

ELECTRONIC INDUSTRIES



THE LAMARCO
COMMERCIAL
SERIAL 10000
SEP 28 1944

1944
OCTOBER
Caldwell-Clements, Inc.

SEP 27 1944

CONTACTS

Can Make or Break a Vibrator



That's the Point
of MALLORY
"Know How"

Contacts in a vibrator take a lot of punishment. They must operate under widely varying conditions of temperature and must "make and break" 115 times a second. Small wonder that alert engineers think of contacts first when selecting a vibrator!

For over 20 years, Mallory has been industrial headquarters for every type of electrical contact. It has introduced new contact compositions . . . evolved better designs . . . formulated improved surface finishes.

As a result of this wide experience, Mallory equips its vibrators with special grade tungsten contacts which are cut in its own

plant from material made to its own specifications. They give longer life, are subject to a minimum of erosion and transfer.

Mallory is ready to apply its special vibrator "know how" to your specific applications.

For Perfect Portable Power . . .



MALLORY Vibrapack*

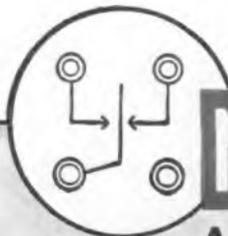
The preferred vibrator power supply in planes, boats and mobile equipment of our armed forces. Operates under great extremes of heat, cold and humidity; withstands an abnormal amount of vibration, jolts and jars.

*Vibrapack is the registered trademark of P. R. Mallory & Co., Inc., for vibrator power supplies.

P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA



*War Bonds Are Your
Personal Investment
in Victory*



P. R. MALLORY & CO. INC.
MALLORY

VIBRATORS

AND VIBRATOR POWER SUPPLIES

ELECTRONIC INDUSTRIES

Including INDUSTRIAL ELECTRONICS

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EDITORIAL STAFF—Ralph R. Batchor, consulting editor; Stanley P. McMinn, managing editor; William Moulic, electronic theory and design; Gilbert Sonbergh, industrial applications; Josepha Zentner, Ph.D., patents and foreign reviews; H. L. M. Capron, engineering management relations; E. T. Bennett, editorial records; Charles Dreyer, art director; Carl Buhrer, circuit diagrams; Barbara Chasen, layout and production; Roland C. Davies, Washington editor.

READER SERVICE—L. D. Chesson, H. Mirtel; data research, H. Kulik.

CIRCULATION—B. V. Spinetta, circulation director; Subscriptions; list compilation: B. Gollub, M. Groening, B. Ruchaisky, A. Warsaw.

BUSINESS—M. H. Newton, business manager; John Samborn, eastern manager; Richard Fitzpatrick, western manager; O. H. Sutter, New England manager; Lee Robinson, district manager; N. McAllister, production manager; Estelle Coven, make-up; E. P. Butler, E. Hekking, E. Duggan; W. W. Swigert, credit manager; M. Feldman, D. Cali.

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WHY AMPEREX

WATER AND AIR COOLED
TRANSMITTING AND RECTIFYING TUBES

Pioneering is another "AMPEREXTRA" which has contributed much to the excellence of the more than 100 different types of transmitting and rectifying tubes developed by AMPEREX. For instance, it was AMPEREX engineers who were first to incorporate specially processed graphite anodes in many of our exclusive designs. One superiority of our graphite anodes is reflected in lower average operating temperatures, more uniform temperature distribution, freedom from warping in processing and operation, absence of change in characteristics with time, and a higher initial vacuum which keeps tubes harder and assures longer life. If you are designing new equipment, or plan to improve existing facilities, talk to an AMPEREX engineer.

*Studying temperature of anode
(attained during bombardment
schedule) through a pyrometer*



AMPEREX ELECTRONIC CORPORATION

79 WASHINGTON STREET BROOKLYN 1, N. Y.
Export Division: 13 E. 48th St., New York 16, N. Y. Cables: "Arlab"

GOOD TO THE LAST DROP ON THE BATTLEFIELD DONATE A PINT OF YOUR BLOOD TO THE RED CROSS

Famous for LONG LIFE!

Tobe Capacitors are built to last. From winding to shipping, each step is under rigid inspection to maintain the high standard set by twenty years' experience.

Below is shown a Tobe RLO Type Capacitor. It is impregnated and filled with mineral oil, made with watchful care and—like all Tobe Capacitors—rated conservatively. Let us know about your capacitor problems.

LONG LIFE ASSURED



SPECIFICATIONS—TYPE RLO[®] CAPACITOR

RATINGS:		
800 VDC	Single Units	.01 to 2.0 Mfd.
	Dual Units	.05 to 1.0 Mfd.
	Triple Units	.05 to 0.5 Mfd.
1,000 VDC	Single Units	.01 to 1.0 Mfd.
	Dual Units	.05 to 0.5 Mfd.
	Triple Units	0.1 and .25 Mfd.

STANDARD CAPACITANCE TOLERANCE—plus or minus 20%^{**}

TEST VOLTAGE—twice D.C. rating

GROUND TEST—2,500 Volts D.C.

OPERATING TEMPERATURE—55° F. to 185° F.

SHUNT RESISTANCE—

.01 to 0.1 Mfd.	—20,000 Megohms
.25 to 0.5 Mfd.	—12,000 Megohms
1.0 Mfd.	—10,000 Megohms
2.0 Mfd.	—5,000 Megohms

POWER FACTOR —1,000 cycles—.002 to .005

MOUNTING HOLE CENTERS: 2 1/4" except for the following capacitance values which are made in containers having 2 3/8" mounting centers:

800 VDC—	Single Units	1.0 and 2.0 Mfd.
	Dual Units	0.5 and 1.0 Mfd.
	Triple Units	.25 and 0.5 Mfd.
1,000 VDC—	Single Units	0.5 and 1.0 Mfd.
	Dual Units	.25 and 0.5 Mfd.
	Triple Units	0.1 and .25 Mfd.

*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

Photo Courtesy of Southern Pacific Lines

Wherever Precision Counts Most...



Products of "MERIT" are passing the test

MERIT has established its ability to produce in quantity and deliver promptly —

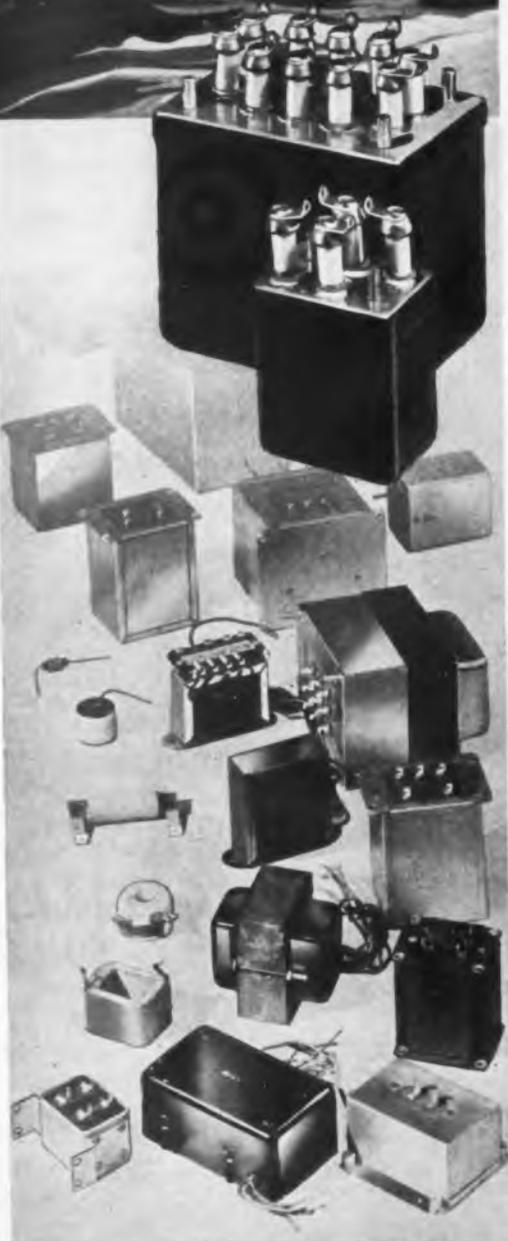
**TRANSFORMERS
COILS
REACTORS**
Electrical Windings of All Types for Radio, Radar and Electronic Applications

● Today these dependable MERIT precision parts are secret weapons; tomorrow when they can be shown in detail as MERIT standard products you will want them in solving the problems of a new electronic era.

ILLUSTRATED: High Voltage Transformers A-2123 (small) and A-2124. Designed for high altitudes. Oil-filled and Hermetic sealed.



MERIT COIL & TRANSFORMER CORP.
311 North Desplaines St. CHICAGO 6, ILL.



This Month's Cover

R. S. Brannin, Project Engineer at the Research Laboratories of the Sperry Gyroscope Co., Garden City, L. I., examines a vertical gyro for a new electronic automatic pilot that is being developed by the company. The vertical gyro component supplies the signals which permit the automatic pilot to operate the ailerons and elevator of the aircraft. In the foreground is shown a vertical gyro from an earlier model electronic automatic pilot. The newer component is lighter in weight.

OMGSHF!

Just as we are beginning to know our way around the spectrum, albeit gingerly, word comes from England that the boys over there are also having a hectic time wrestling with their S, X, Y, and Z bands, asking each other how high is up. At this point we're not even sure whether UHF comes before VHF, although offhand we'd say "ultra" really ought to be more definite than "very." Anyway, in case you thought the heading of this item was a direct quote of a remark caused by a kick in the stomach, OMGSHF! is the present ultimate, meaning "Oh, my goodness, such high frequency!"

Astronomical Crystals

Some reason for military needs for almost astronomical numbers of quartz crystals is indicated by requirements for just two of the Army's basic radio sets—SCR-508 and SCR-608—developed by Western Electric for mobile use in tanks, halftracks, tank destroyers, scout cars and command cars. Both sets are medium high frequency, crystal controlled and push-button operated and both operate on ten basic frequencies. However, with each set there are supplementary crystals providing for frequencies each 100 kc step in the bands in which the transmitters operate. This means that the tank set carries with it some 80 crystals and the artillery set uses 120. They are carried in a storage drawer built in as part of the transmitter. One armored division of our Army carries 975 transmitters.





The tube that shields itself

another G-E electronic



Television receiver
in table-model size

A lot of army-tank radio
equipment in a compact package

Aircraft receiver in
three compact band units

FIRST!

THE G-E development of the metal receiver tube represented a complete departure in the conception and manufacture of electronic receiver tubes and of parts assembly.

The G-E metal receiver tube not only serves as an "envelope" for the tube elements, but in itself provides the necessary "shielding" to prevent feedback (the electrostatic or electromagnetic influences in circuits which interfere with operation). Thus, the elimination of separate, space-consuming shielding devices permitted circuits to be designed more compactly. This, in turn, made possible the simplification and the smaller size of receivers — not only for "consumer" uses, but importantly for aircraft, tank, lifeboat and other vital needs.

General Electric progress during all the years of radio history has been a succession of electronic-

tube "firsts." You may be sure that *all* G-E tubes — transmitting or receiving — possess everything that electronic research and engineering have uncovered . . . and that they have the most exacting construction, highest efficiency, and longest serviceable life the world's finest tube factory can produce.

G-E TUBES ARE "FIRST" IN INDUSTRY, TOO! For example, General Electric pioneered in the application of the phototube in commercial talking moving pictures. G. E. has also contributed to the designing of sorting, inspection, registering, counting and other apparatus employing the light-sensitive characteristics of the phototube.

FREE BOOK, "HOW ELECTRONIC TUBES WORK." Address *Electronics Dept., General Electric, Schenectady, New York.*

* 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

181-C7-8850

Come to the world's

for **FM—Television—AM**

The various G-E studios, stations, equipment and regularly scheduled broadcasts represent the greatest concentration of proving-ground activities in the world for the development and demonstration of FM, television, and standard and shortwave AM. All are located in the Schenectady area—and virtually next door to the engineering laboratories and fac-



WGFM



WRGB



WGEO and WGEA

• 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 N.B.C.

**STATION AND STUDIO EQUIPMENT
TRANSMITTERS • ANTENNAS
ELECTRONIC TUBES • RECEIVERS**

largest proving ground

See G.E. for all three!

ories in which most of the equipment has been designed and built. So, make it a point to come to General Electric at Schenectady. . . . Here is the place to study the newest methods and equipment; to get a picture of the future of commercial broadcasting—in all three fields; and to plan soundly for post-war station operation.*



The first FM station licensed! (1) The ultra-modern WGY studio, in Schenectady, where WGFM also is located and from which programs are relayed—without wires—to the FM transmitter atop the Helderberg Mountains 12 miles away. (2) G-E S-T transmitter. (3) G-E high-gain S-T relay antenna. (4) FM broadcast transmitter at right, and 50-kw experimental transmitter. (5) G-E FM circular broadcast antenna.



Most powerful and best equipped television station in the world! (1) G-E workshop television studio in Schenectady. From here, through G-E television relay equipment, programs are beamed to the giant transmitter on a mountain-top 12 miles away. (2) A studio interior view. (3) G.E.'s pioneer television relay station which picks up programs from New York City and relays them to the main transmitter. (4) G-E directional relay antenna. (5) The G-E 40-kw television transmitter.



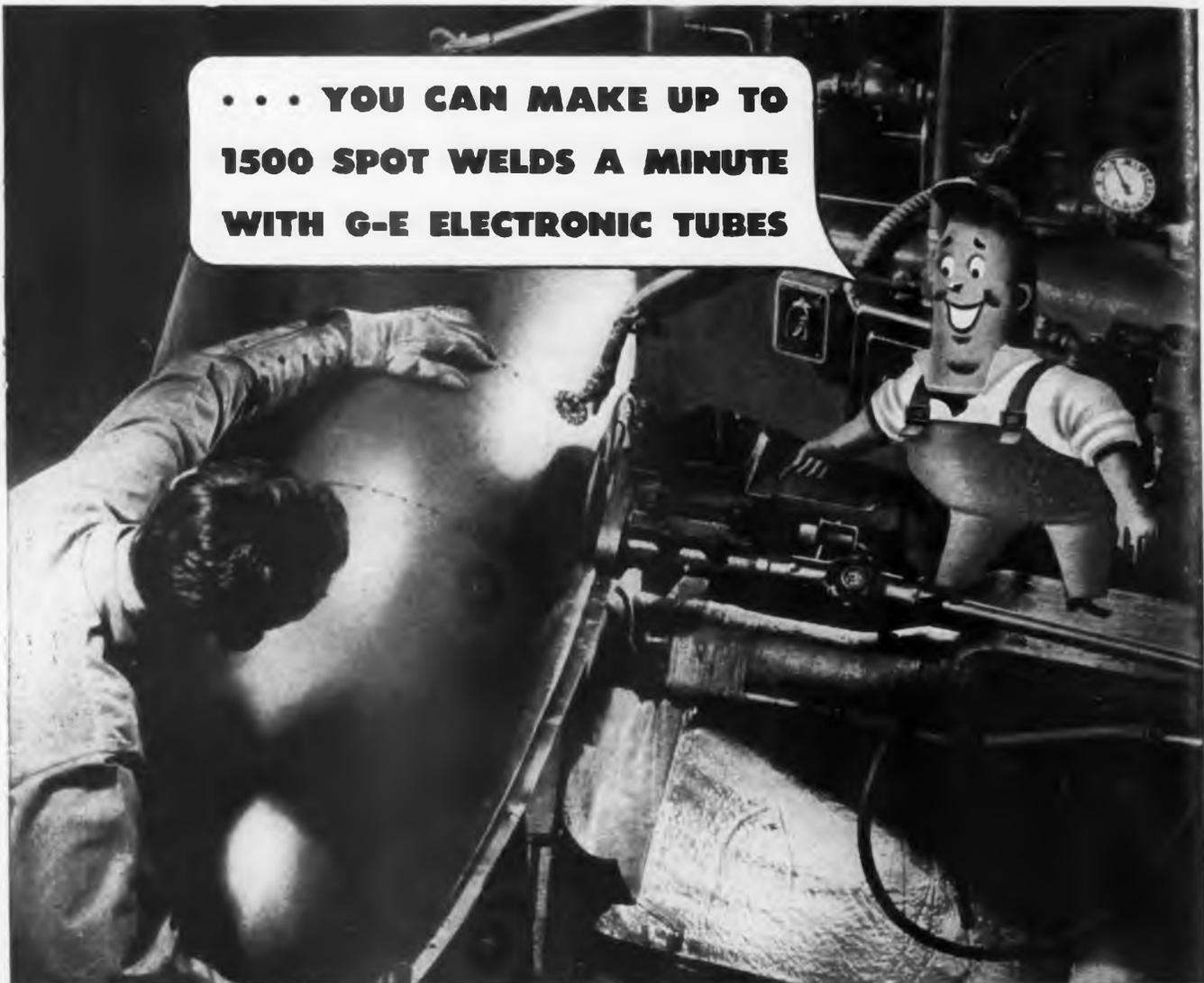
Two of the most powerful international shortwave broadcast stations! (1) Aerial view of transmitter station, and partial view of antenna arrays. (2) G-E high-powered AM transmitter and control console. (3) G-E shortwave broadcast panel antenna. (4) G-E antenna switchyard for the selection of beam antennas for broadcasts to different parts of the world.

★ Write for any of this informative printed material: Book, "Radio Broadcasting Post-war"; book, "Television Broadcasting Post-war"; pamphlets on FM systems and equipment . . . as well as the "G-E Equipment Reservation Plan" which will enable you to obtain quick post-war delivery on equipment you need. Write also for any special information desired; or to make a date to come to Schenectady for a tour of inspection and study of G-E facilities. Address Electronics Department, General Electric, Schenectady, New York.

GENERAL  ELECTRIC

160-C10-8912-8914

**... YOU CAN MAKE UP TO
1500 SPOT WELDS A MINUTE
WITH G-E ELECTRONIC TUBES**



**HIGH-SPEED PRECISION WELDING
IS MADE POSSIBLE BY THE G-E
IGNITRON AND THE G-E THYRATRON**

IN THE photograph above, a droppable fuel tank for aircraft is being seam-welded with the aid of G-E electronic tubes, at a production rate far in excess of what was considered possible only a short while ago.

The heart of the welding control equipment is the G-E electronic tube — the steel-clad ignitron, which provides the high current demanded; and the thyatron, a precision timer, which controls the passage of current as seam

welds are spotted at any desired distance, overlapped, or brought into a solid line. Seam welds can be made at speeds up to 1500 or more welds a minute.

Thyatron control is especially valuable for spot or seam welders because it *automatically* opens and closes the circuit at precisely the same point each time on the a-c supply voltage wave. This minimizes *transient* currents, the cause of non-uniform welds.

Advantages of the electronic-tube method over mechanical methods are: Improved quality of welds; reduced voltage regulation; low maintenance cost; smooth heat adjustment over a wide range.

