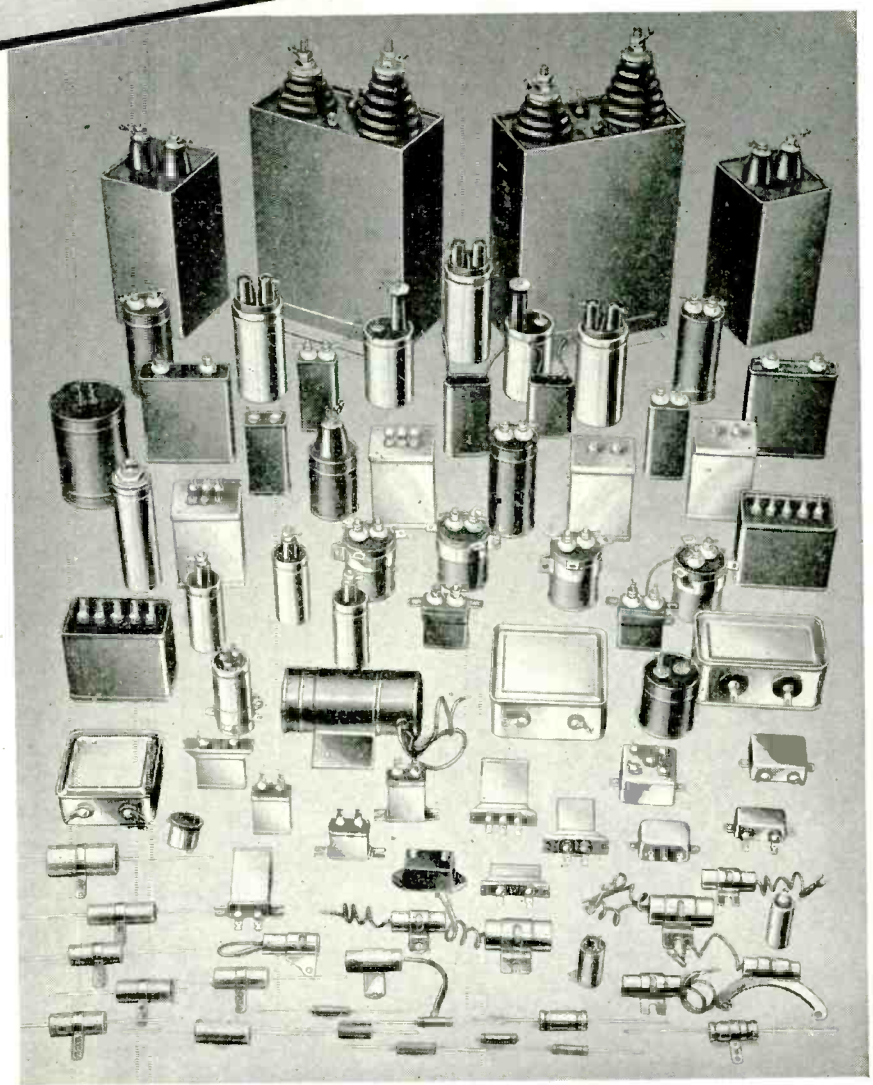
RAYTHEON MANUFACTURING COMPANY

Waltham and Newton, Massachusetts

DEVOTED TO RESEARCH AND THE MANUFACTURE OF TUBES AND EQUIPMENT FOR THE NEW ERA OF ELECTRONICS

A TYPE FOR *Every* APPLICATION

OIL-FILLED CAPACITORS



● Functionally fitted to given application—that's the keynote of the extensive Aerovox oil-filled capacitor line. A plentiful selection of containers, mountings, terminals, sizes and impregnants, assures virtually custom-built capacitors with guaranteed performance.

Aerovox offers both Hyvol and Hyvol-M (mineral oil) liquid impregnants. For applications subjected to wide temperature variations, and where weight and size are important, Hyvol is recommended. Hyvol capacitors are considerably more constant with temperature variations than are those with other impregnating materials of the same specific inductive capacity, showing no capacitance drop until temperatures of −20° F. (−29° C.) are reached. At −40° F. (−40° C.) the maximum capacitance drop that may be expected is of the order of 5 to 10%.

Hyvol-M (mineral oil) capacitors have an exceptionally flat temperature coefficient of capacitance curve but approximately 35% greater bulk and corresponding weight which usually rules them out in favor of Hyvol.

At any rate, Aerovox offers both Hyvol and mineral oil capacitors, as well as wax-impregnated units for limited service—along with that wide choice of containers, mountings, terminals—to meet your exact needs.

● **NEW CATALOG** lists the exceptionally wide selection of Aerovox oil capacitors, as well as other types. Write on business letterhead for registered copy available only to engineers, designers, electronic maintenance men, manufacturers of equipment, and executives.

AEROVOX *Capacitors*

INDIVIDUALLY TESTED

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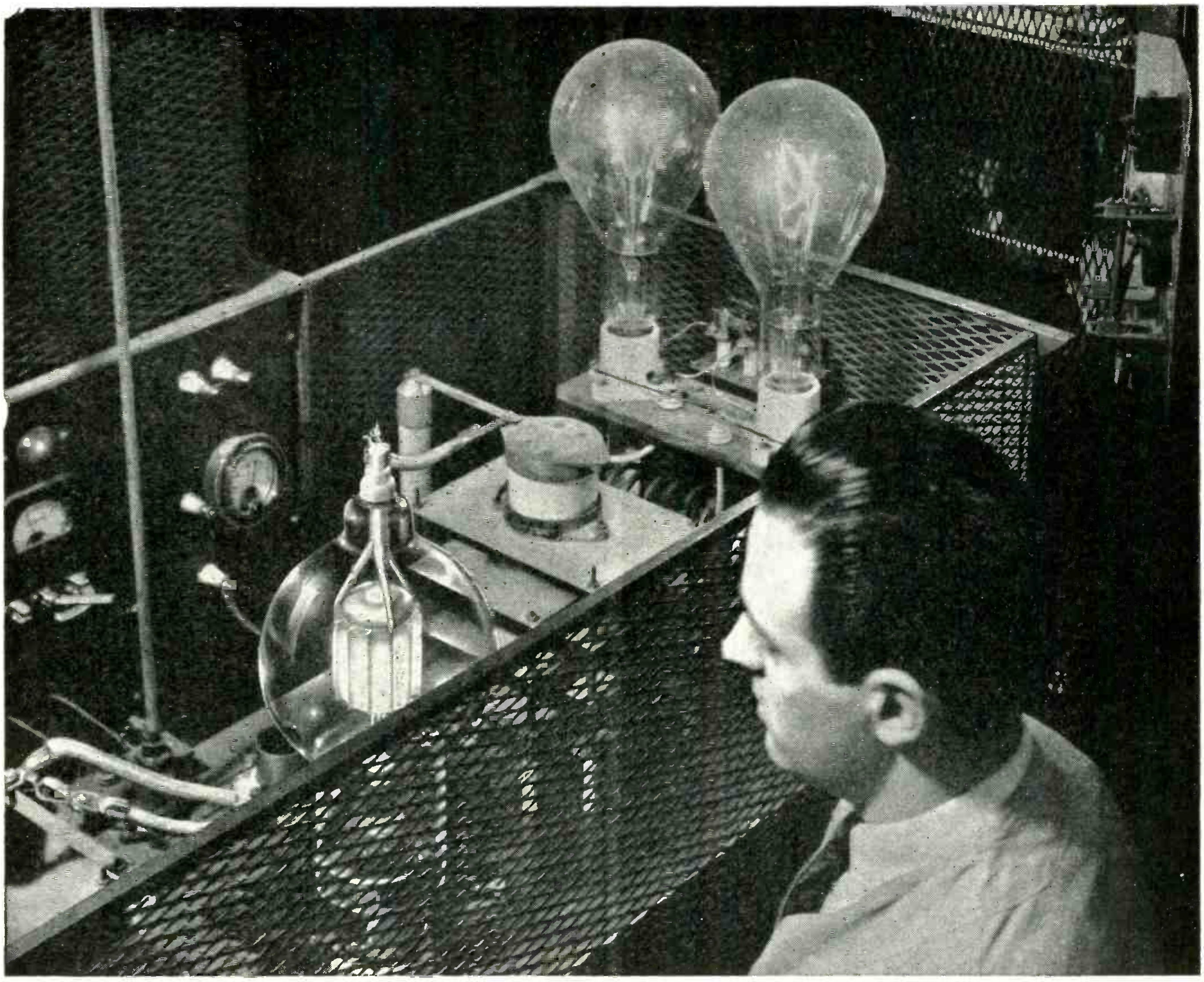

DEATH AT 20 METERS

...or another reason for the long life of Gammatrons

ONE out of every thousand Gammatron tubes is sacrificed in the Heintz and Kaufman laboratory so that the operating life of similar Gammatrons may be periodically checked and assured.

This thousandth tube oscillates at 20 meters, pouring its power into light bulbs until it finally fails. The length of its operating life is carefully recorded, and compared with the previous performance of tubes of the same type. This is but one of 17 checks made in the Heintz and Kaufman laboratory to guarantee the efficiency and reliability of every tube bearing the Gammatron label.

Basically correct design, plus continuous mechanical and electrical tests, have led to widespread recognition of Gammatrons as "the tubes that can take it."

FOR VICTORY AND SECURITY BUY WAR BONDS

HEINTZ AND KAUFMAN LTD.

SOUTH SAN FRANCISCO • CALIFORNIA, U. S. A.

Gammatron Tubes


Electro-Voice
MICROPHONES
The extent of our line is but partially illustrated in this advertisement. Our current production is now being utilized in essential services. Soon, however, there will be Electro-Voice Microphones available for civilian use . . . and these will be described fully in subsequent advertisements.
In our South Bend laboratory, we have complete facilities for accurate frequency checking, harmonic wave analysis, measurement of ambient noise, etc. Electro-Voice Microphones reflect painstaking care in design and construction by superior performance in the field. They serve you better . . . for longer periods of time.
If your present limited quantity needs can be filled by any of our Standard Model Microphones, with or without minor modifications, we suggest that you contact your nearest radio parts distributor.
Paper Packs a . . . . War Punch . . Save Every Scrap
ELECTRO-VOICE MANUFACTURING CO., INC. • 1239 SOUTH BEND AVENUE • SOUTH BEND, INDIANA
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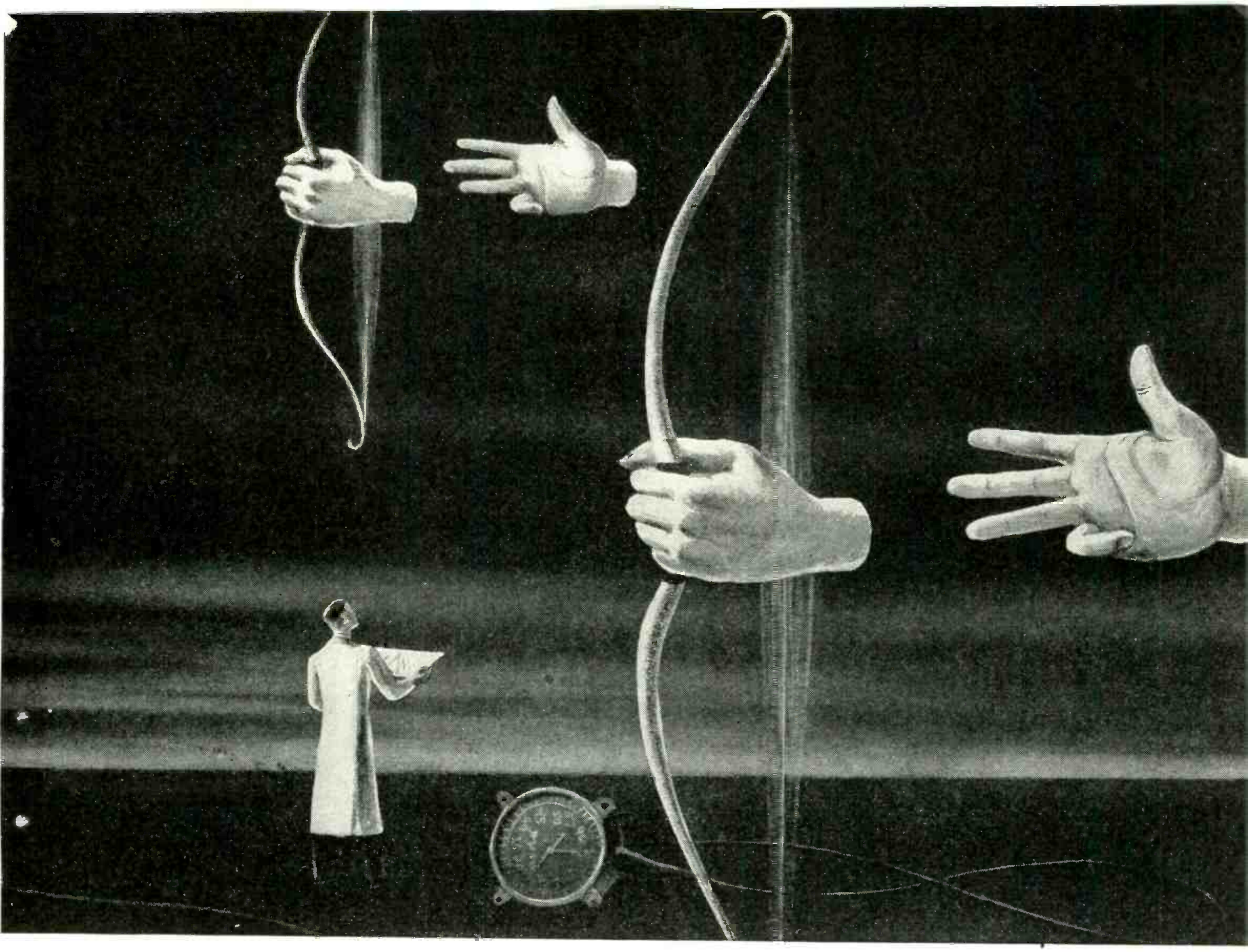

A NEW STRING—A BIGGER BOW

Write for details of Vibration machine VMJ-4VF.

Waugh Laboratories presents a new Waugh-Johnson vibration machine, for high frequency vibration of loads up to 500 lbs. Amplitude 0 to 1.5 inches with frequencies of 600 to 6,000 C.P.M. Automatic electric control of amplitude, frequency and acceleration over entire range while in operation. Table dimension 4′x4′. This is one of a series of Waugh-Johnson high-frequency vibration machines designed to test equipment of all types which must meet Army and Navy specifications.

Send for descriptive literature.

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Pacific Coast Branch: 180 East California St., Pasadena 5, California • **420 LEXINGTON AVE., NEW YORK 17, N. Y.**

You remember him, the kid next door who tinkered with short wave radio. Well, he's in uniform now, calling his CQ from foxholes in Italy and steaming Pacific jungles. Maybe, he's a radio operator on a bomber ...perhaps, he's an instructor. Whatever it is, you can be sure that his knowledge and experience are serving to help build a wartime communications system. Yes, from the hams came ready trained instructors, operators and engineers at a time when skilled technicians were vitally needed.

The radio amateur will be back one of these days, back to his much-loved tinkering. He'll want new equipment to add to his short wave rig. . . . He'll be looking for a JENSEN speaker because he wants highest fidelity in music, code and voice reproduction. There is no finer acoustic equipment than JENSEN reproducers.

Manufacturers and Designers of Fine Acoustic Equipment

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RADIO MANUFACTURING COMPANY
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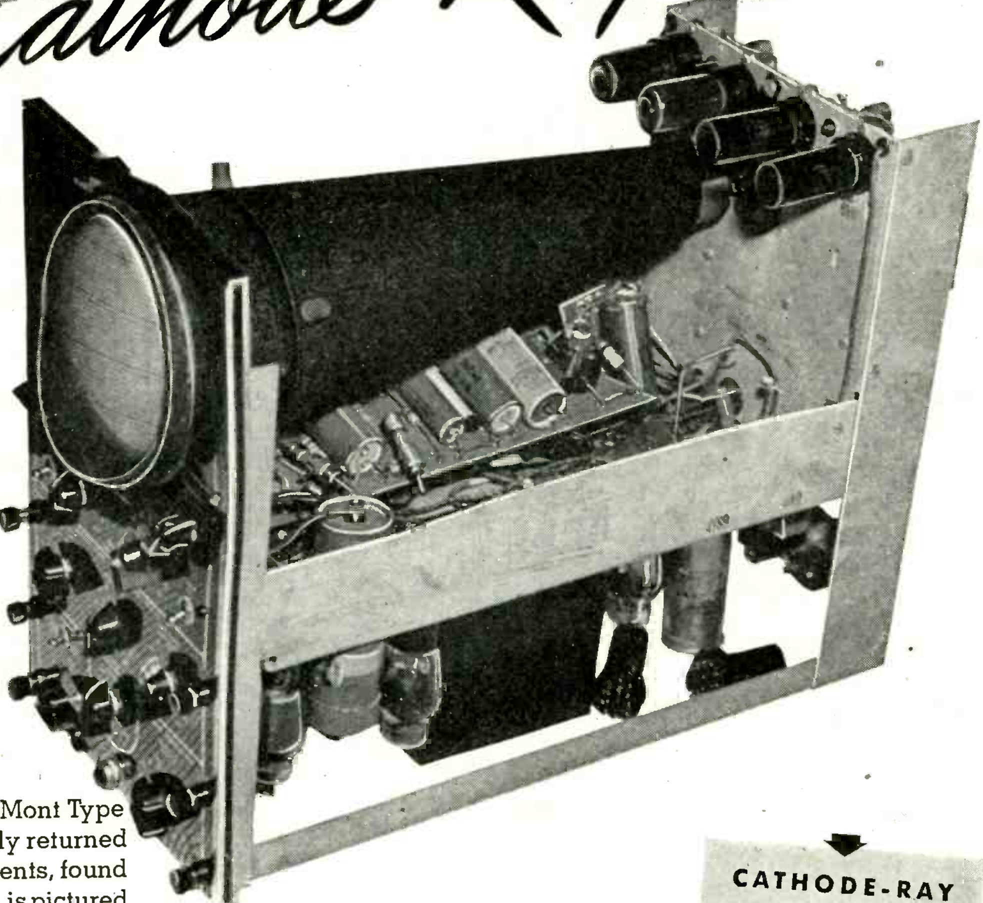
Extra-rugged mechanically as well as electrically, to withstand the most trying use and abuse . . .

DuMont *Cathode-Ray Tubes*



Several badly damaged DuMont Type 208 oscillographs were recently returned for repairs. One of the instruments, found to be definitely beyond repair, is pictured herewith. The main chassis was bent in two directions. The main bank was torn from its fittings, every lead wrenched free from its soldered connection. The panel was badly dented and twisted. Several tubes were jolted from their sockets. The instrument was only good for salvaged components. Yet . . .

The DuMont Type 5LP1 cathode-ray tube in that oscillograph was still in *perfect operating condition*, despite the surrounding wreckage.

Such is typically DuMont tube experience. For these tubes are extra-sturdy *mechanically* as well as electrically in order to withstand the most trying use and abuse. It is this extra factor of safety, along with dependable operating characteristics, that has made DuMont cathode-ray tubes the popular choice in much of the oscillographic equipment now in daily use.

CATHODE-RAY MANUAL . . .

The DuMont combination manual and catalog is available to engineers, designers, electronic equipment maintenance men, instrument-makers, manufacturers, etc. Write on business stationery for your registered copy.

DUMONT *Precision Electronics & Television*

ALLEN B. DUMONT LABORATORIES, INC., PASSAIC, NEW JERSEY • CABLE ADDRESS: WESPEXLIN, NEW YORK

TORTURED to LIFE!

Here's consolidated, living hell for electrical equipment. It's a "torture-chamber" that reproduces the toughest possible conditions of temperature, humidity, atmospheric pressure. It is one of the many "torture devices" at Electronic Laboratories for testing E•L products.

THE HARDEST PART of an *E•L* Power Supply's life is being born. Because then it must survive tests that make its actual service-life a bed of roses by comparison.

E•L Power Supplies have to prove their guts in temperatures more extreme than Siberia's cold or Sahara's heat . . . at altitudes higher than the Himalayas and lower than the Dead Sea . . . in dust storms . . . in salt spray . . . in humidity worse than a Solomons swamp! Severe operating conditions all, yet intentionally exaggerated in tests at Electronic so that *E•L* Power Supplies may live longer in actual service.

If you have power supply needs of converting low voltage to high voltage, obtaining a precisely regulated power output from a varying power input, or anything else, however tough—let Electronic's engineers help you find the answer.

Your problem may be radio . . . motors . . . lighting. *E•L* engineers are familiar with them all . . . and many other applications as well! They are at your service for consultation!

Only *E·L* VIBRATOR POWER SUPPLIES Offer All These Advantages:

1. **CONVERSION**—DC to AC; DC to DC; AC to DC; AC to AC.
2. **CAPACITIES**—Up to 1,500 Watts.
3. **VARIABLE FREQUENCIES**—A power supply may be designed to furnish any frequency from 20 to 280 cycles, or a controlled variable output within a 5% range of the output frequency.
4. **MULTIPLE INPUTS**—For example, one E•L Power Supply, in quantity production today, operates from 6, 12, 24, 110 volts DC or 110 volts AC, and 220 volts AC, with a single stable output of 6 volts DC.
5. **MULTIPLE OUTPUTS**—Any number of output voltages may be secured from one power supply to suit individual needs.
6. **WAVE FORMS**—A vibrator power supply can be designed to provide any wave form needed for the equipment to be operated.
7. **FLEXIBLE IN SHAPE, SIZE AND WEIGHT**—The component parts of a vibrator power supply lend themselves to a variety of assembly arrangements which makes them most flexible in meeting space and weight limitations.
8. **HIGHEST EFFICIENCY**—E•L Vibrator Power Supplies provide the highest degree of efficiency available in any type power supply.
9. **COMPLETELY RELIABLE**—Use on aircraft, tanks, PT boats, "Walkie-Talkies," jeeps, peeps and other military equipment, under toughest operating conditions has demonstrated that E•L units have what it takes!
10. **MINIMUM MAINTENANCE**—There are no brushes, armatures or bearings requiring lubrication or replacement because of wear. The entire unit may be sealed against dust or moisture.

Electronic LABORATORIES, INC.

INDIANAPOLIS

E·L **ELECTRICAL PRODUCTS**—Vibrator Power Supplies for Communications . . . Lighting . . . Electric Motor Operation . . . Electric, Electronic and other Equipment . . . on Land, Sea or in the Air.

Here's a LOT OF INSULATION IN SMALL SPACE

Space is at a premium in most of the war-time uses for insulated wire. Meeting this requirement, **LEXEL** insulation tape provides maximum protection with minimum bulk.

This cellulose acetate butyrate product has high dielectric strength, and low moisture absorption. It is flame retardant.

LEXEL is heat-sealed into a continuous tube by the heat used to drive off lacquer solvents. The wire is automatically and perfectly centered in this tube. Insulation is uniformly effective at all points.

Sizes for all gauges of wire and cable. We'll be glad to send you information and furnish names of manufacturers supplying **LEXEL** insulated wire.

• • •

CUSTOM-MADE INSULATION

As a regular service, Dobeckmun engineers also develop laminated insulation products, custom-made to special purpose specifications, such as slot cell and phase insulation for motors, insulation for shipboard cables and other uses. If your requirements are unusual, call on us.

"LEXEL" is a registered trade-mark of The Dobeckmun Company.

THE **DOBECKMUN** COMPANY

INDUSTRIAL PRODUCTS DIVISION • CLEVELAND 13, OHIO

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For important assignments

The accuracy of DeJur precision meters on the "Testing Grounds" of many important manufacturers has resulted in their preference for standard or special projects.

For instance, the bracket construction, housing the moving coil system, is especially designed to withstand extremes of vibration, shock and humidity. These brackets are standard in all DeJur aircraft instruments and have been incorporated into small panel meters to assure permanently satisfactory performance.

WASTEPAPER IS ESSENTIAL
. . . TURN IT IN REGULARLY

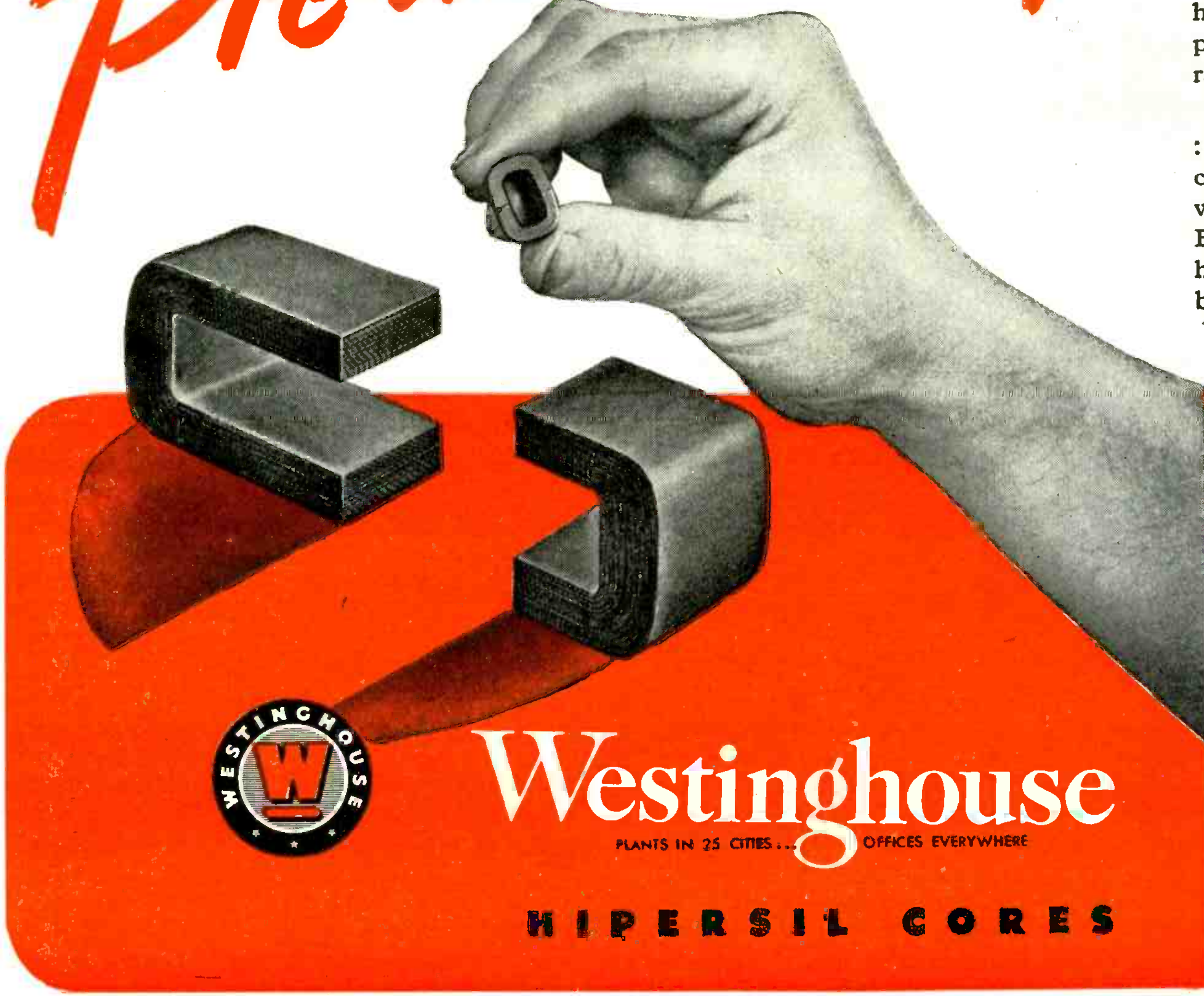
DeJur-Amsco Corporation

MANUFACTURERS OF DeJUR METERS, RHEOSTATS, POTENTIOMETERS AND OTHER PRECISION ELECTRONIC COMPONENTS
SHELTON, CONNECTICUT

NEW YORK PLANT: 99 Hudson Street, New York 13, N.Y. CANADIAN SALES OFFICE: 560 King Street West, Toronto


APPROVED

it's Pre-assembled!



NEW TWO-PIECE HIPERSIL* CORE SPEEDS ASSEMBLY OF HF EQUIPMENT

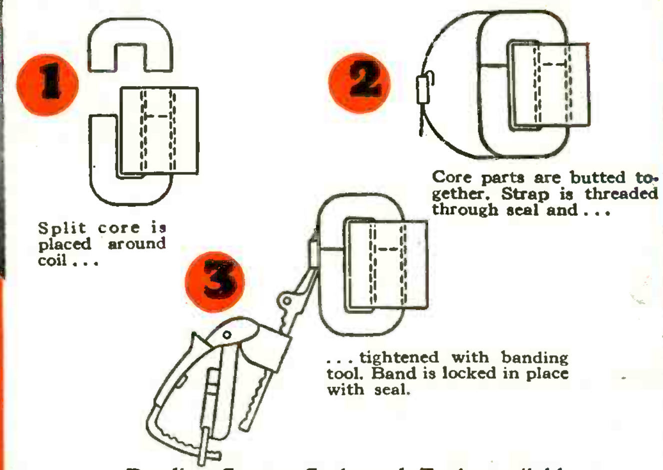
Here's a practical short-cut that will speed assembly of High-Frequency Communications Equipment.

Instead of stacking tissue-thin laminations by hand, you can now get pre-assembled, two-piece HIPERSIL cores, ready for quick, easy assembly. Because there are just TWO pieces to handle per loop, valuable man-hours are saved in production—faults in assembly are prevented. HIPERSIL cores are available in a complete range of standard as well as special sizes and forms.

GET ALL THE FACTS ABOUT HIPERSIL TYPE C CORES : : : write for copy of HIPERSIL Booklet, B-3223-A. It contains performance facts and application data that will help speed the production of vital Communications Equipment for the Fighting Forces. Address: Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pennsylvania, Dept. 7-N. J-70422

**Registered Trade-Mark, Westinghouse Elec. & Mfg. Co., for HIgh PERmeability SILicon steel.*

HERE'S HOW TO SPEED COIL ASSEMBLY



Banding Straps, Seals and Tools available from Westinghouse. See Page 9 of B-3223-A.

In the Jungle... FORMICA MET THE TEST

Thousands of American war planes, their vital electrical systems dependant on Formica insulating parts, have stood up to the humidity and heat of the jungle. They stood equally well the dry substratosphere cold on the way.

For Formica is available in insulating grades that do not change dimensions with changes in temperature, whose efficiency is not reduced by moisture absorption. Some of them permit very slight losses at high frequencies — and they will do most of the work of ceramics. Yet they are easily and readily machined — adapted for fast mass production methods.

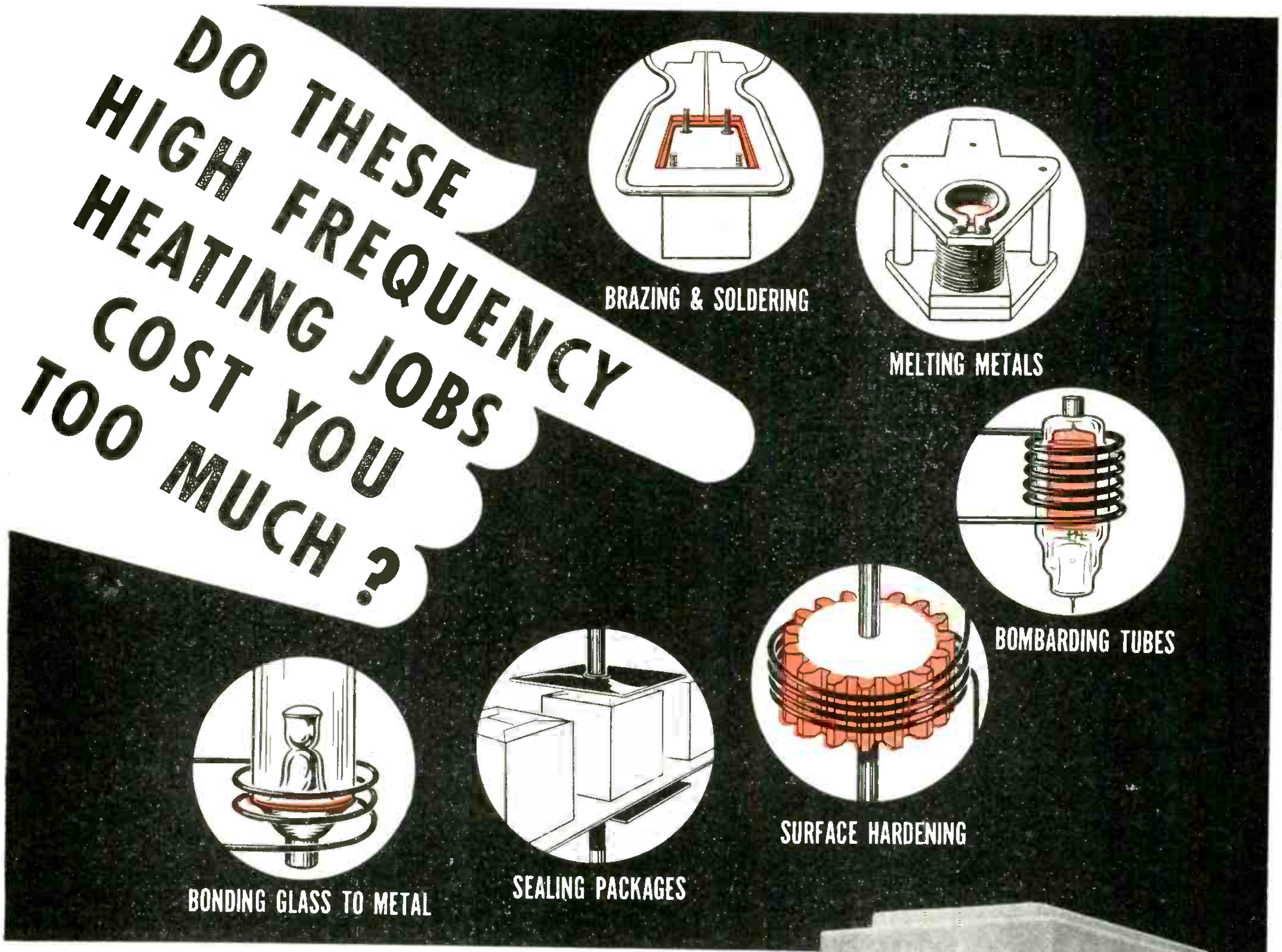
War time experience has provided better insulating grades of Formica than were ever available before. Let us tell you about them now.

"The Formica Story" is a moving picture in color showing the qualities of Formica, how it is made and how it is used. Available for meetings of engineers and business groups.

ARMY E NAVY

FORMICA

THE FORMICA INSULATION COMPANY, 4661 SPRING GROVE AVENUE, CINCINNATI, O.



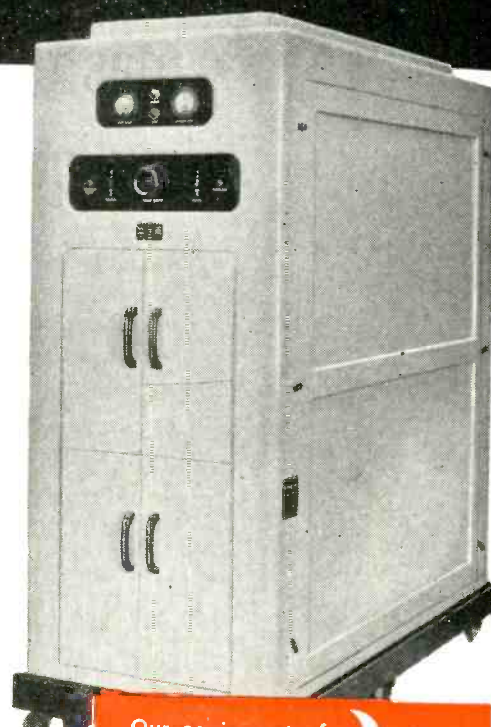
MANY users of electronic heaters are not getting the right combination of high frequency and low cost . . . because their heater units were not designed for *their* particular applications.

The secret of economy and efficiency in high frequency heating is to be sure your unit gives you the correct power-and-frequency selections for the operation involved. Very often one of our machines — costing only a few hundred dollars — will prove more efficient and economical in operation than a larger unit costing thousands.

IS YOUR HEATER A POWER-WASTER?

Whether your heating operations require large or small units, we can give you the RIGHT unit for your applications. You need not use a "misfit" that gives you an incorrect power and frequency selection. Scientific Electronic units usually pay for themselves many times over in *savings*.

Note the wide range of power-and-frequency combinations our equipment offers. Before you buy an Electronic heater, investigate the advantages our units afford. *Write today for detailed information.*



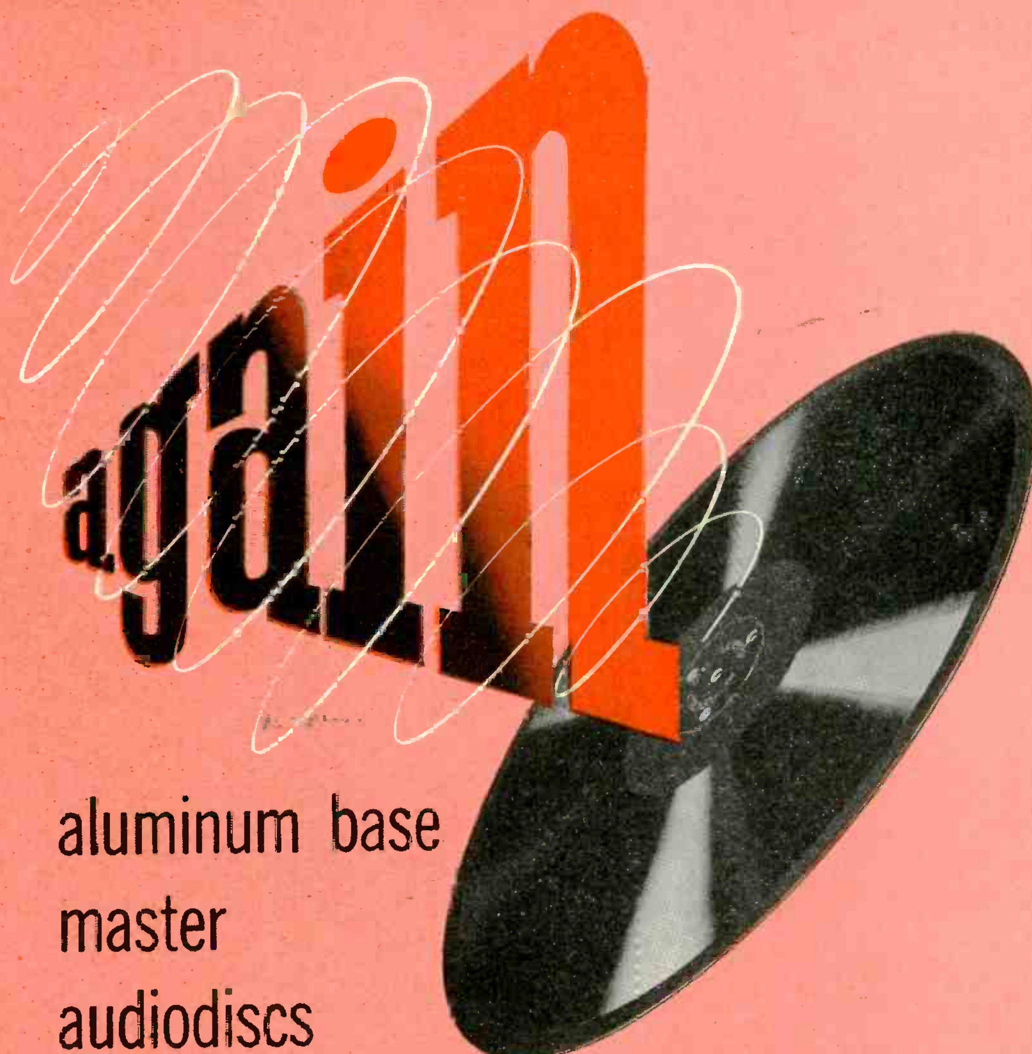
Our equipment offers you a selection of frequencies up to 300 megacycles — and the following power range, with stepless control from zero to full load:

3 Kw
5 Kw
7½ Kw
10 Kw
12½ Kw
15 Kw
18 Kw
25 Kw
40 Kw
100 Kw

Scientific Electric

DIVISION OF "S" CORRUGATED QUENCHED GAP COMPANY
119 Monroe Street Garfield, New Jersey

Manufacturers of Vacuum Tube and Spark Gap Converters since 1921.



aluminum base master audiodiscs

By authority of WPB, we are again able to fill orders for aluminum base Audiodiscs for professional use in all grades, 12 inch and larger. This is particularly good news for those who process Master Audiodiscs. Sizes for this use are 12, 13¼ and 17¼ inches.

Also available in aluminum in 12 and 16 inch size are the first quality Red Label Audiodiscs (double and single face), the high quality Yellow Label Audiodiscs, and Reference utility discs for test cuts, filing, etc.

Your request for our current price list for aluminum and glass base Audiodiscs will receive prompt attention; and orders will be filled in the sequence received. Audio Devices, Inc., 444 Madison Ave., New York 22, N. Y.

audiodiscs

they speak for themselves

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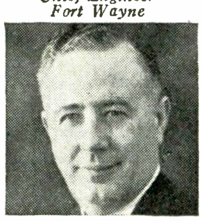

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Credit

They were veterans when they joined Farnsworth 5 years ago! These *21 men* in the Farnsworth headquarters organization today are all in the same important positions they took in 1939 when Farnsworth expanded its research and entered into radio production.

This intact staff is a true indication of the sound planning and development within the Farnsworth organization.

These men are planning post-war products and services and policies now — natural developments of our 19 years of research in the electronics field . . . in television, radio and phonographic reproduction.

After the war, Farnsworth will be in a strong position to work with you in all phases of radio and television transmission and reception. Farnsworth accomplishments have received high recognition. Farnsworth possibilities in the future are unlimited.

★ **FIRST POPULAR INTERPRETATION OF TELEVISION** ★
Write for copies of "The Story of Electronic Television." Prepared for the public, it should be useful to you.

FARNSWORTH

Television · Radio · Phonographs

Farnsworth Television & Radio Corporation, Fort Wayne 1, Indiana • Farnsworth Radio and Television Transmitters and Receivers • Aircraft Radio Equipment • Farnsworth Television Tubes • The Farnsworth Phonograph-Radio • The Capehart

The Facts about MOLDED PAPER CAPACITORS

MOLDED PAPER VERSUS MICA CAPACITORS

—wartime equipment has definitely proven the ability of Micamold Molded Paper Capacitors to function satisfactorily in by-pass, coupling and filter applications above .001 mfd. As strategic mica is scarce, Micamold Molded Paper Capacitors not only fill the breach but materially assist in maintaining the flow of equipment to the Armed Services.

MOLDED VERSUS METAL HOUSED PAPER CAPACITORS

—here again Micamold Molded Paper Capacitors serve as adequate alternates for capacities of .25 mfd. or less. As compared to metal encased paper capacitor the plastic molded types save space, weight and cost.

IN BOTH CASES

—considerable economies in time, labor and materials have resulted. Manufacturers who utilize Micamold Molded Paper Capacitors instead of mica and metal housed paper types can effect substantial savings in their own production.

Manufacturing facilities have been further increased . . . prompt deliveries of large production quantities.

IF YOU HAVE A CONDENSER DESIGN PROBLEM, CALL ON MICAMOLD . . .

we design and build molded paper and mica, oil and electrolytic capacitors for all radionic and electrical applications. We will be glad to cooperate with you on any project . . . for war or postwar assignments.

NO LET-UP AND
NO LET-DOWN . . .
KEEP BUYING MORE
WAR BONDS

MICAMOLD RADIO CORPORATION
1087 FLUSHING AVENUE BROOKLYN 6, N. Y.

CALLITE THORIATED TUNGSTEN FILAMENTS contain the right proportions of tungsten and thorium to give the required electronic emission plus the rugged strength to withstand severe vibration and shock. ℭ That's why the Hytron Corporation of Salem, Mass., chose Callite filaments for instant-heating tubes used not only in police radio cars but also in many radio-equipped vehicles of the Armed Forces as well. Callite thoriated tungsten filaments make it possible to conserve battery power during stand-by periods when the transmitter is turned off. ℭ Manufacturers of heavy duty tubes appreciate Callite's careful processing of tube components, backed by C-T's long experience in tungsten metallurgy. You, too, can rely on us as a dependable source of supply. Callite Tungsten Corporation, 544 Thirty-ninth Street, Union City, N. J. Branch Offices: Chicago, Cleveland.

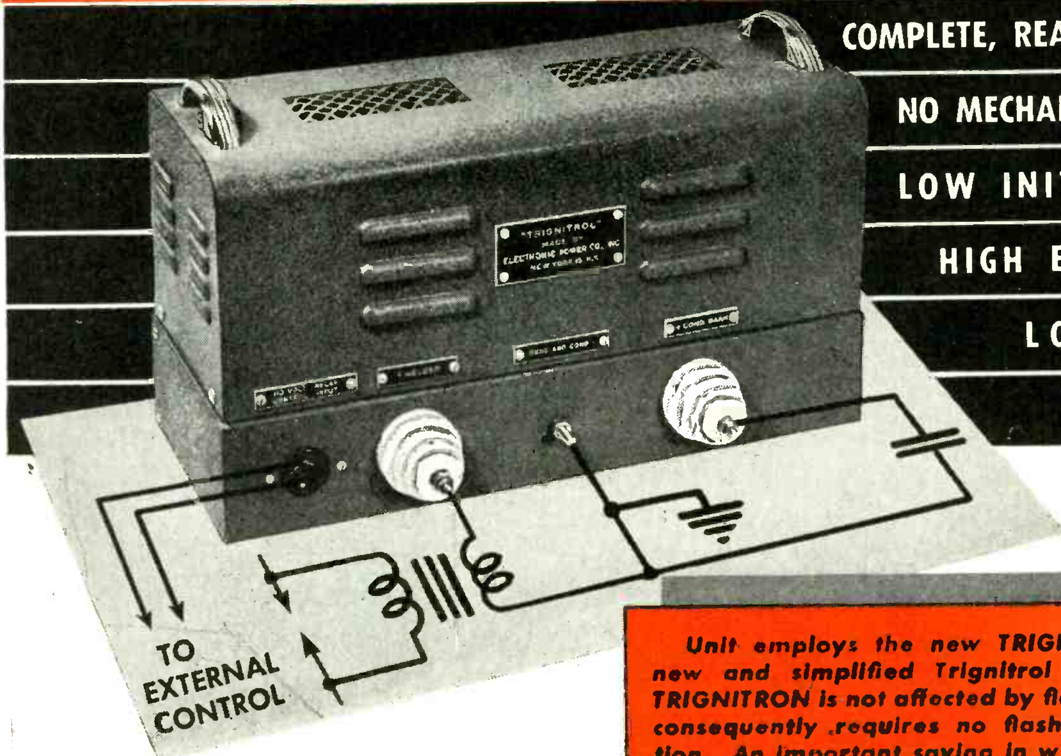
Callite *tube components*

*Out of this wrecked Sacramento police squad car which collided with a truck, a mobile transmitter, equipped with Hytron Tubes, emerged *intact* although mounted near the point of impact! Hytron Tubes types HY65 and HY31Z employ Callite 20 milligram thoriated tungsten filaments.

SPECIALISTS IN hard glass leads, tungsten and molybdenum wire, rod and sheet, formed parts and other components for electronic tubes and incandescent lamps.

THE TRIGNITROL

FOR USE WITH CONDENSER WELDERS AND SIMILAR DEVICES



COMPLETE, READY FOR USE

NO MECHANICAL PARTS

LOW INITIAL COST

HIGH EFFICIENCY

LONG LIFE

SILENT

Unit employs the new TRIGNITRON in a new and simplified Trignitrol circuit. The TRIGNITRON is not affected by flashbacks and consequently requires no flashback protection. An important saving in welder design.

Electronically transfers maximum energy to the welders!

Superseding the usual switching mechanism for discharging the condenser through the welding transformer, the TRIGNITRON discharges the condenser electronically. In this way, *all* energy is transferred from the condenser to the welder.

The TRIGNITRON operates on the principle of a mercury pool conduction tube fired capacitively by a small, compact low-power trigger circuit. When the external relay circuit is closed, a pulse is applied to the tube which fires once, discharging the condenser bank through the load.

Regardless of the time interval that the external contactor is held closed, the tube will not fire again until the contactor is opened and reclosed. The device can be fired as fast as the condenser bank can be recharged. Deliveries are prompt on rated orders.

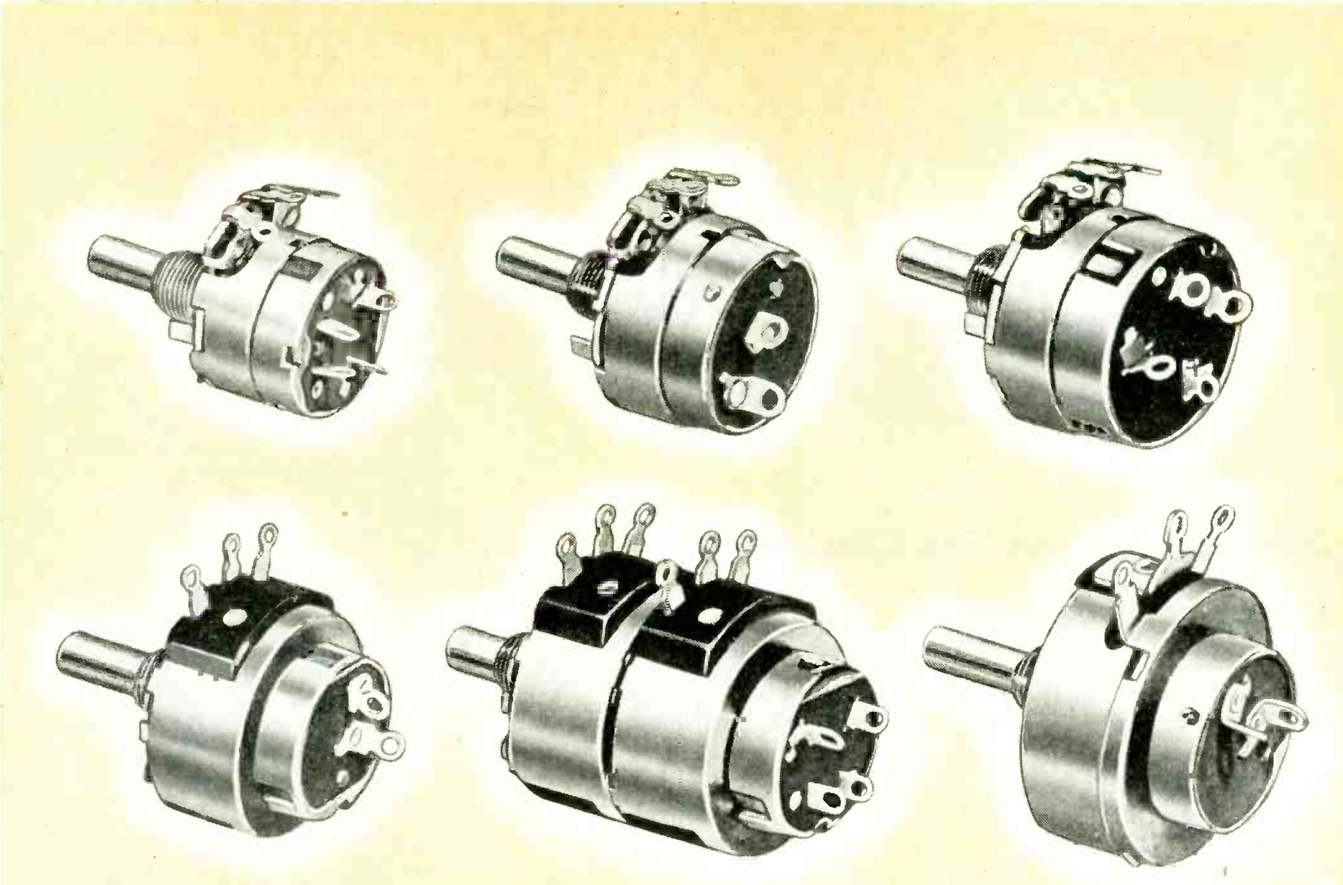
This device and the TRIGNITRON used therein are licensed for exclusive use in welding equipment under the U.S. Pat. 2,287,541. Other patents pending.

EPC INC

A PRODUCT OF

ELECTRONIC POWER COMPANY, INC.

19 WEST 44th STREET, NEW YORK 18, NEW YORK



Behind Chicago Telephone Supply Company are many years of intensive research and the development of a scientific manufacturing organization devoted to high standards in the mass production of variable resistors, both wire wound and carbon types.

Manufacturers of Quality
Electro-Mechanical Components Since 1896

VARIABLE RESISTORS, PLUGS, JACKS, SWITCHES, TELEPHONE GENERATORS, RINGERS

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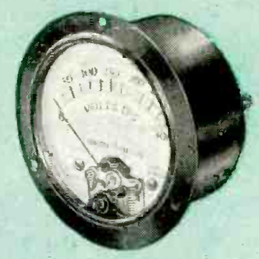
ELKHART ★ INDIANA

New

INTERNAL-PIVOT PANEL INSTRUMENTS

2½-inch—1 inch deep



For radio and other communications service: Type DW-51 d-c voltmeters, ammeters, milliammeters, and microammeters; Type DW-52 radio-frequency ammeters (a-c thermocouple-type). Cases are brass or molded Textolite.

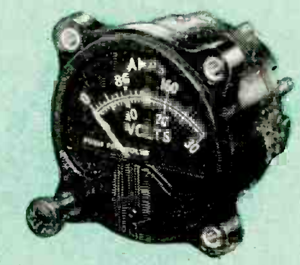
A New Design That Puts More Instrument into *Less* Space

These new, internal-pivot instruments were developed to fill a vital need—particularly in the radio and aircraft fields—the need for compactness. They are *thin*—in most ratings, less than 1 inch deep.

More important is the way their thinness was achieved. In the sketch below, see how the pivots are solidly anchored to the *inside* of the armature shell so they cannot work loose. The moving parts are permanently aligned with stationary parts by bolting the core assembly to a one-piece cast-comol magnet.

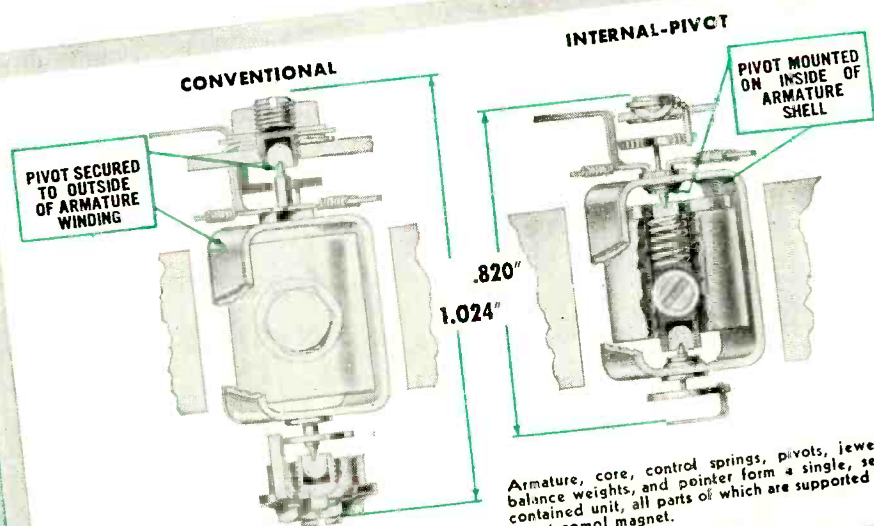
Other features are: large-radius pivots, high torque and good damping, lightweight moving element, and ample clearances. Added up, they give you an instrument well able to withstand vibration and hold its rated accuracy, one that is fast on response and easy to read accurately—a design that packs all-round fine performance in a small space.

For ratings, price, and dimensions, ask our nearest office for Bulletin GEA-4064, which covers instruments for radio and other communications equipment; or Bulletin GEA-4117, which describes those suitable for naval aircraft. *General Electric Company, Schenectady, N. Y.*



Type DW-53 d-c voltmeters, ammeters, and volt-ammeters that are specially designed to measure voltage and current in battery and battery-charging circuits on naval aircraft. They meet applicable Navy specifications.

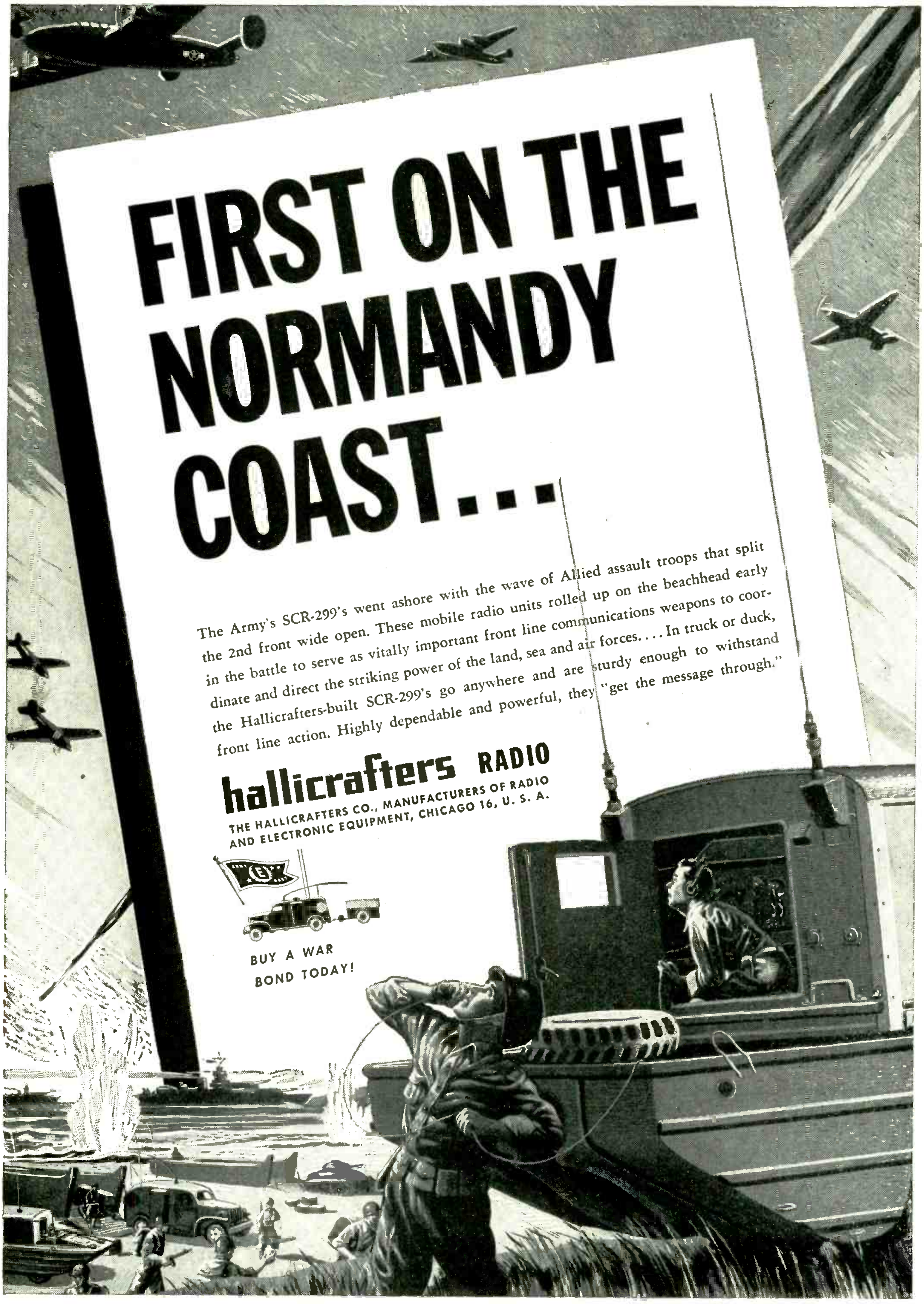
Invest in your future
BUY WAR BONDS



Armature, core, control springs, pivots, jewels, balance weights, and pointer form a single, self-contained unit, all parts of which are supported by a cast-comol magnet.

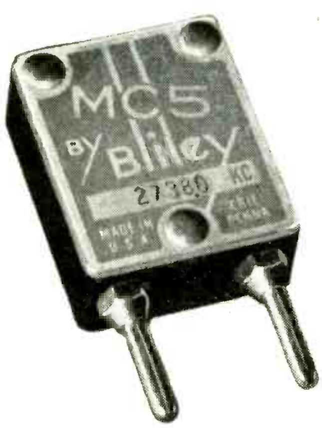
HEADQUARTERS FOR ELECTRICAL MEASUREMENT

GENERAL ELECTRIC


FIRST ON THE NORMANDY COAST...
The Army's SCR-299's went ashore with the wave of Allied assault troops that split the 2nd front wide open. These mobile radio units rolled up on the beachhead early in the battle to serve as vitally important front line communications weapons to coordinate and direct the striking power of the land, sea and air forces.... In truck or duck, the Hallicrafters-built SCR-299's go anywhere and are sturdy enough to withstand front line action. Highly dependable and powerful, they "get the message through."
hallicrafters RADIO
THE HALLICRAFTERS CO., MANUFACTURERS OF RADIO AND ELECTRONIC EQUIPMENT, CHICAGO 16, U. S. A.
BUY A WAR BOND TODAY!

A *New* TWIST

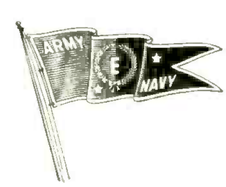
...to CRYSTAL CLEANING



THIS is an actual photograph of the centrifugal air drier, or "spinner," used in Bliley production to facilitate clean handling of crystals during finishing and testing operations. Quartz blanks are dried in 5 seconds in this device which is powered with an air motor and spins at 15,000 r.p.m.

Little things like lint or microscopic amounts of foreign material can have a serious effect on crystal performance. The "spinner" eliminates the hazards encountered when crystals are dried with towels and makes certain that the finished product has the long range reliability required and expected in Bliley crystals.

This technique is only one small example of the methods and tests devised by Bliley Engineers over a long period of years. Our experience in every phase of quartz piezoelectric application is your assurance of dependable and accurate crystals that meet the test of time.



BLILEY ELECTRIC COMPANY - - - ERIE, PA.

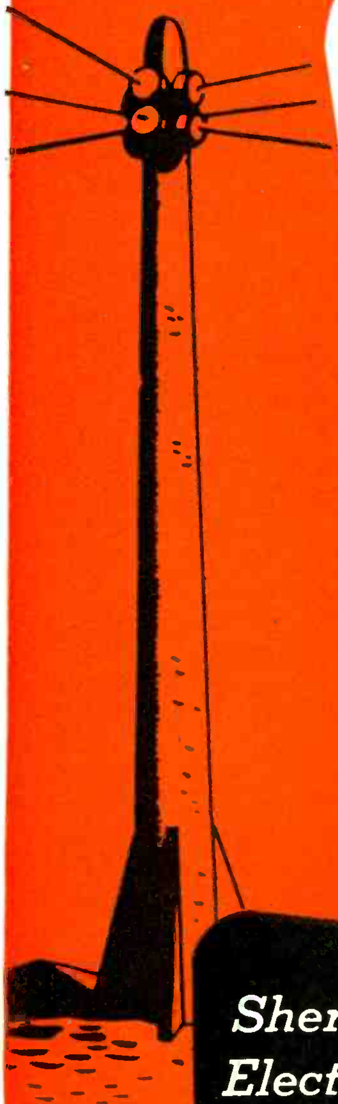
Bliley Crystals

SHERRON TELEVISION TEST EQUIPMENT

Key to Quality Control at All 3 Points

AT POINT OF	**MANUFACTURE**
AT POINT OF	**TRANSMISSION**
AT POINT OF	**FIELD SERVICE**

Sherron Test Equipment qualifies as indispensable to manufacturers of television transmitting and receiving apparatus . . . and operators of television stations. With this equipment on the job, no error can creep in undetected. No flaw can slip by unnoticed. Every characteristic of quality is accounted for—all along the line . . . In their automatic, all-seeing, all-knowing alertness, Sherron Test Units are invaluable in forestalling operational breakdowns in television efficiency . . . at point of manufacture . . . at point of transmission . . . at point of field service.



Sherron Electronics

LABORATORY • DESIGN • DEVELOPMENT

MANUFACTURING . . . The full-scoped facilities and specialized skills of Sherron Electronics are available to manufacturers of television equipment and operators of television stations.

SHERRON METALLIC CORP.

1201 FLUSHING AVENUE BROOKLYN 6, N. Y.

"WHERE THE IDEAL IS THE STANDARD, SHERRON TEST UNITS ARE STANDARD EQUIPMENT"

ERIE BUTTON SILVER MICA CONDENSERS*

Ideal Components
for V.H.F.—U.H.F. APPLICATIONS

ERIE Type 370 Silver Button Mica Condensers have proven to be ideal components for V.H.F. and U.H.F. applications where short ribbon-type leads, low series inductance, and compactness are requisite factors. Their efficiency and quality have been thoroughly established through practical service, in large quantities since 1941.

These small condensers consist essentially of a stack of silvered mica sheets encased in a silver plated housing. The housing forms one terminal, the other terminal being connected to the center of the stack, thus providing the shortest possible electrical path to and from the capacitor.

A wide selection of terminal and mounting designs is available to provide both feed-through and by-pass connections. Capacity ranges and electrical characteristics are given above.

Complete technical information will be sent to interested engineers on request.

CHARACTERISTICS

CAPACITY RANGE:
15 to 500 MMF at 1 mc.

POWER FACTORS:
.08% max. for capacity tolerance ± 5% or closer (for resonant circuit applications).
.12% max. for capacity tolerance over ± 5% (for by-pass and blocking use).

MAX. WORKING VOLTAGE:
350 Volts A.C., 500 Volts D.C.
Flash Test (2 seconds) 1,000 Volts D.C.
Leakage Resistance, Over 10,000 megohms.

*PATENTED

FOR HIGH ACHIEVEMENT IN WAR PRODUCTION

Electronics Division
ERIE RESISTOR CORP., ERIE, PA.
LONDON, ENGLAND • • TORONTO, CANADA

★ ★ ★ *Let's All Back The Attack—Buy EXTRA War Bonds* ★ ★ ★

YESTERDAY

and

TODAY!

Before Pearl Harbor, the leading line of sectional and telescopic antennas used by manufacturers of automobiles, radios and portable radios carried the WARD trademark.

Of course, today, all production is going to further the war effort, and men in tanks, planes, command cars—in communication units of all kinds—are becoming familiar with the name of WARD. It appears on antennas used on communication equipment all over the fighting front.

The expertness of design and manufacture that made WARD the leader in the pre-war period and during wartime, is being supplemented by knowledge gained from the war effort. After the armistice is signed, there will be new and improved products. If the use or specifying of aerials is included in your post-war planning, or if you are a distributor, look to WARD!

WARD *Antennas*

THE WARD PRODUCTS CORPORATION
1523 E. 45TH STREET, CLEVELAND, OHIO

Right on the field of battle is the CBC truck with its Presto recorder taking down the sounds of battle, the words of Canadian men *doing the fighting* . . .

Yes! It actually happens. Canadian families are now hearing the voices of their own loved ones on the battlefronts, thanks to a program service originated by the Overseas News Service of CBC. This enterprising and much appreciated service consists of recordings made right on the scene of battle, the actual sounds of battle forming a terrible background. The recordings are rushed to Algiers, short-waved either via London or direct to Ottawa, where they are re-recorded, and sent out over the CBC leased lines. All this is made possible by the use of PRESTO Recording Equipment, which is used throughout the Canadian Broadcasting Corporation.

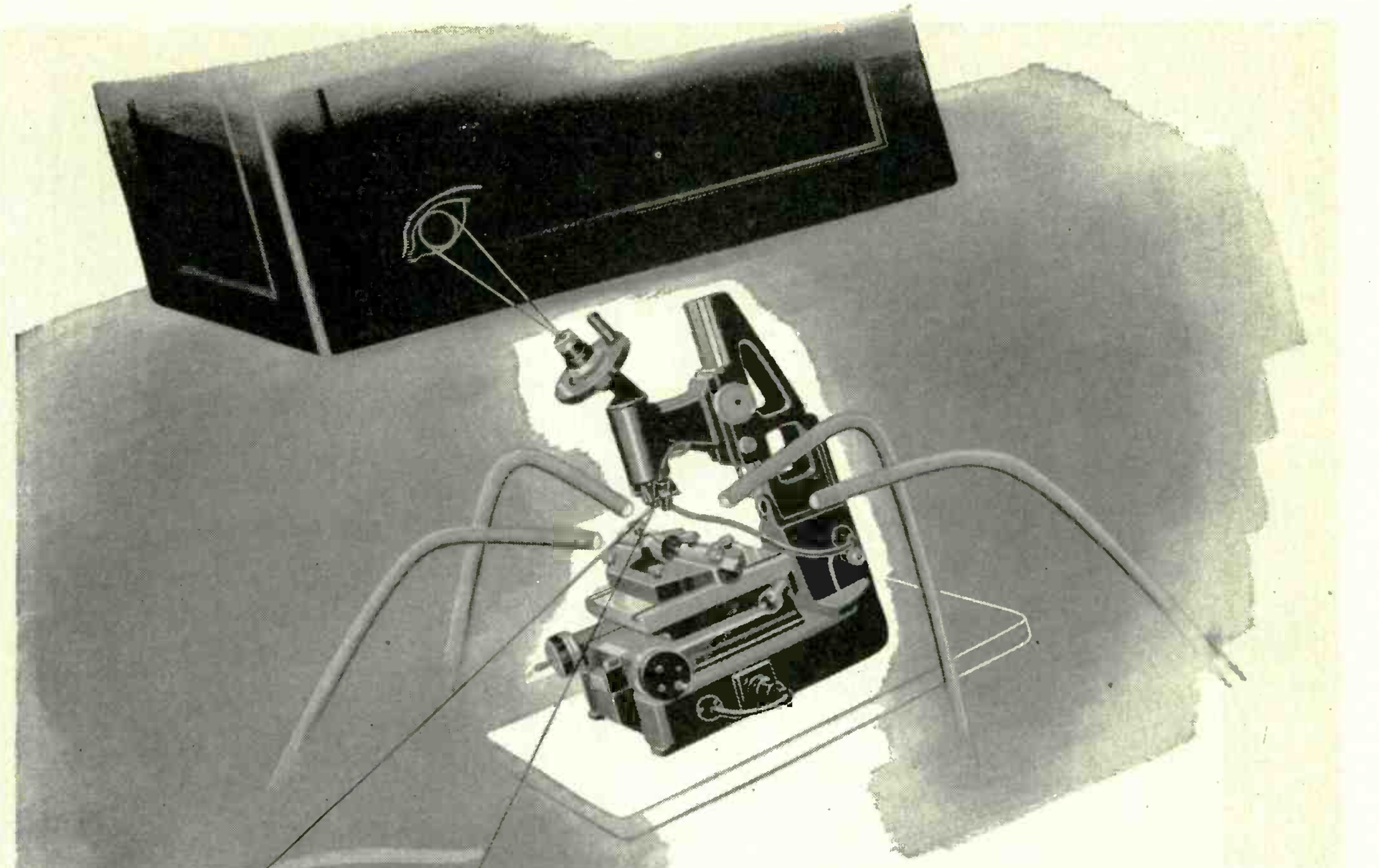
. . . Transmitted by short wave to BBC in London, the broadcast is re-recorded on one of the fifty complete Presto recording installations in the British Isles . . .

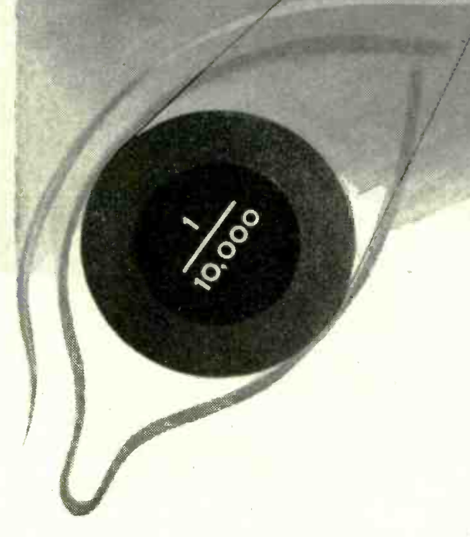
. . . Short-waved again, this time to CBC in Ottawa, the battle-recorded broadcast is then sent over wire lines to the stations on the CBC networks across the Dominion.

Presto Recording Corporation, New York 19, N. Y., U. S. A.

World's Largest Manufacturers of Instantaneous Sound Recording Equipment and Discs


SYLVANIA "LOCK-IN" RECEIVING TUBES
MINIATURE RADIO RECEIVING TUBES
STANDARD TYPE RECEIVING TUBES
TRANSMITTING TUBES
STROBOTRONS
PIRANI TUBES
CATHODE RAY TUBES
POWER MEASUREMENT TUBES
THERMOCOUPLE TUBES
FACSIMILE RECORDING TUBES
GAS VOLTAGE REGULATOR TUBES MINIATURE AND STANDARD SIZE
RADIO TUBE PARTS
WELDS AND LEADS
S
One Standard—
The Highest Anywhere Known
That working principle in radio tubes and related fluorescent and incandescent lamps won Sylvania many important wartime assignments in electronic development and manufacture. Now Sylvania manufactures many different types of electron tubes other than radio to the same high standard. A few of them are shown here. There are many more, some of which are still on the restricted list. For information, write to Sylvania, 500 Fifth Avenue, New York 18, N.Y.
SYLVANIA
ELECTRIC PRODUCTS INC.
500 FIFTH AVENUE, NEW YORK 18, N. Y.





$\frac{1}{10,000}$ ever see of an inch?

Small things are often of major importance—and mean the difference between success and failure. Utah Parts, for instance, must be accurate to the most minute detail. Even an error so small as one ten-thousandth of an inch could result in faulty operation.

This marvelous instrument, the measuring microscope, makes it possible for Utah engineers to spot errors in workmanship—no matter how slight. They are able to make infallible measurements to the ten-thousandths of an inch —just one reason for the split-hair accuracy of Utah Parts wherever they are used.

Utah's outstanding name for dependability and long life is due to the painstaking inspection, ever watchful surveillance and complete testing. These "traits" in Utah's character have been of prime importance in adapting the many war-born miracles of radio and electronics to today's military needs. They will be just as important in transforming them to commercial uses tomorrow.

★ ★ ★

Every Product Made for the Trade, by Utah, Is Thoroughly Tested and Approved

Keyed to "tomorrow's" demands: Utah transformers, speakers, vibrators, vitreous enamel resistors, wirewound controls, plugs, jacks, switches and small electric motors.

utah

Utah Radio Products Company, 857 Orleans Street, Chicago 10, Ill.

FEDERAL HAS DEVELOPED THE FIRST NITROGEN PURIFIER

Intelin Ultra High Frequency Coaxial Cable, developed and manufactured by Federal, has extreme ruggedness and meets all specifications with precision, accuracy, uniformity and dependability.

No oxidation, no contamination, no moisture!

Another Federal First adds extra performance guarantees to FTR vacuum tubes.

In a corner of the new FTR tube plant is this automatic nitrogen purifier. During the process of sealing the anode to the stem, the elements of every FTR tube are now protected from oxidation, contamination and moisture in a scientifically controlled atmosphere of automatically mixed nitrogen and hydrogen.

Here is another reason why you get higher operating efficiency and still longer life when you use FTR tubes. Another evidence of the ability, brains and *technical understanding* which have earned the reputation that "Federal always has made better tubes."

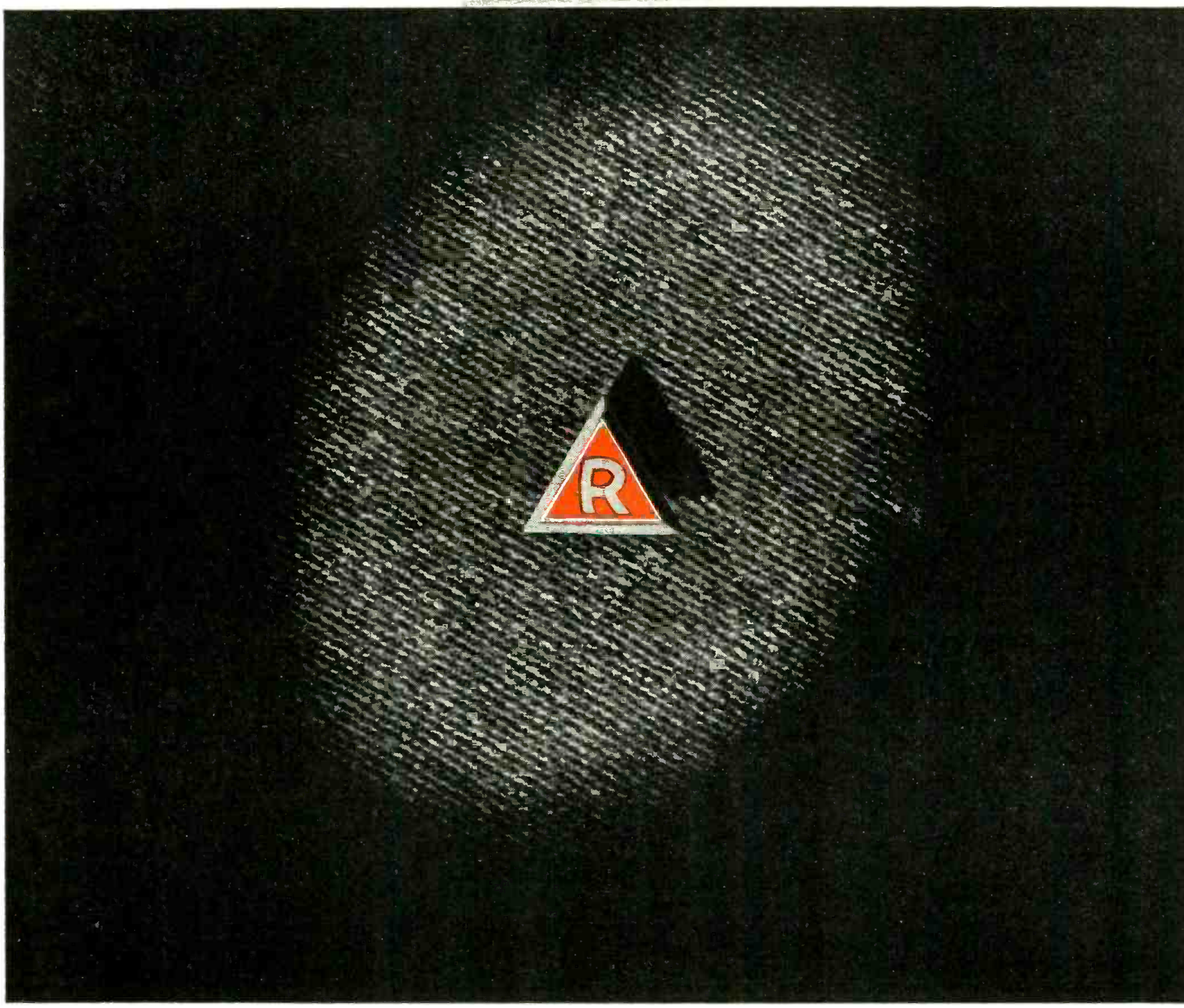
Now is the time to know Federal.

Federal Telephone and Radio Corporation

AN IT&T ASSOCIATE

Newark 1, N. J.

INVEST IN THE FUTURE—BUY WAR BONDS



Achievement has its Trademark

For many years, it has been Raytheon's privilege to provide electronic and industrial concerns with the finest equipment and tubes that loyal craftsmen could design and build. ★ ★ ★ Since December 7th, 1941, we have accepted a major responsibility . . . supplying our armed forces with electronic and electrical apparatus in quantities to bring victory sooner. ★ ★ ★ Even before Pearl Harbor, close cooperation with the Armed Services of the United States had resulted in new production techniques and the design of new, superior products. These new devices have been credited with helping to turn the tide of battle. ★ ★ ★ We find double satisfaction in the task performed today. Developing and producing advanced equipment assures us that our boys are adequately equipped with superior military devices. It also means these responsibilities have greatly added to our abilities to serve industry as designers and builders of electronic equipment and tubes when peace comes.

RAYTHEON MANUFACTURING *Company*

Waltham and Newton, Massachusetts

AUTO-LITE

Electrical

Wire AND Cable

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Wire Division

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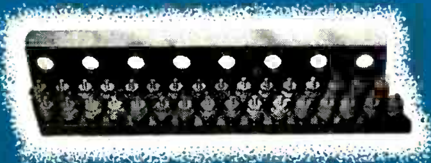
ACCES

Right—KT Terminal Strip. Strips of binding posts mounted in bakelite can be had in any number of pairs specified.



Left—Type K Distributing Strip combined with insulated metal fanning strip—a moulded bakelite strip of high insulating value and great strength. Studs of non-corrosive, high tensile strength metal. Can be furnished in exact number of pairs required.

Right—Type KS Terminal Strip is similar to the K Strip except that it is furnished with a row of solder clips under the nuts. Fanning strip is optional.

Left—Furnished for 6, 11, 16, 26 pairs or multiples thereof, these Distributing Panels are furnished with or without fanning strips. Single piece moulded bakelite faceplate and fanning strip is feature of latter. Non-corrosive studs.

Below—Cable Distributing Strip and Housing for low voltage circuits. Special type housing will accommodate various types of strips.

Below—Type 55 Terminal Strip for interior low voltage circuits. For mounting in instrument boxes and test cabinets.

Below—Type 65 Terminal Strip—Bakelite base, tinned brass connectors, furnished in various lengths.

Left—Type 52 Interior Junction Box showing Type 52 Terminal Strip. Furnished in 10, 20 and 26 pair sizes. Special sizes up to 52 pairs to order. Solder connections for permanently low resistance. Terminal block of heavily tinned, formed metal clips set into hard rubber insulation.

Supplementing the line of Cook Relays, "Spring-life" Bellows and Pressure Detector Switches, is a line of accessories, a representative group of which are shown here.

These are some of the items for which engineers in the aviation, communications, electrical and electronic manufacturing industries "Look to Cook" when planning their requirements.

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- Tooled and fabricated completely under one roof.
- Precision manufactured with modern equipment.
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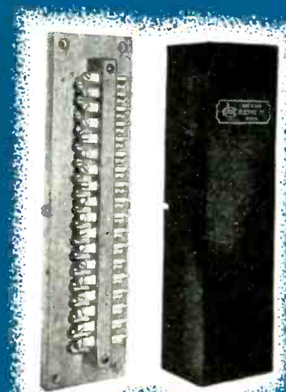
- Highest grades of all materials are used in all parts.
- Manufactured in a model plant with efficiency that provides capacity to produce in quantity.
- You can buy direct from manufacturer—if quantities warrant, we will tool for special requirements.

COOK ACCESSORIES

Left—Type 53 Interior Junction Box showing Type 53 Terminal Strip. Terminals providing solder clips on cable side and screw connections on drop side are mounted in specially selected kiln dried maple terminal strip. Furnished in 13 and 26 pair capacity.



Above—Type 54 Interior Junction Box showing Type 54 Terminal Strip. Similar to Type 53 except that heads are smaller, unit is more compact and has lighter weight studs.

AROUND THE WORLD

WITH AMERTRAN 400 CYCLE TRANSFORMERS

Within the small area of a testing laboratory, AmerTran puts its 400 cycle transformers through a round-the-world trip. Every possible service condition encountered in war or peace is duplicated by pressure, temperature and moisture extremes as well as by impact and vibration.

Among the precautions AmerTran takes to assure that the 400 cycle transformers will pass these tests are: High vacuum impregnation of coils with fungus proof varnish, followed by slow baking; infra-red pre-heating of cores and coils to insure complete adherence of insulating compound; torque gauging of screwed terminals; Neoprene gaskets for ceramic insulators; pressure testing of immersed cases before final sealant is applied.

Because of their minimum weight and dimensions, as well as absolute dimensional conformance, AmerTran 400 cycle transformers are the ideal components for airborne installations. Conservatively rated, they bear the guarantee of AmerTran, pioneers in transformer progress for more than forty years.

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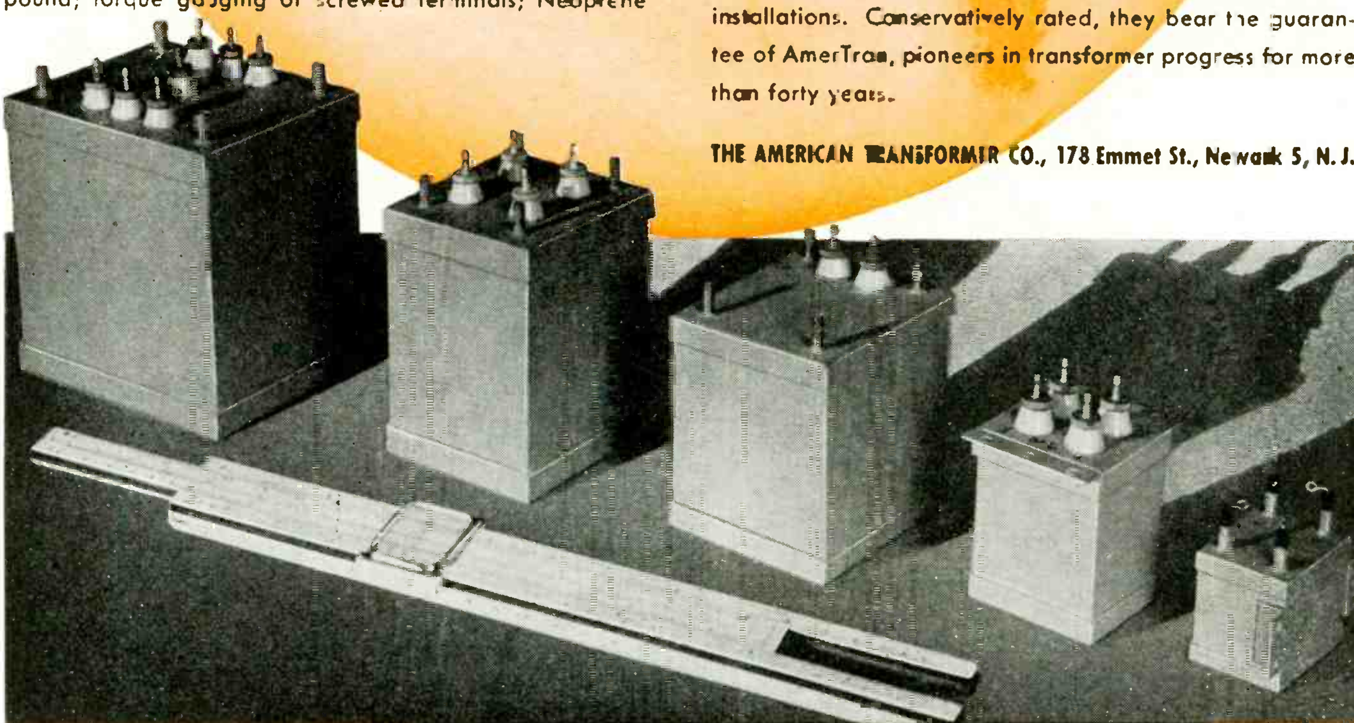

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Izod Impact Strength (ft. lbs. per inch of notch)—0.5 to 20.
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Tensile Strength (psi)—7,000 to 35,000.
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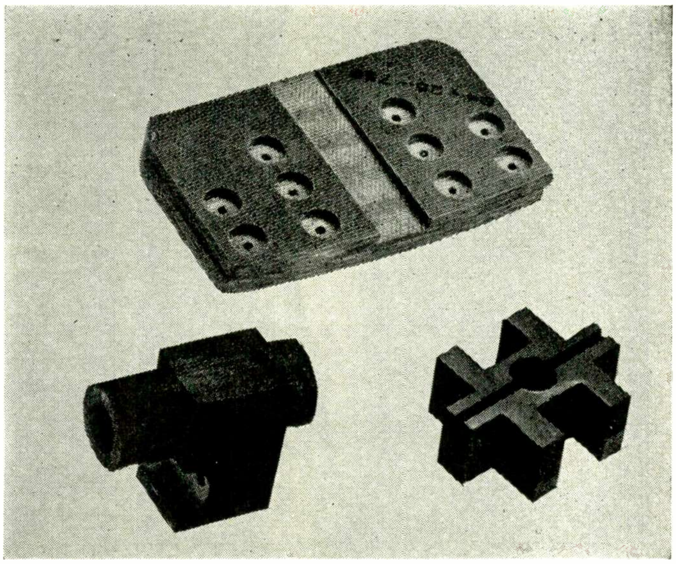

Panelyte, the structural laminated plastic, is both versatile and adaptable. Close tolerance work is possible because sheets are thoroughly bonded and the structure homogeneous. Irregularity of shape or intricacy of design are not obstacles, as parts are lathe turned, milled or drilled to exact specifications.

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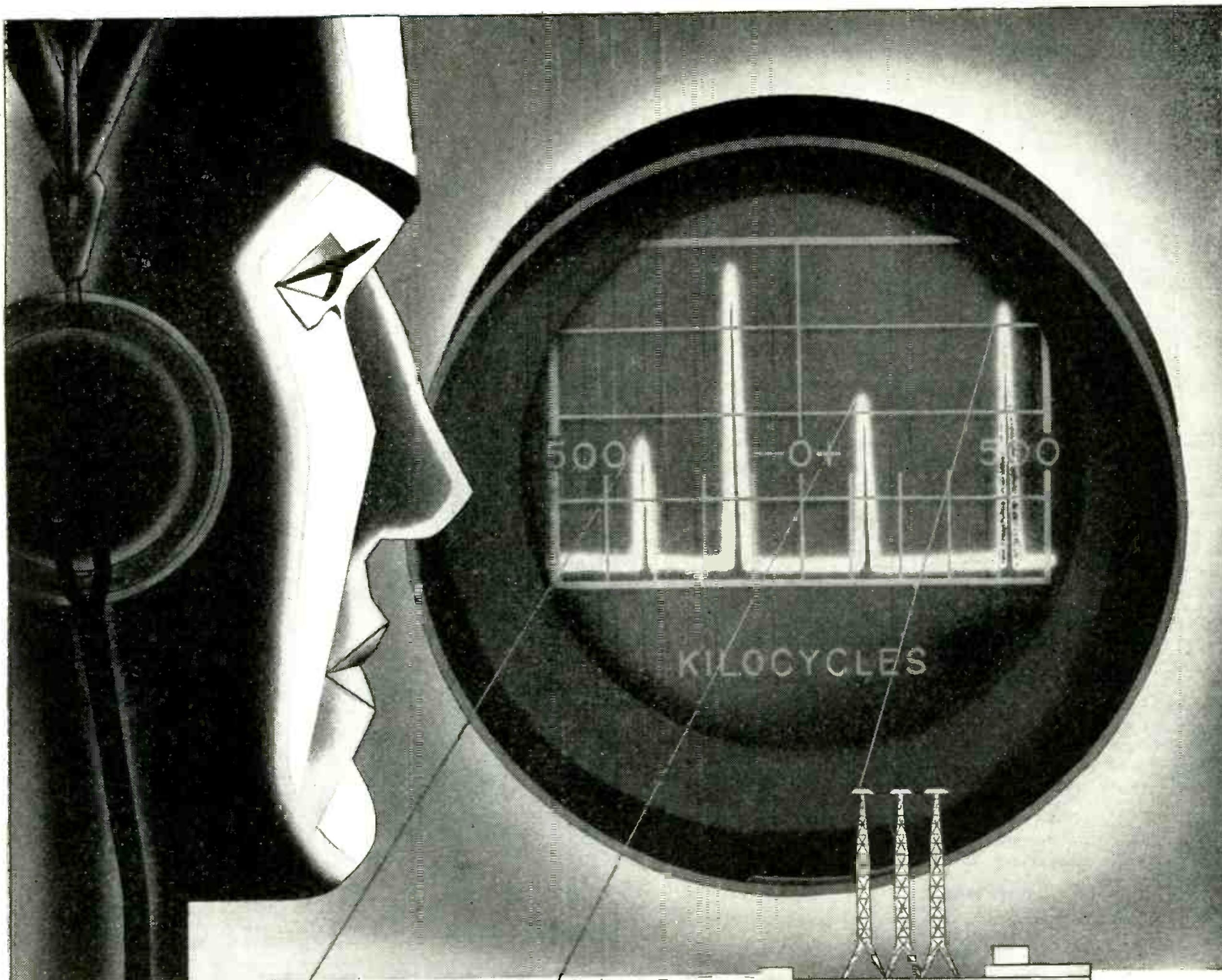
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FREE ENTERPRISE

The Obligation of Management and Labor to Cooperate... in War... in Peace

The Invasion is on! We have unleashed our full might for military victory. We have confidence that our great strength will bring success. We are strong because we have achieved unity in mobilization and in combat.

Though victory appears assured, we cannot rest until we have done everything in our power to speed the day when death and destruction are halted.

The home front is an important factor in this time element, for the fighting power of our Armed Forces depends upon their weapons. Napoleon's army fought "on its stomach"—man against man. Eisenhower's men fight on their tonnage—tanks, artillery, machine guns, heavy bombers.

As never before in the long succession of wars, the legends of heroic deeds on the battlefronts in this world conflict will be paralleled in history by the great accomplishments on the production fronts. Along with these heroic achievements of our Armed Forces, the world will long remember the record of our production accomplishments which have made us the stongest military power in the world, as well as the arsenal of democracy.

As the conflict reaches its climax, as battles grow fiercer and more destructive, our responsibility becomes greater and more critical. We must coordinate our productive efforts with the same ingenuity and the same precision with which our Armed Forces have coordinated theirs. We dare not waste the productivity of a single man or machine in these critical days.

As our landing craft are discharging our fighting men on the beaches of Europe and the Pacific, they must not want for equipment. No interference with war production for any reason can be justified. There must be no picket lines in America!

The landing of American troops in France virtually has stopped all strikes in the United States. This is important and encouraging news because the prelude to Invasion, unfortunately, has been an epidemic of strikes. Time lost through strikes, during the first four months of 1944, was double that lost during the same period last year. April saw more strikes than any other month since Pearl Harbor, and in May the record again was broken. Here is what happened within two weeks in May:

> Nine thousand men in six Chrysler plants in Detroit were out when a jurisdictional dispute in a "soda pop" war between the American Federation of Labor teamsters and the Congress of Industrial Organizations fired their discontent.
>
> A three-day sit-down strike occurred among 950 employees in the B. H. Aircraft plant over the refusal of the company to discharge a superintendent unsatisfactory to the union.
>
> Thirteen hundred men in the Chevrolet transmission and axle plant at Saginaw struck over a no-smoking rule and a change in shift-starting time.
>
> Two thousand employees at the Browne and Sharpe Manufacturing Company walked out when a woman was hired to fill a job long held by a man.
>
> Production of penicillin, blood plasma, and other medical supplies was halted at two Detroit plants of the Parke Davis Company as 1900 employees struck for a ten-cent raise.
>
> Over 25,000 lumber workers in the Pacific Northwest struck because the War Labor Board denied their demand for a wage increase.

At the end of the third week of May, 70,000 workers in 26 plants in Detroit were idle because of strikes.

Strikes in Detroit alone reduced production as much as a moderately successful German air raid would have done. Far more important than their effect on output is the effect of strikes upon national unity and morale. To our home front and to our Armed Forces, strikes belie our pledge to back the attack with all the power at our command. Hence, strikes limit our all-out war effort.

Prompt and decisive action is needed to keep America free from strikes for the remainder of the war. Stoppages of work on the production lines cannot be condoned while lives are being lost in fighting the enemy.

Most union leaders realize this need and are preparing to impose discipline upon their members who violate the no-strike pledge. The Warehouse Division of the International Longshoremen's and Warehousemen's Union (C.I.O.) recently declared: "Strikes in this time of war are treason against the nation and betrayal of the interests of labor." A message sent by William Green to all heads of American Federation of Labor unions stated:

> "D-day is here. From now on until Hitler is finally crushed, every worker enrolled in the army of production must consider himself a part of the invasion forces of the United States and conduct himself accordingly. I call on you in the name of the American boys who are risking their lives under enemy fire to maintain uninterrupted production under any and all circumstances. Until victory is won every worker must give the same all-out service that our Armed Forces are giving on the field of battle."

Strongest of all was the appeal of R. J. Thomas, president of the United Automobile Workers, to members of his union:

> "Our union cannot survive if the nation and our soldiers believe that we are obstructing the war effort . . . there can be no such thing as legitimate picket lines . . . I appeal to our membership. If you value your union, if you want to live and serve after the war, we must restrain ourselves and our hot-headed brothers today. If we do not, there will be no union after the war."

Union officers are entitled to vigorous support from management and government in their efforts to prevent strikes. Behind many a strike is an accumulation of unsettled grievances. Managements are overworked, and many union shop stewards are new and inexperienced and do not always do their part in turning down cases which lack merit. Both of these conditions make it easy for large backlogs of unsettled grievances to pile up. A special drive to clean up unsettled cases and to prevent new accumulations of them is one way by which managements and local union officials can help shorten the war.

The government too has a contribution to make to the prevention of strikes—both through the prompt disposal of disputes and through firm action against the leaders of strikes. The National War Labor Board and the Regional Boards are disposing of over five thousand cases a month and have made an excellent record in reducing their backlogs. Nevertheless, the boards still have many old cases; and about one out of four strikes has been an effort to get action from one of the labor boards. The boards are entitled to cooperation from employers and unions in keeping down their docket. In instance after instance, cases are dumped in the lap of the board before the union and employer have made a real effort to get a meeting of minds and to work out settlements.

In the present emergency, strikes are an expression of the lack of adequate understanding and team work between unions and management. Any future great upsurge in industrial strife likewise will be due to misunderstanding. After this war this country must not go through another "1919" when the time lost from strikes reached an all-time high. With 13 million workers, or almost half of the non-salaried employees of the country, in trade unions, the power and prestige of unions is greater than ever. *The long-run prosperity of the country requires that business and labor learn how to cooperate in supporting the policies which produce the largest possible profits and the largest possible payrolls.*

Although business is primarily interested in the largest possible profits, and labor is primarily interested in the largest possible payrolls, both objectives call for the same basic conditions. Payrolls depend upon the prospects for profits. If bad relations between business and labor or unwise public policies cause employers to take a pessimistic view of the outlook for profits, both employment and payrolls will be depressed.

Individual unions and individual employers always will have differences over wages and hours and the status of labor in particular plants or in particular occupations. Some disputes on such issues are inevitable, but resort to arbitration and calm intelligence can help greatly in avoiding strikes in the long run. Cooperation between labor and management is an economic necessity. In our kind of economy, payrolls and profits *both depend upon the willingness and the ability of business and labor to work together in creating the conditions under which enterprise flourishes.*

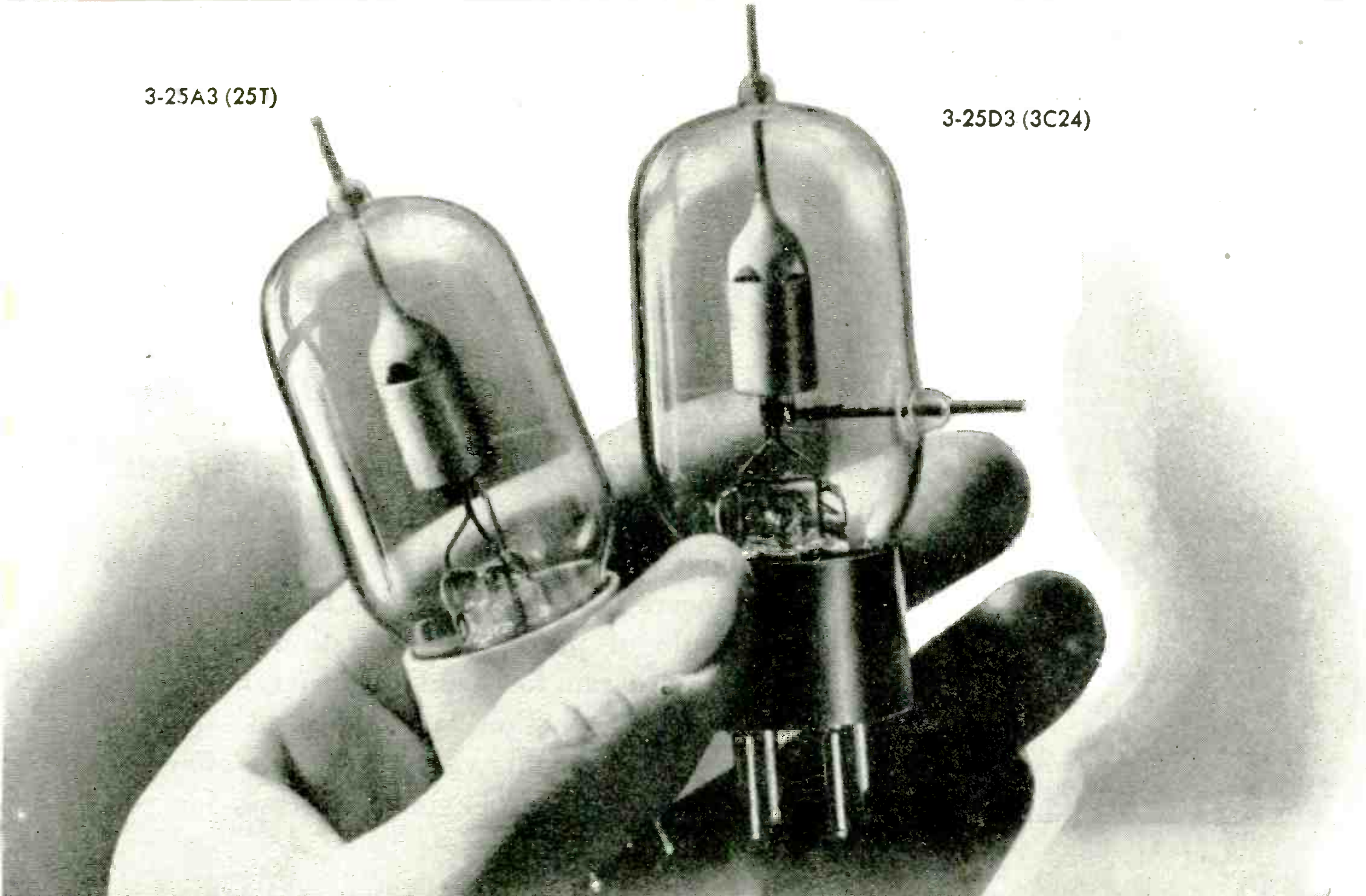
The foundation for intelligent and effective cooperation must be accomplished by skillful and imaginative managers in plants throughout the country who are willing to help unions with their problems, and who are able to interest union leaders and their members in the problems of business. Union members and their leaders are keenly interested as a rule in the efforts of management to win new markets. They know that jobs depend upon the success of managements in improving the product, adding new items to the line, and, less frequently, cutting costs and prices. Employees like to be kept informed about what management is doing, what problems it is meeting, and what success it is having. Most of all, they like to have an opportunity to contribute their ideas and suggestions.

The recent epidemic of strikes should not blind us to the fact that even today there are more plants where managements and unions are on good terms than ever before in the country's history. Consider, on the one hand, the extensive and constantly growing efforts of unions to train and develop shop stewards and, on the other hand, the efforts of employers to teach foremen how to carry out the new responsibilities imposed upon them by union agreements. Unions and managements together are learning how to operate together such technical devices as time study and job evaluation. Managements which, several years ago, opposed the provision of umpires to interpret union agreements and to settle deadlocked cases today are taking the lead in suggesting such arrangements.

The war is reaching a crisis, and all groups in the country must be aware as never before of their common interests. This presents an opportunity which should be seized to lay the permanent foundations for more effective team work in American industry. Let history record that the days when Europe was being liberated also were the days when unions and employers were making unprecedented progress in preparing American industry for the return of the service men by developing policies of cooperation between business and unions. Such cooperation will help achieve a peace worthy of our efforts and our sacrifices.

James H. McGraw, Jr.

President, McGraw-Hill Publishing Company, Inc.



Here are TWO NEW TUBES in the Eimac line

	3-25A3(25T)	3-25D3(3C24)
Plate Dissipation (watts)	25	25
Amplification Factor	25	25
Filament Volts	6.3	6.3
Filament Current (amps.)	3.0	3.0
Interelectrode Capacities:		
Grid to Plate	1.5	1.6
Grid to Filament	2.5	1.8
Plate to Filament	0.2	0.2
Maximum Ratings (Class C amplifier):		
Plate Voltage (DC)	2000 volts	2000 volts
Plate Current (DC)	75 mills	75 mills
Grid Current (DC)	20 mills	20 mills
Maximum Plate Dissipation (watts)	25	25

Smaller brothers of the Eimac 35T and 35TG, these two triodes are filling a need in high-frequency equipment of relatively low-powered class. They attain a high order of efficiency on frequency in the VHF range and perform equally well at lower frequencies.

In every way these two are worthy additions to the Eimac family . . . embodying all the Eimac features including complete freedom from premature emission failures due to gas released internally.

Complete data is available without obligation. Write for it today. Also ask for your complimentary copy of *Electronic Telesis*, a sixty-four page booklet which gives the fundamentals of Electronics and many of its applications. Written in layman's language, this booklet will assist engineers in explaining the art to novices.

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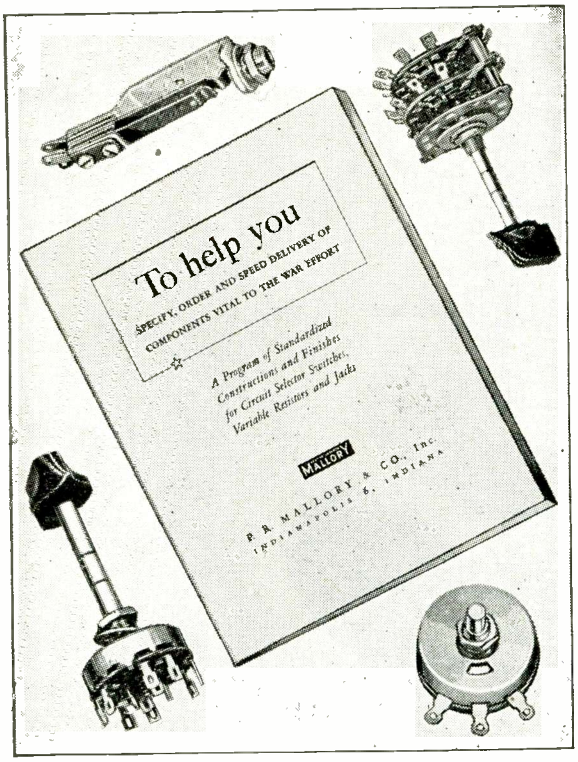

Mallory Standardization Program for Electronic Components

Breaks a Production "Log-Jam"

Cooperation is a reality in wartime. Mallory engineers have just provided another striking example of practical cooperation with a research program for standardization that assures speedier production and improved construction of components vital to the war effort . . . conserves valuable engineering time for you.

For the first time, a manufacturer of electronic parts has thoroughly studied the effects of various salt spray conditions on combinations of metals, alloys and platings. One result has been Mallory's development of two *standard* types of construction for radio components:

Type A—most parts: stainless steel and nickel-plated brass.

Type B—most parts: cold rolled steel and brass, cadmium-plated.

Extensive Mallory research has proved what metals do the best job in each part of a switch, variable resistor or jack assembly—what plating thickness is required—what combination of materials will withstand rigorous salt spray tests. Until now, production of rotary circuit switches and other components has been delayed by dozens of specifications—often conflicting—for materials, plating finishes and special constructions. Mallory's new standards are helping to break this "log-jam", with

- Specifications and ordering vastly simplified.
- Production speeded and made much easier.
- Deliveries to customers made more promptly.

Also, the new Mallory constructions are obvious improvements because the materials selected for each part have been proved best.

Mallory cooperation isn't limited to producing better switches, jacks and volume controls, faster. Normally, the salt spray data would be kept secret and used only by Mallory. But throughout the war, Mallory's policy has been to provide useful information to anyone in American industry who can put it to work for victory. Now Mallory offers complete data on the materials and platings, chosen on the basis of thorough salt spray tests, for various parts of Mallory switches, variable resistors and jacks. Valuable data on fungicidal protection has also been compiled.

Collected in a 20-page booklet, this useful information is yours for the asking. Write us on your business letterhead today.

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MALLORY

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BUY AN EXTRA WAR BOND

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CROSS TALK

▶ ALADDIN . . . Years ago everyone got pretty bored with the constant comparison of the radio tube with Aladdin's lamp. And yet, has man ever developed a new device which required so little raw material, or so little time to build, or so few man-hours of labor and which delivered so much good to the world as the radio tube? What else in man's experience is worth so much in relation to its mass, or volume or any other criterion?

Capable of being held in the palm of the hand, the electron tube controls the communication channels which tie the world together, it may decide the manner in which the war will be won, it is the heart of the world's greatest forces for education and entertainment—broadcasting and the movies.

Truly it can be said that the electron tube is made almost entirely out of men's brains.

▶ TRANSIENTS . . . The post-war technical world of electronics is going to be different—so different in fact that engineers who have not had opportunity to keep themselves up to date by engaging in war-work, by reading or by going to out-of-hours courses will have difficulty in recognizing the new electronics as having much in common with pre-war techniques.

Sending power down a pipe or tube apparently without a return conductor will no longer impress communications men. Antennas only a few inches long, having high directivity, will not be rare. "Megawatts" of power will be closely linked with microseconds of time. The generation and use of pulses, which got their start in television and welding control, will become a new art which radio men must study assiduously. In fact, older methods of analyzing circuits on the basis that only sine waves are to go through them are already outmoded. There is now a whole book on radio principles (published by the Government and on the restricted list) which barely mentions sinusoidal waves.

The future engineer must know as much about strange wave forms as we now know about sine waves. He must know what happens when any of the newer forms of waves are impressed upon combinations of L, C and R. He must know the instantaneous events that occur and will no longer be solely interested in the steady-state conditions.

All of this brings us to the subject of transients. In the old days, transients were annoying occurrences, studied by power engineers concerned with switching problems, but largely ignored by radio men. Those days are gone.

In our August issue, the first of a series of articles on the general subject of transients will appear, a series written by Mr. Dudley, our Western Editor. No reader of ELECTRONICS who hopes to have a stake in the days to come can afford to overlook these articles, or can afford not to study them carefully.

▶ TREND? . . . During the war, there has been much talk—and lots of work—on the science of dehydrating foods. The purpose is obvious saving of shipping space and weight. Electronic heating has been considered as one of the means by which excess moisture can be extracted from foods.

It must be remembered, however, that people still want fresh food, that shipping space will not always be at a premium. Thus, the future role of electronics in food dehydration is still anybody's guess.

▶ DAMN . . . Some high-powered fellows at MIT developed an electronic method of measuring the areas of irregular objects, such as the hide of a cow. The apparatus was duly devised, patented and constructed. It worked swell. Now it seems that the hide people make their profit on fractions of the unit area measured. These fractions are rated up to the next higher whole number and go to the credit of the house.

Trouble is the electronic system is so accurate that there are no fractions, therefore no profit, and no sales for the electronic gear.

Circuit Symbols STANDARDIZED

Conflict between comunications, power, control and measurement usages in representing resistors, capacitors, inductors and contactors resolves in a compromise. New electron tube symbols determined

AFTER a great deal of travail, symbols for certain electrical components entering widely into electronic apparatus have been standardized.

As readers of ELECTRONICS already know, long-standing conflicts have existed between the fields of communications, power, control and measurement concerning the symbols for capacitors, inductors, resistors and contactors. Lack of coordination and standardization in the symbolic language employed in circuit diagrams has interfered with the reading of these diagrams, has made it readily possible to make serious errors in wiring and maintaining equipment, and has caused no end of confusion during the wartime period of intensified production of electronic gear.

Industry Studied Problem

On January 22, a meeting was held under the auspices of the American Standards Association to iron out the difficulties. Up to that time, the facts were as follows: A zigzag symbol represented a resistor to communications engineers and an inductor to power, control and measurement engineers. Similarly, two short parallel lines indicated a simple contactor to a power engineer, and a capacitor to a communications engineer.

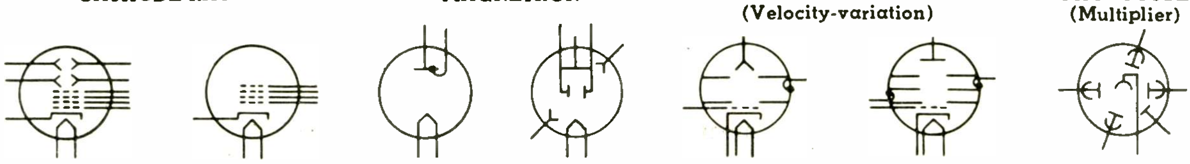
At the January meeting certain compromises were made. In response to a letter ballot to all concerned, however, additional objections and suggestions were offered. These were considered at another ASA meeting in March and at this time coordination was effected.

Solution A Compromise

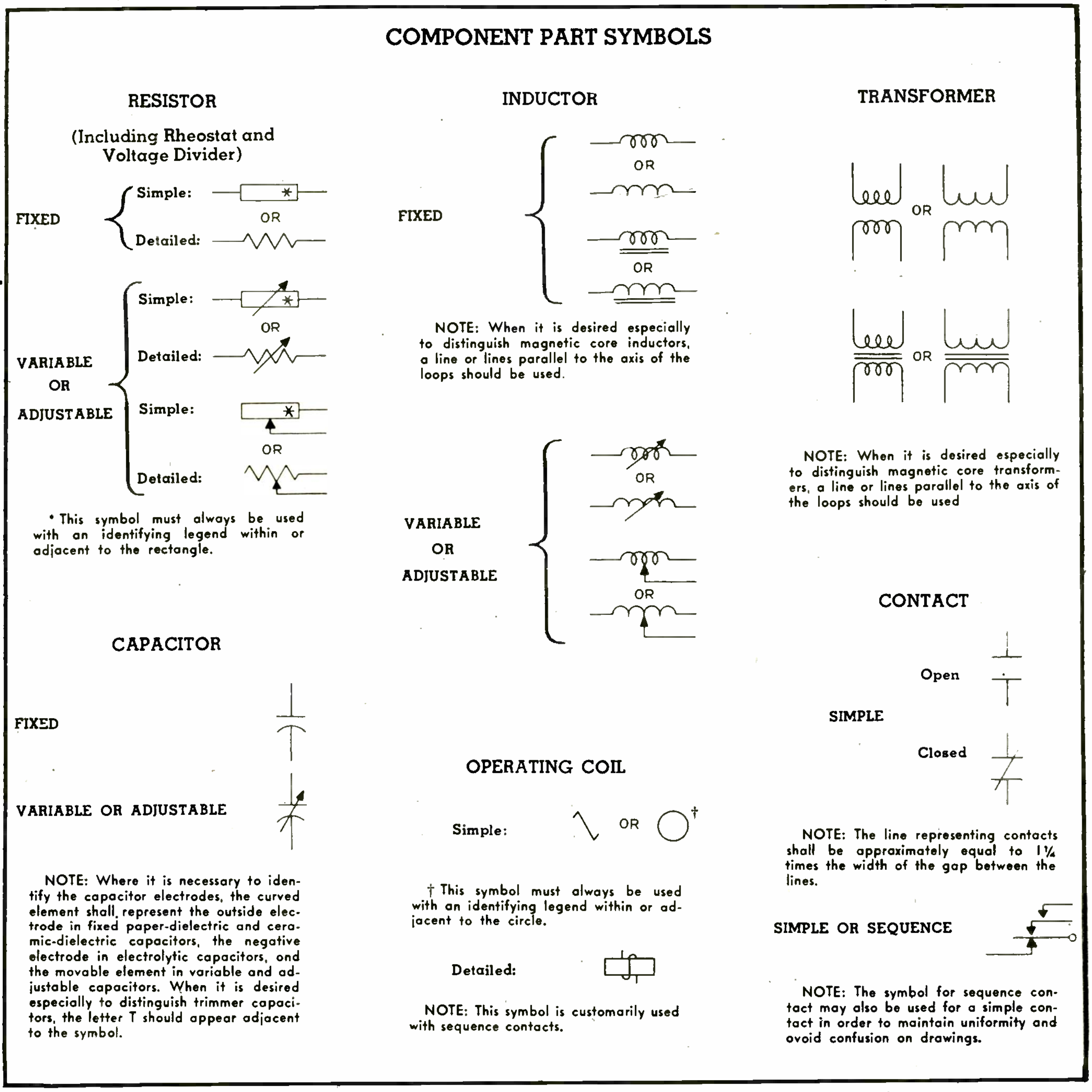
The situation, now, is simply this: A resistor is represented by either the rectangle of the power group or the zigzag of the communications group. An inductor may be shown by a series of closed loops or by a series of half-loops. Thus, while we do not have single symbols for these important circuit elements, and are forced to put up

NEW ELECTRON TUBE SYMBOLS

CATHODE-RAY — MAGNETRON — VELOCITY-MODULATION (Velocity-variation) — PHOTOTUBE (Multiplier)



Electrostatic Deflection — Magnetic Deflection — Resonant (With electro-magnetic loop coupling) — Transit-time Split-plate (With stabilizing electrodes) — Single-Cavity (With reflecting electrode) — Double-Cavity (With collecting electrode)



with an "either or" situation, some confusing factors have been eliminated.

Two unfortunate situations still exist, but under the circumstances all industries using electron tube apparatus must be thankful that at least something has been accomplished. The present simple contactor symbol will continue to confuse a communications man, since it looks like the symbol he has long used for a fixed capacitor. The zigzag symbol for a resistor will continue to look like an inductor to a power man.

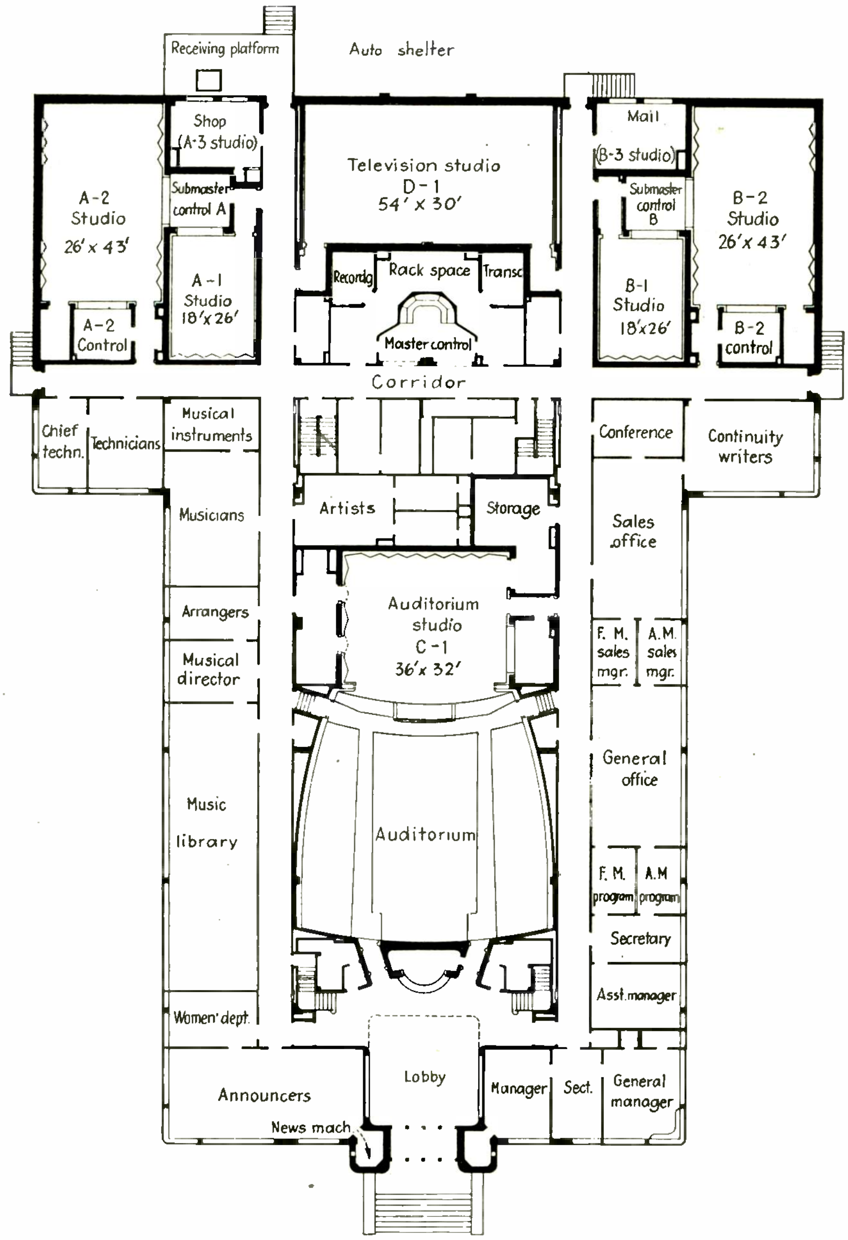
Electronics Will Use

As soon as possible the new symbols will be used in ELECTRONICS and it is hoped that the whole long-continued difficulty due to the lack of agreement will soon be forgotten. Instructors in college and technical schools can help a great deal by initiating the use of the new symbols in their classes at once. In this manner the oncoming generation will start right and will not have to change their language as the oldsters now must do.

Certain other symbols for new types of electron tubes have been tentatively standardized and appear here, together with the new *C*, *R*, *L*, and contactor symbols. Illustrations of the electrical symbols will also be found in ASA publication Z32.11, approved April 18, 1944; the tube symbols are from ASA Z32.10, approved April 11, 1944—K.H.

Milwaukee's Radio City

F-M and A-M programs of Milwaukee Journal radio stations now originate in a modern combination studio and office building having provisions also for television programs. Architectural and technical features are described here to guide post-war planners



First floor plan of offices and studios at the Milwaukee Journal Radio City. In general, offices for executives and announcers are near entrance, musical activities are at the left, sales offices at the right, and studios and operating equipment at the rear of the large auditorium-studio

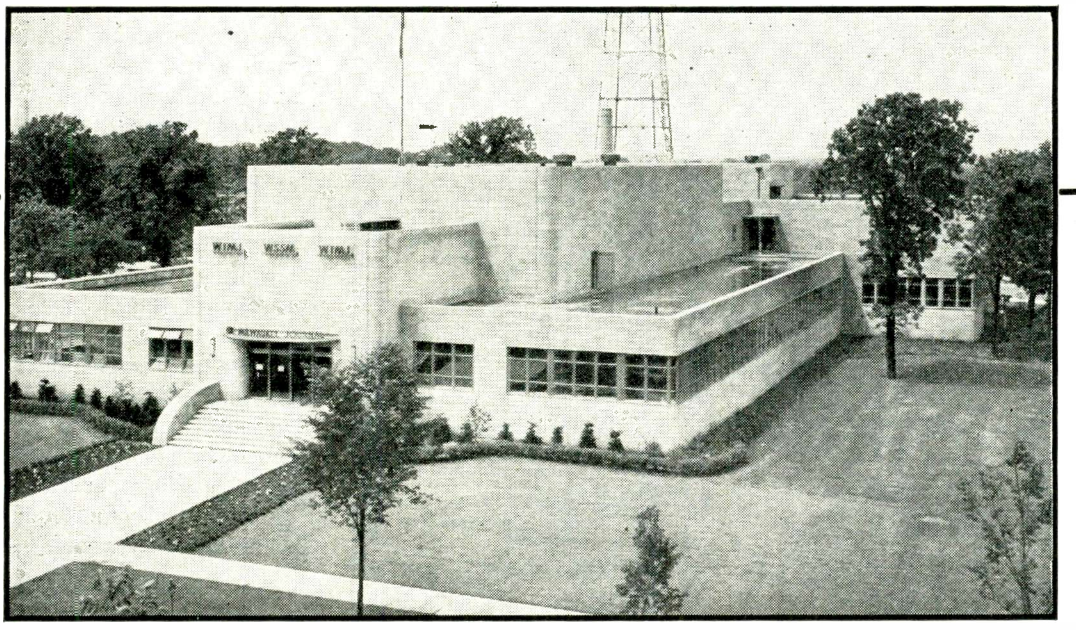
WITH a distinct eye for future developments, executives and engineers of the Milwaukee Journal have designed and constructed new studio and transmitter facilities intended to provide a-m, f-m and television broadcasting service for residents of Milwaukee and the nearby industrial and rural sections of Wisconsin and and Northern Illinois.

Studio offices and program facilities for all three types of stations are centered in the recently constructed studios and offices of Milwaukee's Radio City in the northeast section of the city, well away from the noisier industrial section of the city. These studios now feed two transmitters—the 5-kw broadcast transmitter of WTMJ, located 12 miles west of Milwaukee near Brookfield, Wisconsin, and the 50-kw frequency-modulated transmitter of station WMFM located about 20 miles northwest of Milwaukee at Richfield. A tower and television transmitter building have been erected at Radio City and will be used for the transmission of television programs as soon as equipment can be obtained.

Milwaukee's Radio Nerve Center

A two-story T-shaped building at Radio City houses the studios, executive, sales and announcer's offices, auditorium and control rooms of the system. The auditorium seats 400 people and contains an organ specially designed for f-m broadcasting. The 36 by 32-foot stage is large enough for dramatic productions.

A storeroom with individual cab-



A general view of Radio City in the suburban area of Milwaukee. In the background is the television antenna tower

inets is provided for musical instruments. Temperature and humidity are held constant here to eliminate the detuning and strains which occur with atmospheric variations.

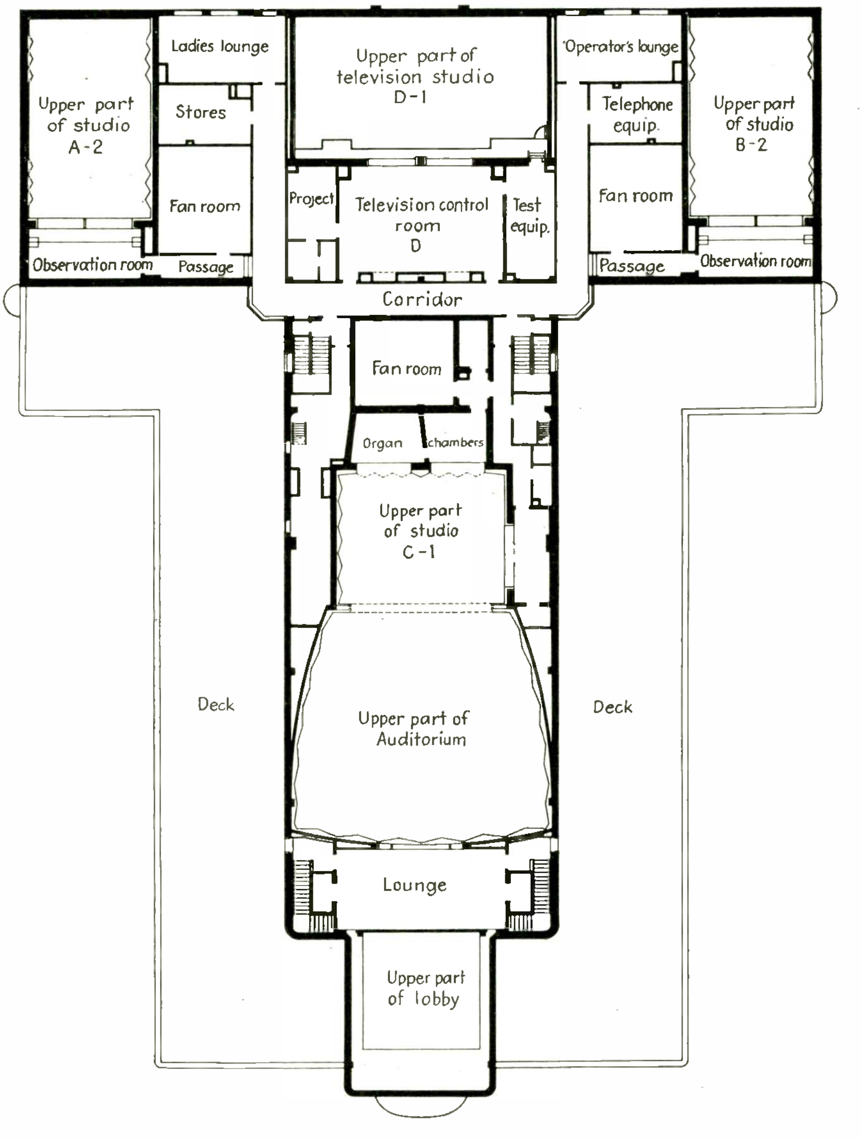
More than one hundred thousand musical selections in the form of sheet music, records and transcriptions are housed in modern metal cabinets in the music library.

A luxuriously furnished observation lounge on the second floor has a window facing the auditorium, and is equipped with complete audio facilities for listening to programs on the air, for use as a studio or for conducting auditions.

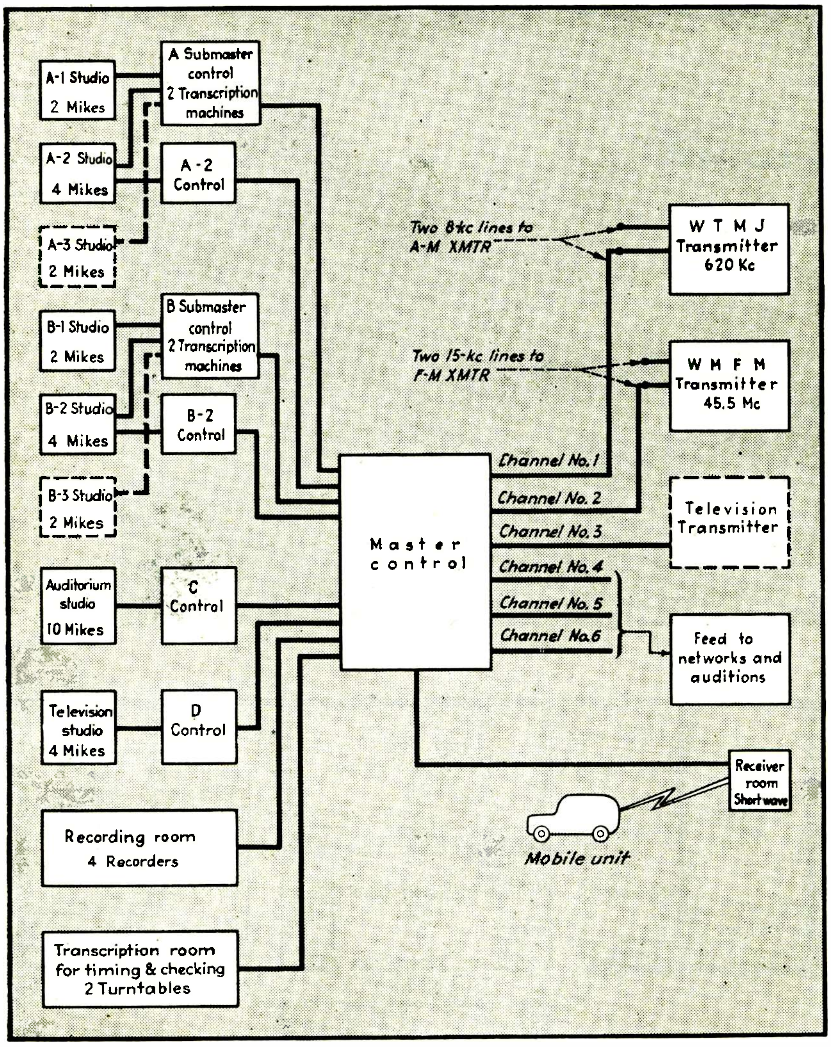
Studios and Control Rooms

Separate control rooms are used for the auditorium and for each of the two larger studios. Two submaster control rooms have observation windows opening into both the large and small studios and may be used for programs originating in either studio. Each submaster control room is set up to handle a third small studio later when needed; the shop on the first floor can be made into one small studio and the mail room can be converted into another.

For each of the larger studios, observation rooms for sponsors are provided on the second floor. Casual visitors to the control rooms are discouraged by placing the win-



Second floor plan of Radio City. Studios and observation rooms occupy most of this space. All television operating facilities are located on the second floor



Block diagram showing arrangement of radio and audio facilities of the Milwaukee Journal, including Radio City and the various remote transmitters. Units shown dotted will provide for future expansion

dows at such a height as to be uncomfortable for those who stand while giving an unobstructed view to the operator seated at the control desk.

Walls and ceilings of all studios are acoustically treated. The monitor speakers in the various studios are embedded in the ceiling behind acoustic material. All observation windows have three panes of glass, each set at a different angle and each having a different thickness to prevent excessive resonant effects.

Television Studio Planned for Expansion

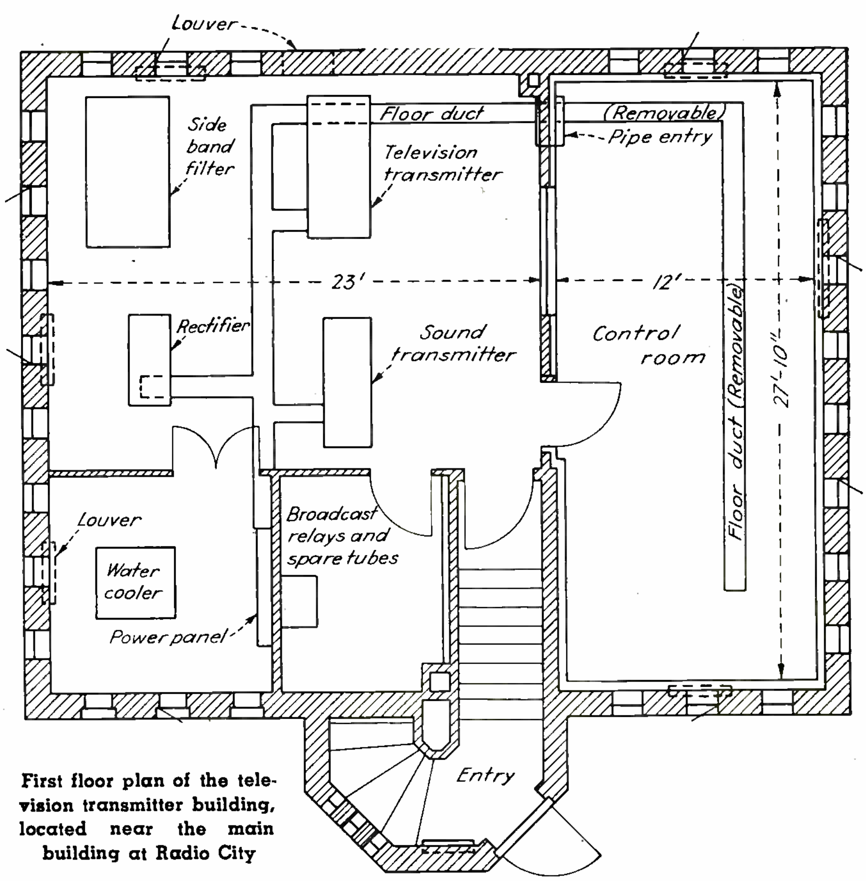
One end of the television studio is provided with a railing for adjusting lights and accessory equipment. The rear wall of the studio is of brick construction without steel reinforcement. By knocking out this wall, the size of the television studio can be increased to any desired depth: Provision has already been made for a television control room and for housing projection and rewind equipment, reels of film and test equipment on the second floor of Radio City.

Equipment for the television station will be housed in a separate building at the right of the main studios of Radio City.

Although all controls terminate at and are accessible from the 6-channel master control room, an operator is rarely in attendance because the master control panels can be set up for operation at some remote control point, usually a submaster control room.

Studio A-F Equipment

All control room equipment employs chassis or panel type of construction especially designed to facilitate maintenance and repair. All audio amplifiers have practically flat response out to 15,000 cycles and are therefore suitable for either a-m or f-m broadcasting. Pre-amplifiers and low-power audio amplifiers are operated in parallel so that the failure of one will not interrupt



First floor plan of the television transmitter building, located near the main building at Radio City

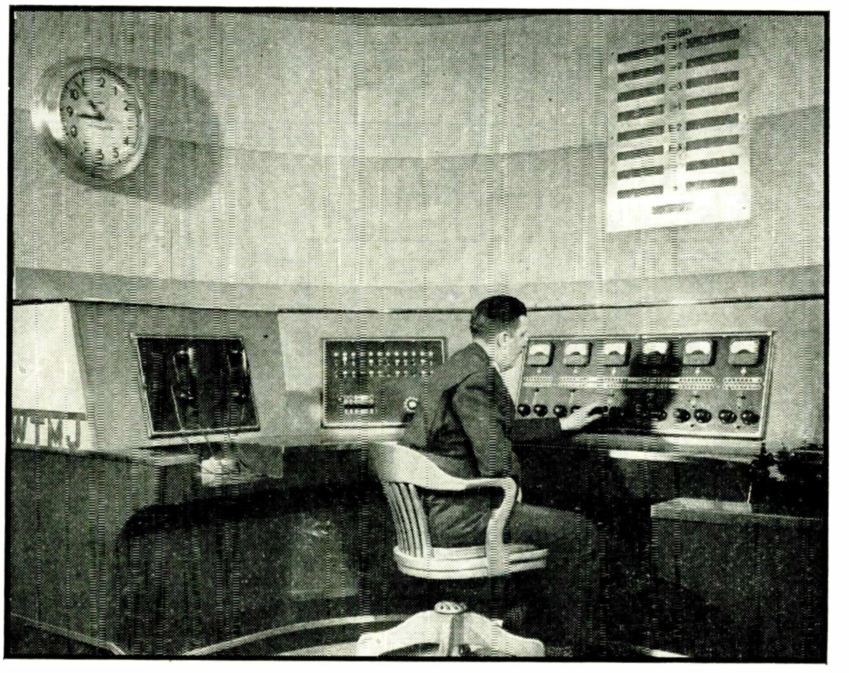
service. The pre-amplifiers and the dual channels of line amplifiers are housed in the side sections of each control desk. Two wire lines, equalized to 8,000 cps, are available for connecting the WTMJ a-m transmitter to Radio City. The two wire lines to the f-m station, WMFM, are equalized to 15,000 cps.

Play-back equipment for both lateral and hill-and-dale recording systems is available in each of the control rooms. So far as possible, all switching is accomplished by panel switches. For normal operation, patch cords are almost completely eliminated although they are available for unusual circuit arrangements or for emergency operation.

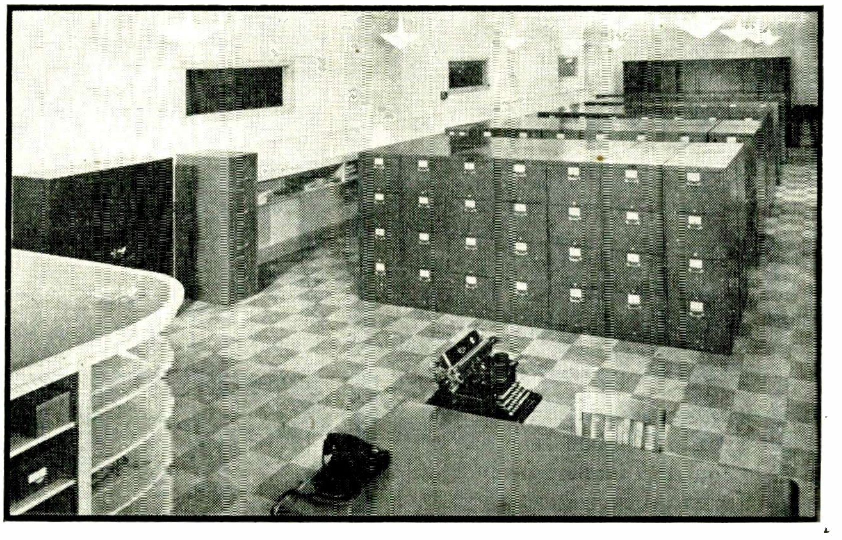
Heating and Wiring

Heating and ventilating equipment to maintain the studios at comfortable temperature and humidity conditions throughout the entire year is located in a separate building that will also house the television transmitter. An underground service tunnel carries heat, hot water, and refrigeration to the Radio City building about 300 feet away. Large fans keep the air in the studios and offices cool and fresh.

About 5 feet of head room under the first floor of Radio City provides for any necessary changes which may be desired in plumbing, wire fixtures, power conduits, etc. Since a considerable amount of power is expected to be used for illumination in television productions, provision has been made to take as much as 150 kw from the local generating supply system. Power and telephone cables are brought into the studio underground to minimize electrical noise and interference in the communication circuits. Power enters Radio City from two directions, each feeder coming from a separate sub-station providing up to 150 kva at 220 v on a 3-wire system. Incandescent lighting is used in the studios and most of the offices but fluorescent lighting is employed in all of the corridors.



Master control room from which circuits may be set up in advance at Radio City

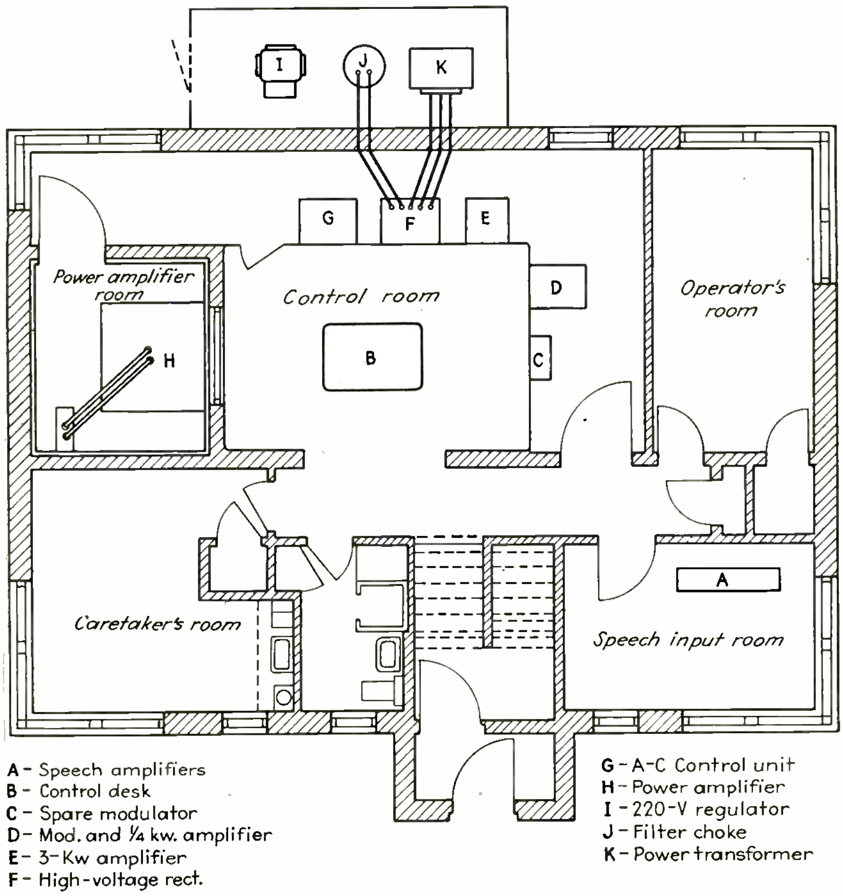


The music library occupies a large portion of the first floor

Transmitters

The 5-kw amplitude-modulated transmitter of WTMJ is located at Brookfield, Wisconsin, and operates on an assigned carrier frequency of 620 kc. A 50-kw frequency-modulated transmitter, WMFM, is operated at Richfield, Wisconsin, about 23 miles northwest of Milwaukee, on a carrier frequency of 45.5 Mc. It was placed in operation early in 1939 with the original call letters W9XAO, later W55M. It is the first f-m station to be placed in operation west of the Allegheny Mountains and has an estimated audience of approximately 21,000 families. Short-wave truck licenses for five short-wave transmitters used in trucks or relay pickups cover the following stations: WEIN, a 50-watt station operating at 37,620 kc; WEIP, a portable 1-watt station operating on 39,820 kc; WEIO, a 7½-watt station operating on 35,020 kc; WJER, a 30-watt station operating on 2,758 kc; WAHB, operating on 2,830 kc with a power of 50 watts.

In 1942 an order was placed for a television transmitter, but this unit was assigned to other services when the United States entered the war. However, channel No. 3, from 66 to 72 Mc, has been assigned to provide commercial television programs. The antenna tower, transmitter house, and studios are already constructed. Present plans call for the installation of a transmitter having a power of 1 kw on the sound channel and 4 kw on the video channel as soon as this equip-



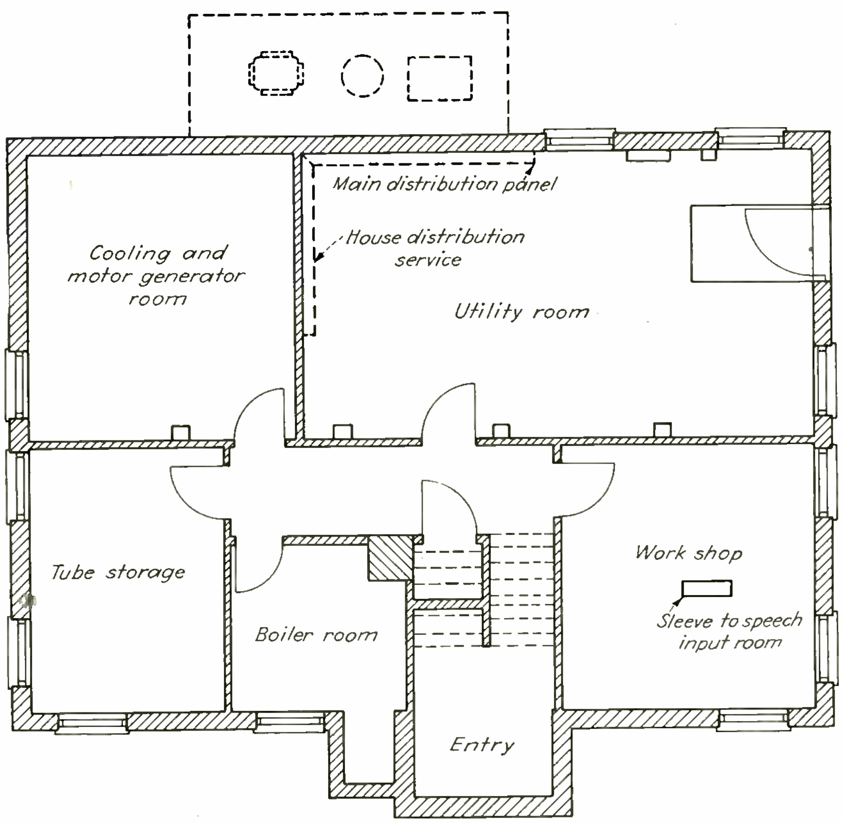
First floor plan of the f-m transmitter building at Richfield, about 12 miles from Radio City. All operating units can be seen from the control desk

ment can be made available. It is estimated that the cost of the transmitter will be about $90,000.

50-KW F-M Transmitter

High-fidelity f-m station WMFM is located on a hill 500 feet above the elevation of Richfield and provides effective coverage of Milwaukee and its vicinity. A compact two-story building houses the r-f system, power transformers and rectifiers, water-cooling radiators and pumps, heating and ventilating equipment, and shop facilities. Permanent living quarters for a caretaker and temporary quarters for operators who may remain overnight are also provided. A balanced concentric transmission line delivers power from the final amplifier to a tuning house located at the base of the antenna tower. The antenna is a two-bay turnstile the center of which is 219 feet above the ground.

The type 558DL phase modulator, manufactured by Radio Engineering Laboratories and representing the latest system of phase modulation designed by Major E. H. Armstrong, is one of five similar units now in commercial service. The phase modulator uses receiving tubes entirely, has an output of 10 watts, and establishes the carrier frequency, produces small phase modulation, and has frequency and phase shift multipliers to produce a signal of the required character at the assigned channel frequency.



Basement floor plan of the f-m transmitter at Richfield. A work shop, boiler room, and tube storage racks are provided. Cooling equipment for the water-cooled tubes and motor generators are also housed in the basement

The 10-watt phase modulator feeds a pair of pentodes in a push-pull amplifier to provide an output of ½ kw. The power output is then increased to 3 kw in a neutralized push-pull amplifier using 1500T triodes. The final stage, employing water-cooled tubes, delivers 36 kw to the antenna with an input of 60 kw. The room in which the final amplifier is housed is completely shielded with solid copper. A large screened window enables this equipment to be watched at all times from the operating desk.

In general, the transmitter represents the most modern design with meters slightly above eye level and operating controls inclosed in a steel cabinet. The class C r-f amplifiers and mercury-vapor rectifiers are behind metal panels, with sufficient room for personnel to get in back of the equipment for necessary servicing, maintenance and repairs. The 10-watt phase modulator is completely inclosed in steel cabinets, with the equipment in two vertical racks. The construction is such that the rear rack can be swung out of the way for maintenance and cleaning, making the first rack accessible for similar operations. With this type of construction, service and maintenance is reduced to a minimum, although in general f-m transmitters are much less subject to interruption than a-m transmitters when both are properly operated.

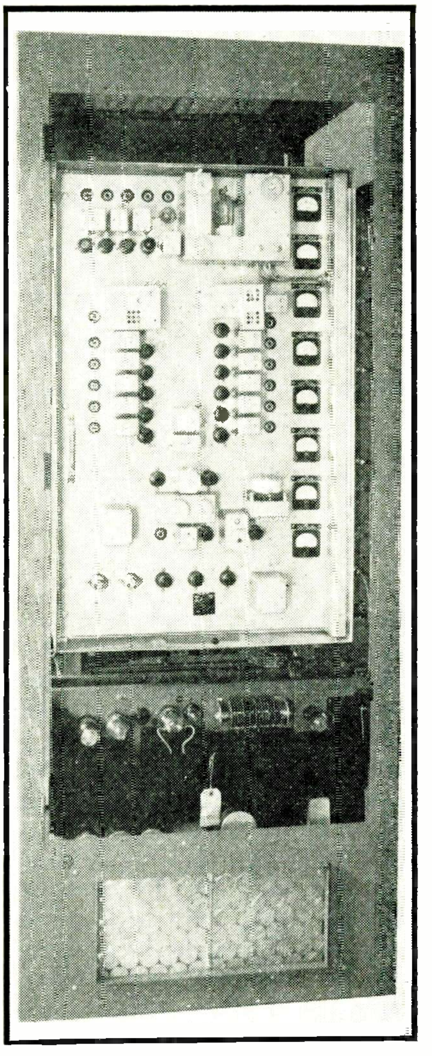
The operation of all important circuits is checked with meters, and the operating temperatures of various portions of the transmitter, particularly in the final amplifier, at various points on the transmission line and in the room housing the final amplifier, are made every hour or two.

5-KW A-M Transmitter

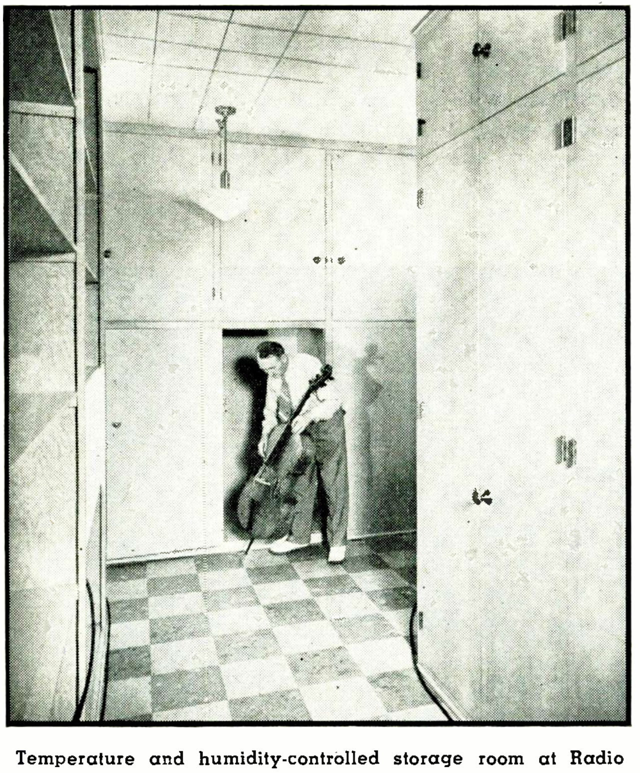
The two 5-kw Western Electric a-m broadcast transmitters at Brookfield are housed in a single-story structure, along with rectifiers and filters for plate supply, filament generators, furnished rooms for the resident operator, temporary living quarters, repair room, store room, and shop. Both transmitters are of standard broadcast design. The unit now in use is a Western Electric type 355-E-1.

A phase-switching unit manufactured by the E. F. Johnson Co. makes possible a change in the radiation pattern from daytime operation to night-time operation by merely pushing a button. The operation of the phase-changing network is sufficiently rapid that the transmitter can be changed from one radiation pattern to another between station announcements. A type D94992 Western Electric 5-kw transmitter serves as an auxiliary and standby unit.

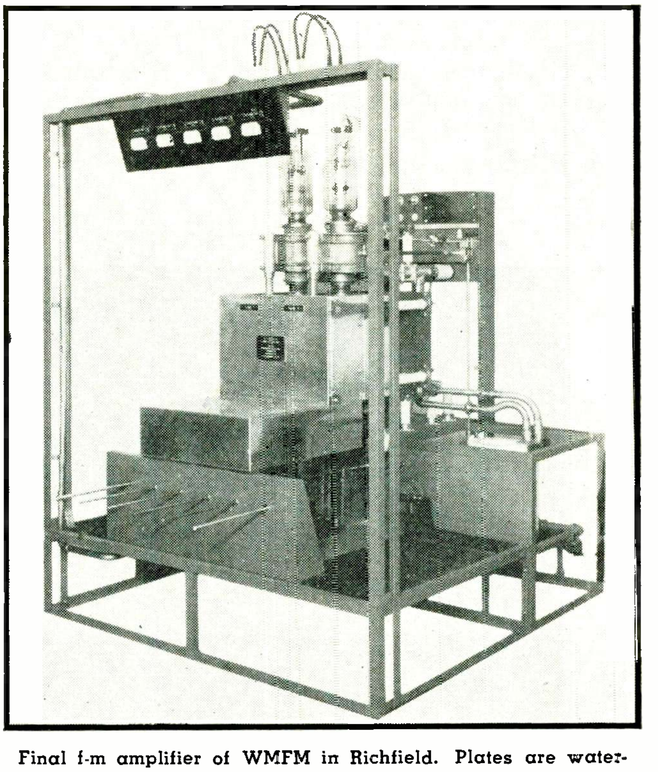
With the recent and growing interest in f-m broadcasting and the uncertainty as to the status of television at the end of the war, Milwaukee's Radio City has become a focal point of interest for those with post-war plans. Almost daily, visitors from various parts of the country arrive to inspect this three-service station.



The Armstrong phase modulator of REL construction used at the WMFM transmitter in Richfield. Spun glass filters cover the air intake and discharge openings



Temperature and humidity-controlled storage room at Radio City for musical instruments. Cabinets of various sizes house all types of orchestral instruments



Final f-m amplifier of WMFM in Richfield. Plates are water-cooled, and jets of cool air are forced around grid and filament leads. Shafts in foreground are for tuning and neutralizing

PORTABLE

Audio-Frequency Standard

Simple unit generating 1,582 cps facilitates adjustment of carrier-current communication system signal-oscillator circuits. Tuning fork maintains frequency with sufficient accuracy to permit aural detection of ½-cps signal circuit drift

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IN THE MAINTENANCE of power-line carrier-telephone equipment of the single-side-band type, numerous tuned circuits at each terminal have to be periodically checked to determine if any frequency drift has taken place. The circuits determining the frequency of audio signal oscillators are frequently the most critical. The frequency of the signal oscillators used on the power line in question is 1582 cps.

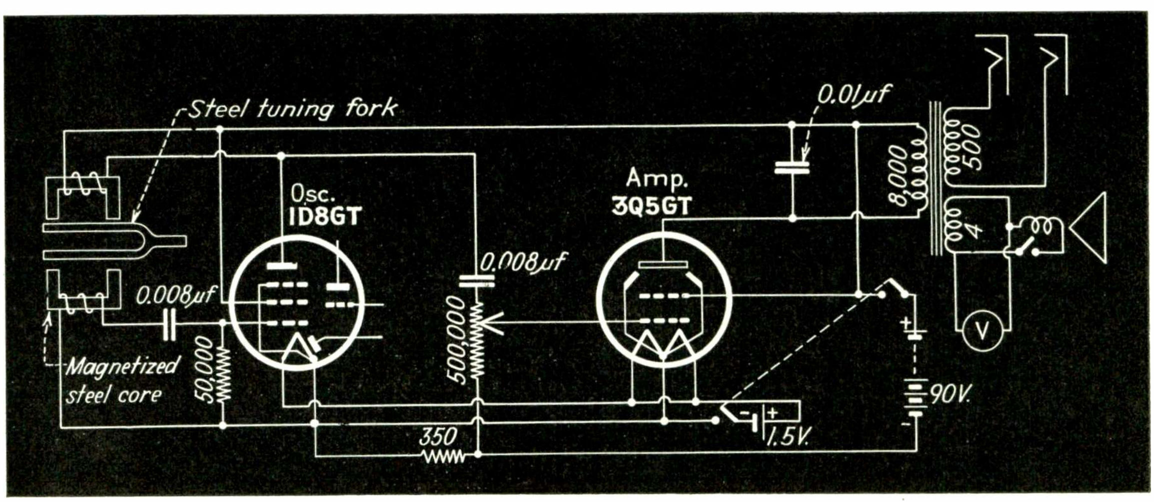
For the first few years after the power-line carrier system in question had been installed, the 1582-cps signal oscillators were checked periodically by comparing them against a high-grade laboratory audio oscillator. This oscillator, however, was not satisfactory for the particular type of work involved. It was so heavy that it took two men to carry it in and out of a car when going on a trip. Also, the rough patrol roads over which it was necessary to travel to reach some of the power-line carrier way stations caused frequent breakdowns. The frequency standard described below was designed and built to overcome these difficulties.

Tuning-Fork Control

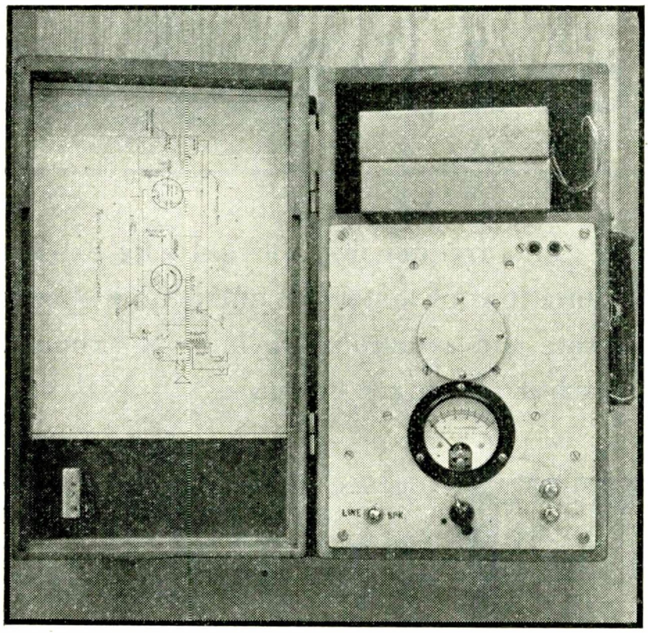
The unit is a self-contained, battery-operated audio oscillator with one stage of audio amplification. As may be seen from the diagram, the frequency of oscillation is controlled by a tuning fork which acts as a mechanical link through which energy is fed back from the oscillator plate to the grid.

The plate load of the 1D8GT tube consists of a coil wound on a U-shaped laminated core. The ends of the U-core are placed in close proximity to one tine of the steel tuning fork. The other tine of the fork is similarly placed with respect to the ends of another U-shaped core made of hardened steel which has been magnetized. The coil wound around this magnetized-steel core furnishes the excitation potential for the oscillator grid.

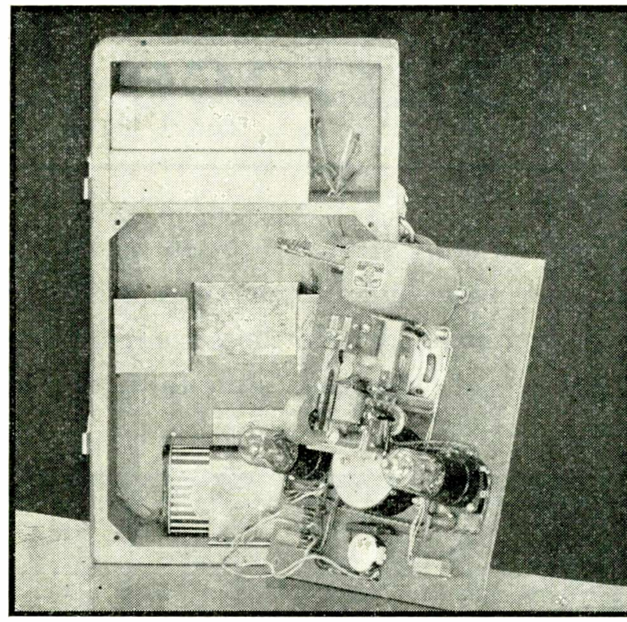
When the switch is first turned on, a pulse of plate current flowing through the oscillator plate load coil magnetizes the associated



Circuit diagram of the oscillator-amplifier. Coupling between the plate and grid of the 1D8GT oscillator is dependent upon mechanical movement of the tuning-fork tines



Front panel of the portable audio-frequency standard



Inside view of the battery-powered unit

plate circuit core and produces a minute deflection of the tuning fork tine near it. This movement is mechanically transmitted through the tuning fork and causes a corresponding deflection of the other tine. The movement of the second tine changes the air gap of the grid-coil magnet and induces a voltage in the grid coil. By proper phasing of the grid coil the conditions for self-sustained oscillation are fulfilled.

The coupling between plate and grid of the tube is through the mechanical movement of the tuning-fork tines and not through any direct magnetic coupling between plate and grid coils. This may be proven by holding a finger against the tuning fork while the tube is in oscillation. Stopping the mechanical vibration of the fork causes the tube to cease oscillation.

Amplifier and Beat Indicators

In order to minimize the effects of changes in loading on the frequency of the oscillator, the output of the 1D8GT tube is fed into an audio amplifier, operating into an output transformer. Output of the unit may be varied by means of a volume control placed in the grid circuit of the 3Q5GT amplifier tube.

The output transformer has four-ohm and 500-ohm output windings. The four-ohm winding is used to energize a two-inch permanent-magnet speaker for aural comparison of the frequency of the signal oscillator being tested with that of the standard. By listening for the beats when the two frequencies are close together, a difference of ½ cps may easily be detected. A rectifier-type a-c voltmeter is also furnished to allow visual comparison of the test and standard frequencies.

As may be seen from the circuit, the frequency being tested may be fed through a double patch cord to the 500-ohm winding of the output transformer. The voltage appearing across the four-ohm winding of the output transformer will then be the vector sum of the voltages induced in the winding by the standard and test frequencies. If the two frequencies are not exactly alike there will be a relative shift in phase relation of the two voltages. When the two voltages are in phase, the meter across the output winding will indicate the sum of the two voltages, while when the voltages have shifted to 180 deg out of phase the meter will indicate the difference between the two voltages. By adjusting the two voltages to the same scalar magnitude, the meter fluctuations will become maximum, going from 0 to twice the voltage.

By the use of the visual method in comparing frequencies a difference of one cycle in 30 seconds between standard and test frequencies may be detected.

The oscillator frequency has been found to be little affected by the condition of tubes or batteries since the frequency of oscillation is determined by the natural period of the tuning fork. Some change of tuning-fork frequency with temperature has been observed. This, however, is small when the instrument is used under normal conditions at room temperature.

Power Supply and Performance

The tubes require little power to operate and standard hearing-aid batteries are used for power supply. The weight of the entire unit, including carrying case and miscellaneous leads, is approximately 15 pounds.

The portable standard oscillator has been in use for over two years and has been extremely satisfactory. Other uses beside the one for which it was designed have been found. On frequent occasions it has been used as a signal generator when measuring telephone-circuit attenuation.

The oscillator is also being used to tune special automobile-radio receivers which are used by power-line patrolmen working near the line. These receivers pick up the power-line carrier signal which is radiated by the transmission line. By talking over the power-line the dispatcher may issue orders to patrolmen provided they are within a mile of the line.

Surface Hardening of

Plain and alloy steels processed by induction at radio frequencies above 10 kc exhibit superior wear and fatigue characteristics. Elimination of external quenching speeds heat treatment, permits close control of cooling rate and assures uniformity of product. Distortion, scale formation and decarburization are minimized

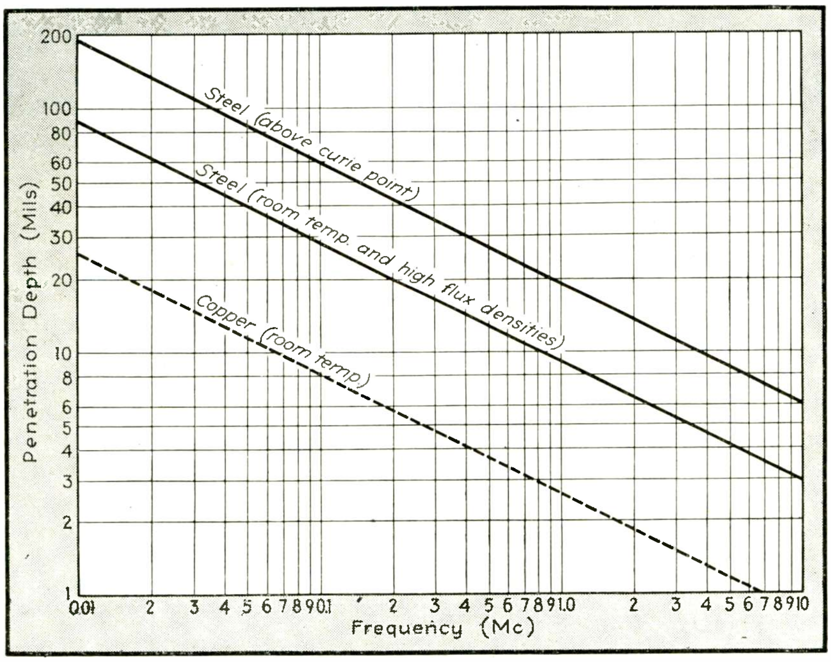


FIG. 1—Penetration depth vs. frequency for steel in the process of being hardened. A curve for copper is shown for reference

TECHNIQUES of using high-frequency power to harden the surfaces of plain and alloy steels have been developed to the point where it can be said where their utility lies and what the requirements of power, time, frequency, and material are. External quenching media have been eliminated, with the result that cooling rates can be accurately controlled and reproduced, thereby insuring uniformity of product. The speed of the process is high enough to make it fit into modern production methods and to minimize the ill effects of any heat treatment (distortion, scale formation and decarburization).

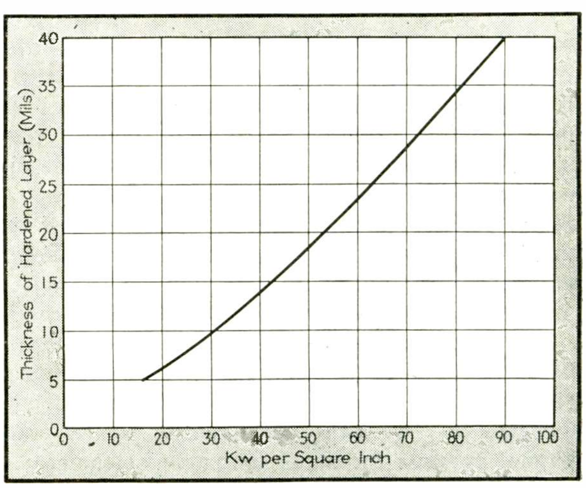
Although a full evaluation of the results has not yet been made, microscopic examination of the structure produced, micro-hardness tests and a limited number of wear and fatigue tests indicate that surfaces hardened in the manner to be described may be expected to have superior qualities, while costing less than surfaces hardened by more tedious and complicated processes.

Importance of Heat Treatment

The importance of proper surface treatment of load-bearing elements is being more fully realized as the power transmitted through or past them is continually being increased. Changes in gas and Diesel engine design toward higher compression ratios and horsepower per pound make increasingly heavy demands on the strength and abrasion resistance qualities of such parts as crankshafts, connecting rods, cylinder walls and wrist pins. It appears to be impossible to obtain all the desired properties in a homogeneous material; tough, resilient cores are needed to prevent breaking and hardened surfaces are needed to resist abrasion and starting of fatigue cracks.

Such a composite structure can be built up of two parts, as in the lining of cylinder walls with hardened liners, or the insertion of valve seats. Or it can be produced

FIG. 2—Power required to produce cases of varying depth, for self-quenching hardening. This curve applies to steel requiring a relatively low quenching rate for full hardening. Steels of lower hardenability require more and steels of high hardenability less power per square inch



Metals

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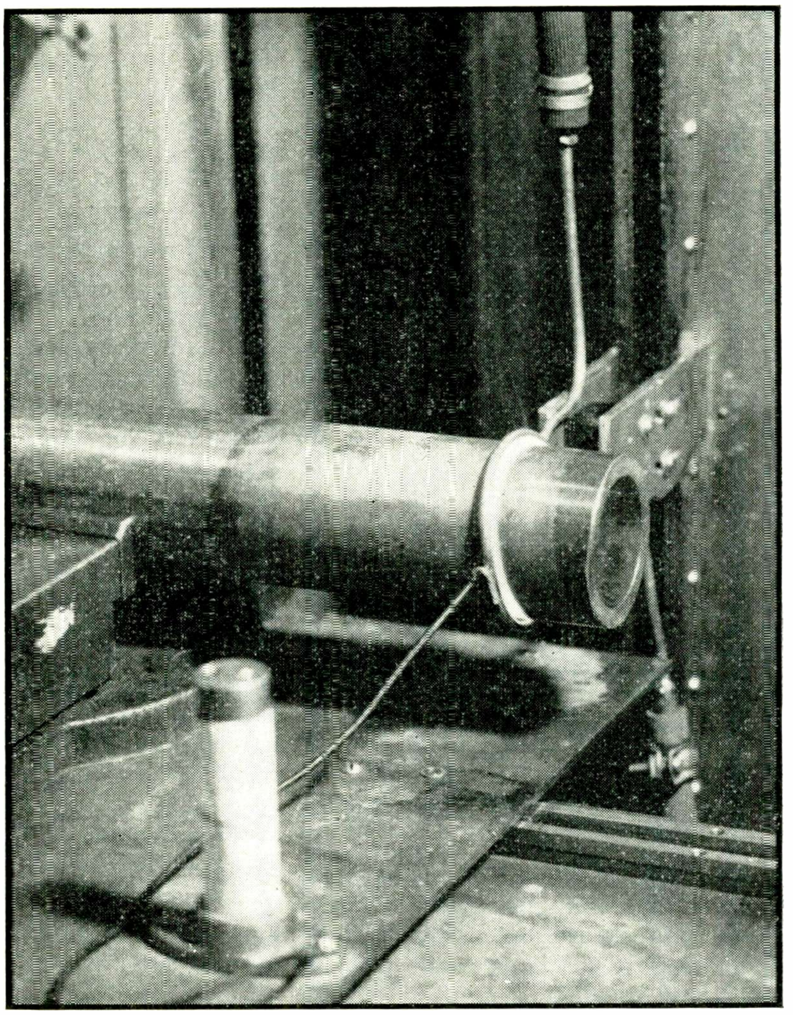


FIG. 3—Photo of 3-in. diameter steel tubing being heated. Motion of tube through coil is from left to right at 1 in. per second, hence length of incandescent tail or band indicates about 0.1 second to go from 1500 deg F to approximately 1000 deg F

by differential treatment of the surface layer with respect to the rest of the piece. Differentiation on the basis of temperature has been impossible until recently, so it has been the practice to differentiate on the basis of composition. This has been done by nitriding or carburizing processes, where the addition of nitrogen or carbon to the surface layer (by diffusion inward from the outside) makes that region hardenable by quenching, whereas the rest of the piece is unaffected. However, this is a time-consuming process, sometimes requiring as much as 96 hours to produce a case of 10 mils thick. On the other hand, differentiation on a temperature basis actually requires that it be done quickly, i.e., in fractional second times, if it is to be done at all.

Advantages of Induction Method

Heating by electromagnetic induction meets the first necessary requirement of fractional-second heating by making it possible to deliver large amounts of power in concentrated form to the surface to be heated. Without this ability, heat would flow out of the surface layer nearly as rapidly as it entered. The rise of surface temperature would be slow and the gradients established would be low. There would be little or no differentiation on a temperature basis. For some time it has been the practice to harden the surfaces of various parts by induction heating, operating at machine frequencies (up to 9600 cps). Cylinder liners for Diesel engines and track pins for tractors[1] are examples of the successful application of differential heating for surface hardening. The surface concentration of power may be as high as 30 kw per sq in.

A logical next step after establishing conditions that meet the requirement for sharply delineating the hardened layer is to increase the concentration of power to the point where the temperature gradients in the material are steep enough to cause a rapid flow of heat from the surface into the metal behind it. It then becomes possible to accomplish the whole hardening operation of localized heating and quenching in a single step. The process is thereby simplified and made more reliable by the elimination of the separate quench and the hardened layer is more sharply defined.

A process that depends on steep temperature gradients in the heated zone necessarily is limited as to the thickness of the case that can be produced. The outside surface should not, of course, be melted, and the inner edge of the layer to be hardened must be at some temperature above the Curie point. The temperature distribution required in the region between these two layers is a complicated function of power, time, frequency and the temperature it is necessary to attain. It has been established, however, that cases from five to fifty mils thick can be produced on steels of moderately high hardenability, and thicker ones on steels having qualities approaching those of air-hardening alloys. It is believed that this range fills an important gap between the relatively thin cases of the carburizing and nitriding processes, and the thicker ones obtained with low-frequency induction heating.

As indicated, the factors involved

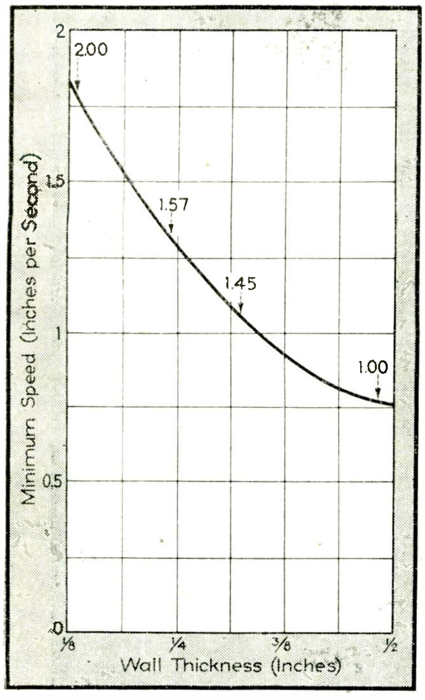


FIG. 4—Scanning speed required for hardening various wall thicknesses by self-quenching, down to ⅛-in. Numbers on curve refer to power requirement relative to lowest

enter in a complicated manner. An experimental approach has therefore been used almost exclusively in determining the operating parameters. It will be useful, however, to examine the effect of one of the parameters, namely frequency, to determine its importance from theoretical considerations.

Function of Frequency

Frequency enters the picture through its effect on the depth to which the heating energy penetrates. The depth of penetration is determined by the attenuation suffered by alternating magnetic flux as it progresses through conducting materials. This attenuation is due to the shunting action of the conducting metal in conjunction with the inductive reaction of the medium, as affected by the permeability of the metal.[2, 3] For flux fields without divergence, this attenuation has exactly the form of the attenuation of a wave progressing down a transmission line.

The complete propagation constant of a line consisting of L henries per unit length in series and G mhos conductance per unit length in shunt is

$$\nu = \sqrt{j\omega L G} = \sqrt{\omega L G/2} + j\sqrt{\omega L G/2} = \alpha + j\beta \qquad (1)$$

on rationalization of the $\sqrt{j}$. Since we are interested in heating effects only, the phase shift factor is not of interest, the attenuation factor telling us all we need to know. In terms of the properties of the material it becomes

$$\alpha = \sqrt{\omega\,\mu\,\sigma/2}\ \text{nepers per meter, or} \qquad (2)$$

$$\alpha = 8.7\sqrt{\omega\,\mu\,\sigma/2}\ \text{db per meter} \qquad (3)$$

μ and σ being in mks units of permeability and conductivity respectively. The depth at which the flux, or current, is attenuated by 1 neper is defined as the penetration depth and is equal to

$$d = 1/\alpha = \sqrt{2/\omega\mu\sigma} \qquad (4)$$

Since we usually want to know the depth of penetration in thousandths of an inch and use cycles per second rather than radians per second, and since the handbook tables list the permeabilities of materials relative to that of space and the conductivity in cgs units, a composite form of Eq. (4) will be given where

μ_1 = relative permeability
σ_1 = conductivity in mhos/cm, and
f = frequency in megacycles

$$d = 1.98\sqrt{1/f_1 M_1 \sigma_1}\ \text{mils} \qquad (5)$$

The values of μ_1 and σ_1 that should be used require some examination before inserting them in the formula. σ_1 is a function of temperature, decreasing about 9 times as the temperature rises from room to hardening temperature. The relative permeability of steel is a function of temperature, becoming unity above the Curie point (about 1425 deg. F. for plain carbon steels). It is also dependent on the strength of the magnetic field in which the steel is placed, being effectively unity if saturation values of magnetization are greatly exceeded.

A chart presented in Fig. 1 shows the penetration depth in steel as a function of frequency for room temperature and for temperatures just above the Curie point. Copper is also shown for comparison. With this as a guide, frequencies can be chosen that will, first, ensure efficient operation, and secondly, confine the heating to a zone within that which is to be hardened. The first requirement is met by using a frequency that is high enough so that the penetration depth is less than about a third of the thickness of the piece; the incident energy is then nearly completely attenuated, i.e., absorbed, by the metal. The second is met by use of a frequency high enough so that most of the power is absorbed well within the thickness of the case desired.

Radio Frequency Power Requirements

Power requirements, as indicated, are high. For SAE. 1095 steel (drill rod) the power required to secure cases of varying thickness by the self-quenching method is shown in Fig. 2. The power referred to on the chart is that actually delivered to the steel.

These data were obtained on 1¼-in. diameter rods, which are considered to have enough metal behind the heated zone to yield a maximum quenching rate at the beginning of the cooling cycle. That is, further increase in diameter does not affect the slope of this part of the cooling curve, because there has been time for no increase

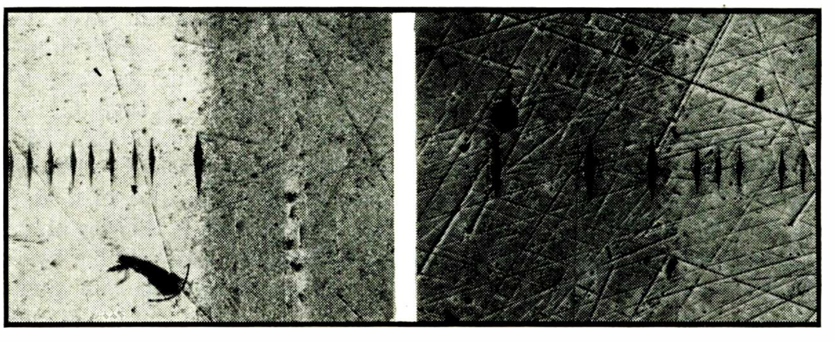


FIG. 5—Appearance of hardness-testing indents at 100 times magnification. These micrographs show a 20-mil layer with several impressions in a line from the core to the edge. The micrograph at the left is SAE. 1095 steel, while the one at the right is SAE 4340 alloy steel. (Courtesy Wilson Mechanical Instrument Co.)

in the temperature at the center of the rod during the short heating cycle. It is the rate of cooling above 1000 deg F that is most important to the hardening process.

On a rod of this diameter the surface area per inch length is $\pi \times 1\frac{1}{4} = 3.9$ sq in. For power outputs within the range of generating equipment of a reasonable size (below 100 kv) it is necessary to limit the length of rod treated at one time. For this reason it becomes necessary to heat a piece progressively, with only a narrow band being heated at any one time. This "scanning" method can only be applied lengthwise of pieces of regular section; if it is attempted to scan around the circumference, or in any pattern that returns the heating coil to the starting point, a softened area will be produced there.

The appearance of a 3-in. diameter tube as it is drawn through a single-turn inductor such as is commonly used in the scanning process is shown in Fig. 3. The incandescent band immediately under the inductor tails off in the direction of the motion of the tube and indicates roughly how long an interval elapses while the temperature of the surface falls to "black heat". It will be noted that the coil is of small-diameter tubing ($\frac{3}{16}$-in. O.D.) and closely spaced from the work ($\frac{1}{32}$-in.). These conditions are necessary to give the required surface concentration of power.

It is often desired to harden the surface of a hollow cylindrical piece, such as the wall of an engine cylinder. Here the thickness of the material becomes an important factor in determining the speed with which the heating must be accomplished. This is shown in terms of scanning speed in Fig. 4, for wall thicknesses down to $\frac{1}{8}$-in. A considerable increase will be noted for the smaller thicknesses,

(*Continued on page* 188)

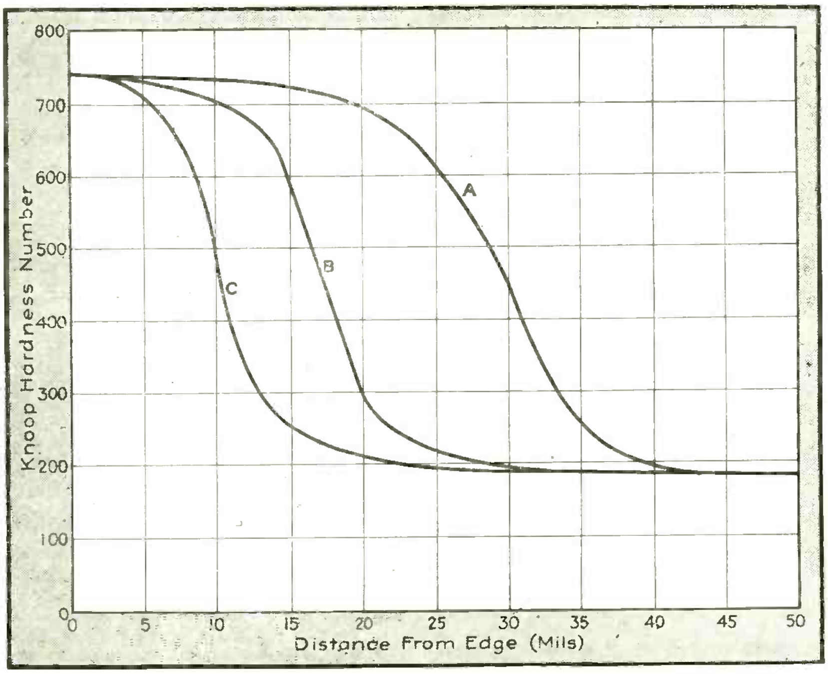


FIG. 6—Hardness traverses taken across samples of hardened 1095 steel. The sample shown by curve A required 50 kw per square inch power input, that of curve B, 30 kw and that of curve C, 15 kw per square inch of area treated at one time

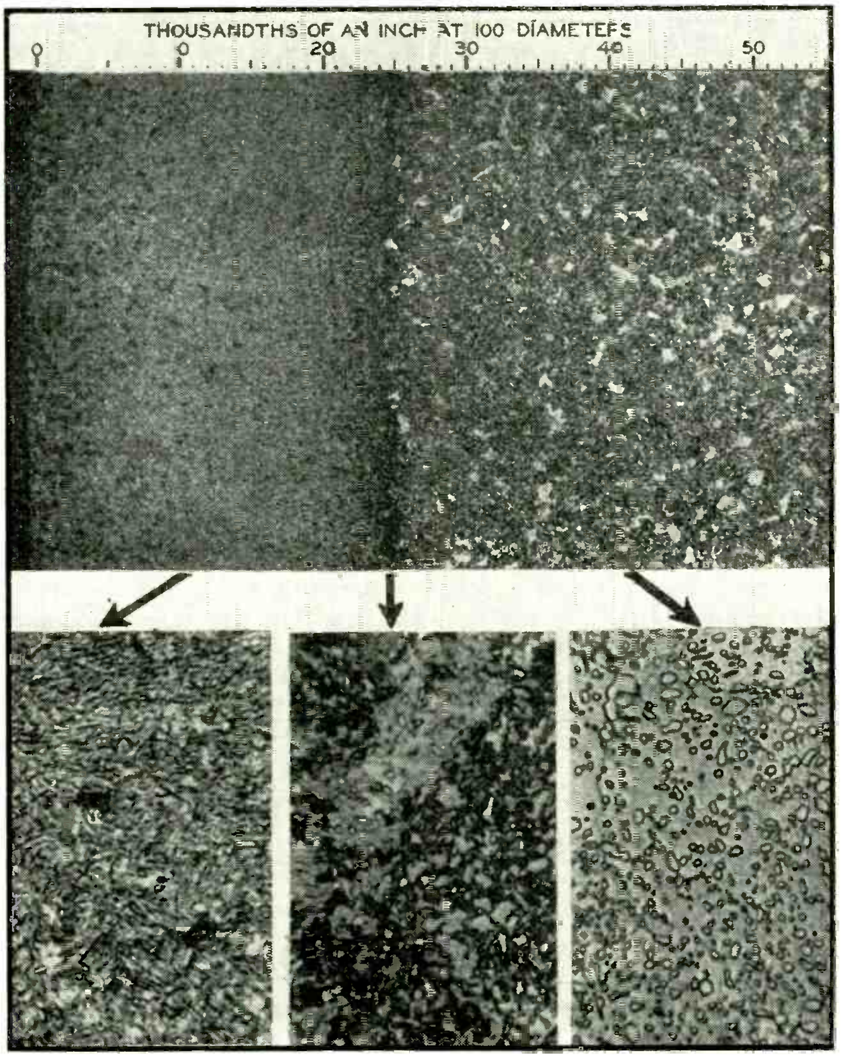
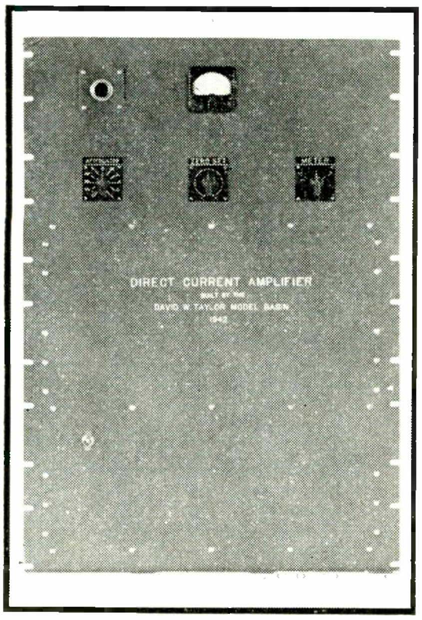
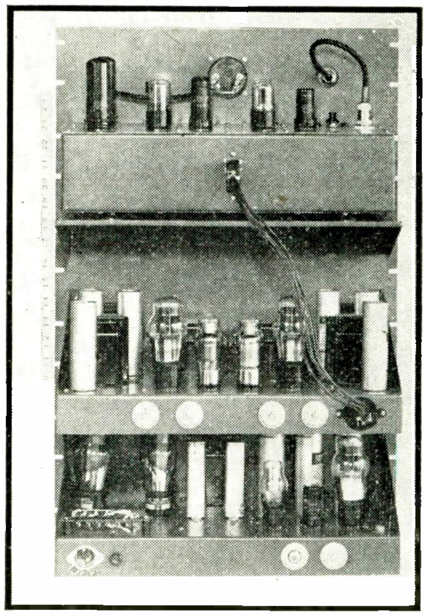


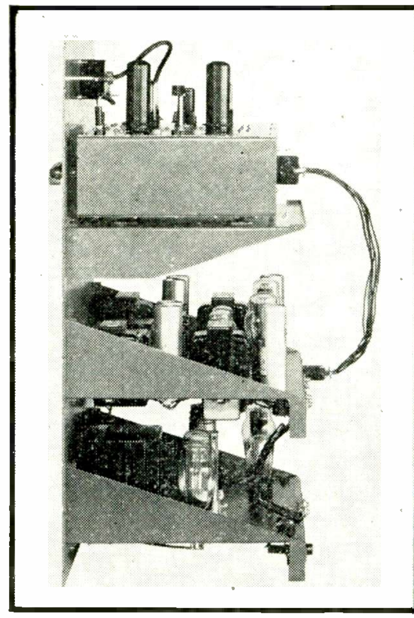
FIG. 7—Structure of core, transition zone, and hardened layer of 1095 steel after treatment lasting 0.1 second at 500 kc. Top section shows thickness dimensions of these regions while bottom views show the micro structure in each of the three zones, at 1500 times magnification



Front elevation of the oscilloscope-deflection amplifier having a voltage amplification of 5000



Back elevation of the amplifier as constructed at the David W. Taylor Model Basin



Right profile showing the arrangement of component parts and tubes in rack-and-panel instrument

A Stable Direct-Coupled

By G. ROBT. MEZGER

Formerly at David Taylor Model Basin, Washington, D. C.; now at Naval Training School (Pre-Radar), Bowdoin College, Brunswick, Maine.

THE DESIGN of high-gain, wide-frequency-range direct-coupled amplifiers always has been hindered by a number of factors which are difficult to control. The term "direct-coupled" as used in this paper embodies any type of interstage coupling system for vacuum-tube amplifiers which permits response of the system to signal potentials of zero frequency. It is not restricted to the case of zero-resistance connection between the output terminal of one vacuum-tube stage and the input terminal of a following stage.

The problem of maintenance of proper electrode potentials in direct-coupled amplifiers usually has occasioned the necessity for having either the output or the input terminals average the signal component of their output about some potential other than that of ground. The use of transformers or capacitors as interstage coupling elements destroys the feature of response to signals of zero frequency.

Direct-coupled amplifiers of high gain often are troubled with uncontrollable drifts in output potential. The term "drift" is used here to indicate any change, usually uncontrollable, which will cause an undesired variation of either the a-c or the d-c component of the output of an amplifier. It is used in contradistinction to the term "noise" which is reserved for reference to short-time disturbances.

Drifts in direct-coupled amplifiers have been known to achieve such magnitude that attempts to correct them have carried the tubes in the latter stages of the amplifier beyond their operating range. Circuit arrangements which have been used to maintain proper electrode potentials usually involve the placement of power supplies or batteries in such a manner that they are required to carry signal potentials. As a result, these large masses, with their high stray capacitance to ground, shunt the high-frequency components of the signal and destroy the high-frequency performance of the amplifier.

Solutions for the Problem

A circuit which has been widely used of late for direct interstage coupling is shown in Fig. 1. In this circuit, a voltage divider is

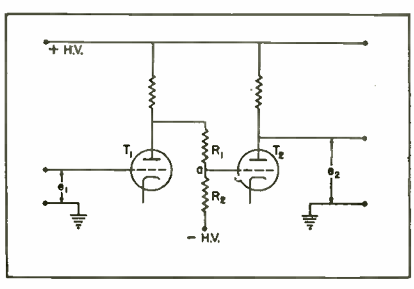


FIG. 1—Hypothetical circuit for direct coupling between two tubes

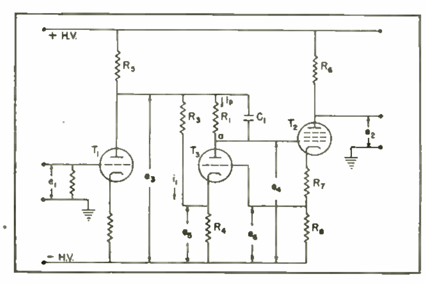
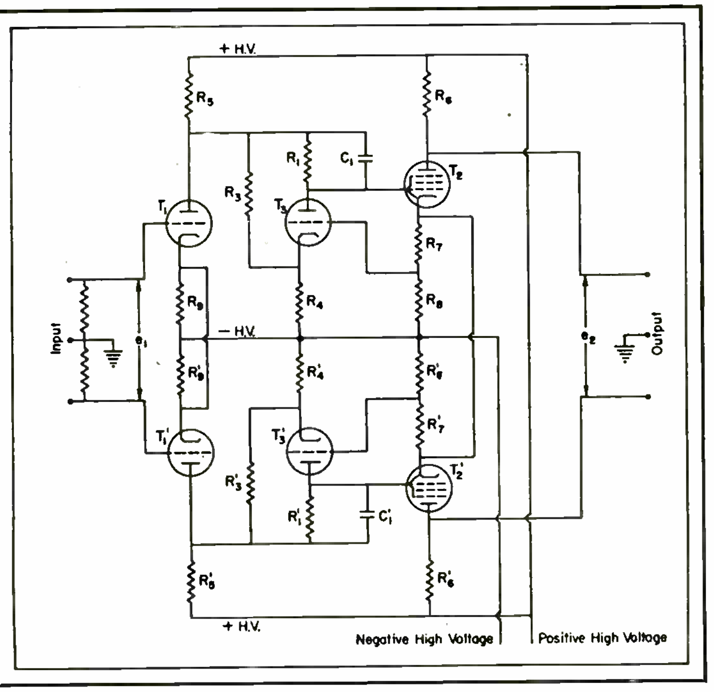


FIG. 2—Basic circuit in which a tube, T_3, stabilizes the amplifier

FIG. 3—Complete basic circuit for the stabilized amplifier. Resistors R_7, R'_7, R_8 and R'_8 are combined into a single resistor; the same is true of R_9 and R'_9



An aperiodic coupling element permits response to zero frequency and to high frequencies limited only by conventional limitations in RC coupling. Useful in CR-tube deflection; has a voltage gain of 5000

AMPLIFIER

placed between the plate of the first stage and a potential source which is highly negative with respect to the grid of the second stage. The two resistors in the divider, R_1 and R_2, are so chosen that the potential of point a is exactly the operating potential desired for the grid of T_2. Attenuation of the signal originating at the plate of T_1 will appear at the grid of T_2 because of the IR drop across R_1.

As the negative-potential source at which R_2 is terminated is made more negative, R_2 must be increased to maintain the same average potential at point a. The attenuation therefore becomes less. If the plate of T_1 were operating at an average potential of +100 volts, and if R_2 were terminated at a source which was negative by 1000 volts with respect to ground, only ten percent attenuation of the signal would occur.

The advantage of the circuit of Fig. 1 as a d-c coupling element is apparent. It requires, however, a high-potential source of low current-capacity, and variations in potential of the source will be evident in high-gain amplifiers.

By inspection of Fig. 1, it can be seen that if it were possible to control the flow of current through R_1 and R_2 so that it is absolutely constant, i.e., so that there would be no *change* in potential drop through R_1 regardless of signal-potential variations, the signal originating at the plate of T_1 would then appear unattenuated at point a. This would be accomplished, for instance, if R_2 were increased to infinity, as is implied in the foregoing, so that the current flowing through the network would be constant at all times. It is also equivalent to saying that if a signal were applied at point a which was equal in both magnitude and phase to the signal at the plate of T_1, then regardless of the current flowing through R_1 the signal potential at point a would be the desired potential.

A Direct-Coupling Circuit

The application of just such a signal at point a is accomplished by the circuit of Fig. 2. In this circuit, T_3 operates as the infinite resistor previously described; the IR drop through R_1, which is produced by the flow of the plate current of T_3, provides the proper average potential at point a while introducing no signal attenuation.

In Fig. 2, the main elements of the coupling device between T_1 and T_2 are resistor R_1, which has the same function as does R_1 in Fig. 1, and triode T_3 which, with its cathode-load resistor, replaces R_2. T_3 operates to maintain the potential of point a exactly equal in magnitude and phase to the potential which originates at the plate of T_1.

Consider the coupling element first as a voltage divider made up of the series combination of R_1, r_p of T_3, and R_4. Then, neglecting any effects caused in T_3 by R_3, the signal at point a would be the plate signal of T_1 reduced by the factor $(r_p + R_4)/(R_1 + r_p + R_4)$. If, however, the plate current of T_3 is decreased just sufficiently, with any increase in e_3, to permit T_3 to develop across R_1 a signal potential of the proper magnitude to compensate exactly for the attenuation produced by this voltage divider, the desired condition for potential at point a will have been obtained. In this manner, R_1 will simulate a resistor which provides a potential drop but which carries no current. This is accomplished by maintaining constant the plate current of T_3 regardless of changes in e_3.

Control of plate current of T_3

to maintain it absolutely constant is effected by varying the cathode potential of the tube by an amount which will vary r_p just sufficiently to compensate any change in plate current which would be caused by variations in e_3. Resistor R_3 is added, therefore, as shown in Fig. 2, to develop the control potential necessary across the cathode of T_3. The value of R_3 is so chosen that, when operating in series with R_4 as a voltage divider across the input potential e_3, the voltage drop across R_3, with constant plate current simultaneously flowing through R_4, is just sufficient to alter the parameters of T_3 to compensate any change in plate current. When this condition prevails, the signal potential originating at T_1 will cause the signal component of the potential at point a to equal exactly, in both magnitude and phase, the output signal from T_1; and i_p of T_2 will be absolutely constant. The average potential of point a, furthermore, can be controlled by design to be exactly the desired operating potential for the grid of T_2.

Analysis of the Circuit

This circuit may be analyzed rigorously as follows: From the definition of μ, constant plate current requires that $\Delta e_g = -\Delta e_p/\mu$, where $e_g = e_6 - e_5$ and $e_p = e_4 - e_5$. Both e_g and e_p depend upon e_3. Therefore, introducing e_3 as independent variable and passing to infinitesimals in place of the finite variations, the condition for constant i_p becomes

$$\frac{\partial e_g}{\partial e_3} = -\frac{1}{\mu}\frac{\partial e_p}{\partial e_3} \qquad (1)$$

The two partial derivatives occurring in Eq. (1) can be readily evaluated by applying Kirchhoff's laws to the circuit of Fig. 2:

$$e_3 = i_pR_1 + e_p + i_pR_4 + i_1R_4$$

$$i_1 = \frac{e_3 - i_pR_4}{R_3 + R_4}$$

$$e_p = e_3\left[1 - \frac{R_4}{R_3 + R_4}\right] + i_p\left[\frac{R_4^2}{R_3 + R_4} - R_1 - R_4\right]$$

$$\frac{\partial e_p}{\partial e_3} = 1 - \frac{R_4}{R_3 + R_4} = \frac{R_3}{R_3 + R_4} \qquad (2)$$

Similarly,

$$e_g = e_6 - (i_1 + i_p)\,R_4 = e_6 - i_pR_4 - \left(\frac{e_3 - i_pR_4}{R_3 + R_4}\right)R_4$$

For the purpose of this discussion, e_6 can be assumed constant. In the circuit actually used, this is assured by the adoption of a push-pull circuit. Then

$$\frac{\partial e_g}{\partial e_3} = -\frac{R_4}{R_3 + R_4} \qquad (3)$$

Substituting Eq. (2) and (3) into Eq. (1), the condition for constant i_p becomes

$$-\frac{R_4}{R_3 + R_4} = -\frac{1}{\mu}\frac{R_3}{R_3 + R_4}\text{, or } R_4 = \frac{R_3}{\mu}$$

The value of R_3, then, is equal to μR_4, where $\mu = g_mr_p$ at the conditions under which the tube is operated. The value of R_3 is not found to be critical in practice. It may vary as much as 15 percent with little change in operation of the circuit. R_3 may be determined empirically by measuring the plate current of T_3 while varying simultaneously the plate-supply for T_3 at the common junction of R_3 and R_1.

The proper grid-bias potential for T_3 is taken from the cathode-load resistor of T_2 by adjustment of R_7 and R_8. The circuit between the grid of T_3 and the cathode of T_2 is degenerative and operates only to maintain a constant bias potential on the grid of T_2, so that a rise in grid potential (rise and fall of potential are given here with respect to *signal* ground potential, which is at a level of —400 volts with respect to absolute ground in the amplifier described) of T_3 increases the plate current of T_3.

The potential of point a with respect to ground (signal) is thus reduced, and the grid potential of T_2 is reduced an equal amount, thereby reducing the cathode potential of T_2 and the grid potential of T_3 by an amount just sufficient to compensate for the original rise. It is this self-stabilization of the coupling element, operating to compensate stage by stage for undesired variations of circuit conditions, which permits these stages to be cascaded without danger from long-time drifts rendering the amplifier unusable.

An inspection of Fig. 2 will show that the compensating action described will occur not only for variations in the parameters of T_2 and T_3, but that it will occur also for any signal which appears at the plate of T_1. This circuit, then, while it is extremely stable, will pass no signal and will not function as an amplifier.

Elimination of Degeneration

A means for permitting the circuit to be self-compensating but nevertheless allowing it to function as an amplifier is shown in Fig. 3. In this circuit, an amplifier, identical in every respect to the amplifier of Fig. 2, has been added to the original circuit to provide a push-pull circuit. It will be noted, however, that, by use of the parallel connection of the cathodes of each amplifier tube in each stage, a variation in cathode potential of one tube in a stage will cause a change in i_p of the other tube, and a signal caused by such a change will appear in balanced form in the output circuit. If an unbalanced input signal, then, is applied to the input of the amplifier of Fig. 3, the common connections of the cathodes of T_1 and T'_1 and T_2 and T'_2 will cause a balanced signal potential to appear at the output terminals.

The circuit in this form is suitable only for push-pull output potentials, which adapts it ideally to deflection of a cathode-ray tube.

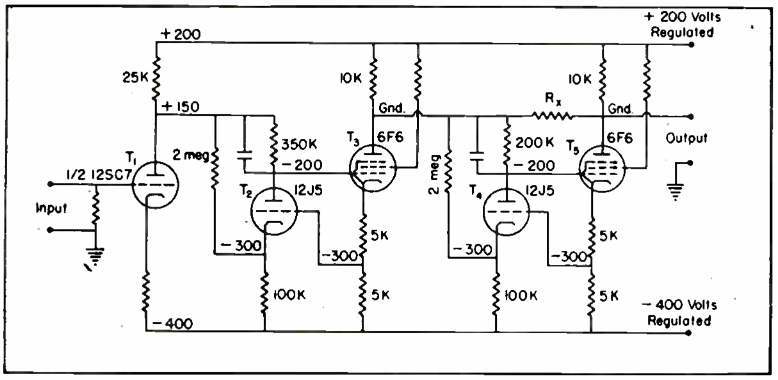


FIG. 4—Cascaded direct-coupled amplifier, showing voltages with respect to ground. For reasons stated in text, this circuit proved impractical

This may restrict its usefulness for some other applications. The input signal may be either balanced or unbalanced with respect to ground in this circuit.

By the self-compensating action described in the foregoing, any variation of cathode temperature, which changes r_p and g_m and which has been a main cause of drift and variation of amplification in direct-coupled amplifiers, has been virtually eliminated. The part of the circuit of Fig. 3, therefore, which consists of all elements following the plate terminals of T_1 and T'_1, may be viewed as a single unit for a direct-coupled amplifier consisting of a self-compensating coupling element and an amplifying stage. The coupling element has the advantage of introducing no signal attenuation, and it operates to correct continuously for any of the usual circuit variations which cause drift in the output signal.

Stages may be cascaded to provide increased gain. It is significant that the self-compensating feature of the coupling element permits stages to be cascaded without the effects of individual stage drifts becoming cumulative due to succeeding amplification. The number of stages which can be cascaded is limited only by the demands for economical power-supply design and by the noise which is introduced by the first stage, which noise is not eliminated by the circuit. By suitable design of the circuit, the proper value of R_a generally may be provided to obtain the requisite frequency response, gain, and average output level which may be desired.

In practice it has been found that R_1 is relatively high. Accordingly, the stray circuit-capacitance and the interelectrode capacitances of T_3 and T_2 operate as a shunt to ground for the high-frequency components of the signal at point *a*. By the addition of C_1, the effect of these stray capacitances is neutralized. Limitations on high-frequency response of the stage, then, become the same as those governing the operation of conventional resistance-capacitance-coupled amplifiers. The value of C_1 must be large with respect to the sum of stray circuit-capacitances and the interelectrode capacitances of T_2

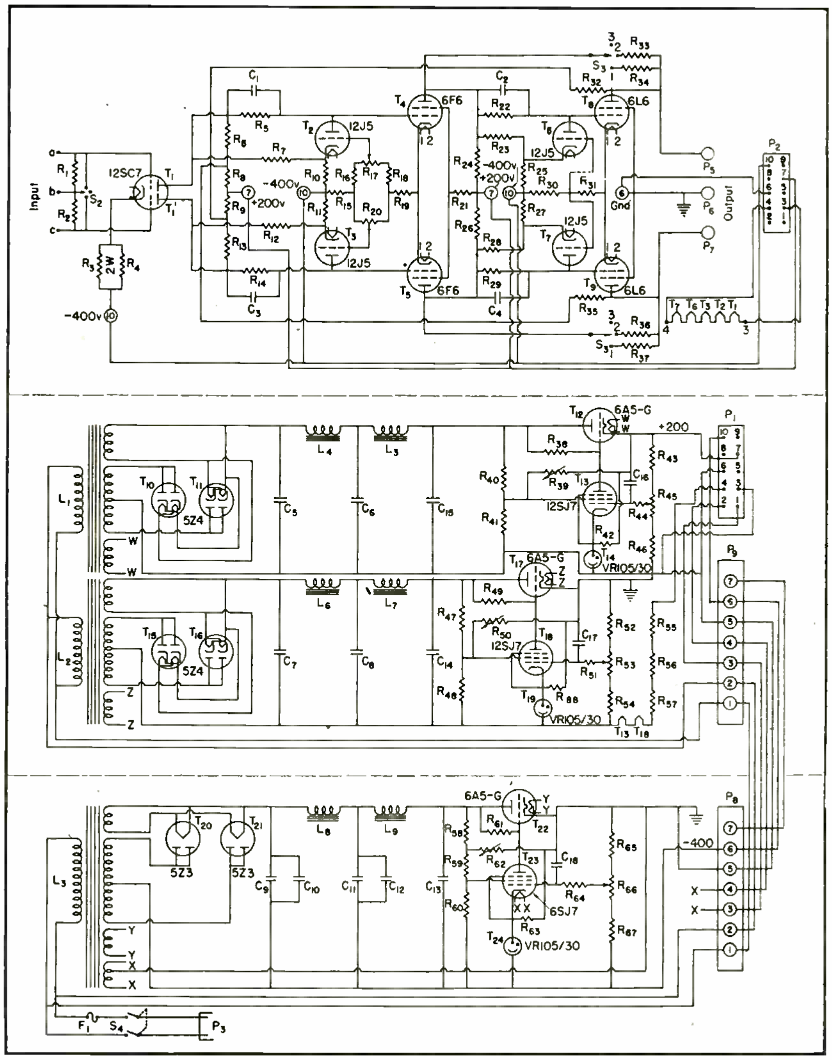


FIG. 5—Schematic of complete stabilized direct-coupled amplifier. Parts list is given in the accompanying text

PARTS LIST FOR FIG. 5

R_1, R_{12} — 1 meg, 1 w
R_3, R_4 — 200,000, 1 w
R_5 — 300,000*
R_6 — 20,000, 1 w
R_7 — 2 meg, 1 w
R_8, R_9 — 25, 1 w
R_{10}, R_{11} — 100,000*
R_{13} — 2 meg, 1 w
R_{13} — 20,000, 1 w
R_{14} — 300,000*
R_{15} — 2,000, 10 w
R_{16} — 1,000, 1 w
R_{17} — 50, pot.
R_{18} — 1,000, 1 w
R_{19} — 2,000, 10 w
R_{20} — 250, pot.†
R_{21} — 25,000, 1 w
R_{22} — 200,000, 1 w*
R_{23} — 2 meg, 1 w
R_{24} — 10,000, 10 w
R_{25} — 100,000, 1 w
R_{26} — 10,000, 10 w
R_{27} — 100,000, 1 w
R_{28} — 2 meg, 1 w
R_{29} — 200,000*
R_{30}, R_{31} — 2,500, 10 w
R_{32} — 10,000, 10 w
R_{33} — 100,000, 1 w
R_{34} — 35,000, 1 w
R_{35} — 10,000, 10 w
R_{36} — 100,000, 1 w
R_{37} — 35,000, 1 w
R_{38} — 1 meg, 1 w
R_{39} — 20,000, pot.
R_{40}, R_{41} — 100,000, 1 w
R_{42} — 5,000, 10 w
R_{43} — 75,000, 1 w
R_{44} — 1 meg, 1 w
R_{45} — 15,000, pot
R_{46} — 75,000, 1 w
R_{47}, R_{48} — 100,000, 1 w
R_{49} — 1 meg, 1 w
R_{50} — 20,000, pot.
R_{51} — 1 meg, 1 w
R_{52} — 75,000, 1 w
R_{53} — 15,000, pot.
R_{54} — 75,000, 1 w
R_{55} — 150, 10 w
R_{56}, R_{57} — 300, 10 w
R_{58}, R_{59}, R_{60} — 100,000, 1 w
R_{61} — 1 meg, 1 w
R_{62} — 100,000, pot.
R_{63} — 15,000, 10 w
R_{64} — 1 meg, 1 w
R_{65} — 250,000, 1 w
R_{66} — 75,000, pot.
R_{67} — 75,000, 1 w

C_1, C_2, C_3, C_4 — 0.1 μf, 600 v
C_5, C_6, C_7, C_8 — 8 μf, 600 v, elec.
C_9, C_{10} — 2 μf, 1000 v, oil
C_{11}, C_{12}, C_{13} — 4 μf, 600 v, oil
C_{14}, C_{15} — 8 μf, 600 v, elec.
C_{16}, C_{17}, C_{18} — 1.0 μf, 600 v, oil
S_1 — Two-gang rotary, each gang SP, eleven-position
S_2 — SP3T rotary
S_3 — Two-gang rotary, each gang SP, three-position
S_4 — DPST toggle
L_1, L_2 — Power Transformer, 180 va, 400–0–400 v, 200 ma d. c., 5 v-amp, 6.3 v — 5.14 amp, Thordarson T-13R16.
L_3 — Power transformer, 590–0–590 v, 200 ma d.c., 6.3 v-3 amp, Kenyon T-247.
L_4, L_5, L_6, L_7, L_8, L_9 — Filter choke, 12 h at 0 ma, 5 h at 200 ma, d.c., 80 ohms, 1600 v insulation test, Thordarson T-67C49.
F_1 — 5 amp, Type 3AG
P_1, P_2 — Ten-terminal flush female chassis connector, Jones S-310-FP.
P_3 — Flush female chassis connector
P_4 — Three-terminal female chassis connector, Amphenol PC3F.
P_5, P_6, P_7 — Banana jack
P_8, P_9 — Seven-terminal terminal strip

* Precision-type, (IRC Type WW-4), wire-wound resistors.

† R_{20} consists of ten 25-ohm, ½ w resistors, connected in series across the terminals of an 11-position rotary switch, and isolated from the remainder of the circuit with a 1000 ohm, 10 watt resistor at either end of the switch.

and T_3. In practice, a capacitance of 0.01 μf or more has been found satisfactory for circuits of the type shown here.

Distribution of Potential

The circuit of Fig. 4 illustrates the type of potential-distribution problem encountered in the application of the direct-coupled amplifying unit to a three-stage cascaded direct-coupled amplifier.

The first stage, which consists of T_1 alone, is a conventional direct-coupled amplifier. Its output signal is superimposed upon its average plate potential of +150 volts. T_2 operates as a coupling element to the grid of T_3, which is an amplifier. T_4 and T_5 operate in like manner to T_2 and T_3. The average potential, with no signal applied to the input circuit, is given for all significant points in the circuit. It will be noted that the output level of each stage, exclusive of the input stage, is at ground potential.

The feedback resistor R_x, which is shown in Fig. 4, has no function in the distribution of average potential. It is employed, rather, in the final design of the amplifier as a gain-control element.

Design for a Typical Amplifier

Figure 5 illustrates schematically a complete design for a direct-coupled amplifier. The maximum voltage-gain of the amplifier is 5000 times. Its input impedance is 100,000 ohms. The high-frequency response of the unit is given in Fig. 6. The low-frequency response of the amplifier is uniform, at the maximum value shown in Fig. 6, to zero cps.

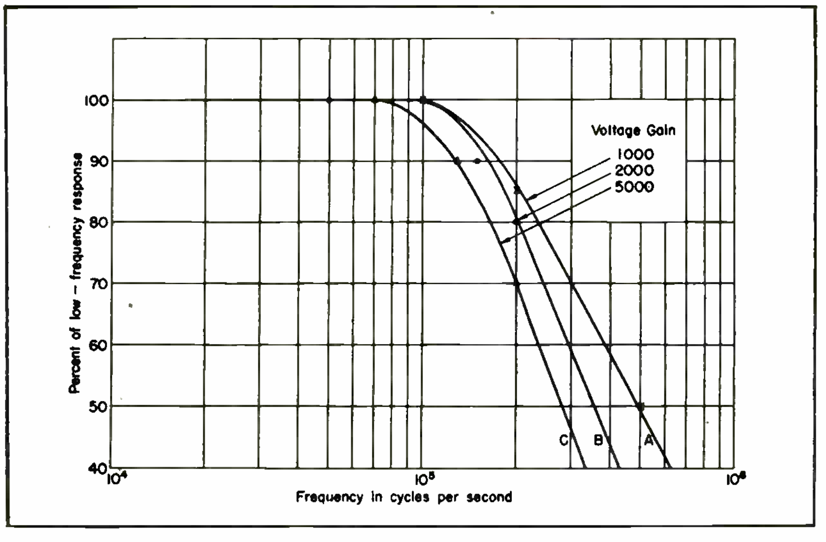


Fig. 6—High-frequency response characteristic of the amplifier

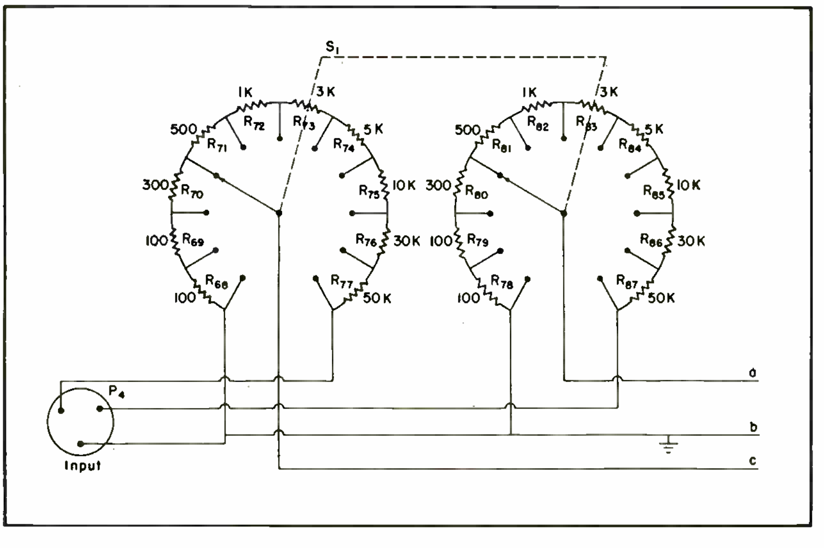


FIG. 7—Input attenuator detail. Each resistor is a ½-watt unit

TABLE I. Overall Amplifier Gain as a Function of Attenuator Setting and Actual Amplifier Gain

Attenuator Setting	Amplifier Gain Setting		
	1000	2000	5000
0	0	0	0
1	1	2	5
2	2	4	10
3	5	10	25
4	10	20	50
5	20	40	100
6	50	100	250
7	100	200	500
8	200	400	1000
9	500	1000	2500
10	1000	2000	5000

The amplifier has been designed for direct deflection of a Du Mont Type 5LP5 cathode-ray tube, which is operated with a second-anode potential of 1000 volts and an intensifier-electrode potential of 2000 volts. Instability of gain and drift cannot be observed on the screen of the cathode-ray tube. The amplifier is operated entirely from alternating-current power.

Input Circuit

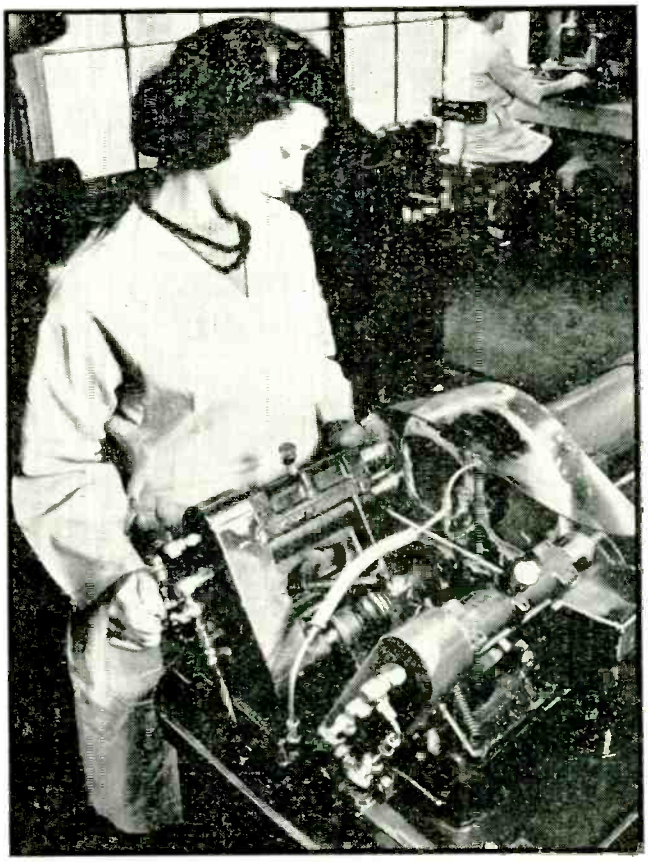
A balanced input attenuator (Fig. 7) is provided in the amplifier for reduction of the input signal to an amplitude which is proper for the grid of the first stage and for control of the magnitude of the output potential. The attenuator gives steps in gain in the ratio of 2 to 1 as closely as could be obtained with available values of standard commercial resistors. Eleven fixed positions of the input attenuators are available which, with three fixed values of amplifier gain, give a total of 33 gain positions. The maximum attenuation, exclusive of the "OFF" position, is 10^{-3}. The gain settings available are given in Table I.

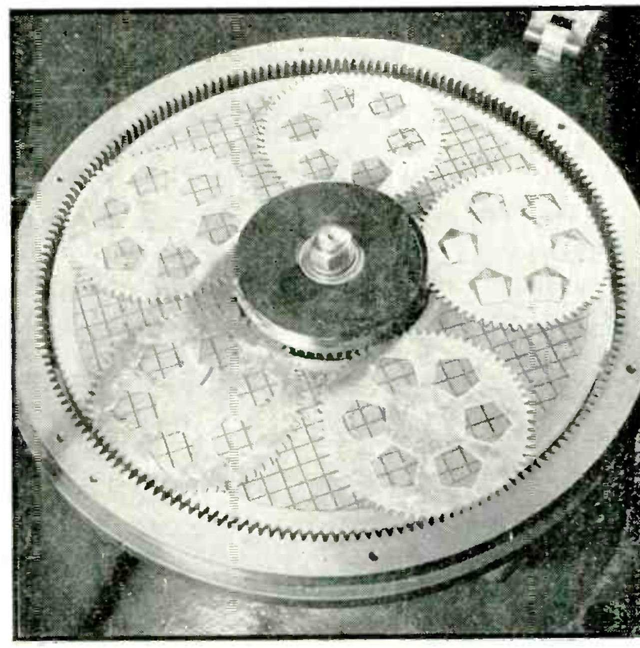
Immediately following the input attenuator in the circuit is a three-position switch which will ground either side of the amplifier input for use with signals which are unbalanced with respect to ground. An ungrounded position is provided for use of the amplifier in the conventional balanced manner.

Balance of the Amplifier

The term "balance" is used to refer to the overall adjustment of any or all of the characteristics of an amplifier to readjust the output-

(*Continued on page* 352)



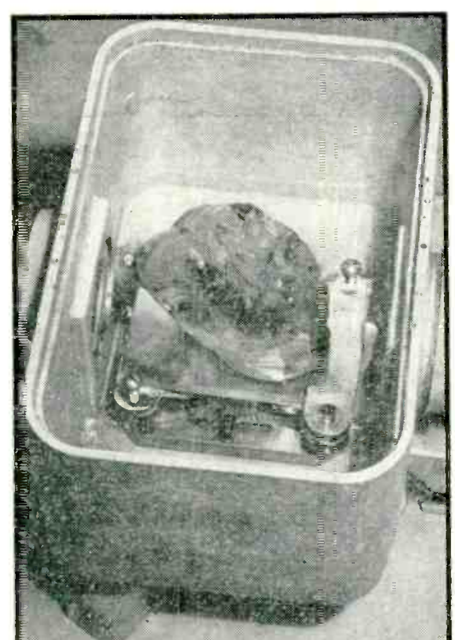


ABOVE: In one step of the grinding process, the quartz wafers are placed in pentagonal holes in planetary gears that revolve and rotate with abrasive between two cross-grooved plates

LEFT: The quartz wafers are held in place by suction and ground against a resinoid diamond wheel on this automatic lapping machine

Lapping QUARTZ for War

Some of the techniques used in processing crystals at Dobbs Ferry, N. Y. plant of North American Philips



After partial orientation with a conoscope (above), accurate checking of the sawing angle is made by x-ray diffraction on the instrument at the left

Measurement of High Vacuums

Gages used in the development of electronic and other devices employing low pressures measured in microns of mercury are described. Their application to automatic control of manufacturing processes is discussed

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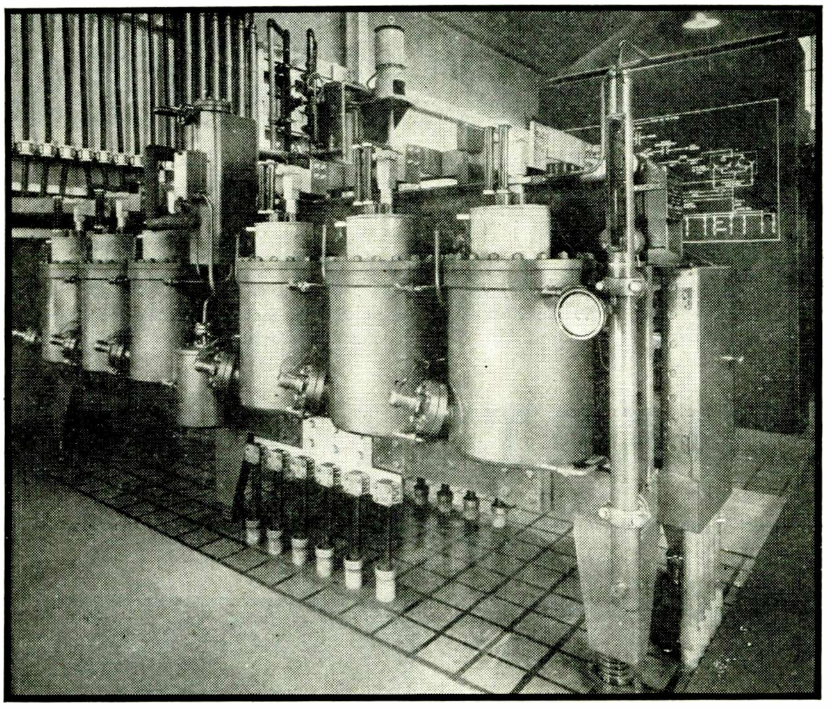


Ignitron mercury-arc rectifier equipped with an industrial type vacuum gage having a handwheel and pinion for operating the mercury plunger. The gage is at the extreme right

THE INDUSTRIAL APPLICATION of gaseous and nuclear discharges is creating a demand for instruments that measure the pressure in vacuum systems. There is also a growing demand for instruments that automatically control pressure, or control an electrical quantity as a function of pressure. It is, therefore, timely to discuss some of the various vacuum gages which are used in the development and application of electronic devices.