There is a complete line of G-E electronic tubes for innumerable industrial jobs; and near you is a G-E electronic-tube distributor who is prepared to fulfil your requirements.

"HOW ELECTRONIC TUBES WORK"

This booklet will be mailed to you on request—without charge. Address *Electronics Department, General Electric, Schenectady, New York*.

• Tune in "The World Today" and hear the news direct from the men who see it happen, 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

162-C9-8850

ELECTRONIC INDUSTRIES • October, 1942



For Your Postwar Needs in Connectors and Related Units

If your postwar plans will involve coaxial cable connectors, cable plugs or special design parts of similar nature—we invite your consideration of our products and facilities.

Besides offering a comprehensive line of standard units, Connector Division possesses a unique engineering skill and knowledge in this field that may prove of valuable help and economy to you.



INTRODUCING MINIATURE BATTERY PLUGS



(Illustrations are actual size)

Anticipating the trend to midget devices, IRC presents this new, easy-grip battery plug. Pins are firmly imbedded in molded bakelite to insure positive contact. Side-positioned lead entries reduce strain on soldered connections. Fitting all miniature batteries, these plugs should find wide application in many types of equipment especially in the radio, hearing-aid, medical apparatus, and appliance fields.

Available in two-pin or three-pin models. Specifications and samples on request.

Write for Catalog



*CONNECTOR DIVISION OF
INTERNATIONAL RESISTANCE CO.
 401 N. BROAD ST., PHILADELPHIA 3, PA.

FORMERLY CONNECTOR CORPORATION

ANNOUNCING*



SPRAGUE

Ceroc 200

**A high-temperature (200° C.) ceramic insulation
for copper, nickel, and other wire**

*We use the word "Announcing" advisedly. Although this is its first public announcement, Sprague CEROC 200 is by no means a new or untried development. Many engineers are already familiar with it. Many have long been using it on restricted war developments on

which details cannot yet be announced. So far-reaching are its possibilities for such a wide variety of electrical products, however, and with our production facilities being steadily and materially expanded we take this means of bringing it to general trade attention.

† T. M. REG. U. S. PAT. OFF.

Ceroc 200

INORGANIC INSULATION FOR COPPER AND OTHER WIRE

PERMITS 200° C. CONTINUOUS OPERATION

FOR MANY TYPES OF ELECTRICAL EQUIPMENT

A CLASS C INSULATION MATERIAL



CROSS SECTION
The extreme uniformity of CEROC 200 makes for smooth, level winding. The thinness with which it may be deposited on the wire saves space.

Culminating seven years of continuous research and development by the Sprague engineering organization, CEROC 200 now paves the way for greatly increased efficiency, smaller sizes, and lighter weight for a wide variety of electrical equipment.

Sprague CEROC 200 is a ceramic (inorganic) insulating coating thinly deposited on copper, nickel, and other types of wire, and permitting much higher continuous operating temperatures than are possible with ordinary Class A insulations such as enamels, varnishes, and other organic materials. Applied to copper wire, it permits of a conservatively rated 200° C. continuous operating temperature as compared to the present limit of 105° C. for Class A materials. Thus, by designing electrical equipment to utilize the full maximum operating temperature of this new wire coating, a very substantial increase in volt-ampere rating can be obtained. We believe that CEROC 200 meets all requisites of a Class C insulating material under A. I. E. E. standards.

THERMAL CONDUCTIVITY: Coils wound with CEROC 200 dissipate heat rapidly. There is little or no tendency toward development of hot spots which might nullify a big percentage of the high-temperature gain that would otherwise be expected. Thus, the high-temperature advantages of CEROC 200 are real and not apparent.

SPACE FACTOR is extremely good. Typical percentages of copper area to total cross-sectional area of finished wire are 96% for AWG #21 wire, and 95% for #24 wire for CEROC 200 by comparison with only 69% and 59% respectively for other insulations that might be used for high-temperature applications. Moreover, CEROC 200 coating is extremely uniform, thus making for smooth, level winding. The preferred coating thickness is $\frac{1}{4}$ mil., and the following characteristics are based on wire so coated:

MAXIMUM STABLE TEMPERATURE for continuous operation—200° C.

VOLTAGE BREAKDOWN between two wires of a twisted pair 4" long:

Standard condition (25° C.)—300 v. A.C.

Humid condition (95% relative humidity)—300 v. A.C.

Hot condition (200° C.)—300 v. A.C.

LEAKAGE between two wires of a twisted pair, 4" long, at 95% relative humidity is greater than 100,000 megohms.

FLEXIBILITY by bending: 16% elongation.

ABRASION RESISTANCE: Average 16-18 scrapes at 200 G. weight on G.E. abrasion tester for #25 AWG wire having the preferred $\frac{1}{4}$ mil. coating thickness. On wire sizes smaller than #25, this average is slightly less, and on larger than #25 wire, it is somewhat more.

WIRE SIZES: Although CEROC 200 is constantly being adapted to new uses, the present preferred ranges for coated wire are as follows:

Copper wire—from 3 to 30 mils (#40 to #21 AWG).

Nickel wire—from $1\frac{1}{2}$ to 12 mils (#46 to #28 AWG).

WINDING CHARACTERISTICS: CEROC 200 is sufficiently flexible to present no winding difficulties that will not be far more than compensated for by its tremendous high temperature and space advantages. In general, round coils can be wound satisfactorily by existing methods. Slight modifications in winding technique may prove necessary, however, in the case of rectangular coils or motor armatures.

Although costs on CEROC 200 are being steadily revised downward, as a result of greatly increased facilities, it should be borne in mind that this material was not designed to compete on applications where conventional organic insulations are giving satisfactory service. Rather, it is intended for those applications where a substantially higher temperature insulation combined with space- and weight-saving factors more than justify a somewhat higher price for the CEROC 200 insulation that makes them possible.

SAMPLES

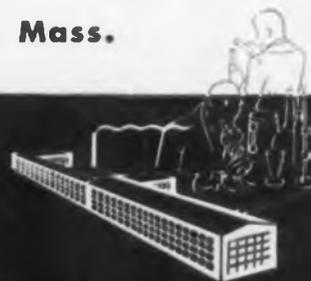
CEROC 200 is by no means a new or untried development. For more than a year, large quantities of CEROC-insulated wire have been supplied for important war applications of the most exacting sort. Thus, although production facilities are being steadily increased, it is still difficult to supply generous samples of specific wire sizes to all who might be interested. As far as possible, however, we will gladly supply small quantities of available sizes to large users who want to test its far-reaching possibilities in connection with their products at a later date when full and prompt deliveries are possible.

SPRAGUE ELECTRIC COMPANY, North Adams, Mass.

(Formerly Sprague Specialties Company)

SPRAGUE

CAPACITORS • KOOLOHM RESISTORS • CEROC INSULATION



↑ TRADEMARKS REGISTERED U. S. PATENT OFFICE



the Improvement goes on...

ENDLESSLY
FORMICA



● Since 1913, in the Formica Laboratories, a considerable force of competent research men has been busy every day seeking new ways to improve Formica and its usefulness to industry.

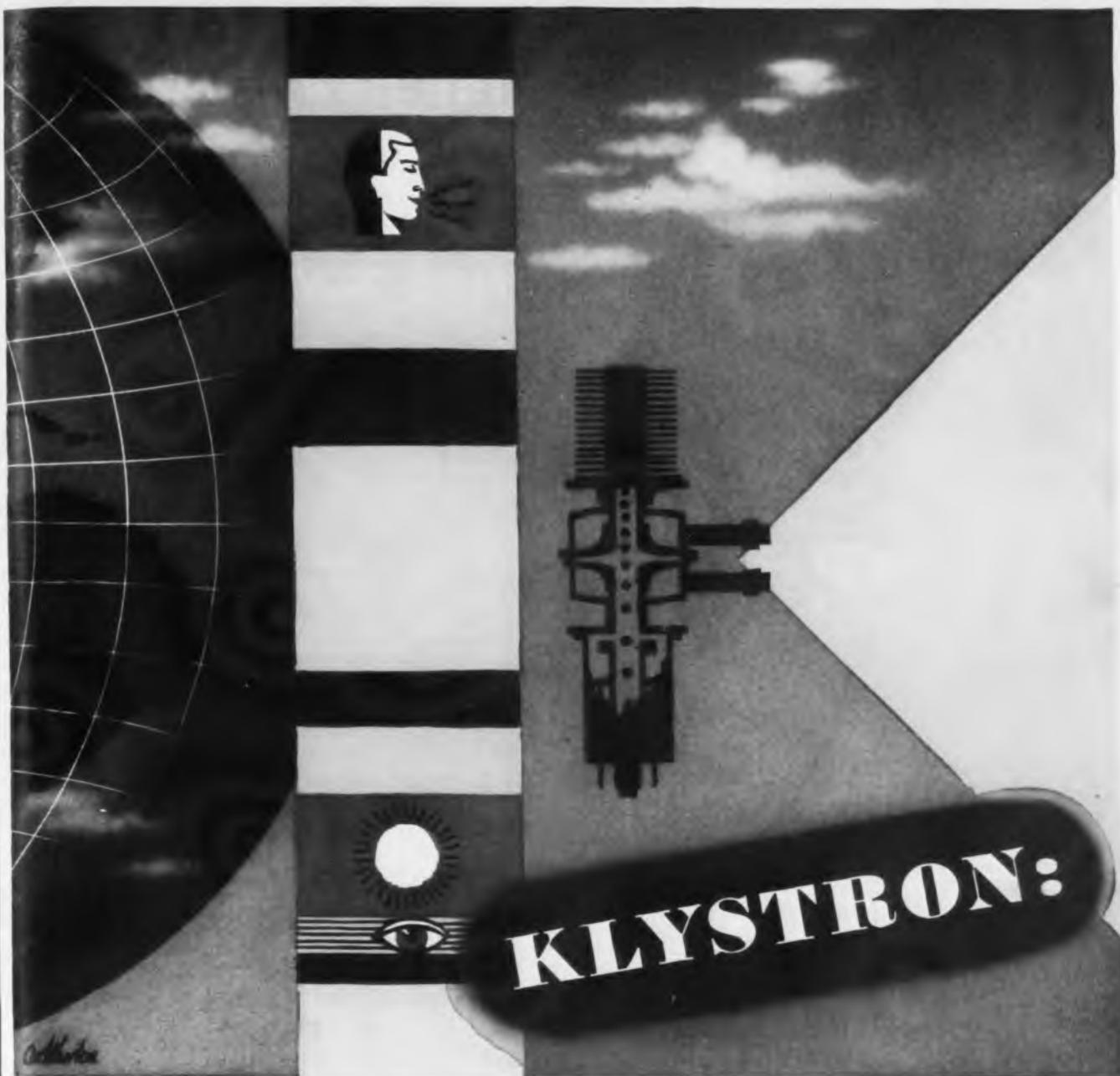
They have worked out a long line of improvements which have been additions to the art. During these war years they have been exceptionally busy, and productive.

Among the important recent developments have been glass cloth and glass mat grades for high mechanical strength, and improved insulation of high frequency currents; Pregwood for airplane propeller blades and other mechanical uses; alkali resistant grades for chemical processes. better laminated translucent sheet, sturdier and more decorative Formica finishes.

There are others which will soon be unveiled. All the knowledge of this laboratory is at your disposal when you have a problem in the use of laminated plastics to solve. Ask for it

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

THE FORMICA INSULATION COMPANY, 4647 Spring Grove Avenue, Cincinnati 32, Ohio



Makes *vhf* waves behave

THE KLYSTRON converts DC energy into radio frequency energy by modulating the velocity of an electron beam between spaced grids.

The ultra-high-frequency waves thus generated are so short that they approach heat and light waves in the electro-magnetic spectrum.

This makes it possible to project, by reflection, a shaped beam of *vhf* waves. Sperry engineers have put this principle to work in important wartime devices for our Armed Forces.

► **Klystrons are now in quantity production, and certain types are available. Write for information.**

The name "KLYSTRON" is a registered trade-mark of the Sperry Gyroscope Company, Inc.

Like other Sperry devices, Klystrons are also being made during the emergency by other companies.

Sperry Gyroscope Company

GREAT NECK, N. Y. • DIVISION OF THE SPERRY CORPORATION



The new **HK-257B**
Gammatron provides
235 watts output with
ZERO DRIVING POWER

OPERATING DATA		
As an RF Power Amplifier, Class C, Unmodulated		
	Maximum Rating	Typical Operation
Power Output		235 Watts
Driving Power		0 Watts
DC Plate Volts	4000	3000 Volts
DC Plate Current	150	100 M. A.
DC Suppressor Voltage		60 Volts
DC Suppressor Current		3 M. A.
DC Screen Voltage	750	750 Volts
DC Screen Current	30	8 M. A.
DC Control Grid Voltage	500	200 Volts
DC Control Grid Current	25	0 M. A.
Peak RF Control Voltage		170 Volts
Plate Dissipation	75	65 Watts

WRITE TODAY FOR COMPLETE DATA

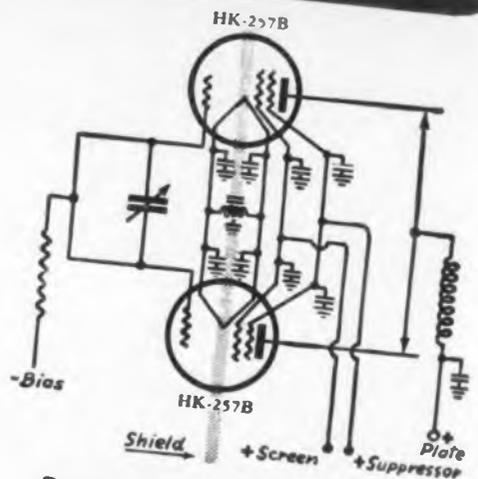
ZERO DRIVE! NO NEUTRALIZATION!
OPERATION UP TO 150 MEGACYCLES!

Now Heintz and Kaufman engineers offer an improved version of the famous HK-257 Gammatron—the tube that produces 235 watts of RF power with zero drive, that operates at high efficiency up to 150 megacycles, and that requires no neutralization.

The special design of the HK-257B permits high screen and plate voltage ratings, which in turn allow high power output with zero drive.

A transmitter designed around this remarkable Gammatron requires a minimum number of stages, few tuning controls, minimum driver equipment, and enables instant channel switching as no neutralization adjustment is needed.

The improved HK-257B is more rigid mechanically, has maximum protection against filament bombardment, and withstands severe momentary overloading without injury.



Because grid current is zero in the above circuit, the HK-257B is being operated at zero driving power. Some power is being fed into the circuit developing the grid driving voltage in order to supply normal loss. This loss in the resonant grid circuit is on the order of 1.0 watts in most practical circuits.

BUY WAR BONDS REGULARLY

14

HEINTZ AND KAUFMAN LTD.
SOUTH SAN FRANCISCO • CALIFORNIA

Gammatron Tubes

ELECTRONIC INDUSTRIES • October, 1944

SIGNAL CORPS EQUIPMENT



Four basic controls

by *Bliley*



All helping to "get the message through"...

all precision proved in the tradition of

BLILEY CRYSTALS



Bliley
CRYSTALS

Do more than before...

buy extra War Bonds

BLILEY ELECTRIC COMPANY • UNION STATION BUILDING • ERIE, PENNSYLVANIA

ELECTRONIC INDUSTRIES ■ October, 1944

Enemy Agents



QUICK LOCAL SERVICE ON INDUSTRIAL ELECTRONIC TUBES

Looking ahead to continued development of electronic equipment in industry, postwar, we now have a plan to make Westinghouse Electronic Tubes quickly and easily available. Stocks of the most widely used tubes are now available through Westinghouse Electronic Tube Distributors and Westinghouse District Warehouses. As rapidly as possible additional types will be added to local stocks to make a complete line of Quality Controlled Westinghouse Electronic Tubes available to everyone.

EVERY FRONT, IN EVERY BATTLE, IN EVERY WAR INDUSTRY

WOULD GIVE THEIR

EYE-TEETH TO KNOW



Secret weapon of American war industry is surely the electronic tube. It has revolutionized industrial and manufacturing methods, brought about startling new production techniques . . . many of them well kept secrets that enemy agents would give their eye teeth to know. As a major supplier of electronic tubes, Westinghouse is proud to be sharing in this still secret, but tremendously vital "electronic revolution."

To meet the enormous demands for Westinghouse Electronic Tubes—from the armed forces as well as war industry, we've increased floor space 20 times, trained 28 new workers for each one formerly employed, multiplied output 30 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

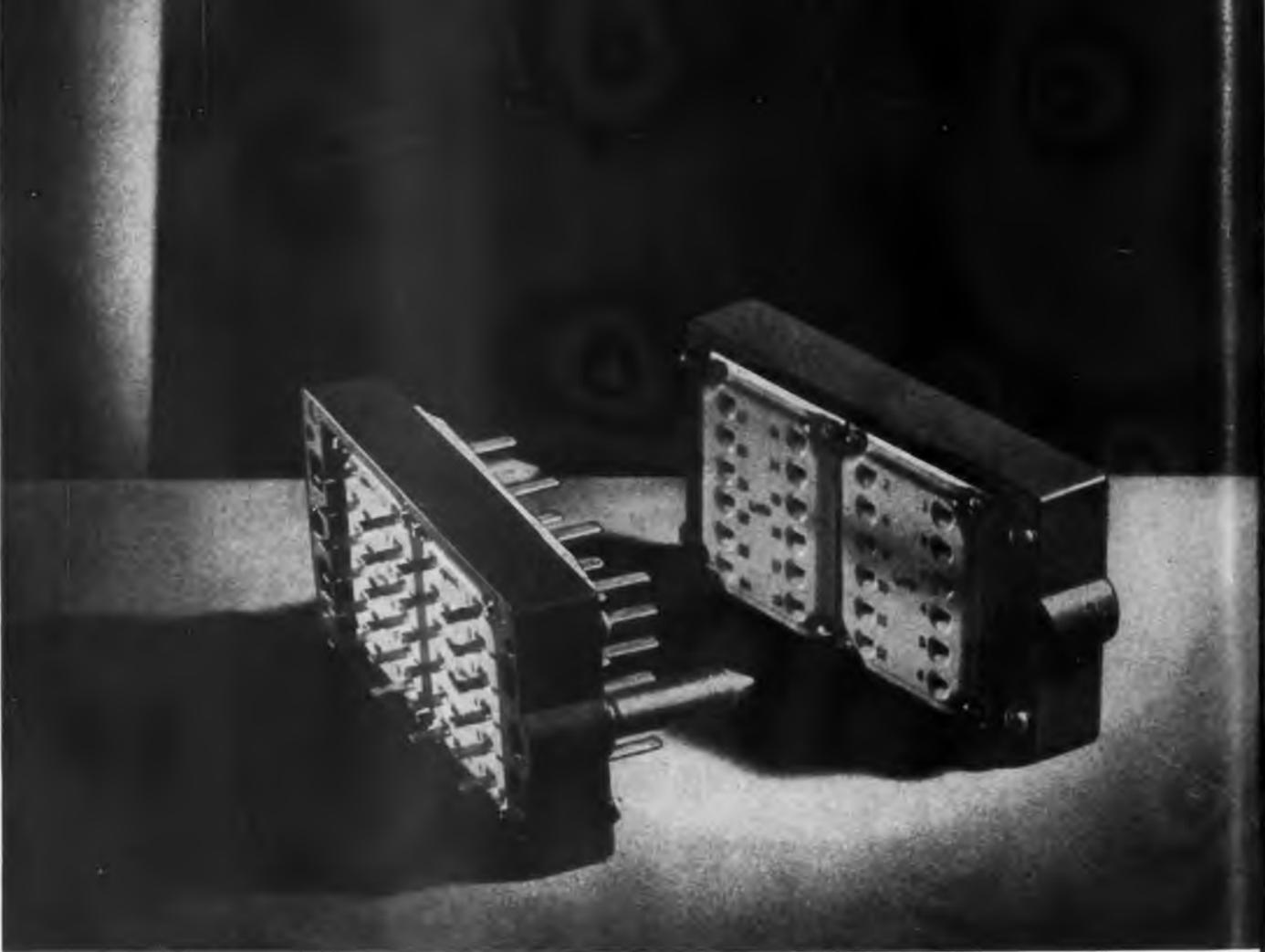
Electronic Tubes at Work

WESTINGHOUSE PRESENTS: John Charles Thomas—Sunday 2:30 EWT—NBC. • Ted Malone—Monday, Wednesday, Friday—10:15 P. M., EWT—Blue Network.