By far the most extensive application for such vacuum gages is found in the production of discharge tubes and incandescent lamps. However, many other industrial processes now require the use of low pressures measured in microns of mercury. In this connection, the barometer-tube diagram of Fig. 1, comparing pressures, will be of interest.

Barometer Vacuum Gage

The barometer vacuum or McLeod vacuum gage operates on the principle of trapping, by means of mercury, a definite volume of gas in the closed end of a glass tube, and measuring the volume of the sample after a definite pressure has been applied. The better the vacuum—i.e., the smaller the number of gas molecules per unit volume—the smaller the volume will be after compression.

According to Dalton's law, the total pressure of a gas mixture is equal to the sum of the partial pressures of the component gases. The gage, however, will not indicate the partial pressures of vapors, as for instance of mercury and water, which condense at the pressure applied in the use of the gage. It will read only the total pressure of permanent gases present in the vacuum system.

The form of this gage, which has found general application, is illustrated in Fig. 2. The glass tube (1) is connected to the vacuum system. The mercury contained in the gage can be lifted by means of a plunger (7), so that it will rise in tubes (5) and (1), and close off the entrance to the bulb (4) and tube (3), When further pressure is exerted on the plunger, the mercury will enter bulb (4) and tube (3), the end of which is sealed, and will compress the gas volume which has been trapped in tube (3).

A scale (2), calibrated in microns, is provided on tube (3) so that the vacuum can be read directly on this scale. A marked comparison tube (6) is provided on tube (1) so that the operator is able to bring the mercury column up to a definite level. This level corresponds to a definite pressure on the volume trapped in tube (3).

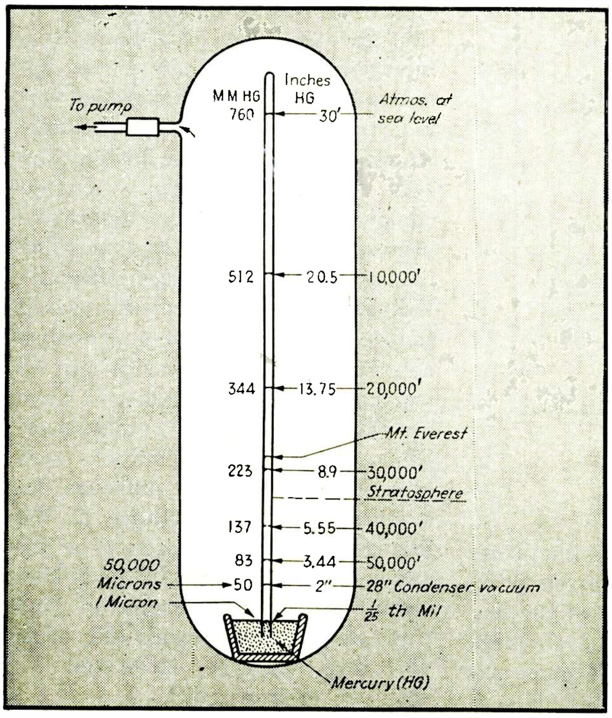


FIG. 1—Columns of mercury (Hg) at various pressures

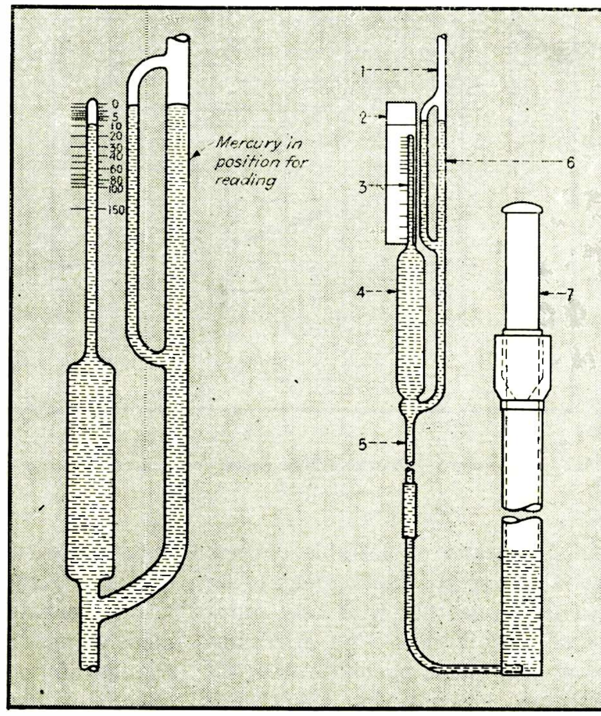


FIG. 2—The barometer vacuum or McLeod gage

The scale of the McLeod gage is usually arranged to read pressures from 0 to 300 microns. Readings can be estimated within limits of about 0.1 micron, which is usually sufficient for technical purposes. Another type is available for reading pressures from 0 to 3000 microns. Special gages are in use for measuring a range of 0.01 to 10 microns.

The gage is easy to manipulate, and the only care which has to be taken concerns the speed of raising the mercury column. This must be done slowly in order not to break the closed end of the gage and to prevent disrupting into sections the mercury column in the small tube, which causes incorrect reading. Industrial type gages are generally equipped with handwheels and pinions for operating the mercury plunger, so that slow movement is assured.

The McLeod gage is generally used to calibrate electrical types of vacuum gages, and is quite popular for laboratory work. Pump-evacuated rectifiers are usually equipped with this type of gage.

Thermocouple Vacuum Gage

The thermocouple vacuum gage employs the heat conductivity of a

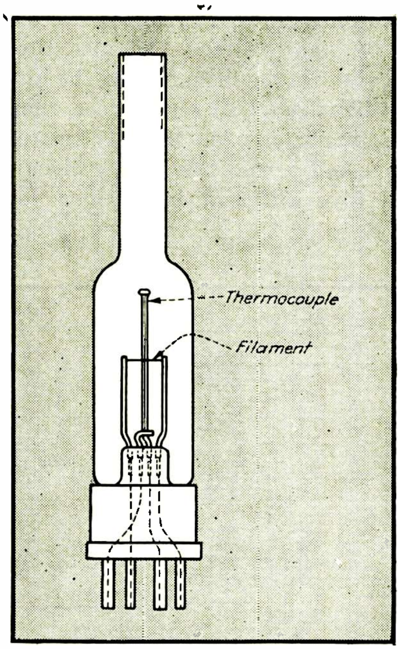


FIG. 3—Thermocouple vacuum gage tube

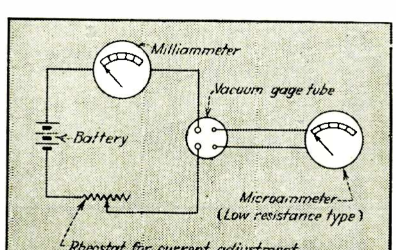


FIG. 4—Circuit for thermocouple vacuum gage

gas or vapor as a mean of measuring the pressure in a vacuum system.

Heat conductivity depends on pressure, i.e., on the number of molecules present in the system. Thus the essential element of this gage is a thermocouple contained in a glass envelope in the form of a vacuum tube, as shown in Fig. 3. The tube is provided with an extended neck by means of which it may be connected to the vacuum system, either through a rubber hose or glass tubing.

A typical tube contains a filament to which a constant current of 0.03 to 0.05 ampere is supplied by a dry battery, this current being variable by means of a rheostat as shown in Fig. 4 to provide suitable full-scale adjustment. The output voltage of the thermocouple is indicated by means of a low-resistance microammeter. High output, corresponding to high temperature at the thermocouple, indicates low pressure or good vacuum, because under this condition the heat conductivity of the gas is low. Vice versa, low thermocouple output indicates a poor vacuum.

The scale of the microammeter may be calibrated in arbitrary divisions to enable the vacuum to be

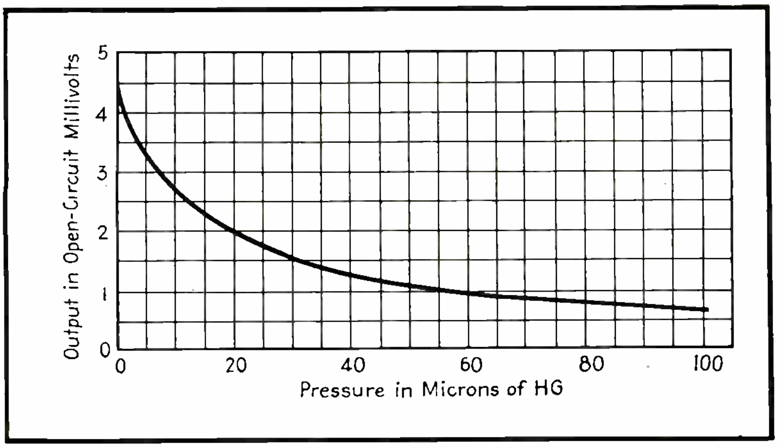


FIG. 5—Characteristic curve for a thermocouple vacuum gage

read by means of suitable curves, thus allowing the instrument to be used in connection with any number of gage tubes. The microammeter may also be calibrated directly in microns, in which case the instrument is used with one gage tube for which it is calibrated. Obviously, the calibration of the tube will depend on the nature of the gas or vapor for which it is to be used, since the heat conductivities of various gases and vapors at a given pressure are different.

A typical complete vacuum gage is supplied in a metal case containing filament milliammeter and thermocouple microammeter, as well as the rheostat. Mounted in a suitable socket, the gage tube may be located at any convenient point in the vacuum system. The range of pressures to which this device is usually applied is from 1 to 100 microns. It has mainly been supplied for use in laboratories. The characteristic curve of readings is shown in Fig. 5.

Hot-Filament Resistance-Type

The hot-filament resistance-type or Pirani-Hale vacuum gage uses the rate at which heat is conducted away from an incandescent filament for indicating the pressure in a vacuum system. Since the rate of heat conduction is a function of the number of gas and vapor molecules in the vacuum system, it is also a function of the gas pressure. Therefore, the higher the pressure in the vacuum system, the lower will be the temperature of the filament.

Assuming the use of a filament material with a high temperature coefficient, such as tungsten wire, any temperature change of the filament will result in a relatively large change of resistance. To make the change of resistance of the filament available for indicating purposes, it is connected to one branch of a Wheatstone bridge as in Fig. 6. Assuming that the bridge is excited by constant voltage and also that the other three branches of the circuit have constant resistances, then a galvanometer or microvoltmeter connected across the bridge circuit will give different indications for various pressures in the vacuum system.

In the practical application of this vacuum gage, the filament is incorporated in an indicator or detector tube which is not sealed but is connected to the vacuum system. Another branch of the bridge circuit contains a highly evacuated compensator tube in comparative position to the indicator tube. The bridge circuit is balanced after the indicator tube has been evacuated to the lowest obtainable pressure, so that under this condition all branches of the bridge circuit have approximately equal resistances. This condition corresponds to zero indication. When the pressure decreases and the resistance of the filament in the indicator tube increases, the unbalance in the bridge circuit causes a current to flow through the instrument, the scale of which may be calibrated directly in microns.

Uses for Pirani-Hale Gage

This gage may be used both for local and remote measurement of vacuum and also for the purpose of controlling vacuum through a contact-making device, as shown in the connection diagram of such a vacuum-regulating equipment (Fig. 6). The instrument of this equip-

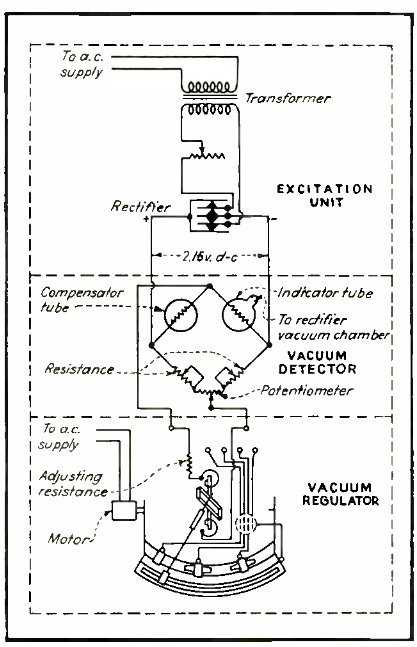


FIG. 6—Hot-filament gage connected in a bridge circuit of a vacuum regulator

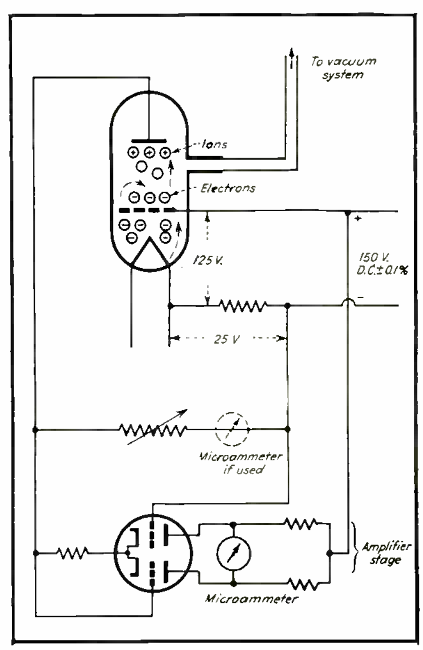


FIG. 7—Circuit for an ionization gage, using a triode tube

ment is provided with a set of contacts so arranged that the indicator needle may close these contacts if it reaches a selected point on the micron scale.

To relieve the needle of any mechanical stress required for exerting a sufficient contact pressure, a small motor is used in the regulator diagrammed. It presses the needle in regular short intervals against the contact bar, through a reciprocating movement, thereby closing the circuit to the vacuum pump. When the needle returns to the selected point, usually low on the scale, another contact is caused to open the circuit.

Devices of this type are usually employed to ring an alarm or trip a rectifier off the line in case vacuum fails. They may, however, be used for automatic control of vacuum pumps if this is desired.

The particular gage referred to is calibrated for a range of 1–10 microns. Readings may be estimated to about 0.1 micron.

Ionization Gage

The ionization gage is perhaps the simplest means for quantitatively measuring a high vacuum. This gage, which consists essentially of a three-electrode vacuum tube, makes use of the fact that an electron emission current from a hot cathode will cause ionization of gas molecules in the tube by bombardment. These ions will flow to any electrode which is maintained at a sufficiently high negative potential with respect to the hot cathode.

The number of ions caused by the collision of a constant electron flow with gas molecules is a measure of the number of gas molecules present, and therefore of the pressure in the vacuum system. Figure 7 shows the connections of such a three-electrode tube. Here the grid of the tube, used as an anode for attracting electrons, is held at a constant positive potential with respect to the filament-type cathode. The electrode which in other applications of such tubes is used as an anode in this case serves the purpose of a collector plate for ions.

A direct voltage of, for example, 125 volts, is applied between cathode (−) and grid (+) to obtain a sufficient flow of electrons. At the same time, a constant difference of potential of, say 25 volts, is applied between the collector plate (−) and the cathode (+), and the electron emission is maintained constant by controlling the filament current.

The ion current is a definite function of the gas pressure, and, therefore, a microammeter may be connected in the plate circuit and can be calibrated to indicate directly the vacuum in microns. By shunting the microammeter, the sensitivity of the gage may be adjusted to suit the prevailing conditions of pressure.

One typical ionization gage may be used for indicating pressures as low as 0.01 micron, and a useful range may be from 0.01 to 10 microns. The upper limit of pressure for this type of gage is that at which ionization takes place throughout the tube, that is, throughout the entire space between filament and grid. This may occur—depending on the design of the tube used—at any pressure between 100 and 200 microns. In this case, some of the ions will go to the cathode and the plate current is then no longer a function of the number of gas molecules present in the vacuum system. Furthermore, rapid destruction of the filament-type cathode will occur as a result of bombardment by ions.

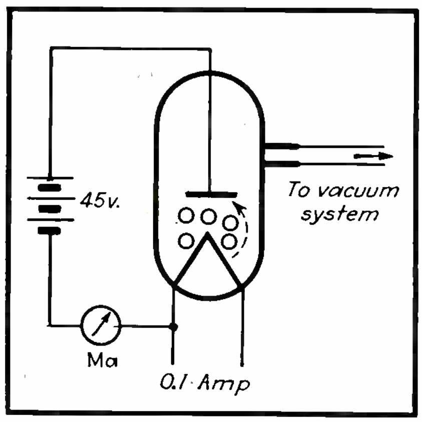


FIG. 8—An emission gage using a diode tube

The principal application of the ionization gage is in laboratories dealing with electronic research and in factories producing vacuum tubes.

In some cases, especially when the ionization gage is used for control purposes, it is advantageous to use an amplifier stage in series with the gage (Fig. 7). The sensitivity may then be changed by varying the resistance in series with the plate, thereby changing the voltage drop for a given ion current.

Emission Gage

A more recent means for qualitatively indicating the degree of vacuum, or a leak in a vacuum system, is the emission gage, which uses a diode tube for indicating the presence of gas in the vacuum system.

In this case, the gage tube contains two electrodes, as shown in Fig. 8, one being the hot cathode and the other the anode, which is arranged close to the cathode. The cathode is heated by a standard low-voltage battery of perhaps 1 volt, while the applied anode voltage may be obtained from a small 45-volt radio battery.

As long as no gas molecules are present in the tube, an electron emission current may be read with a microammeter. If, however, any gas is allowed to enter the vacuum system, the emission breaks down, and the microammeter in the anode circuit will read zero.

Leak Detection

This system is used for indicating leaks in a vacuum system, for instance in an electronic tube being evacuated. In such a case, oxygen is blown through a small hose against the tube connected to the pump, while the microammeter indicating the emission current of the gage tube is observed. If the gas has a chance to enter the vacuum system, and through the system the gage tube, the emission current will disappear. The current will return as soon as the gas flow is interrupted, i.e., the hose is removed.

This method of leak detection is so sensitive that the location of a leak may be determined by directing the flow of gas against a particular spot.

The leak detector has until now mainly been used in the testing of vacuum tubes for possible leaks, while such tubes are being exhausted. Its application may, however, be extended to any other system in which a high vacuum has to be maintained.

PHOTOELECTRIC

An electronic medical instrument for recording the state of fullness of blood vessels. It measures ear opacity by means of a tiny phototube and lamp clipped to the ear. The phototube is connected to a unique direct-coupled push-pull amplifier feeding the moving coil of an inkwriter

By W. E. GILSON, *Univ. of Wisc. Medical School, Madison, Wisconsin*

A PLETHYSMOGRAPH is defined as "an instrument for recording graphically the size of a part as determined by the state of fullness of its blood vessels". This is ordinarily done by placing the part in a chamber filled with air or water, and measuring the displacement of the filling medium with a tambour or similar means. This gives quite accurate quantitative results, but is rather inconvenient and almost impossible to apply to some parts.

An extremely convenient but less accurately quantitative method is photoelectric plethysmography, in which a beam of light is transmitted through the tissues and onto a phototube, the amount of light reaching the phototube depending on the absorption of light in the region. This depends to a considerable extent on the amount of blood in the tissues at the moment. With each contraction of the heart, blood is forced into the peripheral vascular system, causing a momentary dilatation and an increased absorption of light.

A fingertip pulsation as recorded with a capacitor-coupled amplifier and cathode-ray tube, simultaneously with a record of the cardiac action potentials, is shown in Fig. 1. Note the delay between contraction of the heart (at point *B*) and the arrival of the pulse at the finger (at point *A*). In addition to this pulsation there is a slow change due to variations in arterial tonus, as well as other factors. This slow change can be recorded only with a direct-coupled amplifier. An example still occasionally seen is blushing of the face and ears as a response to certain emotional stimuli.

A similar but more pronounced effect may be obtained by the Valsalva experiment, in which an attempt at forced expiration is made with a closed glottis. This raises the intrathoracic pressure above the venous pressure, preventing return of blood to the heart and producing engorgement of the peripheral vessels, especially of the head. This is the most convenient method for testing a photoelectric plethysmograph designed for use on the ear.

Photoelectric plethysmography was first introduced in Germany in 1934,[1] and developed further in this country[2, 3, 4].

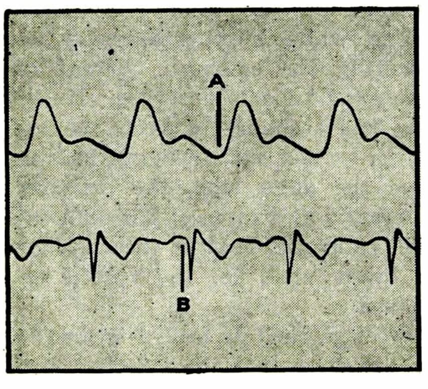
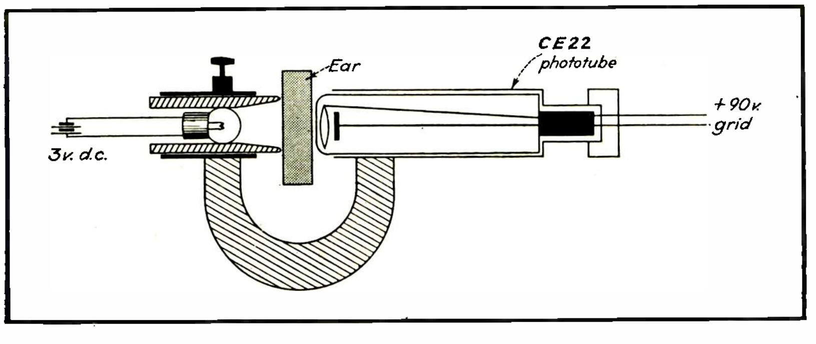


FIG. 1 (Left)—Recording of cardiac action potential (lower record, with beginning of cardiac contraction at *B*), and fingertip pulsations (upper record, with onset of pulse at *A*).

FIG. 2 (Below)—Ear opacity is measured with this arrangement, which is a modification of the Hertzman-Dillon plethysmograph. A compact version is being used by high-altitude fliers to monitor the amount of oxygen in their blood, as this is also related to ear opacity



Recording Opacity of the Ear

In connection with a research problem it became necessary to record with an inkwriter the amount of blood in the ear simultaneously with several other inkwritten records, these records being made by a six-channel Grass electroencephalograph. One of the electroencephalograph inkwriters was not being used for other purposes, so it seemed desirable to use it for recording the ear opacity.

An inkwriter as used for electroencephalography consists of a moving coil and field magnet assembly, much like a dynamic speaker, with the moving coil connected to a lever system which amplifies the motion and applies it to a pen. The moving coil is wound with fine wire, usually No. 41, to a d-c resistance of about 2,500 ohms. Thus it may be con-

PLETHYSMOGRAPH

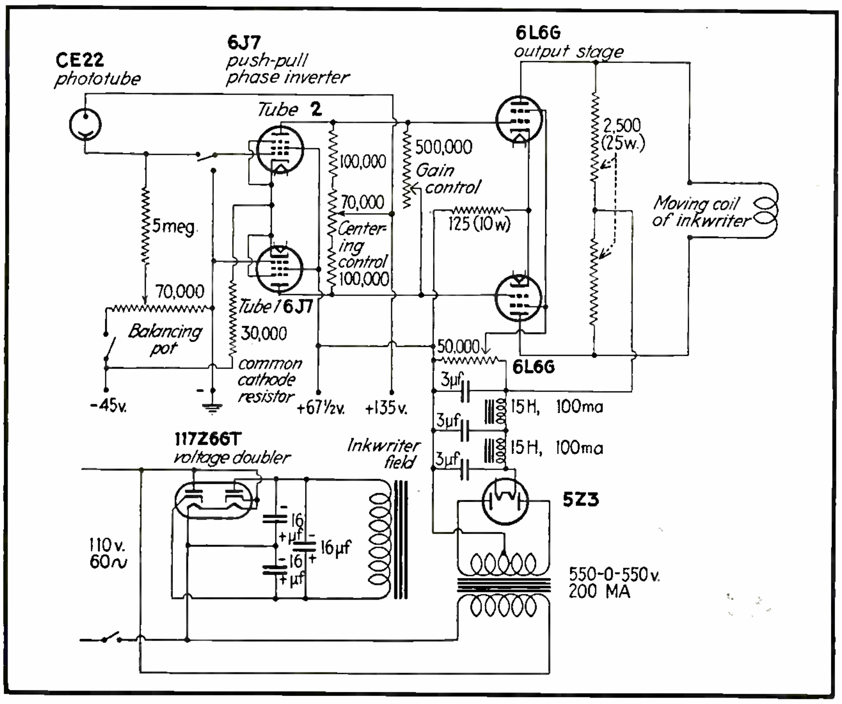


FIG. 3—Push-pull amplifier circuit used with the plethysmograph to actuate one pen of a six-channel Grass electroencephalograph

nected directly into the plate circuit of a vacuum tube, which is necessary in order to record frequencies down to one or two cycles per second. Such frequencies are frequently found in pathological electroencephalograms. (For further information on the Grass electroencephalograph see appendix A, Atlas of Electroencephalography, F. A. Gibbs and E. L. Gibbs, Cambridge, Mass., 1941.)

Plethysmograph Design

A modification of the Hertzman-Dillon plethysmograph was used, the design being changed to allow the light transmitted through the ear to fall directly on the cathode of the phototube, thus obtaining considerably higher output. This modified instrument, shown in Fig. 2, gives an output of the order of one volt with a moderate change in ear density, such as that caused by a Valsalva experiment. A tube well adapted to this purpose is the Continental Electric CE 22 of the flat end type. (This tube is supplied with either a round or flat end, and it is necessary to specify in order to receive the one desired.)

The electroencephalograph amplifiers are capacitor coupled, and would work well for recording pulsations in the ear, but could not of course be used for recording sustained changes in ear opacity. Thus it was necessary to develop a direct-coupled amplifier with sufficient power to drive the inkwriter.

Amplifier Circuit

The amplifier circuit is shown in Fig. 3. The output stage is of a conventional push-pull type, driven by a push-pull phase inverter with a large cathode resistor. The phase inversion is produced by means of the large voltage drop in the common 30,000-ohm cathode resistor. This voltage drop is always larger than 45 volts, so as to make the cathode positive with respect to the grid as required for negative grid bias. The input grid of tube 1 is grounded, and the signal is applied to the input grid of tube 2.

When the grid of tube 2 is made more negative by a change in phototube resistance, the cathodes of both input tubes also become more negative (closer to −45 v), because of the decreased voltage drop in the common cathode resistor. The effect is thus to bring the grid of tube 1 closer to the cathode in potential; since the grid was originally negative, it becomes less negative with respect to its cathode. This is just as if the signal had been applied from grid to grid, rather than from one grid to ground. Therefore, given a sufficiently large cathode resistor, the signals on the two plates of the first stage will be 180 deg. out of phase and approximately equal [5,6,7].

The line voltage on which the photoelectric plethysmograph was to be operated had frequent large transients, and it was decided to eliminate interference from these by operating the first stage of the amplifier on batteries. The drain is extremely small, so that long battery life can be expected. The output stage was operated from a rectifier power supply in order to obtain sufficient power. Push-pull operation makes this stage almost completely stable even with large changes in line voltage.

When operating as an electro-

(*Continued on page* 318)

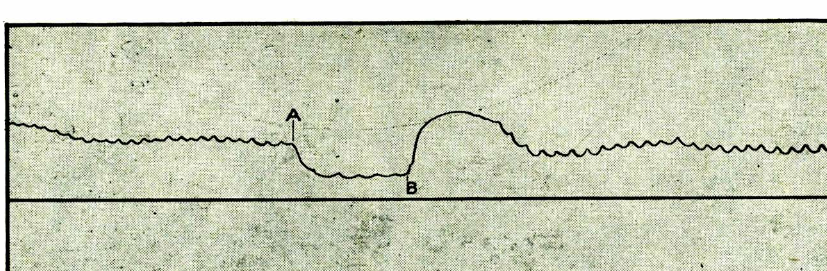


FIG. 4—Inkwriter record obtained by a Valsalva experiment with the photoelectric plethysmograph. The dip between points *A* and *B* indicates increased congestion and corresponding higher ear density

AIRCRAFT RADIO

Aircraft radio mechanic adjusting a 10-frequency combination transmitter and receiver at United Air Lines' maintenance base at Cheyenne, Wyoming

Communications laboratory of United Air Lines in Chicago

By A. F. TRUMBULL
San Mateo, Calif.

AIRCRAFT radio mechanics employed by commercial airlines can be divided into three groups: line service mechanics, who check the radio equipment and affiliated installations in the aircraft itself; shop mechanics, who are responsible for the overhaul, maintenance, rebuilding and revision of such items as transmitters, receivers and other removable equipment; project mechanics, who make major alterations in the equipment and the installation.

General Requirements of Maintenance Mechanics

All mechanics assigned to aircraft radio maintenance must hold at least a second-class radiotelephone license, in addition to technical and personal qualifications. Versatility is highly desirable since a man may be used for all three types of work. An understanding of the requirements for each type of aircraft radio mechanic can be of value, however, in placing those new men whose aptitudes make them best suited for one particular type of work.

Line Service Mechanic

Generally the airplane radio line service mechanic must be able to think and act quickly, be cheerful, present a good appearance, and be cooperative to a greater degree than the shop man. He must be able to diagnose quickly and accurately any irregularities in the operation of every single component of an aircraft radio installation, to determine whether or not it is operating properly and if not, how to fix it. His remedial measure may be nothing more than replacing a defective unit, but he must know for

MAINTENANCE

Duties and required qualifications of each type of aircraft radio mechanic, and general discussion of maintenance procedures used by large commercial airlines to keep both ground and flying radio equipment in proper condition with minimum plane lay-over

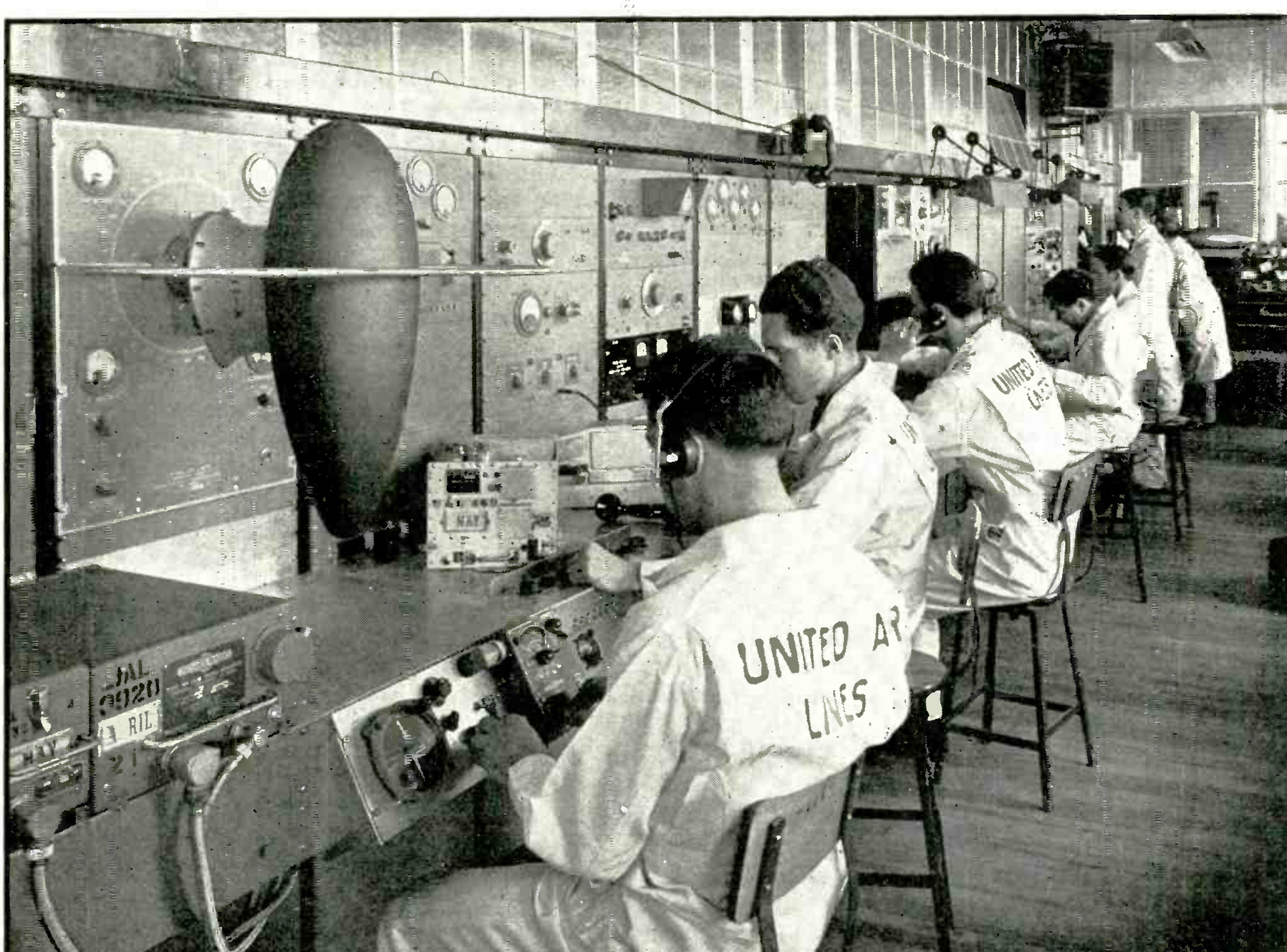
sure that the unit is defective and that its replacement will cure the trouble.

Shop Mechanic

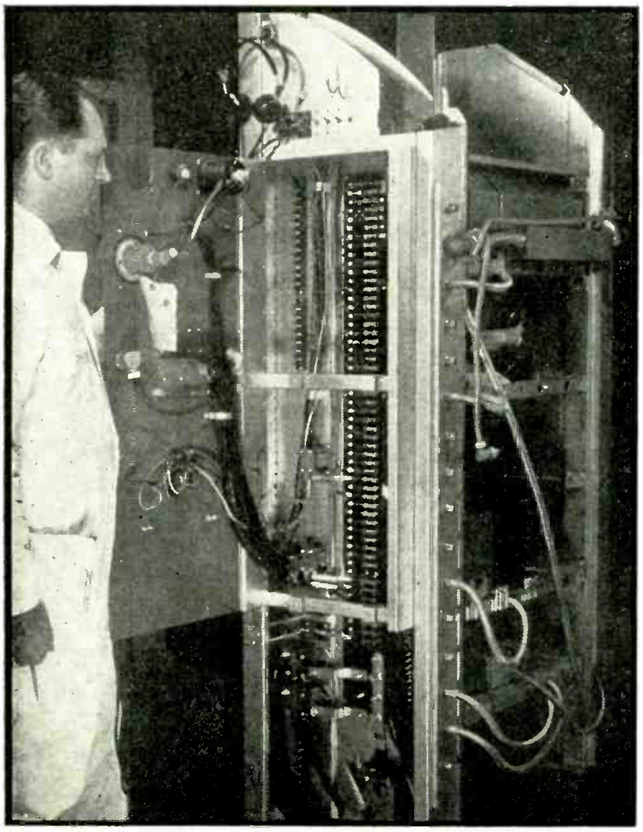
The airplane radio shop mechanic is not required to make the lightning decisions so necessary in "through service" work, but his technical knowledge and his ability to handle tools and machinery are important. He can assume a more or less steady gait at his bench work. The slow-but-sure type of man is valuable at such work, as it usually requires a great deal of patience, consistent and deliberate thinking, planning ahead and sometimes the development of ideas. An analytical mind and a creative instinct are definite assets in radio shop work, especially when completely rebuilding some unit of radio equipment.

Project Mechanic

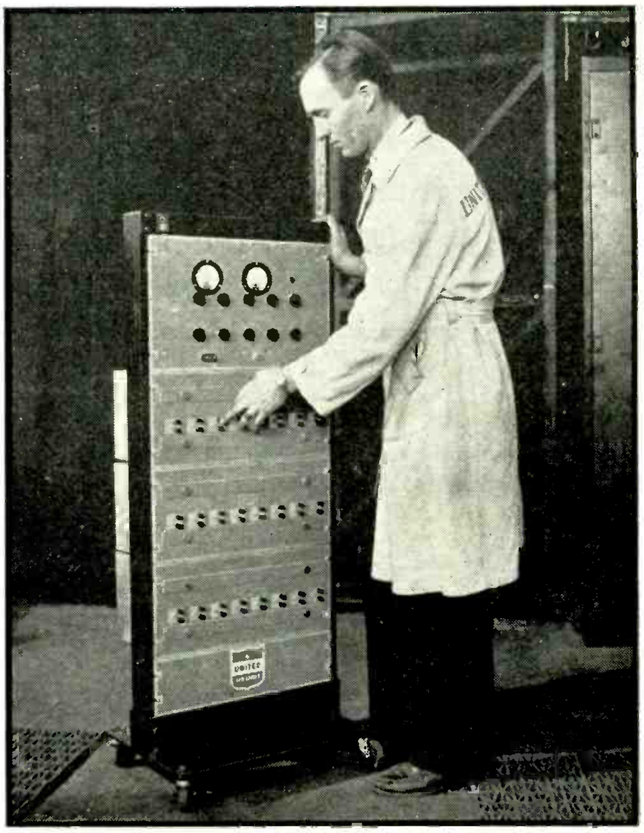
Project work consists of the in-



Test panels in the radio-electric department of United's base in Cheyenne. Left to right: Automatic direction-finder test panel; receiver test panel; interphone and loop test panel; oscillo-scope for visual checking; a-f signal generator and vacuum-tube voltmeter; communications unit test panel; a-f power amplifier; loop gear box test panel; all-wave receiver for checking frequencies; microphone and headset test panel; autosyn test panel; relay test panel; generator test panel



Radio rack mock-up of a Mainliner, wired so sets can be operated as in flight, to study the effects of proposed changes without holding an airplane out of service



Signal generator used for measuring frequencies and aligning all aircraft radio receivers carried aboard Mainliners. Push-buttons select any of 24 crystal-controlled frequencies

stallation of new units, the alteration of existing installations and major overhaul and repair jobs. The airplane radio project mechanic requires many of the attributes of both the line service mechanic and the shop mechanic. His work is usually in the airplane itself and is accomplished at the time the plane is in the shop for engine change and/or plane overhaul. He must be able to cooperate with others to a high degree, and must work fast and accurately so that the plane will not be out of service because of his slowness or mistakes.

About 25 percent of an aircraft radio installation was changed every year prior to the war, in the interest of modernization and improved operation. The changes usually involved the "fixed" equipment in the plane, frequently not readily accessible, hence the work had to be of high quality and require no future attention.

Communications Laboratory

Some of the major airlines maintain a communications laboratory for development work on local problems involving too small an equipment market to interest aircraft radio manufacturers, or for work requiring flying equipment and other facilities available only to an air transport company.

Aircraft radio equipment is usually designed to meet the average requirements of all commercial airlines, and the communications laboratory may often engineer such changes as are desirable for its own airline. Operating service problems which require laboratory equipment and technicians are also handled by the laboratory staff.

Desirable Qualifications for Aircraft Radio Mechanics

In addition to actual radio training and experience, it is highly desirable that all aircraft radio mechanics have at least a high school education, including courses in physics, mathematics through algebra and trigonometry, mechanical drawing and machine shop practice. Training in sheet metal work, welding, brazing and soldering and experience with internal combustion engines and instruments is also desirable in radio maintenance work.

Much or all of this apparently unrelated training is often lacking in applicants for positions in aircraft radio. So often it is not realized that aircraft radio mechanics must thoroughly understand the functions and importance of all airplane controls and the fundamentals of airplane design. The knowledge of controls is necessary so that he will not damage, throw out of adjustment or obstruct the movement of any airplane controls when doing his particular job. A knowledge of the fundamentals of construction makes him realize that even the smallest rivet, gusset or brace may be an important structural member. Accordingly he must not drill holes, bend parts, or otherwise alter any structure without first obtaining proper authority.

Opportunities

Radio maintenance mechanics usually start as apprentices or helpers at 40 to 75 cents per hour. Raises are usually periodical, and after the required length of service the apprentice is made a mechanic at approximately 75 cents to $1.00 per hour. Progress from there to master or lead mechanic and to supervisory duties is usually dependent solely on ability.

Aircraft Radio Maintenance Stations

Radio maintenance facilities are usually established at one or more stations on the airline, so necessary work can be done during layovers between trips. At other than terminal stations a plane is available only from 5 to 30 minutes, which is insufficient to accomplish any work other than replacement of some item of removable equipment.

Maintenance Foreman

The facilities at an aircraft radio maintenance station are usually in the charge of a radio maintenance foreman, who answers directly to the chief mechanic at the station. Such a foreman frequently has as added responsibilities the entire plane electrical system, emergency ground radio station repair, and electrical and communication facilities in airport buildings of the airline. It has been found that much better results are obtained if the entire electrical system of the plane is made the responsibility of one department. Any good radio man can handle the straight electrical work, but the converse is seldom true.

The responsibilities of the maintenance foreman, presuming they are electrical as well as radio, might be itemized somewhat as follows:

(1) Maintenance of the plane radio equipment (both removable and fixed), pilot's headset and microphone equipment, and the use and care of all radio shop equipment.

(2) The instruction of radio mechanics, assigned to the various crews, in the proper maintenance of the plane radio and electrical systems.

(3) To act in an advisory capacity to the crew chief or chief mechanic in the correction of any reported irregularities of radio or electrical systems.

(4) To see that the instructions issued by the superintendent of communications are carried out.

(5) To contact and instruct the flying personnel with respect to the operation of radio equipment.

(6) To maintain proper spare equipment and parts at strategic stations on his division.

(7) To prepare all forms and records required by division or field headquarters, and/or the Civil Aeronautics Bureau.

(8) To be on the alert to suggest improved servicing methods.

(9) To assign radio mechanics to the various crews, and arrange for radio mechanics to rotate shifts so that each man spends sufficient time in the shop to keep fully familiar with radio maintenance work.

(10) To contact other stations on his division, at regular intervals approved by the division superintendent, in order to advise and instruct the crew chiefs, chief mechanics and radio mechanics at those stations in the proper inspection and servicing of radio and electrical equipment.

Formal maintenance orders are issued as bulletins by the superintendent of communications.

Panel for testing microphones and headsets in sound-proof box and recording their response curves

Air-operated vibration generator designed especially for testing aircraft radio equipment

Computing CIRCUIT

A method is outlined for computing the voltage across a particular element of a network at any desired cycle after application of a repetitive discontinuous waveform, such as a rectangular pulse. General equations are given and a numerical example is worked out

By

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If a waveform consists of a number of cycles which cannot be expressed by a limited number of harmonically-related sinusoidal terms, and yet successive cycles are identical, we have a repetitive discontinuous waveform. An example of such a voltage waveform is a train of rectangular pulses.

This paper outlines a method for the computation of circuit responses to repetitive discontinuous voltage waveforms. As compared to alternative methods,[1, 2] the mathematical development is simpler and a clearer physical picture is obtained. A general description of the method will be given, illustrated by working out a specific application.

General Statement of Problem

In Fig. 1(a) a source of voltage e is connected to a load Z. The voltage waveform is as shown in Fig. 1(b). During the interval $0 \leqq t \leqq \tau$, the voltage can be expressed by the function $f(t)$. At τ there is a discontinuity, and from τ to T, the end of the cycle, the voltage is expressed by the function $\rho\ (t - \tau)$, where t has any value between τ and T. It is required to find a circuit response e' where e' is the voltage across a particular element of the network, during the nth cycle. In the case shown in Fig. 1(b), there is a single discontinuity in the voltage waveform at $t = \tau$. It may happen that there is more than one discontinuity, or it may happen that $\rho\ (t - \tau)$ is zero.

With $\rho\ (t - \tau)$ zero, if the interval $(T - \tau)$ is sufficiently long so that the response is effectively zero before the commencement of the next cycle, the problem reduces to one which can be solved by conventional methods. This is done by setting up two equations, one for the period when the emf has a finite value, and the second for zero applied emf. The first of these equations will have initial conditions corresponding to rest conditions for the circuit, while the initial conditions for the second equation will be found from the value of the first equation at the instant $t = \tau$.

First Step in Solution

The general case, where at the end of the cycle the response is not zero, will now be investigated. The first step consists in finding the response for the first cycle. At the instant before the start of the first cycle, there is zero response, hence the initial conditions will be given by, in the notation of Fig. 1, the response to $f(t)$ at $t = 0$. Now $f(t)$ expresses the emf until some time τ, where $\tau \leqq T$. If $\tau = T$, e' for the first cycle has been evaluated. In case $\tau < T$, the response over the interval $\tau \leqq t \leqq T$ must be found. The equation for the response over the second interval is obtained by solving for the response to $\rho\ (t - \tau)$, with initial conditions appropriate to the value of the energy stored in the network at $t = \tau$ due to $f(t)$. The first step in the solution for the response to the nth cycle of emf is then the solution for the response to the first cycle.

The steps in the solution will be illustrated by solving an actual example. The network of Fig. 2 is excited by a source of d-c potential which is connected to the network through switch S. This switch is closed cyclically for an interval τ and opened for an interval $(T - \tau)$. The switch may be a rotating commutator or some type of relay which is repetitively energized and deenergized. The resistance of the voltage source is lumped with series circuit resistance in R_2. It is required to find V_n, the voltage across C during the nth cycle. The applied emf will have the following form:

$$e = f(t) = E \quad \text{where } 0 \leqq t \leqq \tau \qquad (1)$$
$$e = \rho(T - \tau) = 0 \quad \text{where } \tau \leqq t \leqq T$$

The emf is then a pulse of period T and of length τ. The fact that $\rho\ (t - \tau)$ is zero simplifies the equations of the example, but does not result in any loss of generality since it is assumed that at T the response is not virtually zero.

It can be shown[3] that, for the first cycle,

$$i_1 = E\left[\frac{1}{R_1 + R_2}\right]\left[1 + \frac{R_1}{R_2}\epsilon^{-\frac{R_1 + R_2}{R_1 R_2 C}t}\right] \quad \text{where } 0 \leqq t \leqq \tau \qquad (2)$$

Here i_1 is the current through R_2, the subscript of i referring to the first cycle.

From Eq. (2), since $V = E - iR_2$, where $0 \leqq t \leqq \tau$,

$$\alpha_1 = \frac{R_1 + R_2}{R_1 R_2 C} \qquad (3)$$

$$\beta = \frac{R_1}{R_1 + R_2} \qquad (4)$$

Now V is given by

$$V_1 = E\beta\,(1 - \epsilon^{-\alpha_1 t}), \text{ where } 0 \leqq t \leqq \tau \qquad (5)$$

The subscript of V again indicates the first cycle.

Equation (5) gives V_1 for the first part of the cycle only. The value of V_1 for the second part of the cycle will now be found. At $t = \tau$, from Eq. (5):

$$V_1 = E\,\beta\,(1 - \epsilon^{-\alpha_1 \tau}) \qquad (6)$$

With S open, it is evident that C

RESPONSE to Pulses

discharges through R_1 alone and we can write:

$$V_1 = E\,\beta\,(1-\epsilon^{-\alpha_1\tau})\,\epsilon^{-\alpha_2(t-\tau)} \quad \text{where } \tau \leqq t \leqq T \qquad (7)$$

$$\text{and} \quad \alpha_2 = 1/R_1C \qquad (8)$$

Equations (5) and (7) give V_1 for the entire first cycle from $t = 0$ to $t = T$. This completes the first step in the solution.

Evaluation of Response for Following Cycles

At the end of the first cycle the response has a finite value different from zero. It is therefore to be expected that the response to the second cycle will not be identical with the response to the first cycle. The superposition theorem is an important aid in evaluating the response to the second and following cycles. In brief,[4] this theorem states that the response of a network to a number of voltages is equal to the sum of the responses to the individual voltages, if the network is linear.

The superposition theorem allows the response to the nth cycle to be expressed as the sum of the response to the external emf, which is found for the first cycle, plus the response to the energy stored in the circuit at the end of the $(n-1)$ cycle. Beginning with the start of the first cycle, when no energy is stored in the circuit, the response equation or equations are found for the applied emf. These equations are solved for the response at $t = T$. Then the response during the second cycle is equal to the sum of the response to the applied emf and the response due to the energy stored in the circuit at $t = T$ for the first cycle. A similar process yields the response to the third and following cycles. Thus, a general expression for the nth cycle can be set up. It is of advantage to regard t as zero at the start of the nth cycle, and $(n-1)$ cycles to the left of the zero point.

This step in the solution will also be illustrated by the example of Fig. 2. As shown previously,

$$V_1 = E\,\beta\,(1-\epsilon^{-\alpha_1 t}) \quad \text{where } 0 \leqq t \leqq \tau \qquad (5)$$

$$V_1 = E\,\beta\,(1-\epsilon^{-\alpha_1\tau})\,\epsilon^{-\alpha_2(t-\tau)} \quad \text{where } \tau \leqq t \leqq T \qquad (7)$$

At the end of the first cycle, from Eq. (7),

$$V_1'' = E\,\beta\,(1-\epsilon^{-\alpha_1\tau})\,\epsilon^{-\alpha_2(T-\tau)} \qquad (8)$$

where $V_1'' = V_1$ at the end of the first cycle.

But

$$V''_1 = V'_2 \qquad (8a)$$

where $V'_2 = V_2$ at the start of the second cycle. During the interval $0 \leqq t \leqq \tau$ of the second cycle, capacitor C discharges through R_1 and R_2 in parallel, giving rise to a voltage term

$$V'_2\,\epsilon^{-\alpha_1 t}$$

According to the superposition theorem, V_2, the value of V for the second cycle, is given by adding this term to Eq. (5):

$$V_2 = E\,\beta\,(1-\epsilon^{-\alpha_1 t}) + V'_2\,\epsilon^{-\alpha_1 t} \quad \text{where } 0 \leqq t \leqq \tau \qquad (9)$$

and from Eq. (8) and (8a):

$$V_2 = E\,\beta\,[(1-\epsilon^{-\alpha_1 t}) + \epsilon^{-\alpha_2(T-\tau)}\,(1-\epsilon^{-\alpha_1\tau})\,\epsilon^{-\alpha_1 t}] \quad \text{where } 0 \leqq t \leqq \tau \qquad (10)$$

For the remainder of the cycle, where $\tau \leqq t \leqq T$, V_2 is found by substituting $t = \tau$ in Eq. (9), and, recalling that the discharge is through R_1 only over this portion of the cycle,

$$V_2 = E\,\beta[(1-\epsilon^{-\alpha_1\tau})\,(1+\epsilon^{-\gamma})]\,\epsilon^{-\alpha_2(t-\tau)} \quad \text{where } \tau \leqq t \leqq T \qquad (11)$$

$$\text{and} \quad \gamma = \alpha_1\tau + \alpha_2(T-\tau) \qquad (11a)$$

In a similar way V_3 can be found. From Eq. (11), letting $t = T$,

$$V''_2 = V'_3 = E\,\beta\,(1-\epsilon^{-\alpha_1\tau})\,[1+\epsilon^{-\gamma}]\,\epsilon^{-\alpha_2(T-\tau)}$$

Then, from the same considerations used in the derivation of Eq. (10):

$$V_3 = E\,\beta\,[(1-\epsilon^{-\alpha_1 t}) + (1-\epsilon^{-\alpha_1\tau})\,\epsilon^{-\alpha_2(T-\tau)}\,(1+\epsilon^{-\gamma})\,\epsilon^{-\alpha_1 t}]$$

where $0 \leqq t \leqq \tau$, and over the rest of the cycle:

$$V_3 = E\,\beta\,[1-\epsilon^{-\alpha_1\tau})\,(1+\epsilon^{-\gamma}+\epsilon^{-2\gamma})]\,\epsilon^{-\alpha_2(t-\tau)} \quad \text{where } \tau \leqq t \leqq T.$$

It is convenient to generalize the results for the second cycle, found in Eq. (10) and (11), from the superposition theorem, to similar equations for the nth cycle:

$$V_n = E\,\beta\,(1-\epsilon^{-\alpha_1 t}) + V'_n\,\epsilon^{-\alpha_1 t} \quad \text{where } 0 \leqq t \leqq \tau \text{ and } 1 \leqq n \leqq \infty \qquad (12)$$

$$V_n = [E\,\beta\,(1-\epsilon^{-\alpha_1\tau}) + V'_n\,\epsilon^{-\alpha_1\tau}]\,\epsilon^{-\alpha_2(T-\tau)} \quad \text{where } \tau \leqq t \leqq T \text{ and } 1 \leqq n \leqq \infty \qquad (13)$$

Here V'_n is the initial voltage across C at the start of the nth cycle.

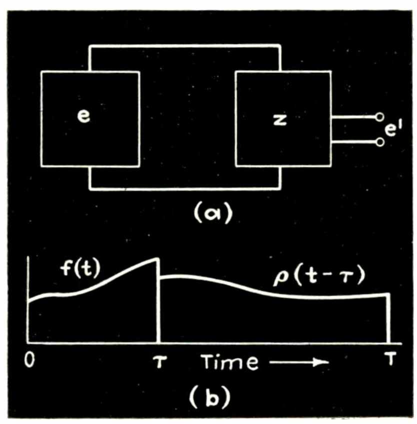

FIG. 1—Block diagram (a) and voltage waveform (b) for the problem under consideration

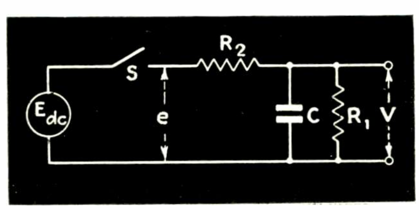

FIG. 2—Network used as actual example in illustrating the various steps involved in solution of the problem

Expansion and Solution of the General Equations

Having found a general expression for the response during the nth cycle, it is necessary to expand this equation and solve it in closed form. This solution takes the form of a summation. If there is a discontinuity in the applied emf during the cycle, then there will be two equations, each covering part of the cycle.

Returning to the example of Fig. 2, Eq. (12) and (13) can be expanded for the nth cycle. By comparison with the equations for the second and third cycles, the equations for the nth cycle are:

$$V_n = E\,\beta\,[1-\epsilon^{-\alpha_1 t}) + (1-\epsilon^{-\alpha_1\tau})\,\epsilon^{-\alpha_2(T-\tau)}\,(1+\epsilon^{-\gamma}+\epsilon^{-2\gamma} + \ldots + \epsilon^{-(n-2)\gamma})\,\epsilon^{\alpha_1 t}] \quad \text{where } 0 \leqq t \leqq \tau \text{ and } \phi \leqq n \leqq \infty$$

$$V_n = E\,\beta\,(1-\epsilon^{-\alpha_1\tau})\,[1+\epsilon^{-\gamma}+\epsilon\,n^{-2\gamma} + \ldots\,\epsilon^{-(n-1)\gamma}]\,\epsilon^{-\alpha_2(t-\tau)} \quad \text{where } \tau \leqq t \leqq T \text{ and } 1 \leqq n \leqq \infty.$$

The terms in the brackets are

geometric progressions with the sums:

$$\frac{\epsilon^{-\gamma(n-1)} - 1}{\epsilon^{-\gamma} - 1} \text{ and } \frac{\epsilon^{-\gamma n} - 1}{\epsilon^{-\gamma} - 1}$$

Hence V_n can be written

$$V_n = E\beta\,(1 - \epsilon^{-\alpha_1 \tau}) \left[\frac{\epsilon^{-\gamma n} - 1}{\epsilon^{-\gamma} - 1}\right] \epsilon^{-\alpha_2\,(t-\tau)} \tag{14}$$

where $\tau \leqq t \leqq T$ and $1 \leqq n \leqq \infty$.

$$V_n = E\beta\,(1 - \epsilon^{-\alpha_1 t}) + E\beta\,(1 - \epsilon^{-\alpha_1 \tau})\,\epsilon^{-\alpha_2 (T-\tau)} \left[\frac{\epsilon^{-\gamma\,(n-1)} - 1}{\epsilon^{-\gamma} - 1}\right] \epsilon^{-\alpha_1 t} \tag{15}$$

where $0 \leqq t \leqq \tau$ and $1 \leqq n \leqq \infty$.

Equations (14) and (15) are a complete solution of the illustrative problem. There are, however, a number of other results which are of some interest.

"Steady-State" Solution

Having found equations which give the response for all portions of the nth cycle, it is convenient to let $n \to \infty$ and derive equations equivalent to the steady-state equations for sine-wave emf's.

In the case of Eq. (14) and (15), the steady-state equations, found by letting $n \to \infty$, are:

$$V_\infty = E\beta\,(1 - \epsilon^{-\alpha_1 \tau}) \left[\frac{1}{1 - \epsilon^{-\gamma}}\right] \epsilon^{-\alpha_2 (t-\tau)} \tag{16}$$

where $\tau \leqq t \leqq T$

$$V_\infty = E\beta\,(1 - \epsilon^{-\alpha_1 t}) + E\beta\,(1 - \epsilon^{-\alpha_1 \tau})\,\epsilon^{-\alpha_2 (T-\gamma)} \left[\frac{1}{1 - \epsilon^{-\gamma}}\right] \epsilon^{-\alpha_1 t} \tag{17}$$

where $0 \leqq t \leqq \tau$ and the subscript ∞ for V indicates $n \to \infty$.

Time Constant Formulas

In the example of Fig. 2, the time constant for charging C may be defined as the number of cycles, multiplied by T, which it takes for V to rise to $(1 - \epsilon^{-1})$ of its final value at τ as given by Eq. (16). Letting N be the particular value of n which gives this result, from the ratio of Eq. (16) and (14).:

$$\frac{V_N}{V_\infty} = (1 - \epsilon^{-1}) = \frac{E\beta\,(1 - \epsilon^{-\alpha_1 \tau}) \left[\dfrac{\epsilon^{-\gamma N} - 1}{\epsilon^{-\gamma} - 1}\right] \epsilon^{-\alpha_2 (t-\tau)}}{E\beta\,(1 - \epsilon^{-\alpha_1 \tau}) \left[\dfrac{-1}{\epsilon^{-\gamma} - 1}\right] \epsilon^{-\alpha_2 (t-\tau)}}$$

$$= 1 - \epsilon^{-\gamma N}$$

From which

$$N = 1/\gamma \text{ and } NT = \frac{T}{\gamma} = \frac{R_1 R_2 C}{R_2 + R_1 \tau/T}$$

The time constant for decaying V when excitation is removed is $1/\alpha_2 = R_1 C$.

Numerical Example

The circuit of Fig. 2 will now be solved for the voltage V across capacitor C for specific values of R_1, R_2, C, and E_{dc}, where the open-closed cycling of switch S is specified. Let $R_1 = 1.8$ meg., $R_2 = 0.15$ meg., $C = 0.5$ μf, and $E_{dc} = 100$ volts.

Switch S opens and closes in a cyclic manner such that the period of closure is 0.01 second and the open period is 0.09 second. In the notation used previously, this corresponds to $\tau = 0.01$ sec. and $T = 0.10$ sec.

Let it be required to find the voltage V of Fig. 2 from the first closure of switch S until steady-state conditions are established.

From Eq. (8),

$$\alpha_2 = 1/R_1 C = 1.11$$

From Eq. (3),

$$\alpha_1 = \frac{R_1 + R_2}{R_1 R_2 C} = 14.45$$

From Eq. (4),

$$\beta = \frac{R_1}{R_1 + R_2} = 0.925$$

and from Eq. (11a),

$$\gamma = \alpha_1 \tau + \alpha_2\,(T - \tau) = 0.2444.$$

Since the time constant of the circuit of Fig. 2, with a rectangular pulsed waveform, has been shown equal to $T/\gamma = 0.41$ sec., the fourth cycle will just fail to bring V up to 0.63 of its final value. By plotting the first seven cycles, the tenth cycle, and the steady state, the value of V from the start of the first cycle to the steady state can be shown reasonably well. Substituting the values of α_1, α_2, β, and γ just found in Eq. (14) and (15), the transient state is found:

$$V_n = 57.1\,(1 - \epsilon^{-0.2444n})\,\epsilon^{-1.11\,(t-0.01)}$$

where $0.01 \leqq t \leqq 0.1$ and $1 \leqq n \leqq \infty$

$$V_n = 92.5 - (40.7 + 51.8\,\epsilon^{-0.2444\,(n-1)})\,\epsilon^{-14.45t}$$

where $0 \leqq t \leqq 0.01$ and $1 \leqq n \leqq \infty$

The steady-state equations, from Eq. (16) and (17), are:

$$V = 57.1\,\epsilon^{-1.11\,(t-0.01)}$$

where $0.01 \leqq t \leqq 0.1$

$$V = 92.5 - 40.7\,\epsilon^{-14.45t}$$

where $0 \leqq t \leqq 0.01$

Figure 3 shows, in graphical form, the value of these equations for the first seven cycles, the tenth cycle, and the steady state.

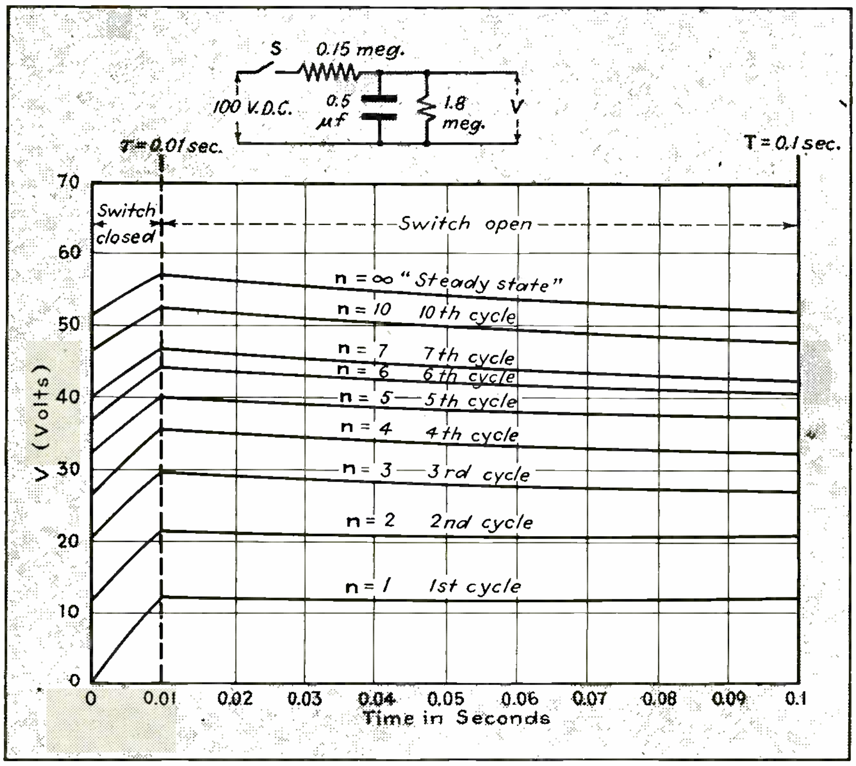

FIG. 3—Output voltage plotted against time for the first seven cycles, the tenth cycle and the final steady-state condition in the circuit shown, for the numerical values and waveform assumed in the example

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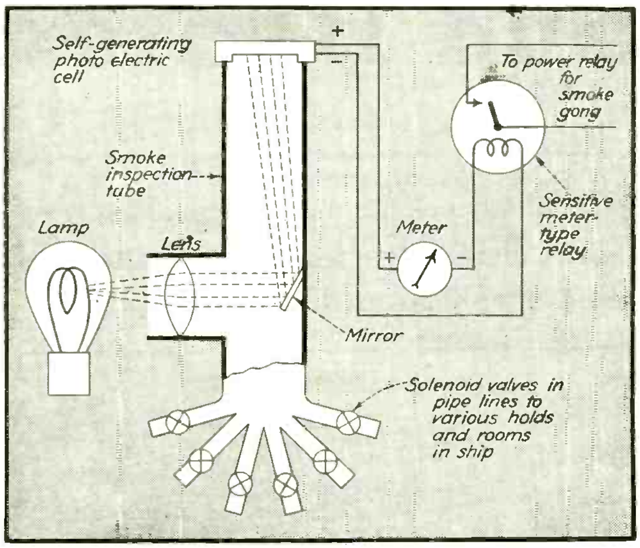


Detecting FIRE at SEA

Air samples drawn from each protected space in a ship are examined by a smoke-detecting unit containing a self-generating photoelectric cell and a light source

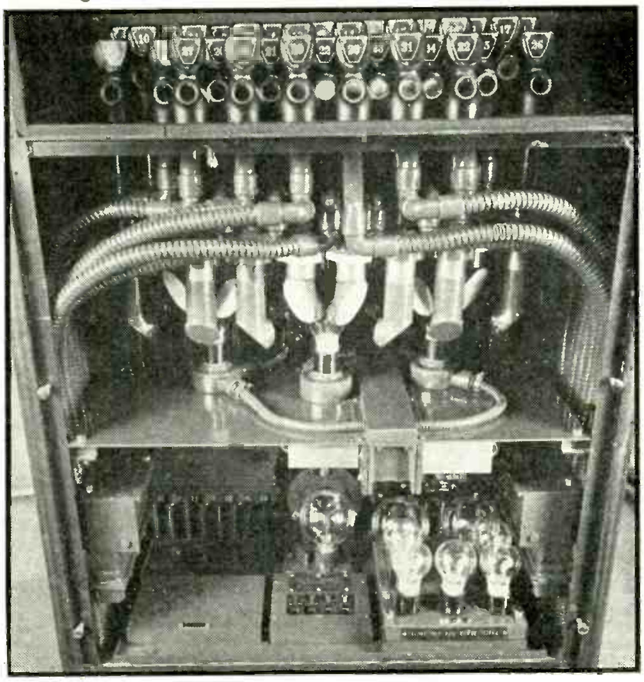
ADDITION of photoelectric smoke-detecting apparatus to the Rich system for detecting smoke by sight and smell provides for ships at sea an automatic fire alarm system comparable in speed and effectiveness to the finest modern installations in buildings.

Air samples from each space protected by the automatic Rich-Audio system are drawn through individual pipe lines to the detecting cabinet, usually in the wheelhouse, by an exhaust fan. The pipe outlets are positioned in concentrated beams of light that illuminate smoke particles and provide visual detection. The air samples are discharged into the wheelhouse, so that smoke will also be detected by smell when present.

Each pipe line is provided with an automatically controlled solenoid valve that momentarily diverts the air sample to a long tube for photoelectric observation. A light beam is directed through this tube to a photovoltaic cell connected to a meter-type relay, as shown above.

A motor-driven selector switch energizes one valve after another at four-second intervals, and drives a number-wheel indicating which line is being diverted at any instant. If no smoke is present, the number changes and another line is diverted for photoelectric inspection. Smoke causes operation of the alarm signals and stops the selector switch so the number remains on the control panel to indicate the source of the smoke. Controls can be adjusted to compensate for dust on the lens, mirror or photoelectric cell surface.

Numbered pipe outlets in the smoke-detecting cabinet show the ship's officer at a glance which space is afire when the photoelectric cell sets off the automatic alarm in the Rich-Audio fire-detecting system made for ship use by Walter Kidde & Co., Inc., of New York



Smoke-detecting cabinet with front panel removed to show pipes going to various parts of a ship. The lamps under the pipes make faint smoke visible in windows under the numbers in the pipe outlets, and the large lamp at bottom center provides light for the photoelectric cell

Filament and Heater

Mathematical analysis of volt-ampere characteristics of various filament metals. Resulting equations are plotted as a reference chart that gives filament current, temperature and wattage for any electron tube at various operating voltages with good accuracy

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FREQUENTLY in the design and application of electron tubes it is necessary to predict the value of filament current and possibly also the filament temperature when the applied filament voltage deviates from the normal or rated value. Such an instance occurs when two or more filaments having different volt-ampere characteristics are operated in series and it is required to predict the voltage variation across each individual filament with respect to the supply voltage variation. The solution of this problem requires a knowledge of the volt-ampere characteristic of each filament. The voltage across each filament can then be determined for any arbitrary assumed current value. If appropriate current values are chosen, a curve of each individual tube voltage versus the supply voltage can be constructed.

A knowledge of the individual volt-ampere characteristics over the required range may not be readily available unless it has previously been experimentally determined. It is the purpose of this paper to indicate a method of constructing the volt-ampere characteristic if the current is known for at least one operating voltage. The knowledge of this point enables the current to be predicted at a new operating voltage with good accuracy providing the change in voltage is within approximately ±25 percent of the known voltage. The same analysis will also permit the determination of the value of watts and temperature in terms of the known operating condition.

Basic Filament Equations

In order to illustrate the method of transposing the operating condition of a filament, the two basic equations involved in the design of filaments and heaters for electron tubes will be considered.

The first equation is:

$$W = K_1 T^{n_w}$$

where

W = power radiated in watts
K_1 = constant of proportionality, which includes the area of the emitter
T = temperature in degrees Kelvin
n_w = an exponent which is reasonably constant for a given metal over a limited range of temperature.

The second equation is:

$$W = E^2/R = I^2R$$

where

E = applied filament voltage
R = resistance of the filament, which is in general a function of temperature
I = filament current

In order to solve Eq. (1) and (2) let

$$R = K_2\, T^{n_r}$$

where

K_2 = a constant of proportionality
n_r = an exponent which may be regarded constant over a limited temperature range.

Solutions of Eq. (1), (2) and (3) for W, I, and T in terms of E yield:[1]

$$W = K_1\left(K_1 K_2\right)^{\frac{2n_w}{n_w + n_r}}\left(E\right)^{\frac{2n_w}{n_w + n_r}} \quad (4)$$

$$I = \left(\frac{K_1}{K_2}\right)^{\frac{n_w - n_r}{2}}\left(\frac{1}{K_1\, K_2}\right)^{\frac{2}{n_w + n_r}}\left(E\right)^{\frac{n_m - n_r}{n_w + n_r}} \quad (5)$$

$$T = \left(\frac{1}{K_1\, K_2}\right)^{\frac{2}{n_w + n_r}}\left(E\right)^{\frac{2}{n_w + n_r}} \quad (6)$$

Thus, when using W_o, I_o, T_o, E_o and W_x, I_x, T_x, E_x as the known and unknown conditions respectively, Eq. (4), (5) and (6) may be written:

$$\frac{W_x}{W_o} = \left(\frac{E_x}{E_o}\right)^{\frac{2n_w}{n_w + n_r}} \quad (7)$$

$$\frac{I_x}{I_o} + \left(\frac{E_x}{E_o}\right)^{\frac{n_w - n_r}{n_w + n_r}} \quad (8)$$

$$\frac{T_x}{T_o} = \left(\frac{E_x}{E_o}\right)^{\frac{2}{n_w + n_r}} \quad (9)$$

Use of Average Values for Exponents

Values for n_w have been determined for some of the more common metals, and are given in Table I. The exponent n_w includes the change of total emissivity with temperature. Since the total emissivity of metals increases with temperature,[2] the Stefan-Boltzmann law of radiation requires that n_w be greater than four. For materials

TABLE I. VALUES OF EXPONENTS FOR FOUR FILAMENT METALS

Material	Temp.	n_w	n_r	$\frac{2n_w}{n_w + n_r}$	$\frac{n_w - n_r}{n_w + n_r}$	$\frac{2}{n_w + n_r}$
Tungsten[1]	1000°K	5.65	1.20	1.65	0.650	0.292
Tungsten[1]	2000°K	4.93	1.19	1.61	0.612	0.327
Tungsten[1]	2500°K	4.66	1.20	1.59	0.590	0.341
Molybdenum[3]	1000°K	5.32	1.15	1.64	0.645	0.309
Molybdenum[3]	2000°K	4.99	1.15	1.63	0.625	0.326
Tantalum[3]	1600°K	4.80	0.785	1.72	0.720	0.358
Tantalum[3]	2800°K	4.80	0.785	1.72	0.720	0.358
Nickel	1000°K	4.65*	0.62**	1.76	0.764	0.379

* Values by different investigators range from 4.65 to 5.29.
** Estimated from experimental data on nickel.

Characteristics

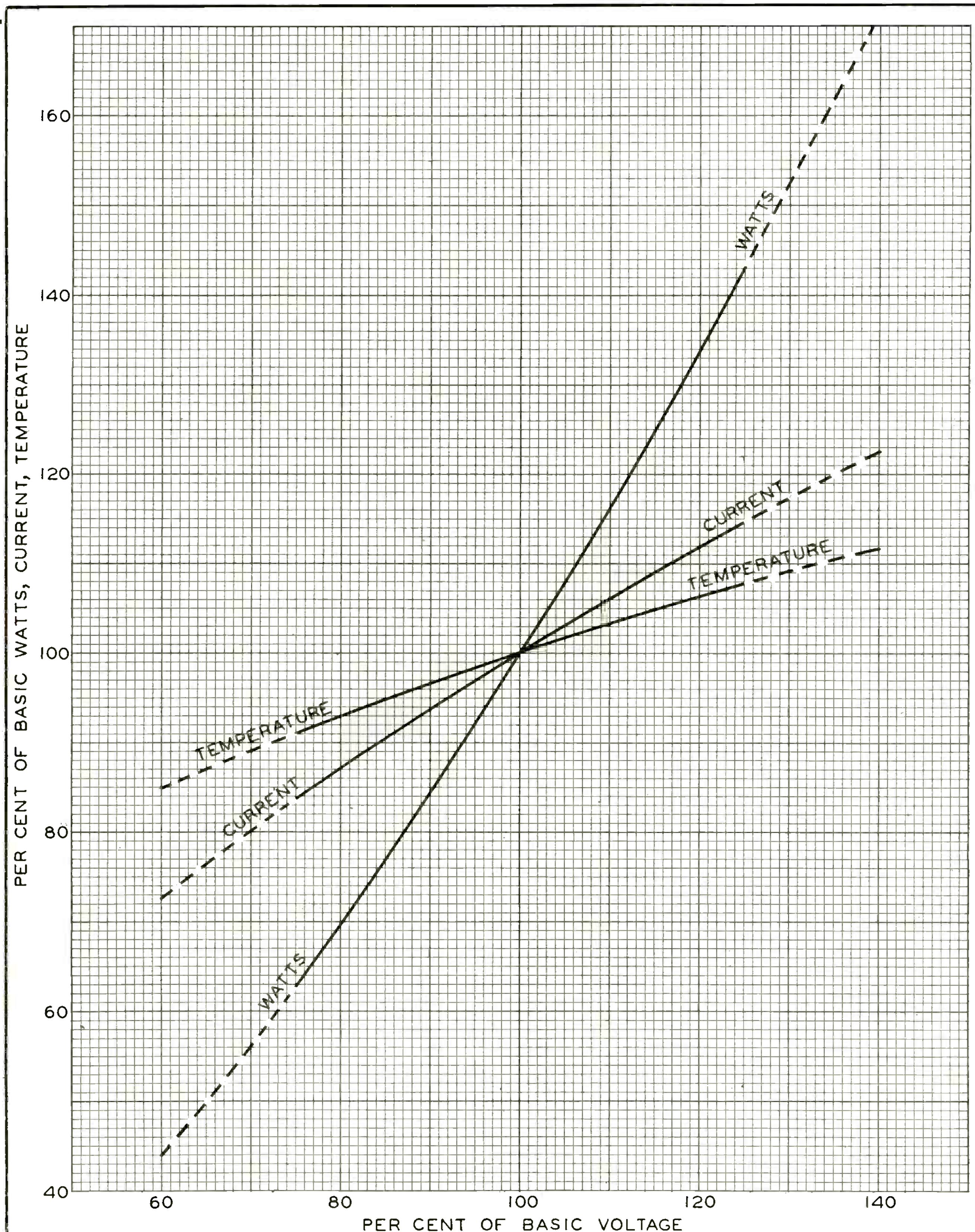

FIG. 1—Chart giving wattage, current and temperature of a filament or heater at operating voltages up to 25 percent above or below basic voltage, with sufficient accuracy for most engineering purposes. Accuracy drops in dotted regions

having an emissivity independent of temperature the value will be four. The value of n_r for some metals at different temperatures is also given in Table I. These limited data indicate n_r ranges from 0.6 to 1.2.

If W_1 and W_2, the watts radiated at temperatures T_1 and T_2 are known, then

$$n_w = \frac{\log (W_1/W_2)}{\log (T_1/T_2)}$$

In a like manner, if R_1 and R_2 are the resistances at temperatures T_1 and T_2, then

$$n_r = \frac{\log (R_1/R_2)}{\log (T_1/T_2)}$$

These permit an experimental check of the values of n_w and n_r if two sets of operating conditions are known.

Table I also gives the value of $(n_w - n_r)/(n_w + n_r)$. It will be noted that it ranges from 0.59 to 0.76. It is now of interest to see what error results in using an average value of this exponent in Eq. (8). A voltage ratio E_x/E_o of 1.25 will be taken as the maximum voltage for which Eq. (8) is to be used. If the exponents 0.59 and then 0.76 are used, the respective values of current ratio I_x/I_o are 1.140 and 1.185 or a deviation of only ± 1.9 percent from the mean value.

Plotting the Chart

It is evident therefore that an average exponent can be chosen which applies to all the metals in Table I, and in general

$$\left(\frac{I_x}{I_o}\right) = \left(\frac{E_x}{E_o}\right)^{0.61}, \quad 0.75 < \left(\frac{E_x}{E_o}\right) < 1.25 \qquad (10)$$

is true to sufficient accuracy for most engineering purposes. This equation has been drawn as the current curve for the chart in Fig. 1.

It can further be shown that the accuracy involved in assuming $2n_w/(n_w + n_r) = 1.61$ and $2/(n_w + n_r) = 0.327$ is even greater than for the case just discussed. Then

$$\frac{W_x}{W_o} = \left(\frac{E_x}{E_o}\right)^{1.61} \qquad (11)$$

$$\frac{T_x}{T_o} = \left(\frac{E_x}{E_o}\right)^{0.327} \qquad (12)$$

These equations are plotted in Fig. 1.

In order to check Eq. (8) and Fig. 1, data were taken for a wide variety of electron tubes. It will be noted from Fig. 1 and Table II that the calculated values of current deviate, in general, by less than ± 4 percent from the measured values. We can conclude from this that Fig. 1 is generally applicable to all types of electron tubes for the specified range of (E_x/E_o).[5] Some samples of the use of this curve will now be given.

Example 1. The type RCA-826 has a thoriated-tungsten filament rated at 7.5 volts and 4 amperes. What will be the filament current at 5.62 volts (75 percent of rated voltage)? Tracing up from 75 on the horizontal scale in Fig. 1 to the current curve, and then across, gives 83.8 percent. The new filament curve is then $0.838 \times 4 = 3.35$ amperes. By actual measurement the current was found to be 3.34 amperes. While no temperature measurements were made at this voltage one would expect the temperature to decrease to 91 percent of its rated value in degrees Kelvin.

Example 2. An oxide-coated cathode has a temperature of 1000 deg. K when the heater is operated at 5 volts. What voltage will be required to increase the temperature to 1060 deg. K? From Fig. 1, when $T_x/T_o = 1.06$ one finds $E_x/E_o = 1.19$ or $E_x = 5 \times 1.19 = 5.95$ volts. The heater voltage was found to be 6.0 volts when determined experimentally. If the voltage had been increased to 7 volts, then $E_x/E_o = 1.4$ and $T_x/T_o = 1.118$ or $T_x = 1118$ deg. K. Actual measurements indicated the temperature to be 1135 deg. K.

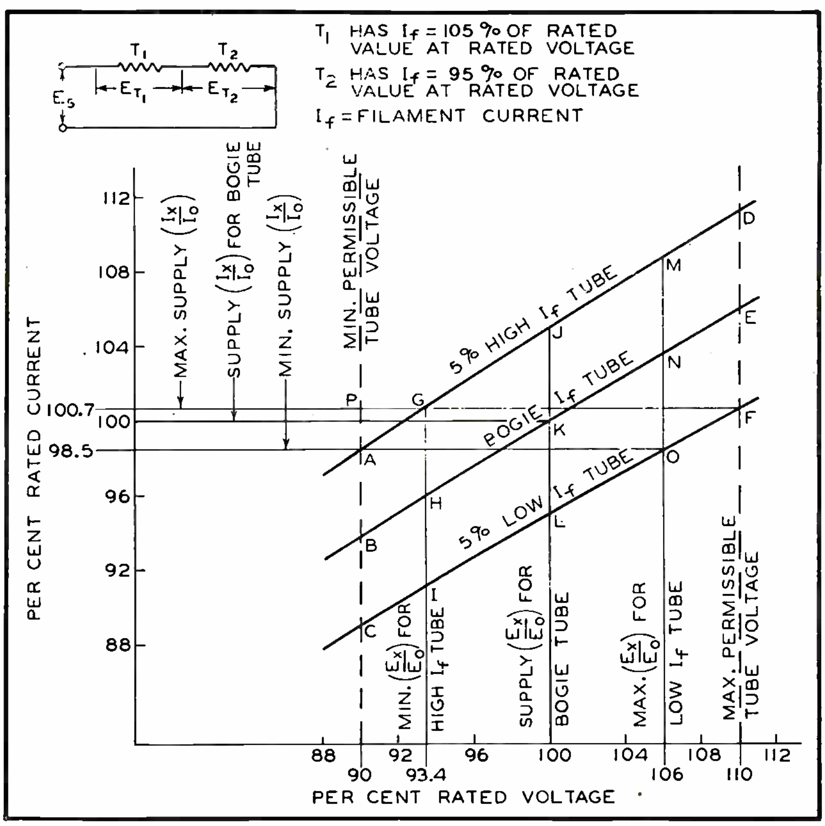

FIG. 2—Volt-ampere characteristics for series operation of filaments or heaters having different characteristics

Two Filaments in Series

In order to examine the operation of filaments or heaters in series, let two tubes T_1 and T_2, having the same nominal voltage rating, be connected in series to a power supply E_s (see Fig. 2). In general the filaments of tubes T_1 and T_2 may have different volt-ampere characteristics. Such differences may be due to the individual variation of filament current when read at a specified or rated voltage. These variations of filament currents, which are expected and normal, result from the necessary manufacturing tolerances on both materials and processes.

The usual filament current tolerance on receiving and the smaller transmitting tubes whose filaments or heaters might be operated in series is generally of the order of

TABLE II. MEASURED AND CALCULATED DATA ON TYPICAL TUBE SAMPLES

Type Number	Filament or Heater	Type of Emitter	Rated Voltage E_{xo}	Rated Voltage I_{xo} Observed	Reduced Voltage E_{x1}	Reduced Voltage I_{x1} Observed	Reduced Voltage I_{x1} Calc. from Fig. 1	Reduced Voltage % Difference	Increased Voltage E_{x2}	Increased Voltage I_{x2} Observed	Increased Voltage I_{x2} Calc. from Fig. 1	Increased Voltage % Difference
203A	Filament	Th-W	10.0	3.28	7.5	2.72	2.74	+0.7	12.5	3.70	3.76	+1.6
801A	Filament	Th-W	7.5	1.22	5.62	1.05	1.02	−0.3	9.38	1.42	1.40	−1.4
807	Cathode	Oxide	6.3	0.87	4.72	0.74	0.73	−1.4	7.88	0.99	1.00	+1.0
813	Filament	Th-W	10.0	5.00	7.50	4.12	4.18	+1.5	12.5	5.80	5.72	−1.4
815	Cathode	Oxide	6.3	1.65	4.72	1.39	1.37	−1.4	7.88	1.88	1.89	+0.5
826	Filament	Th-W	7.5	4.00	5.62	3.35	3.34	−0.3	9.38	4.55	4.58	+0.7
833A	Filament	Th-W	10.0	10.10	7.5	8.50	8.44	−0.7	12.50	11.60	11.56	−0.3
836	Cathode	Oxide	2.5	5.05	1.88	4.22	4.25	+0.7	3.13	5.75	5.78	+0.5
861	Filament	Th-W	11.0	10.05	8.25	8.30	8.40	+0.1	13.75	11.50	11.50	0
866	Filament	Oxide	2.5	5.00	1.87	4.03	4.18	+3.7	3.13	5.80	5.72	−1.4
913	Cathode	Oxide	6.3	0.600	4.72	0.504	0.502	−0.4	7.88	0.685	0.687	+0.3
1616	Filament	Oxide	2.5	4.90	1.87	3.97	4.10	+3.3	3.13	5.73	5.61	−2.1
1624	Filament	Oxide	2.5	1.83	1.87	1.47	1.53	+4.1	3.13	2.12	2.09	−1.4
2050	Cathode	Oxide	6.3	0.575	4.72	0.489	0.481	−1.6	7.88	0.657	0.657	0
2051	Cathode	Oxide	6.3	0.605	4.72	0.515	0.506	−1.8	7.88	0.688	0.693	+0.6
8025	Filament	Th-W	6.3	1.94	4.72	1.65	1.61	−2.4	7.88	2.19	2.22	+1.4
9001	Cathode	Oxide	6.3	0.157	4.72	0.135	1.31	−3.0	7.88	0.177	0.179	+1.1
1T4	Filament	Oxide	1.4	0.0525	1.05	0.043	0.044	+2.3	1.75	0.0613	0.0600	−2.2
6SK7	Cathode	Oxide	6.3	0.310	4.72	2.61	2.59	−0.8	7.88	0.352	0.355	+0.9
6SS7	Cathode	Oxide	6.3	0.150	4.72	0.129	1.25	−3.1	7.88	0.170	0.172	+1.2
12A6	Cathode	Oxide	12.6	0.156	9.45	0.134	1.30	−3.0	15.75	0.177	0.178	+0.6
2AP1	Cathode	Oxide	6.3	0.595	4.72	0.508	0.498	−2.0	7.88	0.668	0.680	+1.7

5 to 10 percent. In order to insure satisfactory operation initially and throughout the expected life of the tube, the tube manufacturer usually specifies the percentage the applied filament voltage may be allowed to deviate from normal. This voltage deviation is usually of the order of ±5 percent for the thoriated-tungsten type emitters and ±10 percent for the oxide-coated filament or heater-cathode types. It becomes apparent that for series operation of the filament or heaters the supply voltage variation needs careful consideration in order to insure that the individual filament voltage tolerances are not exceeded on either T_1 or T_2.

If T_1 and T_2 are both high or both low filament-current tubes, no problem exists since the volt-ampere characteristics are substantially identical (i.e., they have the same currents for the same applied voltage). Only the combination needs to be considered, where one has the higher limit value and the other has the lower limit value of filament current.

Determining Permissible Filament Voltage Variations

As a specific problem, assume the filament-current tolerance to be ±5 percent and let it be required to determine the permissible variation of supply voltage without exceeding an individual tube voltage range of ±10 percent. This problem frequently arises in the design of mobile transmitters when the filament or heaters are operated in series.

The bogie or normal volt-ampere characteristic *BKE* of Fig. 2 may then be constructed from Eq. (10). For T_1, the 5 percent high filament-current tube, the equation of the volt-ampere characteristic is

$$\frac{I_x}{I_o} = 1.05\left(\frac{E_x}{E_o}\right)^{0.61} \qquad (13)$$

Curve *AJD* can be constructed from this equation.

Similarly for T_2, the low filament-current tube, the equation is

$$(I_x/I_o) = 0.95\,(E_x/E_o)^{0.61} \qquad (14)$$

which is represented by the curve *CLF* in Fig. 2.

An arbitrary current may then be assumed in order to determine the individual voltage across tubes T_1 and T_2. The supply voltage is represented by the sum of the voltages across T_1 and T_2. If T_1 (the high filament-current tube) has the minimum permissible voltage 0.9 E_o represented by point A, tube T_2 (the low filament-current tube) will have a voltage represented by point O. The sum of the two voltages at points A and O represents the minimum permissible supply voltage consistent with the previous imposed condition of ±5 percent filament-current tolerance and ±10 percent individual voltage tolerance.

In a similar manner the maximum voltage 1.1 E_o that can be applied to T_2, the low filament-current tube, is represented by point F, and the voltage on T_1, the high filament-current tube, by point G. The sum of the voltages at points G and F gives the maximum permissible supply voltage. The nominal supply voltage is twice the nominal tube voltage or 2 E_o since it was assumed the nominal voltage ratings of T_1 and T_2 were identical. The maximum permissible percentage of supply voltage deviation may then be calculated directly from the graphical analysis. This solution indicates supply voltage tolerance of +1.7 percent and −2.0 percent.

It is interesting to note that the distance A to P represents the maximum permissible range of supply current. This suggests that if the supply voltage cannot be maintained within the required limits, a series ballast tube whose current is maintained within the range A to P might be used to permit a larger variation in the supply voltage. The use of the ballast tube would of course require an increased supply voltage in order to supply the required voltage drop of the ballast tube.

An alternative solution to permit wider supply voltage tolerances consists in shunting the low filament-current tube with a resistor. This resistor is adjusted until both tubes have substantially the same filament voltage. This method is essentially one of shifting the operating point on the volt-ampere characteristic of the low filament-current tube and resistor until at normal supply voltage it coincides with that of the high filament-current tube. This method does not, however, make the volt-ampere characteristics identical and therefore never can permit a percentage supply-voltage change equal to the permitted percentage of individual filament voltages. In order to simplify adjustments, adjustable resistors are frequently used across both filaments.

Generalized Solution for Tubes in Series

The method of the solution of two tubes in series may be generalized for N_H tubes having high filament currents in series with N_L tubes having low filament currents, as shown in Fig. 3. Let

m = percentage filament-current tolerance

p = permissible percentage tolerance of individual applied voltage

The volt-ampere characteristic of a limit tube is expressed by

$$\left(\frac{I_x}{I_o}\right) = \left(\frac{100+m}{100}\right)\left(\frac{E_x}{E_o}\right)^{0.61} \qquad (15)$$

But since E_x/E_o for the limiting condition of maximum voltage on a low filament-current tube is equal to $(100+p)/100$, Eq. (15) may be re-written for a low filament-current tube as

$$\left(\frac{I_x}{I_o}\right)_{\text{max.}} = \left(\frac{100+p}{100}\right)^{0.61}\left(\frac{100-m}{100}\right) \qquad (16)$$

where I_x/I_o is the maximum permissible supply current when at least one each of limit values of high and low filament-current tubes are operated in series. Similarly, the minimum permissible current is given by

$$\left(\frac{I_x}{I_o}\right)_{\text{min.}} = \left(\frac{100-p}{100}\right)^{0.61}\left(\frac{100+m}{100}\right) \qquad (17)$$

Equations (14) and (15) form the basis for calculating the current requirements imposed upon a series ballast tube should one be used.

The values of current given in Eq. (16) and (17), when substituted in the appropriate equations for the volt-ampere characteristics, give the voltage at points G and O respectively as

$$\left(\frac{E_x}{E_o}\right) = \left(\frac{100+p}{100}\right)\left(\frac{100-m}{100+m}\right)^{1.64} \qquad (18)$$

and

$$\left(\frac{E_x}{E_o}\right) = \left(\frac{100-p}{100}\right)\left(\frac{100+m}{100-m}\right)^{1.64} \qquad (19)$$

The value of (E_x/E_o) given in Eq. (18) represents the voltage across a high filament-current tube at the maximum permissible supply voltage, while the value given in Eq. (19) represents the voltage across a low filament-current tube at the minimum permissible supply voltage. The sum of N_H voltages given in Eq. (18) + N_L voltages of the value $(100+p)/100$ gives the maximum supply voltage or

$$\left(\frac{E_s}{E_o}\right)_{\text{max.}} = N_H\left[\left(\frac{100+p}{100}\right)\left(\frac{100-m}{100+m}\right)^{1.64}\right] + N_L\left(\frac{100+p}{100}\right) \qquad (20)$$

In a like manner the minimum supply voltage is

$$\left(\frac{E_s}{E_o}\right)_{\text{min.}} = N_L\left[\left(\frac{100-p}{100}\right)\left(\frac{100+m}{100-m}\right)^{1.64}\right] + N_H\left(\frac{100-p}{100}\right) \qquad (21)$$

The percentage of supply voltage tolerance becomes

$$\%\ E_s \text{ above normal} = \left\{\frac{N_H\left[\left(\frac{100+p}{100}\right)\left(\frac{100-m}{100+m}\right)^{1.64}\right] + N_L\left(\frac{100+p}{100}\right)}{N_H+N_L} - 1\right\}100 \qquad (22)$$

$$\%\ E_s \text{ below normal} = \left\{\frac{N_L\left[\left(\frac{100-p}{100}\right)\left(\frac{100+m}{100-m}\right)^{1.64}\right] + N_H\left(\frac{100-p}{100}\right)}{N_H+N_L} - 1\right\}100 \qquad (23)$$

Equations (22) and (23) were derived on the premise that at least one tube of the group had a filament current $(100+m)/100$ times rated value and at least one other had $(100-m)/100$ times rated value. This premise imposes the condition that both N_H and N_L must be different from zero in Eq. (22) and (23). If either N_H or N_L is zero, the solution is simple as all possess the same volt-ampere characteristic. The permissible supply voltage percentage deviation is p.

Application to Universal Receivers

It is common practice in the design of a-c/d-c sets in which the filaments or heaters are connected in series to use tubes that have different values of rated filament voltage. The analysis of this condition can be reduced to an expression similar to Eq. (22) and (23) except that N_H and N_L must include the equivalent number of respective tubes in terms of the lowest nom-

(Continued on page 354)

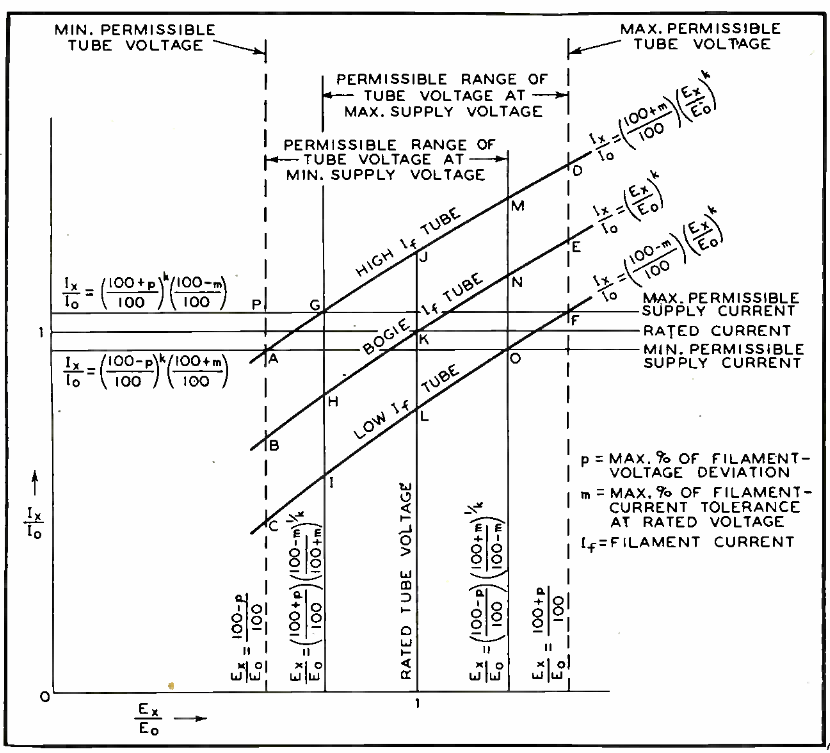

FIG. 3—Generalized solution for any number of tubes in series, some having high and some low filament current

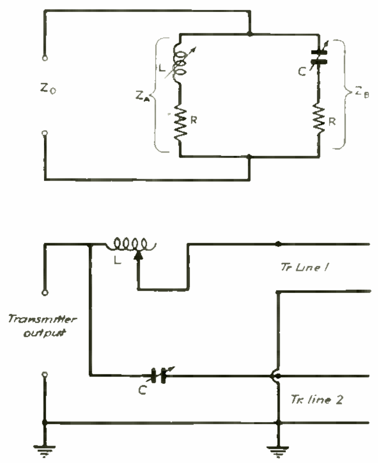

FIG. 1—Basic power-dividing circuit (above, with transmission lines represented by R), and actual circuit

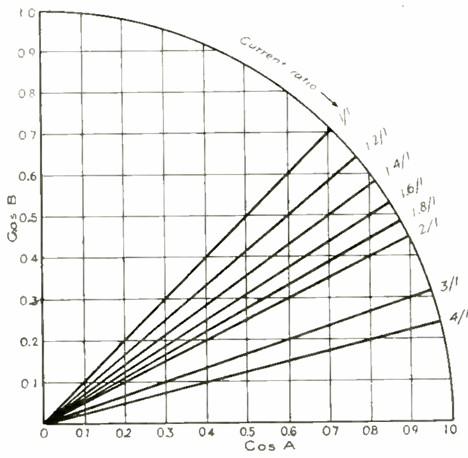

FIG. 2—Cosine values for finding L and C are at intersection of curve with line for desired current ratio

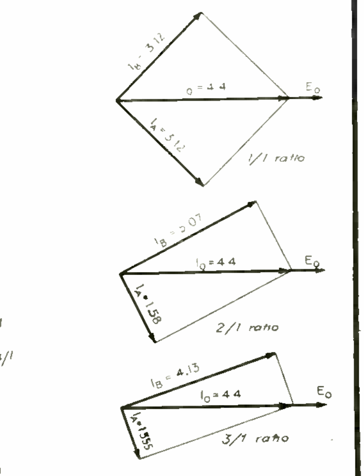

FIG. 3—Vector diagrams showing that input of circuit is always constant and resistive

Antenna POWER DIVIDER

Chart facilitates finding correct values of L and C for any desired division of currents in a two-element broadcast array, with constant phase shift and constant resistive input

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A SIMPLE power divider for a two-element broadcast antenna array can be built from the basic circuit shown in Fig. 1. Here resistors R represent actual measured values of characteristic impedance for the two transmission lines and must be equal, while L and C are variable and allow for any power division desired. As long as the correct relationships are maintained, the input impedance will be resistive and of a constant value, and most important, the phase shift between lines will remain constant. This means that the operator can vary tower current without having to change phasing adjustments.

The required relationships are that X_LX_C always be equal to R^2 and that Z_B/Z_A always be equal to the current ratio K, which is equal to the square root of the power ratio.

By means of the chart in Fig. 2 it is possible to observe these relationships automatically and find quickly the values of X_L and X_C for any current ratio desired. The chart gives the cosine value for each series circuit. From this, the angle and its tangent can be found in a trig table, and the reactance value of each branch computed from $X_A = R \tan A$ and $X_B = R \tan B$. Knowing the operating frequency, L and C are computed from $L = X_A/2\pi f$ and $C = 1/2\pi f X_B$.

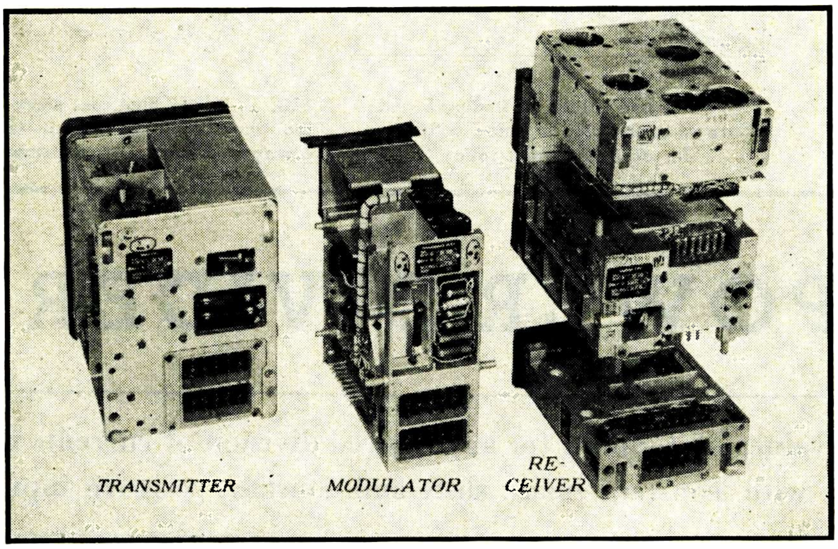
Usually it is best to let cosine B be negative so that branch B is capacitive. This allows for smaller units, but the capacitor must withstand fairly high voltage. In the case of high power it might be better to let cosine B be positive so its circuit is inductive. This will call for larger units, but the capacitor will not have to withstand such high voltage.

Example: Operating frequency is 1000 kc, current ratio is 3/1 and R is 230 ohms. For a current ratio of 3/1, the chart gives a value of 0.950 for cos A, and a trig table is then used to find tan A = 0.3284. Similarly, cos B = 0.312 and tan B = 3.044. Substituting in $X_A = R \tan A$, $X_A = 230 \times 0.3284 = 75.51$ ohms. Similarly, $X_B = 230 \times 3.044 = 700$ ohms. Allowing X_B to be capacitive, $C = 1/6.28 \times 1{,}000{,}000 \times 700 = 227.5$ $\mu\mu$f. X_A is then inductive, and $L = 75.51/6.28 \times 1{,}000{,}000 = 12$ μh. The alternate solution with X_A capacitive and X_B inductive gives $C = 0.0021$ μf and $L = 111.4$ μh.

The vector diagrams in Fig. 3 cover three different current ratios. Note that when the two current vectors are added in each case, their sum is always the same and is along the reference axis. This shows that the input of this power-dividing network is always resistive and of constant value.

New Enemy Radio

Analysis of German and Japanese aircraft radio sets manufactured in 1943, with details of new Japanese Model 99 Type 3 aircraft command set. Current enemy production shows distinct improvements over earlier models, with no apparent shortages of materials



This FuG 16Z German aircraft radio command set is divided into five individual magnesium alloy castings fitted together by means of dowel pins and electrical plugs and jacks

Up to the present time, the general consensus has been that German and Japanese radio equipments are poor in construction, poor in performance, heavy in weight and hard to service. While this may have been true in older and obsolete radio equipment, it definitely does not hold true now. Newer, modern types of enemy radio equipment have long replaced the obsolete sets. Also, the latest 1943 sets show distinct improvement over the same models manufactured in 1941 and 1942 with no substitution of critical materials whatsoever.

German Equipment

German aircraft radio equipment is characterized by excellent mechanical design, standardization for mass production and extensive use of magnesium alloy die castings, only about 64 percent as heavy as aluminum. Each tube utilized in the construction of a receiver has been enclosed in a separate compartment of the die casting for shielding purposes. The castings are fitted together by means of dowel pins and electrical plugs and jacks. One receiver may consist of as many as four separate castings fitted together. In the event one section is faulty, it may be quickly replaced by a duplicate section.

Of the 31 tubes used in one complete German radio set, only two different types are used; 25 receiving tubes Type RV12P2000 and 6 transmitting tubes Type RL12P35. This standardization may sacrifice some efficiency by using a pentode tube for a diode or triode, but it simplifies servicing and means fewer replacement part requirements in the field.

All important units in German equipment are readily detachable from their mounting frames for servicing or replacement, connections being made through multipoint plugs and sockets. All aircraft equipment is supplied with voltages from 24 to 28-volt dynamotors, driven from the main aircraft battery and generator. All microphones used are of the throat type, leaving the wearer's mouth free for oxygen equipment.

The characteristics of German tubes are expressed by their nomenclature. Thus in the type RL12P35 tube R stands for the German word Röhren, or tube; L is an abbreviation of the German word Leistungs, meaning power; 12 is the filament voltage in volts; P signifies pentode; and 35 indicates the overall dissipation of the tube in watts (plate dissipation here is 30 watts and screen dissipation is 5 watts). For Type RV12P2000 high-frequency pentode receiving tube, R means Röhren or tube; V stands for VerStarker or amplifier type tube; 12 signifies the filament voltage; P indicates a pentode; and 2000 represents the transconductance.

Low temperature coefficient inductors and capacitors are used to insure frequency stability since no crystals are used. German laboratories have done considerable research and probably lead in the field of temperature-compensating devices to maintain frequency stability. Variable capacitors are especially manufactured for an individual circuit to permit short connections. Steatite shafts permit stators to be grounded.

German FuG 16Z Set

The German FuG 16Z aircraft radio command set, first introduced in 1941, is now in mass production and is incorporated in practically

Equipment

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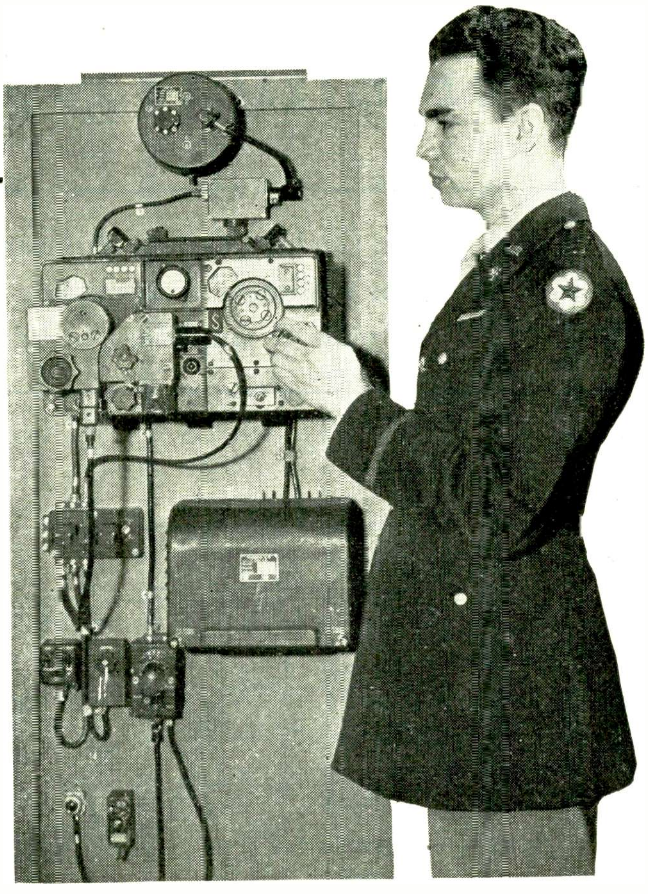

Mockup of German FuG 16Z set being operated by the author. This set was first introduced by the Germans in 1941, is now in mass production, and is used in practically all types of aircraft

all types of German aircraft. Although its primary function is for command purposes (aircraft to aircraft voice communication), it is also used for air-to-ground contacts and direction finding. It operates in the frequency band from 38 to 42 Mc and has an output of 5 watts. (The original FuG 16, designed in 1935 and described in April 1944 ELECTRONICS, had an output of 12.9 watts.) The 5-watt output is ample for command purposes and prevents the signal from being picked up at great distances by the enemy.

The effective range of this latest command set is 125 miles at 10,000 feet and 250 miles at 40,000 feet. Radiotelephone emission is used. The transmitter consists of an electron-coupled oscillator with frequency doubling in the plate circuit, driving a single amplifier tube. The transmitter amplifier is grid modulated by a single receiving tube which is driven by a stage of speech amplification. The modulator is mounted on a separate casting setting between the transmitter

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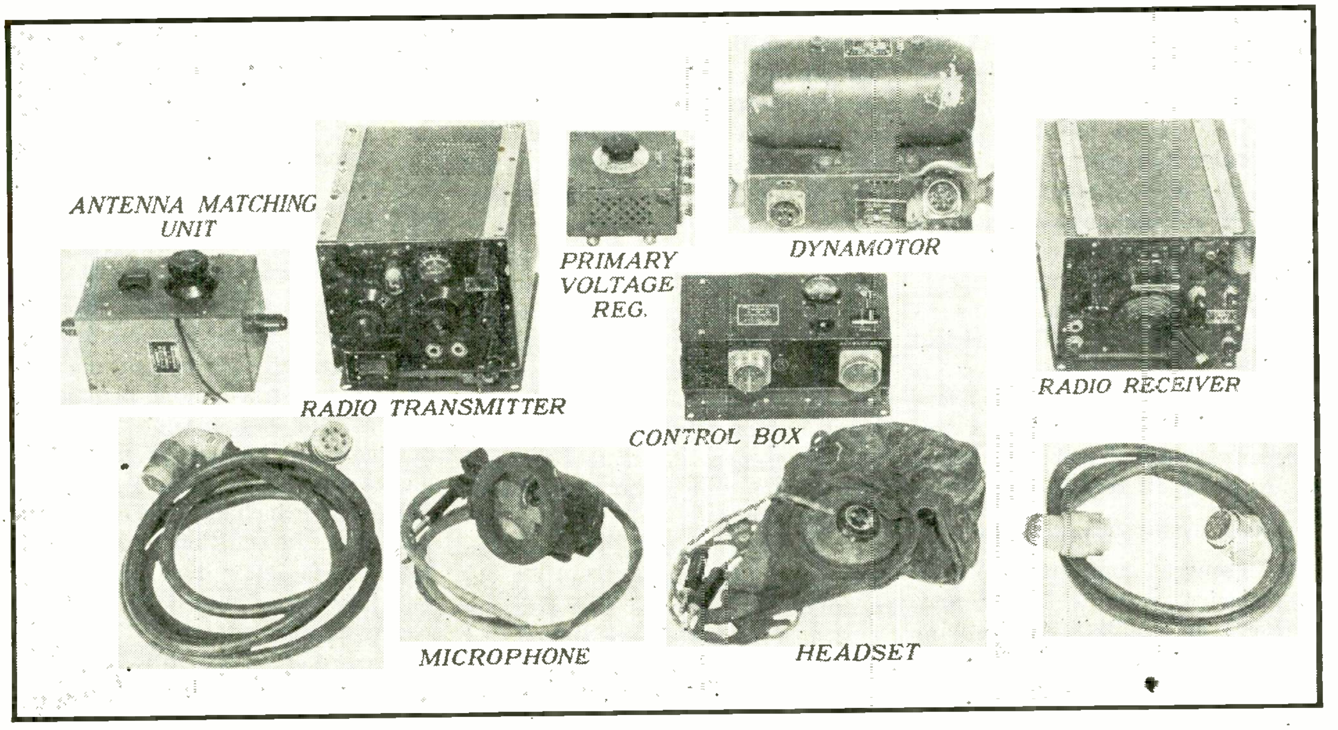

Japanese Model 99 Type 3 aircraft radio command set taken from a plane that crashed in Kunming, China in September 1943. Design, workmanship and performance are excellent, following American rather than German construction practice

Power Efficiency in NONLINEAR

Application of the Chaffee contour-diagram method of analysis to the determination of power efficiency in nonlinear transmission systems with tubes operating as class B or class C amplifiers. Practical examples are given

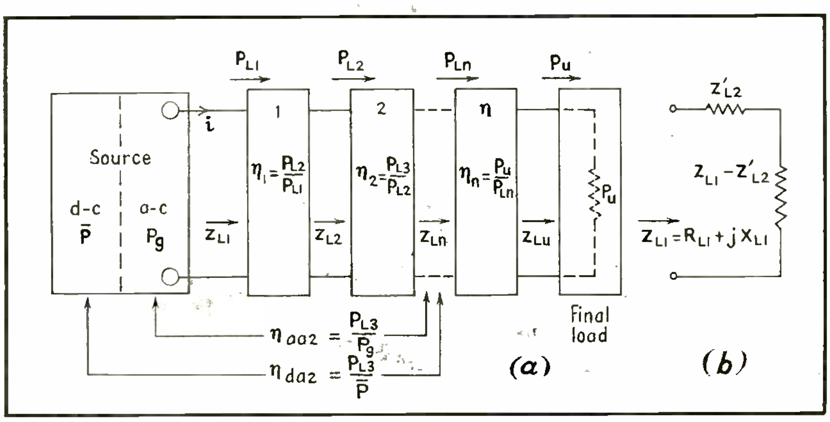

FIG. 1—Power transfer in a transmission chain connected to a nonlinear source

THE POWER EFFICIENCY of such high-power devices as class C stages in radio transmitters has for a long time been a factor of great importance. Lately the power efficiency of such low-power devices as class C operated ultra-high-frequency converters has been given considerable thought.

Both the devices mentioned have one thing in common; an inner impedance that varies within wide limits. As the inner impedance is variable, such technical terms as "conjugate match" and "critical coupling", used in the class A terminology, lose their conventional meaning and must be replaced by modified technical terms or new technical terms.

Fundamental Considerations

The source connected to the transmission chain in Fig. 1 may represent an oscillating tube with its supply. In its symbolic form the source is shown to have one d-c part and one a-c part, the former delivering the d-c power $\bar{P}$ to the latter, and the latter delivering the a-c power P_g to the transmission chain.

In the general case the a-c source is nonlinear. The emf and inner impedance of such a source cannot with advantage be expressed in simple mathematical form, and an analytical treatment of the power relations is therefore not practical and may not even be possible.