ELECTRONIC INDUSTRIES • October, 1944

17





An Electronic Part ... ENGINEERED TO A SPECIFIC NEED

This is a special-purpose electronic part. It is a plug-receptacle assembly for use with rack-panel type of mounting. Twenty-four silver-plated phosphor-bronze contacts are provided, each male and female contact full floating between steatite plates. Heavy guide pins and matching holes in the frame assure perfect alignment.

We don't know that your product has any need for such a part as this. We do know, however, that this part is most exactly suited to its special requirement, just as are hundreds upon hundreds of other parts which have been created through Lapp engineering and Lapp production facilities directed to the solution of specific problems.

With a broad basic knowledge of ceramics—their capabilities and their limitations—Lapp has been able to simplify and to improve many types of elec-

tronic equipment through engineering and production of sub-assemblies that make most efficient use of porcelain or steatite and associated metal parts.

There may be a way you can improve performance, cut costs and cut production time through use of Lapp-designed and Lapp-built sub-assemblies. We'd like to discuss your specific requirements with you. *Lapp Insulator Co., Inc., LeRoy, N. Y.*

Lapp





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A NEW NAME ON THE ELECTRONICS POST-WAR HORIZON

The period after the war may well become known as the "Electronic Era". In the development of the many ingenious post-war products, there will be a need for specialized engineering of precise and intricate high frequency components. This is our field. Our organization, with years of experience designing and making such products is at present devoting its manufacturing facilities 100% to war work. These unusual facilities will soon be available for the peacetime needs of our industry, and our engineering "know-how" is at your service now to help you with your post-war planning.



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DIVISION-BLACK INDUSTRIES

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INDUCTORS AND ELECTRONICS



Typical in precision measuring of R. F. Inductors to rigid war production tolerances, the "Dynamic Inspection Analyzer" is representative of the ingenuity of Guthman "INDUCTRONIC" research. Employing a highly stabilized circuit of our own design this 24-frequency inspection device, used in the manufacture of an Ant. R. F. and Osc. assembly, can analyze the individual coils for band coverage, inductance, and Q. at their operating frequencies. Uniformity of electrical characteristics in the manufacture of Guthman super-improved coils makes...



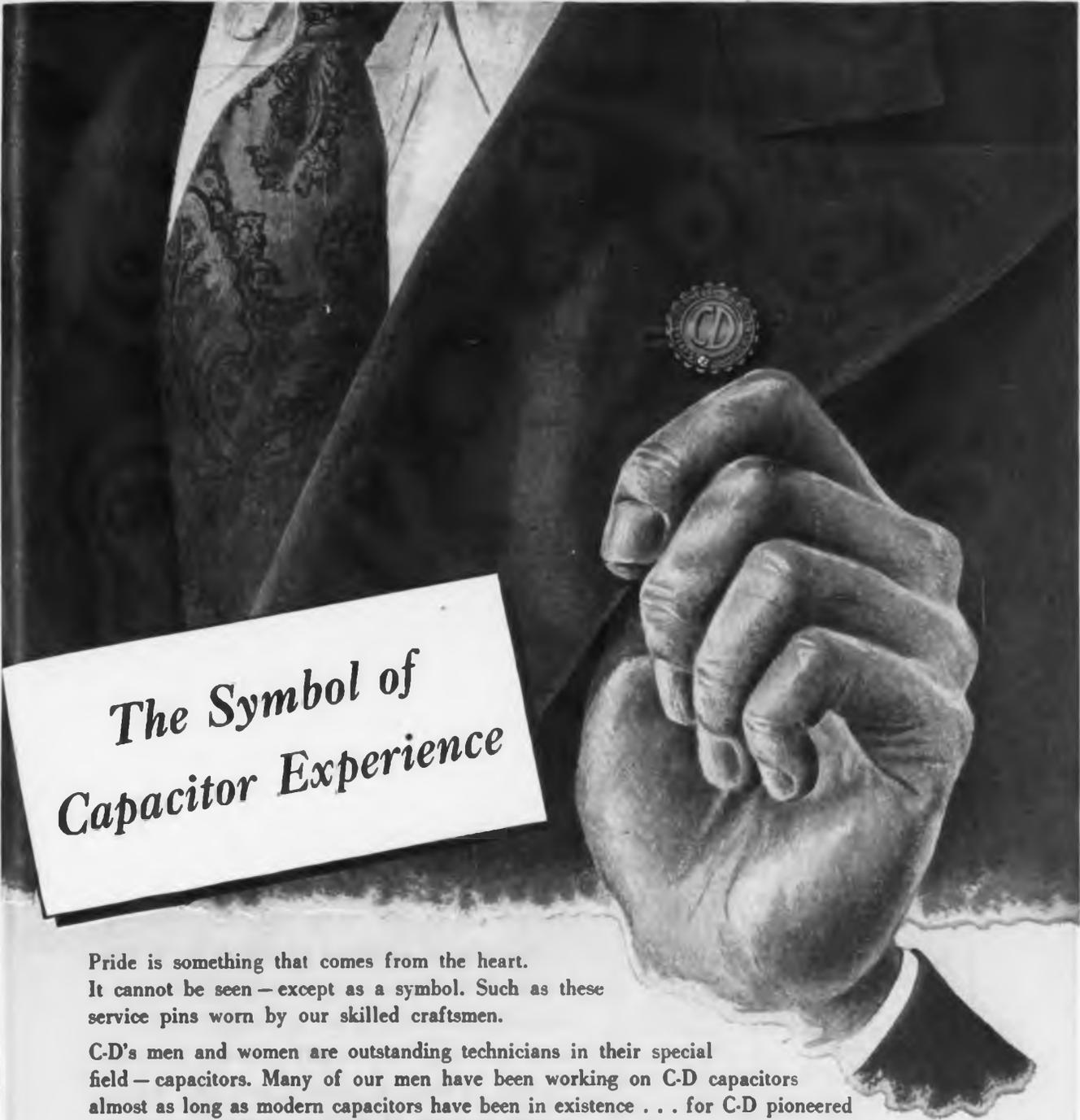
*Guthman... "Leader in Inductronics"**

* Copyright: Edwin I. Guthman & Co., Inc. 1943



EDWIN I. GUTHMAN & CO. INC.

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PRECISION MANUFACTURERS AND ENGINEERS OF RADIO AND ELECTRICAL EQUIPMENT



*The Symbol of
Capacitor Experience*

Pride is something that comes from the heart. It cannot be seen — except as a symbol. Such as these service pins worn by our skilled craftsmen.

C-D's men and women are outstanding technicians in their special field — capacitors. Many of our men have been working on C-D capacitors almost as long as modern capacitors have been in existence . . . for C-D pioneered in capacitors and has manufactured them exclusively for 34 years.

Some of our men designed and made capacitors for wireless equipment used in World War I. They proudly wear their symbols of long service. Others wear their 5-year pins, their 10-year pins, their 20-year pins as a mark of their skill, accumulated knowledge and experience in capacitors.

Our men and women are constantly striving for improvements . . . and out of their inquiring minds come new developments to meet the changing needs of capacitor users. These are the people who build dependability into C-D capacitors — that make them top quality always. Cornell-Dubilier Electric Corporation, South Plainfield, N. J.

CORNELL-DUBILIER
CAPACITORS WORLD'S

LARGEST MANUFACTURER OF CAPACITORS

MICA • DYKANOL • PAPER • WET AND DRY ELECTROLYTICS



1910-1944

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The Ideal Insulating Material

MACHINABILITY

Because of its most original composition this material can be readily cut, drilled, tapped and machined to very close tolerances. While stock sheets are ground to plus or minus .015 closer tolerances to .005 are available at slight additional cost.

STOCK SIZES

PemQue Sheets are available in sizes:

FLAT SURFACE

10 $\frac{1}{4}$ "x12 $\frac{1}{8}$ " 8 $\frac{1}{2}$ "x14 $\frac{1}{2}$ " 6 $\frac{1}{2}$ "x18 $\frac{1}{2}$ "

In these thicknesses

$\frac{1}{8}$ " to $\frac{3}{8}$ " $\frac{1}{8}$ " to $\frac{1}{2}$ " $\frac{1}{4}$ " to $\frac{5}{8}$ "



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Here is the answer to the toughest problems in the field of electrical insulation. Here is a dense Pyro-Welded moisture proof material with High Dielectric strength. Does not deteriorate with age. It is highly resistant to fungi growth, to heat, to electric arcs and with a tensile strength of 6000 pounds to the square inch. We're ready to supply your needs NOW regardless of size or shape or quantity. Write for additional data.

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1/50 H.P. CAPACITOR MOTOR
TYPE J-70

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60 Cycles, 115 Volts • Single Phase-3400 R.P.M. • Low temperature rise • High efficiency: Diameter $3\frac{3}{16}$ " , Overall length $3\frac{1}{8}$ " , Shaft diameter $\frac{5}{16}$ " , Weight 3 lbs. Applications are for driving blowers in high ambient temperatures and for powering small control devices of all types.

We Invite Inquiry
This motor can be supplied to deliver 1/25 H.P., can be wound for 2 or 3 phase and also furnished for 400 cycle applications at higher speeds and H.P.



**A liberal choice
of types to meet most electrical
and mechanical requirements...**

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● Along with pioneering the dry electrolytic capacitor for radio, electronic and motor-starting functions, Aerovox has always maintained an outstanding choice of types.

The new Aerovox Capacitor Catalog now off the press lists 17 types of electrolytics—round-can, square-can, cardboard-case, tubulars, plug-ins, twist-prong base, etc. You will usually find a type listed that precisely meets your capacitance, voltage, mounting, terminal and container requirements. But if your requirements happen to be very unusual, this wide variety of designs enables Aerovox to work out a special type to meet those high-priority needs quickly, satisfactorily, economically.

● **Write for Literature . . .**

Write on your business stationery for latest catalog on electrolytics. Submit that capacitance problem for our engineering collaboration, specifications, quotations.



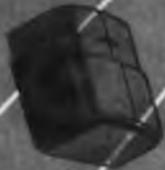
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Opens wide avenues for your successful Post-War Products

*A formable thermosetting sheet material—makes parts more resistant to shock



This is a typical Post Formed Phenolite baffle used in aircraft construction.

Post Formed Phenolite parts are playing an important role in today's airplane construction because of their ability to withstand tremendous impact without fracture. This impact strength is approximately ten times that of usual molded parts.

This remarkable property, combined with Phenolite's other exceptional characteristics—resistance to wear and moisture, light weight (about one-half the weight of aluminum), excellent electrical insulator—recommends the broad advantageous use of Post Formed parts in countless peacetime products.

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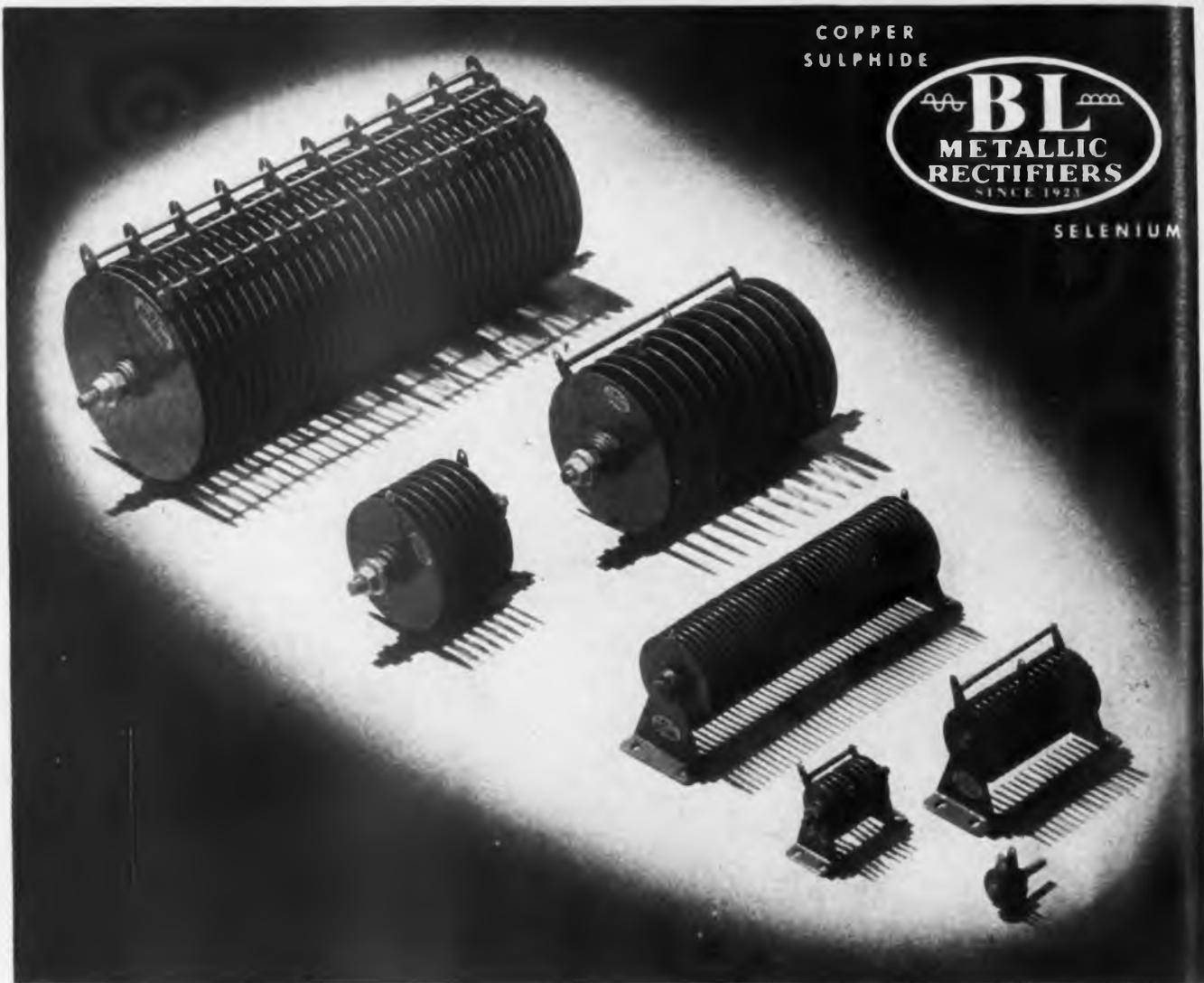
economical to produce. The sheet is heated to forming temperature (a matter of seconds). After heating, it is formed in an inexpensive wooden mold with standard press equipment. Practically any desired form or shape may be achieved. Forming takes place in a few minutes. There are no rough edges to be sanded—no flash to be removed. Fabrication may be done before or after forming.

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Johnson Radio Engineers have been specialists in insulator design for radio frequencies for almost a quarter of a century. Shapes to provide strength for strains and stresses—reinforced mounting holes and carefully designed mountings—high internal resistance to radio frequency voltage—long leakage path—careful treatment to present a surface that will not collect dirt and foreign matter—quality hardware, not punched nuts and poorly formed parts—materials selected for their radio frequency characteristics, not the "flower pot" variety of ceramics.

To Johnson Engineers an insulator is a piece of radio apparatus and given the same careful attention in design and production. As a result you can't buy a better insulator than Johnson. Send your next insulator problem to Johnson for recommendations and quotations. No obligation.