In a special case the source is linear and may then be truly characterized by an emf E in series with an inner impedance Z, independent of amplitude. A simple analytical treatment can now be made but is not of much interest, as linear operation is mostly used when the output power is comparatively small.

As shown in Fig. 1 (a), the dc-ac generator feeds into a load Z_{Lu} via a number of transmission sections 1, 2, ...n, which are introduced either to provide matching or to convey power from one point to another. A transmission section as shown may represent a transformer, a link coupling, a feeder, or a radiation coupling to a receiving device.

The power P_u developed in the load Z_{Lu} is the utilized power. (All power notations refer to active power.) The amount of power delivered to a particular section 1, 2, ...n of the system, or to the load Z_{Lu}, may be calculated if the proper input impedance Z_{L1}, Z_{L2}, ...Z_{Ln}, or Z_{Lu} is known (assuming steady-state conditions). The total power at the specified point is the sum of the component powers, a component power being the power developed by a particular frequency component.

Any specified output power P_{L1}, P_{L2}, ...P_{Ln}, or P_u is conveniently expressed as a fraction of any specified source power. Such a fraction is known as power efficiency and may for practical purposes be defined as

$$\eta = \frac{\text{specified active output power}}{\text{specified active input power}} \quad (1)$$

Power efficiencies may generally be classified as *ac-ac power efficiency* η_{aa} and dc-ac power *efficiency* η_{da} (and in case of rectifying devices *ac-dc power efficiency* η_{ad}). For determination of the power efficiency the nature of each one of the two powers concerned must be known. It may, for example, be necessary to know if the output power includes the fundamental component only, or if it includes all components produced. In addition it may be of interest to know how the power readings are related to various parameters.

If the input power $\bar{P}$ is measured at small amplitudes and the output power P_u measured at large amplitudes, an error may intentionally or unintentionally be introduced

TRANSMISSION SYSTEMS

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which makes the measurement unreliable. In this way boosted power efficiencies can be obtained, which even exceed the limiting values given by mathematical analysis, based on the assumption that $\bar{P}$ and P_u refer to the same amplitude value.

Any power efficiency referring to the source and a specified load in a circuit may be termed *total power efficiency*. Examples of total power efficiencies are η_{aa2} and η_{da2} in Fig. 1. A total power efficiency may be broken up into one power efficiency for the source, η_{aa}, and one power efficiency for each following transmission section, η_{l1}, η_{l2}, $\ldots \eta_{n}$.

The total power efficiencies are then computed as

$$\eta_{aax} = \eta_{aa}\, \eta_1\, \eta_2 ----- \eta_x \quad (2)$$

$$\eta_{dax} = \eta_{da}\, \eta_1\, \eta_2 ----- \eta_x \quad (3)$$

For $x = n$ the power efficiencies include the entire system and may be referred to as *overall power efficiencies* η_{aan} and η_{dan}. This procedure is convenient as the power efficiency for each one of the transmission sections can be investigated and improved without the necessity of taking the circuit components of the rest of the transmission chain into consideration. The total power efficiency is maximum when each η figure involved is maximum.

It is desirable that η_{l1}, η_{l2}, $\ldots \eta_{ln}$ be expressed in network parameters for the individual section. A transformation of the load impedance on the output side of a section to the input side of the same section makes possible a treatment free from voltage and current considerations. Thus in case of section 1, as redrawn in Fig. 1(b) with the load Z_{L2} reflected to the input side as Z'_{L2}

$$\eta_1 = P_{L2}/P_{L1} = I^2\, Re\,(Z'_{L2})/I^2\, Re\,(Z_{L1})$$

$$\eta_1 = Re\,(Z'_{L2})/Re\,(Z_{L1}) \quad (4)$$

This method is of special impor-

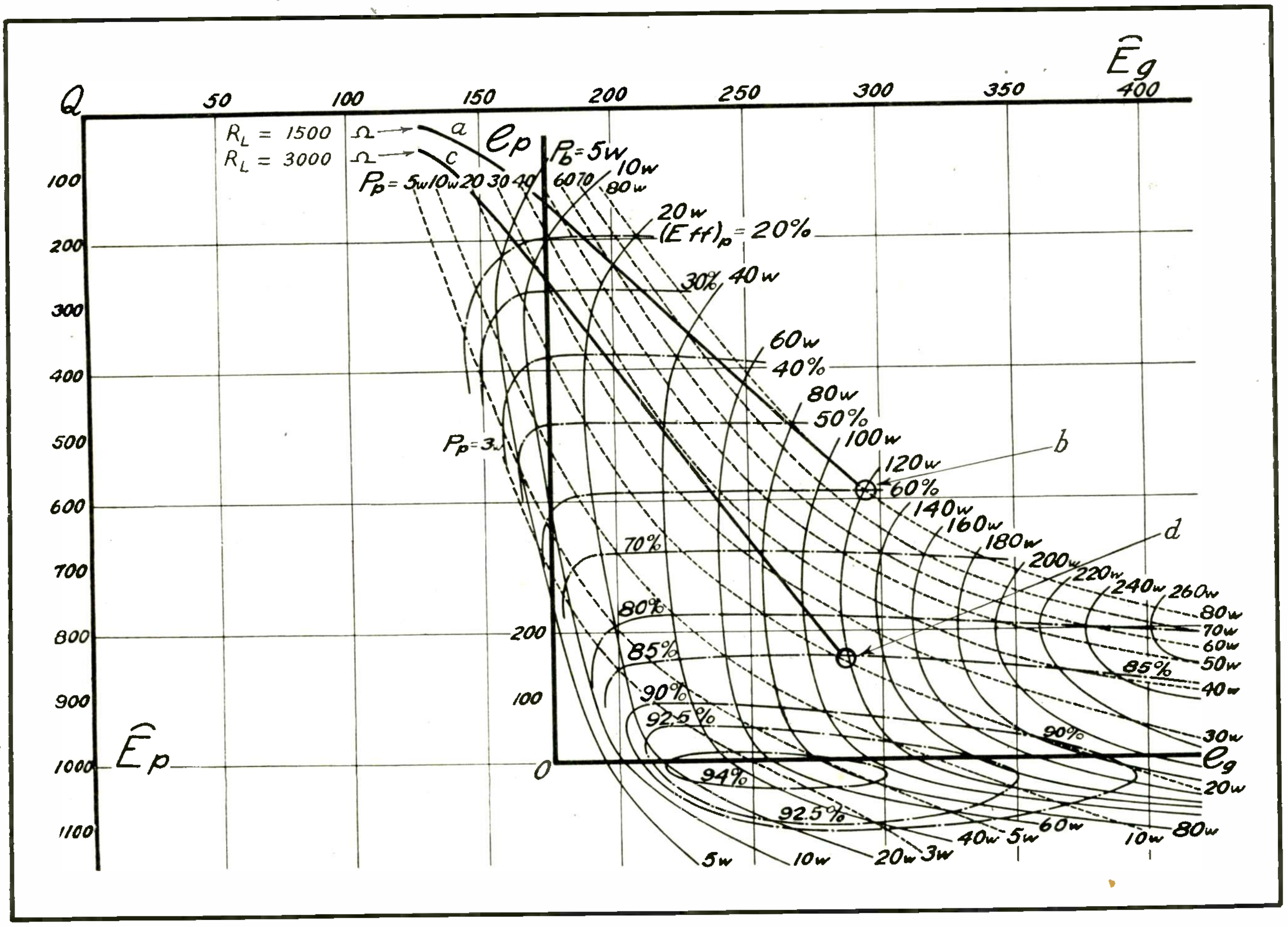

FIG. 2—Chaffee contour diagram for accurate determination of the operating characteristics of a UV211 tube when $\bar{E}_B$ is 1000v and $\bar{E}_C$ is —175v

tance for matching sections employing coupled circuits. An application follows.

Class A Application

In the first case to be considered, the source in Fig. 1 is a tube operated in class A with small constant amplitude. The tube is treated as a linear device. The emf may be sinusoidal and have the form $e = E_m \sin \omega t$, and the constant inner impedance expressed as $Z = R + jX$. A simple derivation shows that conditions for maximum power transfer require Z_{L1} to be the conjugate quantity of Z. Then

$$(P_{L1})_{max} = E^2/4R \qquad (5)$$

where $E = E_m/\sqrt{2}$. For this condition

$$\eta_{aa} = P_{L1}/P_g = 50\%. \qquad (6)$$

P_g is here the source of a-c power (fictitious) in the equivalent plate circuit for the tube concerned.[1] An ac-ac efficiency of 50 percent is the theoretical limit for the conditions specified. The maximum dc-ac efficiency may be much below 50 percent.

Treatment of Class C Devices

The concept of "conjugate match" loses its significance not only for class C operated tubes, but as well for some class B and class A operated tubes, especially when the applied amplitude is comparatively large. The reason for the deviation from the "conjugate match" principle may be the inconstancy of the plate resistance, or the fact that matching to a multiple or fraction of the plate resistance is desirable rather than a matching to the plate resistance itself. It is well known that for some operation of class A and class B amplifiers the introduction of an "optimum load impedance" solves the problem as far as the technical side is concerned. Thus the turns ratio and impedances of a transformer, when matching a loudspeaker to an output tube, may be determined with the optimum load impedance of the tube as the only known tube design data. The plate resistance (or rather average plate resistance) of the tube is of no interest.

In the more extreme case of class C operation of radio-frequency amplifiers, the introduction of an optimum load impedance is not a sufficiently good solution. Various methods for dealing with radio-frequency power tubes have been developed.

The following treatment is described by Chaffee.[2,3,4] Static measurements are performed to give static characteristic curves, preferably $e_p e_g$ curves, from which may be calculated so-called contours, joining points of equal driving power, plate dissipation, output power, plate efficiency, etc. An alternative method is to measure the various operational voltages, currents, and powers and plot the contours in the $e_p e_g$ axes system.

An example of an $e_p e_g$ diagram, including several contours, is shown in Fig. 2. The position of the Q point in the upper left corner is determined by the applied d-c grid potential, -175 volts, and the applied d-c plate potential, 1,000 volts. For these values the plate current is zero. When a sufficiently large alternating voltage is applied to the grid, class C operation with pulsating plate current results. The fundamental component of the plate voltage may reach an amplitude of the order of 500 to 1,000 volts, the actual value being determined by the impedance in the plate circuit. Contours are shown for the plate dissipation P_p, the output power $P_b = P_{L1}$, and the plate efficiency $(Eff)_p = \eta_{da} = P_b/(P_p + P_b)$.

Examples

As an example of the use of the graph,* assume $E_{gm} = 290$ volts, $E_{pm} = 590$ volts, and $R_L = 1{,}500$ ohms. The path of operation Q-b will then have its end-point b located as shown, so that $P_p = 80$ watts, $P_b = 120$ watts and $(Eff)_p = 60$ percent.

As another example, assume $E_{gm} = 280$ volts, $E_{pm} = 840$ volts and $R_L = 3{,}000$ ohms. The path of operation Q-d will now have its end d located further down, so that $P_p = 20$ watts, $P_b = 120$ watts and $(Eff)_p = 85$ percent. The position of the end-point of the path of operation must be given proper consideration. The contours a-b and c-d for plate loads of 1,500 and 3,000 ohms represent loci for end-points when the amplitudes are varied.

———

* In the diagram amplitude is indicated by an eye-brow over the symbol rather than by the subscript m.

A Practical Application

A transmission system including a class C amplifier is shown in Fig. 3 (a). (Neutralization and modulation circuits may be added). The power tube, to which the diagram in Fig. 2 applies, feeds via an output transformer and a feeder a center-driven antenna of input impedance $Z_{L3} = R_{L3} + jX_{L3}$. It is assumed that the antenna half-length h is slightly less than a quarter wavelength so that $X_{L3} = 0$. It may further be assumed that R_{L3} equals the characteristic impedance R_c of the feeder, so that no standing waves appear on the feeder and no reactance is reflected into the secondary of the transformer.

The main requirement on the circuit elements L_2 and C_2 is that they provide resonance for the fundamental transmission frequency. The ratio L_2/C_2 is not critical from the point of view of matching, as the mutual impedance M will be adjusted accordingly so that the load presented to the tube will be the one required by the end-point in the contour diagram. The primary L_1C_1 is tuned to resonance to secure a tube load impedance of zero phase angle and thus secure efficient operation of the tube.

The tube T with power supply represents the dc-ac source in Fig. 1. Leaving the grid dissipation and the grid driving power out of consideration, the power efficiency of interest will be the one indicated in Fig. 3(a). The plate efficiency $\eta_{da} = \eta_p$ is obtained from contour diagrams of the type shown in Fig. 2. The output transformer efficiency η_1 is computed as indicated by Eq. (4), in accordance with the tuned equivalent circuits in Fig. 3(b) and 3(c).

$$\eta_1 = Re\,(Z'_{L2})/Re\,(Z_{L1}) = \omega^2 M^2/R_{L2}\,(R_1 + \omega^2 M^2/R_{L2}). \qquad (7)$$

(The coil resistance of the secondary circuit is assumed to be negligible compared with R_{L2}.) It is important to realize that the power efficiency described by Eq. (7) refers to the transformer and its load only; the tube is in the circuit all the time, but is disregarded in this discussion.

With the tube left out of consideration the circuit is linear and the mutual inductance M and coefficient of coupling $k = M/(L_1L_2)^{\frac{1}{2}}$ can therefore be estimated in terms of critical coupling. For a transformer with both circuits tuned to resonance, critical coupling may be defined by one of the two relations:

$$\omega^2 M^2 = R_1 R_{L2} \quad (8)$$

$$\text{or } k^2_c = 1/Q_1 Q_2. \quad (9)$$

Here $Q_1 = \omega L_1/R_1$ and $Q_2 = \omega L_2/R_{L2}$. As this discussion of critical coupling does not have anything to do with the tube, Q_1 refers to the primary circuit above with no resistance component reflected from the tube into the circuit. At critical coupling the transformer efficiency of Eq. (7) becomes

$$\eta_1 = 1/(1 + (k_c/k)^2)\Big|_{k = k_c} = 50 \text{ percent} \quad (10)$$

Class A Operation

It will now be temporarily assumed that the tube is operated in class A with limited amplitude, so that the entire circuit can be considered linear. The vital question is now: what coupling in the transformer yields maximum power in the load impedance R_{L2}? The simplest case is at hand when the plate resistance of the tube is so high that when reflected into the primary circuit it becomes almost negligible compared with R_1. In this case maximum power transfer is obtained when the critical coupling described by Eq. (8) and (9) is maintained. This follows directly from Eq. (5), or rather from the assumed conditions under which Eq. (5) is derived. Equation (6) gives the system power efficiency as 50 percent.

Consider next a class A tube with somewhat lower plate resistance. The reflected plate resistance r'_p in series with R_1 must now be taken into account and it is therefore necessary to increase the coupling in the transformer until the condition

$$\omega^2 M^2 = (R_1 + r'p) R_{L2} \quad (11)$$

is obtained. The power developed in R_{L2} is then maximum and the power efficiency of the (tube, transformer, load) system is 50 percent.

It would be permissible to say that the conditions for maximum power transfer are obtained for critical coupling in the system, but it is better to continue using the term "critical coupling" for the transformer and load only, especially as the case just discussed is of limited practical value. As far as the transformer is concerned it is over-coupled and has an efficiency above 50 percent.

Now consider the general case when the tube is operating in class C and the system is nonlinear. It is tempting to continue to think of the tube as represented by a reflected resistance in the primary circuit of the transformer, as this explains why overcoupling yields increased output power. It is, however, dangerous to think in terms of class A in nonlinear circuit applications. An equation like Eq. (11) would be misleading if r'_p were used to represent a nonlinear quantity, and would not be of much use anyhow as r'_p is then a notation for something that can not be given a simple mathematical form. There is then so much more reason to restrict the term critical coupling to the transformer part of the circuit. This does not mean, however, that the distance between the coils is to be adjusted for critical coupling. As before, considerable overcoupling is required, and the η_1 figure may in a practical case be fairly close to 100 percent. Thus for a high k value, such as $k = 10\ k_c$,

$$\eta_1 = 1/(1 + (k_c/k)^2)\Big|_{k = 10 k_c} = 99 \text{ percent}. \quad (12)$$

If in Fig. 3 the losses in the antenna are neglected and the losses in the feeder known, the over-all dc-ac power efficiency is obtainable as $\eta_{da2} = \eta_{da}\ \eta_1\ \eta_2$, as indicated by Eq. (3). Here the plate efficiency $\eta_{da} = \eta_p$ is obtained from the contours as previously described.

Conclusion

The necessity for standard definitions of various power efficiencies and their theoretical limits has been stressed. The simplicity of a system, in which the overall efficiency is broken up into a source efficiency and a number of section efficiencies, is brought out in the discussion. In the treatment of class C devices, reference is made to the paramount possibilities of the Chaffee contour method. A transmission system is discussed, in which the source efficiency is obtained by this method. It is suggested that for class C operation the term "critical coupling" be restricted to the matching device only.

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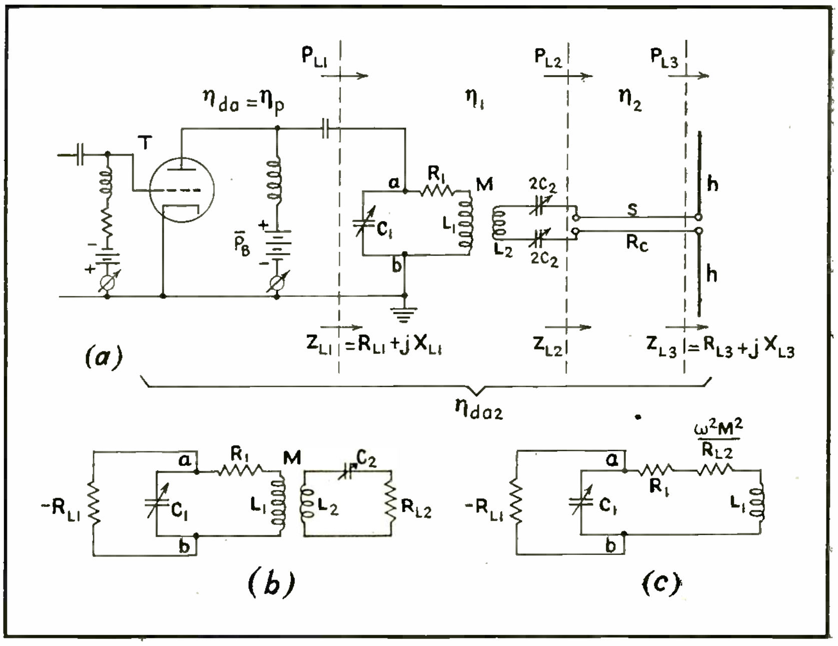

FIG. 3—Transmission circuit with nonlinear generator (a class C r-f power tube)

ELECTRONIC

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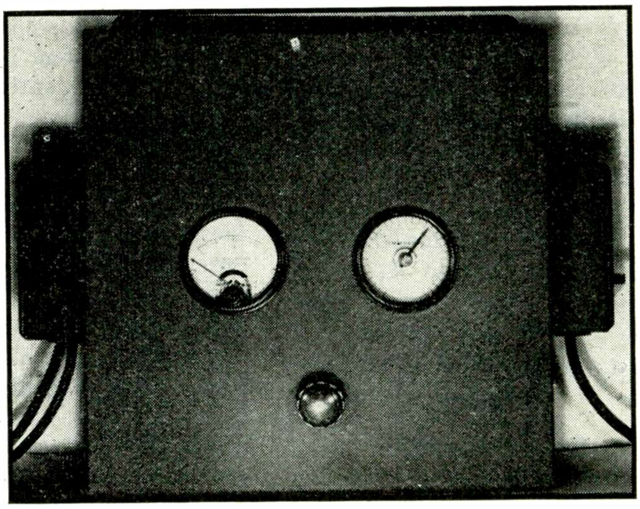


Complete electronic thermometer. The dial at the right is mechanically coupled to the potentiometer used for establishing the control point, and the meter at the left indicates temperature deviation in degrees above and below control point

THE design of the thermometer to be described is based on an accidental observation of the extremely high temperature coefficient of resistance of some organic materials. As these materials also have a high resistivity, the two properties combine to produce a thermometric substance for a resistance thermometer of extraordinary sensitivity. The higher the resistivity of the organic material employed, the greater the voltages which can be applied without dissipating sufficient power to interfere with the accuracy of the instrument.

The electronic thermometer in its present form utilizes a glass bulb 1 in. long and ⅜ in. in diameter completely filled with the thermometric liquid. Two electrodes, entering the bulb through a conventional stem, consist of metallic wires about 0.015 in. in diameter and dipping $\frac{3}{16}$ in. into the liquid.

Electrical Characteristics of Materials

The conductivity of the bulb involves two factors—the real conductivity of the material, and a polarization effect dependent on the surface of the electrodes. The latter effect appears to be related to the viscosity of the material, and any movement of the liquid has a considerable effect on the resistance.

The resistance is a function of frequency, and the current is proportional to the applied voltage up to voltages much higher than any electrode polarization voltage so far observed.

We are using various voltages up to about 20 volts per bulb. With an apparent resistance of some 100,000 ohms at room temperature, this gives a current of 200 microamperes and a dissipated power of 4 milliwatts. These are average figures, and great variations are possible for special purposes.

Temperature Coefficients

The apparent resistance R_t plotted against temperature t on rectangular coordinates is given in Fig. 1. The general shape of this curve is common to a wide variety of materials, and approaches the relation

$$R_t = R_e e^{-\alpha t} \qquad (1)$$

The same data is plotted on semi-log paper in Fig. 2. The temperature-resistance relation is usually linear for a substantial part of the useful temperature range when plotted in this way.

The temperature coefficients in the useful ranges are negative in almost all cases, but some of these materials change to a positive temperature coefficient at higher temperatures.

While the resistance between two small immersed electrodes decreases

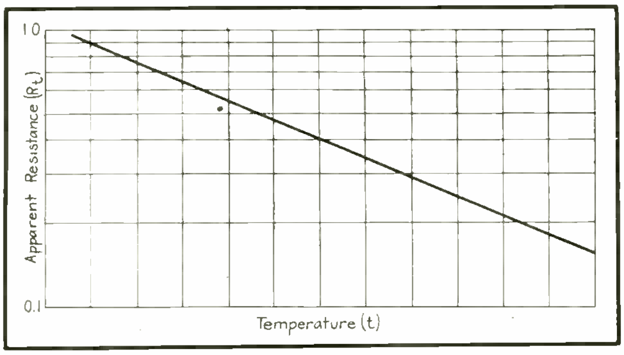


FIG. 1—Typical thermometer bulb characteristic plotted on rectangular coordinates

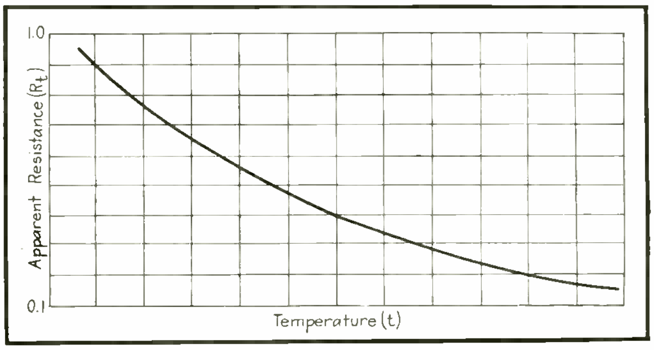
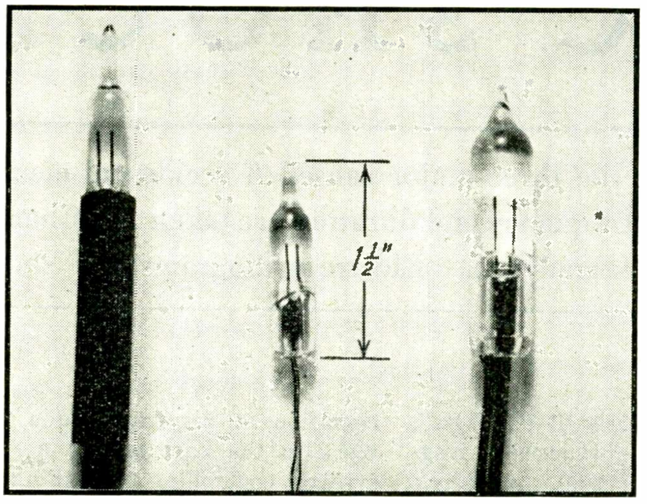


FIG. 2—Same data as in Fig. 1, plotted on semi-log paper to show linear relationship

THERMOMETER



Typical thermometer bulb designs

Description of a new temperature measurement and control system utilizing a resistance thermometer consisting of a small glass bulb filled with an organic material having a high temperature coefficient of resistance. Sensitivity can be adjusted for a ±0.01 deg F control range

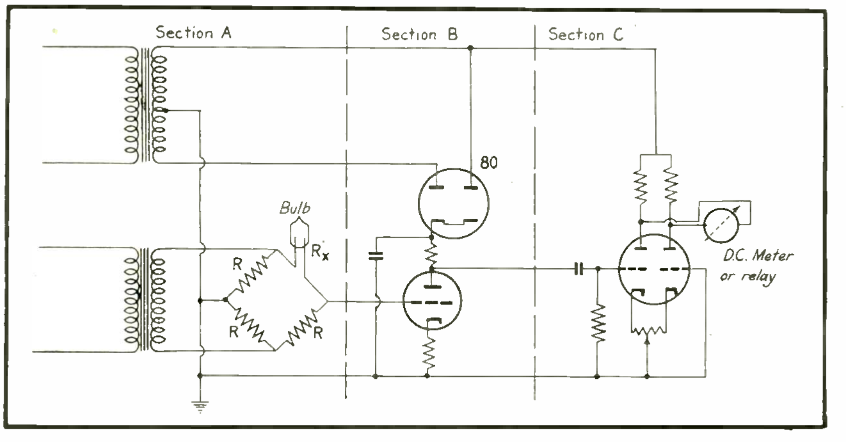


FIG. 3—Basic vacuum-tube circuit employed for the electronic thermometer or heat control system

rapidly with increasing temperature, the apparent capacitance generally increases almost as fast. In some cases the capaitance between the two electrodes was 1,000 times the geometric capacitance, in spite of the fact that the dielectric constant of the liquid was only between 3 and 5. An average value of temperature coefficient of these materials at room temperature is 2.5 percent per deg F.

The apparent resistance of a bulb may range from 100,000 ohms to 1 megohm at room temperature, depending on the material, size of bulb and other factors. To utilize the extraordinary properties of organic materials for temperature indication or control an electronic method is indicated because of the high resistance of the bulbs.

Vacuum-Tube Circuit

The basic circuit employed in the electronic thermometer and control system is shown in Fig. 3. Section A is the bridge element in which a change in temperature of the bulb results in an a-c signal being produced across the output terminals of the bridge. Section B (omitted when the device is used as a thermometer rather than for automatic control) is merely a conventional amplifier. Section C is the discriminator element which receives the a-c signal and produces a pulsating direct current flow between the plates of the two triodes to actuate either an indicating meter or a sensitive relay. This section is essentially an a-c Wheatstone bridge with one triode section serving as the variable resistance element.

The plates of the double triode are fed with a.c. to provide a simple and convenient phase discrimination feature in the bridge. If the a-c signal voltage from the bulb circuit is in phase with the plate voltage of the vacuum-tube bridge, the triode plates will be positive when the grid of the left-hand tube is positive. Consequently, the impedance of the left-hand tube will be lower than that of the right-hand tube and current will flow in one direction through the meter or relay. Conversely, if the a-c signal voltage is 180 deg out of phase with the vacuum-tube plate supply, the meter or relay current will flow in the opposite direction.

If either the two plate resistors or the grid bias of the left-hand tube are adjusted so that current flows between the two plates at all times, an unbalance in one direction will cause an increase in current, while an unbalance in the other direction will cause a decrease.

The circuit can be adjusted in various ways in accordance with particular requirements of indication or control. It is substantially unaffected by normal drift in vacuum-tube characteristics in service, because both tubes drift in the same direction. The effect of differences in tube characteristics when the tubes are changed can be

(Continued on page 362)

Effects of ELECTRIC SHOCK

An engineering report discussing in detail the three major causes of accidental electrocution. Considerations of voltage, current, frequency and duration are taken up. Chances for survival under various conditions are analyzed. Electrocardiograms are shown

An electrical engineer's knowledge of the response to an applied electromotive force should not be limited to networks of resistance, capacitance, and inductance. It should include, also, the response of a human being. Unfortunately, the engineer usually knows little more than the layman about the latter subject, even though he is much more exposed to the hazards of electricity than is the average person. This article is written to acquaint the engineer with the basic principles of the effect of electricity on the human organism.

The first recorded death due to electricity was that of a stage carpenter at Lyon in 1879. He touched a 250-volt line. This, however, was not the first use of lethal electric potentials, for they were used as early as 1849 in the first performance of Meyerbeer's 'Il Prophète", and in 1857 in lighthouses in England. As early as 1890, the electric chair was introduced by the state of New York. Here voltages of 1200 to 1700 volts were used. In electrocutions currents up to 8 amperes were sent through the victim's body for 3 to 8 minutes.

The death rate due to accidental electric shock was low at the beginning of the century, being about 200 a year in countries like England, the United States, and Germany. It rose rapidly, until in 1915 the rate was 0.8 per 100,000 annually. Since then it has remained quite constant, and at present is 1 per 100,000 per year.

Causes of Death by Shock

Death by electricity is due to one of three fundamental causes: a cessation of respiration due to a block in the part of the nervous system controlling breathing; a serious reduction of the circulation of the blood, due to ventricular fibrillation of the heart; or an overheating of the body. Of the three, the second of these is the most dangerous, for there is no practical way of bringing a fibrillating heart into a normal beat. Of course, death may be the result of a combination of the above causes, or due to complications, such as a broken neck, etc. The mechanisms of death will now be discussed in more detail.

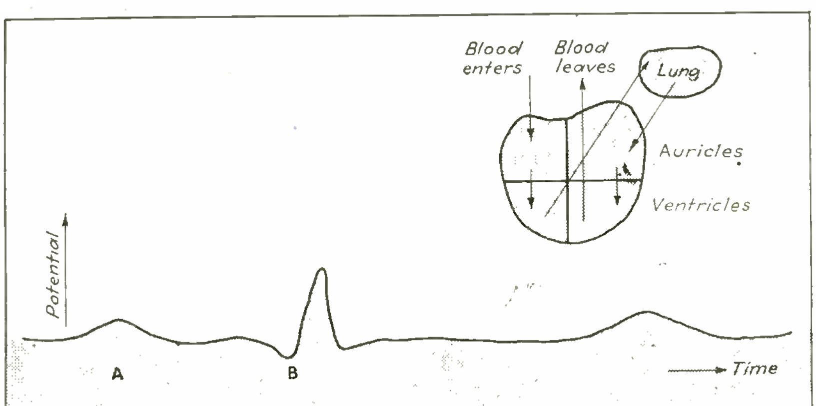


FIG. 1—Electrocardiogram and diagram of normal heart

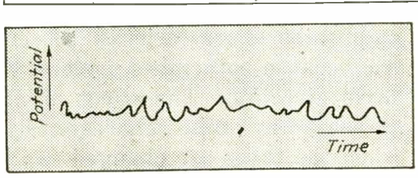


FIG. 2—Electrocardiogram of a sheep's heart in ventricular fibrillation

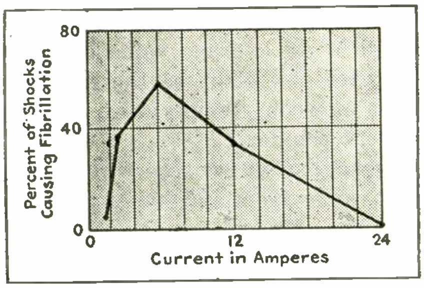


FIG. 3—Effect of electric current on susceptibility of sheep hearts to ventricular fibrillation. Each shock was applied for 0.03 sec at 60 cps, in the most sensitive part of the cycle

Variations in Body Resistance

In the layman's mind, (as well as in that of the engineer) a great deal of confusion exists as to whether the current or the voltage of the circuit is the determining factor in death. This is quite inexcusable, for as early as 1913[1] it was clearly understood that the current passing through a person's

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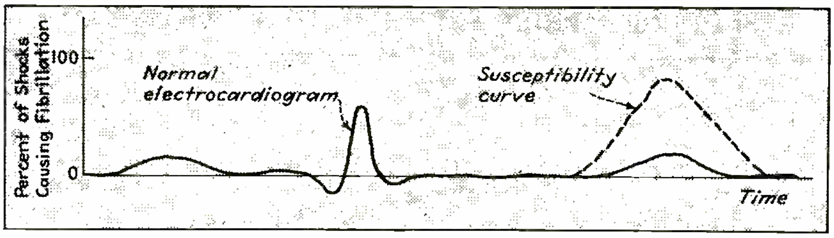


FIG. 4—Effect of position of shock in cardiac cycle on susceptibility of sheep hearts to ventricular fibrillation

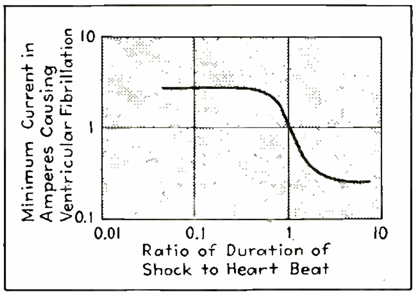


FIG. 5 (RIGHT)—Effect of duration of shock on threshold current for sheep

body (rather than the voltage applied) was the determining factor. The reason for the wide variation in voltage required to send a lethal current through a human body is that the resistance of the body varies from 1000 ohms when wet to 500,000 ohms when dry.

The resistance of the body is made up of the skin resistance and the internal resistance. The former is large when the skin is dry (70,000 to 100,000 ohms per sq. cm.), but falls to less than a hundredth of this value when wet. The internal resistance is low because the tendons, muscles, and blood are relatively good conductors.

In high-voltage shocks serious burns are often produced because the high voltage punctures the outer skin. The body resistance then suddenly falls from a high value to the low value of the internal resistance.

It is understandable that the effect a given current will have depends on the current path through the body. It is found that the heart, the brain, and the spinal column are the three most critical regions.

Effect of Current Magnitude

Let us consider the effects produced when the magnitude of a 60-cycle current is slowly increased. Numerous studies[2] have shown that the threshold of perception is 1 ma. In other words, currents less than 1 ma are not even felt, provided abnormally large current densities, as result from pin-point contacts, are not produced.

Currents from 1 to 8 ma are perceptible, but not yet painful. When the currents reach a value of 8 to 15 ma they are painful, and cause an involuntary contraction of the muscles affected. Muscular control, however, can still be exercised. Currents of 15 to 20 ma are painful, cause involuntary contraction, and muscular control is lost. Currents of 20 to 50 ma, passed between arms, or an arm and a leg, involve the chest muscles and breathing becomes difficult. Currents of 100 to 200 ma, when passed through the body in a path that involves the heart region, produce ventricular fibrillation (an uncoordinated beating of the various heart muscles).

Currents in excess of 200 ma produce burns; if they take a path involving the heart region, the heart action is suspended for the duration of the current passage, but generally is resumed at the end of this period.

If the path involves the part of the nervous system controlling respiration (such as hand to hand, hand to foot, head to hand, etc.) a block in the respiratory system is produced. If artificial respiration is applied, the body may resume its own breathing after as long as 8 hours; if the damage to the respiratory - controlling nervous system is severe, however, breathing may be suspended indefinitely.

Ventricular Fibrillation

The phenomena of ventricular fibrillation and respiratory block deserve closer attention. Ventricular fibrillation is an uncoordinated contraction of the various heart muscles, which makes the heart practically useless as a pump. The phenomenon can better be understood by reference to the electrocardiogram and diagram of a normal heart in Fig. 1. The stimulus *A* corresponds to the contraction of the auricles, which contract together. The stimulus *B* corresponds to the contraction of the ventricles, which also contract together.

The electrocardiogram for ventricular fibrillation can easily be recognized, for it has the irregular pattern shown in Fig. 2.[3] Experimental work on human hearts in regard to fibrillation is of course impossible. But guinea pigs, rabbits, and sheep also are subject to fibrillation, so considerable work has been done with them.

The variation of the percentage of shocks causing fibrillation with the magnitude of the current passed through the body of a sheep is shown in Fig. 3.[3] Each point represents about 75 trials. Note that the susceptibility increases with cur-

UNDERSTANDING PROMOTES SAFETY

ESSENTIALLY medical in character, this paper explains why some people die and some don't after accidental contact with electric circuits

CATHODE-RAY and other electronic apparatus employs high voltages and it is the thought of the editors that the information contained in these pages may, therefore, save many lives

TABLE I.
RESULTS OF A BRIEF EXPOSURE TO A-C POTENTIALS

Body resistance assumed to be	100 volts	1000 volts	10,000 volts
Very low, with good contact (About 1,000 ohms)	*Certain death;* slight burns	Probable death; marked burns	Survival; burns and other sequelae; very severe
Higher (About 10,000 ohms)	Painful shock; no injury	*Certain death;* burns probably slight	Probable death; severe burns
High with bad contacts (About 100,000 ohms)	Scarcely felt	Painful shock, but no severe injury	*Certain death;* burns slight if resistance remains high

rent up to a maximum, and then decreases as the current is increased further. This is in agreement with observed data on man, for it has been observed that as the voltage increases on high-voltage shocks, the percent that can be resuscitated increases.

For shocks short in duration compared to a heart cycle, the probability of producing fibrillation varies with the part of the heart cycle in which the shock occurs. This is shown by the dash-dash curve superimposed on the electrocardiogram in Fig. 4. This sensitive phase represents the decreasing contraction of the heart muscles. At any other time, the heart is quite insensitive to shock.

Duration of Shock

Finally, the effect of shock length was studied. The results are plotted in Fig. 5. Note the sudden increase in susceptibility to fibrillation as the shock length approaches the length of the heart cycle. What happens to this curve as the shock length is decreased to much smaller values, say one microsecond, is an interesting question, but no authentic data is available on this subject.

Resuscitation Principles

Numerous methods have been tried to bring a fibrillating heart back to a coordinated beat. Of these the method of counter shock first used by Abilgaard in 1775 to arrest fibrillation in cocks seems the most promising. It has been used with success on guinea pigs and dogs. It consists of an application of a shock of high intensity and short duration through the heart. The obstacles encountered in trying to apply this to humans are: (1) difficulty in determining whether a heart is actually fibrillating; (2) the availability of proper facilities for applying the shock; (3) the counter shock, if improperly applied, may actually become the cause of the death. As a result, the recommended procedure in all cases of electric shock is to apply resuscitation immediately, and not attempt to apply counter shock.

In many cases of electric shock the victim becomes unconscious and stops breathing, but his heart keeps on beating. This is due to a break in the nervous system controlling respiration. The nerves are paralyzed by the currents and no longer transmit stimuli to the lungs. Here one difference between the operation of the heart and lungs becomes evident; the nervous center which controls the lungs is located in another organ, the brain.

The brain and heart must always be supplied with oxygen. If the oxygen supply ceases, the person first becomes unconscious. If the supply of oxygen to the brain is cut off for more than 5 to 8 minutes, damage is done to the Betz cells in the cortex of the brain. This damage is permanent and cannot be repaired by the body. If the person should be brought back to life his mental capacity will be impaired. Serious damage of this kind results in idiocy.

If the damage to the nervous system is not too severe, the block will pass away (0 to 8 hours) and the person will resume breathing of his own accord, provided the person has been kept alive by supplying the vital cells of the body with oxygen in the meantime through artificial respiration. This explains the prescribed procedure in all cases of electric shock: apply artificial resuscitation immediately and continue until rigor mortis sets in.

In cases of severe damage to the cells of the nervous system controlling respiration (dislocation of the nuclei, swelling of the nucleoli, and cytoplasmic loss of granule) the natural breathing of the body is never resumed.[4]

The third cause of death is excessive heating of the body. The reason for death here is not obscure. The detailed mechanism of death is a medical matter and its discussion would lead us too far astray. It is sufficient to remark that death is due to the destruction by heat of some vital organ, or to hemorrhages, or to third-degree burns.

Effect of Frequency

A further characteristic of current that determines its effect on an organism is its frequency. A ready example is that of direct current and 60-cycle alternating current. The bearable direct current is

(*Continued on page* 250)

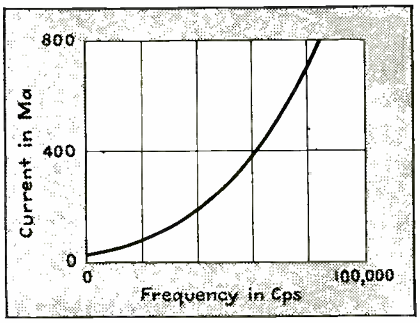


FIG. 6—Effect of frequency on tolerance current

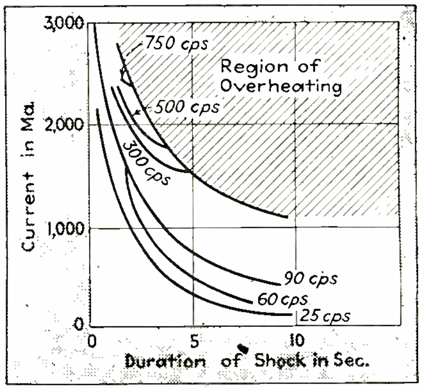


FIG. 7—Minimum currents necessary to cause death from shocks of different duration at several frequencies

THERMAL NOISE
In a Parallel RC Circuit

Chart giving thermal noise voltage in microvolts produced by random electron movement in a circuit composed of resistance shunted by capacitance, for any desired band width and for entire frequency spectrum

By C. J. MERCHANT

The Brush Development Co. Cleveland, Ohio

THE LOWER LIMIT to the magnitude of voltages which can be measured is set by the so-called "thermal agitation" voltages which arise spontaneously in the measuring apparatus itself. When listened to, this noise manifests itself as a rushing, hissing sound, and is familiar to all who have worked with high-gain, wide-band audio amplifiers.

Basic Formula

This voltage is a result of the random movement of electrons in a conductor, and is a function of the temperature of the conductor, its resistance, and the band-width over which the voltage is measured. Since components of all frequencies and random phasing are present, one can only specify this voltage in terms of its rms value. The formula relating the above variables is as follows:

$$E = \sqrt{4kTR\Delta f} \qquad (1)$$

In this formula, E is the rms voltage appearing across the terminals of the resistance, k is Boltzmann's constant, equal to 1.374×10^{-23} Joule per degree Kelvin, T is the temperature in degrees Kelvin, R is the resistance in ohms, and Δf is the band-width over which the voltage is measured. At room temperature this formula becomes

$$E = 1.28 \times 10^{-10} \sqrt{R\Delta f} \qquad (2)$$

This formula holds only for pure wire-wound resistances of zero phase angle. In the case of a general two-terminal impedance containing reactances as well as resistance, F. C. Williams has shown* that one may compute the thermal noise voltage in either of two ways: (a) one may consider that only the resistances in the impedance give rise to thermal-agitation voltages, and that the reactances serve only as filtering agents by suppressing or re-inforcing certain frequency bands; (b) one may reduce the impedance to the equivalent series circuit, integrate the resistive component of the impedance over the desired frequency band, and substitute the result in place of $R\Delta f$ in formula (2). This formula then becomes

$$E = 1.28 \times 10^{-10} \sqrt{\int_{f1} R\,df} \qquad (3)$$

Using either method leads to identical results.

Noise in Crystal or Condenser Microphone Circuit

A case which arises frequently is that of computing the noise voltage, over a given band-width, which arises from a resistor shunted by a capacitor. This is the case of a crystal or condenser microphone which, together with its grid leak, acts as the input circuit of an amplifier. Since such microphones, if their frequency characteristic is flat over a wide range, have relatively low output, the thermal noise output of the microphone and its grid leak often determines the minimum signal which can be measured. The other limiting factors are the ambient noise of the room and the shot noise of the first tube of the following amplifier.

The resistive component of the impedance of a resistor and capacitor in parallel is given by

$$Re\,(Z) = R\left(\frac{1}{1+\phi^2}\right) \qquad (4)$$

where R is the value of the resistor in ohms, and $\phi = f/f_0$, where f_0 is the frequency at which $X_c = R$, and is given by $f_0 = 1/2\pi RC$, where C is in farads. Substituting this expression in Eq. (3) and re-writing f_1, f_2, and df in terms of ϕ expressed in radians, one has

$$E = 1.28 \times 10^{-10} \sqrt{\int_{\phi 1}^{\phi 2} \left(\frac{R}{1+\phi^2}\right)\left(\frac{d\phi}{2\pi RC}\right)}$$
$$= \frac{1.28 \times 10^{-10}}{\sqrt{2\pi C}} \sqrt{\text{arc tan } \Phi_2 - \text{arc tan } \Phi_1} \qquad (5)$$

Equation (5) shows that the high-frequency regions contribute very little to the total noise voltage output. Thus, if one computes the voltage developed across a given resistor in parallel with a given capacitor between f_0 and $100\, f_0$, it is found to be equal to $44.7 \times 10^{-12}/\sqrt{C}$. For the same R and C, the total rms voltage developed between f_0 and infinity equals $45 \times 10^{-12}/\sqrt{C}$. Thus, the entire region between

* Williams, F. C., Thermal Fluctuations in Complex Networks, Wireless Section, *Journal of the I.E.E.* 13, p. 53, Mar., 1938.

100 f_0 and infinity contributes less than 1 percent to the total output. Hence if, as is generally the case, one desires to know the total noise output from a resistor and capacitor in parallel as measured by an amplifier whose lower cut-off frequency is in the vicinity of f_0 and whose upper cut-off frequency is many times f_0, it will be substantially correct to take this upper cut-off frequency as infinity.

Basis of Chart

The accompanying chart was constructed by taking the lower frequency limit f_1 as some multiple N of f_0, and the upper frequency limit as infinity. It gives the value of the rms fluctuation voltage E between the frequency limits ϕ_1 (in radians) $= N$ and $\phi_2 = \infty$, where $\phi_1 = f/f_0$, $f_0 = 1/2\pi RC$, and the value of E is obtained from the following transformation of Eq. (5), in which E is in μv and C is in $\mu\mu$f:

$$E = \frac{128}{\sqrt{C}}\sqrt{\frac{\text{arc cot } \Phi_1}{2\pi}} \tag{6}$$

To accomplish this transformation, ϕ_2 is set equal to infinity, so that arc tan ϕ_2 equals $\pi/2$ radians or 90 deg. The resulting expression under the radical is then equal to arc cot ϕ_1. The change in the numerical coefficient is a consequence of expressing E in μv and C in $\mu\mu$f in the above equation.

Thus, suppose it were desired to find the rms noise-voltage developed across a 20-$\mu\mu$f capacitor and a 10-megohm resistor in parallel, between the frequency limits of f = 400 cps and infinity. Here f_0 is the frequency at which $X_c = R = 10$ megohms, and from the equation $f_0 = 1/2\pi RC$ we get 800 cps as the value of f_0. Hence $N = f/f_0 = 400/800 = 0.5$, and the intersection of the abscissa $C = 20$ $\mu\mu$f and the contour $N = 0.5$ is found to occur on the ordinate marked 12 μv.

Example of Chart Use

By taking advantage of the fact that noise voltages add as the square root of the sum of the squares of the component voltages, the chart can be used to find the noise voltage developed when neither of the frequency limits can be considered infinite. Suppose, for example, it were desired to find the voltage developed across the above R and C between the frequency limits of 400 and 800 cps. From the above, the rms voltage developed between 400 cps and infinity is 5 μv. Proceeding in a similar manner one finds the rms voltage between 800 cps and infinity to be 3.5 μv. Hence the voltage developed between 400 and 800 cps equals $\sqrt{5^2 - 3.5^2}$ or approximately 3.6 μv.

Effect of R on Noise Output Voltage

It is worthwhile noting that the total noise voltage output of a given resistor and capacitor in parallel, measured between the frequency limits of zero and infinity, is independent of the value of R, and depends solely on the value of C, as long as R is some finite value different from zero. The value of R serves only to determine the distribution in the spectrum of the total energy, which is determined by C. Stated in a somewhat different fashion, for any given value of C, the voltage output measured between $f = 0$ and $f = f_0$ is the same as the output measured between $f = f_0$ and f = infinity. Either of these statements may be verified by reference to Eq. 5.

Total Fluctuation Voltage Up to Infinite Frequencies

Although no amplifier or meter can be made that will indicate to infinite frequency, the concept of total noise generated over the total spectrum is useful, since it sets an upper limit to the thermal agitation voltage to be expected from an impedance, no matter what the bandwidth over which the actual measurement is made. Thus, by referring to the contour labelled $N = 0$ on the chart, it is seen that irrespective of either the resistor or the bandwidth, if $C = 10$ $\mu\mu$f the total fluctuation voltage will be less than 20 μv. In some cases this might be all the information needed, as, for example, in the case where the following amplifier itself had a noise- or hum-level of several times this quantity.

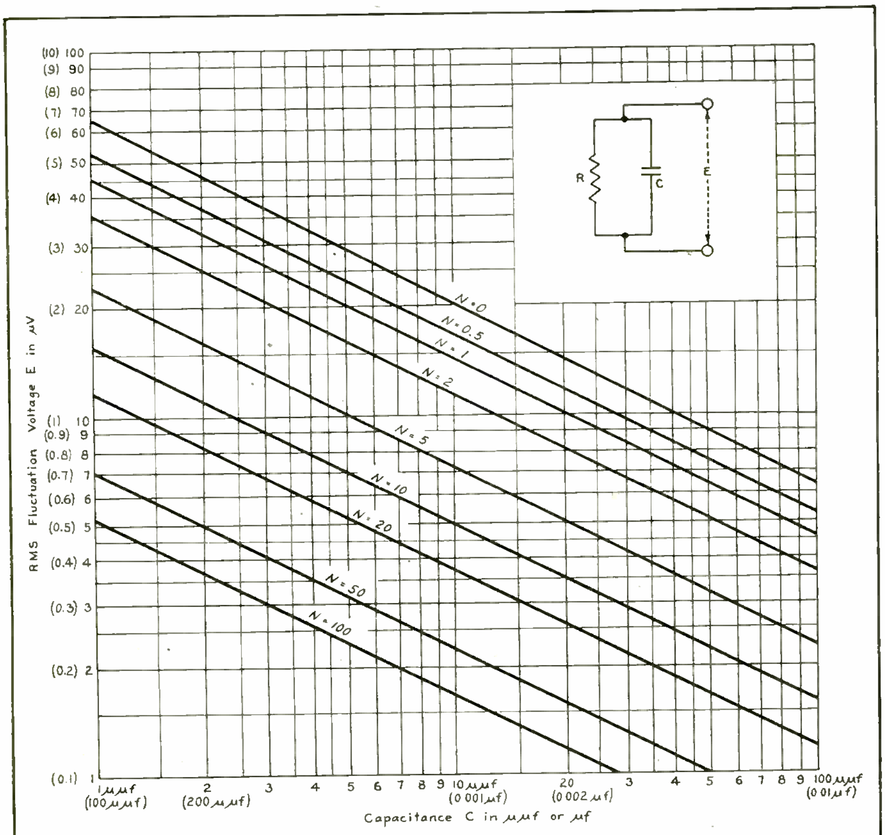
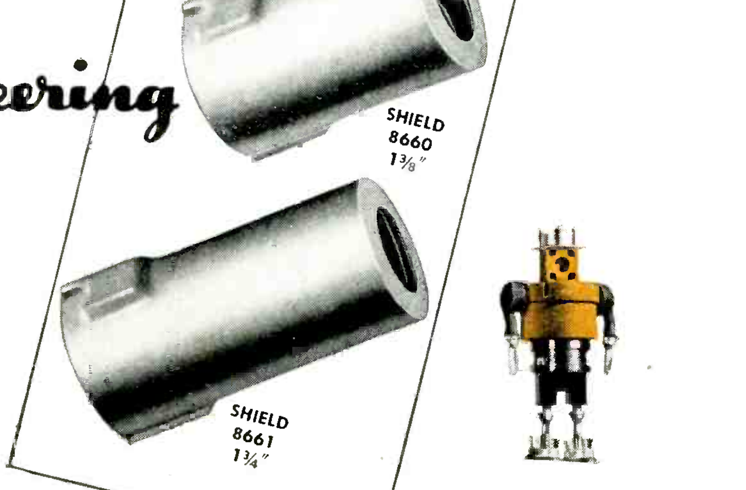


Chart giving rms value of fluctuation voltage across R and C in parallel, between a given frequency limit and infinity. The frequency limit is converted into a value N as explained in the accompanying article. When values in parentheses are used on one scale, the parenthesis values on the other scale must be used



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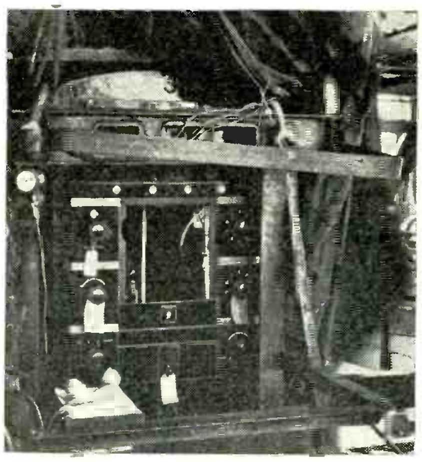
TUBES AT WORK

Industrial X-Ray High in the Air on Cracking Unit

AS RESULT of the successful use of x-ray testing, it was possible to complete the 250-foot high "Baltimore Giant", a fluid catalyst cracking unit for high-octane gasoline at the Standard Oil Company of New Jersey's refinery in Baltimore, without welding defects. All welds were x-rayed.

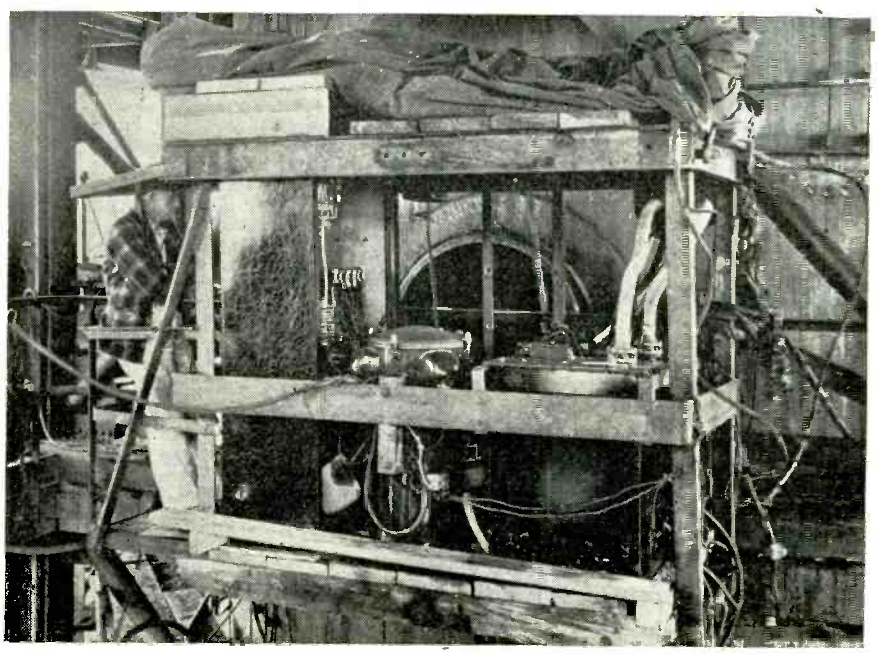
Technical experts of Kelley-Koett Co., worked with the Standard Oil Development Co. and M. W. Kellogg Co., general contractors for the cracking unit, and stripped down a standard 220,000-volt x-ray unit made by the Covington concern. After fitting the unit to special rigging, the equipment was crane-hoisted from level to level.

The x-ray testing of welds in awkward locations went forward successfully despite rainstorms and unavoidable jars and jolts, and is believed to be another indication for post-war x-ray applications in shipbuilding, plant construction and other heavy-industry uses. Solutions to some of the unusual mounting problems are shown in the photographs.



View of the x-ray control panel hanging at one of the skyscraper levels. Colored signal lights replaced the doubly insulated telephone for communication with operators at the tube head when construction noises were too great

The head of the x-ray tube was mounted down inside the reacter for examining the welds in the lower conical sections. A monorail carriage runs on a track parallel to the weld seam



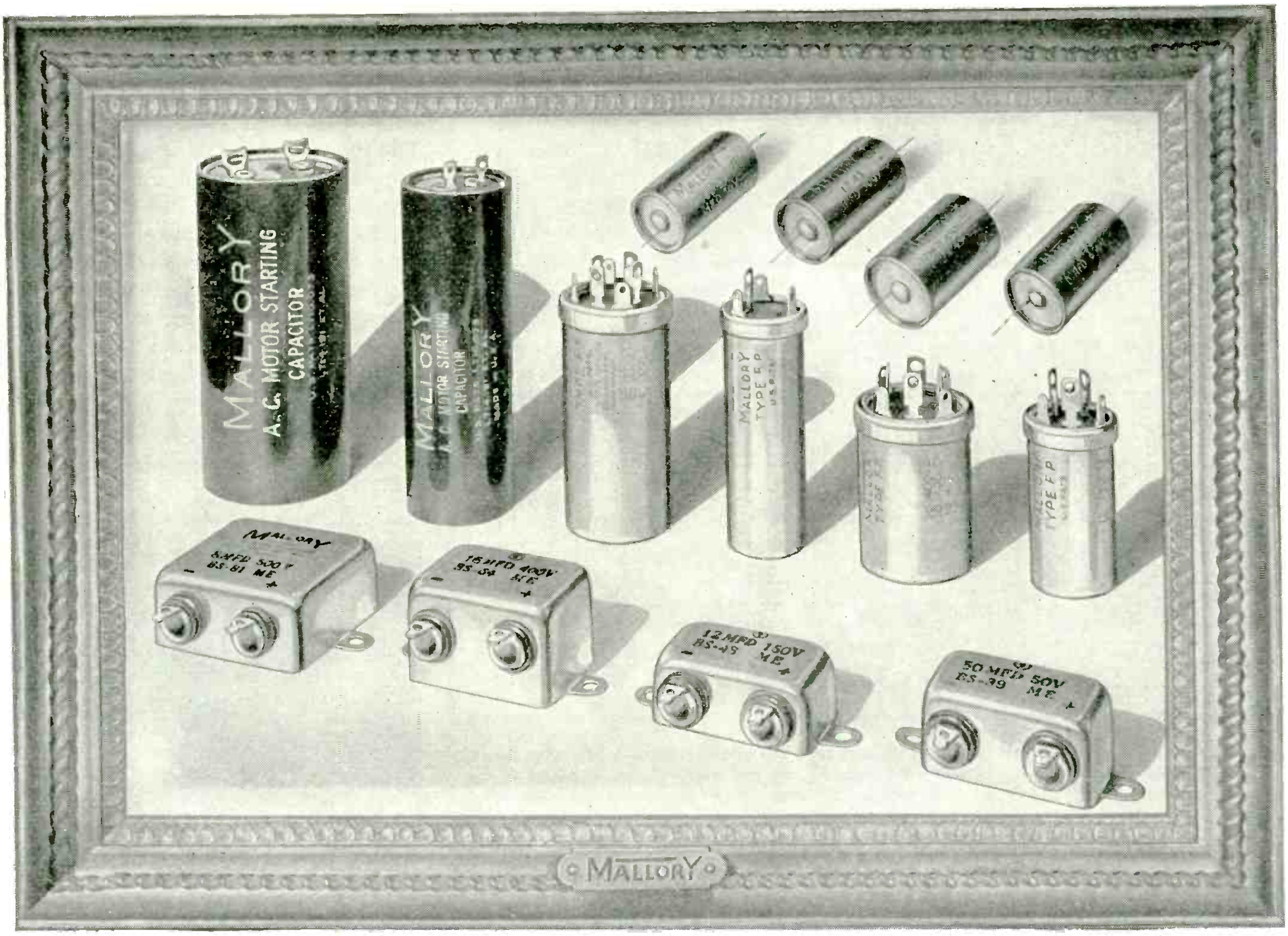
Transformers and other units of the x-ray machine were stripped of protective covers to reduce weight. The only protection against the elements is the tarpaulin shown rolled up atop the suspended crib

Test Set for Strain Gages

By E. H. HEINEMANN
Chief Engineer
El Segundo Plant
Douglas Aircraft Co., Inc.

WIDESPREAD APPLICATION of strain gage techniques to the measurement of stress and strain, and for the accurate determination of applied loads, has necessitated the development of many special instruments for the manufacture of strain gages. The electronic instrument to be described has proven extremely useful as a limit indicator for calibrating gages in the process of manufacture and routine checking of gage installations. Considerable saving of time is effected as compared to previous methods in which a galvanometer is used as the indicating device.

The instrument is shown in the photographs and consists of a null balance circuit using 6E5 tuning-eye tubes as null indicators. It is compact and portable, is not critical regarding severe handling, and may be operated by inexperienced personnel. Small enough to be set up close to the actual work, it per-



Family Portrait . . .

Bearing the Mallory Stamp of Dependability

REMARKABLY numerous is the family of Mallory dry electrolytic capacitors. So numerous, in fact, that not all its members are pictured here. But one thing the family has in common—*reliability!* You can depend on a Mallory capacitor, no matter what the specific job it was designed to do.

Mallory capacitors are the outgrowth of years of development in Mallory laboratories. They embody improvements which have contributed directly to the growth of radio itself. Today they offer greatly increased operating temperature ranges . . . remarkable reductions in size for rated capacity . . . a much greater span of efficiency and life. In addition, Mallory improvements in handling methods, and in control of source materials, assures uniform quality in every capacitor.

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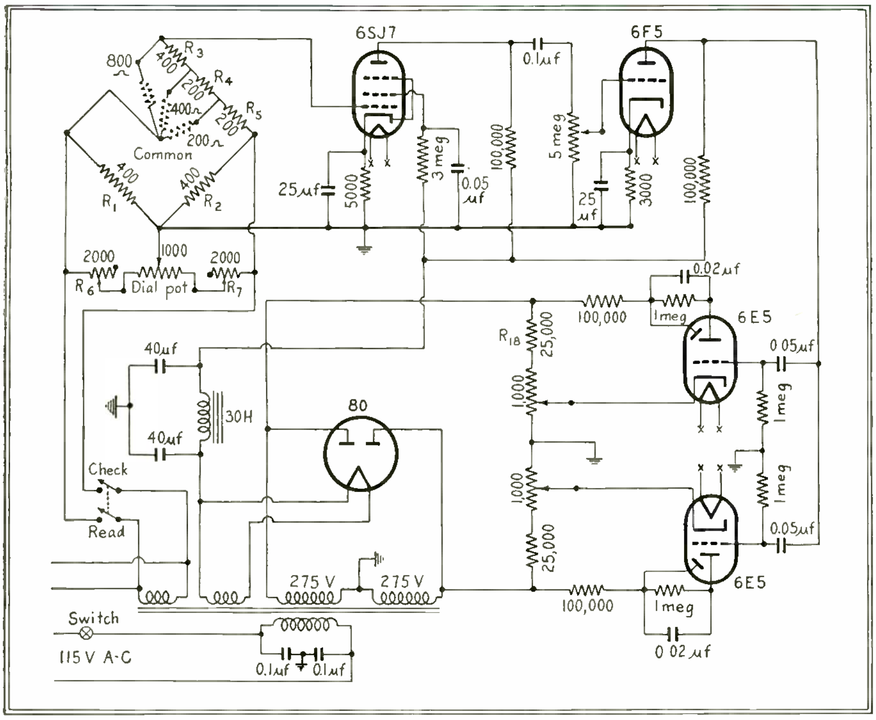


Bridge circuit and electronic amplifier used to feed the grids of the 6E5 indicator tubes. The plates of these tubes are supplied with a.c. by the high-voltage winding of the power transformer

mits strain gages to be checked as work is in progress.

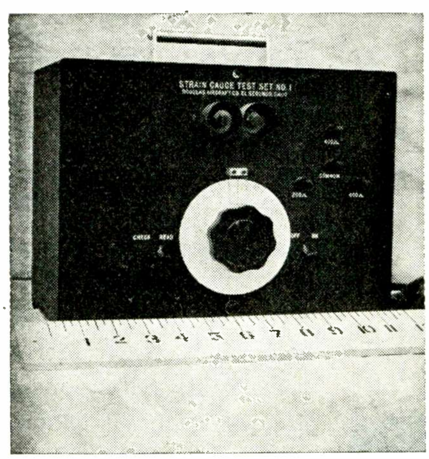
The gage under test is connected to two terminals on the front panel. Evidence of faulty wire in the gage, open gages, corrosion of the wiring junctions, or poor insulation of the gage to ground is immediately apparent as either complete opening of the shadow angle or as an erratic flutter in this angle. Change of resistance in a gage due to aging or other factors may be determined in terms of the standard gage resistance by noting the point on the dial at which balance is obtained. The balance dial is graduated in percent tolerance.

Circuit

The circuit of the gage test set is shown in the diagram. In this, the gage to be tested becomes an arm of the bridge circuit built into the instrument. Resistors have been provided in the bridge to accommodate 200, 400 and 800-ohm gages. Other sizes could be taken care of by additional resistors in the reference arm of the bridge.

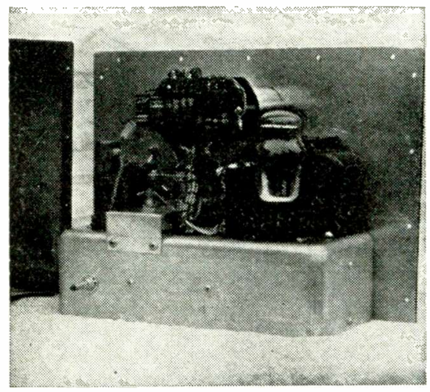
With the balance potentiometer set to center position (zero on the dial), any unbalance of the bridge will be applied to the first tube of the voltage amplifier. The amplified output (60 cps) of the amplifier is applied to the two grids of the tuning eye tubes in parallel. Since these tubes have 60-cycle a.c. on their plates, the shadow angle of one or the other of the tubes will change, depending on the phase relation of the grid signals with respect to the plates.

The amount by which the balance potentiometer must be moved in order to return the bridge to balance is a measure of the variation of the gage resistance with respect to the standard resistors in the bridge circuit. Balance is indicated by the return of the shadow angles to their original setting. The shadow angles of the 6E5 tubes are usually adjusted as close to zero as possible by means of the 1,000-ohm potentiometers which vary the grid bias of the 6E5's. This adjustment is made from the front panel by means of a screw driver. The "check-read" switch is turned to the "check" position for this adjustment to remove the voltage from the bridge.



Electronic test set for calibrating strain gages during manufacture. The dial adjusts a potentiometer to balance a bridge circuit and is calibrated in percent tolerance

Resistors R_1, R_2, R_3, R_4, and R_5 are all precision wire-wound resistors whose accuracy is better than 0.05 percent. These are used as a standard reference. The dial is calibrated by using an additional set of precision resistors with the specified tolerance. The dial divisions represent percent deviation from the nominal values of 200, 400, and 800 ohms. This marking was used since the calibration will be same for all three ranges.



Internal view of the components and their mountings in the strain gage test set. The gain of the amplifier is adjusted by the shaft at the rear of the chassis

The gain of the amplifier may be adjusted from the rear of the test set if necessary. Spread of the dial may be varied by adjustment of the two padding resistors, R_6 and R_7. To make this adjustment, the unit must be removed from the case and the dial recalibrated.

Operation

In using the test set to check a gage already installed, the gage in question is connected to the proper terminals on the front of the set. If the shadow angle has been properly adjusted beforehand, and the dial is at zero, the change in angle,

wherever a tube is used...

for example

THE ELECTRONIC CALIBRATOR

A recently designed automatic calibrator for frequency meters used in conjunction with adding machines largely eliminates tedious hand calibration, saves man hours, reduces element of human error, speeds production.

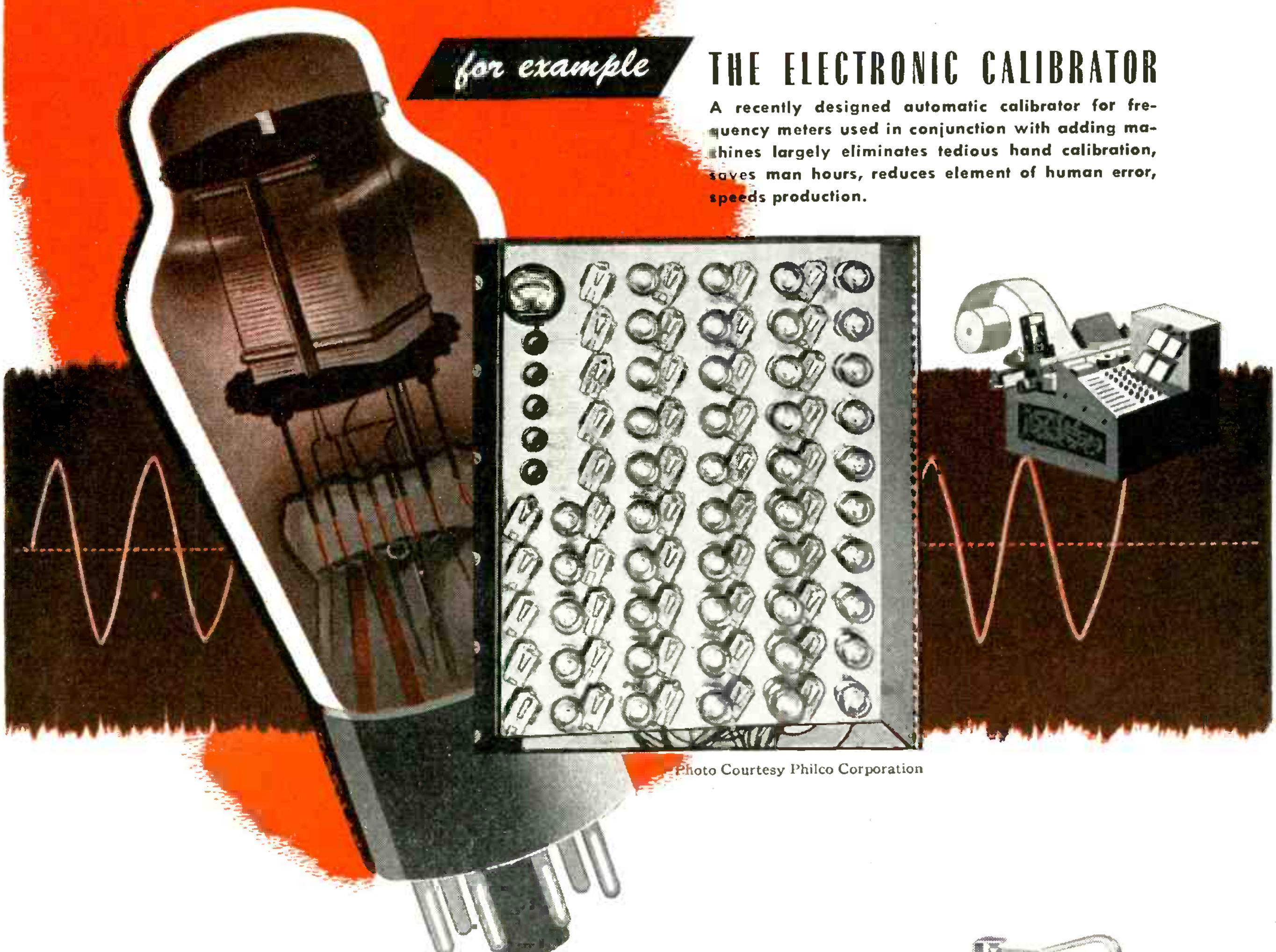


Photo Courtesy Philco Corporation

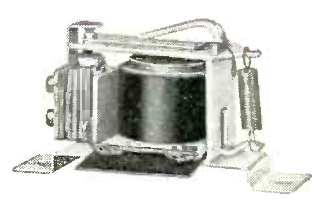
THERE'S A JOB FOR

Relays BY GUARDIAN

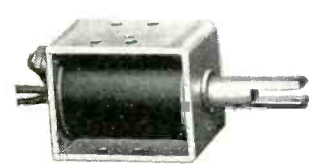
The Philco 126-tube Electronic Calibrator employs a system of fast and slow-acting relays and solenoids to bring about desired end actions. One application is the transferring of readings from the storage bank (shown above) to the keyboard of the adding machine. Operated by the plate current of OA4G tubes the relays on the storage bank energize the adding machine solenoids which press the proper number key of the adding machine.

The Guardian Series 120 relay used in this application is a small, sensitive unit having a minimum power requirement of 0.5 VA and an average of 2 VA. Coils are available in resistances from .01 to 6,000 ohms. Contact combinations up to single pole, double throw with 12.5 amp. points. Send for Bulletin 120.

The solenoid is Guardian Series 4 available for either A.C. or D.C. use. Series 4 A.C. at a maximum stroke of 1" permits a pull of 14 oz. intermittent duty, 3 oz. continuous duty. Series 4 D.C. at a maximum stroke of 1" permits a pull of 6 oz. intermittent duty, 1 oz. continuous duty. Send for information.



Series 120 Relay



Series 4 Solenoid

Consult Guardian whenever a tube is used—however—Relays by Guardian are NOT limited to tube applications but are used wherever automatic control is desired for making, breaking, or changing the characteristics of electrical circuits.

GUARDIAN ELECTRIC

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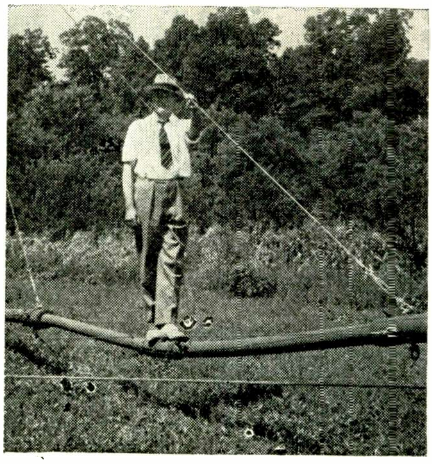
A COMPLETE LINE OF RELAYS SERVING AMERICAN WAR INDUSTRY if any, will indicate deviation in resistance from that of the standard. Erratic fluttering of the shadow angles indicates faulty installation.

If the set is to be used for adjusting gages during manufacture, the procedure is the same as above except that the bridge is made to balance by adjusting the resistance of the gage itself. This may be done while the gage is connected in the circuit. The advantage of this method is that the operator may use both hands for soldering and adjusting, while at the same time observing the shadow angle. It is not necessary to wait for a galvanometer to come to rest before reading the indication.

It is possible to hold gages to better than 0.02 percent of the value of the standard resistors with this method, without sacrificing quantity of production.

Planes Deliver Plywood Radio Masts

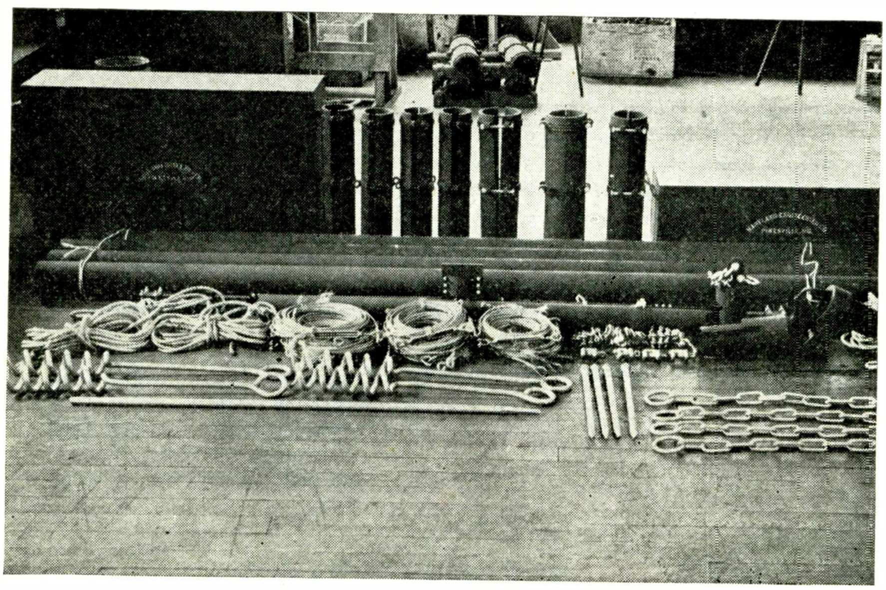
RADIO COMMUNICATIONS equipment flown into captured air fields includes a sectional antenna mast of tubular plywood devised by the signal corps. First used in the African campaign, the mast weighs but a fraction of solid wood or metal masts which were cumbersome to handle. Two miles of plywood sections, enough for 150 masts of the 75-foot height, can be loaded into a single trailer-truck. Complete masts can be packed by the dozen on transport planes and flown anywhere.



Lightness and strength of the tubular plywood mast are demonstrated by a workman at the plant of Maryland Engineering Co., manufacturers of the mast

Three men can erect the plywood mast and have the radio equipment in operation within 30 minutes. The sections are first assembled on the ground, then the base end is set into a hinged metal socket fixed to the ground by long spikes, and the mast raised by a boom. Once erect, it is braced in position by two sets of three guy-wires which run out to a radius of 13 feet. The guys are attached to long pegs hammered into solid ground or to corkscrew-shaped anchors driven into soil.

The plywood tubes forming the mast are four inches in diameter and have a wall thickness of ⅜ in. The fifty-foot mast is composed of four sections about eleven feet long, plus a top section of four feet, eight in. Plywood sleeve couplings are used at the joints and are fastened by metal collars drawn tight by eye-bolts. Mast sections strapped into one bundle, with squares of plywood protecting the ends from damage and providing a solid base for packing, form a package that weighs 152 pounds. Guy-wires, hardware, and square parts are packed separately.



Complete kit of units forming the plywood antenna mast that is flown to captured airfields for ground-to-plane communication by the Army Air Force. Three men can erect it in 30 minutes

Electronic Cooking and Sterilization of Foods

IN ONE INVESTIGATION of the use of electronic equipment for cooking, experiments have been made on a great variety of food products. These have included cereals, steaks, breads and sea food. The results obtained have varied widely and range from excellent to poor, according to data presented by V. W. Sherman, manager of the Industrial Electronics Division of Federal Telephone and Radio Corp., in a paper delivered before the Chicago chapter of the Institute of Food Technologists in May.

He reported that cases of non-uniform heating were traceable to the geometry of the part. For example, in cooking oysters, it was observed that since a portion of the oyster was higher than the remainder, the highest part received the maximum heat and actually began to carburize or burn before complete cooking had taken place in the thinner sections. In the case of steak, heat seemed to develop uniformly during the early stages, but sometimes, during the latter stages, grease released by the heat concentrated in the lower portions of the meat and resulted in a non-uniform distribution of heat. In the case of breads, very satisfactory results were secured provided the lower plate was preheated so as not to chill and thereby retard the heating of the dough in contact with it,

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2. *Metallized filament coating is of high specific resistance and eliminates skin effect at U. H. F.*

3. *Several baked coatings of special varnish provide adequate protection against the effects of humidity and shield resistor from mechanical injury.*

4. *Pre-curing and stabilizing of resistance coating at high temperatures eliminates appreciable aging.*

5. *Tests indicate that water cooling at tap pressure increases power rating approximately ninety times.*

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IRC makes more types of resistance units, in more shapes, for more applications than any other manufacturer in the world.

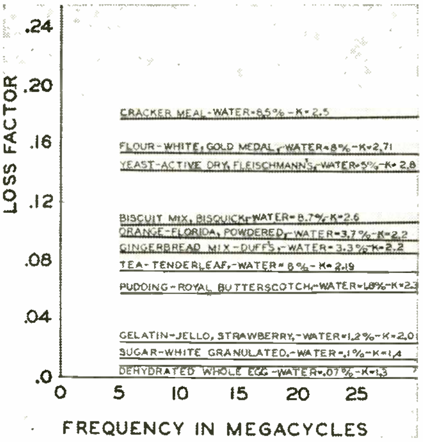
or possibly the action of the leavening agent.

Cost of Cooking

The possibility of using electronic heat as a domestic cooking medium has often been considered, but the economic aspect is the real drawback to its immediate utilization in the home, according to Mr. Sherman. He stated that a two-quart container is entirely practical for electronic cooking and would require about 2 kw of energy. However, the cost is prohibitive at the present time due largely to the fact that the power tubes require an expensive high-voltage power pack.

Development of power tubes capable of operation on plate voltages as low as 440 or even 220, would eliminate the pack expense and provide a relatively low-cost source of high-frequency energy for cooking.

Heating of food products for purposes other than cooking or dehydration was exemplified by success-



The relation between electrical loss factor and frequency is shown by the curves above for a representative selection of foods

ful work in heating cakes of chocolate to the melting point for the purpose of converting it into a liquid state so that it could be more readily handled.

Another example was the heating or roasting of cocoa beans. It was found possible to spread these on a belt, pass them between plates carrying radio frequency energy and thus heat the cocoa beans so rapidly as to shell them by a sort of explosive action. An interesting possibility in connection with this was that continued heating re-


SHURE
Research

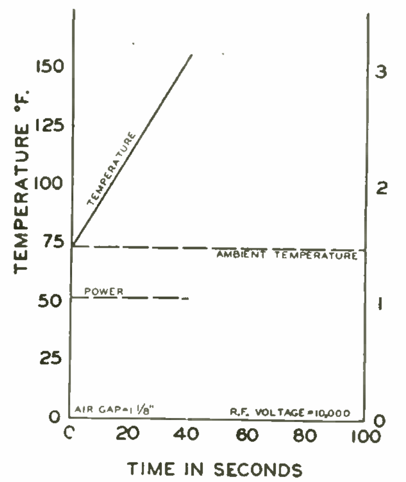
leased oils from the cocoa beans and this may have future commercial value.

Sterilization of food products has developed into perhaps the most important food job for electronic heat at the present time. Whether it will continue to hold this position remains to be seen, but there is now a very imposing list of applications. A number of slides were shown illustrating the electrical loss factor of various foods with various water contents.

Electronic Sterilization

Loss due to insects in grain products amounts to hundreds of millions of dollars per year. The subject of insect damage in stored grain products and in food in general is one of extreme importance not only from the standpoint of monetary loss but also from the standpoint of public reaction.

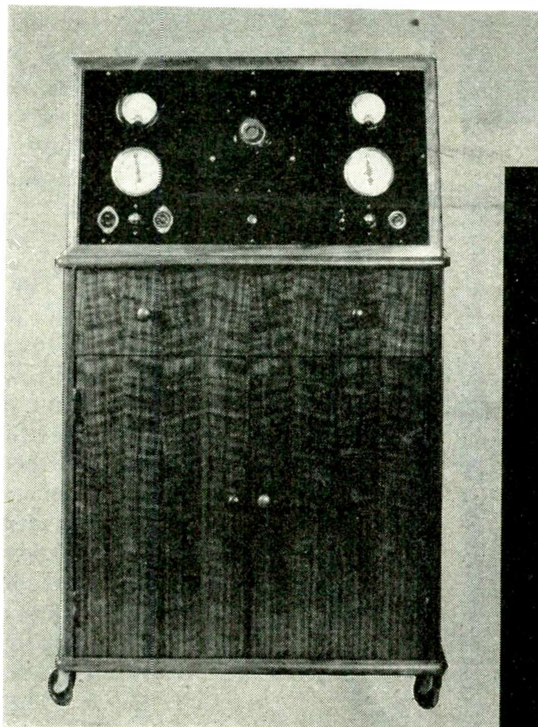
Two boundary temperatures have been tentatively fixed in the food sterilization problem. An air temperature of 180 deg F is considered as maximum allowable temperature for drying wheat without injury to the milling and baking qualities, while a temperature in the neighborhood of 130-140 deg. F is required to destroy insect life.



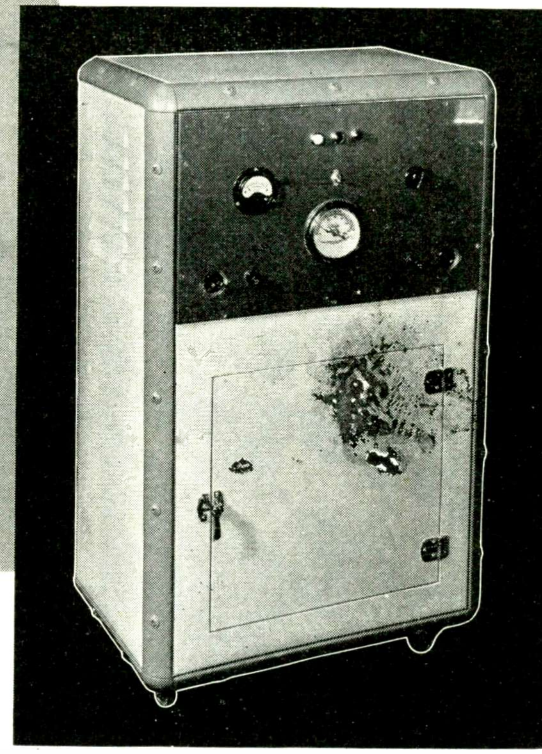
Change of temperature and power with heating time for Bisquick mix in dry form. Here the power input remained practically constant during sterilization

In the sterilizing of food with electronic heat, the product can be treated after packaging. For example, a carton containing 24 boxes of pancake flour can be sterilized as a complete unit on its way to the warehouse. A heat-treat time of 10 to 30 seconds is usually adequate

OLD: Electrical therapy equipment housed in heavy cabinet of ordinary construction.



NEW: The same equipment redesigned and housed in a Lindsay Structure cabinet built by Russell R. Gannon Company, Cincinnati.



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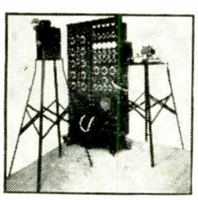
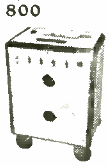
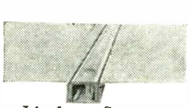
THESE PRE-FORMED ALL-STEEL HOUSINGS SAFEGUARD YOUR EQUIPMENT



Electro-encephalograph in its original form, mounted on telephone relay racks and weighing 800 pounds.



The same equipment redesigned for mounting in an Ls cabinet. The unit is easily moved, weighs only 200 pounds.



Lindsay Structure method of assembly. Units of Ls are easily assembled, disassembled, reassembled.

Cabinets and housings that are light, strong, and streamlined in design can quickly be assembled from Lindsay Structure, modern method of light steel construction. Utilizing all the strength of light metal sheets through uniform tensioning, Ls resists racking and strain —protects delicate electrical and electronic equipment against damage, dust, and moisture. No welding, riveting, trimming, or special tools are required for its assembly.

All parts for Ls are die-formed to exact specifications; completed units have an attractive machine-finished appearance. Equipment and housing alike are readily repaired when Ls is used; parts for Ls are interchangeable, and readily available, while removal of the nearest panel leaves the mechanism beneath it accessible for servicing.

Investigate the advantages of Lindsay Structure today. Send drawings, data, or blueprints to **Lindsay and Lindsay, 222-D West Adams Street, Chicago 6, Illinois; or 60 East 42nd Street, New York 17, New York.**

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U. S. Patents 2017629, 2263510, 2263511
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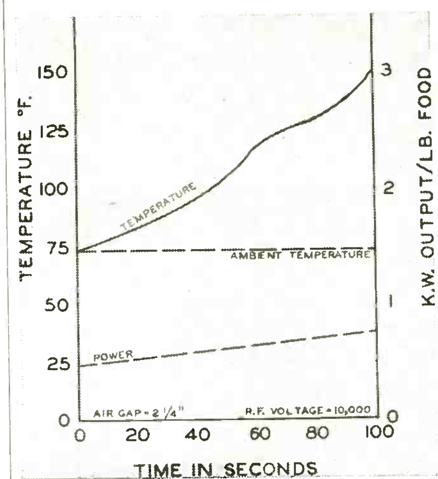
IT S-T-R-E-T-C-H-E-S STEEL

to develop a temperature of 130 deg F. Experiments have shown that complete destruction of all insect life is accomplished in this short time. The power required depends upon lb per hour.

Cost

The cost of the heat treatment and also the power required are both low. The 3-kw output unit will develop over 10,000 btu per hour and is operated for a power cost of 5¢ an hour based on 1¢ per kw-hour rate. Under these conditions, about 480 one-lb packages can be sterilized each hour for 5¢ worth of power. The total cost, including not only power but also vacuum tubes and amortization of the 3-kw equipment over a 10 year period, would amount to 17¢ per hour.

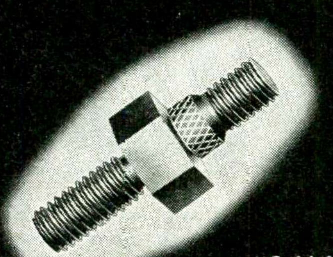
The maintenance of electronic equipment is practically limited to the replacement of tubes. Power tubes have an average life of about 5,000 hours. In the case of rectifier tubes, 10,000 hours is commonly obtained.



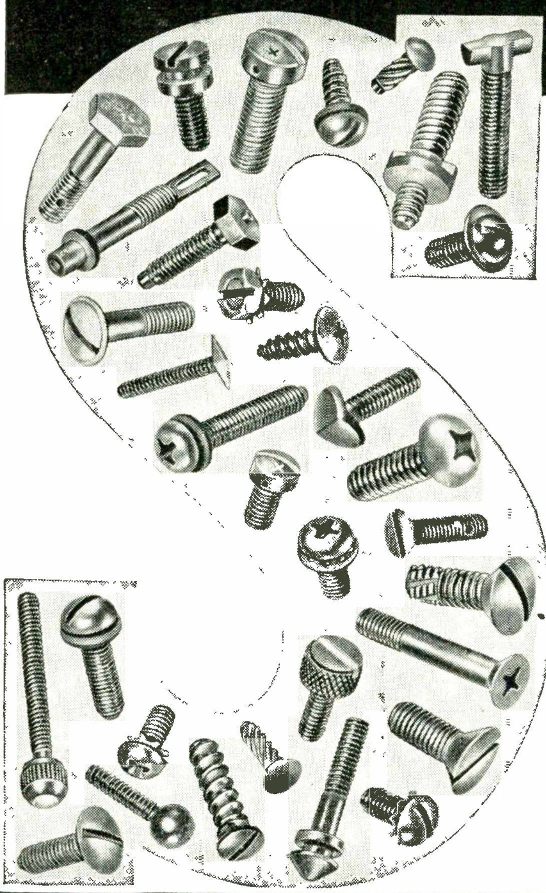
As shown in the curve above, pea soup powder took about 50 percent more power at the end of the run than at the beginning of electronic sterilization

Generation of heat in a food product is accomplished by means of dielectric hysteresis; that is, the molecular friction experienced by the food particles under the action of an alternating electrostatic field. The heat developed per pound of food per second may be expressed mathematically: $H = C \times L.F. \times f \times V^2$, where H = rate of heat in btu per second per pound of material; C = a constant involving density, specific heat and unit conversion factors; $L.F.$ = loss factor ex-

COLD-FORGING SKILLFULLY EMPLOYED LICKED THIS FASTENING PROBLEM



"Cold-forging" proof #21... more each month



The special fastening illustrated here may not look tough to everyone...but design engineers will recognize immediately this job called for fastening experts—both in tool design and cold-forging technique.

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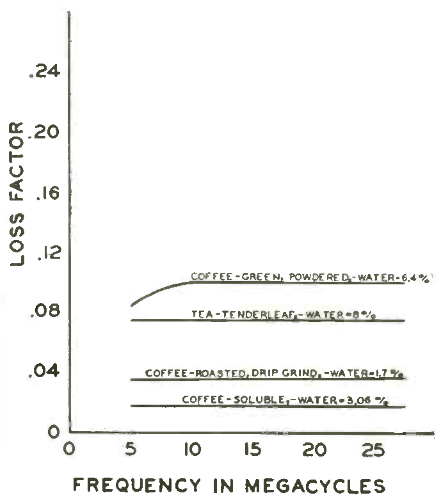
A continuous belt has been added to this Megatherm electronic heating unit, made by Federal Tel. & Radio Corp., for conveying packages of food products between metal plates for dielectric heating to provide sterilization

pressed as a decimal; f = frequency in megacycles; V = volts per inch of preform.

It will be observed on examination of the formula that the heat per pound per unit time can be increased most rapidly by increasing voltage. By doubling the applied voltage, the rate of heating is increased 4 times. It is also possible to increase the heating rate by increasing frequency while at the same time allowing the voltage to remain fixed. As a practical matter, however, if the frequency is in the order of 10–20 Mc, all of the common food materials can be readily handled at voltages safely within their dielectric strength.

For many practical reasons, it is not desirable to use an excessively



Loss factor curves for tea and three forms of coffee, ground, drip and pulverized, show that the loss factor is substantially independent of frequency

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PRODUCTION FOR VICTORY • PRODUCTS FOR PEACE high frequency. It is good engineering, however, to take full advantage of the highest conservative working voltage.

Certain operating data, such as electrical loss factors, and also the appearance of the heating fixtures and the appearance of the electronic unit itself can be more clearly understood by studying the accompanying illustrations.

• • •

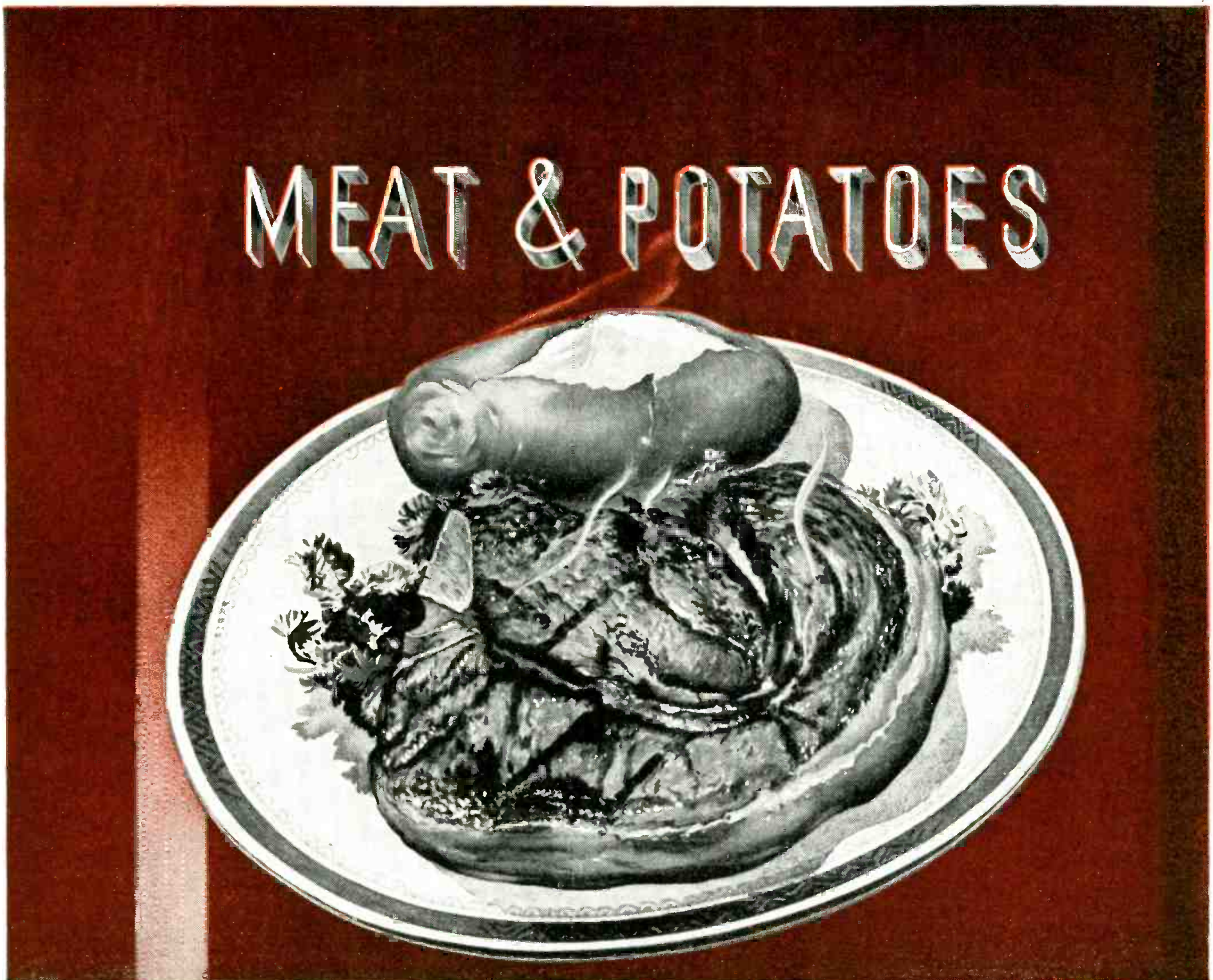
Electronic Voltmeter with 5-ma Meter

By Edward M. Yard

Most vacuum-tube voltmeter designs incorporate a sensitive indicating meter, usually a microammeter requiring only 100 to 200 microamperes for full-scale deflection. With a single d-c amplifier stage, the minimum full-scale direct voltage range is often 3 to 6 volts. It is frequently convenient to have slightly lower full-scale ranges for use in ordinary testing in laboratory or shop, and often desirable to obtain these ranges without the necessity of using microammeters or complicated circuits involving more than one stage of d-c amplification.

With regard to the meter, it is not intended to question the practical qualifications of a microammeter for voltmeter service, but to point out that nowadays a milliammeter is frequently available where a microammeter is not. The milliammeter has the additional advantage of lower cost and somewhat greater mechanical and electrical stamina. Any of these factors may be sufficient to influence the desire to design a practical electronic voltmeter having a d-c full-scale range in the neighborhood of 1 volt using a 2 to 5-milliampere meter.

Electronic voltmeters utilize a vacuum-tube as a d-c amplifier, thus securing the advantage of a high meter input resistance without the necessity of using a galvanometer of high internal resistance. This is possible by virtue of the high grid input resistance of most high-vacuum tubes when operated with the grid negative with respect to the cathode. These circuits are usually operated with large amounts of degenerative feedback and low anode potentials



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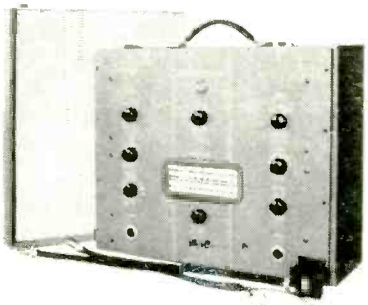
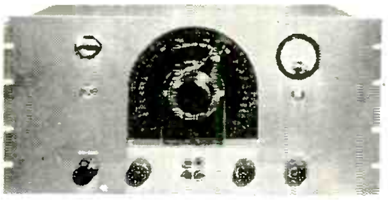
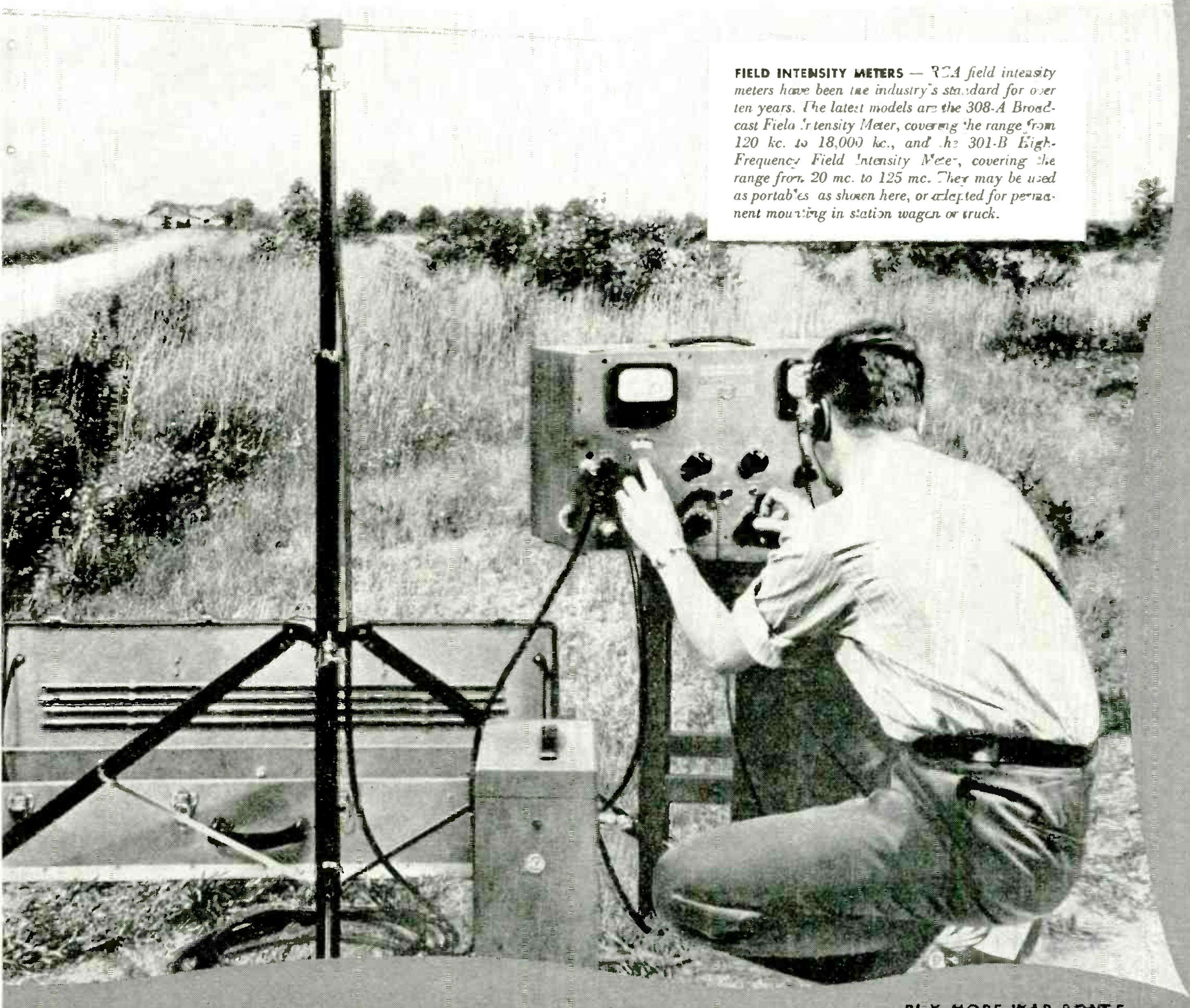


TELEVISION MONITORS
For Television Broadcasting
RCA developed and produced the only line of test and monitoring equipment specifically designed for Television use. This line includes the 351-A Video Sweep Oscillator shown above, the 350-A Square-Wave Generator, the 715-A Laboratory-type Oscilloscope and other units of matching design.

AUDIO MEASURING EQUIPMENT
The 58-B Beat Frequency Oscillator (at right) and the 69-C Distortion and Noise Meter (below) are matched units developed for the single purpose of measuring the frequency response, distortion and noise characteristics of broadcast equipment. The only audio measuring units designed especially for the purpose,



they are ideally suited for measurements on separate amplifiers, complete audio channels and transmitters of all types, including AM, FM and Television Audio. These or the preceding models of the same series are in use in nearly every medium or large station, in network studios and in the laboratories and test set-ups of most manufacturers.



FIELD INTENSITY METERS — *RCA field intensity meters have been the industry's standard for over ten years. The latest models are the 308-A Broadcast Field Intensity Meter, covering the range from 120 kc. to 18,000 kc., and the 301-B High-Frequency Field Intensity Meter, covering the range from 20 mc. to 125 mc. They may be used as portables as shown here, or adapted for permanent mounting in station wagon or truck.*

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in order to obtain high circuit stability and maintain the highest possible grid input resistance. In such circuits, the criterion in determining tube choice is the minimum order of grid current obtainable in the circuit. Special tubes have been built for such service, where maximum input resistance is the primary concern.

However, such extremely high input resistance values are not always necessary. Where input resistance of the order of one megohm per volt is satisfactory, which is true of a large percentage of the work for such a voltmeter, it is possible to design a d-c amplifier with considerably higher current handling ability (power output) by

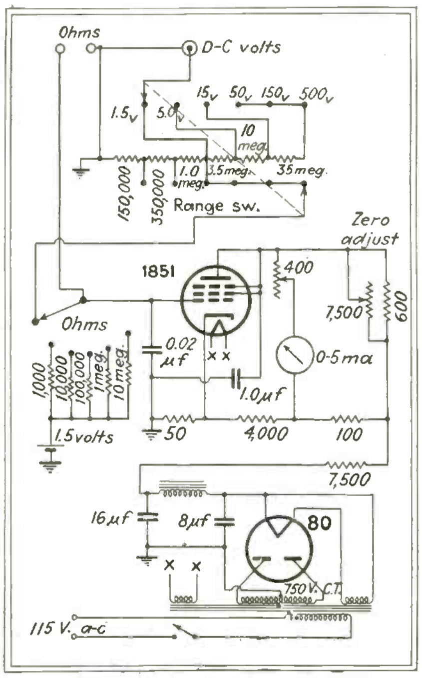
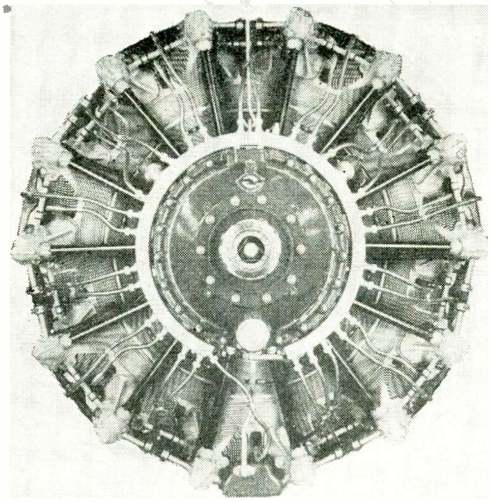


Fig. 1—Complete circuit of the electronic voltmeter using a 0-5 ma milliammeter. Voltages ranges from 1.5 to 500 volts are covered with an input resistance of one megohm per volt

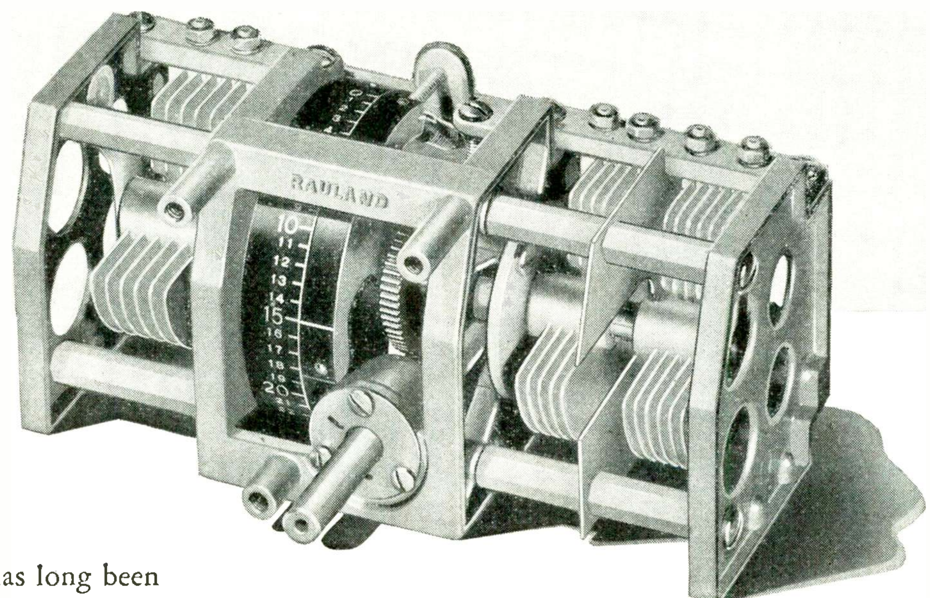
taking advantage of tubes having higher transconductance, and by reducing degenerative feedback. This can be accomplished with adequate stability for the purposes intended in circuits of rather conventional configuration. Such circuits will yield meter deflections of 5 ma for one volt input or even less.

Tube Types

Tubes such as the 6AG7, 1852, 1851, and 7OL7 are available and have a transconductance between 5,000 and 10,000 microhms. A suitable type must have high trans-



Trademarks of Craftsmanship



Superior craftsmanship has long been identified with leadership. Such artistry may be found in the finely engineered airplane engines of today. The RAULAND Tuning Capacitor, shown above, is likewise a fine example of RAULAND engineering craftsmanship. Its battle-toughness is blended with a precision-accuracy which insures minutely controlled variations and a fine degree of tuning. These are the qualities you can be sure of when you specify an *Electroneered** product.

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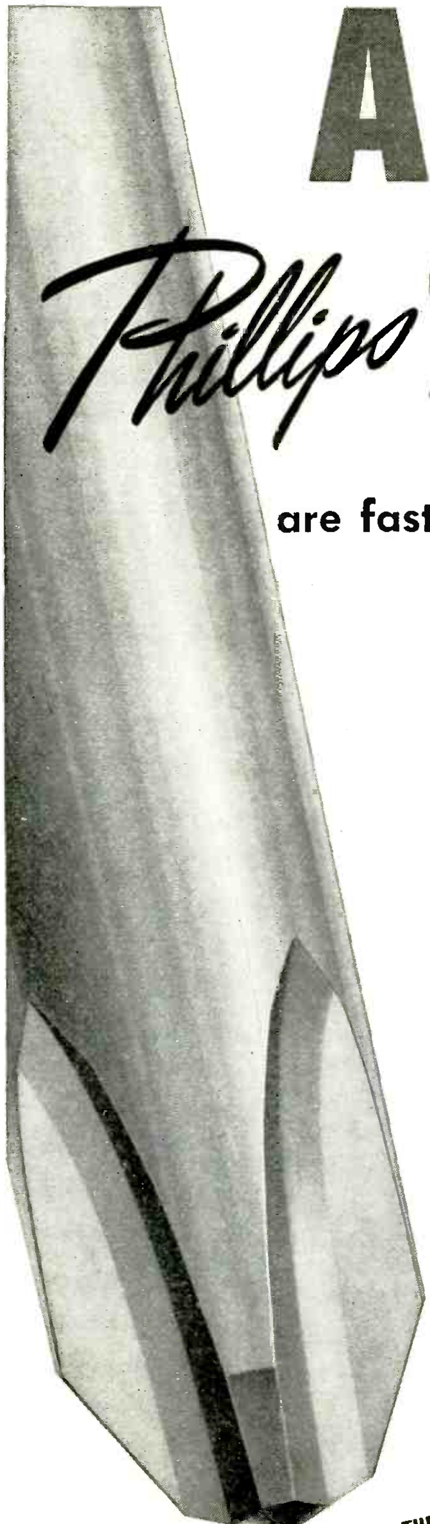
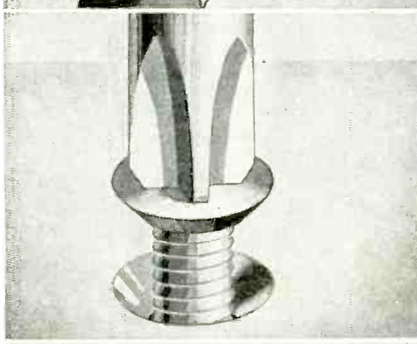


are faster . . . and cost less to use . . . because they're

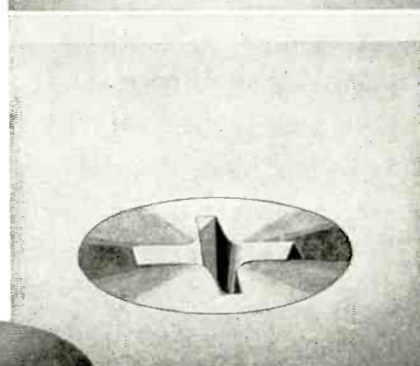
Fumble-Proof

The American Phillips *Recessed Head* fits firmly onto the 4-winged driver . . . which can't slip out or twist out in any direction. So the faster methods of driving (spiral and power) are safe to use. No fumbling, no dropping of screws. *Time is saved.*



Self-Aligning

The American Phillips Screw and Driver form a single unit that is automatically self-aligning. No fussing around to get a straight start, no fatiguing nerve strain which leads to poor work that must be done over. Here again . . . *time is saved.*



Straight-Driving

The American Phillips Screw and Driver *stay in alignment* under the stress of the driving operation. So the screw can't be driven any way but straight. No burred heads, no scarred work. Screw head is set up tight and flush *every time. Total time savings:* UP TO 50% . . . not to mention savings of screws and materials.