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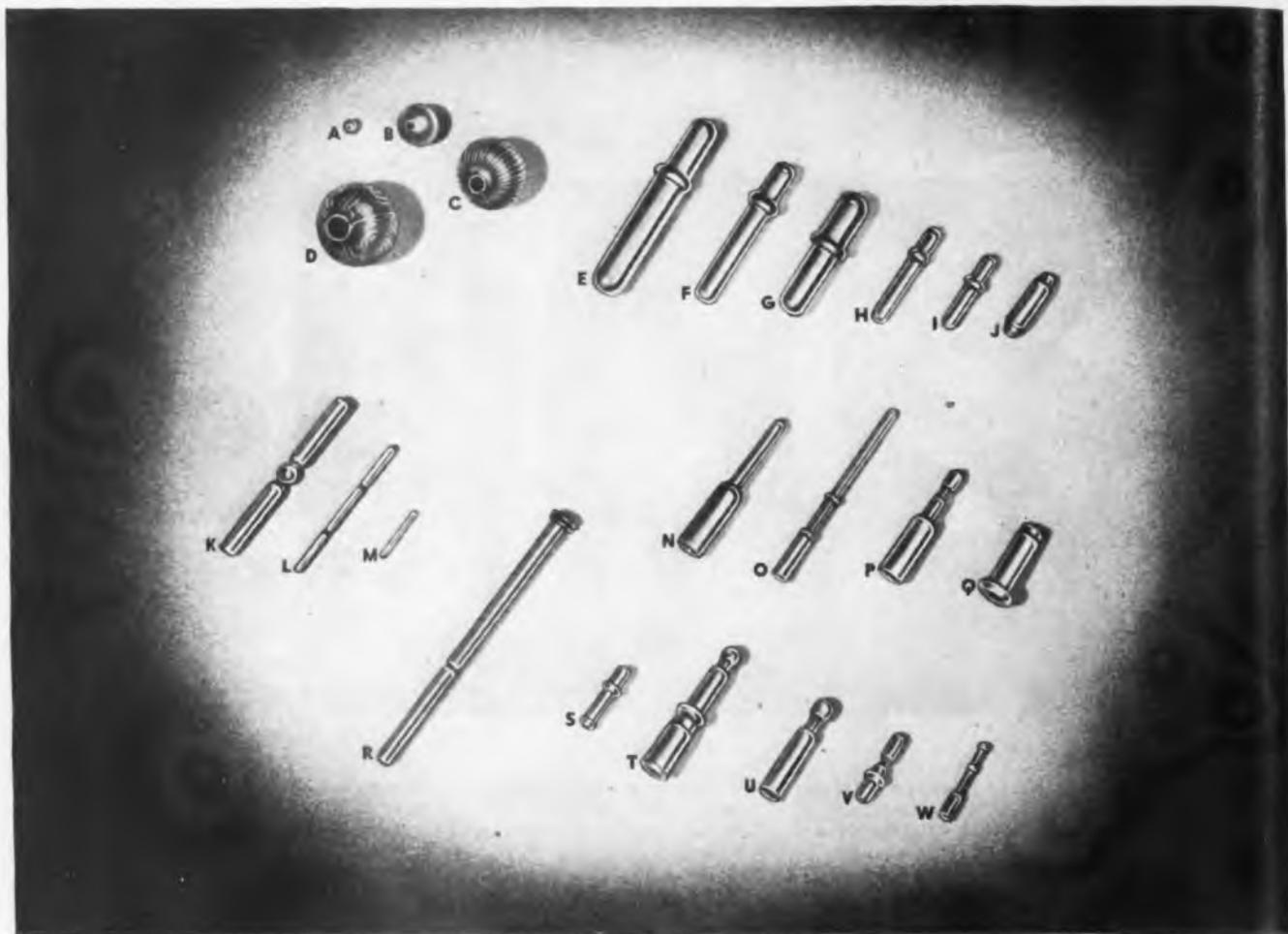
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THESE ITEMS, PICTURED ACTUAL SIZE, ARE TYPICAL MULTI-SWAGE PRODUCTS. THEY SHOW THE APPROXIMATE LIMITATIONS OF THE PROCESS AS TO DIAMETERS AND LENGTHS

MULTI-SWAGE is an advanced swaging process which forms hollow or solid parts from flat stock, seamless tubing, rod, or wire, without scrap. Tolerances are maintained accurately and most metals can be worked. Quantity is a factor to be considered. Because MULTI-SWAGE is a high speed process, 100,000 pieces on other than stock items are usually necessary to justify tool and setting up costs. Compare any small parts you use to those shown above. If the nature of the parts and the quantities indicate they can be made by MULTI-SWAGE, it can be well worth your while to consider the BEAD CHAIN MULTI-SWAGE PROCESS.

Send Samples and Specifications of Your Parts for Specific Information



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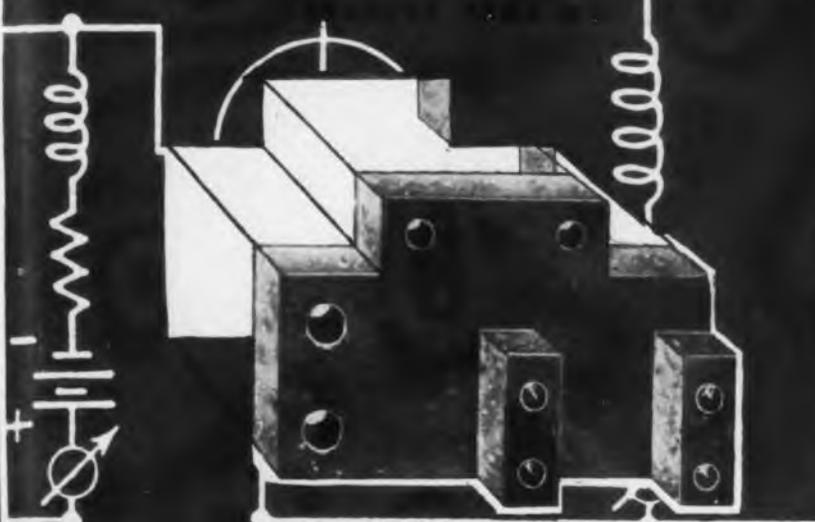
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102 MOUNTAIN GROVE STREET, BRIDGEPORT 5, CONNECTICUT

MYCALEX 400

The 'Last Word' in Low-Loss Insulation — Perfected after 25 years of Research Leadership



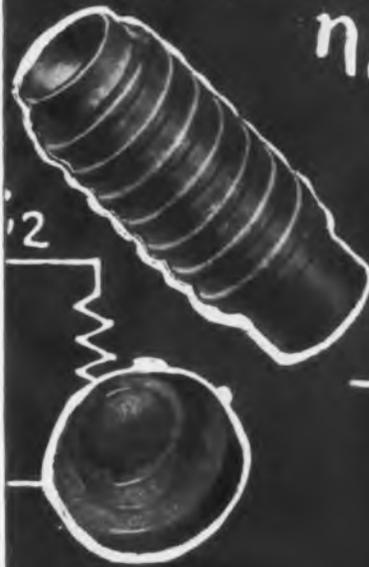
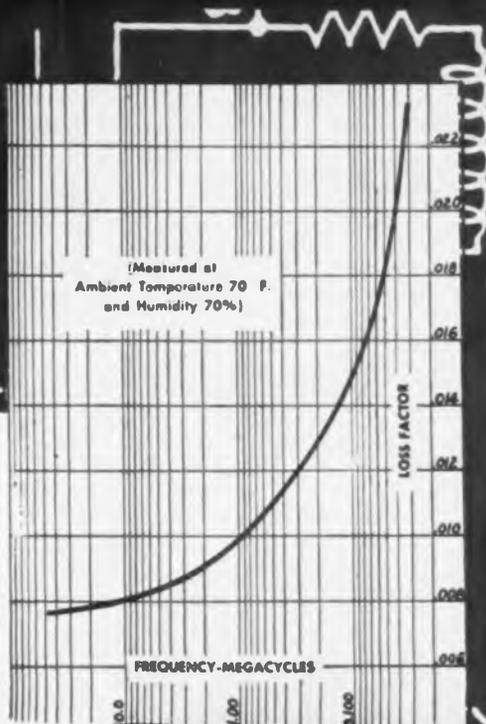
FITS PERFECTLY Into High Frequency Design

AT LAST designers of tomorrow's high frequency apparatus have an improved type of glass-bonded mica insulation to specify where new advancements in low-loss characteristics are desired, as in ultra high frequency applications.

Behind this new product is a history of 25 years of research leadership. Just as the original MYCALEX, developed by the MYCALEX (Parent) Company of Great Britain 25 years ago, was a vast improvement over other ceramics, so the new MYCALEX 400, developed exclusively by the MYCALEX Corporation of America, is a comparable advancement over all early forms of glass-bonded mica.

MYCALEX 400 meets government specifications for L-4 characteristics, by virtue of its pronounced low-loss factor of 0.013 at 1 megacycle. Its surface resistivity is 300,000 megohms. Its power factor is 0.0018 at 1 megacycle, in accordance with American War Standard C-75.1 — 1943 (Jan. 1-10). Its dielectric constant is unchanged from 50 kilocycles to 10 megacycles. MYCALEX 400 can be machined with greater precision . . . drilled, tapped, milled, sawed, turned and threaded.

Improved postwar h-f equipment deserves this newly refined and perfected electronic insulation. Let us supply your stock requirements in sheets and rods; or have us fabricate component parts to your specifications. Write for full details and samples.

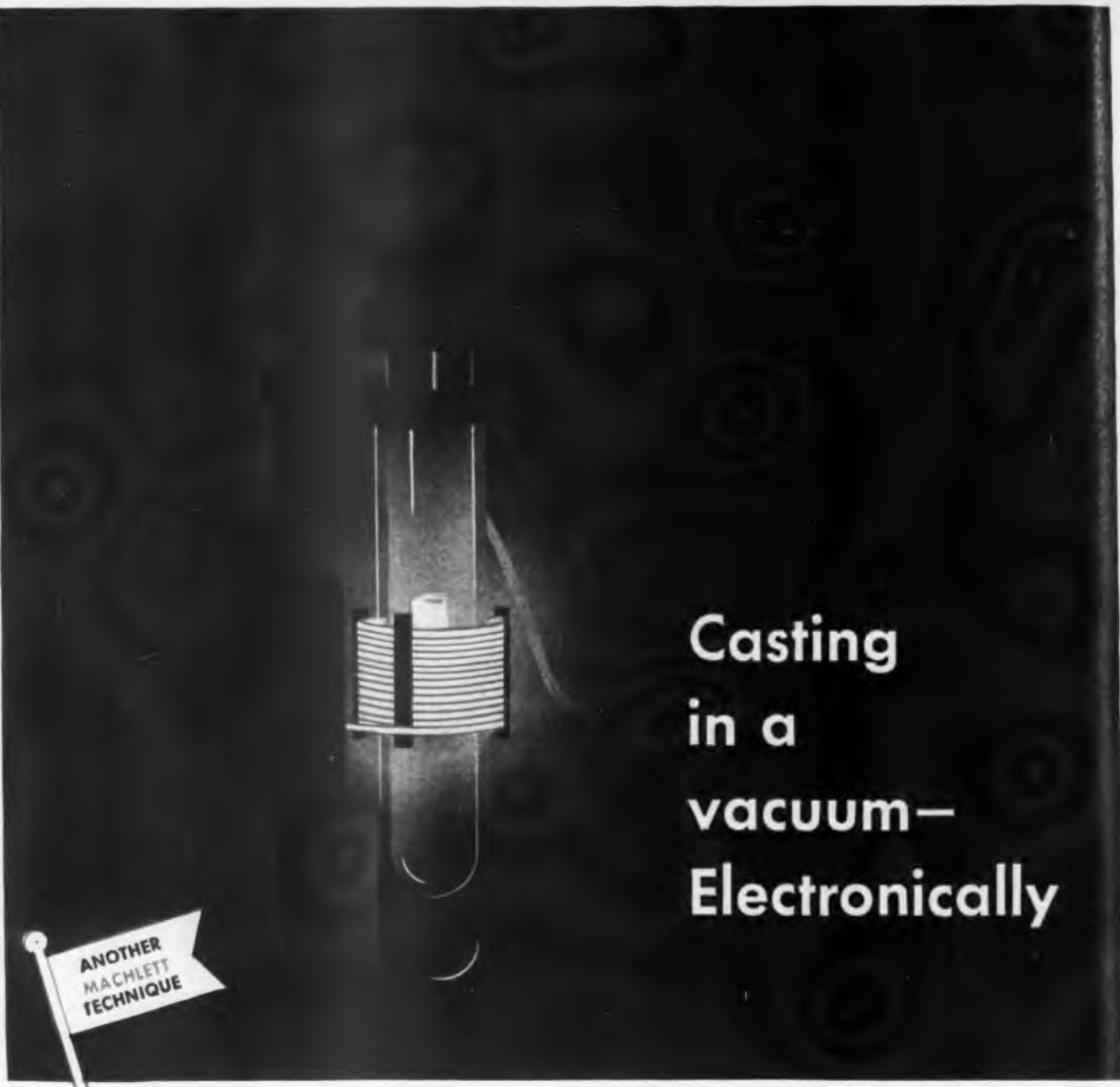


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Casting in a vacuum— Electronically

ANOTHER
MACHLETT
TECHNIQUE

One of the many vital processes that give Machlett vacuum tubes their remarkable quality is a novel method of casting electrodes in a vacuum. Complex parts of high-frequency oscillators, as well as X-ray tube anodes, are made by this unusual technique. Purified copper rod is placed over a mould in a graphite crucible, and the whole enclosed within a double-walled water-cooled quartz-silicon tube, which is encircled by a high-frequency coil. A vacuum of about 10^{-5} mm. of mercury is maintained.

When the current is turned on, the metal melts and flows into the mould. Cooling is precisely controlled by adjusting the position of the heating coil, so that crystals form longitudinally, for

maximum heat transfer under operating conditions.

This method accomplishes a number of things, quickly and simply. No gases can be occluded in the metal to shorten tube life by reducing the vacuum. Oxides cannot form. There are no "pipes" in a casting thus poured. Dimensions can be held to about $1/10,000$ th of an inch—and accurate dimensions are as important as metal purity in protecting transmitting tube performance, both assuring the maximum designed performance and long life. This is but one of our processes that assure radio tube quality . . . Machlett Laboratories, Inc., Springdale, Connecticut.

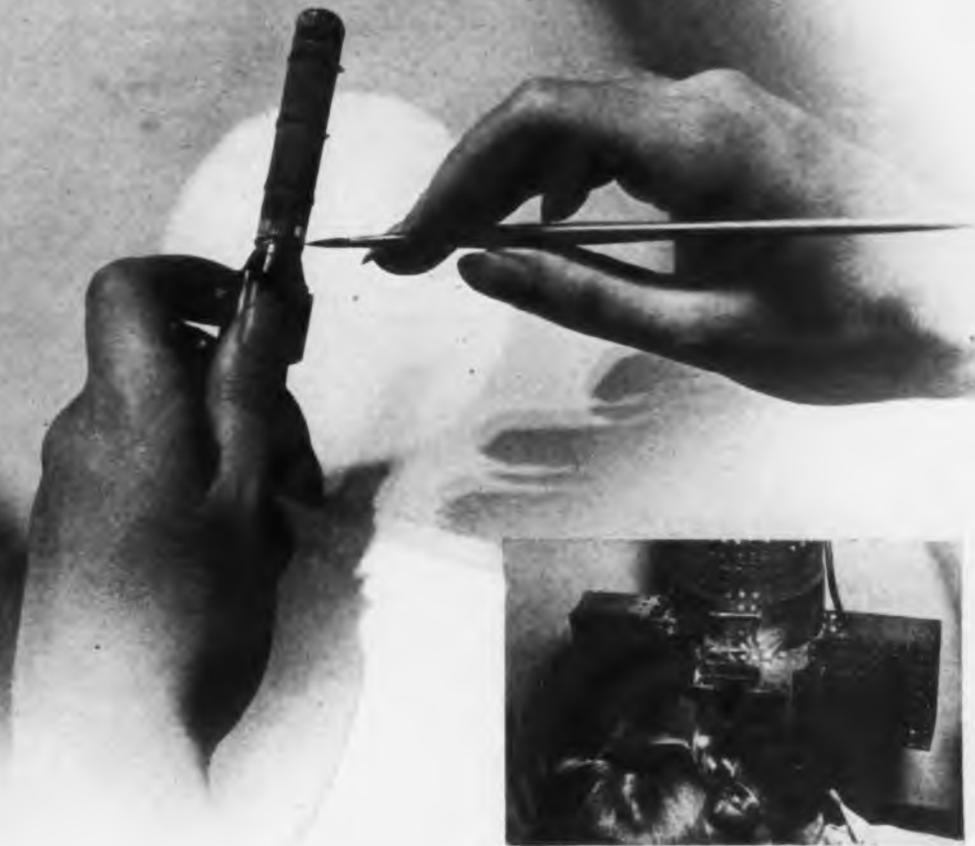


ML-846—An U. H. F. transmitting tube for television and F. M. and short wave broadcasting.



RAY TUBES SINCE 1898
TODAY THEIR LARGEST MAKER

welding with a paint brush?



Alloy flows easily and weld is quickly completed under arc.

To solve a difficult welding problem, Eimac laboratory technicians compounded a welding alloy that could be applied with a paint brush. The alloy flows easily under an arc to complete the weld, yet subsequent heating to temperatures as high as 2900 degrees Centigrade will not destroy the weld.

Such is but an example of the application of the Science of metallurgy in the "science behind the science of electronics." The extent to which Eimac Engineers went to solve this relatively small problem reveals two important facts:—(1.) The thoroughness of Eimac Engineering, and (2.) The completeness of their engineering facilities. The leadership which Eimac tubes enjoy throughout the world in all phases of electronics is attributable to the soundness of this engineering.

Performance of any electronic equipment is a direct reflection of the performance of its vacuum tubes. Hence it is advisable for users and prospective users of electronics to look first to the vacuum tube requirements. Because Eimac makes electron vacuum tubes exclusively their advice to you is unbiased and can be of great value. A note outlining your problem will bring such assistance without cost or obligation.

EIMAC-CULLOUGH, INC., 878 San Marco Ave., San Bruno, Calif.
 Plants located at: San Bruno, California and Salt Lake City, Utah
 Export Agents: **FRAZAR & HANSEN**,
 301 Clay St., San Francisco 11, California, U.S.A.

Write for your copy of *Electronic Tubes*—a 64 page book—fully illustrated—covering fundamentals of Electronics and many of its important applications. Written in layman's language.



Follow the leaders to
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INC. U.S. PAT. OFF.
TUBES

The Science Behind the Science of Electronics

is the focusing of all branches of science upon the development and improvement of electron vacuum tubes.



SPECTROGRAPH... Analysis determines exact characteristics of metals to be joined.



METALLURGY... Compounding special alloys of metals.



OPTICS... For studying the effects of processing.



ELECTRONICS... Welded elements in electron vacuum tubes withstand tremendous heat.

Sgt. Spring, M.E., E.E., MET.E., CH.E., etc.



WE'VE GOT HIM COVERED

From the Hunter Data Book have sprouted many ideas for spring-operated devices that are doing their bit to finish off the Axis. This handy fact-packed book is full of information you need at your desk or drawing board. For a free copy, send your signature on your business letterhead. It will be mailed promptly.

THERE was a time, very likely within your memory—when a spring was simply a curlicue of wire. You made it. If it didn't work, you gave it another twist and tried again. This cut-and-try approach was certainly not design—and hardly economical manufacture. But it had its day . . . and that day is over.

Now, to fit a spring precisely for the job it must do in your product . . . to make it an ambassador of the quality and per-

formance your customers expect from you, requires all the scientific knowledge a spring manufacturer can bring to bear.

The most naive-looking spring will often surrender only to the combined efforts of calculus, metallurgy and statistical control of quality. But in 99-44/100 percent of the problems, science wins out where rule-of-thumb would flop. The war has proved the case for scientific spring making. Future applications will rest on that proof.

THE BARREL SPRING—The barrel spring is a fundamental spring form, designed to resist, or store up until wanted, a compressive force, and to compact into the minimum solid height. One of many for-instance applications for barrel springs is shown in the Plexiglas model below.



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CERAMIC CAPACITORS

for HIGH VOLTAGE

These capacitors are engineered by Centralab for special applications . . . accumulative capacities ranging from 2MMF to 20MMF in zero temperature coefficient . . . to 4MMF to 40MMF in maximum negative (N750 PPM) temperature coefficient.