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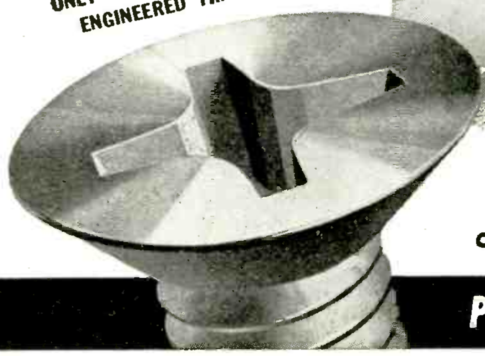

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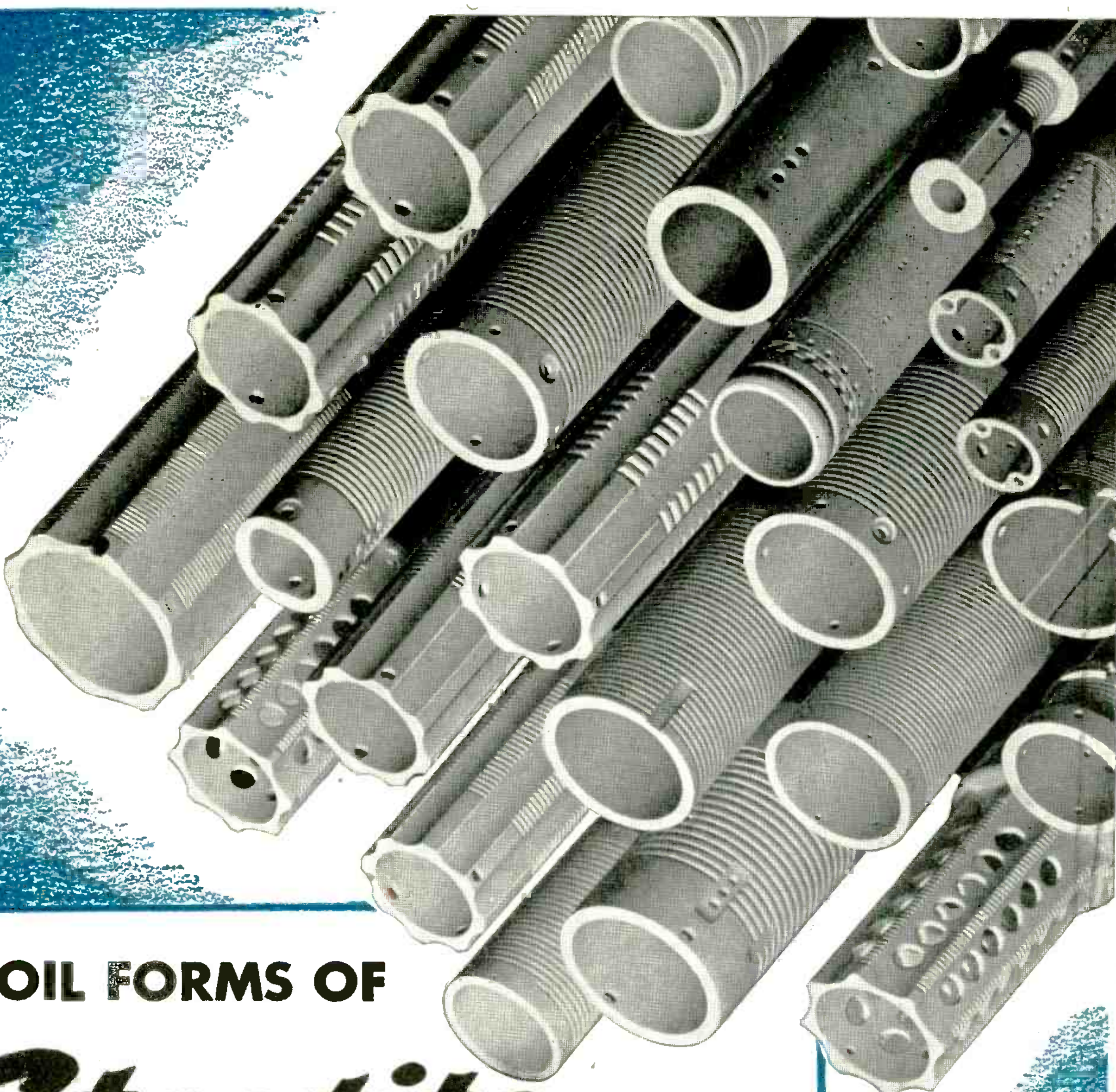

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conductance, adequate plate current handling capacity, and a relatively straight line plate-current-to-grid-voltage curve over the operating range (sharp cut-off rather than variable-mu). The above named tubes among many others would satisfy these conditions.

Some initial experimental work was done with a 6J5. The results were satisfactory, but this tube was discarded for those of higher transconductance in order to obtain lower full scale voltage ranges. In the instrument described, an 1851 was used because there was one on hand. and because it has a transconductance of 9000. The above values of transconductance are for

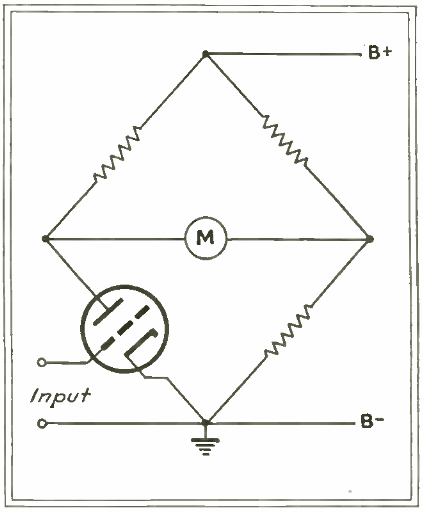

Fig. 2—Stripped to essentials, the electronic voltmeter consists of a bridge circuit in which the current flow in the milliammeter is proportional to the unbalance of the bridge

characteristic operating conditions as an amplifier and are used here only for general comparison purposes.

The reduction in feedback can be accomplished while maintaining the bias requirements by tapping the cathode of the d-c amplifier to a point on the power-supply voltage divider which carries a relatively heavy bleeder current. This method proved much simpler than others which were tried, and yielded satisfactory stability for all purposes intended.

Bridge Circuit

The circuit, shown in Fig. 1, contains a high transconductance tube with much less degenerative feedback than is usually the case. The circuit is of the bridge type to

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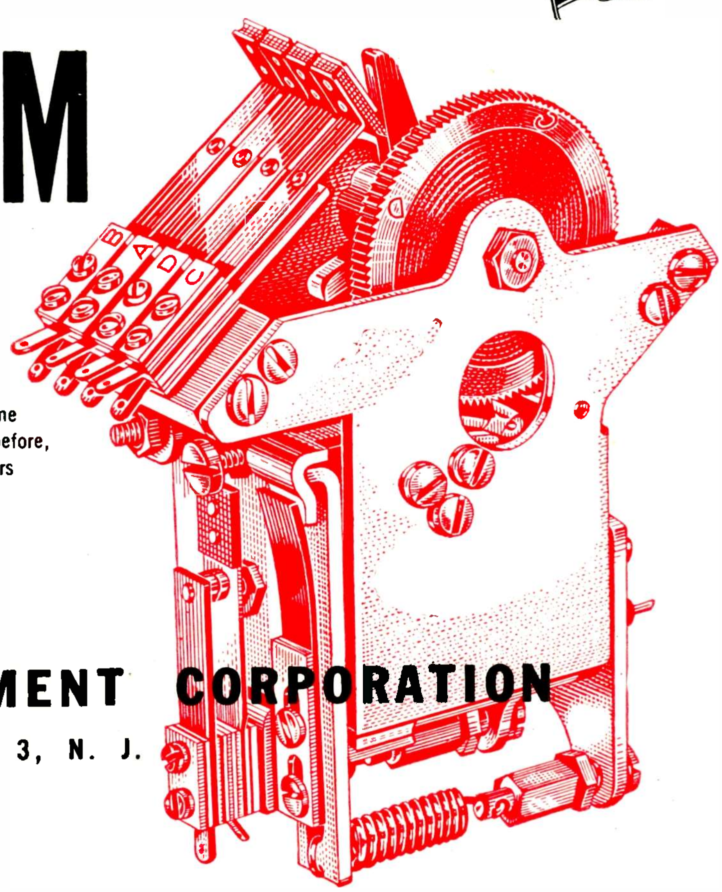

If your problem is marked Post War we may have the solution to that also, for our plans have long been formulated for the swing back into peacetime production with a minimum of interruption. As before, our Post War forte will be variable condensers and record changers — in addition to which there will be new items of considerable interest.

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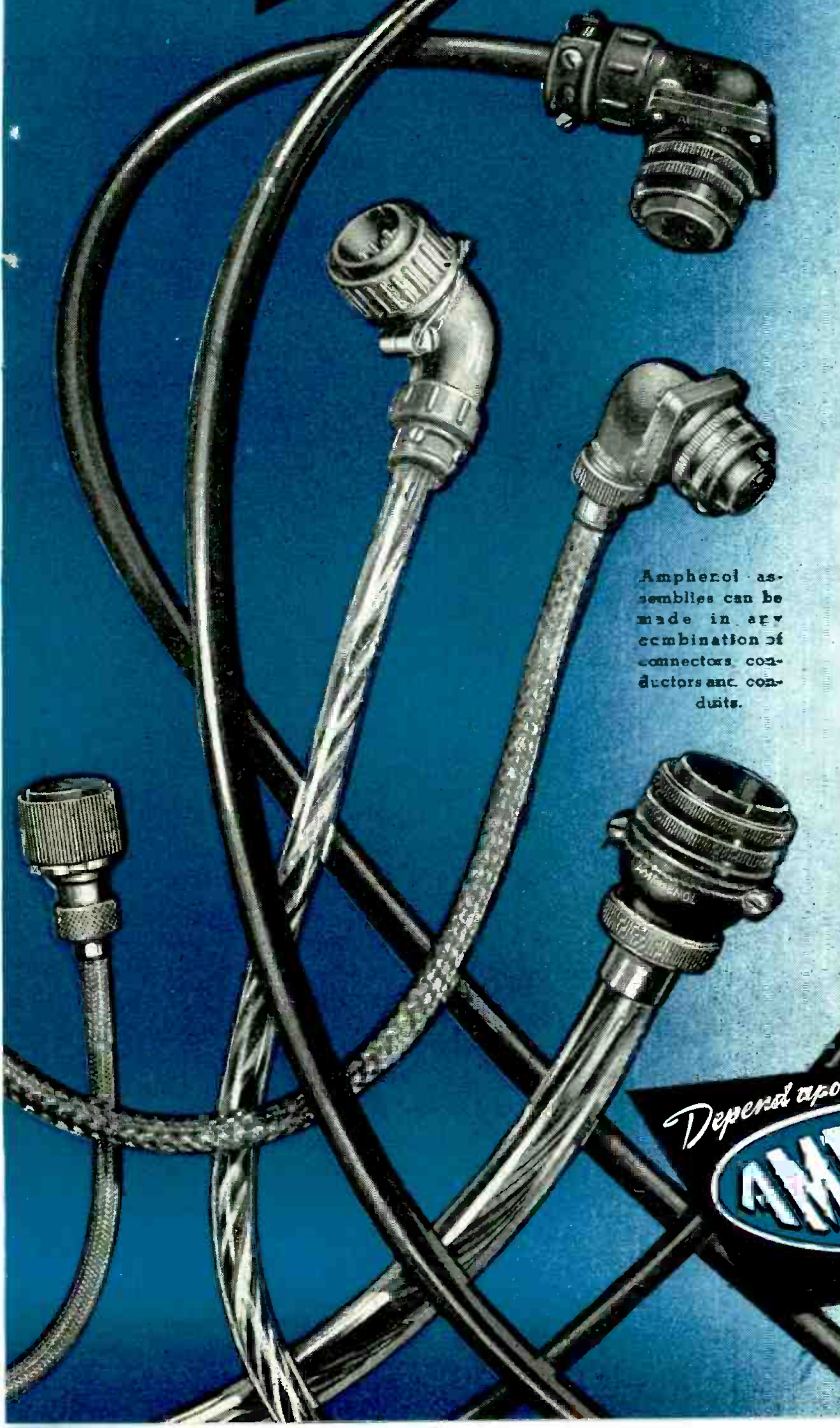

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balance out the initial plate current and obtain an initial meter reading of zero. In operation, the tube serves as one arm of the bridge, the initial balance of which is upset by the change in the tube plate resistance caused by a change in grid bias as the result of applying a direct voltage to be measured to the grid circuit.

Figure 2 illustrates the fundamental bridge arrangement on which the design of this circuit is based. The current flowing in the milliammeter connected across the bridge as a detector is proportional to the unbalance and to the signal causing it. A resistor is used in series with the meter to bring its deflection for 1.5 volts input to the grid to exactly 5 ma. The sensitivity without this resistor is nearer 1 volt for full-scale deflection. A scale can be drawn calibrated directly in volts.

Ohmmeter

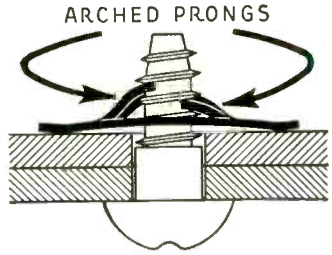
By making the primary range 1.5 volts, it became possible to include an ohmmeter in the instrument rather simply, using a single flashlight cell for voltage supply. This ohmmeter operates upon the principle of measuring the voltage drop across the unknown resistance in series with a known resistance across a known voltage. The scale is calibrated directly in ohms. This feature has proved very convenient for measuring resistance in the megohm range.

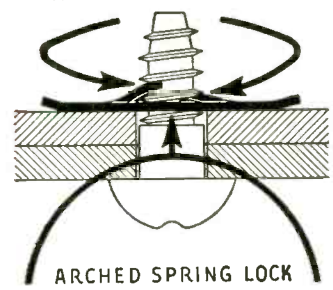
Because of the relatively heavy current drain on the power supply for such service (30 milliamperes), it was decided to use somewhat more filtering than is usually the case in electronic voltmeters. This heavy current makes the instrument slow in heating. It takes from ten to twenty minutes before the slow zero drift is overcome. This has not proved annoying in actual use, since after the first five minutes the drift is very slow.

No voltage regulating circuits have been used to stabilize the effects of line voltage fluctuations, and in over a year of use none has been found necessary. However, tests show that the zero setting shifts an appreciable extent with line voltage changes. The effects on calibration are negligible (2 percent or less for ±10 volts in the line) if the zero is corrected. In a

Look at the SPEED NUTS* [PATENTED]

SPRING-TENSION LOCKING ACTION!





An arched spring lock and an inward thread lock are basic features found only in Speed Nuts. The ingenious design that sets up these two forces accomplishes more than you'd realize unless you checked into it more closely.

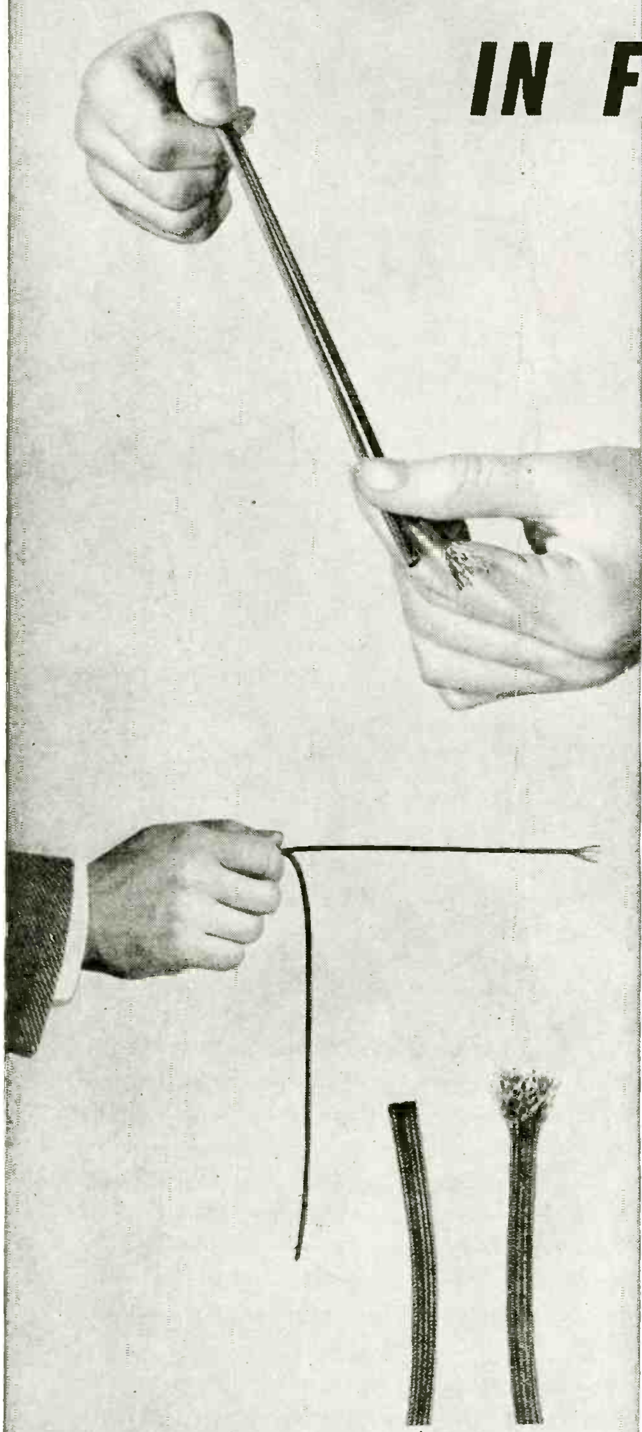
Spring steel Speed Nuts have a base which is well arched, and arched prongs that are formed to follow the helical pitch of standard screw threads. As the screw is tightened, the arch is reduced, forcing the prongs deeper into the root of the screw threads. This provides a double spring-tension lock that prevents vibration loosening.

Speed Nuts eliminate the use of lock washers and are 50% to 75% lighter in weight than other self-locking nuts. They are faster to apply and drastically reduce assembly costs. Double your use of Speed Nuts and you will double your assembly savings. Write for literature.

TINNERMAN PRODUCTS, INC.
2106 FULTON ROAD • CLEVELAND 13, OHIO
In Canada . . . Wallace Barnes Co., Ltd., Hamilton, Ontario
In England . . . Simmonds Aerocessories, Ltd., London

The lightest weight self-locking nuts ever produced!

YOU CAN PROVE TO YOURSELF IN FIVE SECONDS...



THIS—NOT THIS

That new BH Fiberglas "extra Flex" Sleeving is more flexible than saturated sleeving

WE'VE TOLD YOU about the non-fraying quality of the new BH Sleeving. But don't forget the extra flexibility we've built into it. You can prove this to yourself with the five-second test of sleeving flexibility:

Obtain from us a sample of BH Extra Flexible Fiberglas Sleeving equal in size to the saturated sleeving you use now.

Following Figure 1, hold eight-inch lengths of both BH Extra Flexible Fiberglas Sleeving and saturated sleeving between the thumbs and fingers of both hands. Stretch both sleevings to make them straight.

Now release the sleeving ends held in your left hand. Instantly, the new BH Fiberglas Sleeving will fall limp, proving its extra flexibility. The saturated sleeving will remain straight, practically inflexible. The comparison is shown in Figure 2.

NON-FRAYING • FLEXIBLE • HEAT-RESISTANT NON-INFLAMMABLE • WATER-RESISTANT NON-CRYSTALLIZING at LOW TEMPERATURES

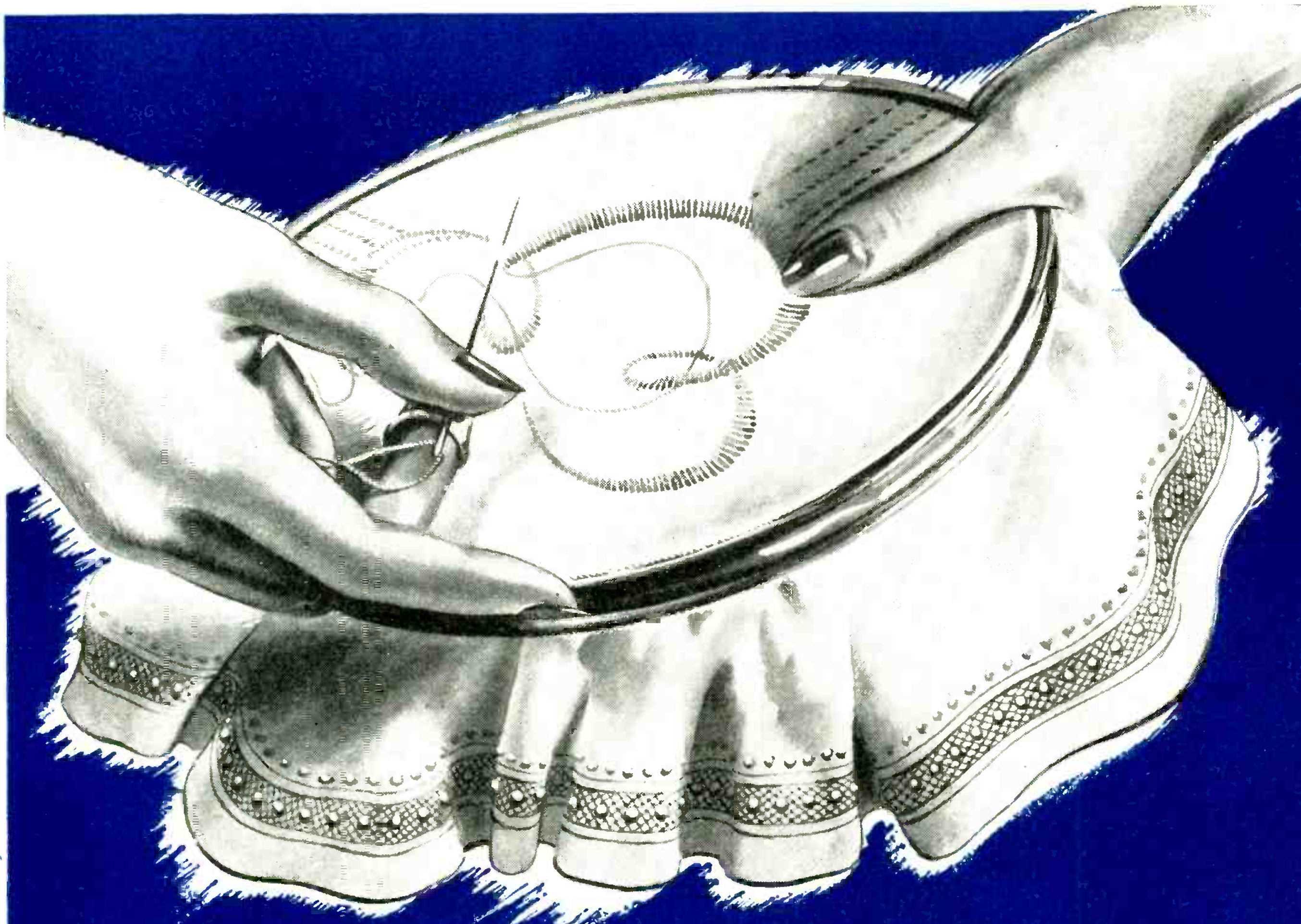
The new BH Extra Flexible Fiberglas Sleeving is woven from the choicest continuous-filament Fiberglas yarns. It possesses high dielectric strength, is water-resistant and, like all BH Sleeving and Tubing—is non-inflammable.

All sizes from No. 20 to 5/8", inclusive, are available. Write for samples of this radically new and different sleeving today—in the sizes you desire. Seeing is believing! Bentley, Harris Manufacturing Co., Dept. E, Conshohocken, Pa.

BH PRODUCTS

NON-BURNING IMPREGNATED MAGNETO TUBING • NON-BURNING FLEXIBLE VARNISHED TUBING • SATURATED AND NON-SATURATED SLEEVING

BENTLEY, HARRIS MANUFACTURING CO.
Conshohocken, Penna.



...of a more successful design for your product, with new adaptations, new uses, and new possibilities. For the types of ends possible on torsion springs are practically unlimited in size and shape. But engineering the best spring end for your application requires experience in design—making it calls for great skill in tooling, and extensive production machinery. That's exactly why you should turn to Muehlhausen engineers for solution to your difficult spring problems.

MUEHLHAUSEN SPRING CORPORATION
Division of Standard Steel Spring Company
760 Michigan Avenue, Logansport, Indiana

MUEHLHAUSEN
SPRINGS
EVERY TYPE AND SIZE

grinding and polishing. In many cases, the final result was not always as exact as it might have been.

The machine contains a probe, mounted in conjunction with a Westinghouse Silverstat regulator, which is used to follow the contour of an accurate model. The model may be made either actual size or to scale. As the probe is moved across the model, it affects the position of the Silverstat as shown in the diagram. Through an electronic amplifier, the cutting tool is moved correspondingly with respect to the work by electric motors.

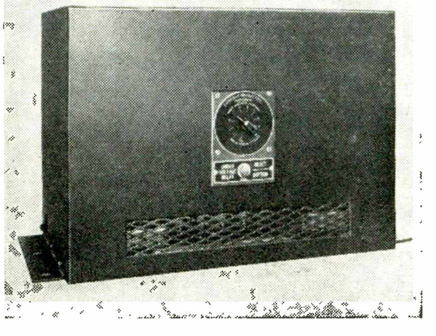
With a well designed machine tool and an actual size model, the contour of the model can be duplicated within two or three thousandths of an inch when a feed speed of twenty to thirty inches per minute is used.

• • •

Electronic Control for Low-Capacity Spot Welders

SPOT-WELDING of vacuum tube parts, with either welding tongs or a small bench welder, can be accomplished with a new thyratron welding control that provides precise control of low-capacity spot welders. Other applications for which the control, in combination with the proper welding transformer, may be used include the welding of solid or stranded wires to terminals of copper, brass, bronze, steel, or ferrous alloys; joining two tinned-copper, steel or alloy wires; and spot-welding thin pieces of various alloys.

Announced by the Industrial Control Division of General Electric Co., the unit operates on either 230 or 460-volt, 60-cycle power and is



Only three tubes are contained in this thyratron welding control panel designed for low-capacity spot-welders

HOW TO MAKE PERMANENT ELECTRICAL CONNECTIONS

permanent

★ **INSERT**

STRIPPED CONDUCTOR INTO
HYDENT CONNECTOR BARREL

★ **INDENT**

CONNECTOR TO WIRE
WITH BURNDY HYTOOL

★ **INSTALLED**

permanently

RESISTS LOOSENING INDEFINITELY

When you indent a HYDENT connector to a wire, you eliminate all doubt about the strength and permanency of the connection and its ability to resist loosening even under severe vibration. You *know* it's a permanently sound connection, because simple indenting compresses conductor barrel and wire into virtually one strong homogeneous whole. Further, the HYDENT connector is of pure copper one-piece construction, a feature which eliminates all extra contact surfaces, thereby assuring maximum electrical conductivity.

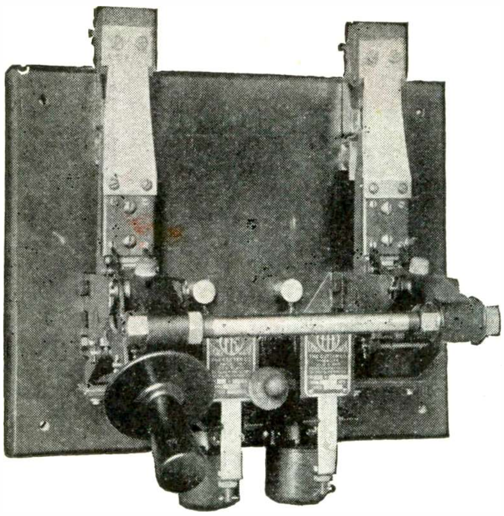
You'll find indenting a real time-saver, too; both for production and maintenance needs. Ask us to send you full details today.

Headquarters for CONNECTORS

Burndy

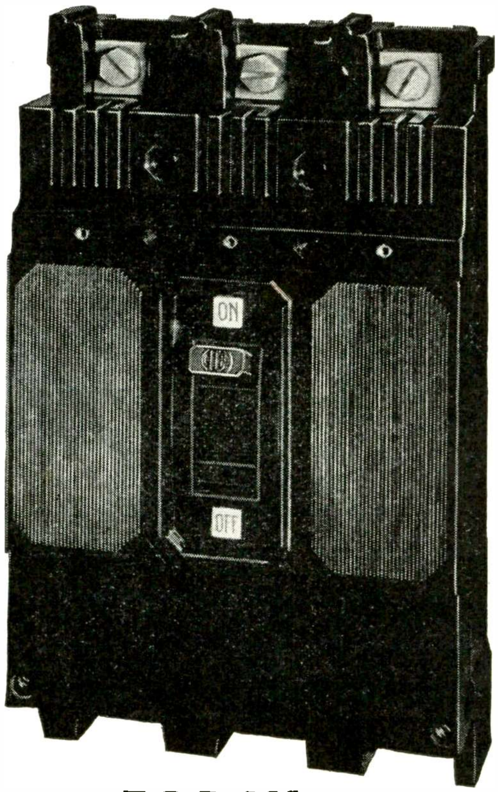
BURNDY ENGINEERING CO., INC.
107 BRUCKNER BOULEVARD, NEW YORK 54, N. Y.
IN CANADA: Canadian Line Materials, Ltd., Toronto 13

WOULD YOU GO BACK?



YESTERDAY

(Photos courtesy
I-T-E Circuit Breaker Co.)



TODAY

Tomorrow!

The design engineer of 1911 worked wonders with the limited materials at his disposal . . . yet few of us would want to go back to 1911 models. C-D DILECTO, a laminated phenolic plastic, was first made in 1911, when it was introduced as a "waterproof" type of vulcanized fibre. Today C-D DILECTO is available in many different grades . . . each engineered to meet specific electrical insulating problems.

C-D Laboratory Research is continuous and tomorrow will be producing new electrical insulating materials to meet the ever more exacting demands of electrical engineers. If experimental work will assist you in your post-war plans . . . write us today.

DILECTO

laminated phenolic electrical insulation

NEMA standards exist for the regular grades of laminated phenolics. These standards provide sufficient design data for the normal electrical insulating requirement. Where special problems are encountered, such as excessive moisture, high or low temperatures, U-H-F, arc tracking; the C-D Laboratory Staff of trained technicians will study your problem and if necessary develop a special grade of DILECTO to meet it.

Through special manufacturing methods, and Laboratory control, the properties of regular grades of DILECTO can be changed to meet special problems. For example, the C-D specifications for special DILECTO XPLW require the following properties as compared to NEMA standards for XXXP—both "low loss" grades of DILECTO.

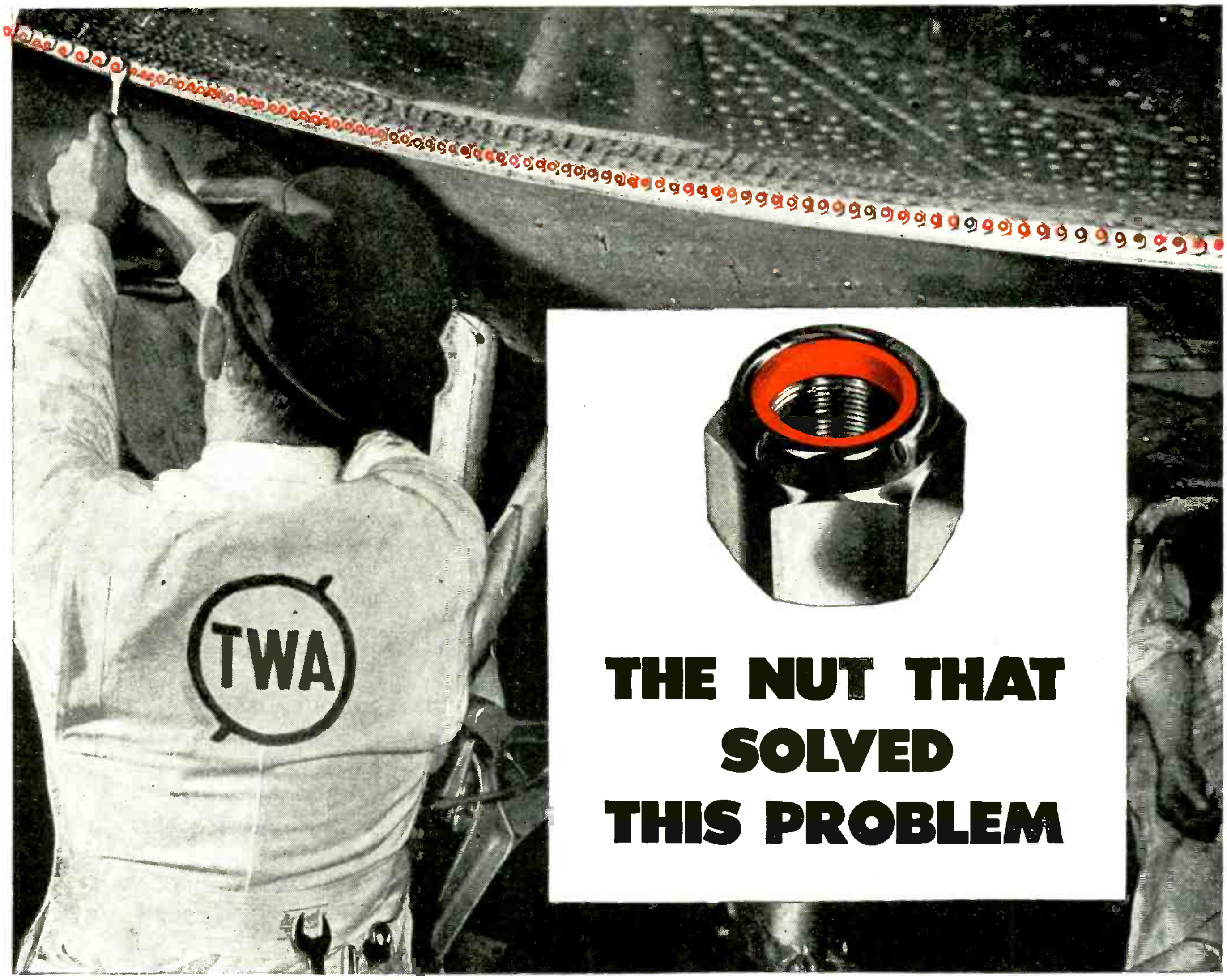
1/8" THICKNESS	C-D Control Standards	NEMA Standards
Tensile Strength lbs. per sq. in. . .	10,000	5,000
Flexural Strength lbs. per sq. in. . .	20,000	12,000
Compressive Strength lbs. per sq. in. . .	30,000	25,000
Water Absorption, 24 hrs., percent .	.75	.85
Dielectric Str., Short Time, volts per mil	600	360
Power Factor— 1000 Kc	.026	.030
Dielectric Constant .	4.00	5.20

DILECTO catalog DO 43 gives complete data on regular and special grades, provides design suggestions, and information on standard sizes of sheets, rods and tubes. Send for your copy today.

W-44

Continental-Diamond FIBRE COMPANY

Established 1895.. Manufacturers of Laminated Plastics since 1911—NEWARK 16 • DELAWARE



How to Make Each of 328 Fastenings Carry an Equal Share of the Load

Each wing of a DC-3 transport plane is fastened on with 328 nuts and bolts.

Unless the stress and strain are distributed equally, some of the bolts shear off.

The answer was found in Elastic Stop Nuts. These nuts can be given precisely the right tension —then lock fast.

This is one of the important structural fastening jobs which Elastic Stop Nuts have solved.

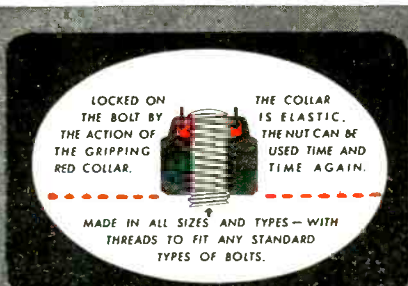
We've been told Elastic Stop Nuts, by solving many such structural fastening problems, have revolutionized aircraft construction.

These nuts lock fast—are safe. They stay tight and secure even in the face of unusual vibration. That's why they are approved for fastening such vital parts of an airplane's structure.

It's the elastic collar that does the trick. It molds itself to the bolt threads and grips them tight. The nut can't jiggle loose.

After the war ESNA nuts with the red collar will be ready to do the hard jobs of peacetime production.

Any fastening problem you anticipate will be welcomed by our engineers. They are ready to help you solve it and recommend the proper Elastic Stop Nut.



ESNA

TRADE MARK OF ELASTIC STOP NUT CORPORATION OF AMERICA

ELASTIC STOP NUTS

Lock fast to make things last

UNION, NEW JERSEY AND LINCOLN, NEBRASKA

an adjustable, synchronous-precision, electronic type in which only three thyratron tubes perform all the functions. Two tubes control the primary current of the welding transformer and another tube controls the firing time. Since the tubes have the same current rating on either voltage, the transformer used on a 460-volt supply can be twice as large as that used on a 230-volt source. This approximately doubles the secondary current.

On a duty cycle not exceeding ten percent, the control is rated at 53 amperes rms (primary current of the welding transformer). As shown in the photograph, a calibrated time adjustment on the front of the panel provides either one-half cycle or any number of complete cycles from one to ten.

• • •

Switch Tube

ONE OF THE TUBE TYPES registered by the RMA Data Bureau during April is, in reality, a single-pole, double throw, vacuum-sealed switch for mechanical actuation. It has been given the tube type designation 1S21 and contains a flexible diaphragm in the base.

Maximum ratings for the unit are given as hold-off rms voltages of 7.5 kv internal and 15 kv external at sea level, and 7.5 internal and 4.5 kv external at 40,000 feet. Life of the device at 15 amp rms is 10^8 operations; at 3 amp, 10^6 operations; and at 0.1 amp, 0.5×10^9 operations. Registration number 375 has been assigned by RMA.

—◇—

TWO SUNSETS in one day can be achieved with television, Ralph R. Beal of RCA Laboratories told members of the San Francisco Engineering Council.

"Here in San Francisco," Mr. Beal said, "you will watch Old Sol dip beyond the New Jersey Palisades as a television camera atop Radio City, New York, scans the horizon at sunset. Then three hours later, New Yorkers in the darkness of the evening will catch up with the sun as a television 'eye' in San Francisco sends a panorama of the Golden Gate back across the Continent as the sun ends the day over the Pacific."

Talk is Important, *here*

Transmitting orders, reporting results, exchanging information . . . even words of encouragement and commendation . . . that's the service that Communication is performing in every phase of our military operations, and under the most adverse and difficult conditions.

At the front, Communication . . . or just plain *talk* . . . is helping win battles, but at home talk *could* be fighting on the side of the enemy. That's why we must heed the warning, "Let the man with the 'mike' do your talking". He knows just what to say.

THE ROLA COMPANY, INC., • 2530 SUPERIOR AVENUE • CLEVELAND 14, OHIO
Makers of Transformers, Coils, Head Sets and other Electronic Parts for Military Communications Systems

ROLA

April 8th a Star was added to Rola's Army-Navy "E" flag.

MAKERS OF THE FINEST IN SOUND REPRODUCING AND ELECTRONIC EQUIPMENT

Surface Hardening

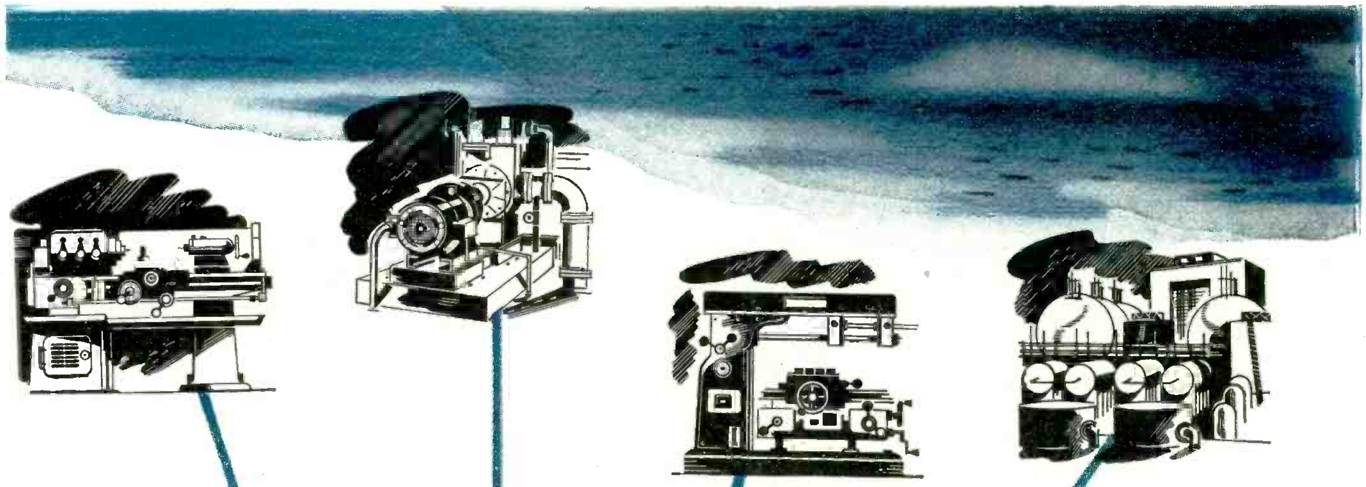
(*Continued from page* 105)

but at the same time there is an economy of energy. At the higher speeds less power is lost by heat conduction in from the surface, as indicated by the relative power figures associated with each curve.

The data presented so far apply to SAE. 1095 Steel. Power requirements are higher and range of permissible operating conditions wider for steels of higher hardenability, such as alloys containing large amounts of nickel, manganese, chromium and the like. If we suppose the effect of these elements to be commutative, it is possible to estimate the required operating conditions for full or partial hardening from the analysis. As more work is done on a variety of steels, data will become available that will put production hardening on a quantitative basis similar to that which now exists only in laboratory tests like the Jominy hardenability test.

Design of Suitable Inductors

The inductors used for this kind of work must be accurately contoured to suit the work piece, of small cross-section to concentrate the power as much as possible, and provided with a channel for 1 to 5 gallons per minute of cooling water. The configuration of an inductor placed within 0.050 in. of the work and carrying current of such a frequency that the penetration depth is less than a similar figure, is more properly thought of in terms of its length rather than of the area enclosed by it, which is usually taken to calculate inductance. The inductance and resistance per unit length looking into such a coil is of the order of $0.01 + j\ 0\text{-}1$ ohms at 0.5 Mc at room temperature. The problem of coupling between impedances of the level of the usual tank circuit reactance (50–100 ohms) and impedances of less than one ohm is most satisfactorily solved by making the coupling as tight as possible. This makes it possible to transfer power to the inductor circuit without tuning the secondary and without an



TIMING...

as Important in Peace as in War!

Time is the one unvariable factor in the chaos of this changing world... and, like prize fighters, our military strategists realize the value of perfect timing in delivering knockout blows.

Men entrusted with the responsibility of planning *now* for future peacetime production can learn much about timing... automatic, split-second control of machines and processes... through the modern miracles of ELECTRONICS.

This forward-thinking organization... one of the largest and most progressive in the field of Electronics... is even now working on revolutionary ideas that may readily influence your plans for conversion.

Though our three plants are engaged 100% in essential war work, our Engineering Department will be glad to work with you in making post-war plans now.

DIVISION OF...

MAGUIRE INDUSTRIES, INC., GREENWICH • STAMFORD • BRIDGEPORT • NEW MILFORD • NEW YORK

3500 WAX

Insulating and Impregnating COMPOUND FORMULAS

55 Years in the Making

MITCHELL-RAND
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**55 YEARS
THE ELECTRICAL
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For more than half a century the Mitchell-Rand research department, in its efforts to serve industry, developed Waxes, Insulating and Impregnating Compounds to meet every known requirement of the Electrical and Electronic industries.

The vast assortment of more than 3500 Wax and Compound formulas, developed over this long period of time, covers every possible requirement of today . . . . . and is available at Mitchell-Rand "Electrical Insulation Headquarters".

FREE FOR THE ASKING

Write today for your Free Card of Varnished Tubing with samples ranging from size 0 to 20 to fit wires from .032 to .325 inches . . . other valuable aids, are the M-R Guide Book of Electrical Insulation . . . the Wall Chart with reference tables, electrical symbols, allowable capacities of conductors, dielectric averages, thicknesses of insulating materials and tap drill sizes . . . and the M-R Wax and Compound Guide Book . . . they are full of valuable information . . . write for them on your letterhead.

Write today on your letterhead

MITCHELL-RAND INSULATION COMPANY, INC.
51 MURRAY STREET **COrtlandt 7-9264** **NEW YORK 7, N. Y.**

A PARTIAL LIST OF M-R PRODUCTS

- Fiberglas Varnished Tape and Cloth
- Insulating Papers and Twines
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- Transformer Compounds
- Fiberglas Braided Sleeving
- Cotton Tapes, Webbings and Sleevings
- Impregnated Varnish Tubing
- Insulating Varnishes of all types
- Fiberglas Saturated Sleeving and Varnished Tubing
- Asbestos Sleeving and Tape
- Extruded Plastic Tubing
- Varnished Cambric Cloth and Tape
- Mica Plate, Tape, Paper, Cloth and Tubing

excessive amount of kva in the tank circuit proper.

The amount of inductive reactance in the inductor circuit is a determining factor in the ultimate choice of operating frequency. Take, for example, the case where it is desired to deliver 100 kw to a 3-in. diameter cylinder at 0.5 Mc. The length of the inductor is approximately 10 in., exclusive of leads. Its total impedance is then 0.1 + 1.0 ohms. To deliver 100 kw to the load, approximately 105 kw must be delivered to the inductor coil, so that

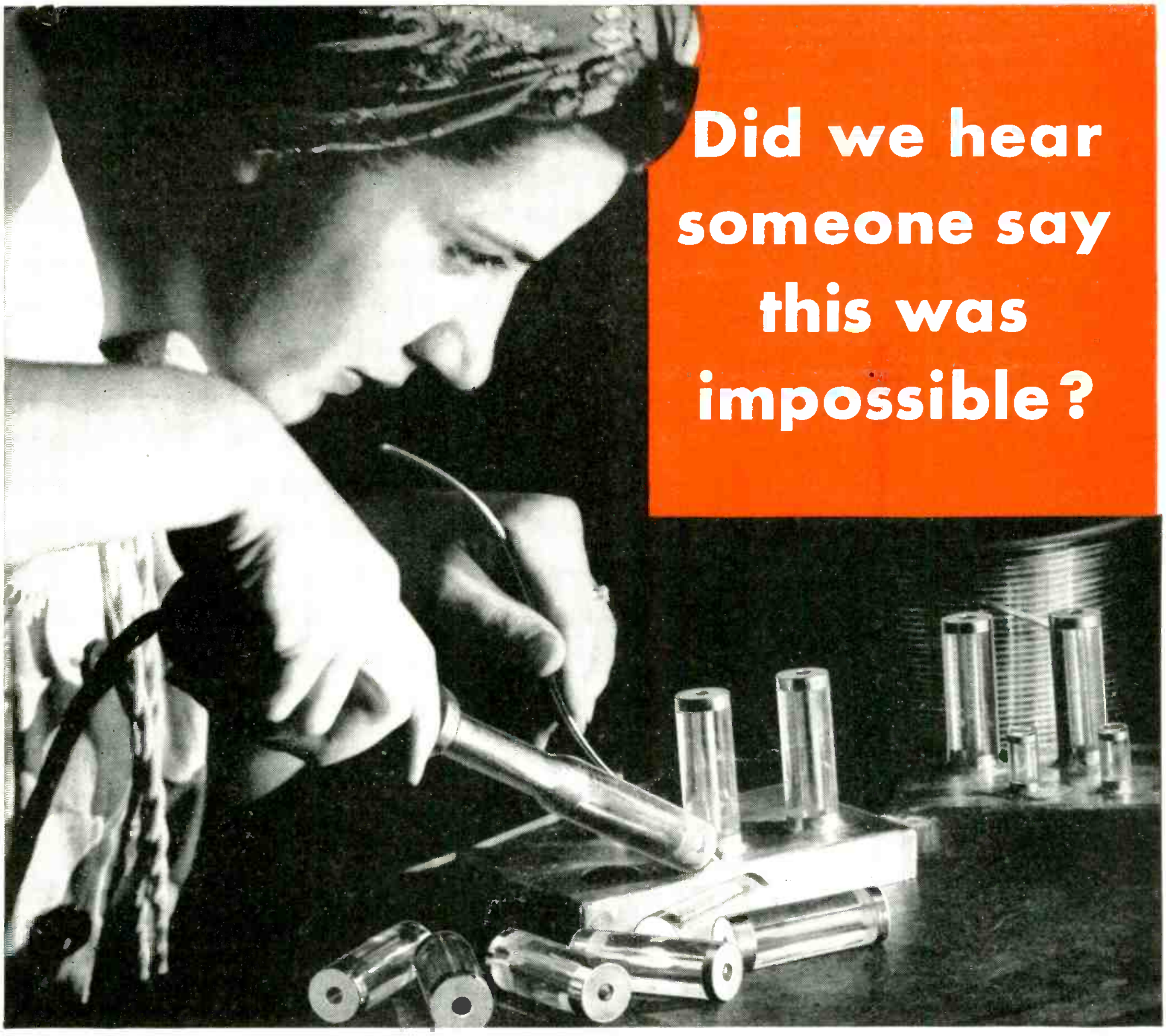
$$1.05 \times 10^5 = I^2 \times 0.1$$
$$I = 1.03 \times 10^3 \text{ amp}$$
$$IX = E = 1030 \text{ volts}$$

across the ends of the coil. At higher frequencies the voltage for similar powers would be proportionally higher. If we are working with $\frac{1}{32}$-in. spacing between the coil and the work piece, the total air gap at the ends of the coil is only $\frac{1}{16}$-in. and dangerously high voltage gradients exist.

Evaluating the Results

The methods of evaluating the results may be of interest here. Hardness measurements across the hardened zone were made with the Knoop indenter[4] with a loading of 500 grams. The indent so produced is small enough across the short diagonal to permit readings every few thousandths of an inch, which gives an accurate picture of the variation in hardness across the hardened layer.

Figure 5 shows how these indents appear at 100 diameters magnification. The length of the long diagonal indicates, inversely, the hardness at the point of indentation. The hardness readings obtained from these indents have been plotted against their locations in Fig. 6. It will be noted that no dip in hardness exists between the fully hardened part and the core of the piece. This can only be true if the prior heat treatment has left it in a fully annealed condition. It is the practice, however, in some instances, partly to harden the piece and then put a hardened shell on it. It then becomes impossible to avoid a slight drawing action at the edge of the hardened zone. However, the thickness of the region so affected is small, of the order of 0.001 in. to .002 in., and



Did we hear someone say this was impossible?

DOING what couldn't be done in glass has become a habit at Corning—and this is a good example. "You can't solder metal to glass"— they said. But Corning Research did it.

Now Corning has developed a metallizing method whereby the base for the solder becomes an inseparable part of the glass and so provides a permanent, air-tight seal. The metallized layer solders almost as easily as brass or copper and is not harmed by normal soldering temperatures. Parts can be soldered to it by any ordinary soldering iron, soft-air-gas flame or induction heating.

Also important—Corning type metallizing can be applied to an extremely wide range of glasses. Where extreme resistance to thermal or mechanical shock is required it can be applied to Corning's tempered glasses. Where electrical characteristics are of first importance it can be applied to Corning's special low-loss glasses.

This unique method of metallizing is just one of the ways that Corning's knowledge and experience may some day save you time and money. If you'd like to know more about us, we have a suggestion. Send for the study, "There Will Be More Glass Parts In Post-War Electrical Products." It's free. Just write to the Electronic Sales Department E-7, Bulb and Tubing Division, Corning Glass Works, Corning, N.Y.

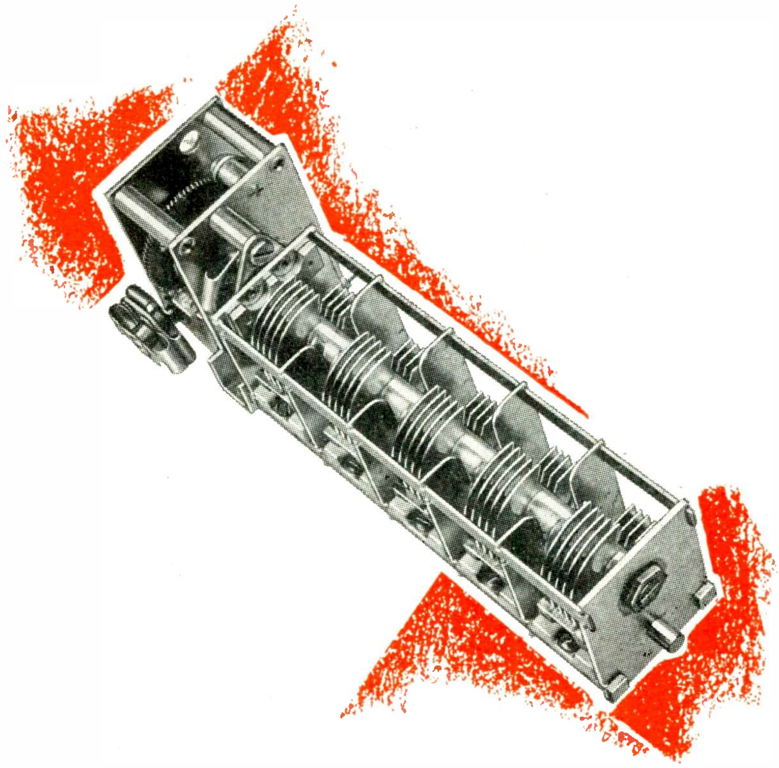
CORNING *means* **Research in Glass**

Electronic Glassware

T.M.REG. CORNING U.S. PAT. OFF. — T.M.REG. PYREX U.S. PAT. OFF.

"PYREX" and "CORNING" are registered trade-marks of Corning Glass Works

QUESTION: Are you planning post-war radio manufacture?



We urge you to include variable air condensers of Radio Condenser Company. We think this important because today they are used on radio apparatus of our armed forces and provide such accurate tuning that these men (your post-war prospects) will want the same type reception in their commercial sets. Available after the war will be both our variable air condensers and push button tuning devices. Plan to use both.

RADIO CONDENSER CO.

CAMDEN, N. J.

RADIO CONDENSER CO. LTD., TORONTO, CAN.

probably has little effect on the strength of the piece.

Micrographs at high and low magnification are shown in Figure 7. The low magnification shows the general appearance, depth, transition zone and core, while the high magnification shows the structure is those three zones.

As stated, wear and fatigue tests to date have been limited. Tests which have been made indicate a superiority of self-quenched pieces over those hardened by other induction methods. It can be said, pending complete evaluation, that a method is available that offers new possibilities as to accuracy of control of depth and hardness in this important category of heat treatment.

References

(1) Somes, H. E., Hardening of Inside Diameters by Inductive Heat Treatment, *Iron & Steel Engineer*, July, 1941.
(2) Schelkunoff, S. A., The Impedance Concept and Its Application to Problems of Reflection, Refraction, Shielding and Power Absorption, *Bell System Technical Journal*, January, 1938.
(3) Wheeler, H. A., Formulas for the Skin Effect. *Proc. I. R. E.*, September, 1942.
(4) *Journal of Research*, National Bureau of Standards, 23, July, 1939, RP 1220.

• • •

ELECTRONIC CONTROL OF WIND TUNNEL

A technician checks some of the electronic equipment used to control the speed of a 24-foot fan in America's fastest wind tunnel. It produces gales of 700 miles an hour, almost equal to the speed of sound, and was dedicated by Boeing Aircraft Co. as the Edmund T. Allen Memorial Aeronautical Laboratories in memory of the test pilot killed last year

THE ELECTRON ART

Electronic Equipment Measures Nerve Activity

NERVE CELLS in the human body have a firing action similar to that of a thyratron and impulses are transmitted from point to point in seriatim style by one cell firing another, according to Warren S. McCulloch, M.D., head of research at Illinois Neuropsychiatric Institute. Speaking before the membership of Radio Club of America in New York during May on the subject of "Electrical Measurements of Nervous Activity", he pointed out further that if all the nerve cells in a human were arranged in a continuous succession and the first fired at birth, the chain would still be ticking away at death without having reached the end.

Dr. McCulloch stressed the urgent need for electronic education among pre-medical students, so that the number of workers investigating the electrical behavior of the nervous system may continuously be increased. Few in the field at present have the combined medical and electronic background necessary for an understanding of what makes the brain and its associated nerves work.

Subjects included in the presentation were theory of the origin of electrical activity of the nervous system, electro-chemical reactions maintaining that activity, the wiring diagram of parts of the system, measurement of physical and chemical alterations by electrical and electronic methods, and the relationship of readings to convulsions and fatigue.

In a period of open discussion following the lecture, detailed aspects of the electronic equipment used in such investigations were covered, and the doctor related a number of case histories correlating theory with physical manifestations.

One interesting example concerned one of his colleagues who submitted to a shock treatment for severing the electrical brain connections involved in a neurotic pattern. After the treatment he could remember his wife and his car but not his house, his daughter, nor his fountain pen. He had owned his car about six years, lived in his house about five. His daughter was only two years old. In a few hours, the electrical connections had so restored themselves that the recollection of his house returned. In a few days, he remembered his daughter. But it was two weeks before his fountain pen became familiar. He had bought it the day before the operation.

Measuring Distance with Reflected Waves

BY ERNST NORRMAN
Williams Bay, Wis.

THE INSTRUMENT to be described gives a direct continuous indication of distance or depth by translating the time interval that a wave takes to travel between two points into a unit of linear measurement. Sound waves are particularly suitable for this purpose because of their relatively slow speed of propagation.

The instrument operates by transmitting a sound wave outward at the same instant that an impulse causes rotating members to assume a reference position. During the time interval of wave travel to some reflecting surface and its subsequent return, these rotating members determine a new position for the pointer to assume at the moment of reception of the reflected wave.

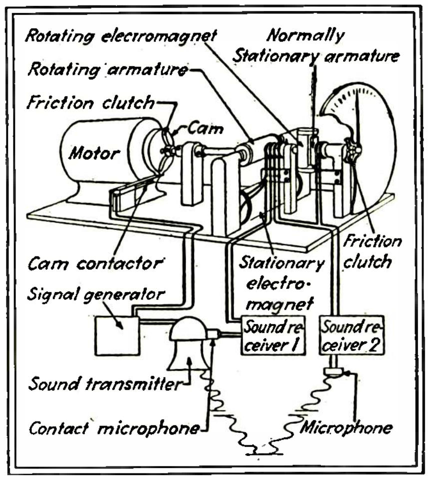


Fig. 1—Mechanical arrangement of an electronic instrument for indicating distance or depth directly on a dial. It operates by permitting impulses of reflected sound waves to determine the pointer position

The complete assembly of the instrument is shown in Fig. 1. A motor drives a cam at a predetermined speed, for instance 10 rps. Coupled to the motor by a friction clutch is a shaft carrying an armature and an electromagnet. The clutch is so adjusted that there is normally no slippage between the motor and the shaft that carries the rotating electromagnet.

The armature on the shaft rotates between the poles of a stationary electromagnet. When this

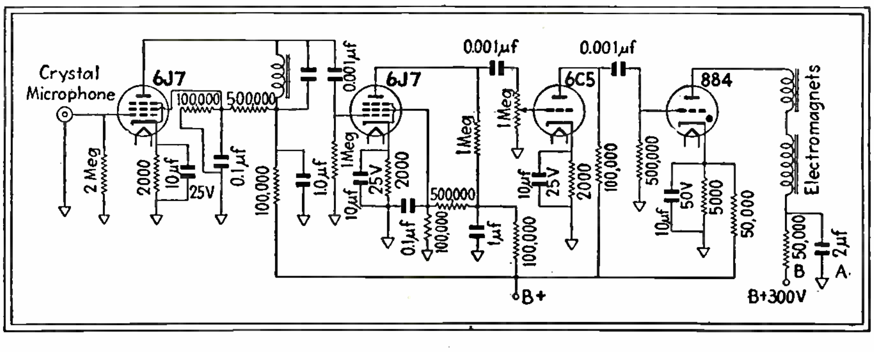
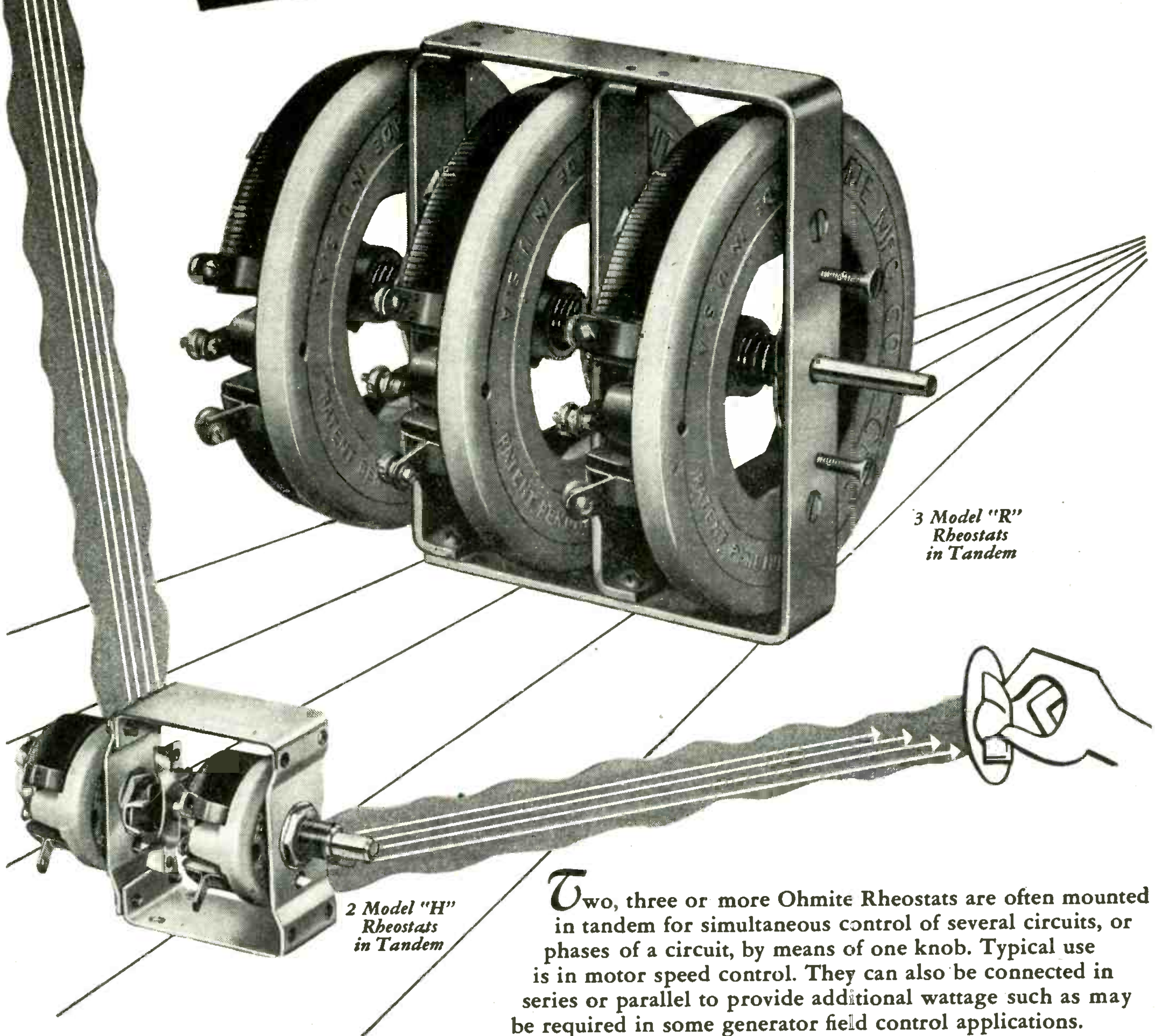


Fig. 2—Circuit of electronic amplifier for energizing the electromagnets that position the indicating pointer of the depth measuring instrument

OHMITE Rheostats in Tandem
For Simultaneous Control of Several Circuits



Two, three or more Ohmite Rheostats are often mounted in tandem for simultaneous control of several circuits, or phases of a circuit, by means of one knob. Typical use is in motor speed control. They can also be connected in series or parallel to provide additional wattage such as may be required in some generator field control applications. Any of Ohmite's ten rheostat sizes, or combination of sizes, may be utilized...rheostats ranging from 25 watts to 1000 watts and from 1-9/16″ to 12″ diameter...with uniform or tapered windings. Concentric control assemblies can also be produced. *In Resistance-Control, Ohmite Experience Makes a Difference!*

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stationary electromagnet is energized by a pulse of current it pulls the rotating armature into line with its poles. The rotating electromagnet, which is keyed to the same shaft as the rotating armature, becomes aligned as shown each time the stationary electromagnet receives a pulse. The energizing pulse must be of very short duration, so that the armature and the rotating magnet are barely pulled into position but not held for any length of time.

A second armature is positioned to cooperate with the rotating magnet so that it becomes aligned with the poles when the electromagnet is energized. This armature is held in a stationary position by a friction clutch. Both electromagnets and armatures have windings so that the armatures can take only one position in respect to the electromagnets.

Electronic Amplifier

Since the energizing impulses in both magnet systems must be of brief duration, an amplifier has been designed for converting impulses, such as trains of audio or supersonic waves, into undirectional impulses of very brief duration.

The circuit of a suitable amplifier is shown in Fig. 2. The plate of the first stage may be tuned to the frequency of the incoming signals. The 884 thyratron has a relatively high grid bias to prevent it from firing except at the reception of signals of a predetermined amplitude.

In the circuit, capacitor *A* is charged through resistor *B*. A positive grid impulse of sufficient amplitude causes the tube to fire and discharge capacitor *A* through the coils marked *Electromagnets*. These coils correspond to one of the electromagnets and its cooperating armature of Fig. 1. The duration of the impulse depends on the capacitance of capacitor *A* and the impedance of the coils.

During the time that the thyratron is not fired, capacitor *A* charges through resistor *B*. The large resistance value of *B* prevents the tube from striking again until capacitor *A* has a certain charge. Thus, even if its grid swings positive after the initial capacitor discharge, it cannot strike

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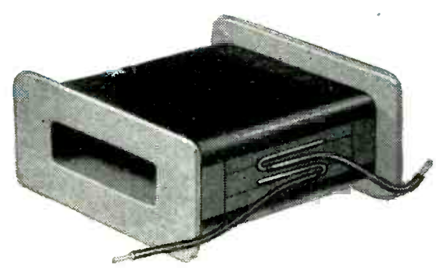

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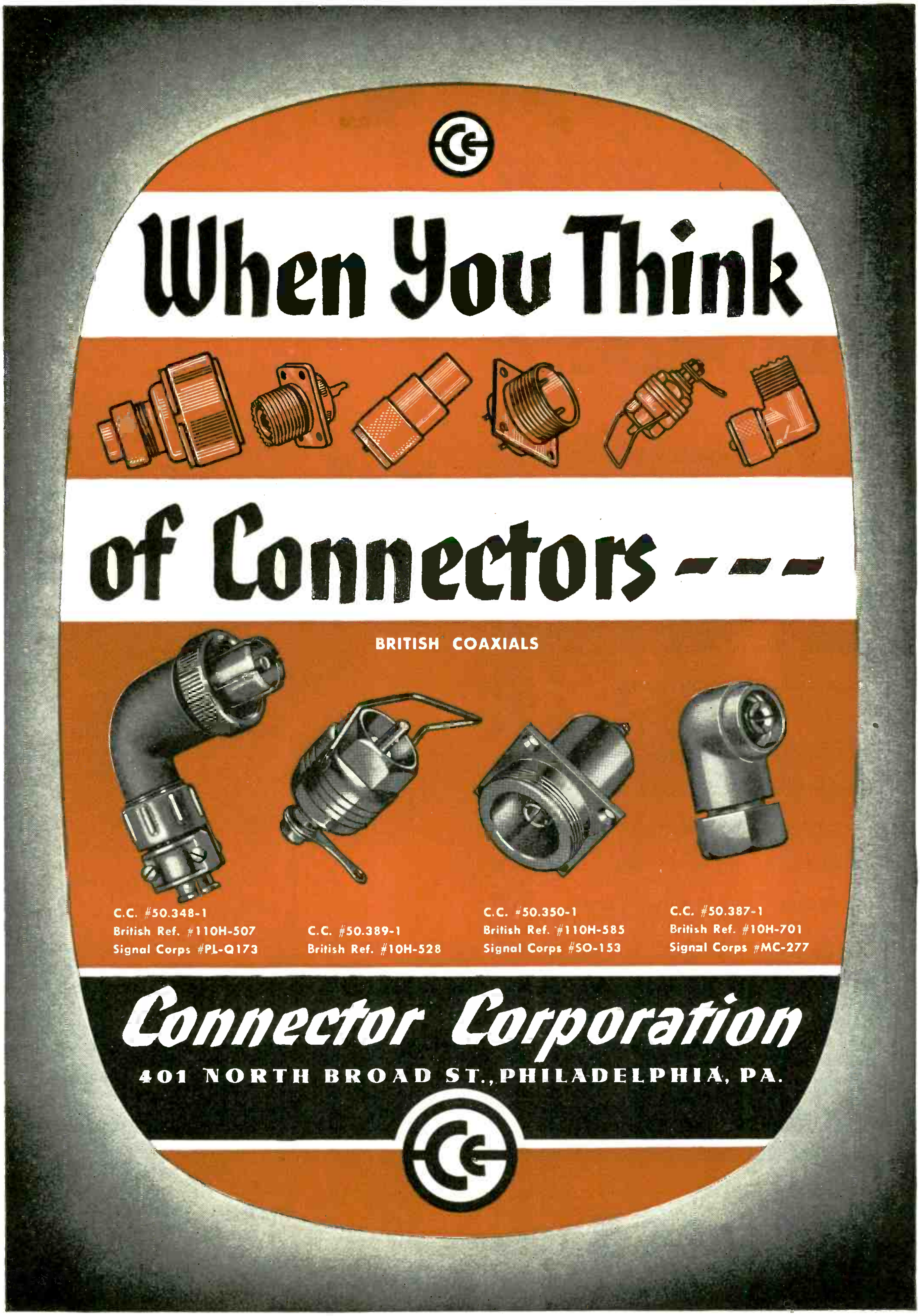
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again until the wave train has ceased; and each train of waves will be registered as a brief unidirectional impulse initiated by the first positive half cycle of the wave train.

Operation Under Water

Figure 1 also shows the arrangement for sounding in water. At each revolution of the motor shaft, the cam contacts close momentarily so that a wave is transmitted towards the bottom by the signal generator and transmitter. The outgoing signal is picked up by a contact microphone at the sound transmitter and amplified by amplifier 1. The output of this amplifier delivers a very short impulse to the stationary electromagnet and its armature.

At the moment the sound signal is transmitted, the rotating magnet is lined up in its vertical position as shown by Fig. 1.

The wave is reflected from the bottom and picked up by microphone 2 and is amplified by sound receiver 2 which delivers an impulse of brief duration to the coils of the rotating magnet and its armature. Some time has elapsed between the zero setting of the rotating electromagnet by the outgoing impulse and the arrival of the reflected wave. During that time the rotating electromagnet has revolved a number of degrees. Therefore the normally stationary armature and its pointer line up at a certain angle on the scale determined by the angle of rotation of the electromagnet during the time interval between the transmission of the sound wave and the reception of the reflected wave.

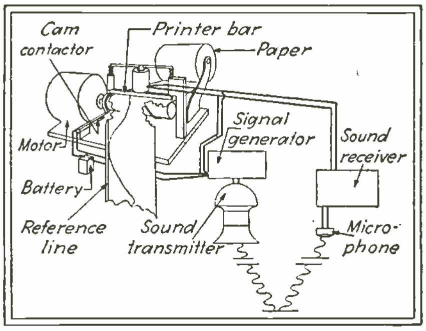
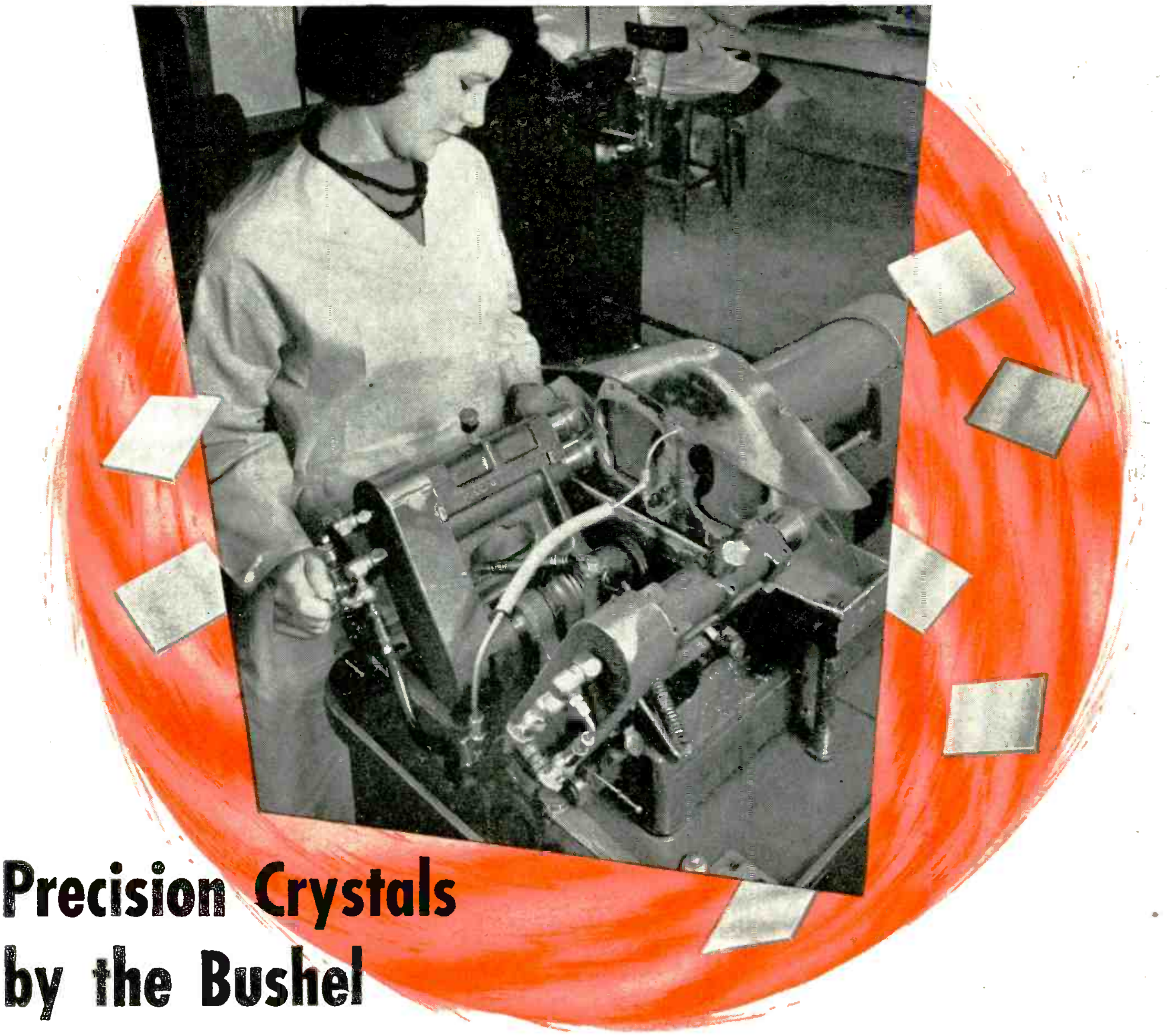


Fig. 3—A continuous recording of depth may be made by permitting the impulses of the reflected waves to actuate a printer mechanism

This process will be repeated at each revolution of the cam. If the



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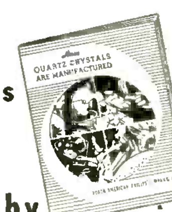

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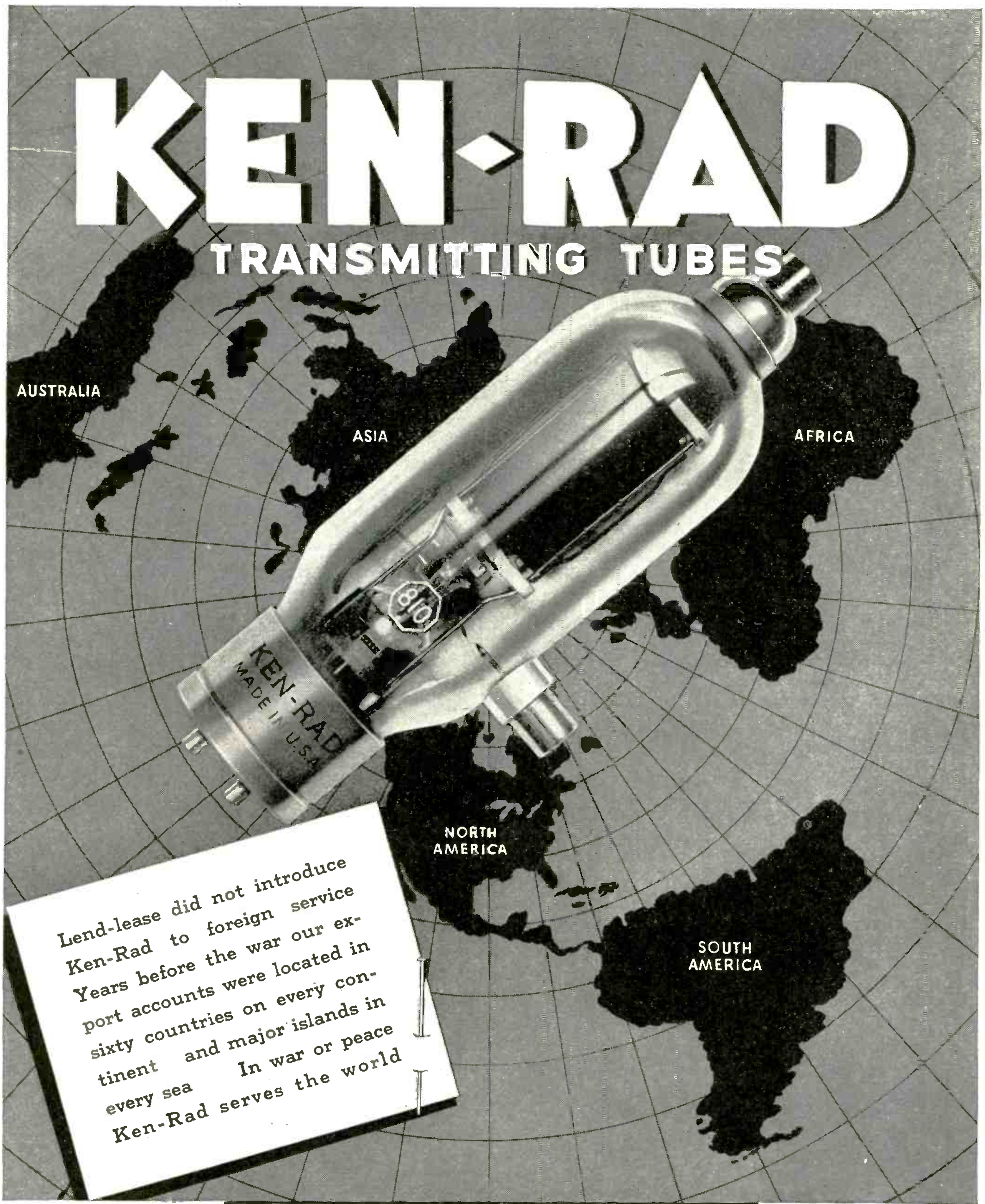

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depth is constant, the rotating electromagnet will always be energized at the same angular position, and its cooperating armature and indicating pointer will remain at rest in that position. If, however, the depth is changing, then the time interval between the outgoing and incoming signals changes, and the energizing of the rotating electromagnet takes place at different angles. The armature and the indicator follow these changes and move back and forth, always showing the correct depth.

Alternative Arrangement

When less accuracy is required, the stationary electromagnet, its cooperating armature, microphone 1 and amplifier 1 may be omitted. The rotating magnet is then keyed to the motor shaft, and the cam is keyed in such a position that the rotating magnet is in its vertical position when the cam closes the contacts. However, errors in the timing of the closing of the cam contacts and other variables in the sound transmitting system may then cause appreciable errors in the measurements.

The greater the speed of rotation of the electromagnet the greater will be the angular displacement of the indicator hand per foot depth, and thus the easier and the more accurate will be the reading of the dial. It must be understood, however, that the rotating electromagnet must not make more than one rotation between the transmission of a signal and the reception of its reflection.

A depth of about 200 feet is the limit at which a rotational speed of 10 rps can be used. At greater depths a speed of 1 rpm is suitable. If it is desirable to measure great depths with the same absolute accuracy as shallower depths, one fast and one slow system may be used.

Charting of Depth

By means of the apparatus shown in Fig. 3 a graph can be made of the bottom of the sea. The recording apparatus consists of a cylindrical drum on the surface of which is stretched a single-turn wire helix, a knife-edge printer bar mounted coaxially with the drum, and a motor to rotate the drum. A sheet of paper is fed slowly be-

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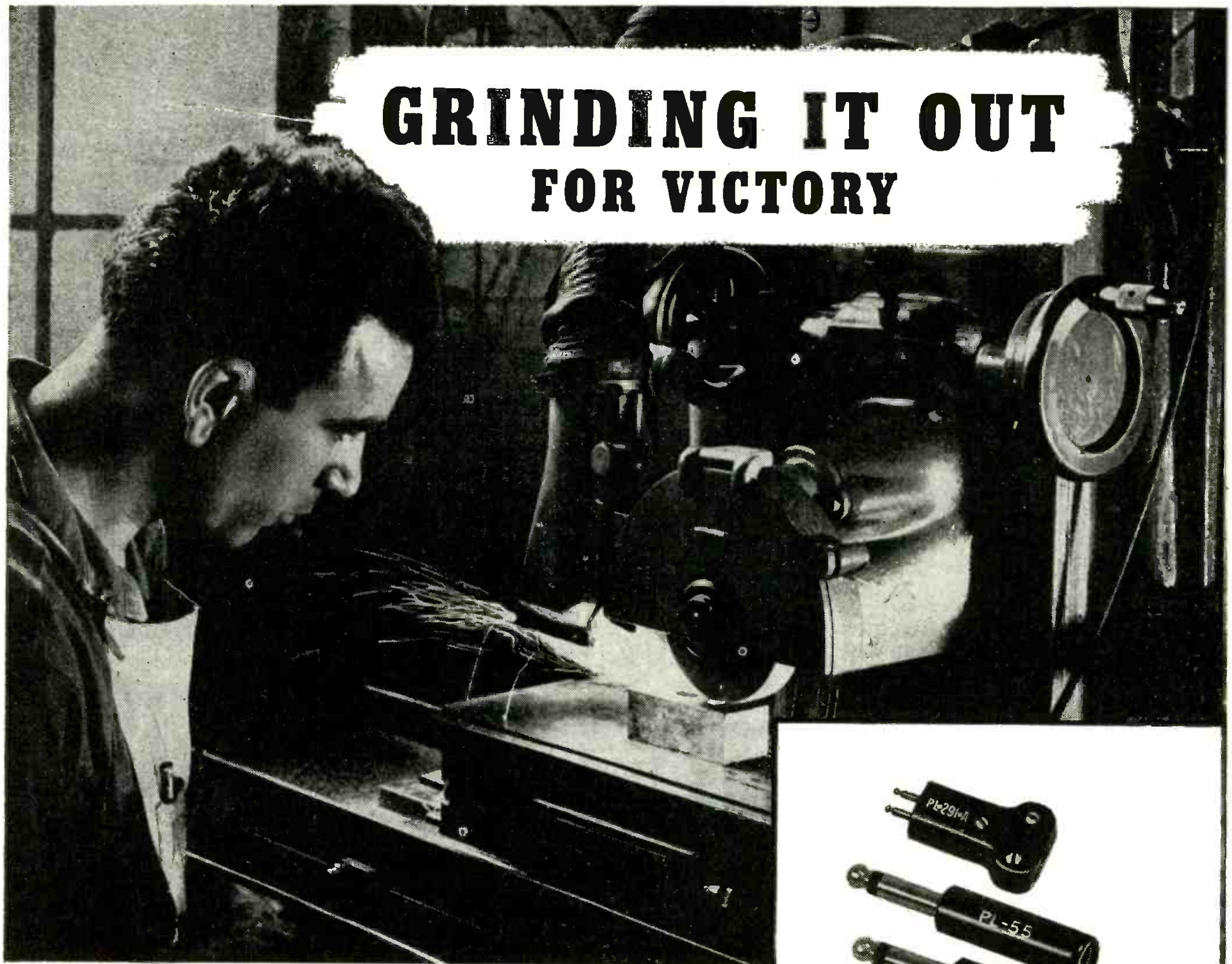

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64		64			

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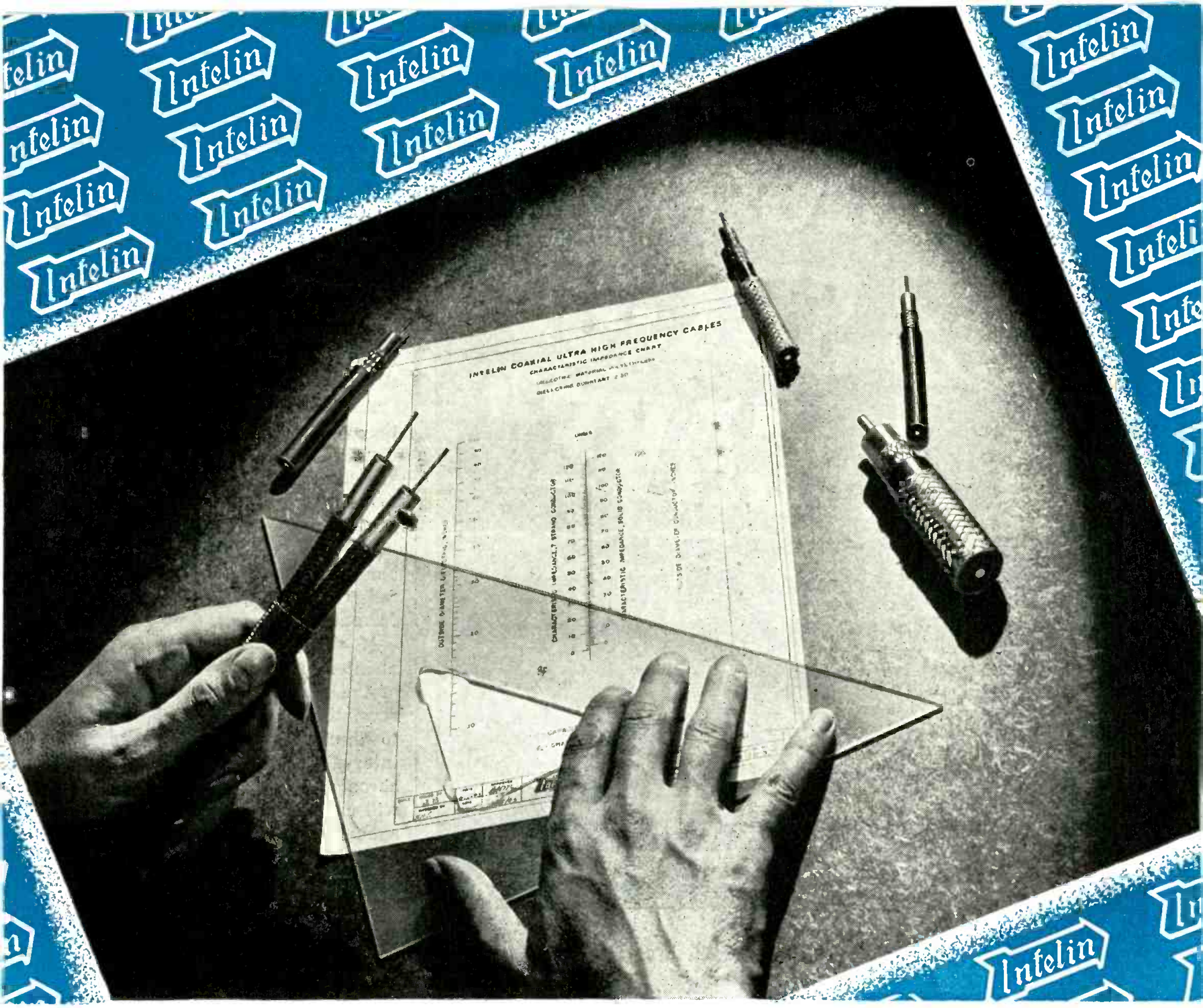

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tween the drum and the printer bar. A printing element under the printer bar serves to make the prints on the paper.

The printer bar is operated by an electromagnet so that a short impulse causes the bar to be momentarily depressed. This causes the printing element to be pressed against the paper strip at a point depending on the momentary position of the wire helix in respect to the printer bar.

As the drum rotates, the point of the wire helix that is directly under the printer bar moves transversely across the paper. Therefore the location of the print depends on the angular position of the drum at the moment the printer bar is depressed. As the paper is fed forward, the prints or dots form a line along the paper.

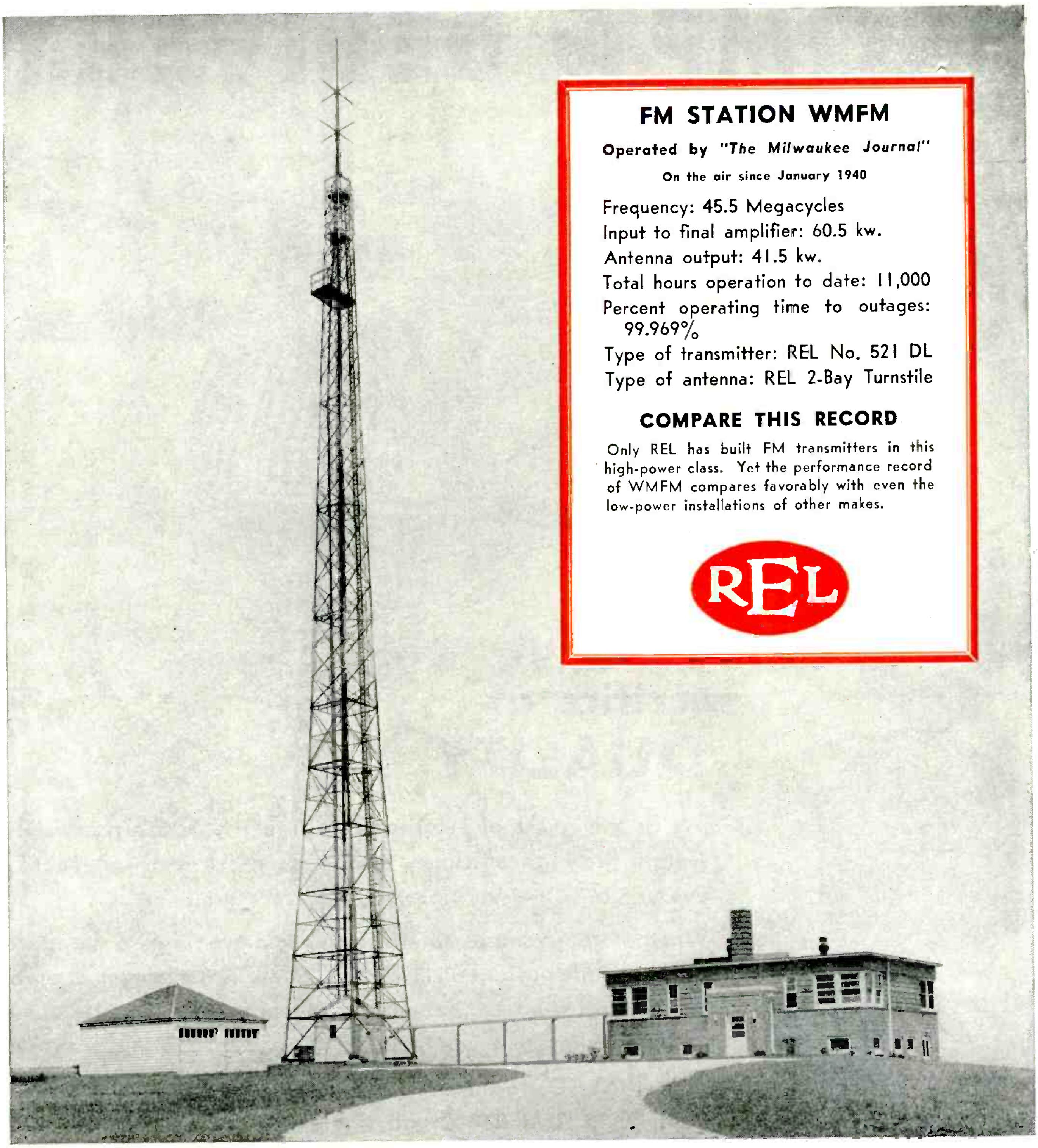
If the printer bar is actuated at intervals equal to one revolution of the drum or an even number of revolutions, the line will be parallel to the edge of the paper. Equal intervals that are not exactly synchronized with the speed of a drum will cause a line to be printed diagonally across the paper, and irregular intervals will cause a complex graph to be printed.

On the drum shaft is mounted a cam which closes a pair of contacts once per revolution and causes a sound signal to be transmitted. The reflected sound is picked up by a microphone, amplified, and caused to operate the printer bar. The cam is keyed to the shaft in such a position that the sound signal is transmitted when the left end of the wire spiral has just passed under the printer bar.

If the depth is shallow, and the reflected sound signal is received a very short time after the transmission, the printing will take place near the left edge of the paper. As the depth, and the interval between transmission and reception of the signals, increases, the printing takes place farther and farther to the right edge of the paper. If the depth is irregular, the line may be similar to the graph in Fig. 3.

In order to avoid errors, arrangements are made to print a reference line at the left side of the paper. The depth is then figured from that line rather than from the edge of the paper.

To obtain still greater accuracy,



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Percent operating time to outages: 99.969%
Type of transmitter: REL No. 521 DL
Type of antenna: REL 2-Bay Turnstile

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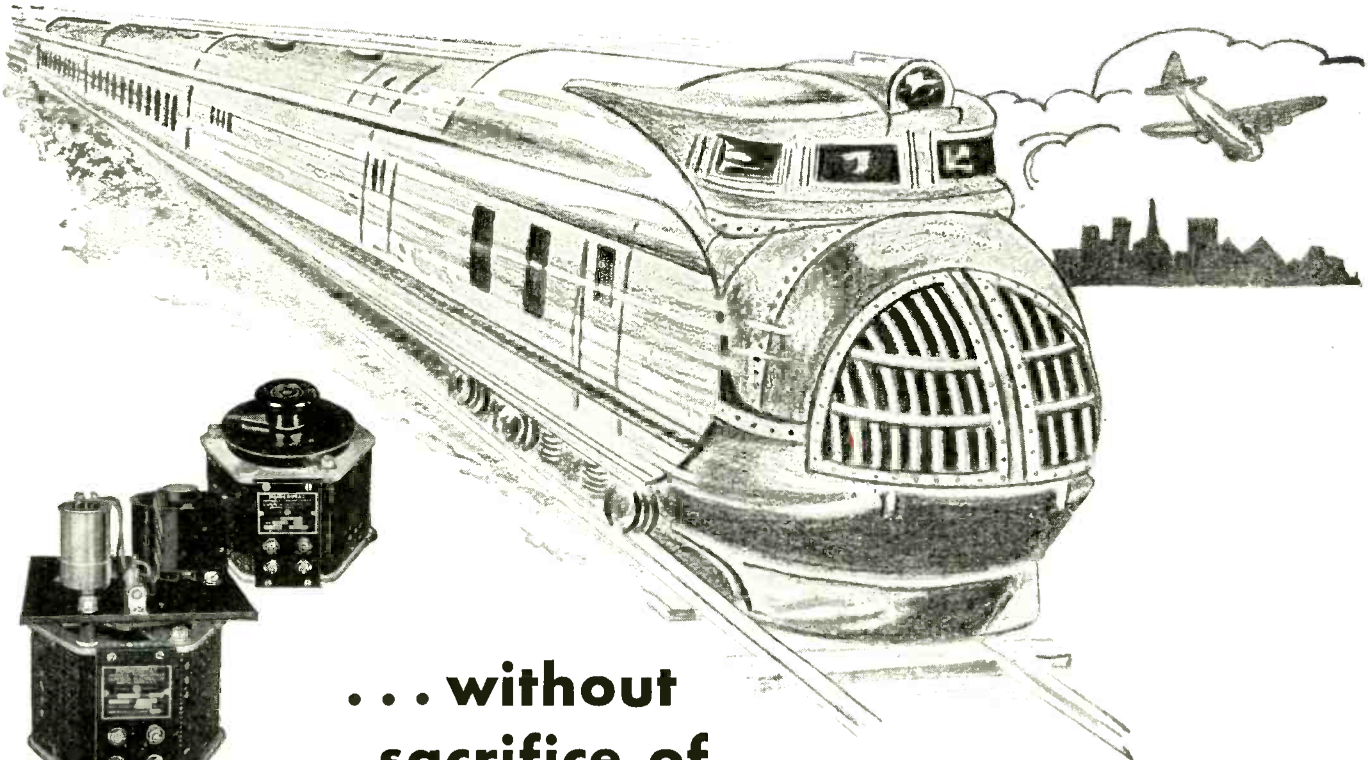

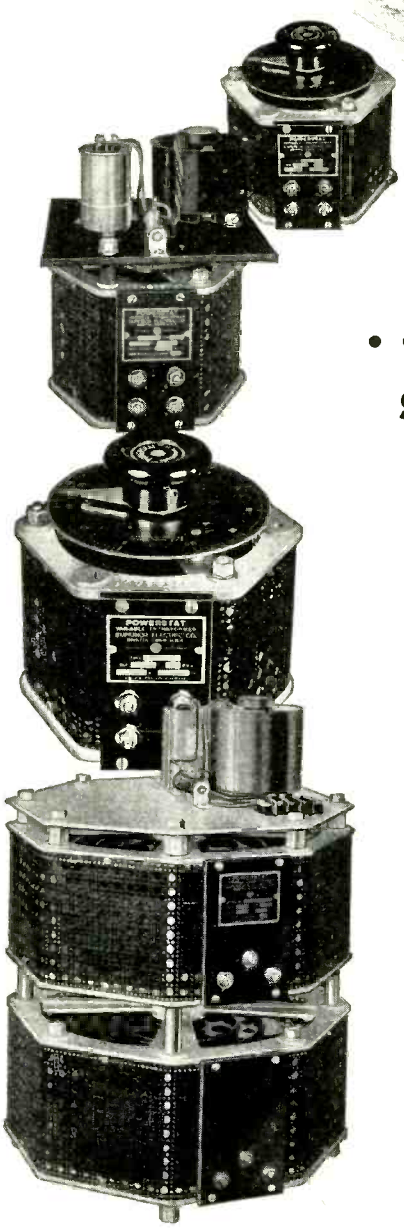

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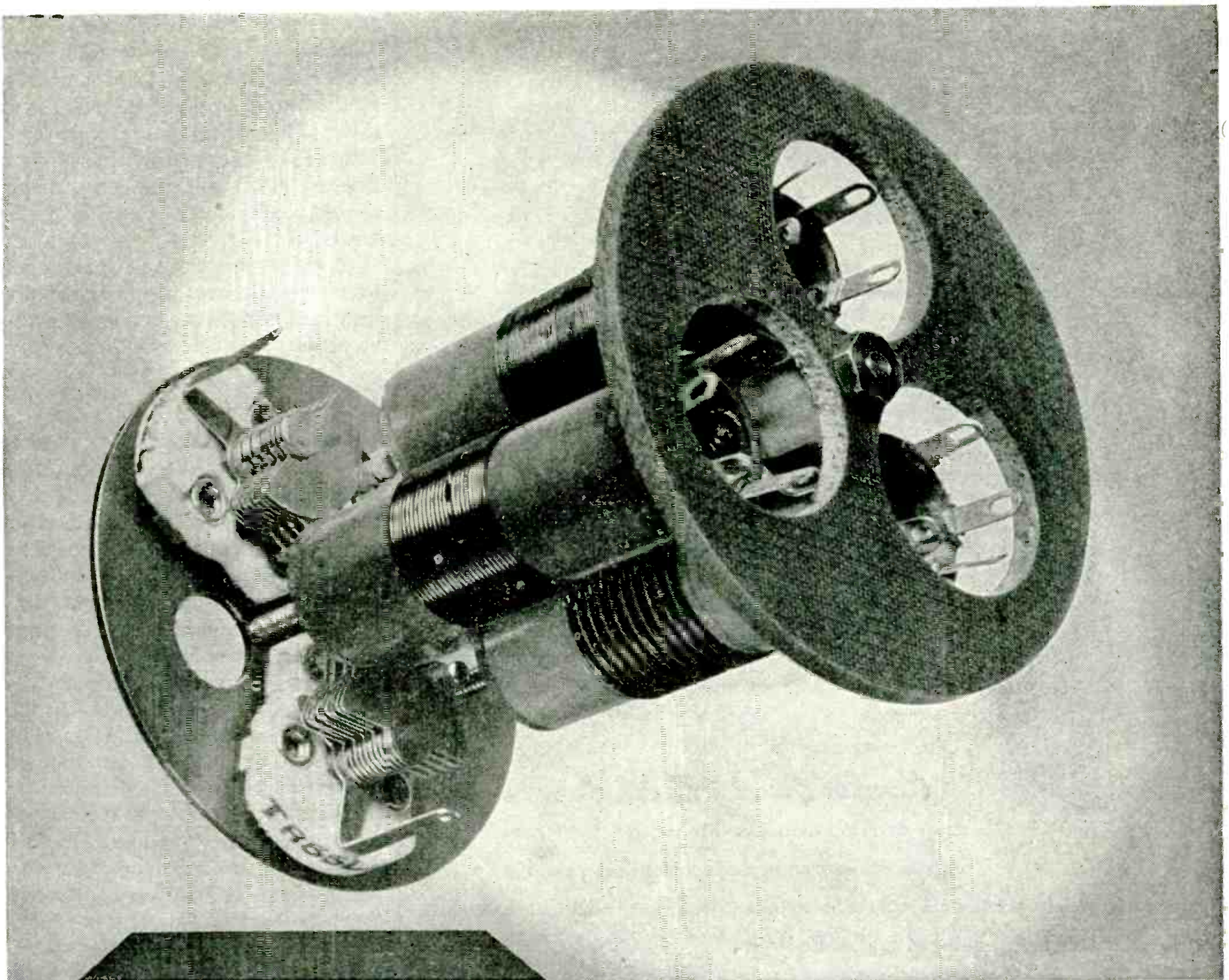

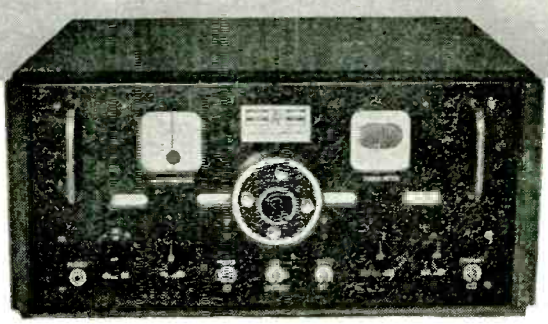

LRR-4

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883

a microphone at the sound transmitter may be used to pick up the initial signal to print the reference line. The drum might also be coupled to the motor shaft by a friction clutch and the zero setting system previously described be used.

A ship sailing back and forth over a certain area can very rapidly map the bottom by using this instrument.

• • •

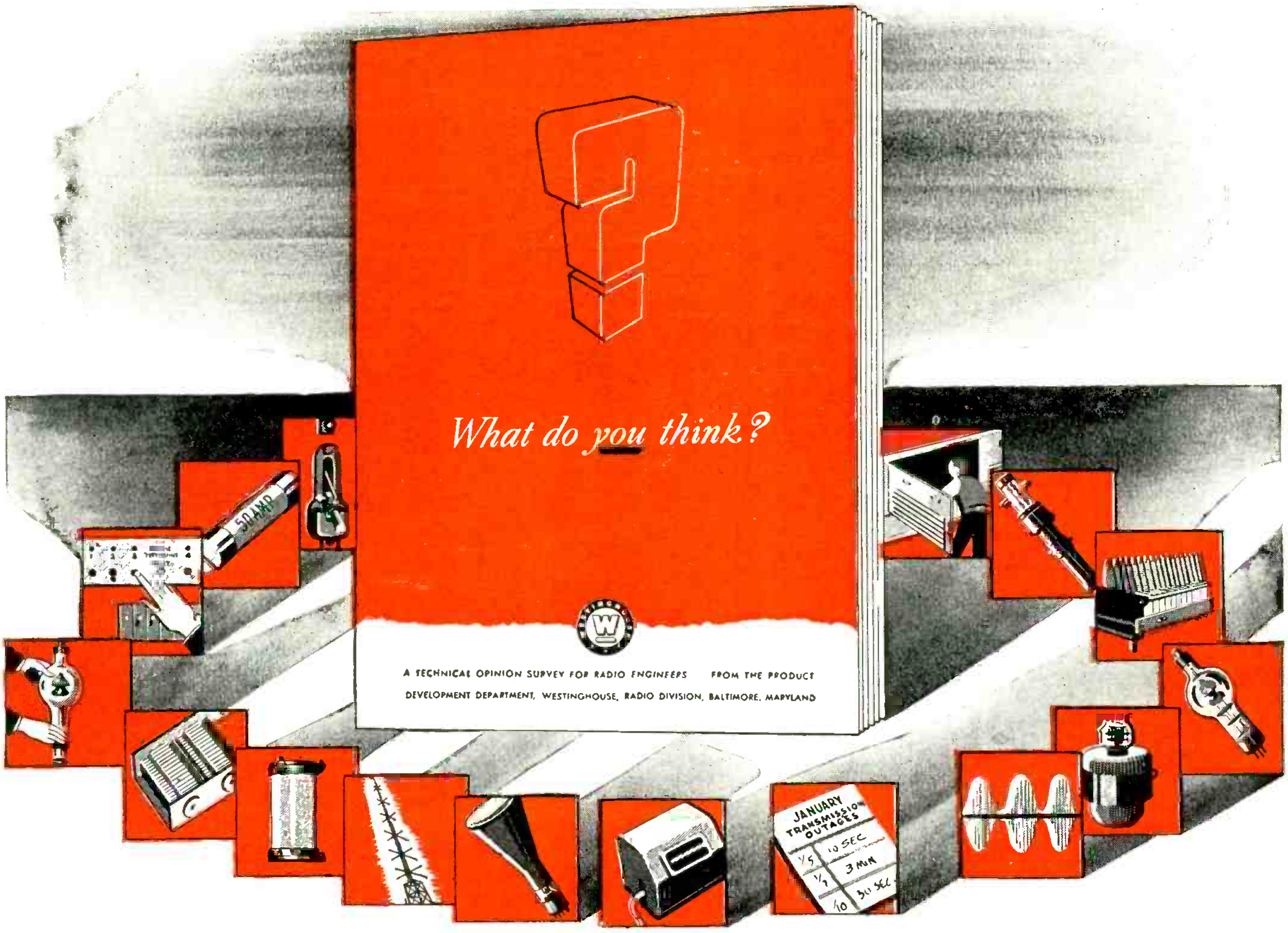
Cosmic Rays

THE FOLLOWING DESCRIPTION of cosmic rays formed a portion of a lecture delivered by Edgar Berry before the Argentine Local Center and abstracted in the *Journal of the Institution of Electrical Engineers* (Savoy Place, Victoria Embankment, London W. C. 2, England) for December 1943.

It was at first believed that cosmic rays had their origin in the stars or nebulae around us, but Compton and others found that 98 percent of the rays are deflected by the earth's magnetic field. Experiment shows no variation in the quantity of the rays according to whether the Milky Way is directly overhead or well towards the horizon, but as the earth moves at 300 km per sec round the center of the Milky Way there is 0.1 percent more cosmic rays on the leading side. This percentage is the exact relation the velocity of the earth bears to that of light. These investigations show that the rays come from the depths of space, where they appear to move at random.

Their energy is equivalent to that of a current flowing into our earth of 1/7 ampere at 10^{12} volts. Their penetrating power is greater than that of any other rays hitherto discovered; after traversing the atmosphere, which is equivalent in stopping power to 10.33 m of water, they bury themselves to a depth of 100–300 m below ground.

The number of rays which reach us exhibits a daily variation, because it depends upon the amount of atmosphere they have to pass through and also upon the earth's magnetic field. This stops all rays having energy less than 500 million electron-volts, and also has the effect of spreading the remainder out towards the Poles from the Equator. The density of distribu-



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SIMPLICITY OF CONTROL . . . LOW OPERATING COST
EASE OF MAINTENANCE

We will appreciate knowing what you consider the best way to incorporate these advantages in postwar transmitters. To facilitate this, the questionnaire booklet pictured above will be distributed to all stations in the near future. If you do not receive your copy . . . write Westinghouse Electric & Manufacturing Company, Dept. 7-N, East Pittsburgh, Pennsylvania. J-08075

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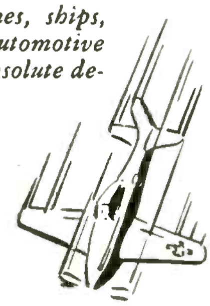

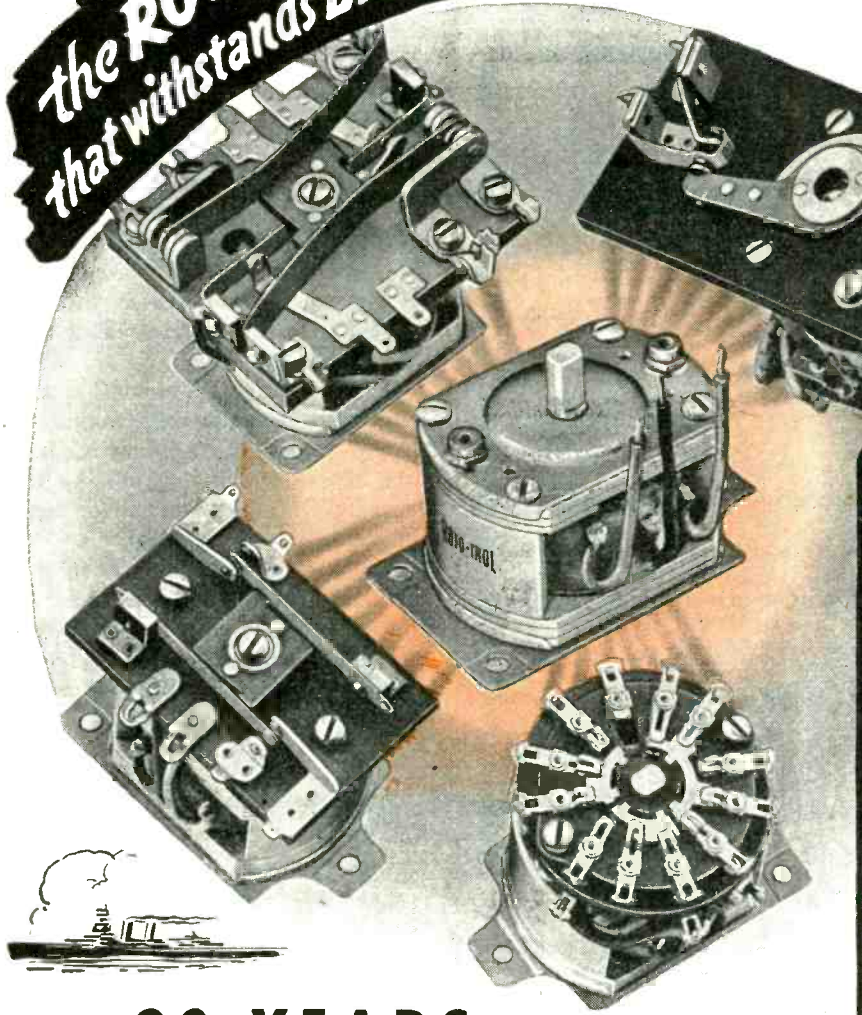

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tion of the rays at the Equator and at sea-level is 0.03 per cm^2, and that at latitude 45 deg is 10 times this value. Cosmic rays produce 30–35 ion pairs per cm of air at 1 atmosphere pressure, and it requires 35 electron-volts to create a pair.