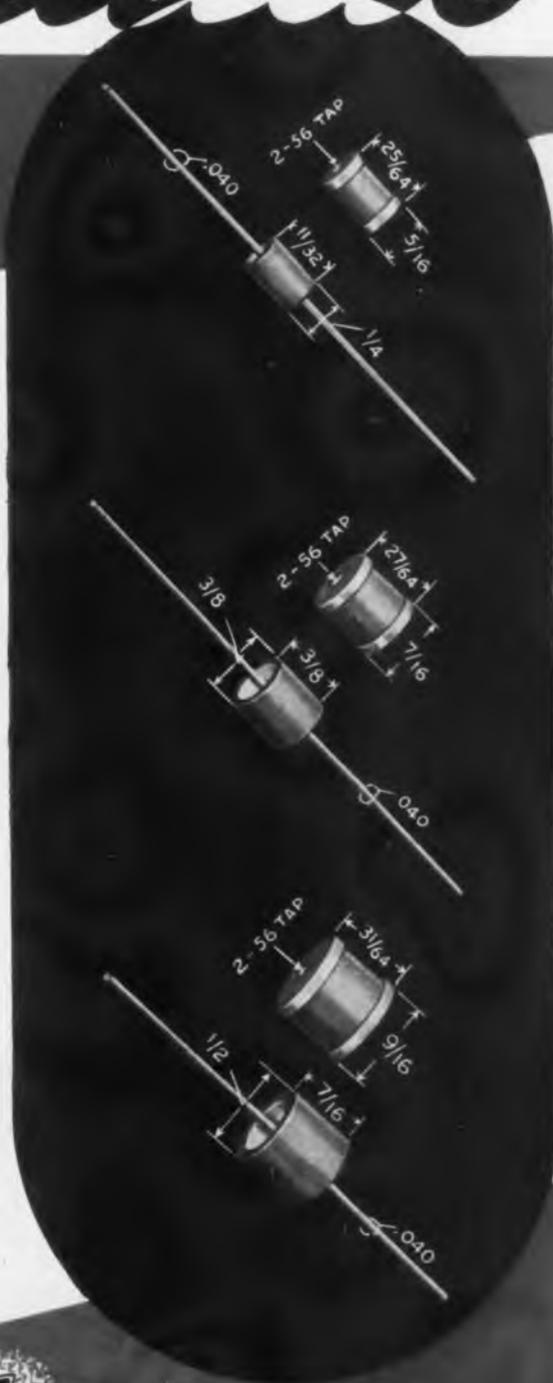
Individually the capacity ranges are as follows:

- 855 2MMF to 5MMF in zero T. C.
4MMF to 10MMF in N750
- 854 5MMF to 10MMF in zero T. C.
10MMF to 20MMF in N750
- 853 10MMF to 20MMF in zero T. C.
20MMF to 40MMF in N750

Working voltages from 8,000 to 10,000 D.C. Energy dissipation up to 2 KVA with 15°C rise.

End lead or axial screw terminals available.

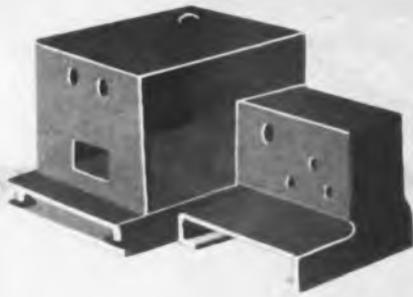
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Producers of Variable Resistors • Selector Switches
• Ceramic Capacitors, Fixed • Variable • Steatite Insulators.

Centralab

Division of GLOBE-UNION INC., Milwaukee



SHEET METAL FABRICATION

Long before the war, "Cole Steel Equipment" had earned its reputation for quality. Tough assignments are part of our everyday job... instrument housings... boxes... and chassis. If your blueprints call for close tolerance sheet metal fabrication, send us your specifications.

Send for our Brochure

"The Plant Behind Your Plant"

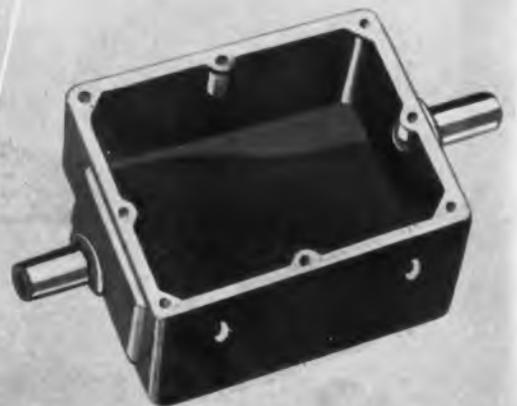
COLE

STEEL EQUIPMENT CO.

349 Broadway, New York 13, N. Y.

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**COLE STEEL
OFFICE EQUIPMENT**
will again be available
after the war



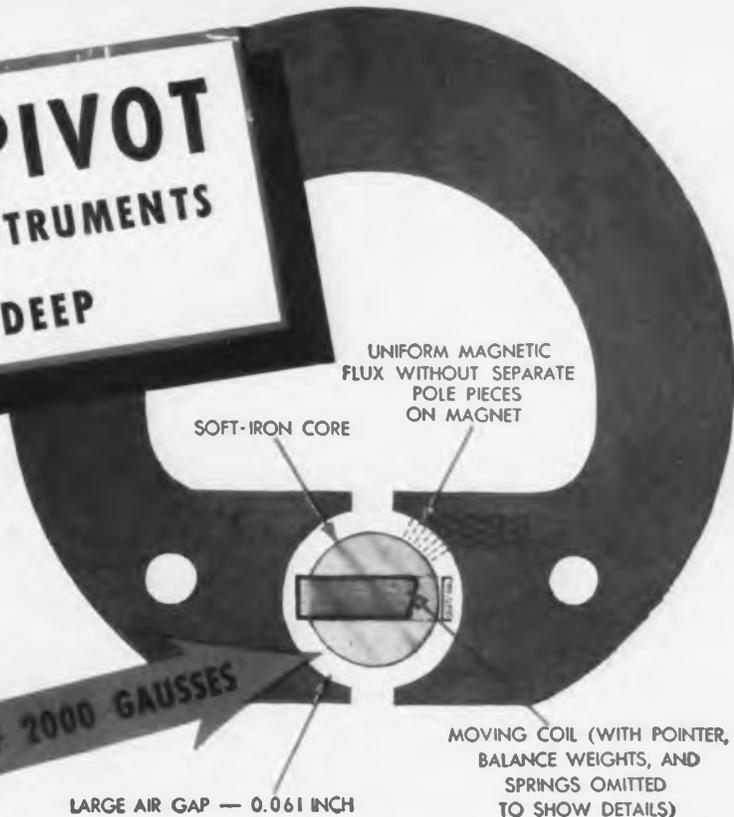
New INTERNAL-PIVOT 2 1/2-INCH PANEL INSTRUMENTS ... 1 INCH DEEP



Moving element mounted on one-piece comol magnet

Designed for thinness—but G-E engineers took advantage of the new magnetic materials to improve performance and add unusual values. Comol was selected for the magnet, and it thus became the basic part around which the internal-pivot element was designed.

FLUX DENSITY OF 2000 GAUSSSES



Extra Values That the Comol Magnet Gives You

AN air-gap flux density of approximately 2000 gaussses—made possible by the comol magnet—means a magnetic field some 50 per cent stronger than that of the conventional chrome-steel magnet.

Higher Torque This greater magnetic strength provides a substantial increase in torque. Since the weight of the moving element is about the same as that of other designs, the torque-to-weight ratio is much higher.

Faster Response The greater flux density also allows the use of a larger air gap, which minimizes any tendency toward stickiness. Faster response, which is assured by the high torque and lightweight moving system, enables accurate readings to be taken more quickly.

Improved Performance Large-radius pivots and good damping are among the other good features in the internal-pivot design—a design that packs all-round fine performance in a small space. They all add up to an instrument that is well able to withstand abnormal vibration and shock and maintain its rated accuracy.

For complete information, ask our nearest office for Bulletin GEA-4064, which covers instruments for use in radio and communications equipment; or Bulletin GEA-4117, which describes those suitable for naval aircraft. *General Electric Company, Schenectady 5, N. Y.*

Buy all the BONDS you can—and keep all you buy

GENERAL  ELECTRIC

102-18-4202



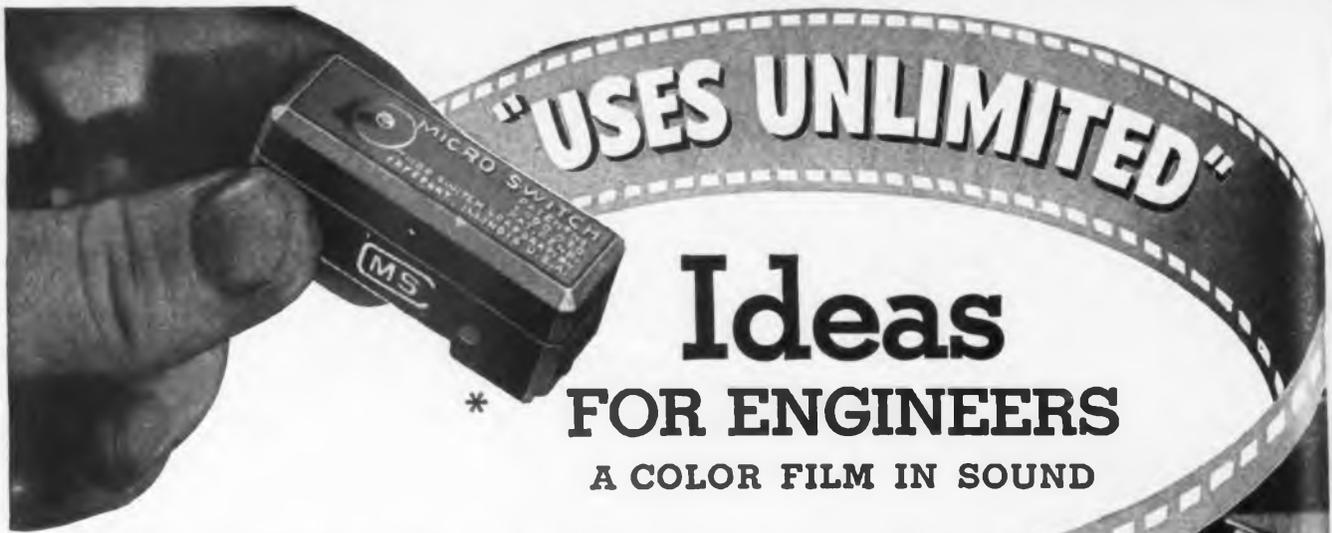
Type DW-53 d-c voltmeters, ammeters, and volt-ammeters. Designed to measure voltage and current in battery and battery-charging circuits on naval aircraft. Designed to meet all applicable Navy specifications.



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

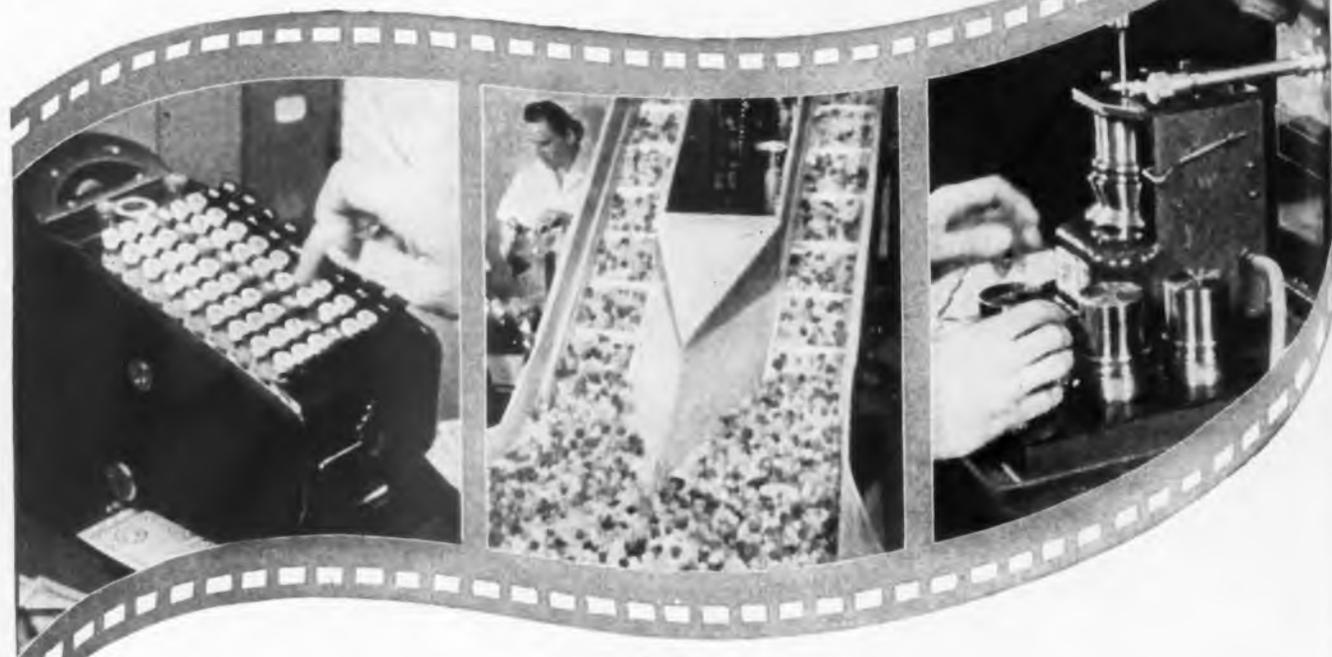


HEADQUARTERS FOR
ELECTRICAL MEASUREMENT



Ideas FOR ENGINEERS

A COLOR FILM IN SOUND



The fast-moving action, interesting color, and concise description in "Uses Unlimited" show how Micro Switches are made, and how they are being used by production and design engineers throughout industry to control everything from sensitive, precise instruments and office equipment to heavy duty machinery. This film is packed with examples of tried and proven applications of Micro Switches. It will stimulate the thinking of your engineers by showing them how

others have solved electrical control problems by the use of Micro Switches.

"Uses Unlimited" is available to industrial groups, technical societies, training classes, schools and colleges. Size: 16 mm. Length: 40 minutes.

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- The basic Micro Switch is a thumb-size, feather-light, plastic enclosed, precision snap-action 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. Wide variety of basic switches and actuators meets requirements varying from high vibration resistance to sensitivity of operating force and motion as low as 2/1000 ounce-inches. Many types of metal housings are available.

MICRO MARK **MS SWITCH**
TRADE

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

pioneer for tomorrow

The world of tomorrow will be one of electronics. Pioneer for that world is the electronic engineer. His vitally important effort during this wartime period in devising electronic equipment is helping to defeat the enemy. Tomorrow, he devotes his specialized scientific knowledge to aid peacetime industries.

Raytheon is applying its efforts to the development of advanced electronic tubes and equipment for the war effort. When that job is done, the knowledge that has been gained will be used to guarantee that post-war radio, industrial and electronic equipment manufacturers will receive Raytheon tubes and equipment with even greater "Plus-Extra" quality.



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Awarded All Four Divisions of Raytheon for Continued Excellence in Production

RAYTHEON

Raytheon Manufacturing Company
ELECTRICAL EQUIPMENT DIVISION
Waltham and Newton, Massachusetts

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

WAR BABY?

...not by a long shot!

CORRY-JAMESTOWN'S basic business has always been the creation of "Steel-Age" Office Furniture. With the war we started to work for the electronics industry, making transformer housings, shelf assemblies, panels, cabinets, and related equipment.

Maybe you could call it a WAR BABY—but, when Peace comes, this baby is here to stay. It has grown up. A great many leaders in electronics have found that we do good, accurate, quality work that meets the most rigid specifications.

They'd like to continue to do business with us and, so far as Corry-Jamestown is concerned, the feeling is mutual.

We invite you to send us your specifications today and in the postwar tomorrow—because we're setting our sights to produce both office furniture and electronic equipment of the very finest kind.



Steel Age

CORRY - JAMESTOWN

MANUFACTURING CORPORATION ★ CORRY, PENNA.



MEETING THE HIGHEST INDUSTRIAL STANDARDS

Nationally recognized engineering talent . . . sharpened by intelligent specialization . . . broadened by the exacting tests of war . . . explains, in part, PLASTIC'S amazing progress in the field of thermoplastic insulation. Also responsible are latest equipment, careful materials control, and a personnel whose loyalty and devotion is "above and beyond the call of duty." You can utilize to advantage . . . in today's planning and tomorrow's production . . . this experience and ability. Available for the asking is the "know how" which can make your product a BETTER product. You can **DEPEND** on PLASTIC for design . . . development . . . delivery.

PLASTIC
WIRE & CABLE
CORPORATION

NORWICH • CONNECTICUT

L. W. LORD, Pres. M. H. PHILLIPS, Vice Pres. and Treas. A. O. BLADEN, Plant Manager

HOW TO MAKE PERMANENT ELECTRICAL CONNECTIONS

permanent



INSERT

STRIPPED CONDUCTOR INTO
HYDENT CONNECTOR BARREL



INDENT

CONNECTOR TO WIRE
WITH BURNDY WYTOOL



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

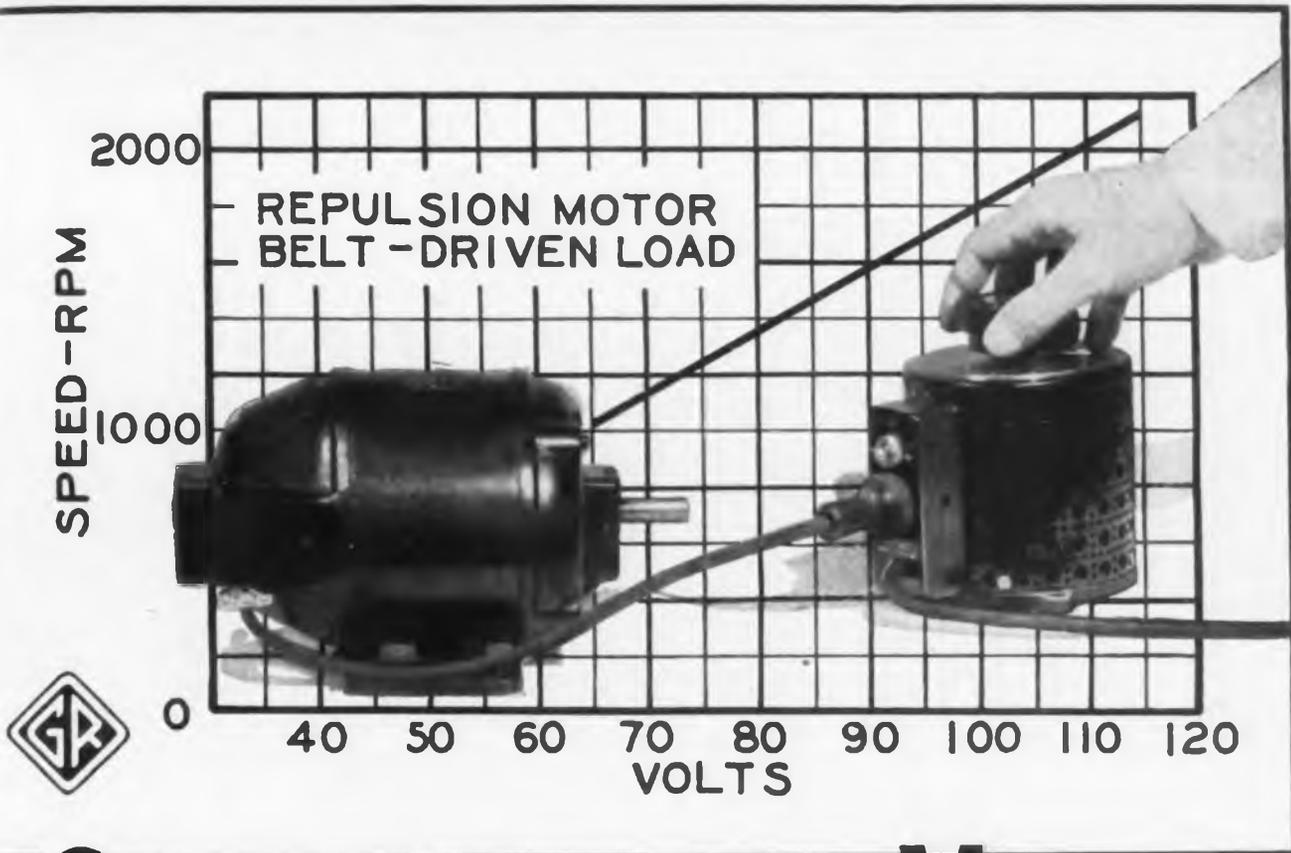
Burndy

BURNDY ENGINEERING CO., INC.
107 BRUCKNER BOULEVARD, NEW YORK 54, N. Y.

IN CANADA: Canadian Line Materials, Ltd., Toronto 13



Patent No. 2,109,837.
Listed by Underwriters'
Laboratories, Inc.



SPEED CONTROL — WITH VARIACS

VARIAC continuously adjustable auto-transformers are widely used to control the speed of fractional horsepower motors. They provide exceptionally smooth control with very low power losses. These types of control, however, cannot be used successfully with all a-c motors; both the type of the motor and the type of load determine whether the variable auto-transformer can be used.

For example, repulsion and series motors can be controlled over a wide range of speeds; induction motors do not lend themselves to voltage control, except with a fan-type load where the effective load varies greatly with speed.

The split-phase motor with automatic cut-out cannot be controlled successfully. Repulsion-start induction motors can be controlled only during the time that the repulsion-start system is cut in, and if the winding is designed for continuous duty.

Variacs are incorporated in so many motor-operated devices that many manufacturers now consider the adaptability of this control when choosing or designing the motor to be used.

A detailed discussion of Variac motor speed control appears in a recent issue of the G-R EXPERIMENTER. May we send you a copy?

VARIAC

VARIACS are available (with suitable priority rating) in power ratings between 170 va and 7,000 va; prices are \$10.00 to \$100.00.

• **WRITE FOR BULLETIN 893**



GENERAL RADIO COMPANY

Cambridge 39, Mass.

NEW YORK
CHICAGO
LOS ANGELES

MADE ONLY BY

Many "missions" are aided to completion by technicians in the N-Y-T Sample Dept.

Whether the mission is accomplished by the Army, Navy or Air Forces—or is in itself a production job of Industry—the result attained, in all probability, had the backing of the N-Y-T Sample Department's engineering staff.

These electronic technicians are supplying a vital part of the custom-designed, specially-built transformers for leading suppliers of electrically controlled or operated apparatus and equipment. Applications covering communications, fire control, mechanisms, locating and directional devices, lighting systems, detecting, navigation, meteorology, photo-electric units, and a host of other equally imperative phases of the war effort, are included in the Victory-function roster.

Missions will not terminate when hostilities cease. The myriad of peace-time problems will be unending . . . and will be accomplished by N-Y-T with the same zeal and thoroughness.



One of the many efficient power transformer designs that can be supplied in almost any voltage, frequency and power rating with mountings as required



A diminutive audio component that incorporates unusual characteristics for such a compact unit. A typical example of N-Y-T resourcefulness.



This 30 V.A. power transformer features a 40% weight reduction over previous designs. Temp. rise 30° C. Ambient — 65° C to + 70° C. Weight 8 ounces!



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22-26 WAVERLY PLACE, NEW YORK, N. Y.



Instantaneous Panoramic Presentation of Conditions!

ELECTRONIC METERING for PRODUCTION TESTING

SHERRON TEST UNITS



The Use of Cathode Ray
Tubes in Modern Test
Equipment Offers 5 Defi-
nite Advantages.

- ➔ 1. Faster — Surer Testing
- ➔ 2. Greater Flexibility
- ➔ 3. Greater Range
- ➔ 4. Greater Sensitivity
- ➔ 5. Reduction of Human Error

**Sherron
Electronics**

This type of equipment is designed, developed and manufac-
tured by Sherron to meet the given customer's specifications.

*"Where the Ideal is the Standard,
Sherron Test Units are Standard Equipment.*

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1201 Flushing Ave. Brooklyn 6, N. Y.

For mobile two-way
communication specify
KAAR RADIOTELEPHONES



KAAR PTL-10X TRANSMITTER
10 WATTS • 1600-2900 KC*

The PTL-10X is a highly efficient medium-frequency mobile transmitter. It provides communication from a moving vehicle over distances ranging from 50 to 75 miles when used with AUTO-LOAD self-loading antenna.

The "Push-to-Talk" button on the microphone completely controls the transmitter, lighting the instant heating tubes, starting the power supply, automatically silencing the receiver, and switching the antenna to the transmitter. The standby current is zero.

Models for special applications are available, including the PTL-22X medium frequency transmitter with 22 watts output, and the PTS-22X, a 22 watt transmitter for operation in the 30-40 MC band.

◀ **KAAR AUTO-LOAD ANTENNA**

This antenna, with matching coil in the base, is designed for use with the PTL-10X (or with similar medium frequency transmitting equipment) and matches the 72 ohm transmission line from the transmitter and receiver without auxiliary tuning equipment. It provides an efficient method of obtaining maximum signal strength at medium frequencies with a short antenna. It can be quickly installed on the rear bumper or on the side of any vehicle.

**Special ranges to 7000 KC available on special order*



KAAR 11X RECEIVER
6 TUBES • 1600-2900 KC*

The popular 11X receiver is a crystal controlled superheterodyne for mounting in an automobile or other vehicle. It contains a no-signal squelch circuit, and is designed for commercial, civil, and military applications.

This receiver offers remarkable accessibility. The top is removed by simply pushing aside two snap catches, or the entire receiver can be whisked out of the vehicle by releasing only four catches.

KAAR

ENGINEERING CO.
PALO ALTO, CALIFORNIA

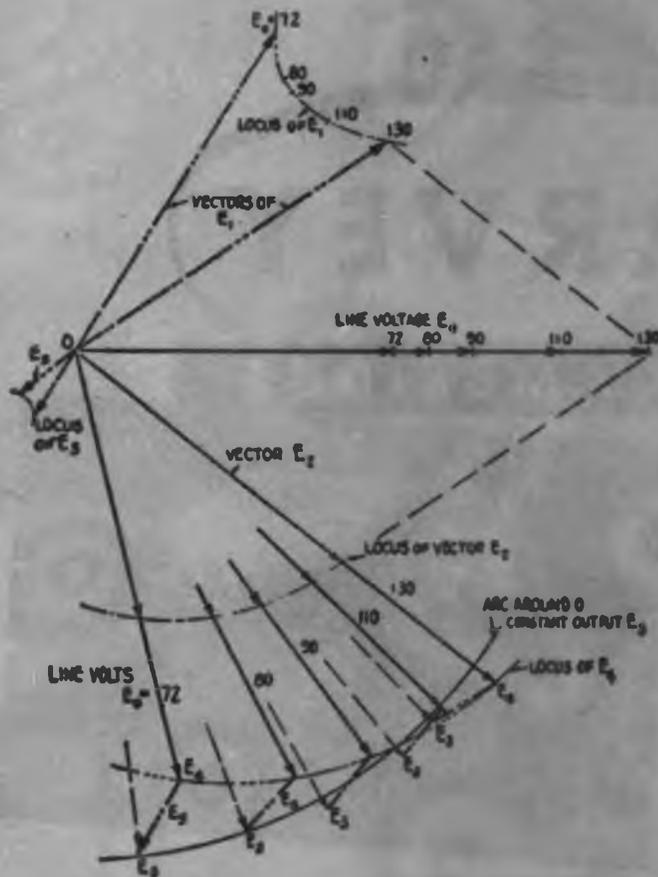


Manufacturers of high grade mobile and central station **RADIOTELEPHONE EQUIPMENT • POWER PACKS • CRYSTALS • VARIABLE CONDENSERS MICROPHONES • AUTO-LOAD ANTENNAS**

Export Agents: **FRAZAR & HANSEN, 301 Clay St. San Francisco 11, California, U. S. A.**

Raytheon Voltage Stabilizers

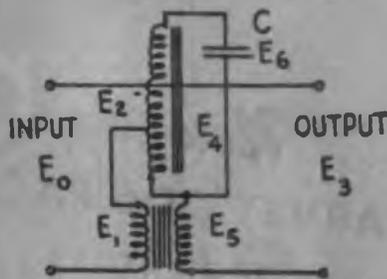
CONTROL Output Voltage to $\pm 1/2\%$



VECTOR RELATIONS FOR FULL LOAD AND VARIABLE LINE VOLTAGE



Endbell Model



PRINCIPLES OF OPERATION

The stabilizer consists of two transformers with the primaries in series. One of these transformers operates at high magnetic density. This transformer with the higher saturation is partially resonated by means of a condenser. The secondary of the two transformers are connected in series opposed. Careful design results in the various voltages adding up vectorially producing the desired output changes compensating for differences of individual voltages. The resultant is a constant output voltage. This action is illustrated above

in the chart of vector relations of voltage.

A Raytheon Voltage Stabilizer . . . built into new equipment or incorporated into apparatus not having voltage regulation . . . improves the performance and assures reliable, accurate operation of the equipment. It stabilizes varying line voltages from 95 to 130 volts to plus or minus $1/2\%$. Entirely automatic in operation, the Raytheon Voltage Stabilizer has no moving parts, nothing to wear out. Simply connect it and forget it. Write for Bulletin DL48-537.



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MANUFACTURING COMPANY
 190 WILLOW STREET, WALTHAM, MASS.

MANUFACTURERS OF VOLTAGE STABILIZERS, RECEIVING AND TRANSMITTING TUBES AND COMPLETE ELECTRONIC EQUIPMENT

The coveted Army-Navy "E", for Excellence in the manufacture of war equipment and tubes. Dies over all four Raytheon Plants where over 15,000 men and women are producing for VICTORY.



HARVEY 106 PA
200 to 300 VOLTS

HARVEY

OF CAMBRIDGE

New
HARVEY 206 PA
500 to 1000 VOLTS



for **REGULATED POWER SUPPLY**

If you're looking for a dependable, controllable source of laboratory D. C. power for operation with pulse generators, measurement equipment, constant frequency oscillators, amplifiers and other equipment requiring a constant flow of D. C. voltage, it will pay you to get in touch with Harvey of Cambridge.

The Harvey Regulated Power Supply 106 PA will meet your every requirement in the lower voltages. It has a D.C. output variable from between 200 to 300 volts that is regulated to within one per cent.

The new Harvey Regulated Power Supply 206 PA is for higher voltages. This latest Harvey development operates in two ranges 500-700 at $\frac{1}{4}$ of an ampere and 700 to 1000 at .2 of an ampere. Both ranges have accurate regulation to one per cent or better.

Whatever your requirements, one of these Harvey Regulated Power Supply units will meet them with efficient, dependable performance.

We'd be happy to supply you with complete information on either or both of them.



HARVEY RADIO LABORATORIES, INC.
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1934

1935

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Year after year Presto has supplied more discs to broadcasting stations than any other single manufacturer.

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IT'S DECIDEDLY WORTH WHILE TO RECHECK
DIELECTRIC SPECIFICATIONS AGAINST THE
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ACADIA

POLYSTYRENE

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SHEETS
MOLDED AND
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SHAPES

WRITE TODAY for data sheet
giving physical properties of
Acadia Polystyrene, with table
of specifications on electrical
properties.

Another Acadia Plastic — Styraloy*
combines the low temperature flexibility of rubber
and electrical properties approaching those of
Polystyrene, and is ideal for numerous electrical
applications. Full information on forms available
to date and physical and electrical properties may
be had on request.

*Licensee of Dow Chemical Co.

★ The combination of highly desirable electrical properties found in Acadia Polystyrene recommend this material for a wide variety of applications. It possesses an excellent dielectric constant value. Its dielectric strength and power factor compare favorably with the electrical quality of ceramics and mica and are superior to any other commercial plastic. Moisture absorption is zero. These and other wanted properties—plus Acadia's wide experience with plastics—suggest an immediate investigation of Acadia Polystyrene. Some values are given below. Complete data are available on request.

Dielectric Constant.....	2.5 to 2.6
Power Factor, 60 cycles.....	.0001 to .0003
10 ³ cycles.....	.0001 to .0003
10 ⁶ cycles.....	.0001 to .0008
Dielectric Strength, Volts/Mil 1/4" thickness..	Short time 500 to 700 Step by Step 450 to 600
Volume Resistivity, ohms-cms.....	10 ¹⁷ to 10 ¹⁹
Heat Resistance.....	105°F Continuous
Softening Point.....	190°F to 250°F
Specific Gravity.....	1.05

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Processors of Synthetic Rubber
and Plastics • Sheets
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Synthetic PRODUCTS

OHMITE EXPERIENCE

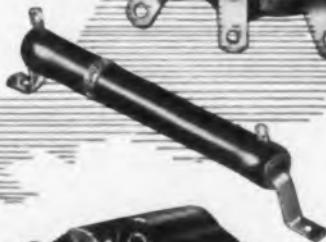
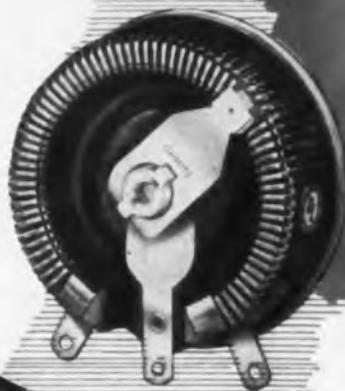
in all types of
Current Control Applications

**Brings
Time-Proved
Benefits**

**1 The Right Rheostat, Resistor,
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**2 Consistently Accurate,
Dependable Control**

**3 Long-Service Economy
Under Varied Conditions**



What better assurance of these important benefits than the record itself! . . . The record of Ohmite experience in pioneering new rheostat, resistor and tap switch developments—in producing the widest range of types and sizes—in meeting the varied requirements of innumerable applications with high quality units that have proved their reliability and long-service economy.

In designing for war or postwar . . . remember Ohmite experience. Consult our engineers on your control problems.

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Foremost Manufacturers of Power Rheostats, Resistors, Tap Switches

Write on company letterhead for Industrial Catalog and Engineering Manual No. 40. Gives complete, helpful data and information. Address Ohmite Manufacturing Co., 4818 Flournoy St., Chicago 44, Illinois.

Be Right with **OHMITE**
RHEOSTATS • RESISTORS • TAP SWITCHES



Insulation between open contacts, 20,000 volts peak R. F. or A. C. Contacts break 4 amperes. With suitable coil, requires approximately 4 watts actuating power. Contact D. C. resistance less than 0.05 ohms in either open or closed position.

I C E
VACUUM RELAYS
are Rugged and
Versatile . . . Give you Reliable
Operation and Long Life

Excellence of construction means this I. C. E. Relay has the strength to resist vibration, shock and exposure . . . resulting in reliable operation and long life. Versatility means that it can be used to do a score of different jobs for you. And of course . . . I. C. E. *precision engineering* is your assurance of correct adjustment to close tolerances. Large quantities of these I. C. E. vacuum relays are proving themselves on battlegrounds all over the world. We can give immediate delivery, in quantity, of these fine relays . . . your inquiries are invited.



INDUSTRIAL & COMMERCIAL ELECTRONICS
BELMONT, CALIFORNIA

Life Testing ON THE GRAND SCALE!



One of the most elaborate cathode-ray tube test racks in this country operates day and night, seven days a week at National Union. For, at N. U., cathode ray tube production

is now reaching heights undreamed of in pre-war days. To achieve this production, entirely new testing techniques, on an unprecedented scale, have been developed.

Examples of the newest tried and proven N. U. products are the four cathode-ray tubes illustrated. All of these N. U. cathode ray tubes

can be produced in a variety of screen materials, which will have various postwar applications in television and industrial electronics.

Here at National Union are many such ultra-modern products ready to serve your peacetime needs. Ready, yes, in large volume—and backed by as fine an electronic tube research service as has ever been available to industry. Ready, indeed, from the day our present obligations are fulfilled and reconversion can get under way. Count on National Union.

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

NATIONAL UNION

RADIO AND ELECTRONIC TUBES

Screening Tubes • Cathode Ray Tubes • Special Purpose Tubes • Control Tubes • Full-Wave Rectifier Tubes • Photo Cathode Cells • Power Tubes • Floodlight Bulbs



◀ STANDARD TYPE RECEIVING TUBES

◀ SYLVANIA "LOCK-IN" RECEIVING TUBES



◀ TRANSMITTING TUBES

◀ FACSIMILE RECORDING TUBES



▲ MINIATURE RADIO RECEIVING TUBES

◀ CATHODE RAY TUBES

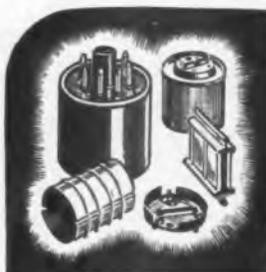


▶ GAS VOLTAGE REGULATOR TUBES
MINIATURE AND STANDARD SIZE



◀ THERMOCOUPLE TUBES

NEED ELECTRON TUBES?



▲ RADIO TUBE PARTS

▼ PIRANI TUBES



▶ STROBOTRONS



DID you know that Sylvania is now making an ever-increasing variety of electron tubes for war uses? What is more, Sylvania now has the experience and facilities to produce even more of these vital components to your specifications after the war. If you have an electron tube problem, bring it to Sylvania. Our engineers will assist you in finding a practical solution. For information, write to Sylvania Electric Products Inc., 500 Fifth Avenue, New York 18, N. Y.