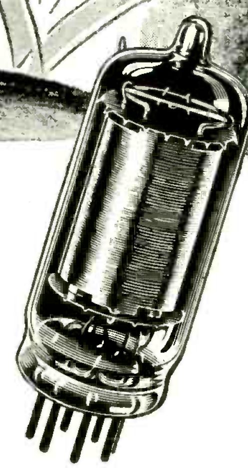
The rays cause many secondary phenomena such as the transmutation of the elements and the creation of helium and hydrogen, besides causing ionization in the atmosphere; they also produce abnormal variations in animal and vegetable life. The secondary rays, produced when cosmic rays strike atoms, appear to be reflected from minerals, oil and water in the crust of the earth. Cosmic rays are one of the causes of the uncertainties associated with flashover in high-voltage work.

The device for the detection and counting of cosmic rays comprises two wires side by side in a glass tube across which a gradually increasing voltage is applied until the sparking potential is approached. To prevent flashovers, a high resistance is placed in series and connected to a sensitive detector such as an electronic electrometer. To determine the direction of the rays, two counters are placed one above the other and are connected in series and wired to a negatively charged screen-grid tube; thus a record is made only when each grid attains a positive potential. When a cosmic ray passes through the counter, positive and negative ions are produced, those of one sign being attracted to the walls and the others to the center wire.

Wilson's expansion cloud chamber is still the best means of obtaining a photographic record of the effects of cosmic rays upon gas molecules. It was by means of this apparatus that the positron was discovered by Dr. Carl Anderson in 1932. In 1938 the mesotron, or heavy electron (approximately 200 times heavier than the electron) was discovered in the Wilson cloud chamber when studying cosmic radiation. The average life of the mesotron is estimated at one millionth of a second.

The positron has the same mass as the electron, namely 9×10^{-28} grams, but its charge is of opposite sign, and the force of attraction between them is 10^{42} times

TUBES GET THE MOST UNEXPECTED ABUSE

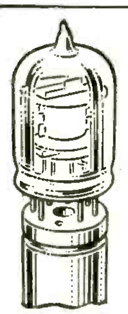


Signal Corps tests for Electronic Tubes are exacting . . . and rightly so. For tubes to be totally satisfactory for civilian or military use, they must be built to operate under the most severe and unusual conditions. That is why "vibration testing" was a routine procedure at TUNG-SOL long before the war.

TUNG-SOL research engineers are continuously working to find "weak points" and developing ways and means of overcoming them. With the advent of the glass base tubes for instance, the cause of base fractures was discovered and a production procedure was developed to eliminate it.

Manufacturers and users of Electronic Equipment will find every tube in the TUNG-SOL line a tube of proven merit.

Why not have TUNG-SOL engineers think and work along with you while you are planning your new developments?



THE TUNG-SOL WAY

OF COOLING TUBES PREVENTS BREAKAGE OF GLASS BASES..

While a tube is cooling, during manufacture, air is blown against the center of the glass base through a hole in the holder thus cooling the base from the center out while natural cooling takes place from the edges in. This uniform cooling relieves internal stresses in the glass, a cause of breakage.

TUNG-SOL

vibration-tested

ELECTRONIC TUBES

ARMY E NAVY

TUNG-SOL LAMP WORKS INC., NEWARK 4, NEW JERSEY

ALSO MANUFACTURERS OF MINIATURE INCANDESCENT LAMPS. ALL-GLASS SEALED BEAM HEADLIGHT LAMPS AND CURRENT INTERMITTORS

greater than gravity. The union of a positron and an electron results in their mass being completely annihilated and generally gives rise to two photons, or electromagnetic waves, travelling in opposite directions with the velocity of light. These can be reconverted into the same material matter in the confines and powerful electric fields of atomic structure. This cycle of change shows that matter and energy are of the same origin.

The work of Goldsmit, Einstein and DeBroglie shows that matter or materials have a fixed energy and have any velocity from zero up to the velocity of light, whilst electromagnetic radiation can travel only at the velocity of light but can have any energy from zero to infinity—the energy always being proportional to the frequency of the wave. Also, every frequency corresponds to a voltage and every voltage to a temperature; thus, there is an upper limit to voltage, temperature and frequency.

The diameter of an electron has never been measured directly, but calculations based on its electrical energy of charge and its mass at zero velocity show that the radius is 1.42×10^{-13} cm, while the radius of the proton, which is 1.835 times heavier than the electron, is 10^{-16} cm. The density of the proton is 5×10^{12} that of the electron.

In considering protons and electrons we are dealing, therefore, with centers of energy and not with the ordinary matter or material that we have been brought up to believe in. Matter is able to exist either as a corpuscular material obeying the laws of gravity or in an undulatory ethereal state.

The whole universe, including man, forms one comprehensive unit and when any particle of this universe changes its state, it is transplanted by different types of radiation and rebuilt in the depths of space.

• • •

Microdensitometer with D-C Amplifier

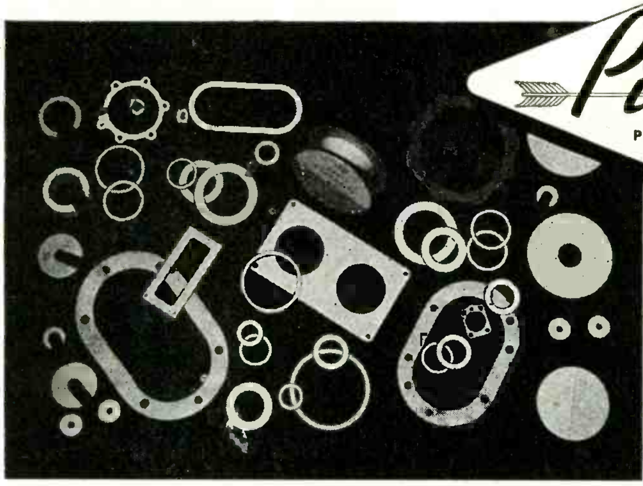
By S. R. Winters

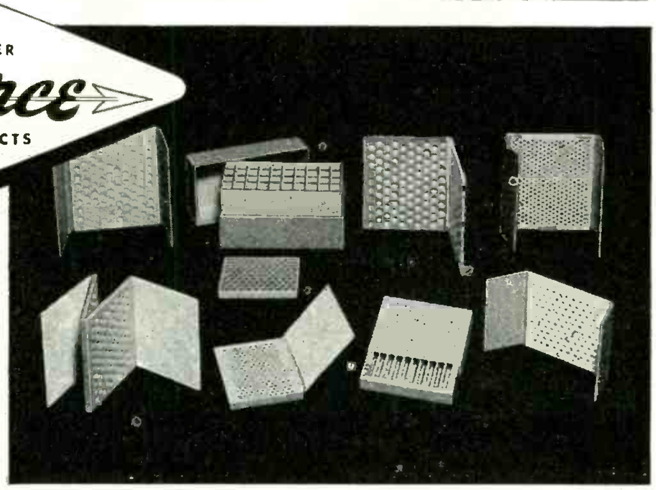
PHOTOTUBES, used in conjunction with a direct-current amplifier in a null circuit where readings are obtained from a calibrated light wedge, comprise an electronic microdensitometer designed by Joseph

We Can Make *These* For You... *Now*

SEND US YOUR SPECIFICATIONS ON STANDARDIZED ITEMS, OR LET US HELP DEVELOP NEW USES TO MEET YOUR NEEDS. WE ARE EXPERIENCED PAPER CONVERTERS . . . HAVE A NEW, UP-TO-DATE PLANT . . . AND ARE IN A POSITION TO SERVE YOU WELL AND PROMPTLY

PAPER Pierce PRODUCTS





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Pierce industrial gaskets: manufactured to precision dimensions from paper, felt, cork, asbestos, synthetic rubber, leather or special compositions; meet specifications for resistence to oil, water, gasoline, heat, pressure. Die-cut specialties: produced by rotary press, platen press, punch press, or drawing methods from paper, felt, cork, special compositions.

NEW...SAF-T-PAK BOXES FOR SMALL PARTS

Pierce Saf-T-Pak Boxes: specially designed to individual requirements for the protection of small precision parts and other fragile items easily damaged in shipment. Can be produced from kraft, chipboard, or special compositions in a wide variety of forms with die-cut cells, cushion liners, partitions, other construction features of protective packaging.

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Pierce packaging envelopes for holding small flat parts; metal-top envelopes for secure fastening and convenient reopening; waterproof and greaseproof envelopes to meet all specifications; duplex shop-order envelopes — with protective glassine panels: the modern method of keeping blueprints and production orders together during work in progress.

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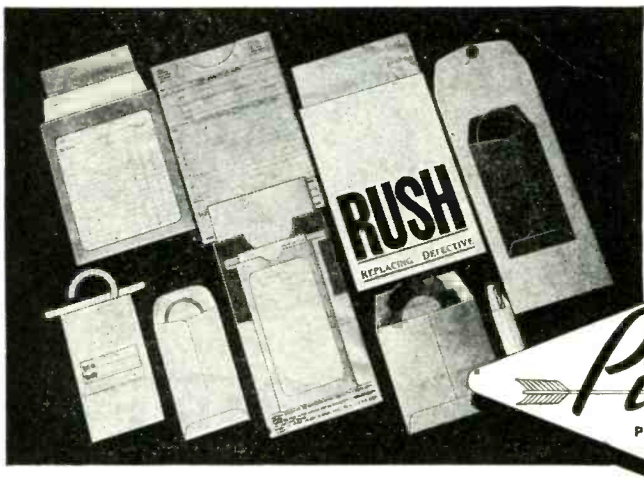
Pierce spiral-wound tubes and cans: in diameters from 3/8" to 6" — any required length — from waterproof paper, kraft, chipboard, special compositions. Also, Pierce Saf-T-Pak tubes with felt liner for protection of fragile parts in shipment. Pierce protective caps and tubes for male and female threads: made in any size, waxed or plain.



PAPER Pierce PRODUCTS

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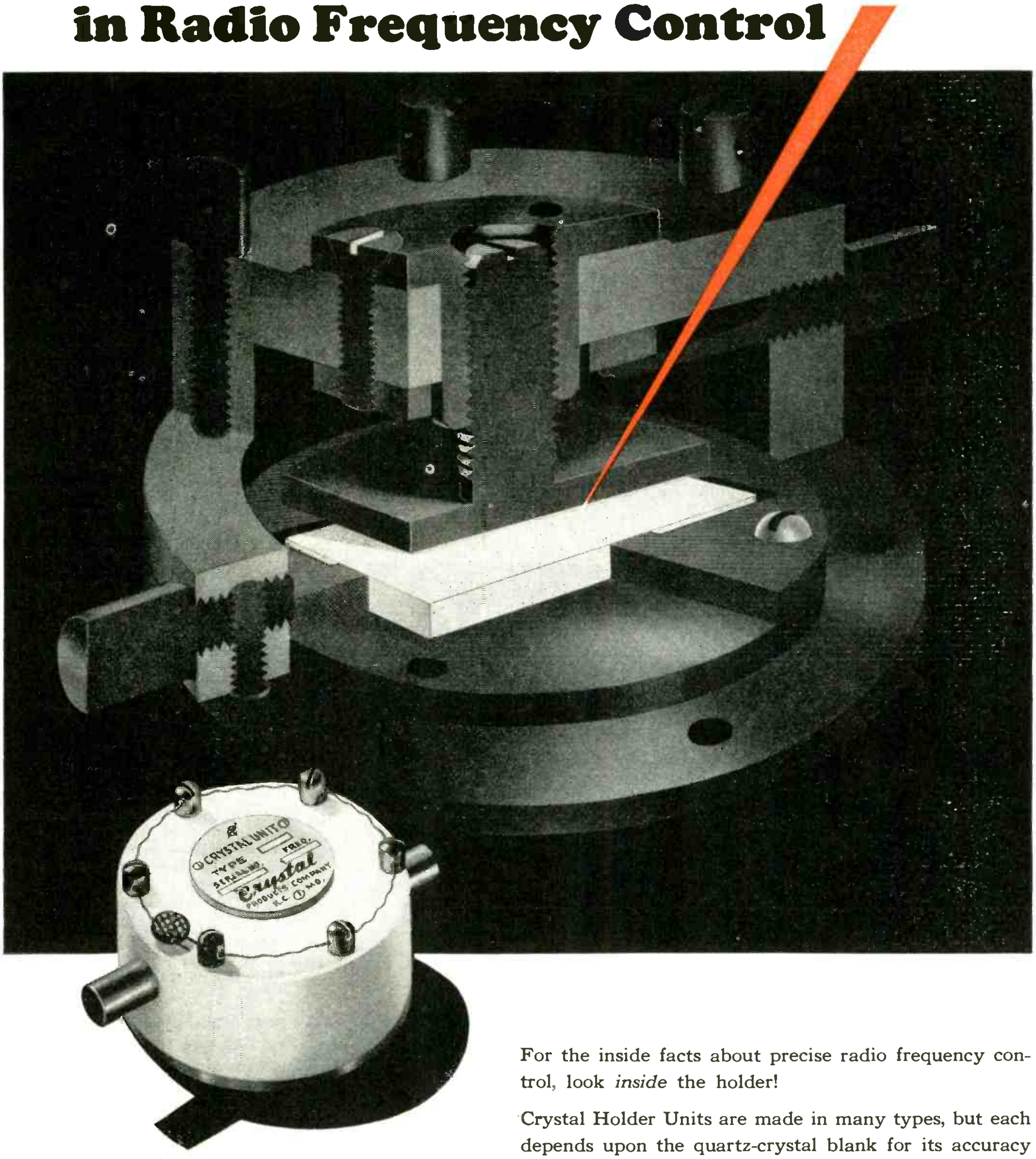
Manufactured by PIERCE PAPER PRODUCTS CO., 2726-A AUBURN STREET, ROCKFORD, ILLINOIS

Here's The Precision Factor in Radio Frequency Control



For the inside facts about precise radio frequency control, look *inside* the holder!

Crystal Holder Units are made in many types, but each depends upon the quartz-crystal blank for its accuracy in final performance.

This is why more and more electronic engineers specify quartz oscillator plates made by Crystal Products Company. Here they get crystals made under the most exacting methods of control. Here, too, they find valuable cooperation in engineering the crystal and its holder for any specific circuits.

Our products and our services are available to you. Use them—and be sure of satisfaction.

Crystal

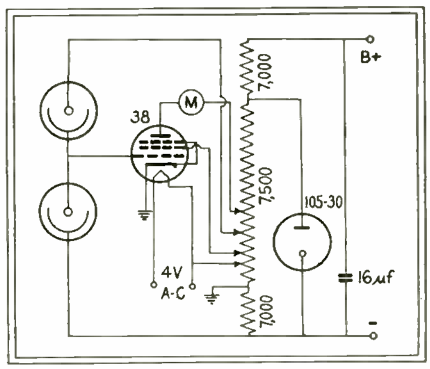
PRODUCTS COMPANY

1519 McGee Street, Kansas City, Mo.

Producers of Approved Precision Crystals for Radio Frequency Control

G. Baier, associate professor of zoology at the University of Wisconsin. The instrument provides a rapid method of measuring the turbidity of tiny amounts of solutions and requires samples of only one cc in standard 75 by 10 mm chemical test tubes for any determination.

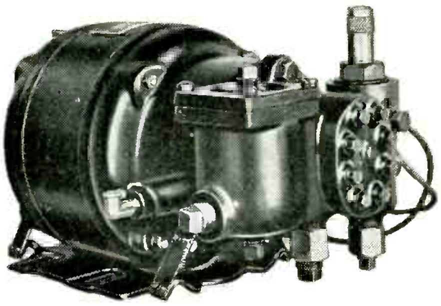
Two phototubes are employed in a balanced bridge circuit and readings are obtained by adjusting a light wedge, calibrated in percentages of illumination, transmission from 100 to zero, to balance the quantity of light absorbed by the unknown over the control specimen. The electronic circuit functions on the null-reading principle and is employed to show the balance point. Graphs were made from dilutions of India ink and copper sulfate (using suitable color filters), and the linearity of these graphs was in conformity with data of the Bouguer-Beer law.

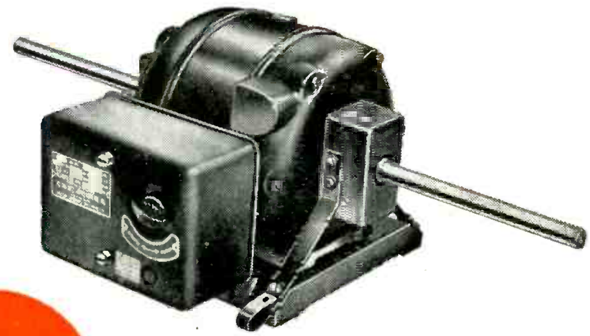


The circuit of the microdensitometer contains a 0-200 microammeter to register the unbalance of the bridge circuit formed by the phototubes. Not shown in the diagram, a 150,000-ohm resistor is in series with the meter to limit the current to slightly less than full-scale deflection of the pointer

A year was spent in designing, constructing and testing the device for use in biological work in the study of animal relationships, involving the measurement of the amount of precipitate in suspension. However, the instrument is also applicable to related biological problems, as well as to measuring the density of colored solutions by employing color filters.

Sensitivity and reliability are the two-fold advantages claimed for this new densitometer, in addition to its requirement of only very minute amounts of a chemical solution to make an exact determination. The two phototubes have maximum





Announcing the New WILCO BLUE BOOK

Giving valuable data on Thermostatic bimetals (Thermometals), Contact materials, and special materials of value to Design Engineers, Production Engineers and Purchasing Agents.

A 90-page, authoritative treatise on Thermometals and Contact Materials

Thermometals (Thermostatic Bimetals)

The Wilco Blue Book deals with the 29 Wilco Thermometals (Thermostatic bimetals)—what they are—how they are made—their properties, functions, applications and temperature ranges. Particularly outstanding are the 37 pages of formulae and charts, which give detailed graphic data regarding deflection rates, corrosion resistance characteristics, resistivity, etc. A large part of the Thermometal section is devoted to formulae on the behavior of various shapes and types.

Contact Materials

The Blue Book also fully describes the new developments in Electrical Contacts made during 30 years of pioneering research in this field. New and old Wilco contact materials listed and described include Silver, Platinum, Gold, Powder Metal and Tungsten Contacts; Wilco Aeralloy Magneto Contacts; Collector Rings and Brushes for use in rotating and control devices; Silver Clad Steel for Bearings, shims and other industrial purposes; Gold-Filled and Rolled Gold Plate and Radio Wire.

The new Blue Book will be sent free to engineers, purchasing agents, instructors in engineering schools and others. Wilco sales engineers will gladly call at your plant to discuss problems involving the application of Wilco products to current or projected devices, or send us your problems for analysis.

The new edition of the Wilco Blue Book makes available to you the extensive knowledge and reasearch of a company, which since 1914 has been an outstanding producer of precision thermostatic bimetal and contact materials. To get *your* FREE copy, write today.

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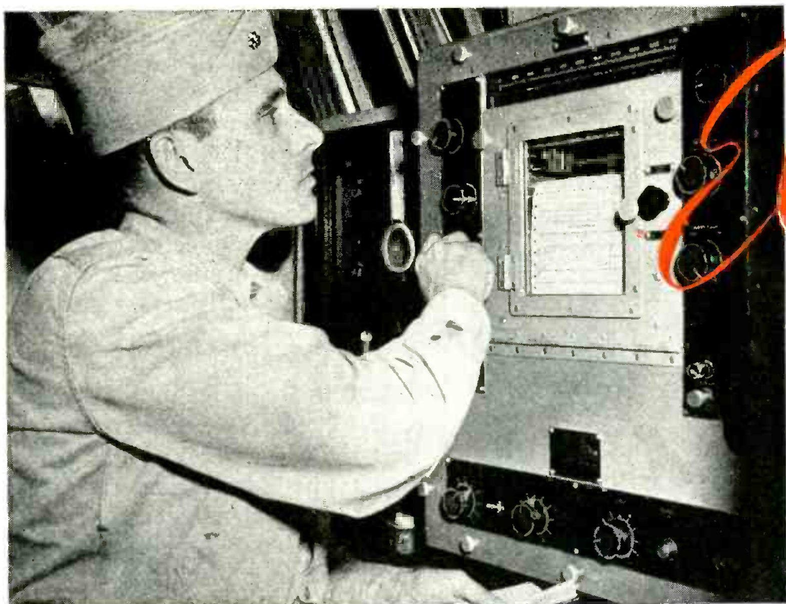
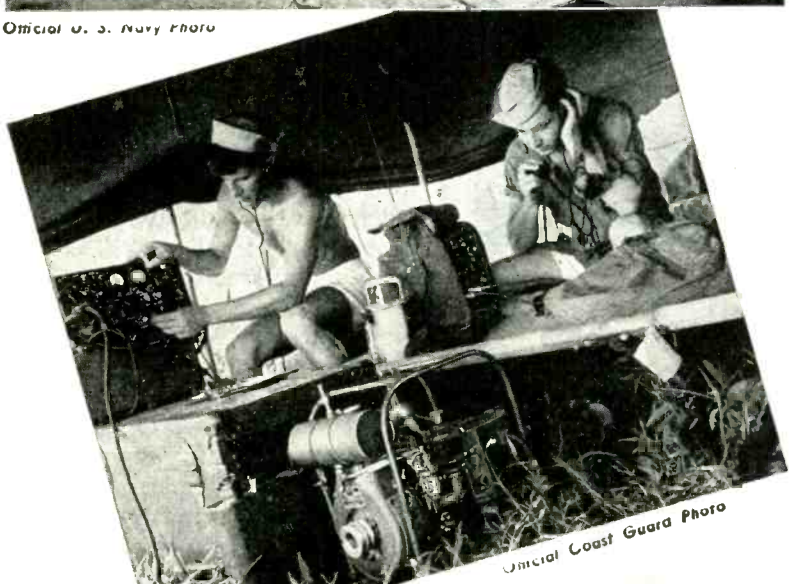
THERMOMETALS WILCO ELECTRICAL CONTACTS

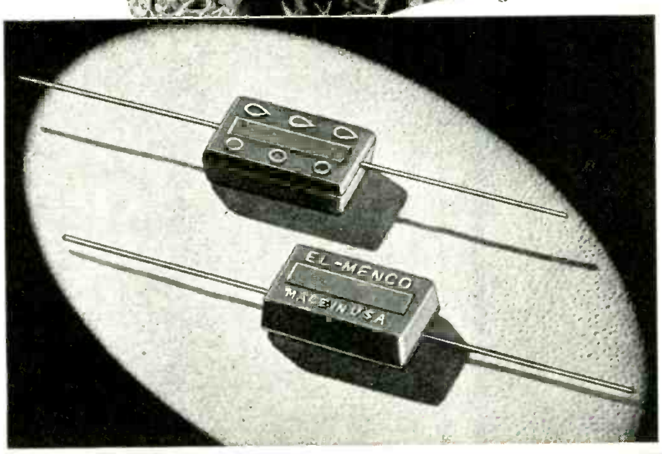
PRECIOUS METAL BIMETALLIC PRODUCTS



Official U. S. Navy Photo



Official Coast Guard Photo



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MOLDED MICA CAPACITORS

The Navigator takes a depth reading from the FATHOM-ETER located in the Chart Room.

★

Somewhere in the South Pacific Coast Guardsmen tune in on their portable set-up on the beach to establish radio contact with their ship standing off shore.

★

Somewhere inside this Fathom-eter—somewhere in the portable radio set-up—but always in a vital spot, will be found EL-MENCO SILVER CAPACITORS performing, in their unobstrusive way, their very important functions.

Our new Capacitor Catalogue, for manufacturers of Electronic Equipment, is now ready for distribution. Send for it today—on your firm letter-head.

The ELECTRO MOTIVE MFG. CO.

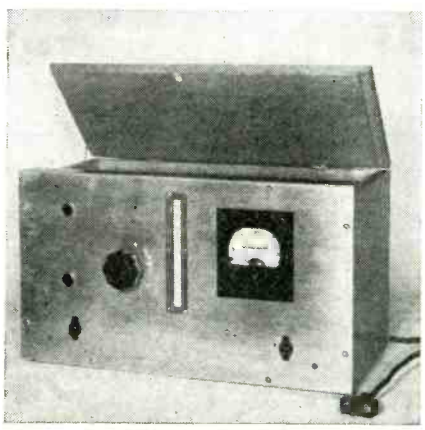
WILLIMANTIC · · CONN.

sensitivity in the red and infra-red region and readings were obtained against dilutions of a standard solution of copper sulfate, containing 6 percent (6.1336 grams of cupric sulfate pentahydrate per 100 ml of water) of copper sulfate. Previously designed densitometers have required relatively large samples of solution for satisfactory analysis.

Operation

In the Baier microdensitometer, both phototubes function through one light source; changes of intensity in illumination having the same effect on both cells but no influence on the null reading. Voltage to the amplifier circuit and the phototubes is stabilized by a VR 105–30 voltage-regulator tube. The instrument functions on the principle that a very minute change in light intensity falling on one phototube against that falling upon the other, after they have been adjusted previously for the null point, causes a change in electronic emission of one phototube. Accordingly, the grid of the electronic amplifier becomes either more or less negative than when at the null point and the tube, in turn, causes the microammeter in the plate circuit to indicate a deflection.

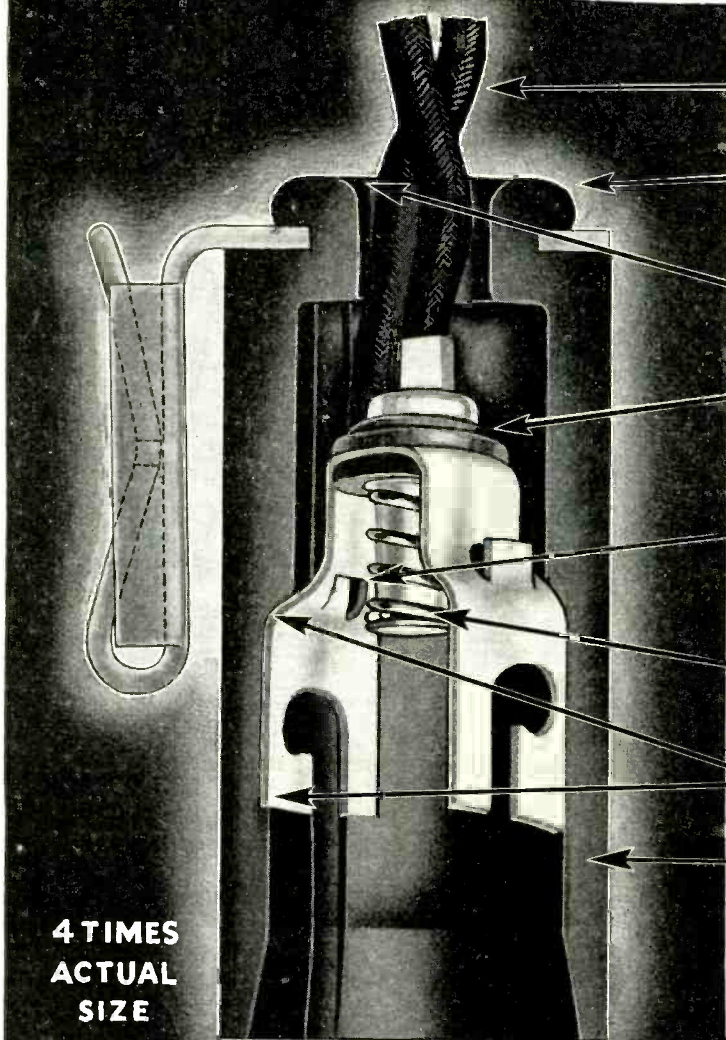
A light wedge (decreasing the size of the light-transmitting window) is then manipulated to cause



The turbidity of small amounts of solutions in chemical test tubes can be measured with this electronic microdensitometer

the microammeter to register the null reading again, returning the phototubes back to the same degrees of illumination and electron bombardment as in the first place. The amount of movement of the light wedge, necessary to return

a New and Superior DIAL LIGHT SOCKET



Tensile strength of leads and connections far in excess of requirements.

Tough, plastic shell molded around bracket providing a secure bond with mechanical strength far beyond any normal requirement.

Rounded edge will not cut or fray wire insulation.

Voltage Breakdown between contacts—1200 Volts. Voltage Breakdown to ground —5000 Volts.

Lug on contact fits in groove in shell so that contact cannot be turned or twisted when inserting lamp.

Center contact mounted so that it cannot protrude from shell and short on chassis when lamp is removed.

Plastic shell is recessed for contacts, which cannot be pushed or pulled out of position.

Stronger, tougher, heavy walled plastic shell.

A variety of different mounting bracket styles available, suitable for practically any mounting.

For Your Present and Post-War Production

Lenz Dial Light Sockets have always been known for their superior mechanical qualities and electrical characteristics.

Now these sockets are still further improved, with even greater mechanical strength. A stronger, tougher plastic shell is attached to the bracket with a new type of construction that provides a virtually unbreakable bond between shell and bracket. Its excellent electrical characteristics are maintained.

Consider these Lenz Dial Sockets for your present and post war production. Write for sample today.

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ELECTRIC CORDS, WIRES AND CABLES

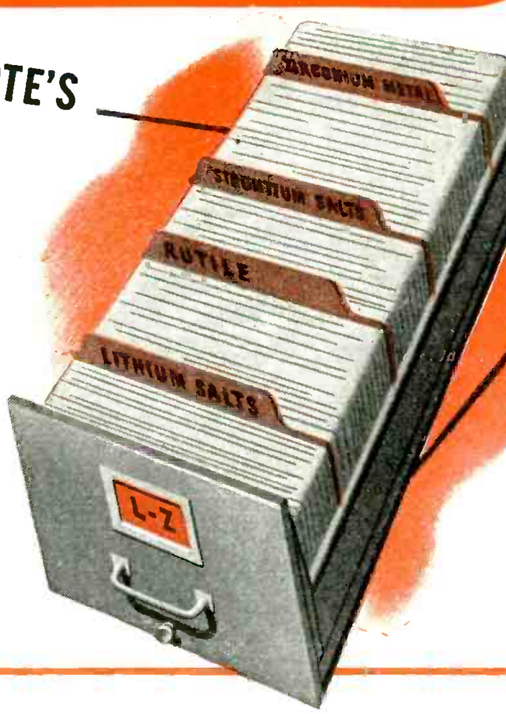
THE GAS GETTER WITHOUT A MIRROR!

Now that pure Ductile Zirconium is a reality, uniform production of transmitting tubes, rectifiers and cathode ray tubes with a perfect gas getter is within grasp. For here is the metal virtually unequalled as a gas getter, now available as readily workable wire, sheets and rods for anodes, grids, or tube supports that can be heated. Ductile Zirconium, produced by the Foote process (decomposition of Zirconium tetraiodide in vacuum), has structural advantages that make practical its widespread use—long obvious from its physical properties.

Zirconium, as you know, is a continuous getter at elevated temperature sorbing all but the rare gases. As such, it cleans up practically all gases in vacuum tubes, producing a better vacuum with less pumping time. Large quantities of oxygen and nitrogen and hydrogen can be sorbed without forming new phases . . . up to 40 atomic per cent of oxygen and 20 atomic per cent of nitrogen without X-ray evidence of a compound.

Except with hydrogen, the process is not reversible. Sorbed oxygen or nitrogen is not liberated even at temperatures exceeding 1500°C. And since Foote Ductile Zirconium won't volatilize below 2900°C., there's no mirroring deposit on tube walls . . . clear glass is assured and inter-electrode leakage is reduced. Consider Ductile Zirconium as a source of more perfect vacuum . . . longer tube life . . . and perhaps other startling benefits yet undiscovered! Small pieces, for instance can be welded to the molybdenum anode for getter flags. Ask us for specific data that might well fit *your* electronics plans.

THIS FILE MEANS BUSINESS—FOOTE'S



From "A" for "Air Conditioning" and "Ammunition" to "W" for Welding and "White ware", Foote research and products are in demand by American industries. Whatever your business there is a strong possibility that you can use one of the hundreds of Foote products (ores, minerals, chemicals and alloys) to advantage or that you may benefit through Foote research. Find out what Foote is doing within your industry. Let Foote work with you in developing the materials you use.

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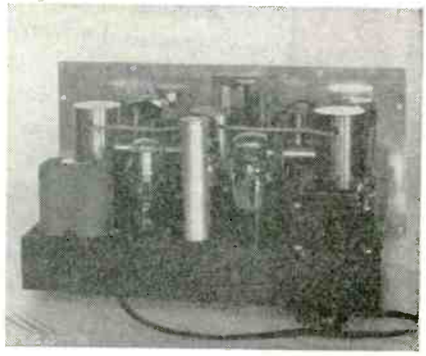
the instrument to the null point, is an exact measure of the quantity of light absorbed by the unknown sample. Thus, this densitometer is brought to an arbitrary null point for each determination by controlling the light shed upon the two phototubes.

A pair of like sample chemical tubes, when positioned successively in the path of the illumination going to one phototube, will not cause a change in the null point. If one of the tubes is replaced by an unknown chemical tube of different density, less light will go through to fall on the one phototube, and the light wedge must be adjusted to return the apparatus to the null reading. Graphs are plotted, on



Light from a centrally located bulb shines horizontally through a tubing to shielded phototubes at the ends of the chassis in the microdensitometer. Chemical test tubes containing solutions are inserted in each lightbeam through orifices in the tubing

semi-logarithmic paper, of the light-wedge observations to be had from solutions of known density, and the unknown sample concentration is obtained by referring to the known graphic determination. With a calibration curve for any substance, it can be employed for computing the unknown sample, inasmuch as the light wedge cannot alter its calibration, as is possible using direct readings from phototube-meter instruments.

The degree of sensitivity can be controlled by varying the voltage impressed upon the phototubes, or on the plate and screen of the amplifier tube. Different ranges of sensitivity can be provided by varying the screen voltage from a tapped voltage divider with a multipole switch. The apparatus may be also used as a turbidimeter and abridged spectro-photometer.

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No Wiring Harness Is Too Complicated For Us To Produce

If your production needs include wiring harnesses, bonding jumpers, or cable assemblies — you have everything to gain by getting in touch with Whitaker... Backed by a quarter of a century of experience in cables for automotive, electrical, radio, marine, and aviation applications, our organization is well qualified to turn out work quickly . . . accurately . . . satisfactory . . . in volume — to your specifications . . . Whitaker has the "know-how", skilled manpower, and ample plant facilities for a big volume of war-time and post-war production.

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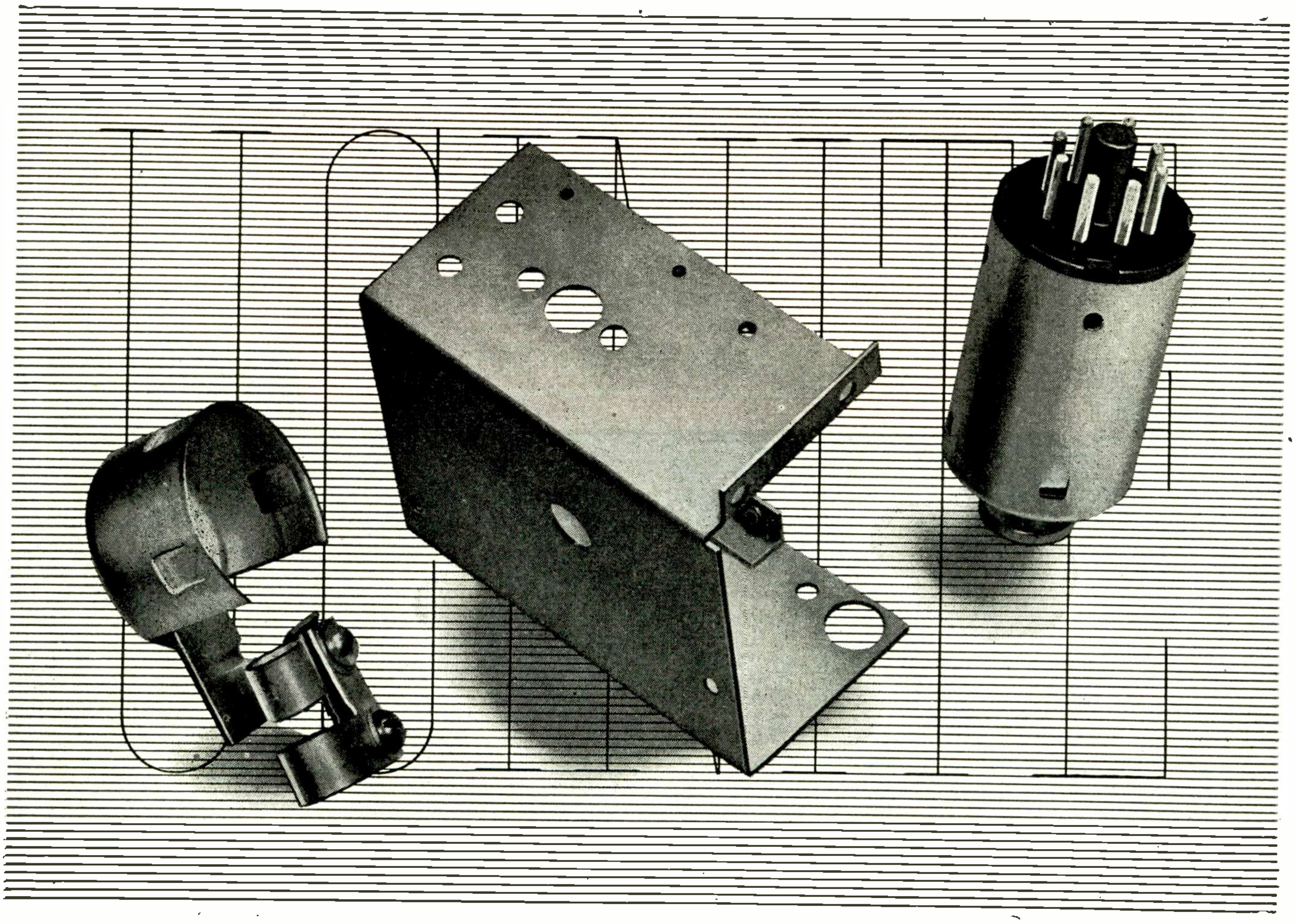

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These drawn-and-formed metal parts are good examples of what our customers say is one of Ucinite's strongest points . . . *ingenuity.*

Ucinite believes in utilizing the skill of its engineers and the ingenuity of its production men to cut corners and costs at the same time. We like to stick to simple tools, as we did in making the metal parts and assemblies shown above.

The results show up in the greater flexibility of our manufacturing schedules, in the higher quality of Ucinite products and in lower prices . . . which can be proved by direct comparisons.

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LAMINATED BAKELITE ASSEMBLIES
CERAMIC SOCKETS • BANANA PINS &
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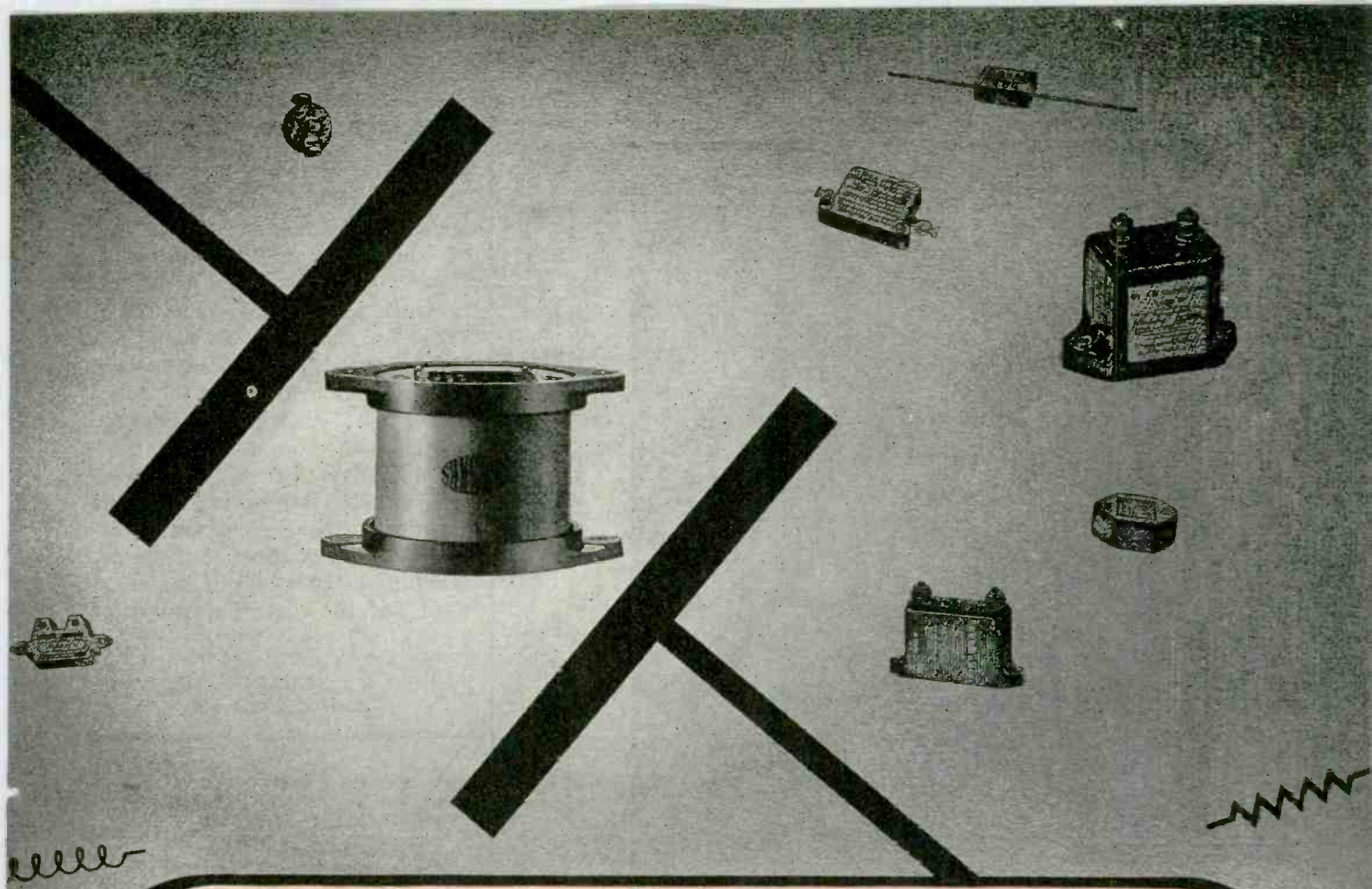


Zeros of Bessel Functions

THE TABLES SHOWN give the positive real roots between 0 and 25 for function and first derivative of Bessel functions of the first kind. These tables were prepared by D. B. Smith, L. M. Rodgers and E. H. Traub for use by the Research Division of the Philco Engineering Department and appear in the *Journal of the Franklin Institute* for April, 1944.

Table I is a table of the roots of the first derivatives ($J'n$) of the functions. These roots were computed by one of three methods depending on the values of the argument and the root. For values of

TABLE I

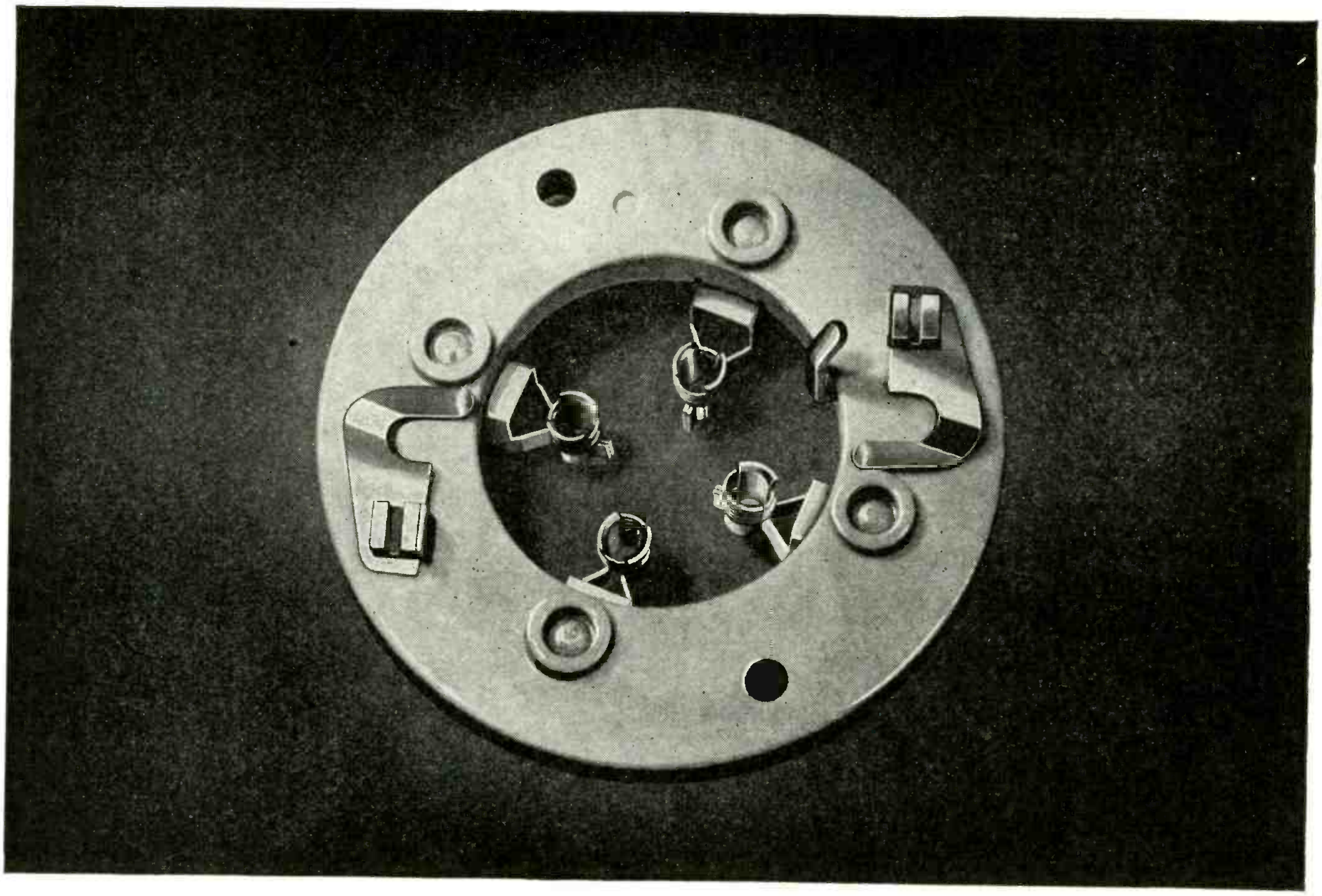
Roots of $Jn'(X_s) = 0$

Order \ Root	1	2	3	4
0	0.0000	3.8317	7.0156	10.1735
1	1.8412	5.3314	8.5363	11.7060
2	3.0542	6.7061	9.9695	13.1704
3	4.2012	8.0152	11.3459	14.5859
4	5.3175	9.2824	12.6819	15.9641
5	6.4156	10.5199	13.9872	17.3128
6	7.5013	11.7349	15.2682	18.6374
7	8.5778	12.9324	16.5294	19.9419
8	9.6474	14.1156	17.7740	21.2291
9	10.7114	15.2868	19.0045	22.5014
10	11.7709	16.4479	20.2230	23.7608
11	12.8265	17.6003	21.4309	
12	13.8788	18.7451	22.6293	
13	14.9284	19.8832	23.8194	
14	15.9754	21.0154		
15	17.0203	22.1423		
16	18.0633	23.2644		
17	19.1045	24.3819		
18	20.1441			
19	21.1823			
20	22.2191			
21	23.2548			
22	24.2894			

	5	6	7	8
0	13.3237	16.4706	19.6159	22.7601
1	14.8636	18.0155	21.1644	24.3113
2	16.3475	19.5129	22.6721	
3	17.7888	20.9724	24.1469	
4	19.1960	22.4010		
5	20.5755	23.8033		
6	21.9318			
7	23.2681			
8	24.5872			

	9
0	25.9037

the argument 15 or less, and for orders seven and below, the first three roots were obtained by the method of successive approxima-



NOW THE SIGNAL CORPS HAS A BETTER TUBE SOCKET

Another Engineering Accomplishment of The Hubbell Development Laboratory

THE IMPROVED rectifier tube socket in some of the Army's radio communication sets resulted from Harvey Hubbell, Inc. being asked to make the socket by a builder of the equipment. Even though the socket had been made by other manufacturers, the Hubbell Development Laboratory made its own analysis for possible improvements.

Four structural changes to give the socket greater dependability, were recommended by the laboratory. These changes are shown in the diagrams below. They were immediately approved by the Signal Corps and are now incorporated in all sockets of this type manufactured by Hubbell.

The influence of Hubbell engineering is seen in the electrical and electronic fields and throughout industry in general. The modern Hubbell line of connectors, switches, sockets and receptacles is the result of more than half-a-century of intensive research and development. New products have been created to satisfy existing needs. Other products long in use have been improved to keep abreast of changes in service conditions.

Today the need for Hubbell products by manufacturers of war equipment limits our commitments for additional business. The laboratory, however, is available to those who need help in the engineering of electrical connectors for war time applications and for post-war uses. Send the details of your problems to Hubbell Development Laboratory, Bridgeport 2, Conn., or if you prefer we will have one of our technical advisers call upon you.

MAJOR IMPROVEMENTS BY HUBBELL

(1) Spring Clip re-designed with coiled reinforcing springs securely held in place and tempered to withstand maximum heat. This increases contact pressure, equalizes bearing on tube pins and "snubs" the contacts against relaxation. (2) Second "Hold-Down" added to prevent tube from "jumping" or rising due to vibration and to completely eliminate any tendency of the tube to rock. (3) Rivet Heads "bossed in." A raised boss surrounding the contact blade mounting rivets was added to the ceramic insulator. This reduced high-voltage leakage by increasing the length of the current path. (4) Contacts anchored to ceramic insulator to assure proper positioning.

TRADE HUBBELL MARK

HUBBELL

DEVELOPMENT LABORATORY OF HARVEY HUBBELL, INC.

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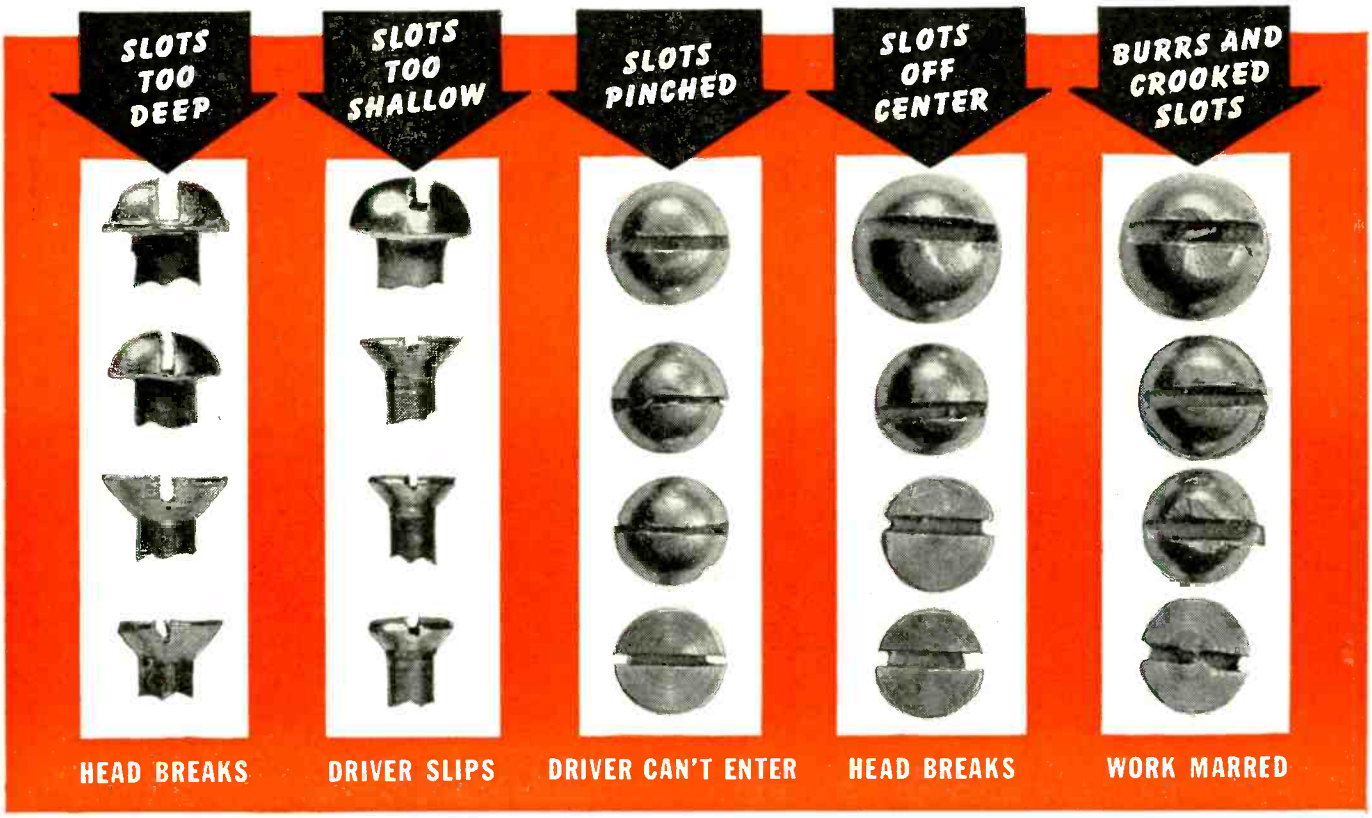
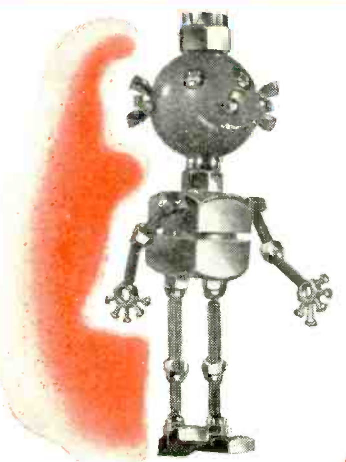
There's a big difference in Fasteners...even in ordinary Slotted Screws. It pays to insist on Fasteners that are made right. Here are some common faults to look for in Slotted Screws...





National
HEADED AND THREADED
PRODUCTS

It is commonly assumed that "screws are just screws"—all pretty much alike—regardless of who makes them. However, quality varies widely even in the common wood or machine screw, and it makes a lot of difference both in assembly time and in amount of spoiled or marred work.

The enlarged photographs above picture a number of the common faults actually found in a single purchase of commercial screws NOT made by *National.*

Insist on the screws you buy having clean slots of the right depth, properly centered, free from burrs, with good threads and points. Attention to details such as these will result in lower assembly costs and a much better product.

THE NATIONAL SCREW & MFG. CO., CLEVELAND 4, O.

tions using elementary functional equations derived from the series solution of Bessel's equation. The values of J_0 and J_1 for this method were taken from Table I of Gray, Matthew and MacRoberts, "Bessel Functions." When values of the argument separated by 0.01 caused the function to change from one sign to the other, two additional places were interpolated, assuming linearity.

Higher roots, i.e., the 3rd and above, of the order to and including seven, were obtained by the M'Mahon series. The equations used were found on page 260 of Gray, Matthew and MacRobert. However, the equation for the zeros of the first derivatives as given there is incorrect, the equation given being that for the $(S+1)$th root, and not for the Sth root as indicated there.

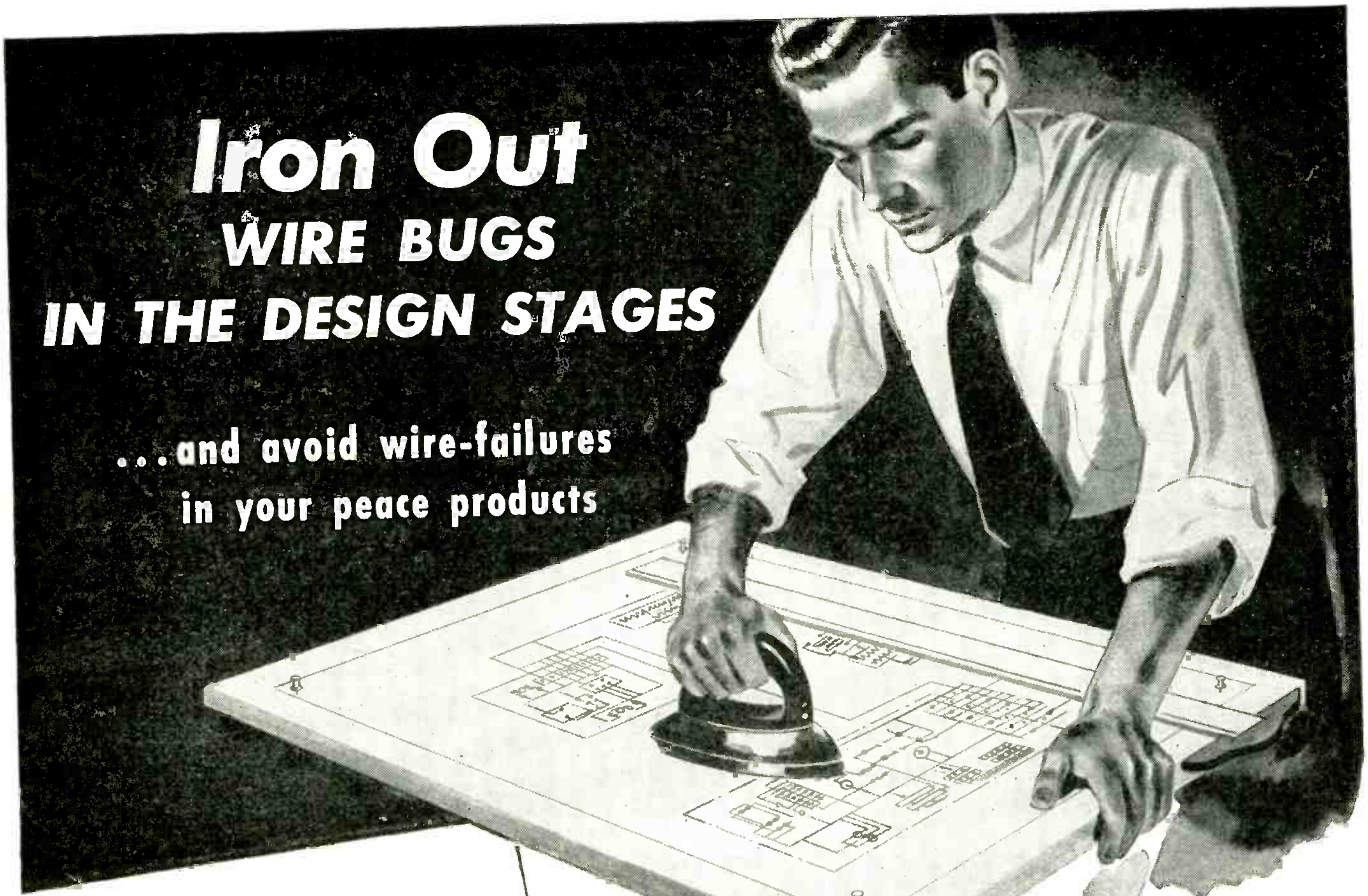
For orders above the 7th, Taylor's series was used for all roots by taking successive approximations. The values of $J_n(x)$ for all orders for integral values of x up to 25 are given in Table II of Gray, Matthew and MacRobert. From this

TABLE II

Roots of $J_n'(X_s) = 0$

Order n \ Root s	1	2	3	4
0	2.40483	5.52008	8.65373	11.79153
1	3.83171	7.01559	10.17347	13.32369
2	5.13562	8.41724	11.61984	14.79595
3	6.38016	9.76102	13.01520	16.22347
4	7.58834	11.06471	14.37254	17.6160
5	8.77142	12.33860	15.70017	18.9801
6	9.93611	13.58929	17.0038	20.3208
7	11.08637	14.82127	18.2876	21.6416
8	12.22509	16.0378	19.5545	22.9452
9	13.35430	17.2412	20.8070	24.2339
10	14.47550	18.4335	22.0470	
11	15.58985	19.6160	23.2759	
12	16.6983	20.7899	24.4949	
13	17.8014	21.9562		
14	18.9000	23.1158		
15	19.9944	24.2692		
16	21.0851			
17	22.1725			
18	23.2568			
19	24.3383			

	5	6	7	8
0	14.93092	18.07106	21.21164	24.35247
1	16.47063	19.61586	22.76008	
2	17.95982	21.11700	24.27112	
3	19.40942	22.58273		
4	20.8269	24.1990		
5	22.2178			
6	23.5861			
7	24.9349			

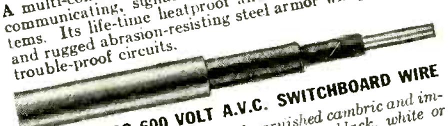


ROCKBESTOS FIREWALL RADIO HOOKUP WIRE

Sizes No. 22 to 4 AWG in 1000 volt rating, and No. 12, 14 and 16 AWG in 3000 volt.
The first lightweight, small diameter, flame-resistant hookup wire, designed in 1937 and widely used since in airborne and ground communication systems, electronic devices, instruments and apparatus. Operating temperatures range from 125° C. to minus 50° C. Also with tinned copper shielding braid and in twisted pair or tripled construction.

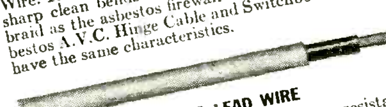
ROCKBESTOS THERMOSTAT CONTROL WIRE

Sizes No. 14, 16 and 18 AWG in two to six conductors with .0125", .025" or (for 115 volt service) .031" of felted asbestos insulation and steel armor.
A multi-conductor control wire for low voltage intercommunicating, signal and temperature control systems. Its life-time heatproof and fireproof insulation and rugged abrasion-resisting steel armor will give you trouble-proof circuits.



ROCKBESTOS 600 VOLT A.V.C. SWITCHBOARD WIRE

Sizes No. 18 to 4/0 AWG with varnished cambric and impregnated asbestos insulation and gray, black, white or colored flameproof cotton braid.
Combine fire insurance and fine appearance in your switchboards with Rockbestos A.V.C. Switchboard Wire. It is fireproof, will not dry out under heat, and sharp clean bends can be made without cracking the braid as the asbestos firewall acts as a cushion. Rockbestos A.V.C. Hinge Cable and Switchboard Bus Cable have the same characteristics.



ROCKBESTOS TYPE CA LEAD WIRE

Has high dielectric strength and moisture resistance for use where heat and humidity are encountered. No. 20 to 8 AWG solid or stranded copper, monel or nickel conductors insulated with synthetic tape and various thicknesses of felted asbestos finished in black, white or colors for coding purposes. Also with All-Asbestos insulation only, where high moisture resistance is not required.

INVESTIGATE ROCKBESTOS PERMANENTLY INSULATED WIRES, CABLES AND CORDS

Wire-planning products when they are on the drawing boards eliminates possible wire bugs that will cause trouble and customer dissatisfaction after the product reaches the user. By giving advance consideration to operating conditions, voltages, dielectric strength, diameters, probable ambients, etc., product designers can then select the right wire to fit the specific requirements, thus assuring dependable, long-lived performance when the product reaches the user.

If you haven't wire-planned your peace product, investigate *permanently insulated* Rockbestos wires, cables, and cords. One of the 122 standard constructions will probably meet your particular requirements. These wires all have a *permanent* asbestos insulation that resists heat, flame, moisture, cold oil, grease and alkalies.

If you need help on your wire problems . . . whether it be complete solution of your wire needs or special wire constructions . . . Rockbestos Research will gladly cooperate with you. Write to nearest branch office or:

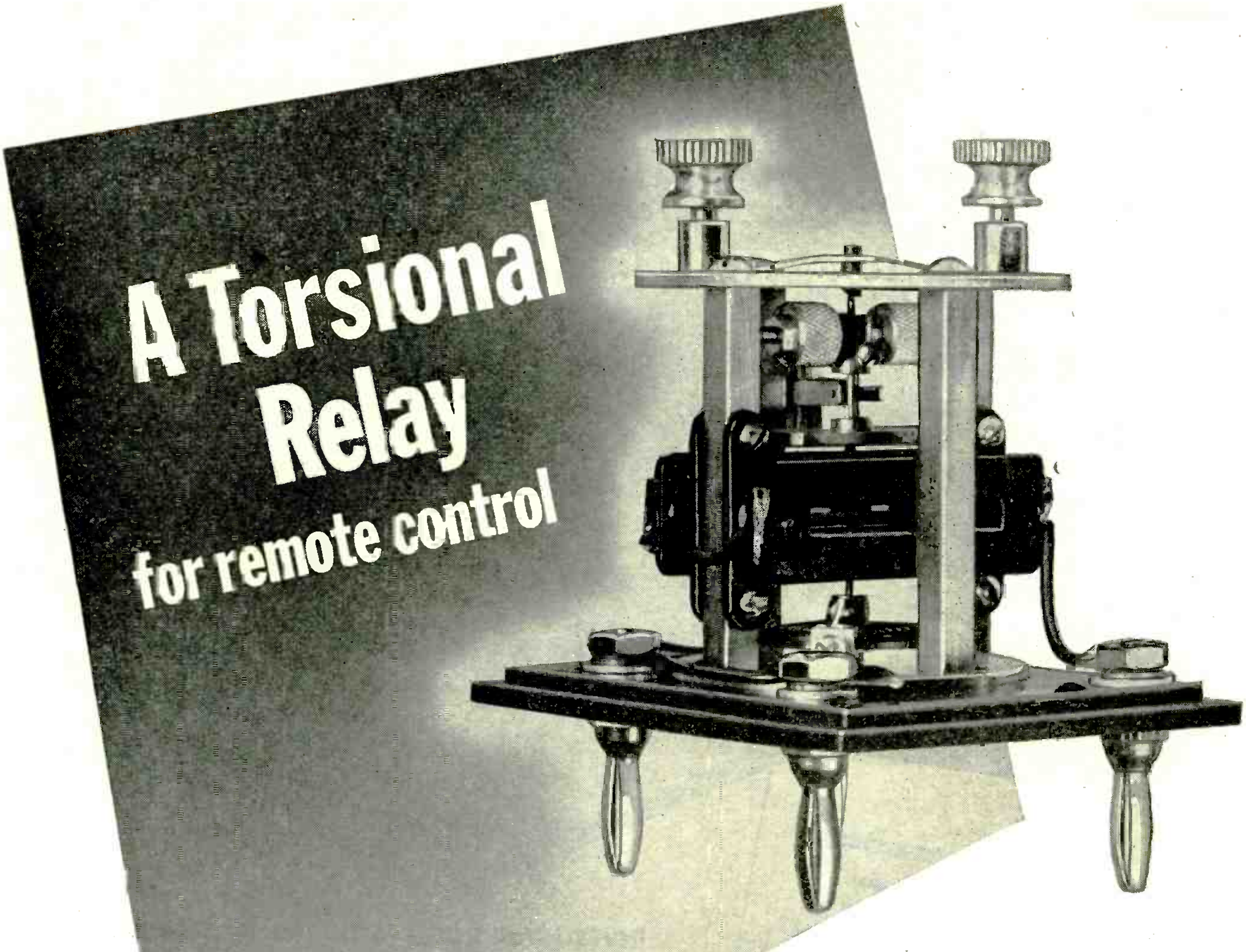
Rockbestos Products Corporation, 413 Nicoll St.
New Haven 4, Conn.

FOR VICTORY ... BUY WAR BONDS

ROCKBESTOS RESEARCH

Solves Difficult Wiring Problems

NEW YORK, BUFFALO, CLEVELAND, CHICAGO, PITTSBURGH, ST. LOUIS, LOS ANGELES, SAN FRANCISCO, SEATTLE, PORTLAND, ORE.



A Torsional Relay
for remote control

through direct wire transmission or with modulated radio carrier waves

PURPOSE: To control a number of operations in a variable sequence from a remote location where the physical limitations and economic factors, such as distance, dictate the use of only one pair of wires or radio carrier waves.

FEATURES: ***Range*** — 10 to 20 cycles per second.

Sensitivity — Less than 3.0 seconds from impression of a 5 volt 0.0012 ampere current pulse of constant amplitude and at the resonant frequency to which the relay is adjusted.

Selectivity — Resonant frequency plus or minus 2.5% under above conditions for response.

Stability — Excellent over a wide range of ambient temperature and pressure.

Contact Capacity — In controlled circuit, 50 milliamperes.

An illustrated technical bulletin will be furnished on request.

ARMY E NAVY

A-16

WALLACE & TIERNAN
PRODUCTS, INC.

BELLEVILLE 9 **NEW JERSEY**

The Problem of Black Light Prospectors ... and how

P. R. MALLORY & Co. Inc. MALLORY Vibrators Solved It

The Mineralight is a quartz ultra-violet lamp which, when used in darkness, excites vivid color responses from fluorescent objects. It is especially valuable in assaying minerals; and in all parts of the world its magic black light rays are uncovering hidden wealth in scheelite, mercury, zinc and other ores.

In ordinary prospecting, no source of commercial alternating current is available to operate the lamp. So the makers of the Mineralight came to Mallory for help in obtaining high voltage direct current from a low voltage storage battery. Standard Mallory vibrators were recommended, and proved their long life and dependability in arduous service. Today the Mineralight is an indispensable instrument in mill and mine operations.

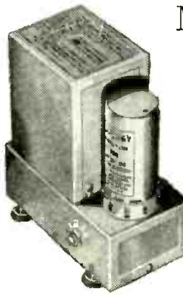
This performance record, like those established by Mallory vibrators in millions of automotive, aircraft and electronic devices, is not a happen-so. It was earned the hard way—by long experience, quality workmanship, and the most extensive research ever undertaken by a vibrator manufacturer.

If the use of your product depends on the conversion of power from low voltage or battery sources, Mallory "know how" can serve you well.

Buy More War Bonds

Preferred by the Armed Forces—

MALLORY Vibrapack*



Flexible, heavy-duty vibrator power supply, built to take rough handling and to operate under great extremes of heat, cold and humidity. Widely used under war conditions. Ideal for peacetime products.

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ARMY E NAVY

P. R. MALLORY & CO. Inc. MALLORY VIBRATORS AND VIBRATOR POWER SUPPLIES

table all derivatives of $J_n(x)$ may be obtained.

Table II is a table of the roots of the Bessel functions themselves and, with the exception of the first roots of the 16th through 20th, orders were all calculated by the last mentioned method, taking two points for each root and interpolating.

The first roots of the 16th through 20th orders were obtained by use of the formula found on page 143 of Jahnke and Emde, "Table of Functions" third edition, which equation holds good only for high orders of the functions.

It is believed that the tables are accurate to the extent that the last figure is within plus or minus two of the correct value.

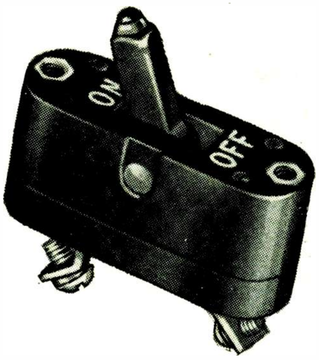
• • •

Effect of Thin Oxide Films on Cathodes

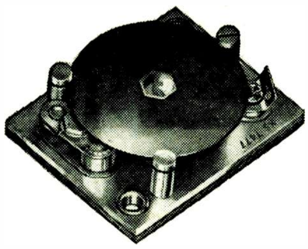
POSSIBLE MODIFICATION in existing theories of oxide-coated cathodes are suggested in a paper by George E. Moore and H. W. Allison of Bell Telephone Laboratories, Inc., abstracted in the *Physical Review* for April 1 and 15, 1944. Data are presented which indicate that approximately 0.001 monomolecular layer of alkaline earth oxide absorbed on tungsten or molybdenum filaments produces optimum thermionic emission which is approximately the equivalent of that obtained with conventional oxide-coated cathodes.

An effort was made to eliminate the effects of free alkaline earth metal. It was found that the heats of adsorption of the oxides to either tungsten or molybdenum are equivalent to the heats of formation of stable compounds and are in the order BaO, SrO, CaO; and that for SrO (and probably for BaO) the tenacity of adsorption to the support metal is in the order Mo, W, Ta, Pt—Rh.

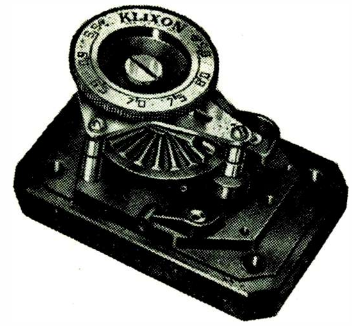
The order of the thermionic emission is the same in the various systems investigated. The chemical activity of the oxides is in the same order. It is suggested that differences in the dipole characteristics of the three alkaline earth oxide molecules are responsible for the differences in thermionic emission, adsorption, and chemical activity. A theory involving oriented adsorption is proposed which appears to account for the phenomena.



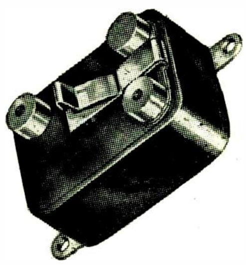
Type C-6363 Switch Circuit Breaker



Type B-3120 Thermostat and Heater, Crystal Dew Point Control



Type RT Thermostat. Adjustable Temperature Control



Type C-7220 Precision Snap Switch. 12 amps. 30 Volts D.C., 125 Volts A.C.

SNAP

the circuit is open . . .

it's closed . . .

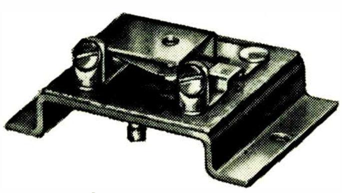
Klixon Disc-Operated Controls

provide accurate, dependable performance

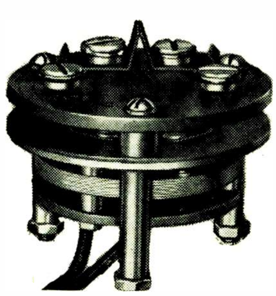
Actuated by the scientifically calibrated thermostatic disc, Klixon disc-operated controls "snap" the circuit open with a quick, clean break—and "snap" it closed again to a solid make no matter how often they operate. Because Spencer Controls have no complicated relays, toggles, magnets or other fussy parts, their accurate performance is unaffected by shock, vibration, motion or altitude regardless of the position of mounting.

No matter what your control problem—such as motor and transformer overheat protection, electrical circuit overload protection, thermal time delays or temperature control for radio equipment—it is probable that one of the many standard types of Klixon snap-acting Controls will meet your requirements. Write for complete information today.

Type C-2851 Thermostat. For such use as Roughing Controls on Outer Crystal Ovens



Type C-4351 Thermostat. Used for Tube Warming, Tube Cooling, High Limit Controls, etc.



Type ER Series. Ambient Compensated Time Delayed Relays

ARMY E NAVY

KLIXON

TRADE MARK REG. U.S. PAT. OFF.

SPENCER THERMOSTAT COMPANY, ATTLEBORO, MASS.

Electric Shock

(*Continued from page* 142)

about three times that of the 60-cycle current. This problem has been studied from two angles, one the maximum current which a person could stand before distress was caused and second, the amount of current required to kill laboratory animals.

The former method of attack was taken by A. E. Kennelly and E. F. Alexanderson.[5] Their data is summarized in Fig. 6. In each case the current was slowly increased until it was felt that further increase would cause distress. Note that the current that can be tolerated without distress rises rapidly with frequency.

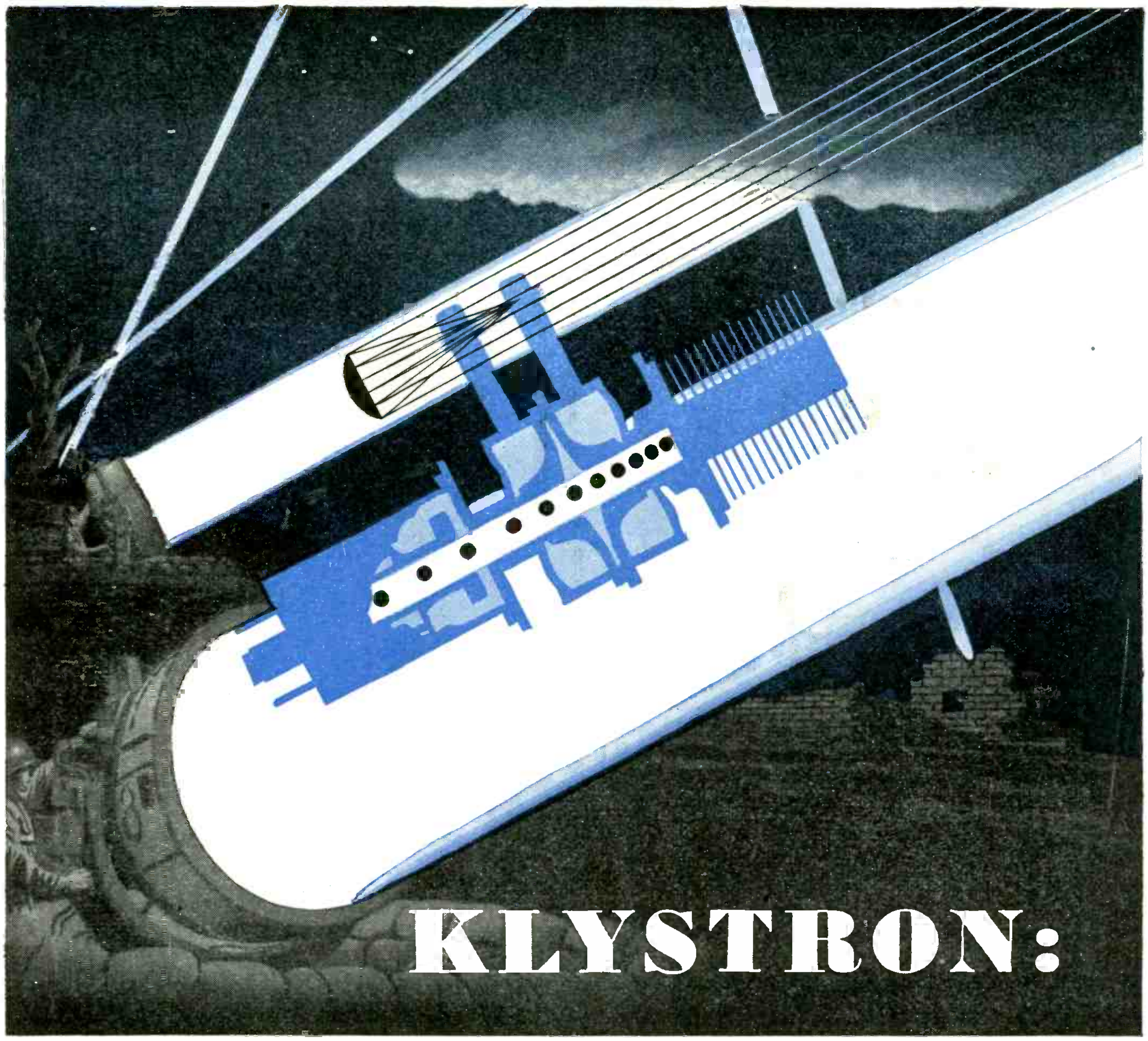
Above 100,000 cps the only effect produced by the current was that of heat. The explanation that has been advanced for this behavior is that the alternations of the current are too rapid to have any effect on the nerve cells.

The heating effect of the higher-frequency currents is used to advantage in diathermy machines where frequencies of 500,000 to 1,000,000 cps with currents of 0.5 to 5 amperes are used. A second application is electrosurgery. Here a platinum needle and a large electrode are used. The needle produces such a high current density that the tissues are completely destroyed by heat.

The second line of attack was taken by A. G. Conrad and H. W. Haggard[6]. They studied the currents necessary to cause death for shocks of different durations at various frequencies. Their results on rats are summarized in Fig. 7. Note that the amount of current required to kill increases with the frequency.

These results as well as those of W. Kouwenhoven, D. Hooker and E. Lotz[7] show that the frequencies that are the most dangerous are those in the neighborhood of 60 cps.

Let us turn our attention to the number of electrical accidents that actually occur, and the percentage of them that turn out to be fatal. An analysis by E. Krohne[8] of 848 electrical accidents in Germany from 1930 to 1935 showed that 314 involved voltages under 500 volts,



A pencil of energy beamed like light

IF YOU'LL imagine an *invisible* searchlight beam, you'll have a good picture of how Klystron-generated radio waves can be directed into a narrow "pencil" of energy.

▶ This direction is accomplished by suitable reflectors. The beam of ultra-high-frequency waves travels in a straight line, and it can pierce fog, smoke, and clouds which would stop a light beam.

Sperry-developed Klystron tubes are used in many equipments now serving our Armed Forces. Later, *Klystronics* will open the door to the development of many ingenious peacetime devices.

▶ **Klystrons are now being produced in quantities, and certain types are available.**

The name "KLYSTRON" is a registered trade-mark of the Sperry Gyroscope Company, Inc. Like many other Sperry devices, Klystrons are also being made during the emergency by other companies.

Sperry Gyroscope Company INC.

GREAT NECK, N. Y. • DIVISION OF THE SPERRY CORPORATION

GYROSCOPICS • ELECTRONICS • AUTOMATIC COMPUTATION • SERVO-MECHANISMS with an average fatality rate of 15 percent. The remaining 534 received voltages over 500 volts, with a fatality rate here of 33 percent.

W. McLachlan[9] gives more detailed information based on studies of 475 cases where electricity alone was the cause of death, not lack of resuscitation, broken necks, burns, etc. (Data by Krohne includes all these cases, hence this difference must be kept in mind when comparing the figures. The difference is particularly noticeable at high voltages, where death from burns, etc., is more probable.) McLachlan's figures are based on U. S. and Canadian industrial accidents, and divide the accidents according to the potential of the circuit involved:

Record of Accidents by Potential of Circuit Involved

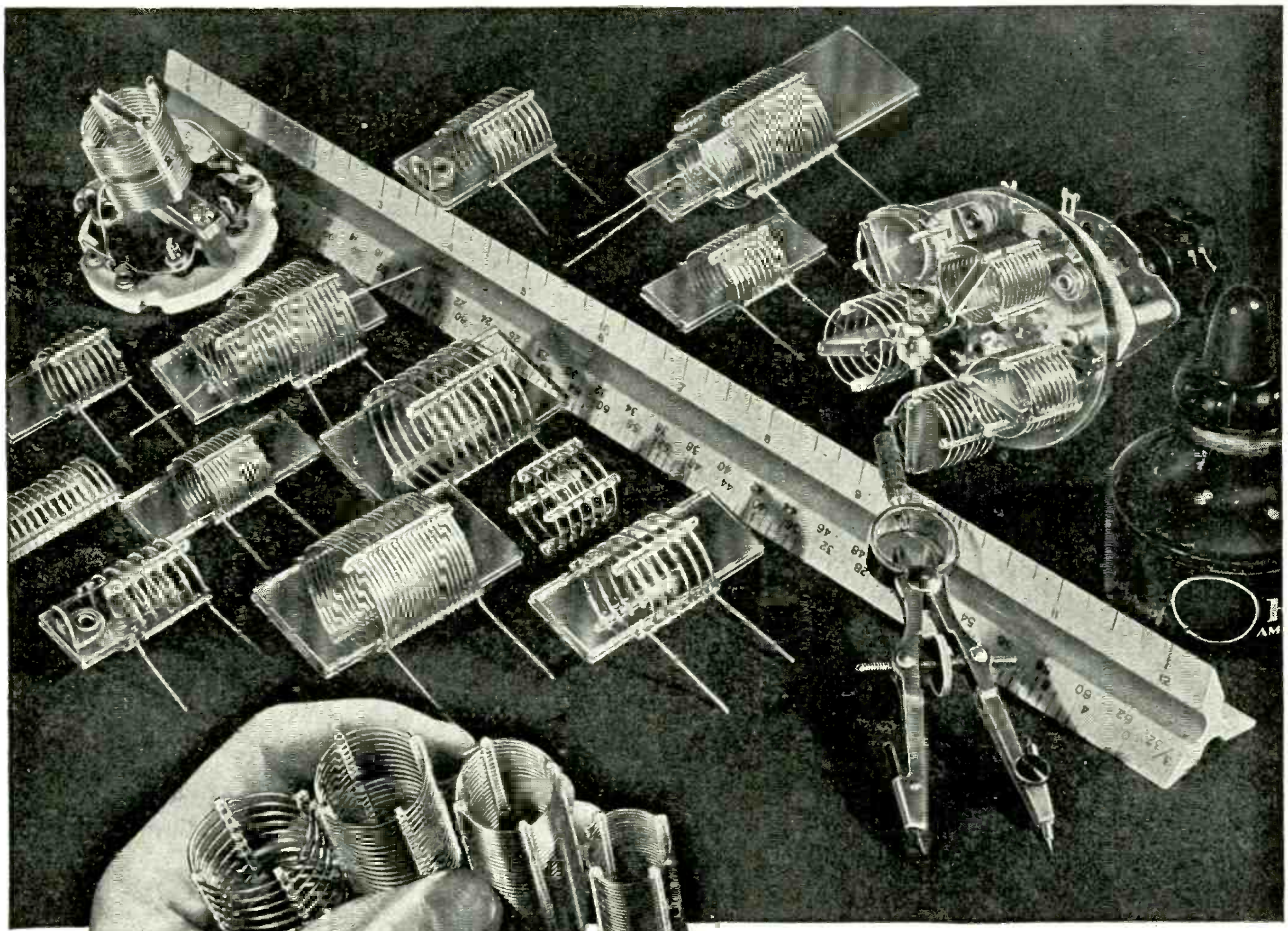
Volts	Total Cases	Successful Revival
0–749	65	63%
750–4999	212	65%
5000–39,999	167	69%
40,000 and over	26	88%

Note that the danger does not necessarily increase with the voltage. This is due to two reasons: first, the muscular reaction is more pronounced at high voltages, making it more likely that the person will be thrown clear of the circuit; secondly, as data on animals has shown, the heart is not thrown into fibrillation by very large currents (greater than 250 ma).

Segregation of these cases according to the method of clearing revealed that of 282 who fell clear, 70 percent were successfully revived of 179 who were pulled clear from the circuit, 63 percent were revived. This may appear puzzling at first, for one would expect the difference to be more pronounced. Remember, however, that it takes only a shock of a fraction of a minute to throw the heart into a fatal fibrillation or to cause a respiratory block. After that, the effect is a heating of the body. It is true that if the heating is very severe, it may cause damage to the cells of the nervous system or severe burns, but often it is not.

The data by McLachlan shows that if resuscitation is instituted soon after the accident, the fatality can be reduced to 33 percent. This is in agreement with the figure of 23 percent obtained by Kawaran-

Real "He Man" Coils IN MINIATURE!



B&W MIDGET
AIR-WOUND INDUCTORS

Now, for the first time, you can get B & W Air-Wound Coils in very small sizes from ½" to 1¼" diameter, in ⅛" steps, and in winding pitches from 44 to 4 turns or less per inch. Almost any type of mounting can be supplied.

Applications for these tiny coils include: coil switching turret assemblies; intermediate frequency transformers; high-frequency r-f stages (low-powered transmitter or receiver); all types of test equipment involving tuned r-f circuits; high-frequency r-f chokes, and numerous others.

The coils have a high Q, due to the almost total absence of insulating material in the electrical field. They are exceptionally light in weight and extremely rigid. Normally wound with tinned copper wire in sizes from #28 to #14, they can also be supplied with coin silver, coin silver jacketed, bare copper, or phosphor bronze wire. All types may be equipped with either fixed or variable internal or external coupling links, or other non-standard features. Samples on request to quantity users. Send us your specifications!

B&W

BARKER & WILLIAMSON
235 FAIRFIELD AVENUE **UPPER DARBY, PA.**

AIR INDUCTORS • VARIABLE CONDENSERS • ELECTRONIC EQUIPMENT ASSEMBLIES

Exclusive Export Representatives: Lindeteves, Inc., 10 Rockefeller Plaza, New York, N. Y., U. S. A.

ura in a study in Japan; the figure of 23 percent obtained by Baraita in a study in France; and the average fatality rate for 1930–1935 in Germany of 24 percent quoted earlier.

Jex-Blake[1] summarizes in a practical form in Table I much of the data presented in this paper.

Life-Saving Precautions

We will close with a few practical pointers:

1. Don't entertain a false feeling of security by believing that resuscitation can always bring a person back to life after an electric shock. If the heart is thrown into fibrillation (and this is quite possible) for all practical purposes death is instantaneous.
2. In case of electric shock, apply artificial resuscitation immediately. Do not delay to summon a doctor but try to get help while resuscitating the victim.
3. Never handle electric circuits with wet hands or when feet are wet.
4. If there is no other means of rescue, use your foot rather than your hand to free the victim from the live circuit.
5. When working on high voltage, be sure the floor is not a good conductor (as far as electric shock is concerned, a concrete floor is a good conductor).
6. When handling high-voltage circuits, it is a good rule to keep your left hand in your pocket.
7. Don't work in a position where your head is likely to become a conductor in an electric shock.

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(4) Langworthy, O. R., Nerve Cell Injury in Cases of Human Electrocution, *Journal American Medical Assoc.*, 95, p. 1107, July 12, 1930.

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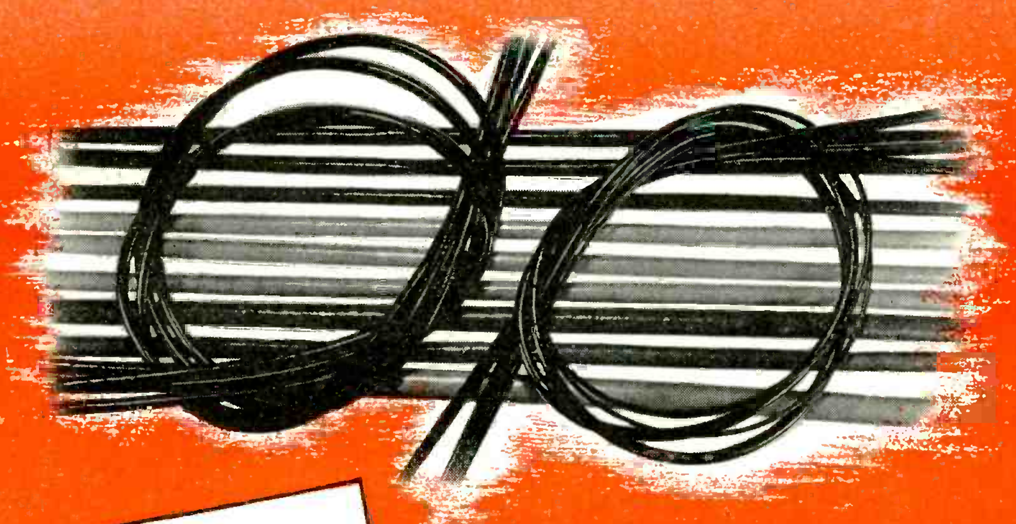
(9) McLachlan, W., Electric Shock; Interpretation of Field Notes, *Jrl. Industrial Hygiene*, XII No. 8, p. 291, Oct. 1930.

IRV-O-VOLT TUBING



VARNISHED inside and out...

TO GIVE YOU THESE 5 PLUS-FACTORS

More than flexibility . . . more than ordinary insulating values . . . are offered in the IRV-O-VOLT line of Varnished Tubing. One reason why: Every length is varnished inside *as well as out.*

This extra *inside* coating means that IRV-O-VOLT . . .

- **Saves assembly time because of greater inside smoothness.**
- **Offers unusually low moisture absorption.**
- **Cuts clean without feathering of braid.**
- **Prevents wicking action when used in oil-filled transformers.**
- **Provides a margin of insulating protection even when outside coating has become chafed.**

At ordinary operating temperatures, all types of IRV-O-VOLT tubing retain their flexibility for extremely long periods. In semi-rigid or rigid installations, they will withstand considerably higher temperatures.

For detailed information, or samples, write Dept. 106.

Wires between motor housing and casting are insulated with IRV-O-VOLT Flexible Varnished Tubing.

THE A, B, C OF IRV-O-VOLT SELECTION

Choose TYPE A-1 where exposure to high temperature cannot be avoided. Average dielectric strength — 7000 volts, 5000 volts minimum.

Choose TYPE B-1 where average dielectric strength of 4000 volts, 2500 volts minimum, is sufficient.

Choose TYPE C-2 to insulate the leads of armatures and field coils later to be dipped in varnish. Average dielectric strength—1500 volts, 800 volts minimum.

Choose TYPE CT for extra mechanical strength. A saturated sleeving of special heavy walled construction.

IRVINGTON VARNISH & INSULATOR COMPANY

IRVINGTON 11, N. J.

RESINS · EXTENDERS · PLASTICIZERS · EXTRUDED PLASTIC TUBING

NEWS OF THE INDUSTRY

Burst phenomenon in FM; railroad radio; television outlook; costs for FM stations; position of small business; experimental aircraft radio; scholarship awards; studying of world communication; London news letter

Pleas for Sustained Electronic Production

EVEN THOUGH ARMY-NAVY Electronics Production agency has been dissolved, the need for highest production levels in military electronics equipment is not abated. In a letter to prime contractors and component suppliers, L. R. Boulware, operations vice-chairman of WPB, pointed out recently that the L-183-a Limitations Order and Precedence List are still in effect and that manufacturers should continue to observe particularly the requirement that purchase orders be identified with Precedence List designations and schedules applicable to them. This information is more important than ever for efficient expediting and scheduling.

At the same time, action was taken against the unauthorized leakage of critical components into the hands of jobbers and distributors for civilian use. John S. Timmons, acting director of WPB radio and radar division communicated with prime contractors and test equipment makers by a letter which stressed the urgent necessity of conserving all idle and excess List B items for use in military production and to meet the heavy requirements of end equipment for the armed forces. Idle stocks held by the Army and Navy and excess stocks remaining after contract cancellations with manufacturers are included in that classification.

Five Video Stations per Company

AN AMENDMENT to the television regulations now makes it permissible for a single company to own or control a maximum of five video outlets instead of the three previously specified. In this change, FCC granted in part a request of NBC for seven licenses covering transmitters in Chicago, Cleveland, Denver, San Francisco, and Los Angeles in addition to the present New York facilities and a previously existing application in Washington.

Applications are also on file by NBC for FM stations in the same cities but existing limitations allow a maximum of six FM outlets for a single company.

Strange Behavior of F-M Signals Recorded

LONG DISTANCE BURSTS causing interference to f-m stations have been continuously recorded by the Federal Communication Commission for more than a year. Before any conclusions as to the causes of outside interference in these channels are reached, findings will be submitted to the Radio Technical Planning Board for criticism. However, certain observations have been made public recently by the Commission. The study is being conducted in spite of the accent on war effort because this recording program will be impossible when several radio stations are assigned and are operating simultaneously on each frequency, as will be the case during the post-war expansion.

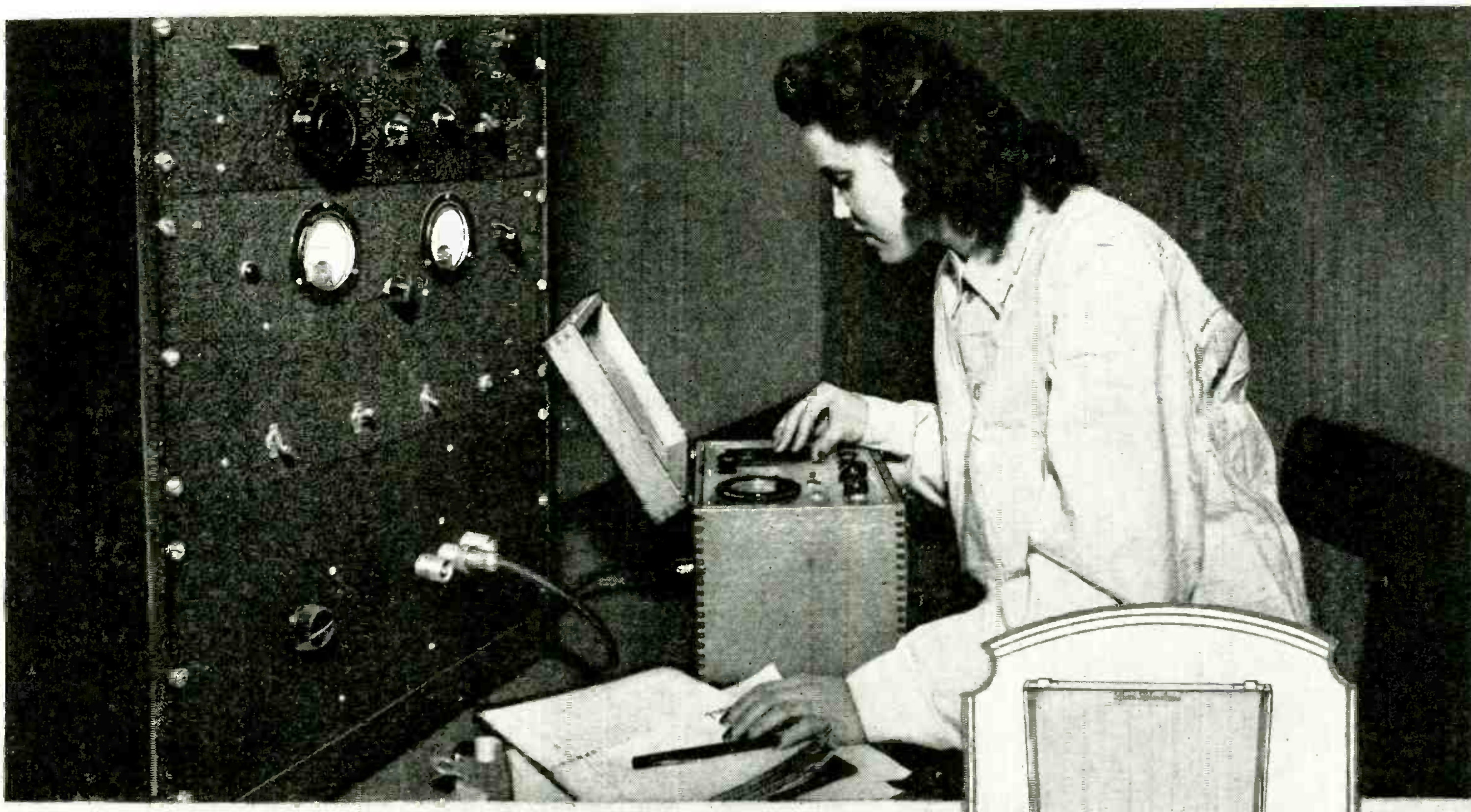
Preliminary recording of tropospheric waves were begun in the early part of 1942 from a location in Washington but the arrangements were unsatisfactory because of diathermy interference at this location. Equipment now installed at the Commission's monitoring station at Laurel, Maryland, has been recording continuously on four u-h-f broadcast stations since February, 1943.

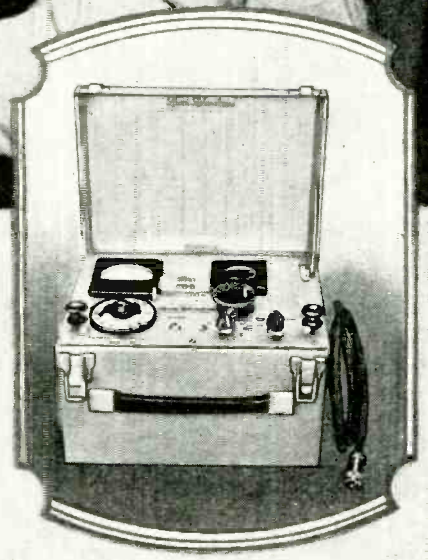
Equipment

The recordings have shown certain unexpected results with regard

Electronic Evolution Toward the Diminutive

Holding in his right hand one of the latest acorn tubes made by Sonotone, Dr. Lee De Forest (center) compares it with one of his own original audions in his left hand. Onlookers are, left to right, Dr. F. W. Kranz and I. I. Schachtel, vice-presidents, Paul Schwerin, tube-plant manager, and L. G. Pacent, consulting engineer, Sonotone Corp.





to radio propagation over distances of several hundred miles. These results indicate a necessity for rapid expansion of the program in order to record simultaneously at several points throughout the Eastern and Central parts of the United States. Additional equipment is now being installed at the Commission's monitoring stations at Allegon, Michigan; Atlanta, Georgia; Grand Island, Nebraska; and Portland, Oregon. When completed, there will be a total of fifteen recorders at the five monitoring stations. Some of the equipment was obtained on loan; some by transferring from other projects of less urgency.

So far recordings have been made only up to 117 Mc. Recordings are also being made of the aural signals of certain television stations on frequencies of 55.75, 65.75, 71.75 and 83.75 Mc.

Each recorder consists of a Hallicrafter S-27 receiver having a properly shunted 5-ma Asterline-Angus Recorder in the plate circuit of the first avc-controlled i-f stage. The receiver is fed from a simple doublet by a coaxial or a twisted pair line. Where several receivers are operated at the same site, they are connected in parallel to the same antenna lead-in. Power is supplied to the set through a Raytheon voltage stabilizer and the temperature of the set is held constant so that calibration and tuning will be maintained.

Nature of Interference

The amplitudes of the bursts, according to FCC engineers, have varied from the lowest levels which can be measured up to levels well in excess of that required to render a satisfactory f-m broadcast service. During periods of maximum activity they may occur at the rate of several hundred per hour. However, the amplitudes of but few of the bursts are sufficient to cause serious interference to a receiver operating within the protected area of an f-m station under present FCC standards.

Each burst is a sharp increase of signal strength of very short duration—seldom covering more than the time consumed by a single spoken word or a note or two of music—from an f-m station located at a considerable distance from the observer. The bursts were observed

RADIO AND TELEVISION

and their post-war prospects as viewed by STROMBERG-CARLSON

WE have built radios since 1924 and commercial television receiving sets as early as 1938. Our confidence in the future of television is best evidenced by the fact that we have recently applied for a license to operate our own television broadcasting station. However, in estimating the post-war market for radio and television, we believe you—and we—will be benefited by taking a strictly business, common sense point of view.

The Television Prospect . . . as we see it

1. Television has a *great* future.
2. There is tremendous public interest in television. However, it will be several years after the war before enough television stations can be built to provide full national coverage.
3. As television broadcasting facilities develop—territory by territory—good business opportunities will be presented to you . . . and to us.

When television broadcasting develops in your territory, Stromberg-Carlson will have a full line of television receiving sets which will bring to this rich field the 50-year-old fact: "There is nothing finer than a Stromberg-Carlson!"

The Radio Forecast . . . in our judgment

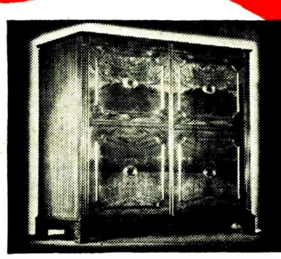
1. There always has been—always will be—a profitable demand for a good radio and radio phonograph—a fine musical instrument.
2. For the immediate post-war years, the expanding market for FM receivers and phonograph combinations will provide your greatest profit opportunity.
3. We believe that such instruments must have superlative tone quality and an appearance in keeping with the best in furniture design.

AND HERE'S OUR PLEDGE to get you back into profitable post-war business!

1. We will have—soon after Victory—a fine line of Stromberg-Carlson FM and AM radios, phonograph combinations and television receivers in a wide range of prices.
2. We will have a policy of distribution planned to give every Authorized Dealer a good profit opportunity on the Stromberg-Carlson line.
3. And the Stromberg-Carlson name will be even more widely and more favorably known than ever before.

STROMBERG-CARLSON
ROCHESTER 3, NEW YORK

RADIOS, TELEVISION, TELEPHONES, AND SOUND EQUIPMENT



ARMY E NAVY

from the higher powered f-m stations only. This may account for the failure of amateurs, experimenters, and others, to have reported this type of interference. The bursts are not normally observed from nearby f-m stations, since the steady ground wave signal is of sufficient strength to obscure them, but they may be observed in such instances by a system of pulsing or by a directional antenna which discriminates against the ground wave. At greater distances where the steady signal is absent or of low intensity, the bursts may be heard through the loudspeaker or may be recorded.

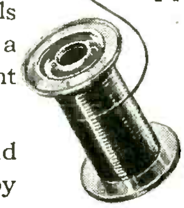
Bursts have been observed by both methods at distances up to 1400 miles from certain f-m stations, but are neither so intense nor so numerous at the longer distances as they are at distances of 300 to 700 miles. A systematic variation in the relative numbers of bursts occurs from hour to hour during the day, the highest number occurring near sunrise and the fewest near sunset.

It was pointed out these bursts may be related in some way to bursts of somewhat longer duration and greater frequency of occurrence which have been reported by other engineers on frequencies below 20 Mc. The distances over which the f-m bursts are received, as well as certain measurements of signal path length, indicate they are ionospheric in origin, just as are the bursts at the lower frequencies. There is also substantial agreement between the daily variations in the f-m bursts and the lower frequency bursts.

Commission engineers are continuing their experiments and it is hoped data will be obtained which may serve as a basis for approximating the amplitudes and numbers of the bursts to be expected at various distances from a transmitter at any given time. This determination involves not only a long-time measurement of burst amplitudes from f-m stations, but measurements as well of the path lengths and directions of arrival of the signals, in order to identify the medium causing the bursts.

Sporadic Action of E-Layer

There is another distinctly different kind of interference to v-h-f



reception which has been recognized for some years. It happens occasionally that a normally unheard station will come in with sufficient signal strength to operate a receiver satisfactorily for a considerable length of time—many minutes or even hours. This effect, easily distinguishable from the burst phenomenon by its duration, can be produced by transmitters of low power and has been known to produce a signal sufficiently strong to take control of a receiver tuned to a local station on the same frequency. The cause of this phenomenon has been traced to abnormal "patchy" ionic densities in the lowest of the ionospheric layers—the "E" layer—and is known as "sporadic E transmission." While much data on this effect has been accumulated at lower frequencies, more is needed for the v-h-f region.

Both of these interference effects are being studied by the appropriate Panels of the Radio Technical Planning Board. With this co-operation and that of other organizations, it is believed the Commission will find a satisfactory solution of the problems involved.

Working on the Railroad

FEASIBILITY OF RADIO MEANS for adding safety and efficiency to railroad operation is being investigated at an accelerated pace as the Federal Communications Commission orders an investigation and public hearings on the subject at a future date, as yet unspecified. The Interstate Commerce Commission may cooperate by establishing a committee of commissioners to attend.

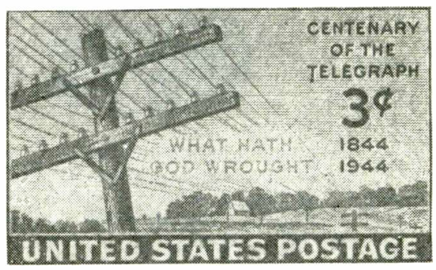
Specific possibilities mentioned by James L. Fly, FCC chairman, include radio-operated block systems, radio flagging of trains, and communications for crew contact between engines and rearend cars. While no regular use of railroad radio is listed in the United States, 22 applications have been submitted to FCC during 1944 for experimental stations. Represented are: Baltimore & Ohio and Atlantic Coast line; Chicago, Burlington & Quincy Railroad Co.; Atcheson, Topeka & Santa Fe Railroad Co.; Chicago, Rock Island & Pacific Railway Co.; Reading Co.; and Denver & Rio Grande Western as well as

equipment-manufacturing Bendix Radio Div. of Bendix Aviation Corp.; Westinghouse Radio Stations Inc.; and Jefferson-Travis Radio Mfg. Corp.

Construction permits have been authorized to cover 9 experimental installations on the B&O between Baltimore and Pittsburgh and on the Burlington between Chicago and Denver as well as into Montana. Railroad radio in this regard is considered as distinct from carrier-current activities using rails or trackside conductors for transmission. Radio developments were contemplated in both the Radio Act of 1927 and the Communications Act of 1934. The latter specifically authorizes FCC in its discretion to exclude from requirements of its regulations in whole or part any radio station upon railroad rolling stock.

Anniversaries in the Electronic Family Tree

TWO OF THE PROGENITORS of the electronic art are celebrating birthdays. In May 1844, Samuel Finley Breeze Morse sent the first telegraph message, "What hath God wrought!" over a line between Baltimore and Washington. His original apparatus, property of



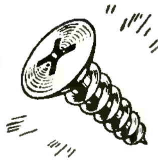
Special issue stamp commemorates the hundredth anniversary of Samuel F. B. Morse's "What hath God wrought!" message, the first practical application of intelligence communicated by wire. Photoelectric registration is used for perforation of the issue

Cornell University now, was sent to the Capitol for re-enactment of the original transmission.

Ezra Cornell, founder of the University, was an associate with Morse in the pioneering work and invented the special equipment which dug the trench, laid the cable, and covered it with soil in readiness for the first message. Defective insulation made the line unus-

IT'S LIKE GIVING YOUR ASSEMBLY LINE A SHOT IN THE ARM

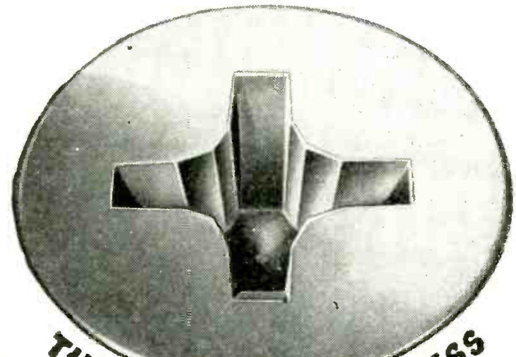
TO SWITCH TO



THE SCREWS WITH THE ENGINEERED RECESS THAT SPEEDS UP ASSEMBLY AS

MUCH AS 50%

IT'S PHILLIPS



THE ENGINEERED RECESS

Manufacturers in every industry can tell you that switching to Phillips Recessed Head Screws acts like a tonic to assembly lines.

To start with, you get faster – *much faster* – screw driving. Comparisons made in scores of plants prove that Phillips Screws step up fastening speed as much as 50%.

Next, Phillips Recessed Head Screws save precious man hours. The scientifically Engineered Recess utilizes the worker's full turning power and skill. Time and muscle are not wasted on wobbly starts, slantwise drives and dangerous driver skids – nor on correcting sloppy work.

Finally, with all this increased speed, you get vastly better workmanship. Phillips Recessed Head Screws make driving so simple, so steady that the most inexperienced operator soon becomes master of the trickiest fastening jobs!

If these are the kind of results you'd like, but aren't getting from slotted and other type screws, you owe it to yourself and to your workers to switch to Phillips – the screws with the *Scientifically Engineered Recess.* They cost *less to use* . . . because they help you *produce much more.* Any one of the 23 manufacturers below will enable you to prove it in your own plant.

TO MAKE WARTIME QUOTAS AND PEACETIME PROFITS

Faster Starting: Driver point automatically centers in the Phillips Recess . . . fits snugly. Fumbling, wobbly starts, slant driving are eliminated. Work is made trouble-proof for green hands.

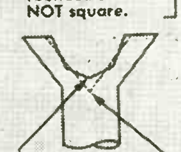
Faster Driving: Spiral and power driving are made practical. Driver won't slip from recess to spoil material or injure worker. (Average time saving is 50%.)

Easier Driving: Turning power is fully utilized. Workers maintain speed without tiring.