One Standard—the Highest Anywhere Known



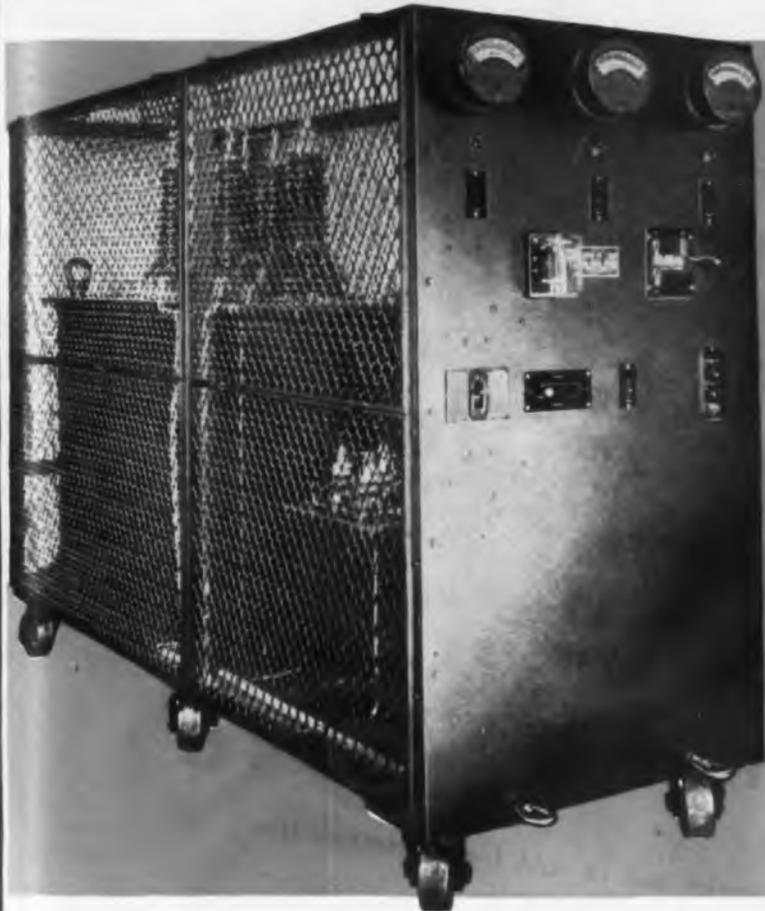
SYLVANIA



ELECTRIC PRODUCTS INC.

500 FIFTH AVENUE, NEW YORK 18, N. Y.

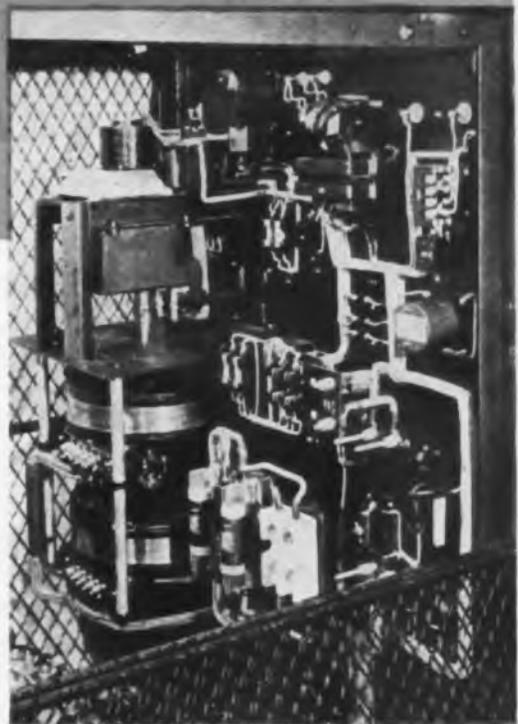
AMERTRAN HIGH VOLTAGE TEST SETS



Retain Calibration
Reduce Manual
and
Visual Errors

Improved reliability of AmerTran High Voltage Test Sets is readily apparent under operating conditions. Recalibrating intervals are usually lengthened—a substantial time saving that results from combining precision and sturdiness to an unusual degree. This sustained accuracy wins operator confidence, as do the positive acting, easily manipulated controls and quickly read dials. Built-in safeguards protect both operator and equipment. An important advantage is their versatility—multiple secondaries allow quick output range adjustments within which Transtat Regulators provide close control in small voltage increments.

Comprising many models, AmerTran High Voltage Test Sets have ample facilities for all kinds of dielectric and general testing involving voltage application of any required duration. Into each unit goes the same craftsmanship that has made AmerTran the standard for electrical testing in leading industries, utilities and universities since 1901. Write for complete details.



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of Transformers, Reactors
and Rectifiers for Electronics
and Power Transmission

AMERTRAN



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MOISTURE

the enemy of radio insulators

CAN'T PENETRATE STEATITE

Moisture in hot steaming jungles and in cold foggy climates is a life-shortening enemy of radio equipment.

Steatite is absolutely impervious to moisture. The American Society of Testing Materials porosity test (Steatite placed in a chamber with fuchsine dye under five tons of pressure for six hours) has proved that General Ceramics and Steatite insulators are not porous and therefore do not absorb moisture.

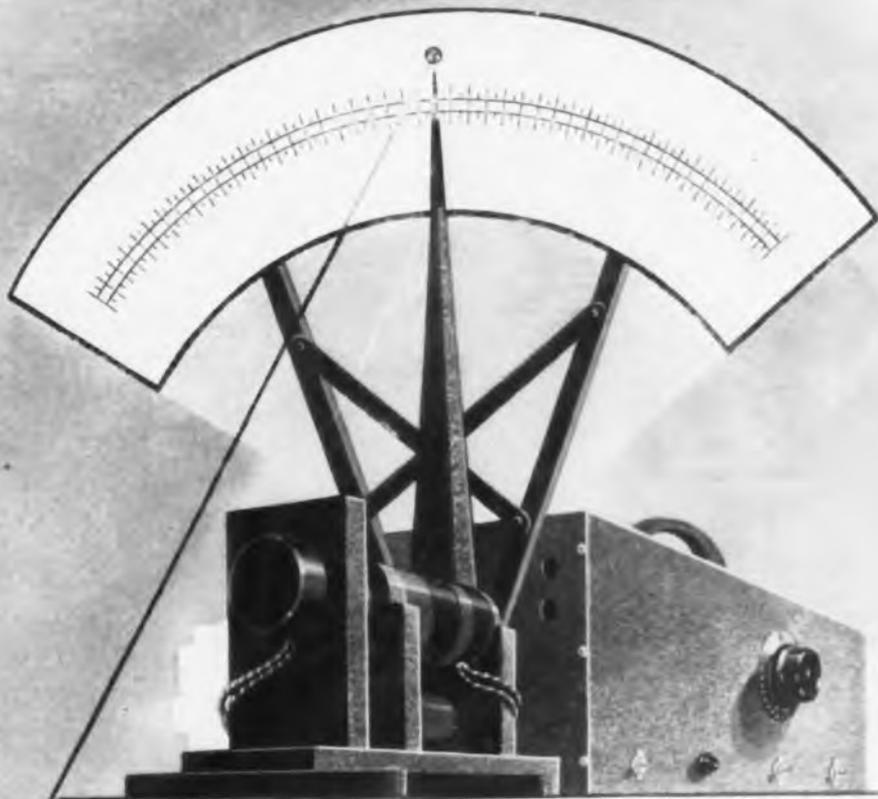
The low loss factor, the high physical strength, the stability of shape of Steatite is not affected by age or climatic changes. For a long trouble-free life of your equipment specify Steatite

Insulators made by
General Ceramics &
Steatite Corporation.



General Ceramics
AND STEATITE CORP.

GENERAL
NEW JERSEY



measuring mighty muscles of midget motors

● The might of this midget motor is no secret to this special dynamometer used in the Utah laboratory. It accurately measures the horsepower; actually pre-determines the successful performance of this Utah motor in its many vital functions in actual use.

Utah's complete testing service is

playing an important part in the war effort today, and is scheduled for an equally important role tomorrow . . . in adapting war-born electronic and radio developments to commercial and consumer needs. ★ ★ ★

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

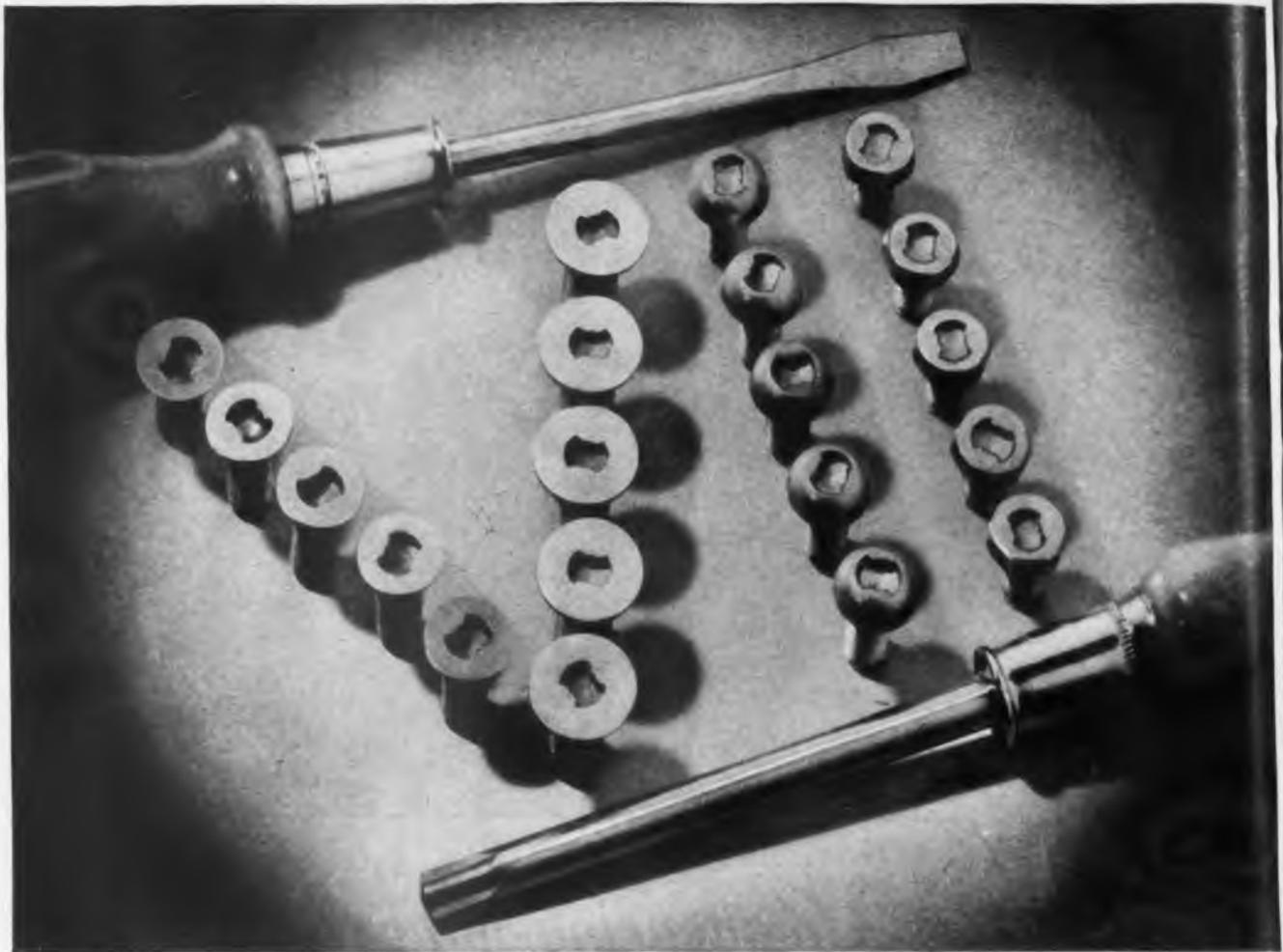


Keyed to "tomorrow's" demands: Utah transformers, speakers, vibrators, vitreous enamel resistors, wirewound controls, plugs, jacks, switches and small electric motors.

utah



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Seven Major Features

have established
CLUTCH HEAD as
the most modern

screw on the market . . . for safer, speedier production and lower final cost.

- I** The wide roomy Clutch, an easy-to-hit target, inviting operator confidence and speed.
- II** Center Pivot entry to prevent canting; deep positive engagement for protection against slippage . . . safeguarding manpower and materials.
- III** No end pressure. The straight-walled Clutch matched by straight-sided driver disposes of "ride-out" tendency as set up by "tapered" drive home.
- IV** CLUTCH HEAD's exclusive Lock-On unites screw and bit as a unit . . . substituting easy one-handed reaching for fumbling with mechanical fingers.
- V** The rugged Type "A" Bit delivers a longer uninterrupted spell of service . . . and may be repeatedly reconditioned to original efficiency by a 60-second application of the end surface to a grinding wheel.
- VI** Simplified field service . . . because CLUTCH HEAD is the only modern screw operative with the ordinary type screwdriver, or any flat blade, of proper width.
- VII** Here again the CLUTCH HEAD Lock-On saves the day. With the Type "A" Bit, rusted-in and frozen-in screws may be withdrawn undamaged and held secure against dropping for re-use.

Because CLUTCH HEAD is "The Screw That Sells Itself," we invite you to personally examine and test these features. Your re-



quest will bring you. BY MAIL, a package assortment of CLUTCH HEAD Screws and sample Type "A" Bit; also fully illustrated Brochure.



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COMPLETE PLASTICITY!

-MEGATHERM*

**CUTS
MOLDING TIME**

90%



▲ The molded handset ready for ejection from the mold after the 30 second perfect cure.

◀ Megatherm heated preforms in press transfer chamber just before closing.
Photos Courtesy Shaw Industries Co.



Federal Industrial Power Tubes give power and performance to Megatherm and other industrial heating equipment.

Molding time on these telephone handsets was reduced from five minutes to 30 seconds with Megatherm.

In addition to rapid molding Megatherm provided a complete and uniform cure which was free of all internal stress.

Megatherm is doing plastic preform heating better and more quickly than any other method. In many cases Megatherm has made a plastic molding job possible which could not be done by other methods.

Megatherm units are compact, and may be easily moved from one production line to another. One of the four standard models will fit your production needs. Megatherm is available in 3 KW, 7 KW, 15 KW and 25 KW output capacities.

Cost of operation is low, the popular 3 KW Megatherm has a power cost of 5¢ per hour.

If you have a plastic preheating problem, now is the time to talk about it with Federal.

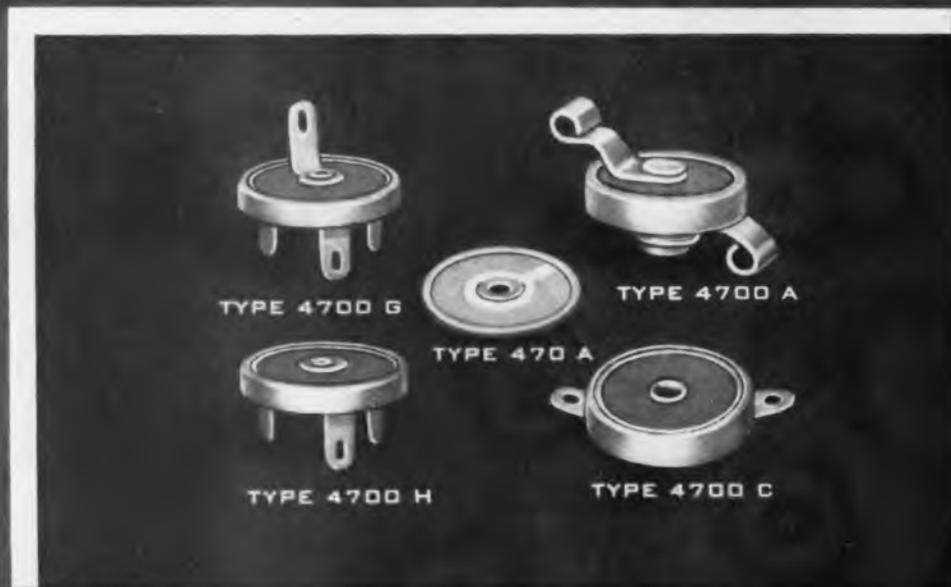
Federal Telephone and Radio Corporation

INDUSTRIAL ELECTRONICS DIVISION

Newark 1, N. J.



Compact · Efficient · Time-Tested



Erie Button Silver Mica Condensers

THE efficiency, quality and practical application of Erie Silver Button Mica Condensers has been thoroughly proven since 1942.

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 through the capacitor.

Types 470 and 4700 have comparatively high capacity ranges and their compactness, together with the wide selection of terminal mounting designs, for by-pass applications, makes them ideal components for V. H. F. and U. H. F. applications, where short ribbon-type leads and low series inductance are prime requisites.

Capacity ranges and electrical characteristics are shown at right.

Samples will be sent to interested engineers on request.

CHARACTERISTICS

CAPACITY RANGE:

Type 470 A — 100 MMF to 1000 MMF
Type 4700 A — 500 MMF to 3000 MMF
Type 4700 C — 500 MMF to 3000 MMF
Type 4700 G — 500 MMF to 2000 MMF
Type 4700 H — 500 MMF to 2000 MMF

INITIAL POWER FACTOR:

.12% Maximum @ 1 Mc. and @ 25° C.

WORKING VOLTAGE:

500 Volts DC
350 Volts AC

TEST VOLTAGE:

1000 Volts DC

INITIAL LEAKAGE RESISTANCE:

Greater than 10,000 Megohms @ 25° C.

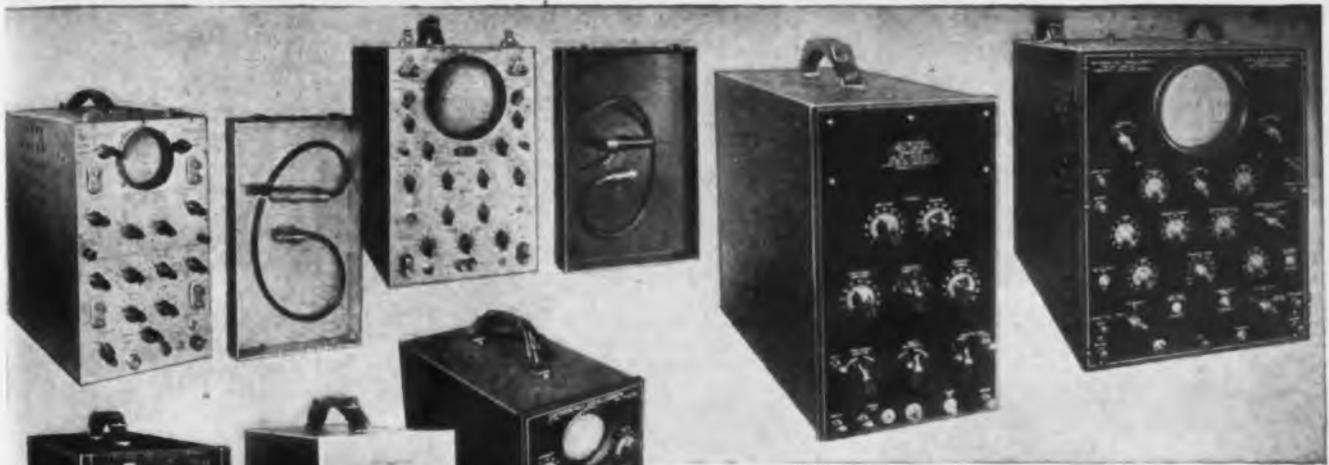


Electronics Division

ERIE RESISTOR CORP., ERIE, PA.