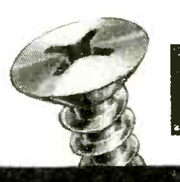
Better Fastening: Screws are set-up uniformly tight, without burring or breaking of screw heads. The job is stronger, and the ornamental recess adds to appearance.

IDENTIFY IT!

Center corners of Phillips Recess are rounded . . . NOT square.



Bottom of Phillips Recess is nearly flat . . . NOT tapered to a sharp point.



PHILLIPS *Recessed Head* SCREWS

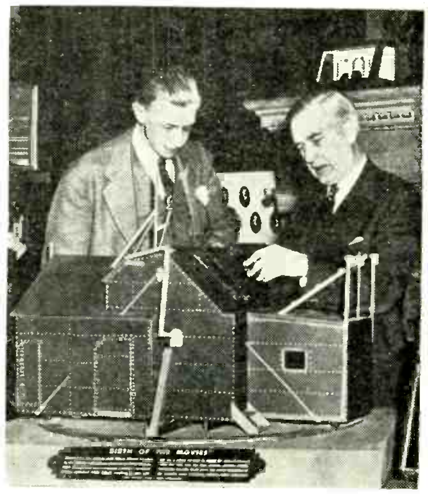
WOOD SCREWS · MACHINE SCREWS · SELF-TAPPING SCREWS · STOVE BOLTS

23 SOURCES

American Screw Co., Providence, R. I.
The Bristol Co., Waterbury, Conn.
Central Screw Co., Chicago, Ill.
Chandler Products Corp., Cleveland, Ohio
Continental Screw Co., New Bedford, Mass.
The Corbin Screw Corp., New Britain, Conn.
General Screw Mfg. Co., Chicago, Ill.
The H. M. Harper Co., Chicago, Ill.
International Screw Co., Detroit, Mich.
The Lamson & Sessions Co., Cleveland, Ohio
Manufacturers Screw Products, Chicago, Ill.
Milford Rivet and Machine Co., Milford, Conn.
The National Screw & Mfg. Co., Cleveland, Ohio
New England Screw Co., Keene, N. H.
Parker-Kalon Corp., New York, N. Y.
Pawtucket Screw Co., Pawtucket, R. I.
Pheoll Manufacturing Co., Chicago, Ill.
Reading Screw Co., Norristown, Pa.
Russell Burdsall & Ward Bolt & Nut Co., Port Chester, N. Y.
Scovill Manufacturing Co., Waterville, Conn.
Shakeproof Inc., Chicago, Ill.
The Southington Hardware Mfg. Co., Southington, Conn.
Wolverine Bolt Co., Detroit, Mich.

able so an overhead installation was substituted. It was Mr. Cornell who supplied the name Western Union to the subsequent operations.

Speaking before the IRE in the Western Union Building, New York, I. S. Coggeshall, of the company, observed that the entire electrical engineering profession, including its latest development, electronic engineering, in actuality stems from the telegraph. Establishment of many of the professional electrical societies was by telegraph engineers and others connected with the industry. In Washington the Post Office commemorated the anniversary by issuance of a special stamp (see illustration).



Replica of Thomas A. Edison's original movie studio, the Black Maria, is examined by John Coakley, of Thomas A. Edison Inc., and Charles Edison, son of the inventor and ex-governor of New Jersey. Scene is in the library and office used by Edison at the main plant of the company in West Orange, N. J.

Meanwhile, motion pictures reached their half-century mark, dated from the building by Thomas A. Edison of the so-called Black Maria studio for filming of the early cinema. Universal Pictures doumented the occasion with a news feature titled, "The Birth of the Movies" featuring Charles Edison, former governor of New Jersey and son of the inventor.

Survey of Postwar Electronic Employment

REPRESENTING PRACTICALLY the entire radio industry, 400 concerns are included in a survey presently being conducted by RMA. Questions concern 1940 employment,

present employment, number of employees in the armed services, and prospects for future magnitudes of workers going back to other jobs or to their homes. Estimates of employment figures a year after the war are also being requested. Government and other interested agencies will be given access to the figures on completion of work.

Electronic Heat Units For Plastics

THE LATEST DEVELOPMENTS in electronic heating equipment were exhibited at the May Conference of the Society of the Plastics Industry held in Chicago during May. Among those exhibiting equipment were Illinois Tool Works, RCA, Girdler Corp., and Federal Tel. & Radio Corp. Most of the units on display had a power rating of two kilowatts and contained improvements designed for convenience of operation and safety.

New Kind of Engineer

EFFORTS OF THE American Federation of Musicians and its president, James C. Petrillo, to extend musical activities into the realm of turntable operation on the networks has created considerable heated discussion in broadcasting circles. By the terms of an agreement with the four major networks, jurisdiction over transcription handling would go to AFM while other technical operations would come under International Brotherhood of Electrical Workers.

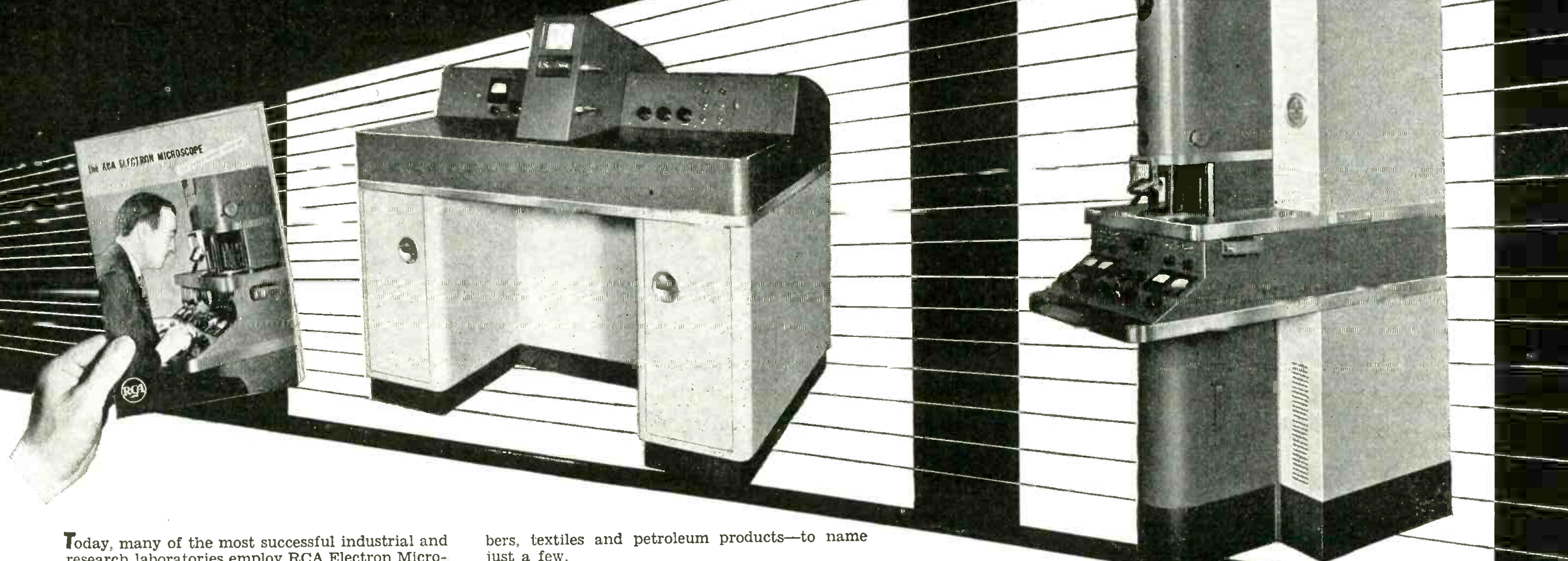
As a result of the controversy ensuing, one anonymous engineer was inspired to compile for publication in *Broadcasting* this list of functions which might define the capability of a musician-engineer of the new school:

First: Remove a record from its envelope by grasping the bottom of the envelope with one hand and the record with the other and moving the hands in opposite directions.

Second: Holding the record poised above a turntable, align the hole in the record so that it is directly above the small cylindrical projection on the surface of the turntable.

Third: Lower the record until it rests upon the surface of the turntable with the hole in the record

RCA ANNOUNCES *NEW MODELS* OF THE FAMOUS RCA ELECTRON MICROSCOPE



Today, many of the most successful industrial and research laboratories employ RCA Electron Microscopes in solving vitally important problems—problems relating to the processing and use of metals, chemicals, ceramics, plastics, synthetic rubbers, textiles and petroleum products—to name just a few.

Equally noteworthy is the fact that several industries at present are using this equipment for purposes of production or quality control. This is an application of the Electron Microscope which should be considered by every industry in which size or shape of small particles or fine details of surface structure are important in processing or manufacturing.

To further enlarge its utility and convenience to science and industry two new models of the RCA Electron Microscope are now offered. These new instruments . . . one a compact desk model, the other a de luxe Universal model incorporating an electron diffraction camera . . . are described in a bulletin "The RCA Electron Microscope." The coupon at the left will bring you this bulletin by return mail. Fill it out *now.*

Please Use This Coupon

Electron Microscope Section, Dept. 103
Radio Corporation of America, Camden, N. J.
Please send me the new bulletin entitled "The RCA Electron Microscope."

Name..

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BUY MORE WAR BONDS

RCA

RADIO CORPORATION OF AMERICA

RCA VICTOR DIVISION • CAMDEN, N. J.

LEADS THE WAY.. *In Radio.. Television.. Tubes.. Phonographs.. Records.. Electronics* completely surrounding the aforementioned small cylindrical projection.

Fourth: Raise the pickup head from its support and swing it out over the record in such a manner that the stylus is directly above the first groove in the record.

Fifth: With the head (the pickup head, not the musician's head) poised in this manner slowly lower it until the stylus rests in the first groove of the record.

Sixth: Throw the switch. This should start the motor. (If not, run to the control room and holler for an engineer.)

Materials for Electronic Experiments

IN A NEW RULING, the War Production Board says a person who gets materials with the priorities assistance of Preference Rating Order P-43 may use them to build experimental electronic equipment for his own use. Interpretation 2 to Limitation Order L-265 states that the restrictions of paragraph (b) (1) apply to persons only to the extent that they are engaged in the manufacture of electronic equipment for transfer or commercial use.

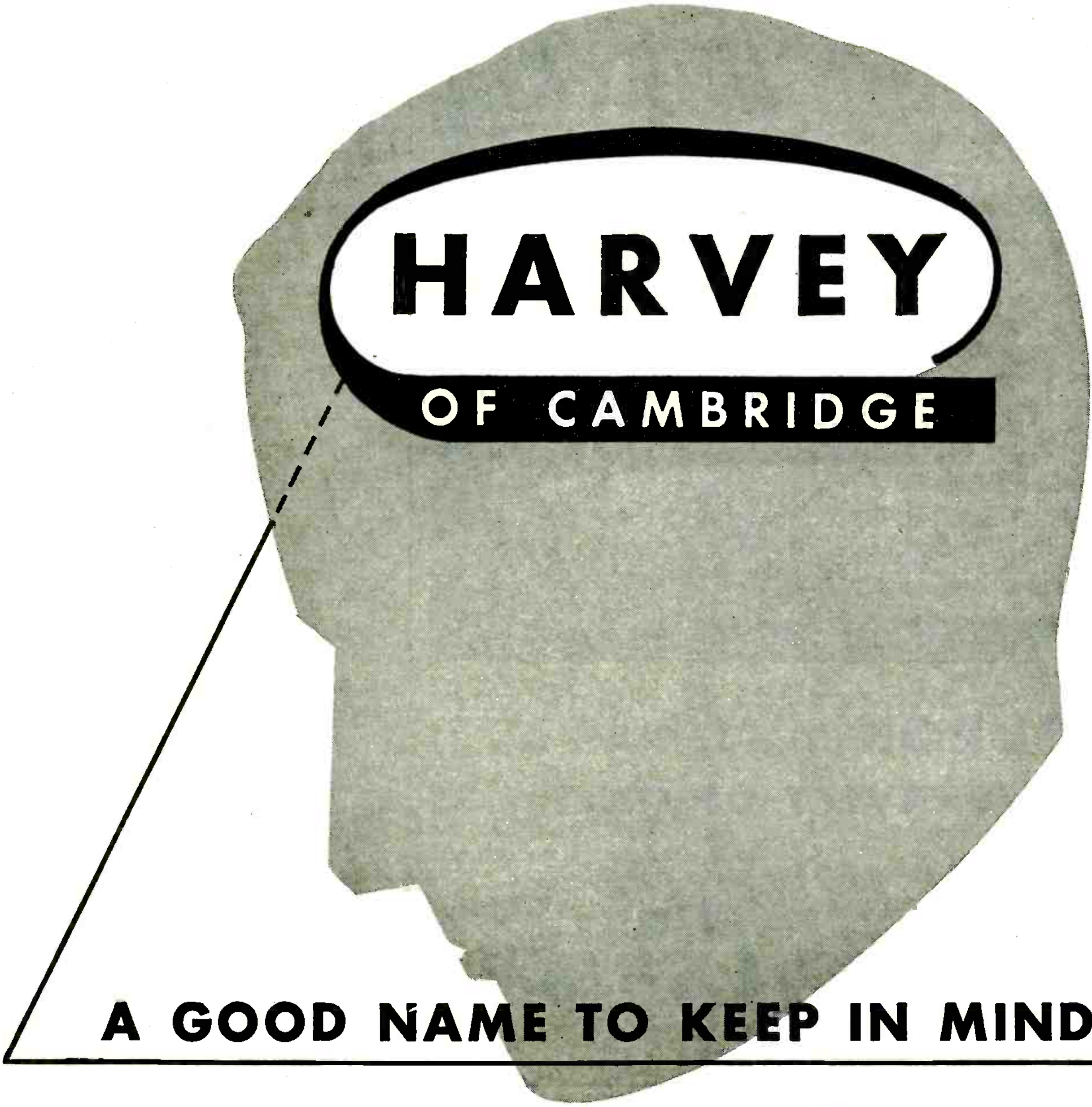
Electronic Institute for Power Engineers

ELECTRONIC SERVICES to industry were recently expounded for a group of industrial engineers from Philadelphia Electric Co. by members of the staff of RCA Victor Div., Radio Corp. of America, at their Camden plant. Three days were devoted to high frequency heating while plant broadcasting and communication systems and the electron microscope were described and demonstrated on the fourth day.

An explanation of electronic power heating was given by Fred W. Wentker, manager of the electronic apparatus section, in a talk at the opening session.

Graphic evidence of its advantages was presented in demonstrations of soldering, drying, sealing, and other processes with heat generated by electrical currents alternating at frequencies of 400 kc to 200 Mc.

Later, the utility engineers were escorted on a tour of RCA's appli-



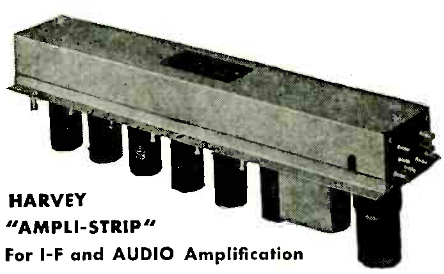
A GOOD NAME TO KEEP IN MIND...

Here's why:

The HARVEY organization devotes itself entirely to the development and production of electronic and radio equipment and components.

The HARVEY organization has the engineering and creative resources to assure you a source of supply of the utmost reliability. This was true long before the present crisis and intensive war work of the highest importance has vastly increased our scope and facilities for present and postwar usefulness to you.

For radio-electronic apparatus you can depend on and for assistance on your present or projected plans remember—



HARVEY "AMPLI-STRIP"
For I-F and AUDIO Amplification

HARVEY Regulated Power Supply 106PA
(Write for new bulletin)

HARVEY RADIO LABORATORIES, INC.
439 CONCORD AVENUE • CAMBRIDGE 38, MASSACHUSETTS

cation engineering laboratories in Camden, where the engineers witnessed further demonstrations of electronic power-heating involving larger units. These included welding, case-hardening, the making of safety glass, bonding of large glued plywood assemblies, and preheating of large preforms of plastic material to prepare them for molding.

Talks, demonstrations, and movies at ensuing sessions explained the operation of electron tubes and vacuum-tube oscillators, peculiar characteristics of high-frequency transmission lines, factors affecting high-frequency induction and dielectric heating, present and possible future applications, and service and maintenance requirements.

Music While You Work

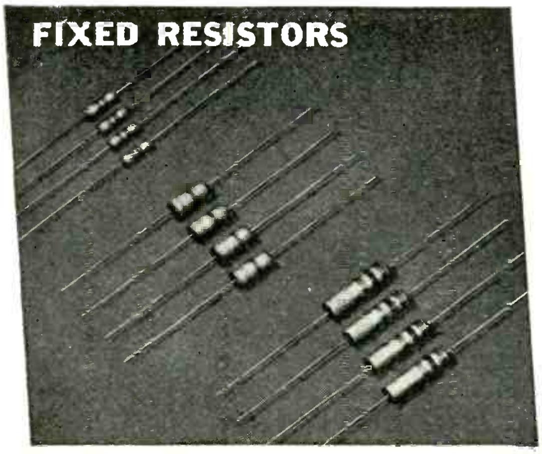
Presenting the subject of plant broadcasting and industrial music, Dan D. Halpin, of RCA's sound and picture section, declared that these services are helping to compensate for manpower shortages in many war industries, both by direct saving of time, and by improving net output of workers. As an example of direct time savings realized from other uses of plant broadcasting systems, he reported that in one plant 4,000 man-hours per month were saved by paging service alone.

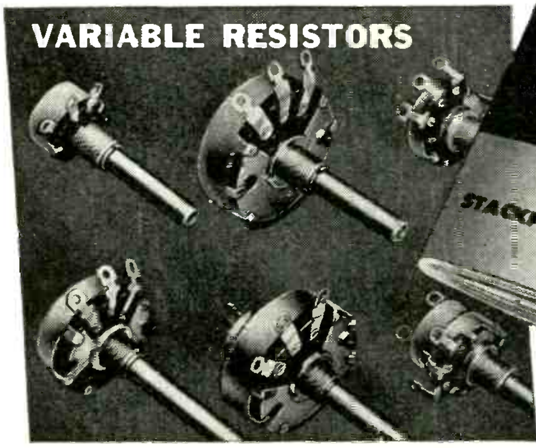
Discussing point-to-point communication systems in industry, Russell Stier, commercial engineer, pointed out that industrial expansion, adding acres of floor space and thousands of workers, has made such systems essential for efficient direction and control of many plants. In this type of installation, he said, microphone stations are located at vital control points or at specific operating positions, while loudspeakers are so placed as to cover operating positions or local areas only.

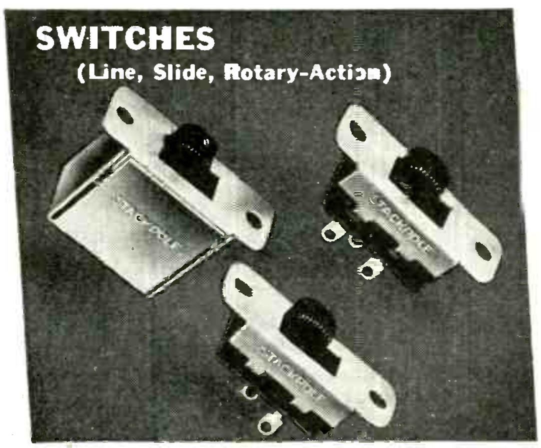
Workings and advantages of the electron microscope, for which RCA developed the first commercial design in 1940, were explained by Perry C. Smith, under whose supervision two new, improved models, recently introduced by RCA, were designed and engineered.

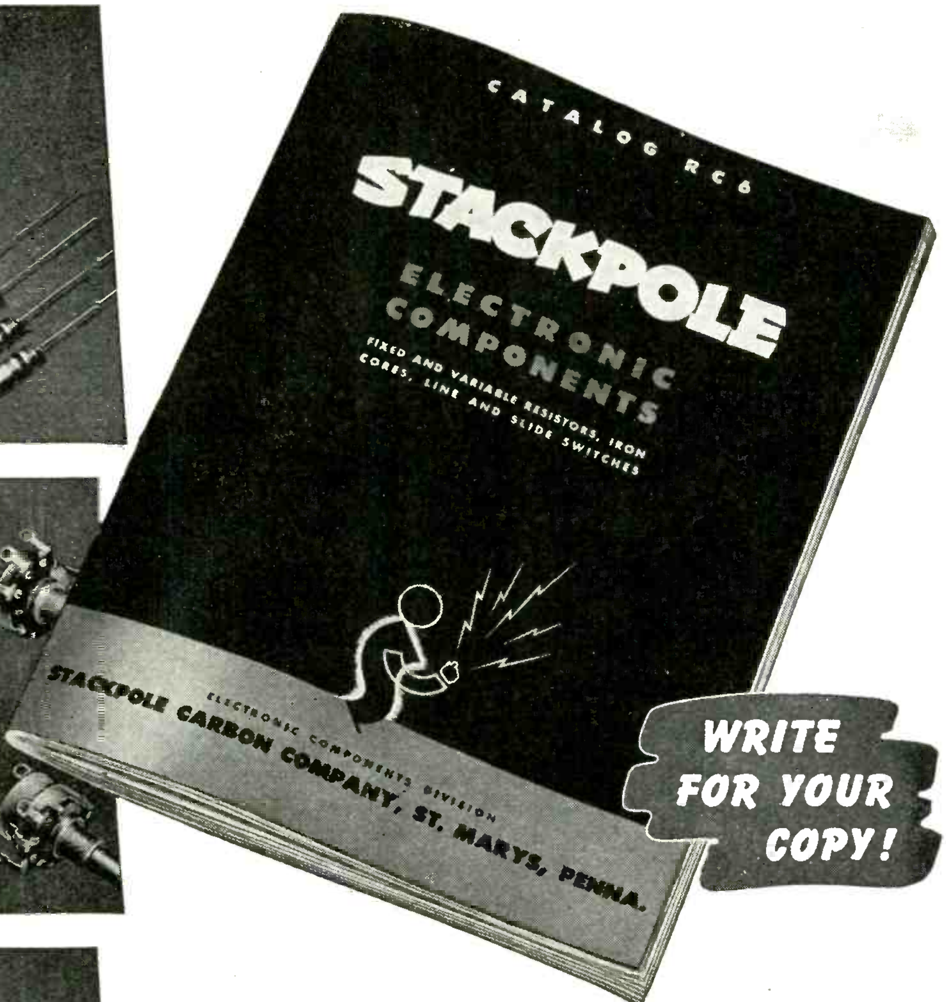
Food Was in Character

At the dinner in the evening of the first day's session, the engineers were confronted by this menu: chemotronics, flashover, electronic









...for today's needs
...for post-war planning

USE this new 1944 Stackpole Electronic Components catalog as your guide to up-to-the-minute Fixed or Variable Resistors; Iron Cores; and inexpensive line, slide, or rotary-action Switches. In addition to *complete* information and dimension diagrams on the components, you'll find data pages and charts that will prove mighty handy in your daily work. Please ask for Catalog RC6.

STACKPOLE CARBON COMPANY, ST. MARYS, PA.

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**BRUSHES FOR ALL ELECTRICAL ROTATING EQUIPMENT • CONTACTS
WELDING RODS, ELECTRODES, AND PLATES • CARBON PIPE • BRAZING BLOCKS • RHEOSTAT PLATES & DISCS
CARBON REGULATOR DISCS • PACKING, PISTON, & SEAL RINGS • SINTERED IRON COMPONENTS, ETC.**

nerve tonic, extruded burps, oscillated chicken with elongated protons and electronic bombardment, ion-iced electrons with case-hardened granules, preheated pre-forms and micron lubricant, and condenser oil.

When the dishes were served, they discovered they were drinking and eating: cocktail, grapefruit, celery, radishes, boned chicken with duchess potatoes and lima beans, ice cream and cookies, hot rolls and butter, and coffee.

Franklin Institute Award to Dr. Rentschler

DEVELOPMENT AND APPLICATION of a bacteria-killing ultraviolet lamp has gained for Dr. Harvey C. Rentschler, director of research at the Westinghouse lamp division, the Frank P. Brown Medal, annual award of Franklin Institute. Founded in 1938, the medal is devoted to inventions of merit in the building and allied industries.

Presentation was made by Charles S. Redding, president of Franklin Institute at a dinner which concluded the yearly medal day ceremonies. The honor was specifically for the application and source of bactericidal ultraviolet radiation in air-conditioning systems in a scientific and practical manner.

Engineering Scholarships Go to Ten Students

ATTENDANCE AT THE College of Engineering in Carnegie Institute of Technology is the prospect for ten of the 684 entrants in the seventh annual scholarship competition sponsored by Westinghouse Electric & Mfg. Co. Awards are valued at $1850 each. Recipients were chosen on the basis of mental ability, aptitude for engineering, and qualities of leadership and personality. The successful ten were: George Baldwin, New Caanan, Conn.; Richard Eschenbach, Williamsport, Pa.; Clifford Gower, Austin, Minn.; Thomas Hall, Kenton, Ohio; Warren Helmer, Spokane, Wash.; Richard Huntoon, Detroit, Mich.; Vincent Prus, Baden, Pa.; Chandler Sammons, La Grange, Ill.; Clark Sloan, Nashville, Tenn.; and Dale Wright, Amarillo. Tex.

Tests for the 16- and 17-year-old

This is How Your Product is Sealed in Ideal Working Conditions by

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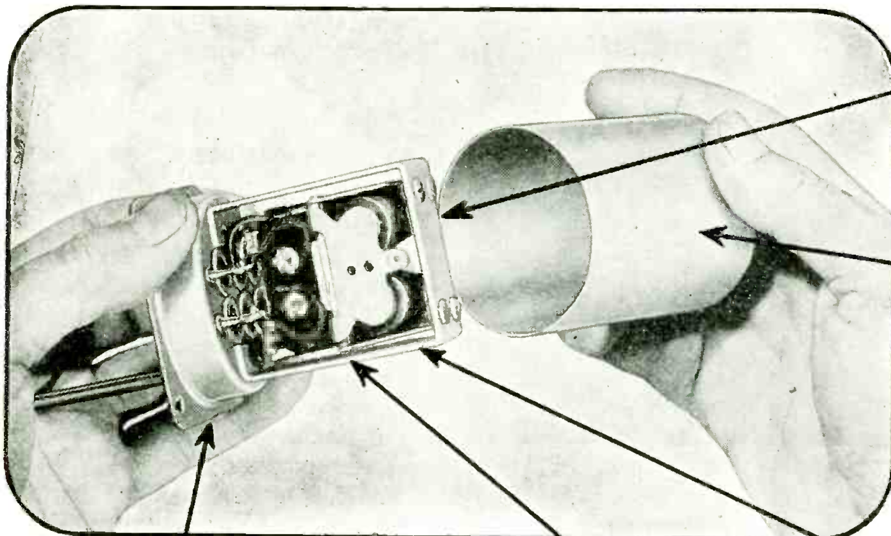
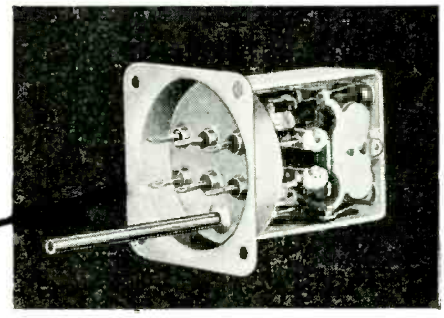
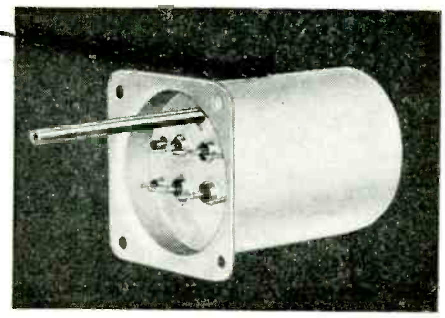


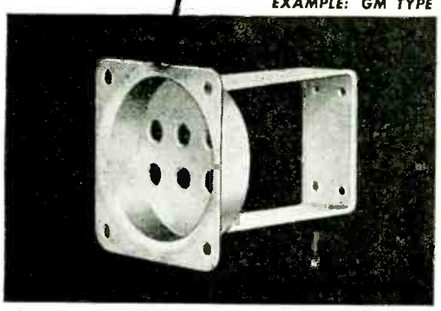


3. Relay is mounted on the base assembly and wired to the sealed terminals.

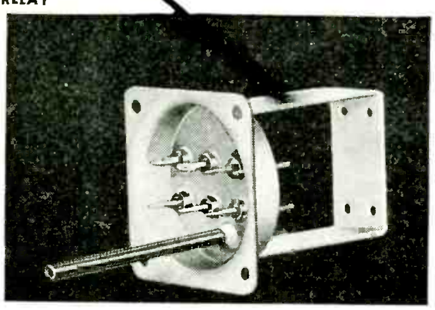


4. Steel enclosure is placed over the relay base assembly and hermetically sealed to the base. Filling gas is inserted through metal tube.

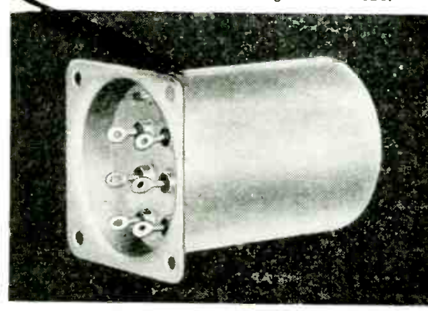
STEPS EMPLOYED BY FEDELCO-SEAL TO SEAL IN IDEAL WORKING CONDITIONS
EXAMPLE: GM TYPE 27 RELAY



1. Mounting bracket for holding or supporting relay is spot welded to the base assembly of the can enclosure.



2. Shows various types of glass to metol seals soldered to the base assembly, providing a hermetically sealed joint. A tube is provided for obtaining a vacuum.



5. Completed assembly after operating atmosphere has been introduced and tubulation sealed off.

Fedelco-Seal offers you something new . . . something extra that may make your present product operate still better and more effectively.

Fedelco-Seal is a new method of sealing ideal working conditions within the housings of mechanical and electrical devices. It brings to the products of all industry an entirely new conception of performance.

No matter how superior your product may be, think what it would mean to be able to assure your customers that your electrical device is explosion proof . . . delivered with sealed-in operating conditions that varying atmosphere, pressure or temperature cannot affect.

That is what Fedelco-Seal offers. With this method you can permanently seal about your product operating conditions as favorable as you can create in your own laboratory . . . dry air at sea level pressure . . . gases such as oxygen, helium and nitrogen . . . complete protection from moisture, abrasive dust or corrosive fumes.

Fedelco-Seal may be the something new for which you have been looking. If you will send a sample and specifications of your product, Federal Electric's engineers will gladly study your sealing problem and make recommendations that may make your product an even better one.

FEDERAL ELECTRIC COMPANY, INC.
8700 SOUTH STATE STREET, CHICAGO 19, ILLINOIS

aspirants included a range from simple word associations to questions tough enough to stop most college seniors, but the results showed that the group scored well within the top standards set by foremost colleges and universities. Among those participating were found many interests aside from the scientific urge which impelled them all. Some are musicians, some athletes, and one a journalist; while most maintain active interests outside the classroom.

Television Standards and Allocations

MANY OF THE TELEVISION improvements made possible by war-stimulated research and development are suitable for incorporation within the art without the necessity of changes in standards, according to David Smith, director of research at Philco, who talked on the standards situation before the second meeting of the Television Seminar of the Radio Executives Club in New York recently. On the other hand, he said that some of the improvements might necessitate changes. Describing the organization and activities of RTPB, he pointed out that it was the responsibility of the engineers on its panels to agree on the basis of engineering facts as to the things which should be done.

In response to questions from the audience, Mr. Smith opined that the video component of television transmission would be likely to stay on amplitude modulation but that the optimum selection between AM and FM for the audio section had not yet been established. Relay stations probably should be established in the upper, less crowded portions of the spectrum, but could be operated on the frequencies of the basic transmissions if space requires, he said. The problem of reflection in large cities, he characterized as a still unsolved problem.

Speaking to the same group on frequency allocation, Dr. C. B. Jolliffe, RCA chief engineer, said that the development of a competitive system of television in this country would need the space in the 150–300 Mc band which has not yet been opened up by technical development—difficulties in general being in the generation of power at

such frequencies, or, in other words, a tube problem. He also stated that the problem in Great Britain was much less difficult because of the monopoly set-up which made it possible to cover the Isles with as few as four or five channels.

Answering questions, Dr. Jolliffe predicted the unlikelihood of channel-sharing because of the high cost of equipment which could hardly be amortized on the basis of part-time service. He felt that there was no merchandising advantage inherent in the coverage aspects of channels in one part of the spectrum as against those in another.

On the subject of extremes in transmission distance and possible interference, he told of certain peculiarities related to the sunspot cycle and other sporadic phenomena. For a period of a month or so, and for only a few minutes a day, reception of British signals was accomplished on Long Island at one time. Again, New York to Chicago transmission was discovered accidentally once when both transmitters were on the air with the same picture. When Chicago closed down, the picture was found to remain on the receiver screen. However, neither of these cases held the likelihood of trouble, because of rarity and low signal strength.

Electronic Eyes for the Works Manager

ONE OF THE FIELDS into which television may very likely expand after the war is the monitoring and coordination of factory operations from either a centralized point of convenient observation by those in control, or from a vantage point remote from the dangers inherent in certain operations. This suggestion was recently presented at a meeting of the Engineering Society of Detroit by Ralph R. Beal, assistant to the vice president in charge of RCA Laboratories.

Television cameras located at strategic points throughout the plant would permit the manager to make an inspection tour without leaving his office and in a fraction of the time presently required. Used in connection with chemical reaction chambers, cameras could bring the process operator to a closeup of the actions under his charge

WRITE FOR FREE WALL SIZE COPY OF THIS REACTANCE CHART

Always use corresponding scales

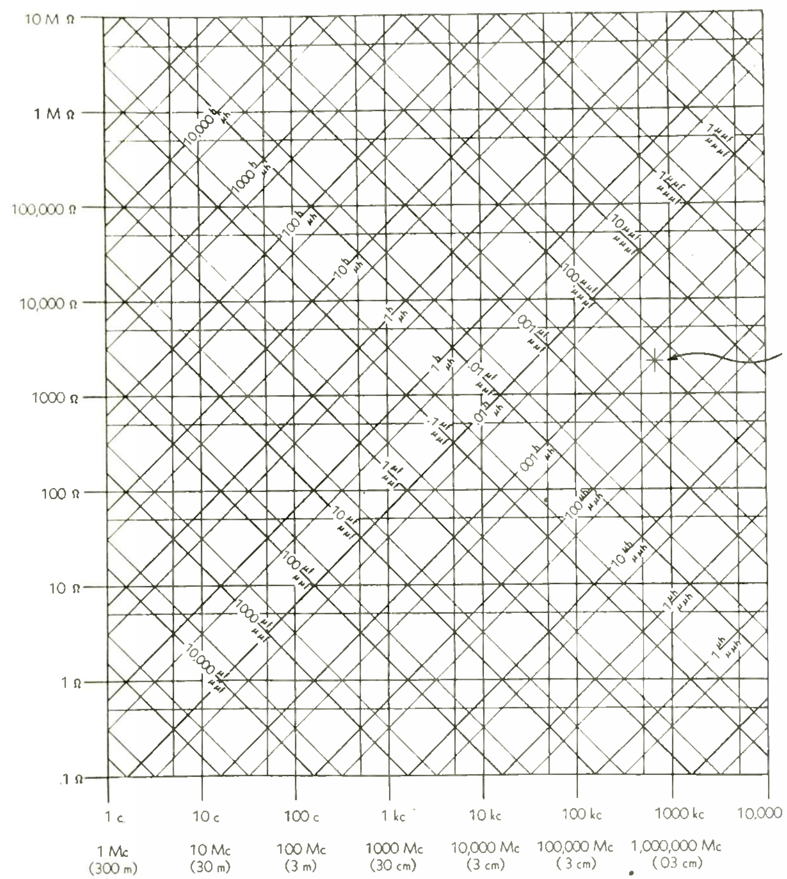


FIG. 1

Always obtain approximate value from Figure 1 before using Figure 2

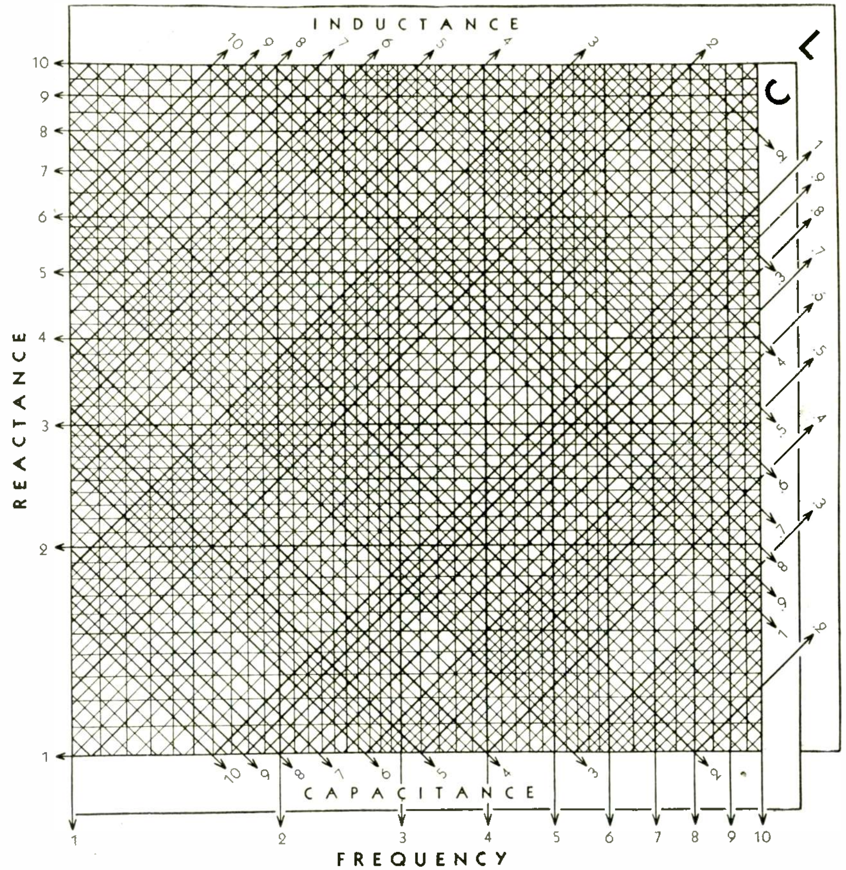


FIG. 2

The accompanying chart may be used to find:

(1) The reactance of a given inductance at a given frequency.

(2) The reactance of a given capacitance at a given frequency.

(3) The resonant frequency of a given inductance and capacitance.

In order to facilitate the determination of magnitude of the quantities involved to two or three significant figures the chart is divided into two parts. Figure 1 is the complete chart to be used for rough calculations.

Figure 2, which is a single decade of Figure 1 enlarged approximately 7 times, is to be used where the significant two or three figures are to be determined.

TO FIND REACTANCE

Enter the charts vertically from the bottom (frequency) and along the lines slanting upward to the left (capacitance) or to the right (inductance). Corresponding scales (upper or lower) must be used throughout. Project horizontally to the left from the intersection and read reactance.

TO FIND RESONANT FREQUENCY

Enter the slanting lines for the given inductance and capacitance. Project downward and read resonant frequency from the bottom scale. Corresponding scales (upper or lower) must be used throughout.

Example: The sample point indicated (Figure 1) corresponds to a frequency of about 700 kc and an inductance of 500 μh, or a capacitance of 100 μμf, giving in either case a reactance of about 2,000 ohms. The resonant frequency of a circuit containing these values of inductance and capacitance is, of course, 700 kc, approximately.

USE OF FIGURE 2

Figure 2 is used to obtain additional precision of reading but does not place the decimal point which must be located from a preliminary entry on Figure 1. Since the chart necessarily requires two logarithmic decades for inductance and capacitance for every single decade of frequency and reactance, unless the correct decade for L and C is chosen, the calculated values of reactance and frequency will be in error by a factor of 3.16.

Example: (Continued) The reactance corresponding to 500 μh or 100 μμf is 2,230 ohms at 712 kc, their resonant frequency.

GENERAL RADIO COMPANY • 30 STATE STREET, CAMBRIDGE 39, MASS., U. S. A.

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without exposing him to personal risk from heat or corrosive materials.

Other proposed uses of postwar television in industry and commerce included equipment to facilitate movements of ships in port by four-way iconoscope eyes and monitors for traffic control on busy or hazardous highways.

Costs for FM Stations

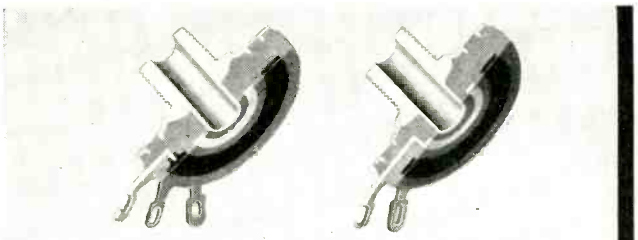
URGED BY THREE AUTHORITIES in FM broadcasting, newspaper owners were recently given specific data concerned with their possible entry into the field. At a special session of the American Newspaper Publishers Association in New York, Major Edwin H. Armstrong pointed out that those publishers who missed their first opportunity to get into radio were being given a second chance.

Dr. W. R. G. Baker predicted a tenfold expansion of outlets within five years of war's end and a corresponding reduction in AM stations from the present 912 to about 750. Walter J. Damm, vice president of the Milwaukee journal and president of Frequency Modulation Broadcasters Inc., presented the following figures for the guidance of his fellow newspapermen. He based the tabulation on an assumption that operation was to be started from scratch and that studios, transmitter, and antenna would be located together—a condition feasible up to 10,000 watts.

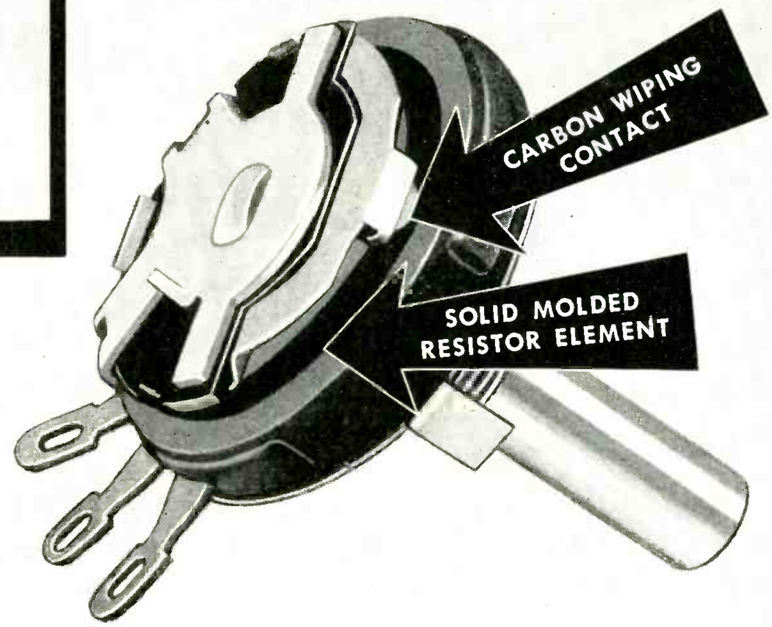
ESTIMATED CONSTRUCTION COSTS

Wattage	1,000	3,000
Filing	$2,500	$2,500
Transmitter	10,000	13,750
Antenna	6,000	7,500
Studio Control	4,000	5,000
Installation	2,500	3,000
Measuring Equipt-ment	2,000	2,000
Proof of Perform-ance	2,500	2,500
Miscellaneous	1,000	2,000
Totals	$30,500	$38,250
Wattage	10,000	50,000
Filing	$2,500	$2.500
Transmitter	25,000	75,000
Antenna	12,500	17,000
Studio Control	5,000	10,000
Installation	7,500	15,000
Measuring Equip-ment	3,000	3,000
Proof of Perform-ance	2,500	2,500
Miscellaneous	3,000	5,000
Totals	$61,000	$130,000

No provision has been made in



Cross-section views of Type J Bradleyometers showing how terminals are connected to resistor element.



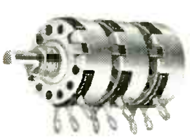
Type J Bradleyometer showing how low-resistance carbon brush makes a smooth contact with the resistor element.

For War Service—Use these solid molded resistors

...not affected by cold, heat, or moisture

Type JS Bradleyometer with a built-in switch.

Bradleyometers may be used singly or assembled for dual



—or triple construction to fit any electronic control need.

The resistor element in Allen-Bradley Type J Bradleyometers has substantial thickness (approximately 1/32-inch thick), and in this respect differs from film, paint, or spray type resistors. The resistor is molded as a single unit with insulation, terminals, face plate, and threaded bushing. There are no rivets, welded or soldered connections, or unreliable conducting paints. Allen-Bradley resistors are therefore reliable under all extremes of service conditions.

During manufacture, the resistor element may be varied throughout its length to provide practically any resistance-rotation curve. Once the unit has been molded, however, its performance is not affected by heat, cold, moisture, or hard use.

Bradleyometers are the only continuously adjustable composition resistors having a two-watt rating with a good safety factor. The Allen-Bradley Bradleyometer is the only commercial type adjustable resistor that will consistently stand up under the Army-Navy AN-QQ-S91 salt spray test. Write for specifications.

Allen-Bradley Company, 110 W. Greenfield Ave.
Milwaukee 4, Wisconsin

FIXED RESISTORS

Bradleyunits are molded, fixed resistors with lead wires embedded in homogeneous resistor material. They will sustain an overload of ten times rating for a considerable period of time without failing. No special wax impregnation is necessary to pass the salt water immersion test. Available in standard RMA values from 10 ohms to 10 megohms in both the insulated and non-insulated types.

½ WATT

1 WATT

ELEMENT ACTUAL SIZE

ALLEN-BRADLEY

FIXED & ADJUSTABLE RADIO RESISTORS

QUALITY

the figures for control equipment such as microphone amplifiers and associated equipment used to pick up temporary programs from locations outside the studio. It is estimated that $800 should be sufficient to cover a reasonably efficient equipment setup of this kind. Studio construction costs present such a variety of problems that any cost estimate would be a stab in the dark.

Assuming the simplest kind of remodelling job and allowing for a minimum of studio space, a control room and space to house the transmitter (not beyond 10,000 watts), $12,000 should do the job. This would cover a reasonable amount of sound isolation and acoustical treatment.

As to Operating Costs

Under similar conditions, figures for annual operating expense were given on the basis of six-hour transmission at 1000 watts and for independent operation of FM facilities. Combination with existing services would permit reduction of some items. To these figures must be added items for taxes, copyright fees, and transmitter site rental.

ESTIMATED ANNUAL OPERATING COST

Rent	$6,000
Station Manager	5,000
Announcer	3,000
Stenographer	1,800
Telephone-Office Supplies	1,000
Operators (3)	8,500
Promotion	2,400
Power and Light	1,200
Tube Replacements	450
Social Security & Compensation Taxes	1,000
Apparatus Maintenance	750
Depreciation	6,000
Insurance	350
Program Production	6,000
Transcription Service	2,500
News Service	3,335
FMBI Dues	300
Misc. Program Material	1,400
Total	$52.585

As power increases, operation expenses in certain classifications will also increase, particularly in such items as electric power and light, tube replacements, operators salaries, and depreciation.

Developments in Television

SUPERSEDING PREVIOUS experimental installations, the first regularly scheduled commercial television relay system in the U. S. has been completed by a link station installed

The Legion of Life..

An army within an army . . . the 75,000 doctors and nurses of the Army Medical Department have the job of *saving*, rather than taking life. The victory they are winning is magnificent beyond praise. Want facts?

In the last war, eight of every hundred wounded men died. Today, ninety-seven of every hundred wounded recover. And that is not the whole story, either . . . the tragic toll of men suffering amputation, prolonged hospitalization, recurrent operations and permanent disability is being drastically reduced.

The wartime products of *Connecticut Telephone & Electric Division* (field telephone equipment, electronic devices, and aircraft ignition components) are helping the Army Medical Department to practice its skill and devotion with greater promptness than ever before.

Here at home, *Connecticut Telephone & Electric* hospital communicating and signalling equipment (installed before the war) is also lending a helping hand. Civilian doctors, nurses, and volunteer aides in understaffed institutions are doing a job under trying conditions which too few of us appreciate. "Connecticut" equipment adds to their efficiency in hundreds of American hospitals.

After the war, needed hospital construction will be one of the most active and important elements of the nation's building program. "Connecticut" engineers are planning even now to return to the hospital field with new and better systems for communications, signalling, paging and "electronic supervision".

CONNECTICUT TELEPHONE & ELECTRIC DIVISION

GREAT AMERICAN INDUSTRIES, INC. • MERIDEN, CONNECTICUT

at Mt. Rose, N. J., making available the programs of WNBT, New York, to the viewing audience of WPTZ, Philadelphia, Philco Corp. outlet. It was dedicated during a meeting of the Poor Richard Club at the Franklin institute in Philadelphia recently.

Other Philco activities were described at the meeting by James H. Carmine, vice-president. They include a picture tube with flat face which avoids distortion in picture with angle viewing, and a so-called ion trap which removes the brown blemish at the center of the picture tube by filtering out the heavy negative ions emitted by the electron gun.

Registration of Professional Engineers in Illinois

THE ILLINOIS PROFESSIONAL Engineering Act, requiring the licensing of professional engineers to practice in the state, was passed on August 1, 1943. With certain exceptions, on and after that date, it became unlawful to practice professional engineering without being licensed by the Department of Registration and Education at Springfield, Ill.

An injunction obtained by Arthur H. Krebs prohibits the expenditure of public funds to administer this Act. Accordingly, the peculiar situation arises in which a law affecting engineers has been passed in the State of Illinois, but the Department of Registration and Education is restrained from spending public funds for its administration and cannot license engineers since it could not print applications or conduct necessary correspondence.

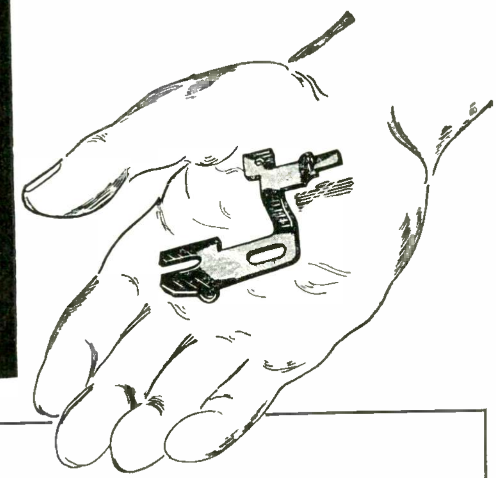
The Illinois Engineering Council, representing the majority of engineering societies of the State, has cooperated during the drafting and passage of the Act to prevent conflict with other existing engineering statutes. The Council has also assumed the responsibility for protecting interests of engineers in the State until the case is decided upon by the Supreme Court of Illinois.

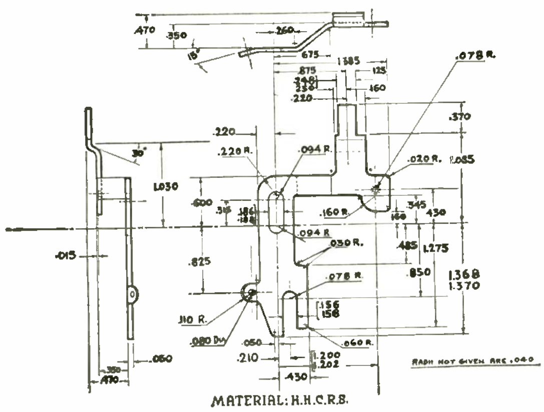
Decision in Fall

One of the provisions of the Act is a "grandfather clause" permitting resident engineers to apply for licenses without written or oral

SHORT-RUN METAL STAMPINGS WITHOUT HIGH DIE COST!

How much would this Stamping cost you for a lot of 100 pieces?





Typical Saving on Intricate Stampings

Check the dimensions on the left, covering the small part shown in drawing above. Produced with ordinary dies, one hundred would cost approximately \$180 to \$250. By Dayton Rogers service, with strict adherence to working tolerances, cost was brought down to 40¢ each. Let us quote *you* on your short-run stamping jobs!

DIE cut metal stampings in small lots in quantities as low as 25 or 50 pieces can be produced as accurately as with permanent dies at a cost of *15% to 20%* of conventional type permanent tools.

This service eliminates costly permanent dies on your small lot stamping requirements. These small lot jobs can be die cut and produced to a close working tolerance with duplication assured throughout the entire lot.

Stampings of any *size* and *shape* according to your special custom made requirements can be blanked, pierced, and formed from practically any sheet metal.

Capacity at Present

Maximum Thickness, 3/8″.

Maximum Blank Size, 22″ x 22″.

Maximum Blanking Pressure, 350 tons.

Average Die Life, 8000 to 10,000 duplicate blanks.

No matter how small your quantity requirements are or how intricate your work may be, we can show you a definite saving.

See example illustrated on this page. Data on other representative jobs will be sent to you on request.

Send us your blueprints or samples and state quantities required. Our quotation will be forwarded immediately.

Send for This Booklet

New booklet No. 176-17 "Metal Stamping in Small Lots" gives valuable information for Designing Engineers and Production Executives. Tells how small-lot metal stampings can be furnished at surprisingly low costs. Ask for copy on your letterhead.

DAYTON ROGERS MFG. CO.

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examinations within a year after the law has been passed. The deadline for applying for licenses under the grandfather clause is July 31, 1944. The Supreme Court of the State of Illinois heard the case on May 17, 1944, but its decision is not expected until Fall—well after the deadline for filing applications.

To assure that engineers will be adequately protected in the event that the Supreme Court upholds the Act, the Council was authorized to furnish secretaries of the various engineering organizations with application blanks, sheets of instructions and summaries of the Act for distribution to individual engineers.

The application is to be filed with the Department of Registration and Education at Springfield, Ill. together with a fee of $10.00. Remittance should be in money order or certified check and not by a personal check. A duplicate form is retained by the applicant.

In the event the Supreme Court reverses the decision of the Circuit Court, licenses can be issued only to those applicants who have filed applications by July 31, 1944. Thus far, no provision has been made for extending the date limiting application.

Correspondence should not be directed to the Department of Registration and Education but should be directed to the secretary of the applicant's engineering organization or to Frank F. Fowle, President of the Illinois Engineering Council, 35 E. Wacker Drive, Chicago, Ill. Radio engineers may address their inquiries to W. O. Swinyard, Hazeltine Electronics Corporation, 325 W. Huron Street, Chicago, Ill.

Although relatively few engineers will be *required* to register under the provisions of this Act, many will probably desire to register to avoid any difficulty should they desire to or find it necessary to do so at some later date. Failure to file applications by July 31, 1944, will mean that the applicant will have to pass a written or oral examination in engineering to obtain a professional engineering license at some subsequent date. The fee in this case is $20.00.

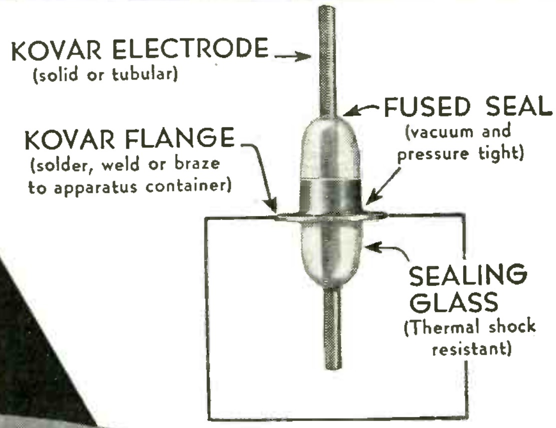
To qualify under the grandfather clause without examination, a person must submit evidence, under

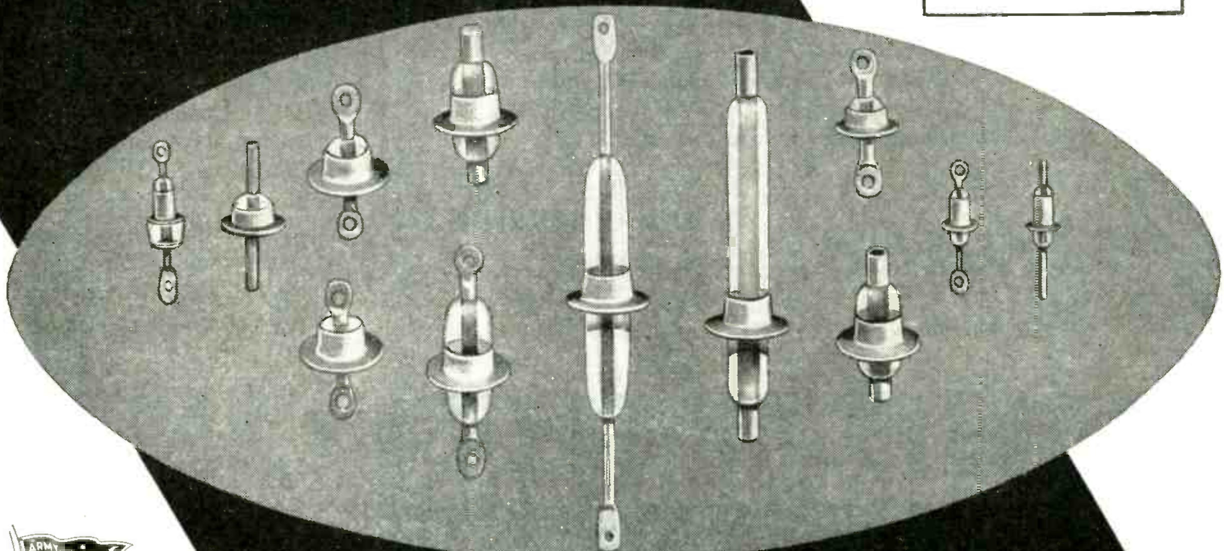
METAL-GLASS TERMINALS

by

STUPAKOFF

Products for the World of Electronics





"FOR GREAT ACHIEVEMENT"

for POSITIVE HERMETIC SEALING

Illustrated are representative styles and sizes of single electrode type Kovar-glass terminals, manufactured by Stupakoff for the electronic industry.

The metal, KOVAR, a cobalt, nickel, iron alloy, has made possible a hermetically sealed terminal without the use of cements or gaskets. The seal between Kovar and glass is a chemical bond in which the oxide of Kovar is dissolved into the glass during a heating process. The result—a permanently vacuum and pressure tight seal—effective under the most extreme climatic conditions.

Stupakoff also supplies Kovar as rod, sheet, wire, tubing, eyelets, cups and other forms for those equipped to do their own glass working.

Kovar-glass seals answer most hermetic sealing problems. Write today for technical data Bulletin KA-12 listing currently available Kovar-glass terminals and Bulletin KA-11A for standard Kovar shapes and sizes.

Use KOVAR* for sealing

ELECTRONIC TUBES
TRANSFORMERS
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oath, that he is of good character, has been a resident of the State of Illinois for at least one year immediately preceeding the date of application, and was practicing engineering at the time the Act became effective. In addition, he must have performed work of character satisfactory to the examining committee.

Electronics Jobs in Alaska

OPPORTUNITIES EXIST on the 7000 miles of civil airways in Alaska for 60 radio electricians, according to a recent announcement of Civil Aeronautics Administration. The jobs pay about $3500 for a 48-hr week while other openings paying up to $4600 call for more highly skilled radio men. Ten radio engineers are wanted at salaries ranging between $3700 and $5600.

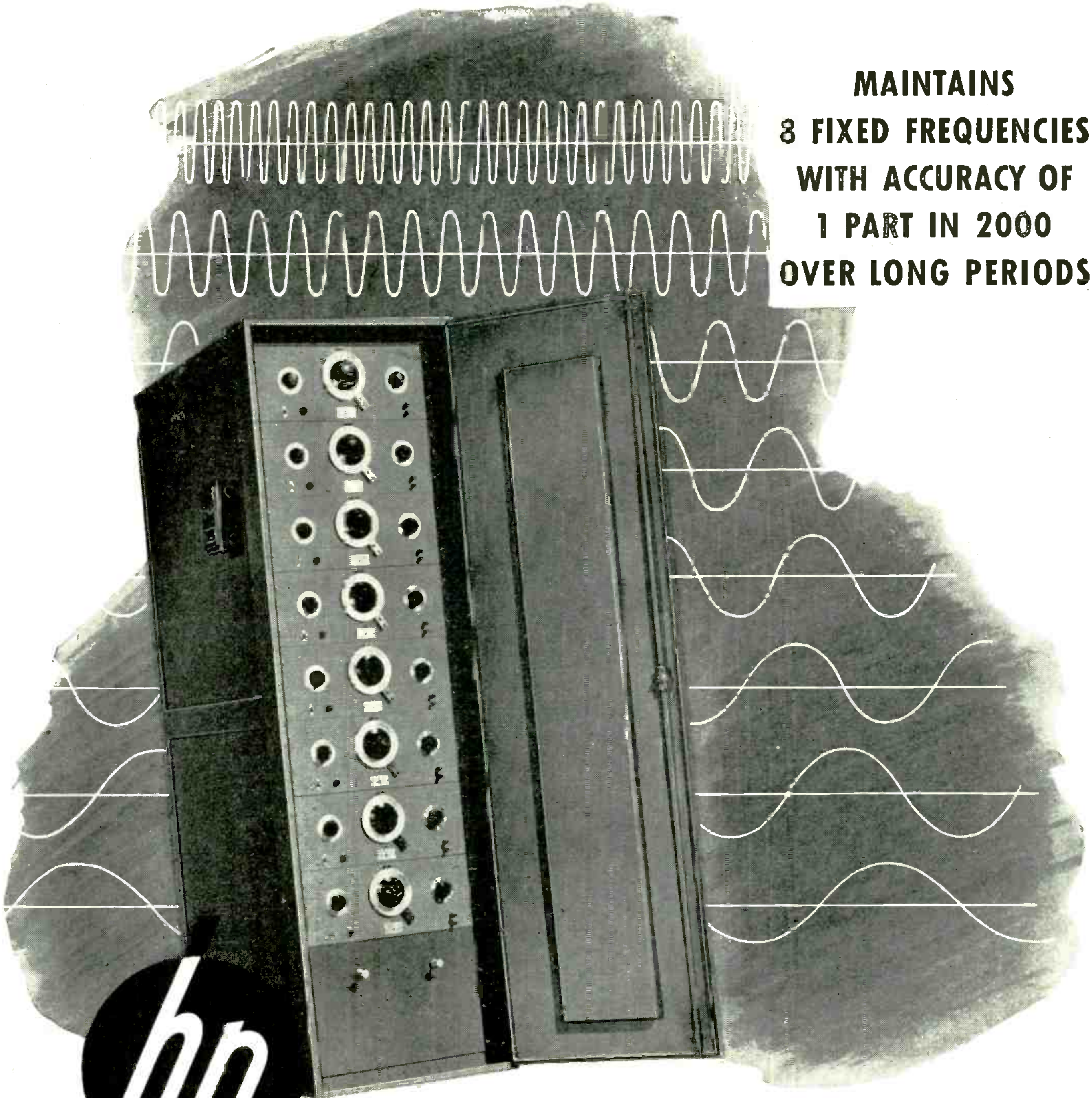
Applicants must be draft exempt and equipped with releases and medical certificates. Men over 38 are acceptable and discharged service men given preference. Although facilities are presently so limited that technicians can only go on a bachelor basis, provision for the later importation of families is planned. Address Alaska Projects Depot, 224 Westlake Ave., North, Seattle, Wash.

Delays in Industrial Electronic Applications

ECONOMICS OF INDUSTRIAL ELECTRONICS are largely governed by tube life and therefore many of the industrial functions which were technically feasible many years ago had to wait for development of suitable tubes with extended life factors before coming into widespread use. Speaking before an IRE audience in New York during May, W. C. White of the Electronics Division, General Electric Co., presented this and several other points in explanation of the time lag which sometimes seems incomprehensible to those engineers active in the early work on a project which comes so slowly into full use.

Other things involved are a high ratio of application-engineering cost to equipment value; lack of knowledge and plain inertia to change; relatively wide discrepancies in supposedly identical tubes —causing design limitations in

MAINTAINS 8 FIXED FREQUENCIES WITH ACCURACY OF 1 PART IN 2000 OVER LONG PERIODS



-hp- Instruments are rated within conservative limits because of the wide range of applications which are normally encountered. However, their performance can be depended upon within much closer limits when proper care is taken.

For example: *-hp-* Audio-Oscillators are rated to maintain accuracy within 2 parts in 100 yet here is a case where they are performing successfully in an application which requires accuracy to be within 1 part in 1000. In this case the problem was to supply 8 separate frequencies simultaneously for continuous laboratory and production testing.

8 Standard *-hp-* model 200BR, Resistance-Tuned Audio Oscillators were mounted in a single rack and each set to a desired frequency. The Oscillators were then enclosed in a temperature controlled chamber which maintains operating conditions close to the ideal. The result: accuracy is maintained to 1 part in 2000 . . . which is 40 times better than the normal ratings for the oscillators, and even better than the strict requirements of the applications.

-hp- Resistance-Tuned Oscillators require *No Zero Setting* and they have but 3 control dials on the panel. Their simplicity of operation makes for great speed in production testing with no sacrifice of accuracy.

-hp- Engineers are ready and willing to assist you in any special problem. Just drop a note giving the details. There is no cost or obligation. Ask for catalog number 17A.

Such performance serves to assure you of the dependability of *-hp-* specifications. *-hp-* Instruments will always perform up to published ratings.

HEWLETT-PACKARD COMPANY

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877

equipment; the fact that development difficulties are in series rather than in parallel—making it impossible to iron out all the bugs at once; and failure to introduce the product in a test installation where conditions are reasonably favorable, where the user is friendly rather than antagonistic, and where a patient study of the unpredictables can be made for modification of subsequent models.

Tube Ceiling Prices

ESTABLISHED TO COMBAT black market operations in electronic tubes for civilian radios and phonographs, specific dollar-and-cent wholesale and retail ceiling prices now apply to new, replacement items. Designated as Amendment No. 134 to revised Supplementary Regulation No. 14 to the General Maximum Price Regulation, the ruling also covers charges for tube testing and associated services.

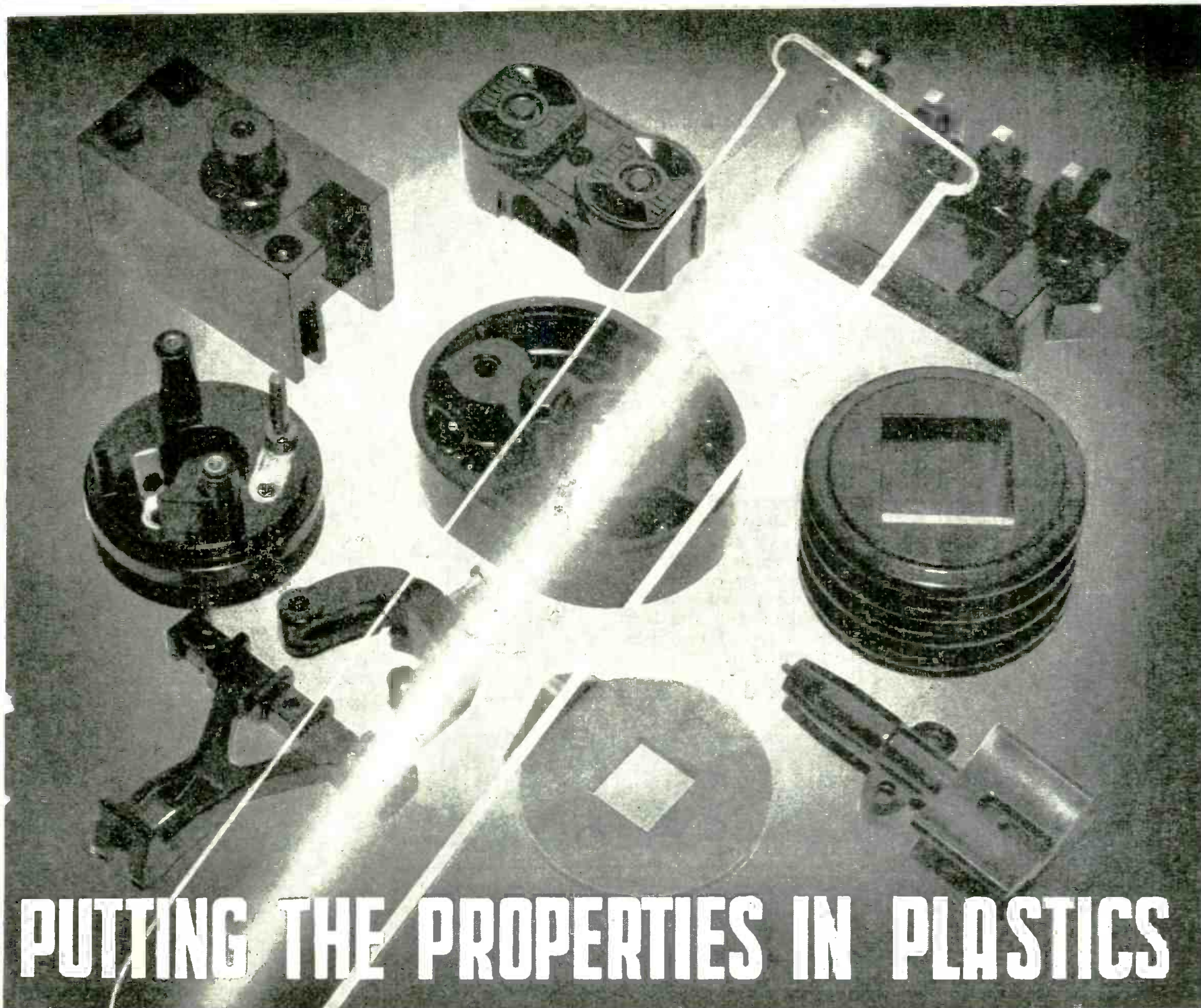
For some of the most common tubes, these prices apply, including the customary 90-day guarantee and the 10 percent manufacturers Federal excise tax: 1A5GT—$1.10, 1A7GT—1.30, 1H5GT—1.10, 1N5GT—1.30, 12SA7GT—1.30, 12SQ7GT—1.00, 25L6GT—1.10, 35Z5GT—.85, 50L6GT — 1.10, 5Y3G — .70, 6F6G—.90, 6SA7GT—1.10, 6SK7GT—1.10, 6V6GT—1.10, 42—.85, 80—70.

Program for Veteran Rehiring

AT WESTINGHOUSE, 1800 returning war veterans have been put back to work as part of a company-wide program devoted to the sympathetic and understanding treatment of those men with physical disabilities Most of the discharged men are normal in mind and body and eager to get back to their old jobs, but the handicapped group is being given special attention from the point of view of placement in activities suited to their altered capabilities.

Surveys have been made of occupational requirements with the indication that approximately 19 percent of the tasks could be satisfactorily done by persons having only one leg, 17 percent by operators who must use crutches, 83 percent by men with only one eye, and 82 percent by deaf persons.

These are some 20,000 Westing-



PUTTING THE PROPERTIES IN PLASTICS

ONE of the significant things about General Electric's self-contained plastics operation is that your product can receive the attention of experts in every phase of the business.

In a manner, it is comparable to submitting your proposed plastics part to a round-table discussion of chemists, designers, engineers, moldmakers and manufacturing men. From it can only come the plastics part that best suits your requirements.

The contribution of the chemist to the successful solution of your problem is interesting and important. For "Putting the Properties in Plastics" is more than an alliterative phrase. It is the action taken by General Electric chemists to give your product the electrical, mechanical and chemical characteristics that its application demands.

This phase of G.E.'s operation is particularly pertinent at this time because most products, like most men, must work harder and longer in these times of war. Today's products must perform greater tasks. At One Plastics Avenue, chemists are helping them to do so.

Hear the General Electric radio programs: "The G-E All-girl Orchestra" Sunday 10 P.M. EWT, NBC. "The World Today" news, every weekday 6:45 P.M. EWT, CBS.

FIFTY YEARS IN THE PLASTICS INDUSTRY

BUY WAR BONDS

GENERAL ELECTRIC

house employees on leave of absence with the armed forces and the number of men being returned is steadily increasing. As long as wartime levels of production are maintained, there is no problem of placing the veterans but the company foresees the necessity of a large percentage of the temporary workers returning to other activities with a change to normal civilian levels.

Small Business Shrinking

ONLY 7.3 PERCENT of the communication and electronic equipment shipped out by US producers between 1939 and 1943 came from plants employing less than 500 wage earners. Of the total, the very big plants—2500 workers and over—manufactured 68 percent. These figures, in dollar values, were presented by Maury Maverick, vice-chairman of WPB and chairman of the Smaller War Plants Corp., in testimony before the Senate Small Business Committee.

Mr. Maverick and SWPC were demonstrating that because the proportionate share of little business in metal products industries as a whole has been cut roughly in half since the war began, the saving of free enterprise through restoration of a more equitable proportion will be a job of second importance only to that of winning the war.

Worldwide Communications

WITH THE IDEA that problems should be considered and policies established before the end of the war, Senator Burton K. Wheeler, chairman of the Senate Committee on Interstate Commerce, has announced the appointment of a five-man subcommittee to study international communications. Other members of the subcommittee will be Wallace White Jr., Maine Republican; Lister Hill, Alabama Democrat; Ernest McFarland, Arizona Democrat; and Warren Austin, Vermont Republican.

Among the factors leading up to this step are (1) rate discrimination by foreign press associations against American news dispatches, (2) need for assurance of National security, (3) possibility of impending cartel-type deals between Amer-

ican and foreign carriers involving policies opposite to future National policy; (4) questions related to the disposal of several billion dollars worth of public-owned communications equipment, and (5) the opportunity to promote future peace by expediting the interchange and dissemination of information on a worldwide scale.

War on Spark Plug Interference

IT IS PREDICTED by Delmar G. Roos, vice-president in charge of engineering at Willys-Overland Motors, that the wartime developments used to suppress radio interference by military vehicles will ultimately accrue to the benefit of the public. Techniques are in contemporary use for the complete elimination of ignition disturbances on a mass production basis without impairment of motor performance.

Benefits possible to users of high-frequency receivers—both in homes and possibly in vehicles—suggest to him the advisability of legislation which would require noise suppression on all existing cars and trucks as well as those being produced.

London News Letter

By JOHN H. JUPE
London Correspondent

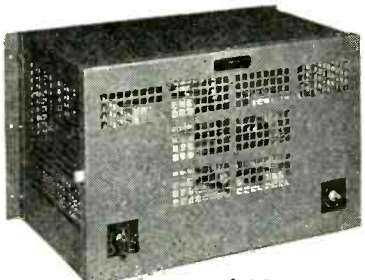
Television and frequency problems. Quite naturally, the radio industries of the United States and Britain are considering where they stand with respect to television in the post-war world and it is significant that several committees have been set up to handle the problems involved. In the United States the Radio Technical Planning Board will presumably make recommendations regarding picture standards, while over here in Britain the newly formed Government Television Committee will probably do the same.

Lord Hankey is the chairman and he is a man well fitted for such a post, having presided over a Government inquiry into the enormously difficult subject of technical manpower. Sir Noel Ashbridge (chief engineer), and Mr. Hayley represent the British Broadcasting Corporation. Sir Edward Appleton, one of radioloca-

101 SERIES *Amplifiers*

WITH RACK PANEL OR WALL MOUNTING ACCESSORIES

Input impedance 600 ohms and bridging. Gain 600 ohm input 61 db., bridging input 46 db. Frequency response 30 to 16,000 c.p.s. either input—600 ohm output ±.5 db., 30 ohm output ±1 db. Power output—production run average: +47 V.U. with less than 3% RMS harmonic content.



TYPE 201-A Wall Mounting Cabinet permits universal installation of 101 Series Amplifiers to any flat surface. Well ventilated and designed for maximum accessibility for servicing and convenience of installation. Standard aluminum gray finish.

TYPE 7-A Modification Group permits 101 Series Amplifiers to mount on standard 19" telephone relay racks. Occupies 12¼" rack space. Allows servicing from front of rack. Standard aluminum gray finish.

THE TYPE 101 Series Amplifiers are the results of twenty years' experience in the sound engineering field. They are identical with the exception of the output coil.

Type 101-A has output impedance adjustments to match loads from 1 to 1000 ohms and possesses excellent low frequency waveform at high output levels.

Type 101-B with a single nominal 6 ohm output is intended for use with wide range loudspeakers representing an 8 to 16 ohm load. Its output coil with a single secondary provides improved efficiency and even better waveform at high levels of low frequencies.

Type 101-C answers the demand for a good amplifier at lower cost. This lower cost is obtained by the use of a less expensive output coil with the only change being that the low frequency waveform is not as good as the A or B types but is equal to or better than any contemporary commercial amplifier. Output impedance is adjustable to loads of 1 to 1000 ohms.

The Langevin Company

INCORPORATED

SOUND REINFORCEMENT AND REPRODUCTION ENGINEERING

NEW YORK	SAN FRANCISCO	LOS ANGELES
37 W. 65 St., 23	1050 Howard St., 3	1000 N. Seward St., 38

tion's "parents", represents the Department of Scientific and Industrial Research; while Professor Cockcroft, an expert on electronics and atomic structure, speaks on behalf of the Ministry of Supply. Sir Stanley Angwin (Pres. IEE), and Sir Raymond Birchall are sitting on behalf of the British Post Office and R. P. Harvey speaks for the British Treasury.

The whole composition of this Committee shows that the British Government is taking the question of television very seriously and, although he is not a member, it is interesting to note that the British Broadcasting Corp. has called home from its North American office Mr. G. Cock, who was the Corporation's Director of Television from 1935 till the outbreak of war.

Industry Committees

Two other television committees have also been formed in this country with the support of the Radio Manufacturers Association and the Radio Industry Council. The first is the Television Policy Committee and it will assist the Government Committee by offering advice, providing data, etc., as well as considering means of restarting television. The second is the Television Commercial Development Committee, which will confine itself to problems within the radio industry and unify trade activities generally.

One of the outstanding problems which the main bodies in America and Britain will have to face is the allocation of frequencies. In the matter of interference between our two countries, some folk may say that television will consist of local services only, but I would remind them that the BBC's pre-war service was purely local and yet it was once received in South Africa. Since television is pre-eminently a radio service which cannot tolerate even a small degree of interference, we shall have to co-operate quite a lot with respect to frequencies.

Radar

We can be sure that radar will have many peacetime uses concerning the safety of aircraft and shipping. Also, the frequencies used will be those which might be used for television. The best radar fre-

quencies for war uses are kept secret, but we know, very broadly, in which bands they lie and it would certainly cause trouble if New York television programs were ruined because a British liner was entering the harbor in a fog and was using the same frequency for a radar collision detector. Even on centimeter waves we may meet trouble.

Not only does this matter concern our two countries but all the United Nations, and even our enemies. Once the German nation has been cured of the loathsome political disease now afflicting it we can be certain of some good radio developments from that quarter.

Again, with international air links a certainty, the correct allocation of ether space must be settled early. Without adequate radio support, world wide air services will be an impossibility, both from the point of view of safety and commercial organization.

So it at once becomes clear that the question of waveband allotment must not be dealt with in a restricted sense, applying to television only, but must be handled internationally with representation from every country.

International Convention

The logical step is to hold a Frequency Allocation Conference between the United Nations, as soon

• • •

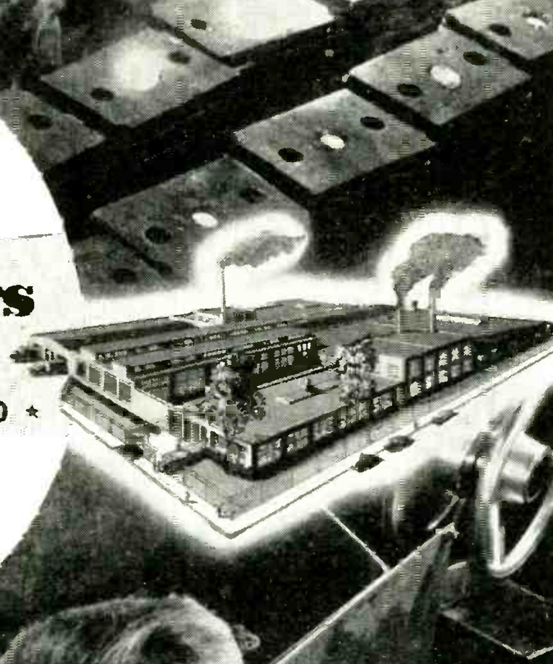
JIG FOR C-R TUBES

Glass bulbs for cathode-ray tubes are rotated in this jig at a constant speed while the operator moves a brush containing Aquadag up and down the vertical axis of the tube. The unit is in use at the Dobbs Ferry, N. Y. plant of North American Philips Co., Inc.

PERMANENT MAGNETS MAY DO IT BETTER

VITAL SOURCE OF SUPPLY

Modern facilities . . . specialized engineering experience . . . highly skilled workmanship . . . that's what it takes to produce *quality* permanent magnets in *quantity*.



The
INDIANA STEEL PRODUCTS
Company

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★ **Specialists in Permanent Magnets Since 1910** ★

Our engineers will be pleased to consult with you on any problem you may have involving permanent magnets. Write us, on your letterhead, for address of our office nearest you and a copy of our "Permanent Magnet Manual".

Help Win the War in '44 — Buy War Bonds!

as possible, and definitely before the war ends; at which the whole radio spectrum could be reviewed and television correctly placed. Technical representatives from the occupied countries could represent their own governments and enemy countries could be represented either by friendly aliens or could be alloted portions of the wavebands, the acceptance of which could be stipulated as part of the peace terms.

To wait until the end of the war will inevitably hold back television and air line developments because of the interference difficulties encountered when each country allots its bands separately. The spirit of the United Nations is to cooperate and the time to cooperate is *before* and not when you meet trouble.

Electronic Training For Salesmen

MANUFACTURERS are urged to insure the best service along engineering and technical lines for their industrial consumers by providing training for the selected representatives of the wholesalers who will distribute the products. This suggestion was part of the report made by the industrial electronics committee of National Electrical Wholesalers Association at their 36th Annual Convention in Chicago during April. Special attention of the wholesalers was directed toward the opportunities of high-frequency induction heating. Another feature of the session was the release of information obtained in a study of 1946 appliance-market potentials and announcement that the information was being published in book form to be sold by the association from its headquarters at 500 Fifth Ave., New York 18, N. Y. Copies are $1.

Radio Intelligence Activity Reduction

BECAUSE OF A million-dollar cut in the appropriation of the FCC division of Radio Intelligence it may be necessary to curtail or eliminate the emergency service which has furnished 540 bearings for planes in distress and thus aided in saving many times its entire $8-million budget in material alone. Also, four of six direction finders in the

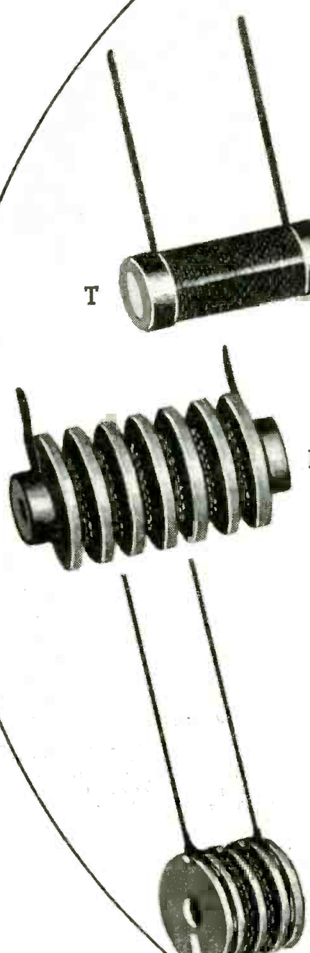
BREAK BOTTLENECKS WITH

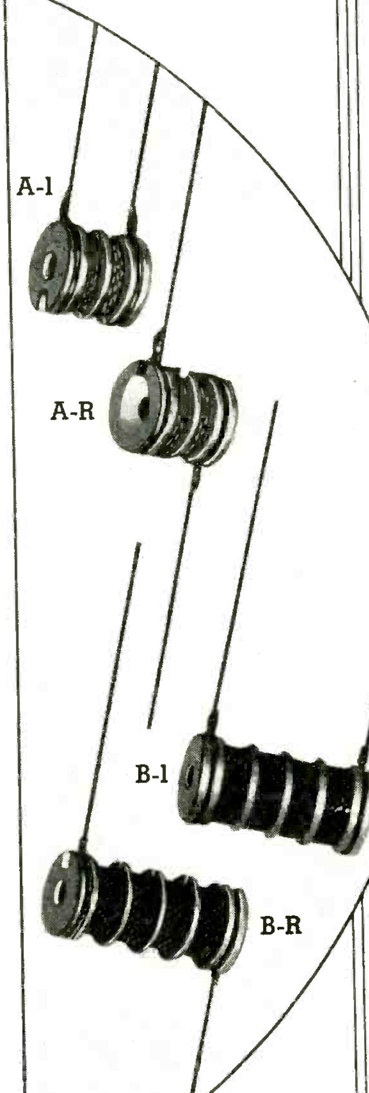
PROMPT DELIVERIES *of* PRECISION *wire-wound* RESISTORS!

ELCO wire-wound PRECISION RESISTORS are seeing active duty on every fighting front. Their ability to stand the "gaff"— their high degree of accuracy—makes them a "first" with the BIG names in radio and instrument manufacturing.

Resistors may be YOUR bottleneck in YOUR production schedule. You can break this bottleneck by specifying ELCO—the resistors that are meeting war-time deadlines—only because they are delivered when YOU want them as YOU want them—

PROMPTLY!





SPECIFICATIONS:

"A-1"—15/32 long x ½" dia.—Mountable with 6-32 flat or filester screw. No. 21 tinned copper wire leads. 1 to 300,000 ohm value—½% standard accuracy—non inductive pie wound—½ watt, 30° C. temperature rise in free air—100° C. maximum operating temperature—200 D. C. maximum operating voltage. Baked varnish finish.

"A-R"—Same as A-1, with leads reversed.

"B-1"—15/16 long x ½" dia.—Mountable with 6-32 flat or filester screw. No. 21 tinned copper wire leads. 1 to 500,000 ohm value—½% standard accuracy—non inductive pie wound—1 watt, 30° C. temperature rise in free air—100° C. maximum operating temperature—300 D. C. maximum operating voltage. Baked varnish finish.

"B-R"—Same as B-1, with leads reversed.

"T"—1-1/32 long x 7/16" dia.—Inductively wound—⅛ x .015 strap terminals—35 to 35,000 ohms—2 watts, 100° C. maximum operating temperature—normal accuracy 1%. Baked varnish finish.

"M"—1-13/32 long x ¾" dia.—Mountable with 6-32 screw—⅛ x .015 thick strap terminals —non inductive wound—1 meg ohm maximum resistance—600 volts maximum operating voltage—100° C. maximum operating temperature—1.5 watts—1% normal accuracy. Baked varnish finish.

"G"—15/32 long x ½" dia.—Mountable with 6-32 flat or filester head screw. No. 21 tinned copper wire leads. 1 to 500,000 ohm value. ½% standard accuracy— non inductive pie wound .8 watts, 30° temperature rise in free air. 100° C. maximum operating temperature. 200 D. C. maximum operating voltage. Baked varnish finish.

Get to know **ELCO**

RESISTORS COMPANY

114 West 18th Street, New York, N. Y.

Telephone - Watkins 9-4774-5

Hawaiian Islands will have to be closed and the East and West Coast direction finder networks reduced from their previous 24-hour service.

These facts were related recently in testimony by George E. Sterling, RID chief, before a House committee. He characterized such emergency activities as an important by-product of basic operations concerned with location of interference which had been hampering vital war communications.

Receivers Back in Westinghouse Line

PRODUCTION OF HOME RADIO receivers, discontinued in 1928, will be reinstated at Westinghouse when the war is over. As soon after that as possible, television receivers will be added. Facilities currently in radio production there total 51 times the prewar activity and the company suggests that such additional capacity will be needed after the war as a result of the long period of depreciation and obsolescence which will have intervened since civilian radio production was halted. Specifically, the types planned include both AM and FM as well as phonograph combinations.

Electronic Standardization Saves Money

RESULTS FROM THE RECENT standardization program covering radio tubes for Army, Navy, and Canadian armed services show important savings of manpower, money, and time. The Office of the Chief Signal Officer reveals that benefits include interchangeability, simplification of inspection, and use of common stockpiles.

Tube quality is improved too because the manufacturer is freed from the necessity of making separate runs on the same basic tube with slightly different tolerances. In the field, the advantages of interchangeability on emergency replacement are notably apparent.

War Memorial Scholarship Awarded

THE MEMORY OF more than 5000 Westinghouse employees who served in World War I is perpetuated by four annual scholarships which go

Electronic Voltmeter Ohmmeter Capacitymeter MODEL 663A

RANGES: D.C. Vacuum-Tube Voltmeter—Direct Reading • Sensitivity: 160 megohms (high ranges), 16 megohms (low ranges) • Six Ranges: 0-6-30-150-600-1500-6000 Volts • Voltmeter readings can be taken without affecting circuit constants • A.C. Vacuum-Tube Voltmeter—Direct Reading • Input capacity 0.00005 mfd. at terminals of instrument • Input resistance: 160 megohms (high ranges), 16 megohms (low ranges). • Seven Ranges: 0-3-6-30-150-600-1500-6000 Volts • Measures signal and output voltages, etc. • Vacuum-Tube Ohmmeter—Direct Reading • From 0.1 ohm to 1,000 megohms • Seven Ranges: 0-1,000-10,000-100,000 ohms; 1-10-100-1,000 megohms • Vacuum-Tube Capacitymeter — Direct Reading • Accurate measurements from 0.00005 to 2,000 mfd. • Seven Ranges: 0-0.002-0.02-0.2-2-20-200-2,000 mfd. • No danger of shock on low capacity measurements. No test leads to short • No resetting when changing ranges.

A vacuum-tube instrument combining sensitivity, flexibility and utility, is used extensively by the Navy. Model 663A cannot be damaged by measuring resistance when resistors are "live"; or by using a low range on high voltage readings; matched-pair multiplier resistors are accurate within 1%; errors due to voltage fluctuation are eliminated by use of VR105-30 tube and associated circuits; there is no danger of shock on high resistance measurements.

Model 663A, complete, for operation on 110-volt, 60 cycle A.C., costs **$55.50**
on 210-270 volt, 50-60 cycle........$59.50; on 25-cycle........$63.50.
Full details in Catalog 128 will be sent promptly on request.

RADIO CITY PRODUCTS COMPANY, INC.

127 WEST 26th STREET — RCP — NEW YORK CITY 1, N. Y.

MANUFACTURERS OF PRECISION ELECTRONIC LIMIT BRIDGES — VACUUM TUBE VOLTMETERS — VOLT-OHM-MILLIAMMETERS — SIGNAL GENERATORS — ANALYZER UNITS — TUBE TESTERS — MULTI-TESTERS — OSCILLOSCOPES — AND SPECIAL INSTRUMENTS BUILT TO SPECIFICATIONS to young employees and sons of employees. This year they have been given to Charles C. Brinton Jr., Edgewood, Pa.; Robert I. Hayford, Wilkinsburg, Pa.; Robert Louis Sauer, Sharon, Pa.; and Richard Lewis Hart, Aldan, Pa.

Awarded on the basis of competitive examinations, the scholarships are valued at $2000 each. They will be held aside for those winners who enter the armed services. Choices of study among the four entail, respectively, physics, electrical engineering, metallurgical engineering, and mechanical engineering.

Experimental Airport Stations

TEMPORARY LICENSES have been issued by FCC through Aeronautical Radio Inc. for experimental airline communication in the VHF (30,000 to 300,000 kc) band. Aeronautical Radio is the non-profit organization which handles the communications activities of all U. S. commercial carriers, of some international lines, and of unscheduled airplane operators by contract.

First of the companies in the band is Pennsylvania Central Airlines operating under a six-month license. Upon certification of successful results, a renewal can be requested. Although results have been good, complete conversion to these frequencies must wait until after the war because of restrictions on equipment required.

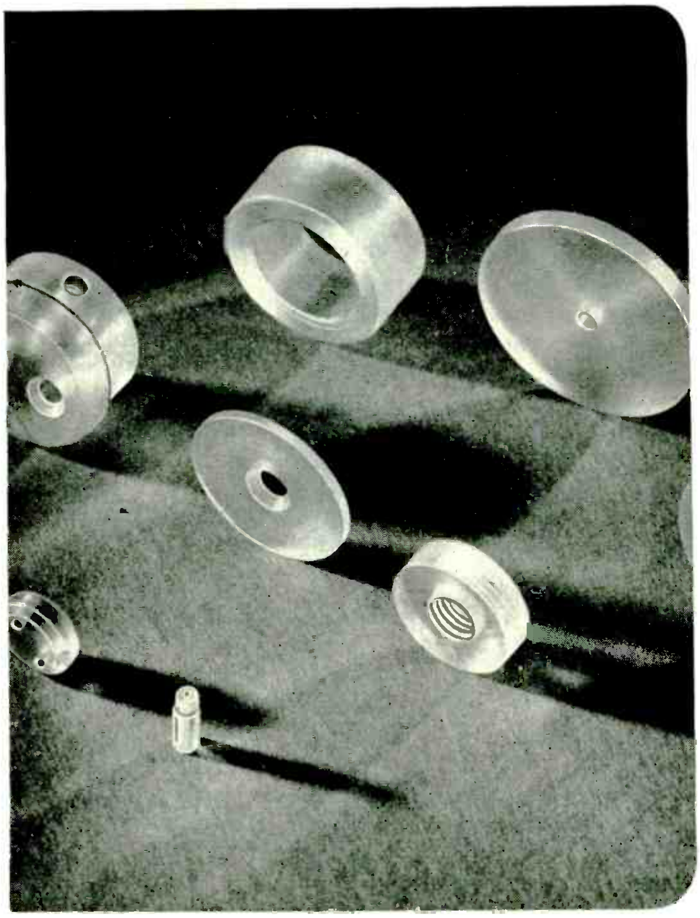
Radio Business News

GENERAL ELECTRIC Co. has, among other postwar plans, a scheme by which television transmitters can be reserved now for as-when delivery. Forty-kw stations have already been ordered by the New York Daily News and the Chicago Tribune.

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION has formed an aircraft electrical council to expedite the flow of information between equipment manufacturers and representatives of the Armed Forces and aircraft companies interested in electrical components.

COLUMBIA UNIVERSITY has established a center for the study of high-frequency induction heating. Located in Havemeyer Hall, the

HOW TO USE COOLANTS WITH PLAX POLYSTYRENE



PLAX POLYSTYRENE IS SUPPLIED in sheets, rods and tubes. It is also available in the famous Polyflex* Sheet and Polyflex* Fiber, tough and flexible extruded forms with wide insulation application. Machined parts such as those shown above (in actual sizes) are produced by Plax, to your specifications. Plax also supplies a polystyrene cement.

Other Plax wartime production includes various forms of cellulose acetate, cellulose acetate butyrate, ethyl cellulose, methacrylate, and styramic.

Write for bulletin on "Fabricating Polystyrene," containing full details of polystyrene's properties.

*Trade Mark Reg. U. S. Pat. Off.

If the temperature of polystyrene is not raised above 60°C (140°F) during machining operations, no difficulties will be encountered.

Gumming, surface disfigurations, and crazing (surface cracking) occur when heat generated by drilling or cutting exceeds this temperature. Crazing will occur even before gumming, and it may appear immediately, or a week after machining.

It is almost impossible to measure the surface temperature rise of plastics, because heat is generated for a very short time at a usually very small point of cutting. Polystyrene's splendid electrical insulation properties are accompanied by exceptional heat insulation qualities, which prevent this plastic from quickly giving up its heat.

Overheating can be prevented by (1.) elimination of excessive friction and provision of adequate chip clearance, and (2.) use of a proper coolant. Kerosene or other ordinary cutting oils will damage polystyrene.

Laboratory study at Plax has shown that a water soluble coolant that will wet both polystyrene and metal gives the best cooling action. (And, incidentally, eliminates change-overs when the same machine is used for both plastics and metals.)

Most coolants in this category are injurious to polystyrene but several that are completely neutral to the plastic are available at low cost. Two of these are Shell Oil Company's Vergo Oil 38-P and Stanco's Solvac 100-M Special. One of these, or a coolant equal in performance, should always be used in all sawing and drilling and in some turning and milling operations.

When the above-mentioned points about machining polystyrene are recognized and provided for, intricate parts can be produced without trouble due to overheating.

PLAX
FOR PLASTICS
NOT SUBSTITUTES---IMPROVEMENTS
133 WALNUT STREET · HARTFORD 5 · CONN.

laboratory will be operated by engineers from both the University and Induction Heating Corp., New York, N. Y.

HOFFMAN RADIO CORP., Los Angeles, Calif., has purchased a cabinet plant in Los Angeles containing facilities for the fashioning of special designs with a specifically Western motif.

ALLEN-BRADLEY CO., Milwaukee, Wis., has moved its Cleveland office to 4506 Prospect Road, Cleveland 3, Ohio.

AMERICAN RADIO RELAY LEAGUE president George W. Bailey sent transcribed greetings in the name of American hams to their opposite numbers in China, celebrating China Amateur Radio Day on May 5. Unlike US operators, Chinese amateurs have been on the air throughout the war, supplying, in many cases, the only means of communication between widespread parts of the country.

ELECTROMATIC MANUFACTURING CORP. is the new name for Electromatic Distributors Inc., New York, N. Y. The company has been making radios for a number of years.

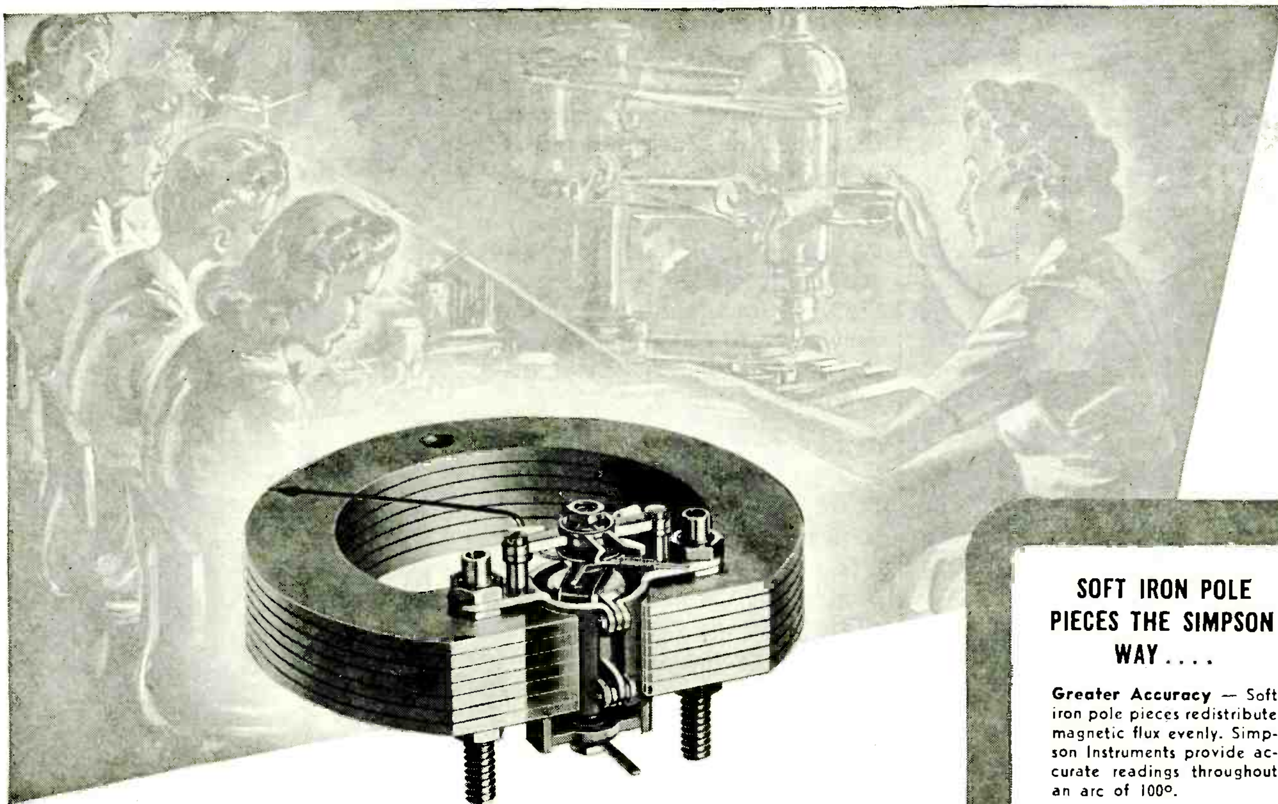
WESTERN ELECTRIC CO. has taken possession of a Defense Plant Corp. factory in Scranton, Pa., formerly engaged in piston ring manufacture.

ALLEN B. DU MONT LABORATORIES has been granted a commercial license for the television transmitter W2XWV. New call letters, derived from the initials of the owner, will be WABD.

FIXED AND VARIABLE RESISTOR INDUSTRY increased its production during April by more than 20 percent over the averages for February and March with backlogs of unfilled orders on a level for the three months. Expanded facilities are expected to be in operation during July.

D. E. REPLOGLE & CO. has opened a New York office at 1819 Broadway for consulting engineering on electronics for transmitting and other radio activities.

ELECTRONIC CORP. OF AMERICA and its workers were commended by a special award from the Blood Donor



These soft iron pole pieces tell the story—

EXPERIENCE is a much used, and too often abused, word. Yet in any field experience is the only source of practical knowledge—the only sound basis for further advance.

Measured in terms of time alone, the experience of the Simpson organization is impressive enough. For more than 30 years this name has been associated with the design and manufacture of electrical instruments and testing equipment. But the real value of this experience is to be found in the many fundamental contributions Simpson has made to instrument quality.

The use of soft iron pole pieces in the patented Simpson movement serves as an example. An admittedly finer type of design, these soft iron pole pieces have been employed by Simpson to provide maximum strength as well as accuracy, and to achieve a simpler assembly that permits faster, more economical manufacture.

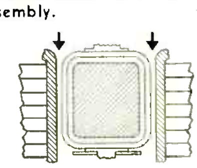
For today's vital needs, this experience enables Simpson to build "instruments that stay accurate" in greater volume than ever before. For your postwar requirements it will insure the correct interpretation of today's big advances.

SOFT IRON POLE PIECES THE SIMPSON WAY....

Greater Accuracy — Soft iron pole pieces redistribute magnetic flux evenly. Simpson Instruments provide accurate readings throughout an arc of 100°.

Greater Strength — Pole pieces are used to anchor full bridges across top and bottom of movement. Moving assembly is locked in permanent alignment.

Smooth Walled Air Gap No cracks or irregularities to invite dust or other foreign particles, which might interfere with movement of armature. Reamed to accurate dimensions after assembly.



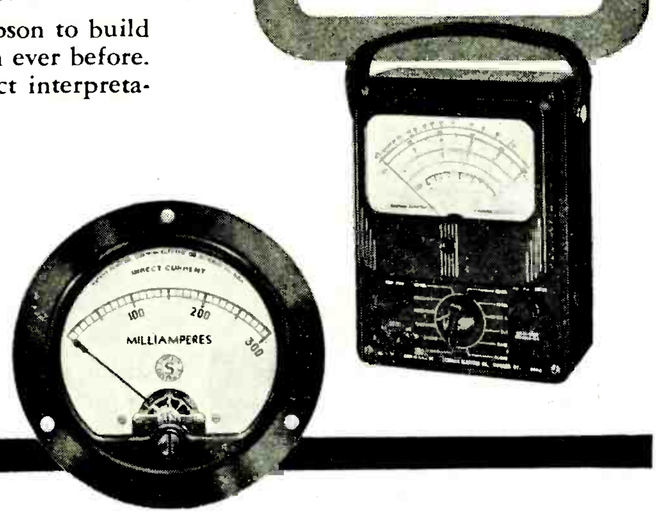
Speed and Economy—Pole pieces are stamped, not machined. This is one of many ways Simpson has speeded construction, and lowered costs, of this basically better movement.

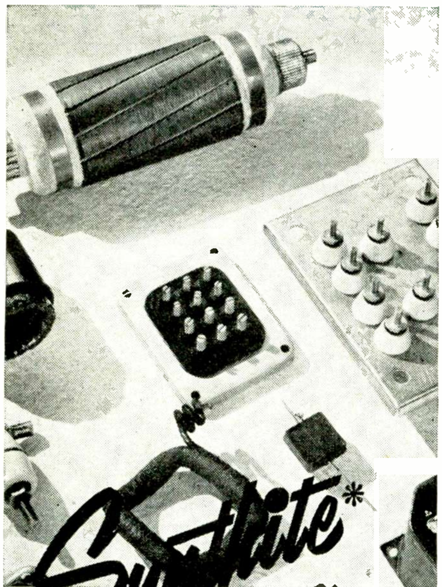
SIMPSON ELECTRIC CO.
5200-5218 Kinzie St., Chicago 44, Ill.

Simpson

INSTRUMENTS THAT STAY ACCURATE

Buy War Bonds and Stamps for Victory





Div. of the American Red Cross for their respective efforts in blood giving. Employees go to the blood bank in groups on management's time when the general rush is off.

PURDUE UNIVERSITY is training girl high-school graduates as engineering drafting aides. Students are selected by RCA Victor working with United States Employment Service. On completion of their training they enter RCA plants as apprentice detailers.

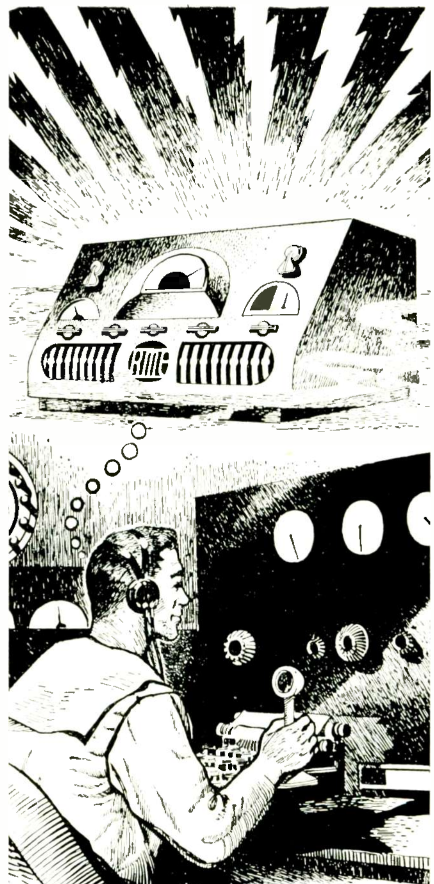
CONTINENTAL CAN CO. has formed a plastics division to make Marco-Board, a thermosetting, contact laminate, fabricated from a new-type synthetic resin. In this division will be the newly acquired facilities of the Reynolds Molded Plastics Div. of Reynolds Spring Co., Cambridge, Ohio.

EMERSON RADIO & PHONOGRAPH CORP., announces that one of its \$24.95 (prewar) personal radios has been auctioned off at a Flag Day ceremony for sailors in England at the possibly record figure of \$2200. Auctioneers were stage and screen stars.

OFFICE OF PRICE ADMINISTRATION has changed the pricing order setting manufacturer's ceiling prices for new radios and phonographs so that wholesale and retail prices can be set under the same orders which establish the makers' prices.

CHICAGO AREA RADIO CLUB COUNCIL staged what they called a "Hamboree' to emphasize the important part in the war being played by hams. Speakers included Commander James E. Parrott, USNR, communications officer of the Ninth Naval District; Cyrus T. Read, assistant secretary of ARRL; and Clifton Byrne, acting regional representative of the War Shipping Administration.

WAR MANPOWER COMMISSION is giving vocational training courses to 935 veterans of this war . . . mostly in radio, machine operation, welding, and aircraft subjects. The majority are already in active production jobs but take the training as a supplement. Administration of the program in most states is handled by the US Office of Education in cooperation with state and local education boards.



When you specify this

OSTER MOTOR

you are assured of dependable performance in 4 different ways . . . .

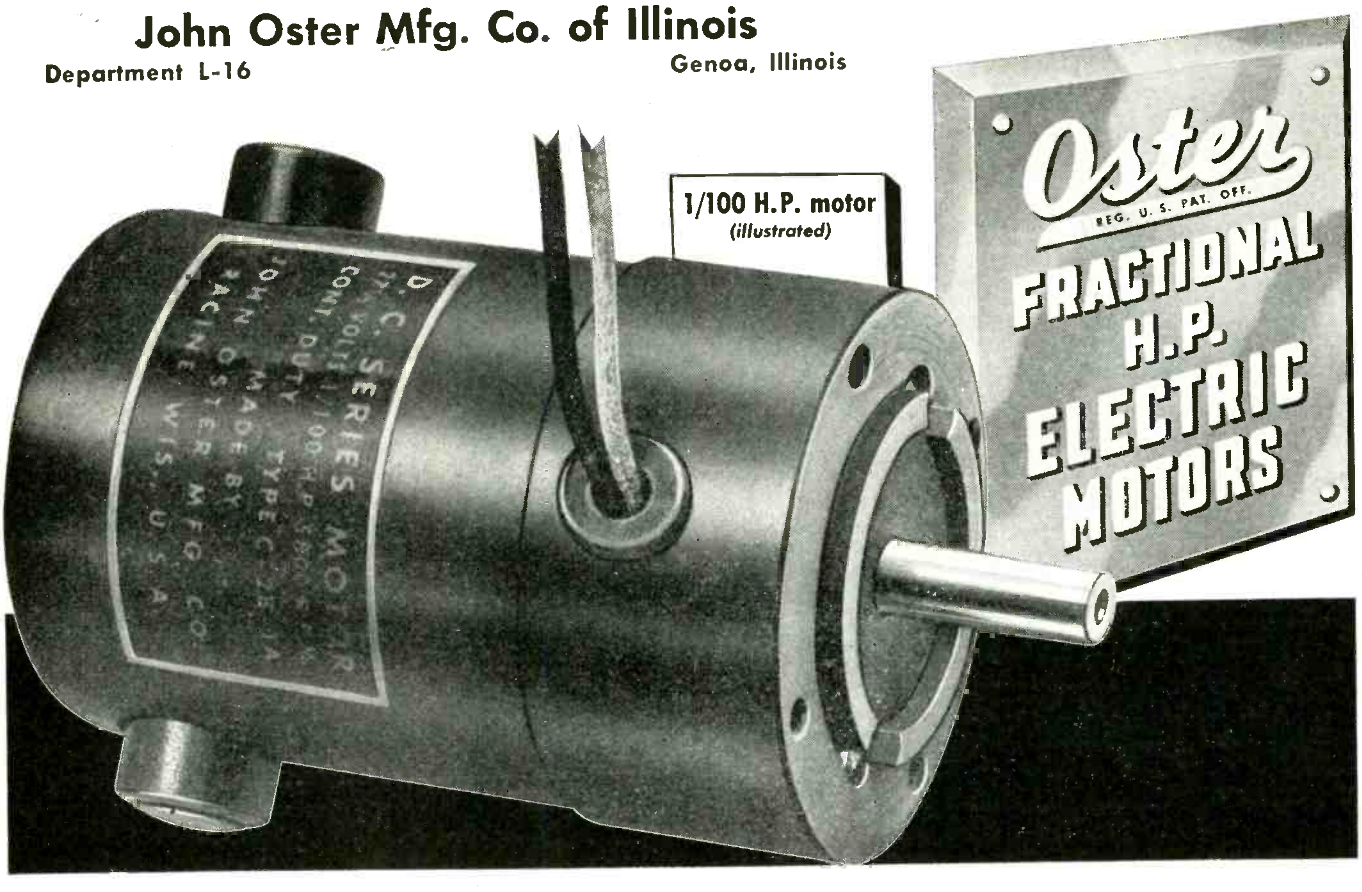
1. **Sound, conservative engineering**
2. **Established precision standards**
3. **Trained production staff**
4. **15-year performance record**

When you specify Oster Fractional Horsepower Motors, you know that you are dealing with a seasoned, dependable source—experienced for 15 years in building motors for Oster peacetime appliances which enjoy a world-wide reputation.

Illustrated below is Type C-2B-1A, 1/100 H.P. model in current production; developed for aircraft use and adaptable to blower applications. It's equipped with ball-bearings and built in an aluminum die-cast housing; 6, 12, 24, or 115 volts D.C. 115 volts A.C.

You can depend on Oster Motors to deliver creditable results that add to your own reputation for selecting sources wisely. Let us help you fit this or other Oster motors to your requirements. Write for details.
M-16

John Oster Mfg. Co. of Illinois
Department L-16 **Genoa, Illinois**



Personnel

William H. Newbold, assistant director of research for Philco Corp., died recently in St. Luke's and Children's Medical Center, Philadelphia, Pa.

H. H. Rogge, manager of the Washington Government Office for Westinghouse Electric & Mfg. Co., has advanced to vice-president.

Raymond C. Bierman has become chief engineer at Permoflux Corp., Chicago, Ill. He had been studio field engineer with NBC.

John H. Ashbaugh, newly appointed vice-president of Westinghouse Electric & Mfg. Co., continues as manager of the electric appliance division, Mansfield, Ohio.

Stuart Ballantine, president of Ballantine Laboratories, Boonton, N. J., and prominent radio engineer, died after a two-day illness, in Morristown, N. J. The throat

microphone, currently in aviation use, is one of his many inventions. His professional radio career dates from 1913 when he became operator for the Marconi Company.

Eugene M. Keillor has been appointed head of the design department of Peerless Electrical Products Co., Los Angeles, Calif. He was previously a design engineer at the Muskegon plant of Anaconda Wire & Cable Co.

R. L. Irvin has advanced from industrial manager of the Northwestern district to application manager of the small motor division within Westinghouse Electric & Mfg. Co., Lima, Ohio.

Dr. George R. Town has become manager of research and engineering at Stromberg-Carlson Co. He

has been that company's representative on various standardization panels of the National Television System Committee and Radio Technical Planning Board.

Earl R. Sayre has been appointed an application engineer for P. R. Mallory & Co., Indianapolis, Ind. He was formerly with Arrow-Hart & Hegeman Electric Co.

Paul H. Thomsen, former chief engineer at Air-Track Mfg. Corp. is now vice-president in charge of engineering. He is succeeded by Charles B. Raybuck who has Charles R. Browning for assistant. Charles J. Alba is development engineer.

William W. Wells, previously with Marine Radio, has become senior engineer at Hoffman Radio Corp., Los Angeles, Calif. William J. Green, late of Philco Corp., holds a corresponding title.

William Montgomery, production coordinator at John Meck Industries, has been named executive engineer for contact with Government agencies.

E. J. Oberle, commercial engineer of Arpin Mfg. Co., Orange, N. J., has been placed in charge of the equipment division.

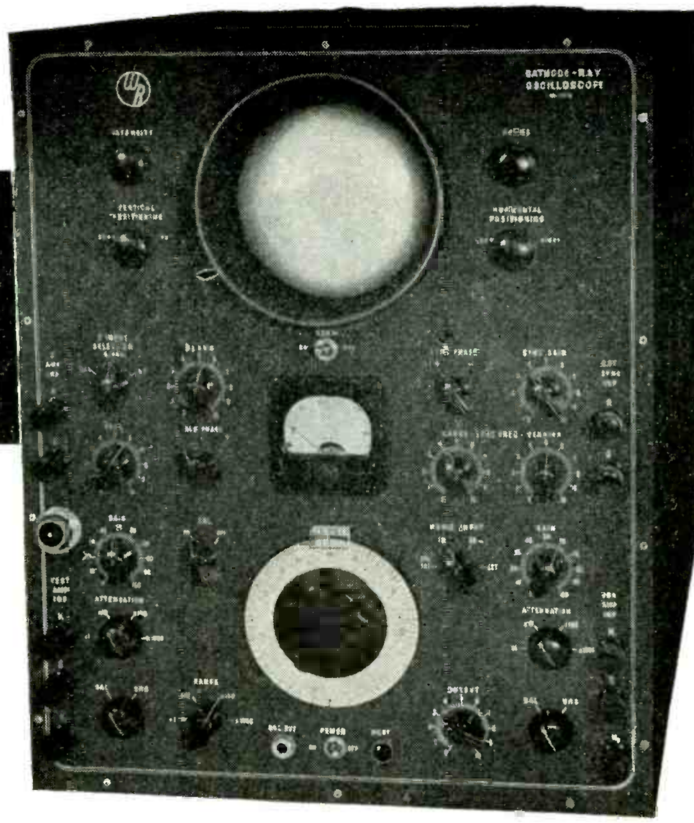
Stanley W. Goulden, commercial engineer in the RCA Victor Div., Radio Corp. of America, Camden, N. J. died in Philadelphia recently of a heart attack. He had been associated with the company since 1919.

John F. Dryer Jr. has joined the engineering staff of Amperex Electronic Products Inc. He will work on development of power and control tubes for industrial use.

Fritz H. Behrendt, president and founder of Recoton Corp. and head of Selectar Mfg. Corp. died recently after an illness of three years during which he nevertheless maintained active control of both companies.

C. D. Geer, onetime chief engineer of Thomas A. Edison Inc., and recently general manager of the instrument division, has been made a vice-president. K. G. Berggren, manager of the special products division, has been given the same title.

George H. Clark, vice-president in charge of engineering at Formica Insulation Co., Cincinnati, Ohio, has been elected to a direc-



A NEW *WIDE-RANGE OSCILLOSCOPE*

★ **D. C. to 4 megacycles**

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One of several instruments designed to meet the requirements of our military development program — now made available for general sale.

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X and Y amplifiers — 2000
Z amplifier — 100

INPUT IMPEDANCE
5 megohms; 15 $\mu\mu$f on all amplifiers; either balanced or unbalanced input may be used

MAXIMUM INPUT
500 volts — X and Y amplifiers
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DEFLECTION CALIBRATION
Comparison Voltmeter for calibrating deflection against sine wave

LOW IMPEDANCE ATTENUATOR
Eliminates troublesome capacity effects

SWEEP CIRCUITS
Hard tube linear sweep circuit, 2 cycles to 1 megacycle
Also, calibrated sweep circuit — saw tooth or sine wave — 20 cycles to 100 kilocycles
Internal oscillator provides square wave or sinusoidal wave for external use — 20 cycles to 100 kilocycles

LIGHT SHIELD
An adjustable light shield is provided, maximum projection — 8 inches

CATHODE RAY TUBE
Type 5 CP1
Accelerating potential — 3000 volts
Facilities are included for making a quick change to 5CP5 tube for high speed photography or to 5CP2 long-persistence tube

DIMENSIONS
Height — 20″ Width — 16″ Depth — 26″

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WHITE Research

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torship in Society of the Plastics Industry. SPI is the national organization of molders, machinery makers, and materials suppliers.

Theodore W. Case has died. He was one of the early workers on invention of sound for motion pictures and an executive of Fox-Case Corp. since his sale of Movietone to the Fox film interests. He was active during World War I on work connected with infrared signalling between ships.

R. C. Brannan has been appointed manager of the transformer equipments section of the transformer division, Westinghouse Electric & Mfg. Co., Sharon, Pa. He has been headquarters commercial engineer in the power transformer section.

Frank H. McIntosh, chief of the domestic and foreign branch, Radio and Radar Div., WPB, has resigned to return to private electronic-engineering consulting practice. He is succeeded by his former assistant, John Creutz.

Major General Harry C. Ingles, chief signal Officer, has been awarded the decoration of the Orden del Libertador in the grade of Commendador by the Republic of Venezuela. This was for communications services rendered while General Ingles was chief of Staff of the Caribbean Defense Command.

Garet W. Denise, former industrial consulting engineer has been made general manager of the Chicago plant operations of Littelfuse Inc. He has also been associated with Temple Radio Corp.

Major George A. Rote, member of the engineer board at Fort Belvoir, Va., has been appointed to the American Standards Association committee on standardization of vacuum tubes for industrial purposes.

Wilbur B. Driver has resigned as president of the company bearing his name and has been replaced by his son Robert O. Driver. The company manufactures resistance wire and special alloys.

Jay L. Taylor has joined the staff of Hoffman Radio Corp., Los Angeles, Calif., as a senior engineer. He has been in the research laboratory of Colonial Radio Corp.

James W. McLaughlin has been made president of Bakelite Corp., New York, N. Y. His direction

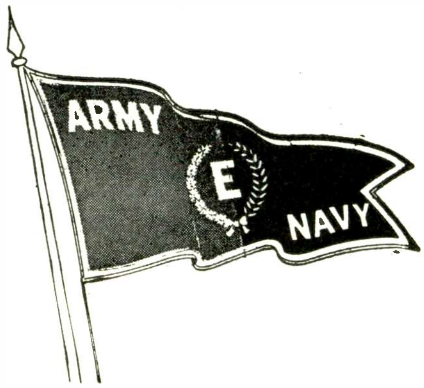
will encompass all plastics operations of Union Carbide and Carbon Corp.

T. R. Porter has become technical-commercial engineer on high-frequency heating for North American Philips Co., New York, N. Y. He was formerly concerned with electronic development at Westinghouse.

Donald M. Campbell, former electronic engineer with Bell Aircraft Corp., has joined the staff of Hoffman Radio Corp., Los Angeles, Calif.

T. A. M. Craven, FCC Commissioner, has announced his affiliation, in a technical capacity, with the Cowles interests, operators of Midwestern radio stations and newspapers.

L. Gale Huggins has been named assistant manager of air conditioning, covering engineering matters, at Westinghouse Electric Elevator Co., Jersey City, N. J. Other appointments include Walter C. Goodwin, negotiation manager over application engineering, and Howard A. Blair, electrical engineer, as service manager.



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COOLING AND FIRE prevention are provided by a newly patented television antenna that consists of a perforated metal tube from which water can be sprayed. Water in the tubing improves reception of undamped waves in dry weather, according to the claims.


Extra hands
KARP facilities and men, skillful in engineering and fabricating metal parts and products of simple or complex design, are your extra hands. In design, our engineering department has helped solve the knottiest of problems. In production and deliveries, our facilities have been praised for maintaining and beating standards and schedules. In cost, KARP extensive stocks of dies have saved thousands of dollars for customers.
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PANELS
KEEP BACKING THE ATTACK . . . BUY MORE WAR BONDS

Plethysmograph

(*Continued from page* 117)

encephalograph the inkwriter field is energized by the power supply for the final amplifier which drives the moving coil of the writer. Because of the small amount of power required, it seemed preferable to supply the inkwriter field from a separate power supply, making it completely independent of the electroencephalograph amplifiers and power supply. A voltage doubler, using a 117Z6GT, was provided for this purpose and placed in the chassis with the direct-coupled power amplifier.

Adjustment Procedure

The first stage of the amplifier is adjusted with the 6L6G output tubes removed from their sockets. The common cathode resistor value (nominally 30,000 ohms) is varied until the voltage from the common cathode connection to the plates (shorted together) is about 60 percent of the voltage from the cathodes to the plate supply connection. The 6L6G tubes are then inserted, and the connection between the battery and the rectifier so adjusted that approximately the same condition exists in the power stage.

The gain of the amplifier is controlled by varying a shunting resistor across the plates of the 6J7 tubes. In effect, this changes the amplifying efficiency of the first stage. This method of gain control is particularly advantageous for d-c amplifiers, as it does not affect the output voltage when the amplifier is set at "center."

The amplifier is adjusted by grounding the input grid with the switch provided, turning the gain to maximum, and bringing the pen to a central position with the centering control. The gain may then be reduced to near minimum. The plethysmograph should then be placed on the upper part of the ear and adjusted so that there is a slight comfortable pressure. Under these conditions a considerable basal quantity of light reaches the phototube, producing a large voltage drop in the 5-megohm load resistor. This makes the grid of tube

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The flexibility of N-Y-T engineering is emphasized by the type and scope of its transformer designs. Prior to the Defense era, N-Y-T technicians produced special custom-designed units for general precision applications. Then, with military preparations, transformers, rectifiers and solenoids — for practically every phase of electronic equipment—were included in N-Y-T production.

With the advent of war, the ingenuity and resourcefulness of the NEW YORK TRANSFORMER Sample Department kept pace with the unprecedented demands of Army, Navy and Air Forces.

The experience gained now in producing for the war effort is helping gear NEW YORK TRANSFORMER COMPANY to peace time requirements for both civilian and industrial transformer products.

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2 positive, and throws the pen to one side of center. The voltage drop is then balanced out by a negative voltage from the 70,000-ohm balancing potentiometer, which is so adjusted that the pen is returned to a central position.

For a few minutes the pen will drift to one side, because of the vascular dilatation resulting from the heat of the light bulb near the ear. When the drift has ceased, the apparatus may be tested by doing a Valsalva experiment. An example of the resulting record is shown in Fig. 4. Increased congestion is indicated by a downstroke on the record, starting at *A*. Intrathoracic pressure is released at *B*, and is usually followed by a period of overcompensation. The instrument is then ready for operation.

If a larger record is desired, the pen may be extended to almost any length desired. The frequency to be recorded is very low, so that inertia is not a problem.

The amplifier may be used for many other purposes. It works very well with a photoelectric membrane manometer previously described by the author[8]. Pressure variations up to about 50 cycles per second can thus be recorded with the inkwriter. The input need not be from a phototube circuit, as the instrument will work equally well with any other voltage input giving a signal of the order of one volt.

The output can also be used to drive an electromagnetic oscillograph of the optical type, which might require more power than the usual small direct-coupled amplifier can deliver.

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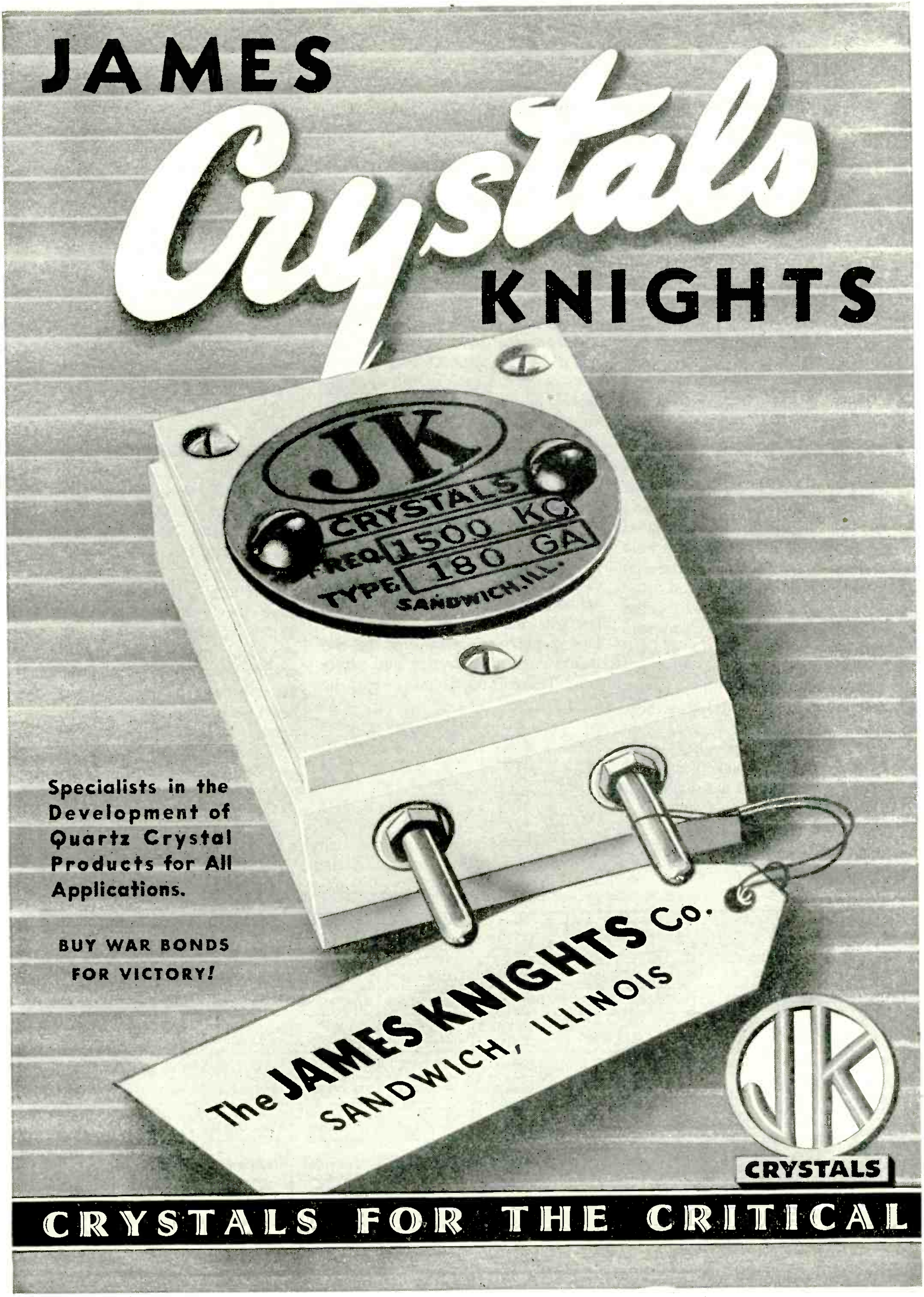
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CRYSTALS
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NEW PRODUCTS

Month after month, manufacturers develop new materials, new components, new assemblies, new measuring equipment; issue new technical bulletins, and new catalogs

New Heat-Resisting Plastic for Radio Parts

A NEW THERMOPLASTIC that can hold its shape and strength in boiling water and yet can be molded by fast and economical injection molding methods is announced by Monsanto Chemical Co.

The new plastic known as Cerex has already found wide use in war work, particularly radar, radio and other military electronic equipment where light-weight substances having good electrical and heat-resistant properties are in demand.

Cerex is one of the results of a long-range research program started six years ago to develop new thermoplastics, from petroleum sources, to overcome the poor dimensional stability of existing thermoplastics.

The fact that thermoplastics repeatedly soften under heat and harden on chilling is a fabricating advantage, but this characteristic involves low heat resistance in a molded part. The temperature resistance of a thermoplastic as indicated by its ASTM* heat distortion point determines the approximate ceiling for service temperatures, although the exact value depends upon the imposed load.

Two classes of materials were developed. One, designated as Styramic HT, is a specialized high-cost material of critical importance in super-high-frequency insulation. A secrecy order forbids discussion of its properties. The other is Monsanto Cerex, which has an ASTM heat distortion point of 220° F. It is a co-polymer containing the elements carbon, hydrogen and nitrogen. These three elements may be combined in various forms to give various characteristics but the present war development is concentrated on Cerex, X214.

Electrical properties of the new material are superior to those of most other thermoplastics although they are not as good as polystyrene and Stryamic HT at very high frequencies. The dielectric strength of the material is excellent (over 500 volts per mil). Surface and volume resistivity are also excellent and are not appreciably affected by prolonged immersion of the material in water. Maintenance of electrical properties under high humidity conditions is assisted by the low water absorption of Cerex.

The material now being produced has a transparent amber natural color. Color possibilities in molding compounds are somewhat limited although a range of transparent, translucent and opaque colors can be obtained. In flamability tests, the material is rated as slow burning.

War applications of Cerex X214 have received exclusive attention in development work. These include electrical applications where moderately low electrical loss properties are required in combination with heat resistance higher than supplied by present thermoplastics. Coil forms, crystal holders and capacitor cases are typical of the applications being studied. Aircraft

* In ASTM test method D648-41T a load of 2.5 kg is applied to the center of a ½" x ½" molded bar supported on 4" centers while the temperature of the specimen is raised slowly. The temperature at which a deflection of 0.01" occurs is taken as the heat distortion point.

Comparison Chart for Injection Molding Materials

Test	Cerex X 214	Polystyrene	Methyl Methacrylate	Vinylidene Chloride	Cellulose Acetate	Cellulose Acetate Butyrate	Vinyl Acetate Chloride	Ethyl Cellulose
Specific Gravity	1.07	1.05–1.07	1.18–1.19	1.68–1.75	1.27–1.37	1.15–1.23	1.30–1.45	1.07–1.18
Flexural Strength in P.S.I.	13.000	8,000–10,000	10,000–15,000	15,000–17,000	2,000–16,000	2,100–12,700	12,000–14,000	3,000–12,000
Impact Strength in Ft Lb/In: (Izod Milled Notch)	0.40	0.30–0.40	0.2–0.4	0.3–1.0	0.7–6.0	0.5–7.5	0.4–1.2	0.6–8.0
Distortion Temperature in °F	220–230	168–176	125–160	150–180	106–213	117–214	140–155	120–200
Rockwell Hardness	M100	M80–M90	M60–M90	M50–M65	M19–M81	M23–M72	M60–M80	M25–M65
Dielectric Strength, Short Time, in V/Mil	>510	500–700	500	350	290–600	250–400	400	400–700
Power Factor:								
60 Cycles	......	0.0001–0.0003	0.05–0.06	0.03–0.08	0.01–0.06	0.01–0.04	0.008	0.005–0.015
1000 Cycles	0.0024	0.0001–0.0003	0.06–0.07	0.03–0.15	0.01–0.06	....	0.01	0.005–0.025
1,000,000 Cycles	0.0024	0.0001–0.0003	0.02–0.03	0.03–0.05	0.01–0.05	0.01–0.04	0.014	0.007–0.030
Dielectric Constant:								
60 Cycles	......	2.5–2.6	3.4–3.6	3.0–5.0	3.5–6.4	3.5–6.4	3.26	2.5–3.5
1,000 Cycles	2.72	2.5–2.6	3.3–3.5	3.0–5.0	3.5–6.4	......	3.21	2.5–3.5
1,000,000 Cycles	2.76	2.5–2.6	3.1–3.3	3.0–5.0	3.2–6.2	3.2–6.2	3.08	2.0–4.0
Water Absorption, 24 Hr, in %	0.30	0.05	0.4–0.6	<0.1	1.6–3.6	1.2–2.0	0.05–0.15	1.0–2.0

THE SCIENCE OF ELECTRONICS ALSO PROVIDES A NEW TRIUMPH IN ELECTRO-MEDICAL ANALYSIS AND LABORATORY RESEARCH . . .

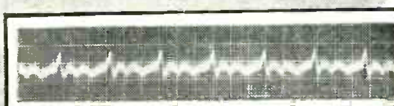

FIGURE A—Photographic Method

FIGURE B—EPL Method

FIGURE C—Calibration

The exact similarity between the standard photographic cardiogram and the direct writing instantaneous cardiogram on this new EPL instrument is indicated in Figures A and B, which are records of the same subject taken a few minutes apart.

New EPL Direct-recording Electrocardiograph*

...giving instantaneous *standard* readings

- Built to exacting laboratory standards after years of research
- Completely eliminates all photographic procedures
- Useful in the laboratory as well as a benefit to mankind
- Compact, lightweight, portable; simple and efficient in operation
- Cardiograph record appears instantaneously
- Built-in interference filter makes possible perfectly usable cardiograms in strong interfering electrical field
- Operates from any 110-120 volt, 60 cycle, AC service
- Uses no ink or other fluids
- High operating economy

*PATENT PENDING

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We will gladly demonstrate this new Direct-recording Electrocardiograph before you at your convenience. We sincerely believe that this instrument can lend material assistance to the work that the Armed Services are now doing in the rehabilitation of wounded veterans.

For Laboratory Procedure

The recorder of this new Electrocardiograph may be used in conjunction with other equipment for laboratory research. It provides an amplifier and recorder which will give a graphic record between .1 cycle and 80 cycles per second at a sensitivity of 1 millivolt for 2 cms total deflection; or a range from zero to 80 cycles for 60 millivolts for 2 cms deflection. A high speed writer can be supplied which will extend the operating frequency to about 200 cycles. Because of the special damping circuit employed, excellent transient response is secured.

Although in the high sensitivity connection, the amplifier is not a true D-C amplifier, the phase correction is such that perfect square wave response from .25 cycles to 80 cycles is realized with the one millivolt sensitivity connection.

At present, deliveries will be made on priority only. Write for descriptive booklet.

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Manufacturers of Electro-Encephalographs and Electric Shock-proof Machines
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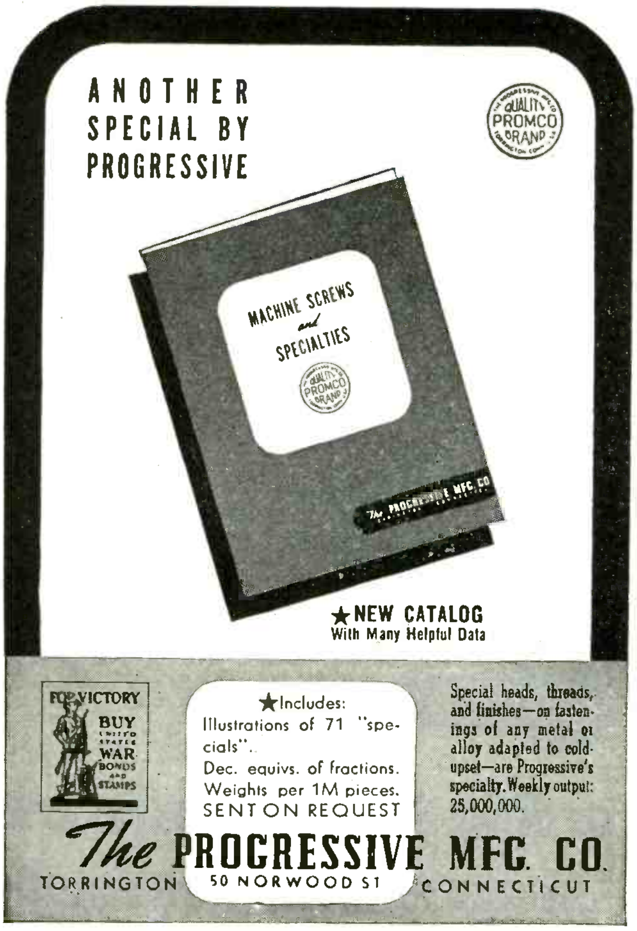

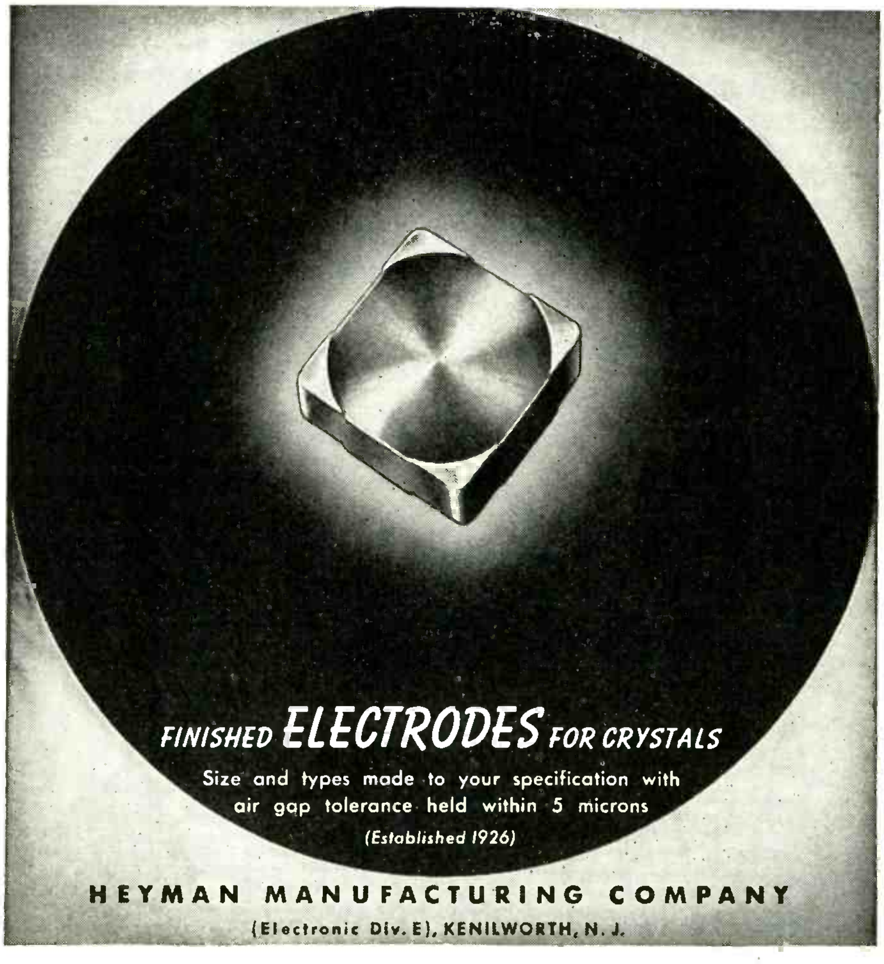

Dr. Reid Fordyce and Dr. David T. Mowry, co-discoverers of Cerex, hold up for comparison two radio parts. Although identical in size and shape before immersion in the boiling water, the ordinary plastic (left) wilted and shrunk, while the black Cerex part was unaffected by boiling water

battery cases molded of Cerex X214 have withstood very severe tests. In one such test the sulfuric acid electrolyte contained in a Cerex X214 jar was actually boiled without deformation or chemical attack of the molded case.

In effect, this new material breaks down the dividing line between the fields of application for injection and compression molded products. The injection molder can now produce parts for service at temperatures that previously have required the use of thermosetting materials. Radio and electronic parts can now be injection molded and yet have resistance to the ambient temperatures encountered in such apparatus even in tropical locations.

New and Improved Cetron Tubes

INDIVIDUAL BULLETINS which contain complete technical data on the following new and improved Cetron tube types are available. Briefly, the tube types are as follows:

CE-29 is an improved type of blue sensitive phototube, using an

Television sees Democracy in Action

● AMERICANS have always been eager to share in the political life of our Democracy. This year, the two great political conventions will be filmed in Chicago and the reels will be rushed to New York for broadcasting over WNBT, NBC's pioneer television station.

Four years ago, in 1940, WNBT made television history, by directly telecasting the Republican Convention at Philadelphia and by broadcasting films of the Democratic conclave in Chicago.

When Peace comes, a greater and more widespread television audience—expanding into millions of homes equipped with RCA television—will see as well as hear Democracy in action . . . thanks to the new super-sensitive television camera, and other radio-electronic devices developed in RCA Laboratories.

Today, RCA research and engineering facilities are devoted to creating the best possible fighting equipment for the United Nations. Tomorrow, RCA—Pioneer in Progress—looks forward to supplying American broadcasters, and the American public, with still finer radio, television, and electronic instruments.

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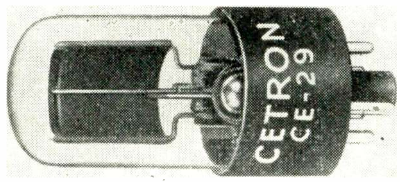
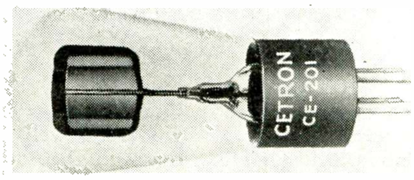


octal 5-pin base, interchangeable with similar tubes produced by other manufacturers. This tube is similar to the manufacturer's type CE-30. These two tubes together may be used to convert equipment from being red sensitive to blue sensitive and vice versa. CE-29 is particularly sensitive to blue and violet light near the short wavelength limit of visibility. Bulletin No. PC-15.

CE-200 and CE-201 are 2-amp, full-wave, mercury vapor rectifiers suitable for applications up to about 250 volts d.c. They have been redesigned for improved performance. CE-201 has a special long-pin in-



dustrial base, and is interchangeable with other tubes of the same characteristics. CE-200 has a standard 4-pin base. They are designed to eliminate the cost of installing two sockets to provide full-wave rectification. Bulletin No. 111 covers both types.

CE-202 is a long life, high efficiency rectifier tube designed particularly for the 250-volt d-c field and may be used in applications where d.c. is required for operation of d-c motors, magnetic chucks, magnetic brakes from a-c lines. It is rated 15 amp d-c output; 900 volt inverse peak; arc drop 7.5 volts. Guaranteed for 2,000 hours operation it may be used in most conventional 250-volt d-c circuits. Bulletin No. 108.

CE-222 (3B22) is a new xenon-filled full-wave rectifier and is interchangeable with other tubes designated as RMA 3B22. It has a d-c output current rating of 1 amp continuous; average arc drop is 8 volts. Bulletin No. 115.

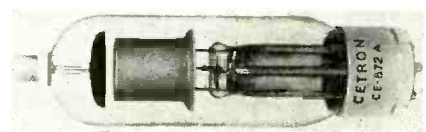
CE-303 is a 1-amp xenon-filled thyratron especially designed for

industrial application such as welding control, motor control, and controlled rectifiers. Inverse peak voltage rating is 700 volts. The tube draws low critical grid current, the maximum limit being 5 microamp; it has a standard 4-pin base. Bulletin No. 114.

CE-305 is a gas-filled thyratron introduced as a medium current tube. It uses a standard 4-pin base and has a maximum inverse peak rating of 1,700 volts; a d-c output current rating of 2 amp. It may also be used in industrial control applications. Data sheet No. 116.

CE-306 is a gas-filled grid control tube (thyratron designed). It is rated 6 amp continuous load; peak forward volts (maximum) is 750. Mechanical dimensions are 9½ inches high and 2 inches in diameter. It is for industrial control applications. Bulletin No. 118.

CE-872A is a mercury vapor high-voltage rectifier tube and may be used in radio transmitters, or



for high frequency heating equipment. It is rated 10,111-volts inverse peak, and 1.25 amps d-c output. It may be used to replace tube types 872, 872A/872 and 872A made by other manufacturers.

Continental Electric Co., Geneva, Ill.

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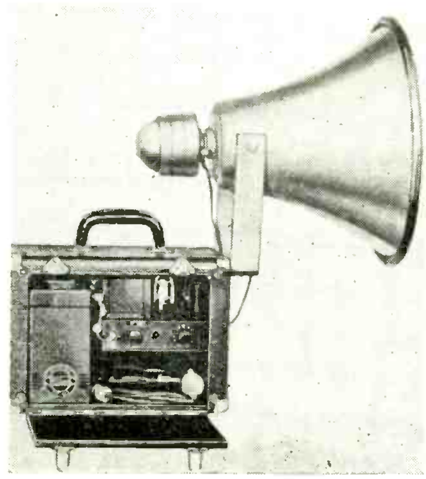
THIS PORTABLE SOUND system is supplied with a self-contained power

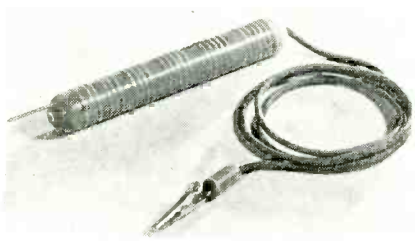


supply having acoustic output of 95 db at 100 feet. Reception at sea is good up to 2 miles, on land up to ½ mile. Power requirements are reduced to approximately 85 percent during standby periods by the use of a press-to-talk switch (located in the microphone handle) which automatically connects the power supply. The unit may easily be carried by one person (it weighs 39½ lb including microphone, amplifier, power supply and loudspeaker). The system is especially useful in ship-to-ship communication where the use of radio may be dangerous or in situations that require vocal control over great distances.

Newcomb Audio Products Co., 2315 S. Hill St., Los Angeles 7, Cal.

Continuity Tester

THIS NEW CONTINUITY tester checks for an open circuit or a short in coils, fuses, lamps, tubes, appliances, and in more complex assemblies. The unit lights up at the point of application and eliminates



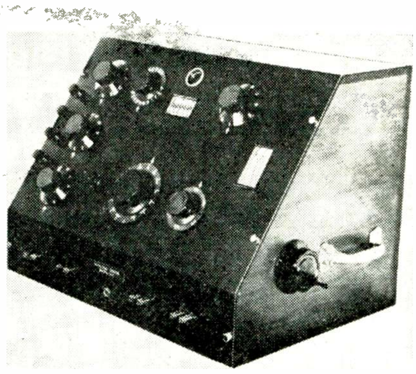
the need for looking back and forth at a meter. The tester is applicable to intermittent or production testing.

Walker-Jimieson, Inc., 311 S. Western Ave., Chicago 12, Ill.

Direct-Reading Megohmeter

MODEL 404-F megohmeter permits rapid measurement of resistance from 400 megohms to 100,000 megohms. It is especially designed for checking condenser dielectric, but may be used for other high megohm testing, or for production testing. A built-in current limiter prevents damage to the instrument if the test terminals are accidentally shorted. The resistance values are measured under an applied d-c potential of 90 volts and are indicated on an individually calibrated scale. Accuracy is rated at 5 percent.

Controls consist of a master switch, range selector, and zero adjustor and these are conveniently grouped on the front panel which also contains the resistance indicating meter, pilot lamp and a terminal strip. This is made of high resistance, non-hygroscopic material so as to avoid error caused by humidity. The measuring circuit, including its 110 volt, 60 cps power supply and test battery, is contained in a steel housing which



1 megohm to 100 megohms, 1 percent, and above 100 megohms the error increases to 5 percent. The capacitance range is 10^6 to 100 microfarads. Accuracy on these ranges are 100 $\mu\mu$f to 1 μf within $\frac{1}{2}$ percent and on other ranges the accuracy is rated within 2 percent. Inductance measurement (with no d.c. flowing) ranges from 10^{-6} to 100 henrys. Accuracy on inductance measurements are 100 μh to 1 h, within 1 percent. Other ranges are within 2 percent. Inductance of iron-cored chokes and transformers can be measured with up to 500 milliamps of d.c. flowing. Facilities for measurement of frequency, Q, and power factor are included in the bridge. The bridge contains a 1 megohm resistance decade in steps of 1 ohm (this is brought out to terminals so that it can be used externally.) An additional feature is the provision to plug in external facilities such as outside standards, oscillators, null indicators, and other instruments.

White Research Associates, 899 Boyleston St., Boston 15, Mass.

Pulse Generator

THIS INSTRUMENT, Model 700-A, is designed for laboratory use in the development of electrical apparatus in which pulse generation or transmission is an important characteristic. It is essentially a signal generator of d-c pulses. Specifications of the instrument are: Pulse amplitude, 0.03 to 20 volts from a calibrated attenuator with an accuracy of $\pm$10 percent; pulse duration, 0.4 to 120 microseconds in four ranges calibrated to 0.05 microseconds or 3 percent, whichever is the greater (for higher pulse rates the duration is limited to 40 percent of a cycle); pulse form, leading and

The New Model 710

VOLT — OHM — MILLIAMMETER

NOW AVAILABLE FOR PROMPT DELIVERY ON PRIORITY OF AA3 OR BETTER!!

Sensitivity—

1,000 OHMS PER VOLT

ON BOTH A.C. AND D.C.!!

Measures:—

A.C. AND D.C. VOLTAGES UP TO —

1500 VOLTS

A.C. CURRENT UP TO —

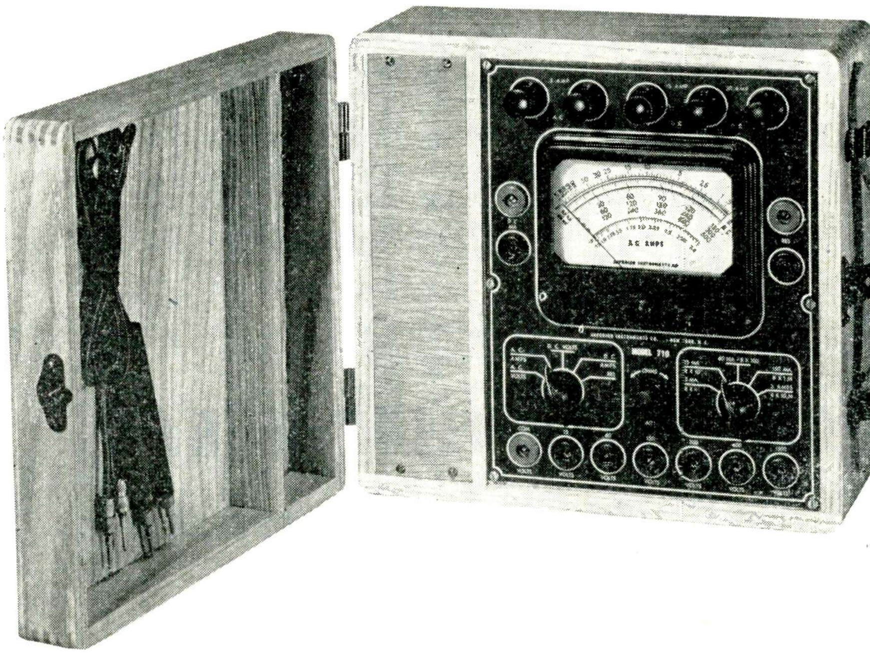
3 AMPERES

D.C. CURRENT UP TO —

30 AMPERES

RESISTANCE UP TO —

10 MEGOHMS



Features:—

*Uses New 4½" Square Rugged 0-400 Microampere Meter.

*Direct Reading—All Calibrations Printed Directly on Meter Scale in Large Easy-to-Read Type.

*Housed in Rugged Heavy Duty Portable Oak Cabinet.

*Completely self-contained—No external Source of Current Required.

A 400 Microampere meter movement is shunted to provide a sensitivity of 1,000 Ohms Per Volt on both A.C. and D.C. This method—using a 400 Microampere meter instead of a 1 Milliampere meter—affords improved damping because the meter is at all times shunted by a resistance. An Ayrton universal shunt is used for all current and resistance ranges. Paired multipliers insure accuracy of all voltage ranges and in addition two individual master calibrating adjusters enable precise calibration of all A.C. and D.C. Voltage Ranges. An almost perfectly linear A.C. scale is provided by using a special copper oxide rectifier unit which has an inverse to forward "a" resistance ratio of better than 400 to 1. Although the current carrying capacity of this rectifier is 15 ma., a maximum of 1 Milliampere is permitted to pass through the unit. This insures minimum heating in the rectifier unit guaranteeing high stability of all A.C. calibrations.

Specifications:—

6 D.C. VOLTAGE RANGES (1000 OHMS PER VOLT)
0 to 15/60/150/300/600/1500 Volts.

6 A.C. VOLTAGE RANGES (1000 OHMS PER VOLT)
0 to 15/60/150/300/600/1500 Volts.

7 D.C. CURRENT RANGES:
0 to 3/15/60/150 Milliamperes 0 to 3/15/30 Amperes.

A.C. CURRENT RANGE:
0 to 3 Amperes.

5 RESISTANCE RANGES:
0 to 1,000/10,000/100,000 Ohms. 0 to 1 Megohm 0 to 10 Megohms.

The MODEL 710 comes complete with cover, self-contained batteries, test leads and instructions. Size 6" x 10" x 10". Net weight 11 pounds. Price.................. **$34.50**

SUPERIOR INSTRUMENTS CO., Dept. M,
227-A FULTON STREET, NEW YORK 7, N. Y.

trailing sides of the pulse each consume approximately 0.15 microsecond or 1 percent of the pulse length, whichever is greater. Top is flat to within 1 percent; pulse polarity, either positive or negative pulses are obtainable by means of a switch; pulse repetition rate, internal oscillator gives either 500 or 5,000 pulses per second.

External oscillator gives 50 to 20,000 pulses per second, with excitation of 2 volts rms sine wave output impedance is rated 100-ohm-termination at end of a three foot line; high amplitude pulse, a negative pulse of 30 to 100 volts at 1,000 ohms impedance is supplied on separate terminals. The sides of this pulse each consume approximately 0.3 microseconds or 2 percent of the pulse length, whichever is greater; sweep voltage, sine sweep 7 volts peak to peak, phase continuously variable throughout 360 deg. Expanded sweep 4 volts peak to peak, duration approximately 10 deg, with adjustment to center the pulse; synchronizing pulse, positive pulse of approximately 20 volts; advance pulse, a positive pulse of 80 volts (rising to 50 volts within 0.25 microseconds), and leading the output pulse by 0.5 microsecond, for slave sweep oscilloscope operation. Stray field is negligible.

The instrument is supplied with removable line cord, output cable, and an instruction book. It is housed in a metal cabinet whose panel is standard rack and panel size. Dimensions of the cabinet are 19¼ x 14½ x 13¼ inches and of the panel 19 x 14 x 13¼ inches.

Model 700-A is available only for 115 volt, 60 cps a-c supply from Colonial Radio Corp., Buffalo 7, N. Y.

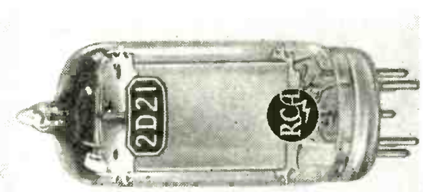
Relay Contactor

THIS RELAY-CONTACTOR is for use in heavy duty circuit control applications. Single or dual-voltage operating coils for all standard voltages are available. Standard units are conservatively rated 30 amp at 110 volts, 20 amp at 220 volts, or 10 amp at 440 volts. The contact carrying bridges are designed for a wide range of contact arrangements.

Glenn-Roberts Co., 2107 Adams St., Indianapolis 1, Ind.

New Tubes

Two new tube types include a miniature thyratron which is designated as RCA-2D21. It weighs half an ounce and measures $1\frac{7}{8}$ inches. The tube provides stable operation and a high control-ratio for a variety of functions as an electronic switch. It is particularly useful for control jobs where



lightness and small size are essential factors. The tube will carry 0.1 amp plate current continuously, and for periods up to 6 seconds out of 30 will safely carry 0.5 amp. It uses xenon filling instead of mercury vapor.

The second tube is designated RCA931-A. It has a sensitivity of 2 amp per lumen when operated at 100 volts per stage. This tube is a 9-stage multiplier phototube which is capable of amplifying signals 200,000 times and more, and may be used in astronomical studies to measure intensity of starlight, or in quantitative spectrographic analysis. Sensitivity is obtained by the use of secondary emission as cathode electrons which are impelled against nine successive dynodes before they reach the plate. The electron current is multiplied by the release of secondary electrons at each dynode.

Radio Corp. of America, RCA Victor Div., Camden, N. J.

Portable Electric Megaphone

The equipment is for police and fire departments and other protective organizations. The manufacturer states that under favorable conditions intelligible speech can be projected up to one-half mile; and under normal conditions on ships, the megaphone transmits voices clearly at one-quarter of a mile. Condensers, resistors, and component parts are easily accessible for servicing and replacement. Both the speaker and the microphone are made with water-proofed, molded phenolic diaphragms. The unit consumes power only during actual transmission of voice. The batteries operate for approximately 40 hours or more. The megaphone cabinet is waterproof and measures $9\frac{1}{2}$ x $4\frac{1}{2}$ x $7\frac{1}{8}$ inches. It weighs $11\frac{1}{4}$ lb. The speaker is $13\frac{3}{4}$ inches long (with a $7\frac{3}{4}$-inch diameter bell opening). The complete unit weighs 15 lb. 5 ounces.

National Scientific Products Co., 5013 N. Kedzie Ave., Chicago 25, Ill.

Wire Printer

MODEL PW HIGH SPEED rotary multiple wire printer will print up to four wires simultaneously with the same or independent markings on each wire. A variation of Model PW is Model PW-2 which has the same characteristics as Model PW but which is capable of printing on two sides of the wire at one time. The imprints may be closely spaced, and the machines will print diameters from No. 22 to $\frac{3}{8}$ inches on 6, 3 or 2-inch intervals without affecting the speed of the wire travel. Reels are available which will feed long runs of wire into the printing machine, or an operator may feed lengths as short as 2 inches into the four printing locations. Changes of spacing for printing is made by changing the printing wheel. Quick, interchangeable type inserts are used. The equipment is supplied with ink reservoir mechanisms which are self-contained and instantly removable. Spare reservoirs are available for quick color changes.

Markem Machine Co., Keene, N. H.

Attenuators

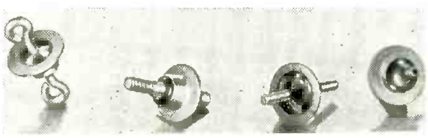
AN IMPROVED line of attenuators features a detent gear which is designed to provide more positive action, a greater degree of accuracy, more uniformity in operation and a stronger stop mechanism. Contacts and switches of these attenuators are made of tarnish-proof silver alloy. Cleaning and lubricating of the contact points is unnecessary. A steel cover protects the resistors, and provides im-

proved magnetic shielding. A snap-on cap makes switch blades and contacts readily accessible. The attenuators are quiet, and positive values for each setting of the dial are obtained. They meet rigid specifications.

The Daven Co., 191 Central Ave., Newark 4, N. J.

Hermetic Seals

STURDY AND EASY to solder by means of electronic heating, oven soldering, iron, or torch methods are hermetic seals. They are subjected during manufacture to a hydrogen pressure test for leaks. Danger of carbonizing the electrode is eliminated by the use of a high flash-over voltage seal of glass. Leakage resistance is 30,000 megohms, minimum. Thermal operating range is from −70 deg to 200 deg C. The seals will withstand temperature changes of 140 deg C. Types of seals available include either single terminals or multiple headers. Among the types is W-100, a small, one-piece unit for use on component parts. Types 1182 and 1183 differ in size and shape but both are larger terminals for use in higher voltage applications.

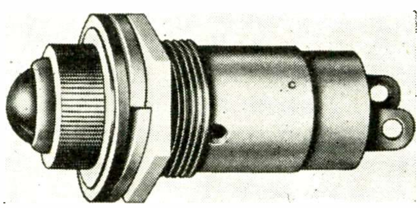


Sperti, Inc., Beech and Kenilworth, Cincinnati 12, Ohio.

Enclosed Pilot Light

KNOWN AS SERIES #1110, these pilot lights are available in several variations. Models No. 1110 (faceted jewel) and No. 1111 (plain jewel) take long bulbs. Models No. 1112 (faceted jewel) and No. 1113 (plain jewel) take round bulbs. These pilot lights are primarily for use in ungrounded panels, and all are equipped with two solder terminals.

Other models available are shutter-type lights for applications that require variable intensities for varying conditions. Ninety-degrees turn of a shutter provides gradation from bright light, through intermediate glows to a



dim glow, or to total blackout. The shutter-type models are No. 1114 (faceted jewel) and No. 1115 (plain jewel) which take round bulbs. They mount in an 11/16 inch hole and have ½ inch jewels, and can be furnished with polarized lenses.

Gothard Mfg. Co., Springfield, Illinois.

H-F Plastic Preheating Equipment

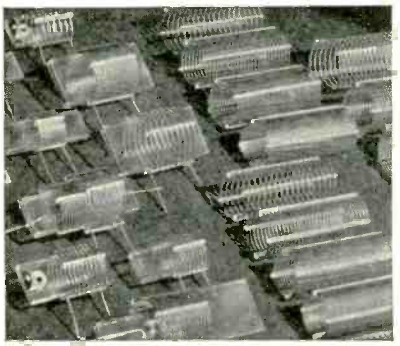
ILLITRON DESIGNATES a machine designed for easier and faster preheating of plastic preforms (such as wood-flour, rag, and mica-filled phenolic) for multi-cavity molds. The heating is done between self-adjusting plates which operate similar to those of a waffle iron. A heat retainer is incorporated in the plates to maintain temperature in the preform after the heating is off to allow more time between preheating and press loading. An automatic timer finally cuts off the heat, after a predetermined time. Close temperature control is maintained by a meter which indicates in watts the amount of heat per second that is generated in the preforms. Whenever an operator changes from one type of preform to another, a manual adjustment is made. A marking on the heat-rate meter indicates the proper adjustment, and this initial matching insures the maximum heating for any type and size of preform within the limits of the unit. A power input control permits the operation of the unit at any power level from zero to its maximum rated capacity. To safeguard the operator, external portions of the circuit are grounded, and the power is cut off by switches when the plates are open.

The manufacturer also has available equipment for high-frequency dielectric heating of other materials, including metals.

Illinois Tool Works, 2501 N. Keeler Ave., Chicago 39, Ill.

Miniature Coils

NEW MINIATURE INDUCTOR coils for high-frequency, tuned, r-f circuits are available in diameters from ½ to 1¼ inches. The units are air wound to combine lightness of weight, maximum rigidity, and accuracy. The Q characteristic is high because no insulating material is used in the electrical field. These coils are available in any type



of mounting, with fixed or variable, internal or external coupling links. There are five standard diameters and each diameter is available in any winding pitch from 44 to 4 or less turns per inch. Wire sizes range from No. 14 to 28 and any type of wire can be supplied.

Barker and Williamson, 235 Fairfield Ave., Upper Darby, Pa.

Soldering Irons

SOLDERING IRONS (built in the shape of pencils, compact and easy to handle) are designed for speedy, precision operation for the assembly and repair of radio and radar apparatus and aircraft instruments. A single pencil weighs 3.6 ounces, and measures 7 inches in overall length. The heating elements in these irons heat in approximately 90 seconds, use 17 watts power, and may be replaced instantly when necessary. The irons are designated as Pencil No. 207 and sell at a $1.00 each, in quantities. Extra heating elements (No. 536) sell at $0.50 each. A priority number is required on all orders.

Harry A. Ungar, Inc., 615 Ducommun St., Los Angeles 12, Cal.

Current Transformer

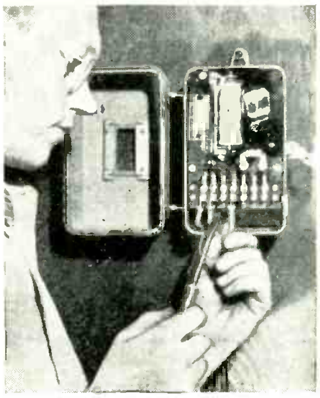
Type NAS current transformer is a wide-range-accuracy transformer which enables users to stock only a few sizes to cover the entire field of low voltage measurements. The instrument is made in three ratios of 200/5, 400/5 and 600/5 amp, insulated for circuits not to exceed 1000 volts and capable of high accuracies up to 25 volt-amp. The instrument is built to AIEE, EEI and NEMA specifications. Features of the transformer include permanent, easily discernible polarity markings; similar primary mounting dimensions on all three ratios to facilitate interchangeability; simple clamping structure; mechanical, connector-type, primary potential terminal; secondary short-circuiting device; tamper-proof sealing; and extreme accuracy.

Bulletin S-502 describes the instrument which is available from The Standard Transformer Co., Warren, Ohio.

Electronic Relay

A new electronic relay for amplifying limited current which is transmitted by delicate control contacts or high resistance circuits materially increases the application range of many control devices. Operated by any material having a resistance from 0 to 500,000 ohms, or greater if necessary, the new relay is especially suitable for controlling liquid levels in tanks and boilers, sorting metallic parts by size, detecting broken threads in textile machines, and as a limit switch requiring extremely light pressure to operate. The relay is small and lightweight, and consists of a standard type electronic tube, a supply transformer, and an electromagnetic relay, all mounted in a totally enclosed, weather-resistant enclosure suitable for wall or machine mounting.

In operation, the electromagnetic relay in the device is kept ener-



gized as long as the controls connected to the input grid circuit of the electronic tube remain open. The instant these contacts close, the relay is de-energized. A built-in time delay feature prevents chattering when the contacts in the input circuit are momentarily closed. A contact arrangement on the electromagnetic relay permits the device to be used either to make or break a load circuit when the actuating contacts connected to the input circuit on the electronic relay are closed. Bulletin GEA-4214 describes Type CR 7511-A. General Electric Co., Industrial Control Div., Schenectady, N. Y.

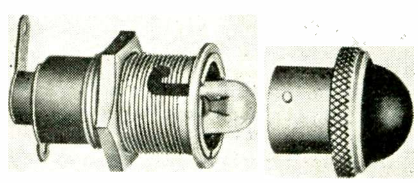
Resistance Measurement Instrument

COMBINING BOTH KELVIN and Wheatstone bridges, Type 638-2 bridge is a resistance measurement instrument which has a range from 0.0001 ohms to 11.11 megohms in a single, portable unit which may be used in laboratories, schools, in maintenance work, production line testing and field investigation. When used as a Wheatstone bridge for measurements between 1 ohm and 1 megohm, a normal accuracy of 0.3 percent or better is obtained. Low resistance measurements using the Kelvin range utilize current and potential terminals to eliminate lead and contact resistance. The accuracy of Kelvin measurements at ranges lower than 0.1 ohm is 3 percent. The rheostat is variable in steps of 1 ohm for Wheatstone bridge measurements, and 1 microhm for Kelvin bridge measurements. Separate keys are provided for the battery and galvanometer circuits. Accuracy of component resistors is 0.1 percent (the 1 ohm resistors have an accuracy of 0.25 percent.) A sensitive built-in galvanometer is included.

Shallcross Mfg. Co., Jackson and Pusey Aves., Collingsdale, Pa.

Indicating Light Unit

TYPE T3-BLC INDICATING light unit is for single-hole mounting on a panel with a T3 ¼ type single-contact bayonet lamp. The indicating unit has a bayonet-locked lens cap which is inserted and held



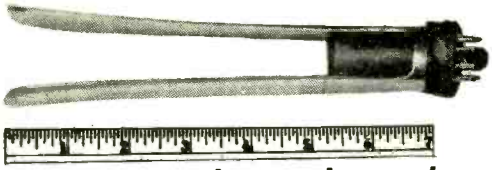
in place similar to a bayonet-type lamp. It requires only ten degrees turn to be held firmly in place. The unit is for use in applications where excessive shock and vibration are to be encountered.

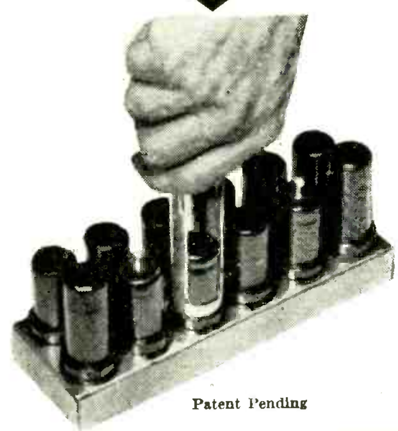
The H. R. Kirkland Co., Morristown, N. J.

Knopp Instruments

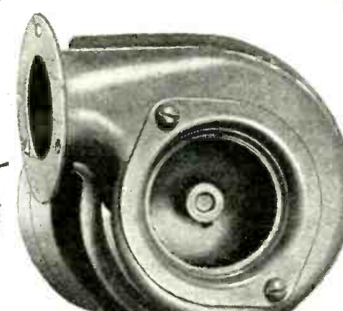
KNOPP PRECISION MULTI-RANGE current transformer (Type P-1200) is useful in a laboratory, a shop, or in the field, for testing, measuring, and calibrating. A self-contained primary provides primary ranges from 0.5 to 100 amp. Primary ranges can be obtained with an inserted primary of from 1 to 8 turns with ratings of from 150 to 1200 amp respectively. By connecting primary and secondary in series, additional ranges (some of which are for intermittent use only) up to 3600 amp may be obtained. The transformer housing of the instrument insulates the inserted primary from the transformer windings for 2500-volt circuits. The wound primary is for use on 250-volt circuits.

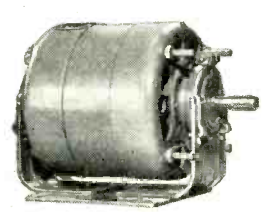
KNOPP LOAD ANALYZER is a portable instrument which measures, by one direct reading, the power factor (without calculation) by merely turning a knob. Measurement is independent of wattage or voltage readings or variations. Watts and volts are also quickly read by means of the same measuring element. The analyzer is rugged and has no indicating pointers or delicate movements. It will withstand severe momentary overloads





Patent Pending





without damage. Accuracy of the instrument is not materially affected by ordinary variations in current wave shape. Measurements from a few watts up to 48,000 watts (depending on the voltage range) may be made.

Electrical Facilities Inc., 4224 Holden St., Oakland, Cal.

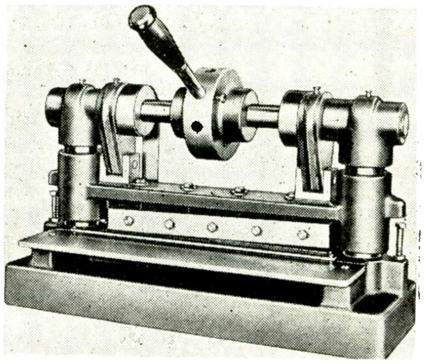
Flexible Insulating Varnish

R-851 DESIGNATES a flexible insulating varnish which is of high mechanical strength and is particuarly suitable for use with electrical equipment wound with glass-covered wire and designed to operate at exceptionally high temperatures. The manufacturer states that the varnish shows little progressive hardening when the dried film is exposed to the air and that it is recommended for coating armature and stator coils that will be stored for long periods before assembly. This material is a clear baking varnish which dries completely when baked at a temperature of 135 deg C. The dried insulation is oilproof and is resistant to acids and alkalis.

The Sterling Varnish Co., 181 Ohio River Blvd., Haysville, Pa.

Die-Less Duplicating Shear

DI-ACRO SHEAR NO. 3 is an improved model which incorporates a precision adjustment for accurately stopping blade travel. The shear may be used for a large variety of



slitting and notching operations to close tolerances. Tolerance accuracy is 0.001 inches in all duplicated work. The maximum shearing width is 12 inches, and the maximum shearing capacity, for instance, on 18 gauge steel plate is

0.048 inches. A delivery chute is built within the unit to facilitate delivery of the materials, fabrics, or tissues to the shear. The unit is mounted on an 80-lb., iron bed casting. The total weight of the unit itself is 150 lb. O'Neil Irwin Mfg. Co., Minneapolis 15, Minn.

Solderless Terminals

SOLDERLESS TUBE-CAP terminals designed for adaption to heavy load, high temperature operation on power tubes and in confined areas can be furnished in two types. The Diamond Grip Tube-Cap units are for use on insulated wire where an insulation-support type of terminal is required. The standard type "B" units may be used on either insulated or non-insulated wire. Each type of tube-cap terminal is available as an individual item or may be ordered as an integral part of a complete lead built to users' specification. Hand, foot or power installation tools are also available to those manufacturers who prefer to make up the lead assemblies.

High temperatures do not appreciably affect the efficiency of these connections. The caps and leads are made in various metals for operation in any range of temperature.

Aircraft-Marine Products Inc., 1591B N. 4th St., Harrisburg, Pa.

Literature

Audio Development Co. Products. A 16-page book undertakes to give factual, informative and helpful data about such products as transformers, reactors, filters and electronic components available from Audio Development Co., Minneapolis 7, Minn.

General Electric Company Literature. The following new literature is available from General Electric Co., Electronics Dept., Schenectady, N. Y.

1. Industrial Electronic Tubes Chart. A quick-selection chart of electronic tubes for industry is contained in a mailing-piece which has been printed in a size so it can be filed in a handbook. The chart is designed to make it easy to select tubes for electronic devices or applications. A bulletin number is listed with each tube type. The bulletins are available separately and contain installation, operating and technical data.

Tube types listed in the chart include phanotrons (gaseous-discharge rectifier); thyratrons (grid-controlled gaseous-discharge rectifier); pliotrons (grid-controlled high-vacuum); vacuum gages (to measure gas pressure); ignitrons (high-peak-current, pool-cathode tubes); phototubes (light-sensitive); ballast (resistor-type tubes used to maintain a constant average current); glow (cold-cathode tubes for use as voltage regulators); vacuum switches (SP,DT); kenotrons (high vacuum rectifier); and vacuum capacitors.

2. New Price List of Radio Transmitting Tubes. Bulletin ET-5 supersedes the manufacturer's bulletin GEA-3315C. The newer bulletin contains ratings and prices of such tubes as high-vacuum types; high-vacuum, air and water-cooled types; mercury-vapor rectifiers; high-vacuum rectifiers; and gaskets for water-cooled types.

3. One Plastics Avenue. This is

a booklet which uses color illustrations and short descriptions to tell the reader about General Electric's work and what they have to offer in the plastics field.

General Radio Co. House Organ. *The General Radio Experimenter*, April issue, contains two articles which readers may find of value. The first of these is an article A Bridge-Controlled Oscillator by J. K. Clapp, and the second article is entitled The Effect of Humidity on Electrical Measurements by R. F. Field. General Radio Co., 30 State St., Cambridge 39, Mass.

Mechanical Springs. A 106-page book called "Mechanical Springs, Their Engineering and Design" is a publication issued jointly by various divisions (consisting of about eight manufacturers) of the Associated Spring Corp., Bristol, Conn. In the book are discussed the various types of springs; formulas are given, and tables include data on the physical properties of spring materials, moments of inertia of rectangular sections, weight of flat cold rolled steel, weight of round steel spring wire, strain gauges, circumference and area of circles, decimal equivalents, third and fourth powers of wire diameters, and Rockwell hardness conversion values. Enclosed in the book is a handy spring data computer. The book is available from ASC or from Dunbar Brothers Co., Bristol, Conn.

Quartz Crystal Manufacture. "How Quartz Crystals Are Manufactured" is the title of a 36-page booklet which contains a series of articles reprinted from *Communications*. The subjects covered include inspection, grading and classification; orientation of the crystals, the use of orientation devices and sawing equipment, lapping and finishing, and testing. Other sections are devoted to the future of quartz crystals and the manufacturer's tubes, equipment, and semi-fabricated materials for industry. North American Philips Co., Inc., 100 East 4nd St., New York 17, N. Y.

Background Data of Underwriters' Laboratories, Inc. This book contains 32-pages and is a report of 50 years of continuous service of Underwriters' Laboratories, Inc., a non-profit, scientific, and technical organization devoted to the safeguarding of lives and property from the hazards of fire, casualty, and crime. A balance sheet of the organization is also included in the book. Underwriters' Laboratories, Inc., 207 East Ohio St., Chicago, Ill.

Spring-lock Fastener. Such information as parts and assembly, how it operates, outstanding features, performance by test, operating torque and initial tension tests, engineering data, and types available are contained in a 36-page booklet called "Spring-lock Fastener" available from Elastic Stop Nut Corp. of America, Union, N. J.

C-D House Organ. A recent issue of *The Cornell-Dubilier Capacitor* contains a reprint of the last half of an article by Lt. R. C. Hitchcock entitled Thermionic Rectifier Circuits which appeared in February ELECTRONICS. Another article in this issue is AM Detector Operation which is reprinted from *Radio Retailing Today*. Six pages of this same issue are devoted to "The Radio Trading Post" which is a free market-place for buyers, sellers, swappers and jobs in the radio field. The Cornell-Dubilier Electric Corp., 1049 Hamilton Blvd., South Plainfield, N. J.

Immediately-Available Equipment Lists. Each month this manufacturer publishes for the benefit of its equipment users a 12-page book called "Industrial Availability Booklet" which shows items available on priority for immediate delivery from stock. This booklet is available to engineers or purchasing agents. Walker-Jimieson, Inc., 311 S. Western Ave., Chicago 1, Ill.

Time Delay Relays and Switches. A 6-page leaflet describes and illustrates Series EX-511 switches for automatic time control of vacuum tube plate circuits and similar applications; Type EX-461-E momentary impulse timed interval relays for standard Air Corps application; Type EX-475 sustained-impulse, delayed-time-interval relays; Type EX-500-B heavy-duty, delayed-response, sustained-impulse, duration-type relays; and Type EX-512 heavy-duty time switch. M. H. Rhodes, Inc., Hartford, Conn.

Crystal Holders and Electrodes. Thirteen different types of crystal holders together with several types of electrodes are illustrated and described in a 26-page booklet which also contains price lists for these units. Howard Mfg. Corp., Council Bluffs, Iowa.

Machine Screws and Specialties. A new catalog (No. 18) shows, in addition to this manufacturer's standard items, several dozen drawings of special fastenings now available. Tables are given of standard weights of machine screws, stove bolts, and machine screw nuts in pounds per thousand pieces, and decimal equivalents of fractions. Progressive Mfg. Co., Torrington, Ct.

Laboratory and Switchboard Plugs. A 12-page bulletin (10M 3-44) contains information, photographs, drawing and data on this line of fittings for various switchboard requirements in all types of laboratory and testing equipment and for experimental operations. Cannon Electric Development Co., 3209 Humboldt St., Los Angeles 31, Cal.

Resistor Catalog. A 1944 catalog, just off the press, contains illustrations and descriptive matter of the basic line of vitreous-enamelled, wire-wound Army-Navy type resistors. Haines Mfg. Corp., 274 McKibben St., Brooklyn 6, N. Y.

Direct-Coupled Amplifier

(*Continued from page* 110)

circuit performance to compensate variations such as drift, change in gain, change in output level, and other factors. Practically all direct-coupled amplifiers require a balance control of some type for final adjustment of the operation of the amplifier. The balance of the amplifier shown in Fig. 5 is controlled by adjustment of potentiometers R_{17} and R_{20}. The balance control for this amplifier is merely an adjustment for the potential of the grid of T_3, Fig. 2, which adjustment is obtained by varying its position along the cathode resistor of T_2, Fig. 2. Potentiometer R_{20}, Fig. 5, has a wide range of control, and it is mounted on the chassis of the instrument for adjustment only during servicing and maintenance, or when tubes are changed. Potentiometer R_{17} functions as a vernier on R_{20}, and it is mounted on the front panel of the amplifier for use as a spot-position or pattern-centering control.

Feedback Circuits

Negative voltage-feedback is employed in this amplifier to vary the voltage gain, to stabilize the voltage gain, to reduce drift, to broaden the frequency response, and to reduce the effective output impedance of the unit.

One feedback circuit extends from the plates of the output tubes to the plates of the input tubes. To obtain the proper polarity for negative feedback, the two balanced sides of the amplifier must be cross-connected. This type of feedback minimizes differential variations between the two sides of the push-pull amplifier. The feedback elements between T_8 and T_1', for example, consist of R_{32} and R_9.

Negative voltage-feedback also is employed to control voltage gain of the amplifier. This is accomplished through feedback used independently on each phase of the balanced unit. T_8 feeds signal voltage back to T_4, and T_9 feeds back signal to T_5. S_2 is a two-section gang switch which controls the feedback simultaneously on each channel. Positions are provided for voltage gains of 1000, 2000, and 5000 times.

Direct-Current Heater Operation

Since the interstage coupling elements T_2, T_3, T_6 and T_7 are the most likely single sources of instability in the amplifier, their internal characteristics are kept as nearly constant as possible by operation of their heaters from a regulated d-c source. This precaution has been found to contribute greatly to the freedom from drift found in this amplifier. Much of the drift problem in this design depends upon the constancy of the operating parameters of these coupling elements. In this connection, also, it was found highly desirable to employ commercial "precision" resistors, such as IRC Type WW-4, for the plate-load resistors of the coupling tubes because of their low temperature-coefficient of resistance.

Inasmuch as the input stage receives no compensation of any type, and to reduce a-c ripple in the amplifier output, the heater of this tube also is operated from a d-c source.

Amplifier tubes T_4, T_5, T_8 and T_9 all are operated from a conventional alternating-current source.

Power Supplies

Power for the complete amplifier is supplied by three separate rectifier-filter systems. The output of each system is controlled by an electronic regulator. The first system, reading from the top of Fig. 5, has an output of +200 volts. The second system furnishes regulated power for operation of all heater circuits which require direct-current operation. The third system has an output potential of −400 volts for operation of the amplifier.

Acknowledgments

The concept and design of the basic coupling circuit and the development of the final amplifier unit are the work of Mr. George W. Cook of the Electronics Section of the David Taylor Model Basin. The mathematical analysis of the circuit was performed by Mr. Westley F. Curtis of the Structural Mechanics Section.

A PARATROOPER'S radio set consumes almost 2 lb of copper and copper alloys.

Filament Characteristics

(*Continued from page 130*)

inal voltage tube. For example, a 35-volt tube may be represented by 5.55 tubes of 6.3 volts nominal rating.

Substitution in Eq. (22) and (23) of the conditions of the previously discussed case of two tubes ($N_H = 1$ and $N_L = 1$) with $m = 5$, $p = 10$ and $(n_w - n_r)/(n_w + n_r) = 0.61$ gives $+1.8$ percent and -2.0 percent for the supply voltage tolerance, which is in good agreement with the graphical solution.

An examination of the case of three tubes in series where $N_H = 2$, $N_L = 1$, $m = 5$, $p = 10$, and $(n^w - n_r)/(n_w + n_r) = 0.61$ gives the tolerance on the supply voltage as -1 percent and -4.7 percent. In other words the supply voltage can never be permitted to rise to normal without exceeding the maximum voltage rating on the low filament-current tube.

Conclusions

The curves given in Fig. 1 enable the transposition of heater or filament operating conditions within

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HANDIE-TALKIE IN THE NEWS

While watching American paratroopers make practice jumps, Prime Minister Winston Churchill listens to the orders and directions given by radio with a Handie-Talkie made by Galvin Mfg. Co.

the usual desired engineering accuracy for electron tube applications. These curves should not be used when an accuracy within ±3.5 percent for filament current is desired with a ±25 percent change in filament voltage. The percentage of error in all equations converges to zero as the ratio of E_x/E_o approaches unity, or the smaller the percentage change of voltage in the transposition the smaller the degree of error. A limited number of types of filaments and heaters have been examined and found to give good agreement with the curves of Fig. 1. The accuracy of the volt-ampere characteristic can be established by experimentally determining $(n_w - n_r)/(n_w + n_r)$ for the particular application. This determination may be made from the relation

$$\frac{n_w - n_r}{n_w + n_r} = \frac{\log (E_1/E_2)}{\log (I_1/I_2)}$$

where I_1, E_1 and I_2, E_2 are currents and voltages at known operating points.

Once the value of $(n_w - n_r)/(n_w + n_r)$ has been established over the probable application range of voltage the operating conditions of a group of filaments in series may then be predicted for various supply voltages. This permits the supply voltage tolerance to be established such that the applied filament voltage tolerance may not be exceeded.

The solutions given here represent the steady-state conditions and do not indicate what may happen during the initial application of voltage or for short-time voltage transients.

The writer is indebted to Mr. A. C. Grimm for suggestions as to the method of attack in the solution of a group of tubes in series and to Mr. E. E. Spitzer for his criticism and suggestions in the preparation of this manuscript.

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Enemy Radio Equipment

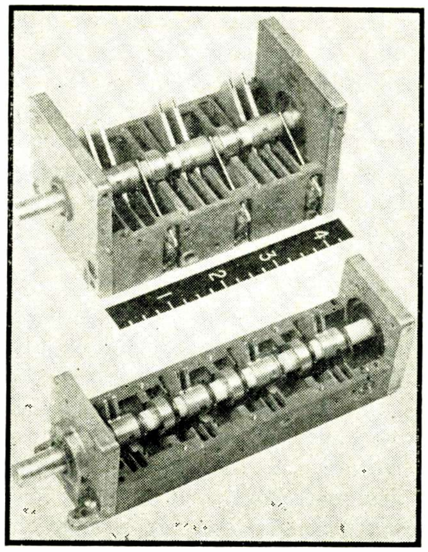
(Continued from page 133)

and receiver chassis castings.

The sensitivity of the 9-tube superheterodyne receiver was found to be 4 microvolts for a 10-milliwatt signal, and selectivity was 50 kc at 20 db down. The intermediate frequency is 3 Mc. The receiver chassis is divided into three castings; the top section houses the i-f and second detector stages, the center section houses the r-f and mixer stages, and the bottom section contains the output stage. A section can be replaced in half a minute if faulty or damaged. All nine tubes are Type RV12P2000 pentodes.

Four click stop, pre-set frequencies may be set up on both units to aid in easy and quick tuning. The dials of both the transmitter and receiver are identical in appearance and directly calibrated in Mc to further facilitate tuning.

In many installations, the set is



German variable capacitors used in current production. Steatite shafts insulate the molded alloy rotor section, permitting grounding of the one-piece molded alloy stator. Grooves in rotor plates permit spreading apart or squeezing together rotor surfaces for precision tracking

not placed so that the operator can manually adjust the controls; therefore, tuning motors have been added and by merely flipping a switch, either of two channels may be selected. An additional tuning motor is used to change the frequency as much as plus or minus 30 kc in the event the frequency is off calibration.

German equipment was designed for use only on the European continent and therefore does not require tropicalization to prevent fungus growth or humidity troubles.

Japanese Equipment

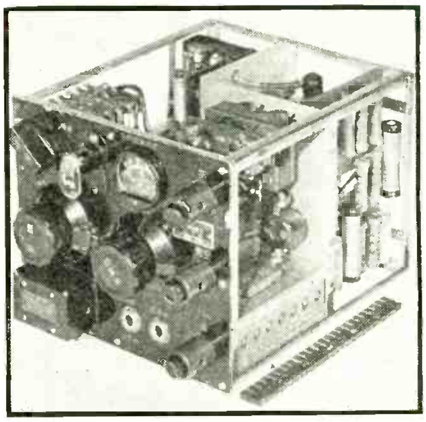
Japanese radio equipment first brought into this country after Pearl Harbor showed inferior design and workmanship, but today we have a much different picture. Newer and altogether differently designed equipment with excellent workmanship and performance has been found, which proves that the Japanese have advanced considerably in the field of radio, or have hired competent foreign engineers. Chassis are patterned after American design, and the framework around the chassis is usually made of stainless steel or chrome plated brass. An abundance of brass is used throughout the construction for shielding, gear mechanisms, nuts, bolts and brackets. Power is brought in through cables that have plugs resembling American patterns.

All sets are mounted on a horizontal plane, like American equipment, rather than a vertical plane as used by the Germans, and, of course, real rubber shock mounts are used. Crystal control is used throughout; crystals, most of which are "BT" cuts, possess a low temperature coefficient. Antenna ammeters have changed from the old hot-wire type to the moving-coil variety. Resistors are usually one physical size, capacitors use high-grade mica insulation with Bakelite covers, and relays are of the plug-in type. High-grade Bakelite and steatite insulation is used throughout. Units have test panels to facilitate quick checking of voltages. Tubes have been standardized to make replacement easier.

Japanese Model 99 Sets

One of the latest complete Japanese sets received in this country is the Model 99 Type 3 aircraft radio command set. It was removed from a light bomber-reconnaissance plane which crashed in Kunming, China, in September of last year. It consists of a 5-watt crystal-controlled transmitter using two 807-A tubes, one as an oscillator and one as a modulator, a superheterodyne receiver using four 6F7A tubes in an eight-stage straightforward circuit, a dynamotor junction control box, antenna matching unit, and primary voltage regulator unit. The emission is CW, MCW or phone, and the normal range is 75 miles at 10,000 feet using phone, and up to 300 miles using CW. The frequency of the transmitter is 2.4 to 6.0 Mc, and the receiver frequency is 1.5 to 6.7 Mc in two bands. The 807A tubes used in the transmitter are almost identical in electrical characteristics to American 807 tubes, except the Japanese 807A has a smaller glass envelope. The receiver 6F7A tubes, except for an octal base and metal envelope, are identical to the American 6F7 which uses a seven-prong base and glass envelope.

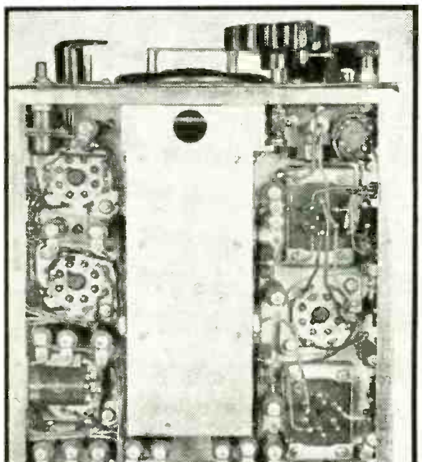
Excellent performance of the receiver is suggested by the sensitivity, found to be 1.2 microvolts for a 5-milliwatt signal at its optimum point; the selectivity measured 6 db down at 10 kc off resonantance. The image rejection ratio is 62.66 db at 3.2 Mc. Voltages supplied



Modern Japanese aircraft radio transmitter, a part of the Model 99 Type 3 set. Values of resistors and capacitors are marked in English, and American chassis construction is employed

from the associated dynamotor unit are 600 volts to the transmitter and 250 volts to the receiver.

The Model 99 Type 3 is well designed with regard to servicing as well as electrical performance. Parts are all standardized, with very few special parts incorporated. Values of resistors and capacitors are marked in English and are not critical. The fixed capacitors varied 2 to 10 percent from indicated values. Mica capacitors use sprayed metal on mica instead of metal foil separated by mica insulation. The capacitor leads are heavy, flat, hard tinned copper, which facilitates rigid mounting. Although the maximum voltage used is 600 volts, the capacitor ratings are all 1000



Bottom view of modern Japanese aircraft radio receiver, used with Model 99, Type 3 radio set. Note mounting of resistors in vertical positions to 1500 volts. A highly polished high-grade Bakelite is used throughout the set except for coil forms and tube sockets, which are of steatite. The undersides of the receiver and transmitter chassis contain clearly numbered resistors, capacitors and chokes, arranged in an orderly manner, according to size, in a vertical position. Despite the small space available in this receiver, the arrangement and neat color-coded wiring of components is such that it provides for ready accessibility and servicing.

The set does not have push-button tuning as used in the newest American sets, nor does it operate in a vhf band like both the American and German command sets. However, it has been superseded by a new Model 99 Type 4 aircraft radio command set, which does operate in a vhf band.

The Type 4 is of the same general construction as the Type 3, but of a different frequency range, 44 to 50 Mc. Although the receiver of the Type 4 is crystal-controlled by three crystals, it receives over the entire range, 44 to 50 Mc. This is accomplished by tuning the intermediate frequency stages. This system not only provides excellent frequency stability, but also provides i-f alignment at all times.

By comparison with American equipment, the enemy's equipment is definitely below standard; however, enemy equipment does perform well and serves its purpose very well. Standardization in order to achieve mass production, provide simple servicing in the field, and make operation simple has been incorporated in enemy equipment and shows that the enemy is aware of the important factors governing successful communications for fighting forces.

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Electronic Thermometer

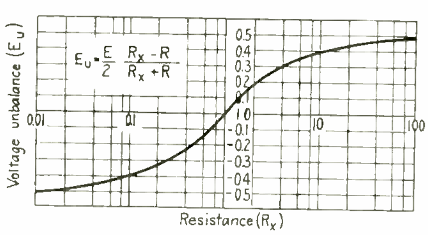
(*Continued from page* 139)

easily compensated by shifting the grid bias. The same adjustment also serves to adjust the meter zero. As the output of the vacuum-tube bridge is in a straight-line relation to the grid voltage, the full-deflection setting of the meter can be corrected by a shunt across the meter.

Temperature Control Arrangements

If the circuit is to be used directly for control, the meter is replaced by a sensitive relay and a potentiometer is used in place of the two resistors across the relay. The setting of the potentiometer then determines the control point, which is the temperature at which the bulb has the proper resistance for bridge balance.

To bring up the sensitivity of the device, a conventional amplifier stage is added ahead of the vacuum-tube bridge. The plate voltage is



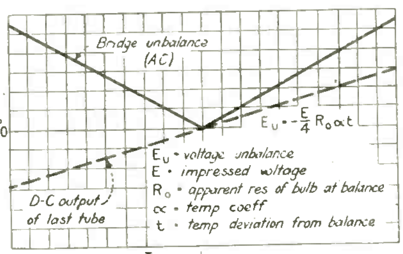
Voltage unbalance of a Wheatstone bridge plotted against the value of the variable thermometric resistance in one arm of the bridge, for a constant impressed voltage *E* and equal resistance values *R* in the other three arms of the bridge

supplied by a type 80 tube, filtered merely by a capacitor.

The sensitivity of this circuit can be easily adjusted to a control range of ±0.01 deg F. To allow sufficient safety factor for reliable operation in cases where occasional sticking of the relay would provide a major hazard, the relay should, however, be adjusted to a sensitivity of not more than ±0.1 deg F.

Advantages of Electronic Thermometer

The instrument has a number of advantages over the usual type of temperature indicators and controls. It is inherently remote indicating. The line between the bulb



Relation between temperature and voltage unbalance for the electronic thermometer (solid curve), and equation used for plotting the curve. The relation between temperature and the output voltage applied to the meter or relay is also shown (dash-dash curve)

and the amplifier may be flexible and up to several hundred feet long.

To operate over longer distances, either the relay or meter may be removed from the amplifier assembly and placed at the end of another line. As the impedances of meters and relays are reasonably low, effects of leakage are not serious.

The control circuit is independent of line voltage variations, making voltage regulators unnecessary.

Range and sensitivity of the instrument depend primarily on the constants of the bridge, and can be varied over wide limits. As the bulbs contain only between 1 and 2 cc of liquid, the response to changes in temperature is very rapid.

The bulb for this thermometer can be made exceedingly small when particularly close control of temperature is required in heating systems, but even with normal size bulbs the heat lag is much lower than with most conventional types of temperature controls.

NEW BOOKS

Table of Circular and Hyperbolic Tangents and Cotangents for Radian Arguments

WPA MATHEMATICAL TABLES PROJECT, *conducted under Sponsorship of National Bureau of Standards. Published by Columbia University Press, Morningside Heights, New York 27, N. Y., 1943, 412 pages, $5.00.*

THE MAIN TABLE in this volume is devoted to the circular and hyperbolic tangents and cotangents, for radian arguments ranging from 0 to 2 at intervals of 0.0001. Supplementary tables for all four functions over the range from 0 to 10 at intervals of 0.1 are also included. These tables may be regarded as forming a companion volume to the "Tables of Circular and Hyperbolic Sines and Cosines" which appeared in 1939. The entries in the latter volume are given to nine decimal places—equivalent to eight, nine, or ten significant figures almost everywhere. Since the tangent and cotangent vary from $-\infty$ to ∞ over a range of π, the tables in this volume are given to eight significant figures rather than to a fixed number of decimal places. An exception has been made in some entries near the origin and near $\frac{1}{2}\pi$, where a few additional significant figures are given for the sake of regularity in format.

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Table of Reciprocals of the Integers from 100,000 Through 200,009

WPA MATHEMATICAL TABLES PROJECT, *conducted under Sponsorship of National Bureau of Standards. Published by Columbia University Press, Morningside Heights, New York 27, N. Y., 1943, 204 pages, $4.00.*

TABLES OF RECIPROCALS are in frequent use by spectroscopists for the conversion of wavelengths into wave numbers, and vice versa. They may be applied also to all manner of computations, especially with calculating machines, by using multiplication to perform an indicate division. To carry out these operations the computer may make use of the 7-figure reciprocals of Oakes or of Cotsworth. However, in the interval from 100,000 to 200,000 the differences between the successive entries of these tables vary from 1000 to 250 and interpolation between the tabular entries is somewhat difficult. To facilitate the use of reciprocal numbers, it was therefore decided to expand by tenfold the scope of the existing tables in this interval.

Preparation of manuscript tables was begun in December 1934, by Dr. C. C. Kiess of the National Bureau of Standards. As a result of numerous requests for the reproduction of the table, the manuscript was given to the Mathematical Tables Project in March 1940. This project recomputed the values, checked them against the National Bureau of Standards MS, and prepared the table for publication.

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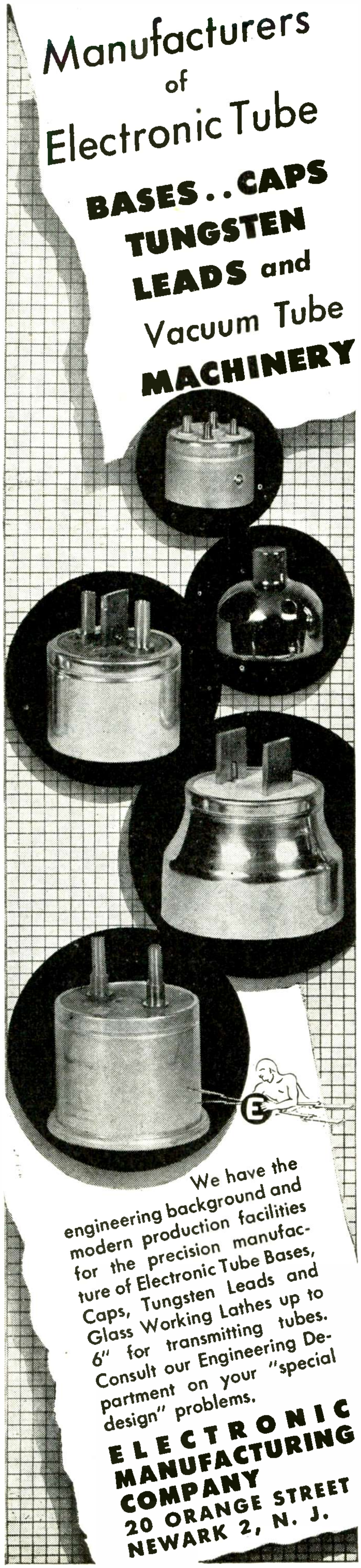
Radio Data Charts

By R. T. BEATTY, *Wireless World, Dorset House, Stamford St., London, S.E. 1, Third Edition, 1943, 85 pages, price 7/6.*

A COLLECTION of forty radio charts, variously called nomograms, nomographs and abacs, that have appeared from time to time in the British publication *Wireless World*. Much of the text was rewritten to give as much factual information



as possible in the limited space available, with purely theoretical notes omitted. This collection covers the most frequently recurring problems associated with the design of radio receivers. The 8 x 10½-in. page size with limp paper covers makes individual charts readily accessible and large enough for accurate usage.

Representative charts are: No. 9—Self-inductance of multi-layer coils of circular cross-section; No. 13—Diameter of wire or strand to give coil of minimum r-f resistance; No. 15—Ratio of r-f to d-c resistance of a coil; No. 17—Increase of r-f resistance of a coil due to a coaxial copper screening can; No. 33—Determination of optimum gap in iron-core chokes; No. 36—Loudspeaker dividing networks.—J.M.

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The Oxy-Acetylene Handbook

By THE LINDE AIR PRODUCTS CO., *30 E. 42nd St., New York 17, 500 pages, price $1.50, 1943.*

PLANNED AS A BASIC MANUAL on oxy-acetylene welding, cutting, and related processes, this how-to-do-it book is valuable to anyone desiring to be a welder or user of the oxy-acetylene torch, and to those concerned with teaching or training students or employees. The low price makes the book particularly attractive.

The subject is written interestingly, comprehensively, and authoritatively, and is accompanied by 400 illustrations, the combination making the book easily understood by those with little or no knowledge of metals and their properties. Much of the basic material on weldability of metals will be of interest even to those working exclusively with electronic welding equipment.

The first of seven parts covers applications of the oxy-acetylene flame, historical development, metal properties important to welding, thermal expansion, tests for identifying metals and various methods of preparing for welding. Considerable space is devoted to the operating principles of equipment, and its care and maintenance.

The second and third parts deal individually with different metals and forms such as sheet steel, plate, pipe, cast iron and steel, galvanized

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iron, alloy steels, aluminum, copper alloys, nickel alloys, magnesium and lead. Part IV covers miscellaneous applications such as bronze-surfacing, hard-facing, silver brazing, and flame treating.

The remaining parts describe flame cutting, inspection and management, and conclude with 25 tables of welding and cutting data, properties of metals, etc.—M.G.V.

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Tables of Lagrangian Interpolation Coefficients

WPA MATHEMATICAL TABLES PROJECT, *conducted under Sponsorship of National Bureau of Standards. Published by Columbia University Press, Morningside Heights, New York 27, N. Y., 1943, 390 pages, $5.00.*

SEVERAL TABLES are available giving the coefficients required in interpolation with the aid of differences. However, there are no extensive tables for interpolating by means of the most fundamental methods—the Lagrangian formula —which involves only the tabular entries themselves and requires no differences. The Lagrangian interpolation formula (without the remainder term) approximates a given function by a polynomial. The polynomial of degree $n-i$, determined by n tabular entries, is referred to as an n-point interpolation polynomial. The present volume extends the few existing tables of Lagrangian interpolation coefficients in these n-point polynomials for $n = 3, 4, \ldots, 11$ by giving the entries at smaller intervals of the argument and by making adequate provisions for interpolation near the beginning and near the end of a table.

Furthermore, all the coefficients of Everett's central difference formula involving differences up to the eighth order are identical with certain Lagrangian coefficients given in the table. In particular, Everett's second-order coefficients are here tabulated at the interval of 0.0001—a smaller interval than in other existing tables. Coefficients of the Gregory-Newton and Newton-Gross formulas may also be found in this volume.

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Industrial Electronic Control

By W. D. COCKRELL, *McGraw-Hill Book Co., New York, 1944, 247 pages, price $2.50.*

REALIZING that it would be impossible to describe and analyze in one volume all the elements and circuits used in the application of electronic control for industrial uses, the author has concentrated his presentation on the important basic circuits that can be combined to form an endless variety of complete circuits. Design mathematics has been studiously avoided. This interesting and up-to-date book should be of value particularly to industrial engineers and radio servicemen who sell, install and service electronic devices for the machine tool, printing, processing, packaging and other industries.

Functions and characteristics of standard and special tubes as integral parts of circuits are emphasized, rather than what takes place in the tubes themselves. Electron tubes covered include vacuum and gas-filled rectifiers, grid-controlled vacuum and gas-filled tubes, secondary-emission tubes, fluorescent indicator tubes, cathode-ray tubes, kenotrons and phanotrons. The mechanical construction and

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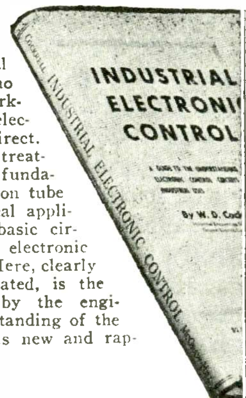

This is the first book written especially for the practical electrical man in industry who desires a basic working knowledge of electronic control. In a direct, non-mathematical treatment, it gives you fundamental facts of electron tube operation and practical applications of tubes in basic circuits of industrial electronic control apparatus. Here, clearly explained and illustrated, is the information needed by the engineer for quick understanding of the special aspects of this new and rapidly growing field.

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INDUSTRIAL ELECTRONIC CONTROL

A Guide to the Understanding of Electronic Control Circuits for Industrial Use

By W. D. COCKRELL

Industrial Engineering Divisions, General Electric Co.

247 pages, 5½ x 8½, 175 illustrations, charts, and tables, $2.50

The book emphasizes the fundamental functions and basic circuits important to an understanding of any control circuit and illustrates them by standard commercial devices in use today. Part I describes the various types of electron tubes and explains their construction and operation. Part II gives you basic circuit components, reviews the fundamental nature of such terms as resistance, capacity and inductance and covers the instruments which measure voltage and current. In Part III the basic electronic circuits are classified into general types, and the necessary parts, the operation and the common applications of each are described. Part IV shows you how to analyze a complicated circuit and break it down into its component parts, giving standard commercial devices as illustrations.

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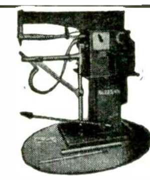

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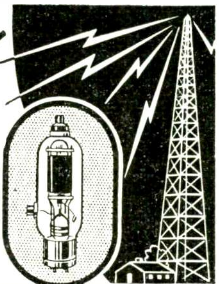

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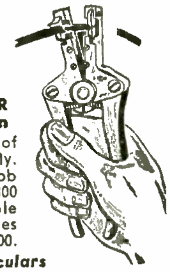

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Specialists in Equipment for the manufacture of Radio Tubes, Cathode Ray Tubes, Fluorescent Lamps, Incandescent Lamps, Neon Tubes, Photo Cells, X-ray Tubes and other glass or electronic products, on production or laboratory basis.

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Only 2⅛" by 3" by ⅝"

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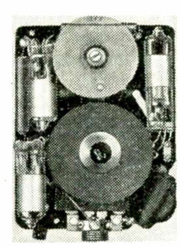

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Making a modest but effective contribution in Electronics' War accomplishments.

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MICROMETER FREQUENCY METER

for checking transmitters from 1.5 to 56 mc., within 0.01 per cent

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designations of tubes are included.

The section on circuit components deals with instruments, meters, resistors, capacitors, reactors, transformers, and miscellaneous components. A chapter on combinations of component elements summarizes the results obtained by connecting resistance, capacitance and inductance in various ways.

Electron circuits for industrial control are functionally described. These circuits include: Rectifying of a.c. to d.c. and the inverse, filtering, frequency conversion; amplification of signals; oscillator circuits; timing circuits and switches; phase-shifting circuits. The book uses industrial symbols throughout.

Descriptions of the construction and operation of industrial electronic control devices and their various applications include d-c photoelectric circuits, d-c motor control, a-c relay and timing circuits, a-c power circuits, resistance welder controls and welder current regulators. The appendices are devoted to nomenclature and symbols, nomograms for values of resistance and reactance, wave shapes and characteristics, and notes dealing with photoelectric phenomena.

References cited throughout the book comprise a valuable bibliography. Numerous diagrams and illustrations are used to supplement the text.—J.K.

• • •

Infrared Spectroscopy

By R. BOWLING BARNES, ROBERT C. GORE, URNER LIDDELL and VAN ZANDT WILLIAMS. *Reinhold Publishing Corporation, 330 W. 42nd St., New York 18, N. Y., 1944, 236-VI pages, price $2.25.*

INDUSTRIAL APPLICATIONS of the infrared spectroscopic technique of identifying unknown materials are stressed in this compact discussion of the subject. Only 40 pages are taken up with text that covers the general principles for both qualitatives and quantitative analyses. Attention is called to the fact that much research needs to be done on quantitative analysis by spectroscopy to bring it up to the present level of qualitative analysis.

Of particular interest to manufacturers of electronic equipment would be a two-page section on the present status of infrared spectroscopy in industry. In this section

(*Continued on page* 374)

POSITIONS VACANT

ELECTRONIC ENGINEERS wanted for new department in old company with outstanding reputation. Development or production abilities sought in field of electronic instruments and control devices. Advancement should be rapid. Write stating experience, education, salary expected, draft status and availability if now engaged in essential war work. P-637, Electronics, 330 W. 42nd St., New York 18, N. Y.

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SALARIED POSITIONS — This advertising service of 34 years' recognized standing negotiates for high salaried supervisory technical and executive positions. Procedure will be individualized to your personal requirements and will not conflict with Manpower Commission's. Retaining fee protected by refund provision. Identity covered and present position protected. Send for details. R. W. Bixby, Inc., 278 Delward Bldg., Buffalo, N. Y.

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SALES ENGINEER: desires change. College, 40 years old, capable, enthusiastic. Professional experience of 22 years, including broadcast operation, design, test of radio and allied equipment, and 10 years continuous contact Federal bureaus radio and aviation applications. Washington, D. C. or southern location preferred. PW-689, Electronics, 330 W. 42nd St., New York 18, N. Y.

PRODUCT DESIGNER—Technical illustrator, creative ability engineering background, long experience electro-mechanical devices. Radio, electronic control equipment. Prefer permanent connection with long established company. Salary $4,000.00 per year. PW-690, Electronics, 330 W. 42nd St., New York 18, N. Y.

MECHANICAL ENGINEER and expert mechanic with 30 years experience in tool, die, machine design and production whose hobby is invention, seeks connection where inventive ability, initiative and supervising talent can be given full scope. Some knowledge of electronics. Metropolitan New York area. Salary $6500. PW-692, Electronics, 330 W. 42nd St., New York 18, N. Y.

SPECIAL SERVICE

TECHNICAL TRANSLATIONS: from Russian, other languages. Electricity, radio, etc. Service for exporters: machinery catalogues, manuals, guides, pamphlets, etc. translated into Russian. Graduate Russian and American University, employed large engineering firm, long experience. SS-683, Electronics, 330 W. 42nd St., New York 18, N. Y.

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MANUFACTURERS REPRESENTATIVE wanted by a midwestern manufacturer of metal stampings in small lots. Some very desirable territory still open on a protected commission basis. Die stamping knowledge an advantage. Reply Room 209, 549 Washington Boulevard, Chicago, Illinois.

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Flourishing transformer business. Gross near quarter million yearly. Wonderful opportunity to purchase going concern with 70 employees.

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There is an excellent opportunity for several men in our comparatively small organization located in the Midwest. Our plant is now devoted entirely to war work, but we have extensive post-war plans and large resources.

Our staff knows of this advertisement, so have no hesitancy in writing. Give complete information of education, experience, age, salary desired, and telephone number.

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Several openings for men with E.E. degrees and experience in high frequency electronic equipment for patent preparation, interference and appeals. U. S. Patent Office experience desirable, but not required. High Salary. Good Post-War opportunity with a company which holds many basic electronic patents. Write Box 815, Equity, 113 West 42 St., N. Y.

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A central New England Manufacturer employing over 1000 people needs Draftsman-Designer on telephone and signaling (mechanical) apparatus. Knowledge of die-casting and plastic applications desirable.

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Equipment for the manufacture of all kinds of electron tubes, radio tubes, incandescent lamps, neon tubes, photo electric cells, X-ray tubes, etc.

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Additional Employment Advertising on pages 334, 355, 372 and 373

some of the possible applications of electronic principles to spectroscopic technique that would shorten the time of testing and simplify the procedure, particularly for standardized units to be used in production processes, are pointed out.

Nearly 70 pages are devoted to a presentation of 363 standard reference curves developed by the authors in the research laboratories of the American Cyanamid Company, where they are employed. These curves can be used, within limitations, to study correlations between molecular structure and spectral characteristics, to identify unknown materials and to determine in advance the possibilities of infrared analysis of mixtures. They are indexed both by empirical formula and alphabetically.

A bibliography that takes up more than 120 pages contains over 2,700 references to technical articles and books on spectroscopy. It is arranged alphabetically by authors and is also indexed by subject.—K.S.P.

• • •

Control of Electric Motors

By PAISLEY B. HARWOOD, *John Wiley and Sons, Inc., New York, Second Edition, 1944, 479 pages, price $5.00.*

SINCE PUBLICATION of the first edition, the author has received many welcome comments and suggestions, all of which have received careful consideration in the preparation of this edition. As a result, about 80 more pages have been added, which include complete chapters on synchronous motor control and variable-voltage control. Many new tables give the ratings of motors and controllers. Text and illustrations have been revised to conform to latest practice and to include new devices and methods.

The book describes the characteristics of various types of motors, and explains how the inherent features of each are used for control purposes. Design, construction, and operating characteristics of controllers and control devices are described in detail. Motor acceleration methods, dynamic braking methods, and resistor design are discussed in a practical comprehensive manner. Numerous diagrams and graphs contain much reference material.—J.K.

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Vinyl Resins & Plastics

Versatile synthetic materials offered for

INSULATION AND SHEATHING OF ELECTRICAL WIRE AND CABLE

FROM GEON resins may be made a wide variety of thermoplastic elastomers, possessing unusual electrical and mechanical properties. These materials can be extruded, pressure or injection molded, calendered, or cast into sheet and film.

Here are the specifications and properties of a representative formulation of GEON for cable insulation, in this instance, GEON 2046:

Dielectric strength	800 volts per mil
Insulation resistance	6.0 x 10^{15} ohm-cm @ 15.5° C.
Dielectric constant	6.0 @ 15.5° C.
Power factor	.09 @ 15.5° C.
Chemical resistance	Outstanding
Flame resistance	Will not support combustion
Abrasion resistance	Excellent
Air and ozone resistance	Excellent
Moisture absorption	Comparable to best grades of rubber
Tensile strength	2500 p.s.i.
Elongation	300%
Oil resistance	Excellent
Aging and light resistance	Excellent
Color range	14 Standard NEMA colors

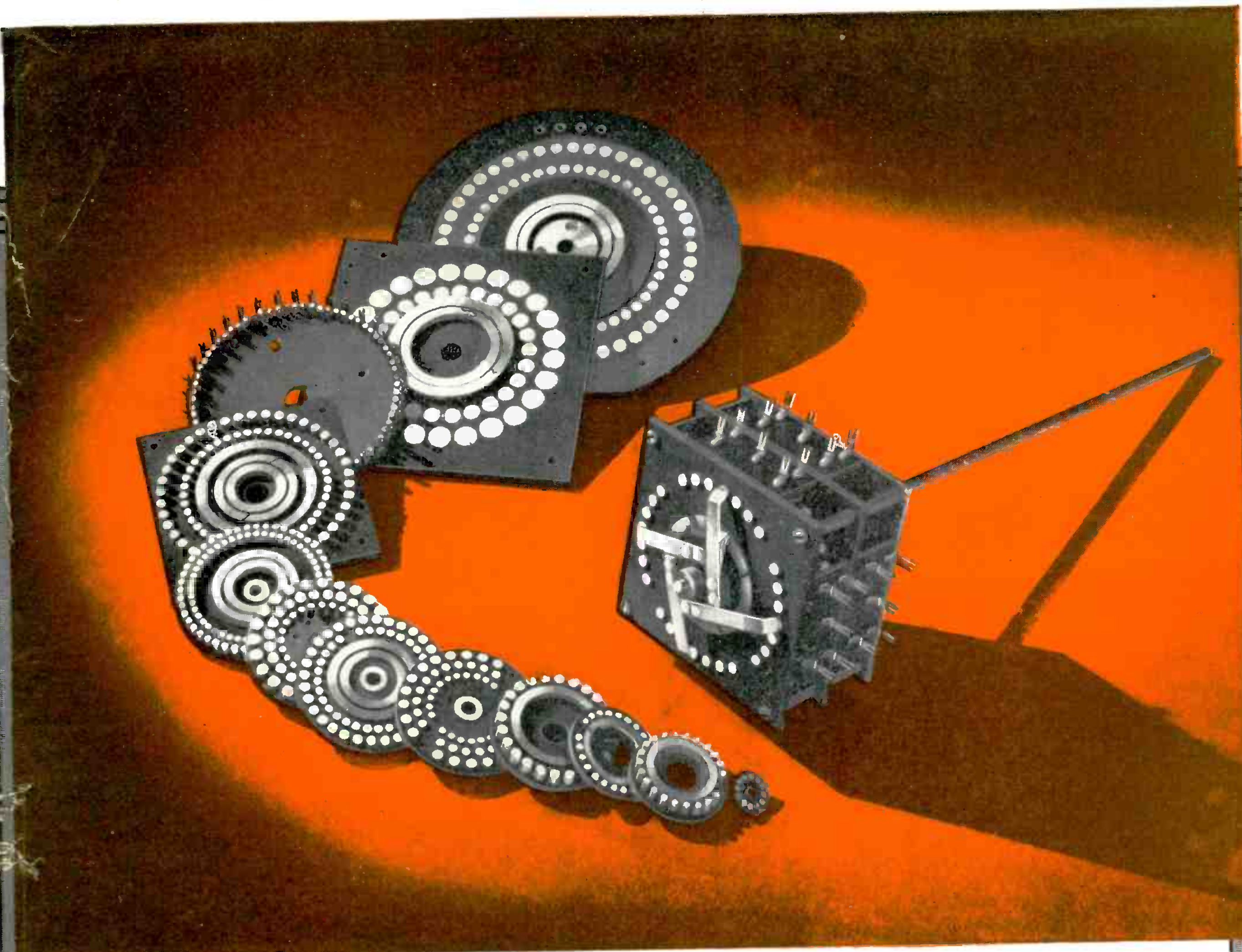
GEON insulation and sheathing can be extruded directly onto the wire or formed into slip-on tubing. GEON film or GEON-treated materials can be made into tape for very fine insulation. GEON can be molded into plugs, connectors, etc.

By varying the type of GEON resins and plasticizers a great number of different combinations of properties may be obtained. Or, GEON, properly blended with certain synthetic rubbers, will impart to the rubber characteristics otherwise unobtainable.

The complete GEON story cannot be told in this limited space. But our research staff and laboratory facilities are available to help you work out any special problems or applications. *For answers to your questions write*

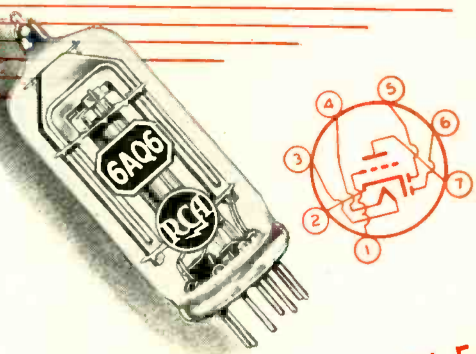
Dept. F-2 CHEMICAL DIVISION
The B. F. Goodrich Company
ROSE BUILDING E. NINTH & PROSPECT CLEVELAND 15, OHIO

GEON is available to industrial users subject to allocation under General Preference Order M-10. Limited quantities can be had for experiment.



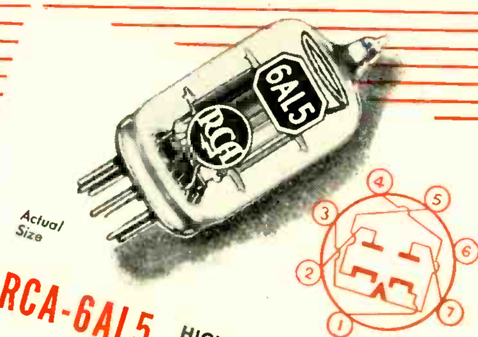
3 NEW RCA MINIATURES

(All on the Army/Navy Preferred List)



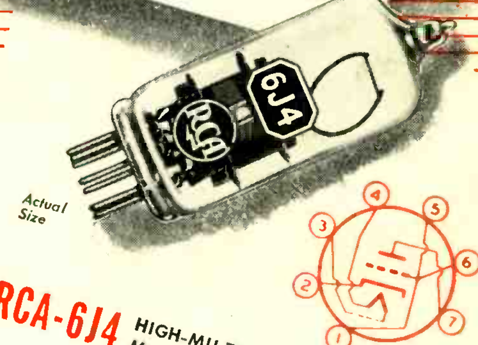
RCA-6AQ6 DUPLEX-DIODE TRIODE $1.50

A multi-purpose miniature electrically similar to the metal 6SQ7, but with half the heater-power requirement. Primarily for use as a combined detector, amplifier, and avc tube. Diode biasing of the triode unit is not suitable. Interelectrode capacitances are low. Heater: Volts, 6.3; Amp., 0.15. Max. overall length, 2⅛ in.; seated, 1⅞ in. Triode Characteristics (class A1 Amplifier): Plate volts, 250; Grid volts, −3; Amplification factor, 70; Plate resistance, 58,000 ohms; Transconductance, 1200 micromhos; Plate current, 1.0 ma.



RCA-6AL5 HIGH-PERVEANCE DOUBLE DIODE $.75

A heater-cathode type of miniature twin-diode. Its low tube-drop, 10 volts at 60 ma. per plate, permits the design of high-efficiency broad-band circuits. Diodes can be used separately or in parallel. Heater: Volts, 6.3; Amp., 0.3. *Max. Ratings* (Design center values): Peak inverse plate volts, 420; Peak current per plate, 54 ma. D-C output current per plate, 9 ma.; D-C heater-cathode potential, 330 volts. Max. overall length, 1-13/16 in.; seated, 1-9/16 in.



RCA-6J4 HIGH-MU TRIODE MAX. FREQ.—500 Mc $8.35

A heater-cathode type of miniature triode. Excellent as a grounded-grid u-h-f amplifier (up to 500 Mc); provides high signal-to-noise ratio. Amplification factor, 55. Transconductance, 12,000 micromhos at plate current of 15 ma. Useful in conventional circuits with ungrounded grid. Heater: Volts, 6.3 (a-c or d-c); Amp., 0.4. Max. overall length, 2⅛ in.; seated, 1⅞ in. *Max. Ratings* (Design center values): Plate volts, 150; Plate dissipation, 2.25 watts; Plate current, 20 ma. Mounts in any position.

EACH of these 3 new tubes meets an important need in the miniature field:

RCA-6J4 as a high-gain triode for frequencies up to 500 Mc

RCA-6AL5 as a high-perveance double-diode for efficient broad-band circuits

RCA-6AQ6 as a duplex-diode/triode to combine several functions in one miniature envelope

All 3 combine sturdy construction with small size and high performance.

All 3 are on the Army/Navy Preferred Type List!

All 3 were completely engineered by RCA!

Additional technical data is available on request. Ask for it by tube type number.

If you have an application involving these or other RCA tubes, get in touch with us. Our tube application engineers will be glad to help you. Radio Corporation of America, Tube & Equipment Department, Harrison, N. J.

Listen to "The Music America Loves Best" on the RCA program every Saturday, 7:30 P.M., E.W.T., Blue Network.

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