LONDON, ENGLAND · · TORONTO, CANADA

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



**A standard type to meet the
widest range of requirements**

DuMONT *Oscillographs*

► The maintenance man in need of a low-cost, simple, portable, rugged instrument; the laboratory technician requiring an instrument covering an exceptionally wide range of frequencies; the instructor demonstrating intricate wave forms to large student bodies—for each of these widely varying applications, and all those between, there is a DuMont cathode-ray oscillograph and cathode-ray tube, as well as accessories, best suited to the precise operating conditions.

Furthermore, as new requirements arise in this rapidly developing technique there become available still more up-to-the-minute DuMont types to fill the bill.

The DuMont Cathode-Ray Manual already lists an outstanding selection of oscillographs, tubes, accessories. New bulletins are constantly being issued on new items, refinements, applications. And for "scoops" on the very latest cathode-ray developments, just follow these monthly DuMont advertisements.

► *Write on business stationery
for literature . . .*

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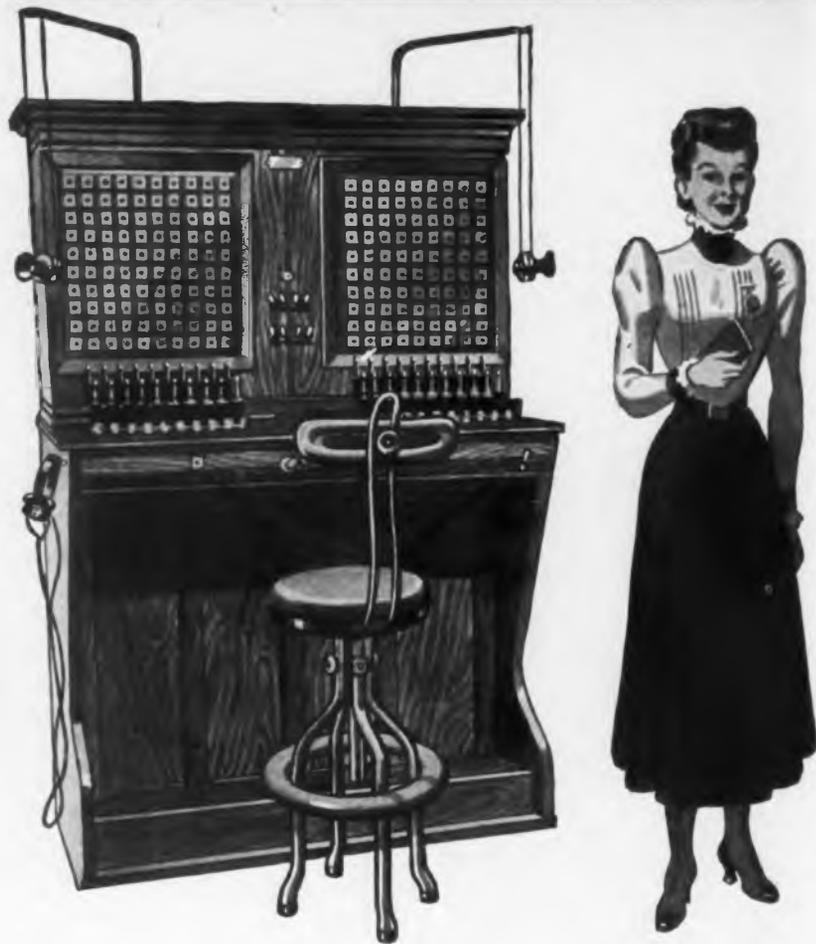
DUMONT

Precision Electronics & Television

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



**“They make
everything
in their line
from the raw
material to
the finished
product.”**



This sentence was written about a news-worthy feature of Connecticut Telephone and Electric operations nearly forty years ago. It has been important ever since.

This Division's facilities for complete fabrication of electrical parts and devices within its own plants are unusual. Because of them, the production of vital communications equipment, aircraft ignition devices and other urgently needed war material is being speeded. It permits important manufacturing economies. It gives us better control of the equipment we make. These things are important in war and peace alike.

CONNECTICUT TELEPHONE & ELECTRIC DIVISION

GREAT AMERICAN INDUSTRIES, INC.

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TELEPHONIC SYSTEMS • SIGNALLING EQUIPMENT • ELECTRONIC DEVICES • ELECTRICAL EQUIPMENT • HOSPITAL AND SCHOOL COMMUNICATIONS AND SIGNALLING SYSTEMS • IGNITION SYSTEMS



THE 400 SERIES

Input Transformers



Designed to occupy minimum space with excellent frequency response, the 400 Series Input Transformers are intended for high quality amplifier requirements. Combines high permeability shield with rotatable strap mounting for minimum stray field pick-up. Equipped with 10" Surprenant color-coded leads. 2" center to center mounting, 1 1/2" O.D. x 2 1/4" high. Baked gray enamel finish. Available for immediate delivery.

TYPE 401-A INPUT TRANSFORMER

30/250/600 ohms to 30,000 ohm secondary center tapped. Maximum operating level +10 V.U. at .001 milliwatt reference level.

TYPE 400-C BRIDGING INPUT TRANSFORMER

Nominal impedance 600/15,000 ohms to 60,000 ohm secondary. With proper input circuits, input impedance range 0/25,000 ohms. Maximum operating level +10 V.U. at .001 milliwatt reference level.

TYPE 402-A INPUT TRANSFORMER

Nominal 30/120 ohm primary to 50,000 ohm secondary. Input impedance range 0/250 ohms. Maximum operating level +10 V.U. at .001 milliwatt reference level.

Frequency response characteristics as usually expressed for input transformers of wide frequency response are not complete due to variables in circuit constants. Therefore we have prepared an engineering bulletin illustrating exact operating measurements, which is available upon request.

The Langevin Company

INCORPORATED

SOUND REINFORCEMENT AND REPRODUCTION ENGINEERING

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CANNON PLUGS ARE DEFINITELY ON THE LIGHT SIDE . . .

Sure Cannon Plugs do weigh a little something—but the least possible. They're engineered that way.

First off they're *designed* for aircraft use—not just adapted to it. They're strong where strength is needed. Excess weight is saved by cutting out factors that don't contribute to structural soundness.

Then, too, Cannon Plugs are precision built which means more than just the close fit of all parts. With Cannon, precision also means burring and cleaning, trimming down and finishing off all excess material.

Shells are die-cast of alloys that are tough but light. Pins and sockets machined to closest tolerances to save weight. Inserts, rings, springs, clips and clamps—each part designed to do its job exactly without waste.

The weight saved with one Cannon Plug makes little difference. But with Cannon Plugs on all the circuits a great deal is saved—actually several pounds per plane.

Speaking of weight saving, just look over the lightweight connectors in the Cannon Type AN series, built strictly to Army-Navy Specifications. A new 4th Edition Type AN Bulletin is ready for distribution. It's free for the asking. Write Dept. A-122, Cannon Electric Development Co., Los Angeles 31, Calif.

CANNON ELECTRIC



Cannon Electric Development Co., Los Angeles 31, Calif.

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REPRESENTATIVES IN PRINCIPAL CITIES—CONSULT YOUR LOCAL TELEPHONE BOOK



A *New* G-E COMPONENT

LECTROFILM CAPACITORS

Their high dielectric strength assures dependability

Lectrofilm* capacitors are excellent for radio-frequency blocking and by-pass applications where "Q" and temperature coefficient are not critical. Many thousands have been proved in G-E radio equipment now in use on every battle front. Among their outstanding features are the following:

Wide operational margin insures dependability—note the high ratio of d-c test voltage to d-c working voltage shown in table.

Dependable operation over a wide range of ambient temperatures—from minus 55 C to plus 85 C.

Mechanically interchangeable with mica capacitors of the same ratings built to American War Standards (C-75.3—1942) in case sizes CM 60, 65, and 70.

Dense, strong, and moisture-resistant cases made of a distinctive-green, low-loss plastic. The case-60 type is molded under high pressure and high temperature; the case-65 and case-70 types are potted with a special G-E compound, selected for its moisture resistance and stability at high temperature. Lectrofilm capacitors will pass the above American War Standards thermal-cycle tests without difficulty.

For information on "Q," temperature coefficient, and r-f current-carrying capacity, ask for Bulletin GEA-4295. General Electric Company, Schenectady 5, N. Y.

Illustration shows case 65 or 70 type. Bulletin GEA-4295 lists ratings available

**Buy all the BONDS you can
—and keep all you buy**



RATINGS CURRENTLY AVAILABLE IN CASE-60 TYPE SHOWN ABOVE

Micromicro-farads †	D-c Working Voltage	D-c Test Voltage	Cat. No.
100	2500	6250	29F21
150	2500	6250	29F22
220	2500	6250	29F23
330	2500	6250	29F24
470	2500	6250	29F8
680	2500	6250	29F9
1000	2500	6250	29F10
1500	2500	6250	29F11
2200	2500	6250	29F12
3300	2500	6250	29F13
4700	2500	6250	29F16
6800	1200	3000	29F25
10000	1200	3000	29F26

†Capacitance tolerance ± 10 per cent. Capacitance temperature coefficient approximately 700 parts per million per degree C, as measured at 1000 cycles over a temperature range of minus 40 C to plus 85 C.

*Lectrofilm is General Electric's new synthetic dielectric made from materials that are available in the United States.

GENERAL ELECTRIC

407-TB-8700



TURNER MICROPHONES

Partners in Performance



TURNER
211 DYNAMIC
BROADCAST TYPE

Utilizing a new type magnet structure and acoustic network, Turner 211 extends the high frequency range and raises the extreme lows from 2 to 4 decibels — to compensate for overall deficiencies in loud speaker systems. Unique diaphragm structure results in extremely low harmonic and phase distortion without sacrificing high output level. A reliable unit for use in war plants, P. A. Systems and broadcast studios.

Leading designers and builders of rugged electronic recording devices ally their products with TURNER applications for sure-fire performance under varying acoustic and climatic conditions. Today these recorders play an important role in essential war communication activities. In the world tomorrow, they will open new horizons in the fields of radio, entertainment, education and business.

It's time to Turn to Turner for suggestions and applications in your electronic developments. The clear crisp reproduction of any sound — the rugged construction, accurate response, professional appearance and maximum performance of Turner Microphones give them a prominent position in any microphone discussion. While orders are being filled currently for those whose needs meet priority requirements, Turner invites your inquiry for collaboration with post-war developments.



TURNER — *Pioneers in the Communications Field*

The **TURNER** Company
CEDAR RAPIDS, IOWA

Write for your Free copy of Turner's Illustrated Catalog

Consolidated Turner-United Partner of the Brush Development Company

Speak no . . . See no . . . Hear no . . .

Do no



post war reconversion

No wonder American industrialists are dizzy — Columnists, commentators, conferences and a host of critics on the sidelines advising business to "Go ahead" — to "Hold back" — to "Stand still."

Red lights today, green lights tomorrow.

Through the maze of conflicting regulations, press releases, industry bulletins, it is safe to predict, however, that civilian production will resume shortly. But we must win the war first.

We at G. I., realizing that wars always end more suddenly than they begin, decided long ago on a post war planning schedule. It may help



to clarify your problem to know that we will be under way immediately when Uncle Sam issues the go-ahead signal.

Our products comprise new and improved components in the electronic and radio fields — variable condensers, automatic tuning mechanisms, record changers and new items developed and perfected from the research of our wartime experience.

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TRANSFORMERS

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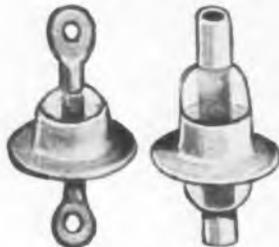
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GAUGES

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TRANSMITTERS



ILLUSTRATED are several examples of metal-glass hermetic seals produced by Stupakoff for various types of equipment.

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.



DO MORE THAN BEFORE—BUY EXTRA WAR BONDS

*TRADE MARK 337982 REGISTERED IN U.S. PATENT OFFICE

STUPAKOFF CERAMIC AND MANUFACTURING CO., LATROBE, PA.

HEAT IT

fast!

✓ SAME DEPTH

✓ SAME AREA

✓ SAME TIME

✓ SAME TEMPERATURE



Westinghouse 20 Kw Radio Frequency Generator

This unit with a nominal output of 20 kw is designed to handle a wide range of induction and dielectric heating applications. It is designed for fixed installation. All controls and meters are located on the front panel. Dead-front construction safeguards operating personnel.

- Single unit construction
- Automatic operation and control
- "Long life" air-cooled tubes
- Shielded to minimize radio interference
- Substantially built housing
- High efficiency—simple maintenance

Electronics at Work

... ONE OR A MILLION

How fast? Well . . . with Westinghouse Radio Frequency Heating you start figuring a lot of jobs in *seconds* that now may be taking five to ten minutes—and more.

It will change your ideas about rejects, too. You'll get unvarying uniformity of depth—area—time and temperature—on one or a million pieces.

By creating instant, uniform heat throughout the predetermined area, Westinghouse Radio Frequency Heating Units keep parts free from damaging internal stresses set up by uneven heating. And highly-developed automatic operation turns tricky heating operations into simple "push button" jobs—whether it's annealing, hardening, sintering, brazing, soldering.

Westinghouse single unit design "packages" all the radio frequency generating and control equipment into a safe, compact unit. These units are available in output capacities ranging from 1 kw to 200 kw for every induction and dielectric heating application. Why not investigate Westinghouse Radio Frequency Heating immediately?

For more information write for Booklet B-3261-A and Descriptive Data 85-800. Or if you have a specific application in mind a Westinghouse engineer will be assigned to discuss your problem with you—write Westinghouse Electric & Manufacturing Co., P. O. Box 868, Pittsburgh 30, Pa.

J-08084

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RADIO FREQUENCY HEATING

The instruments of Sudden Death will bring them longer life!

TODAY, electrical instruments are among the deadliest weapons in freedom's arsenal. They guide planes on bombing missions, direct gun-fire, and perform a hundred other killing missions.

But the magic of instruments will not always be put to these frightful uses. The day is coming when they will bring better health, greater happiness, and increased usefulness to everyone. They will be used more

and more to improve the efficiency of industry's products—to safeguard our safety in the home, in the factory, and on the streets or in the skies—to improve all the services of the professions and sciences so that they can make a better world in which to live longer.

Many companies will make these instruments and will make them very well. Among them, we believe, will be our own organization, creating in-

struments of *sustained accuracy** to be used for all the purposes of peace, progress, and longer life.

*SUSTAINED ACCURACY is not an easy quality to achieve. It must take into account all factors of use—must then employ the design, the alloys, the construction that infallibly protect an instrument against all threats to its reliable performance. Such instruments, obviously, must be built with performance—not price—in mind. We invite the inquiries of those who are interested in such standards.



Boes instruments

for Measuring, Metering & Testing Equipment ☆ The W. W. Boes Co., Dayton, Ohio

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Hermets



* Hermetically sealed relays,
—a new development by
Allied.

- **AIRCRAFT USE**... designed to overcome altitude effects to 60,000 feet.
- **GROUND SERVICE**... under tropical conditions—where fungus growth is serious hazard.
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HAMMARLUND



THE HAMMARLUND MFG. CO., INC., 460 W. 34TH ST., N. Y. C.
MANUFACTURERS OF PRECISION COMMUNICATIONS EQUIPMENT

Our Customers wrote this Postwar Plan

Our Customers, old and new, have learned many things about Sickles' capacity to produce in wartime. Their experiences as reported to us, indicate clearly the role Sickles will play in their peacetime production.



1. **Our Old Customers** say that they were delighted with the speed with which Sickles met their wartime demands, got *quantity* up, kept *quality* up, and met *delivery* promises.
2. **Our New Customers**, many of whom had never before used a subcontractor for parts and components, say that they found our facilities *competent, flexible, economical*. They made no sacrifice in the closely guarded quality of their product. Result — many of them expect to continue to use Sickles' facilities, after Victory.

To add our customers' experience to our own and get a clear and workable postwar plan, was a simple matter:

When the demand for wartime communications parts and products has abated, and the need for similar peacetime products rises, we will reconvert to peacetime production as smoothly as we converted to war. We are ready.

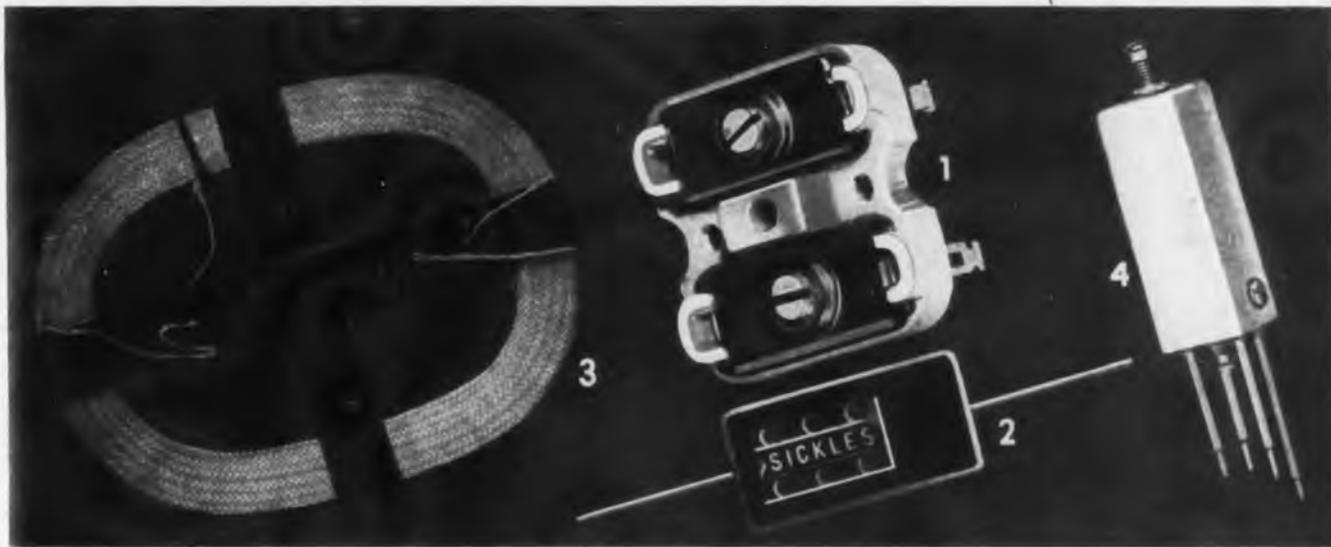
Yes, our plan is as simple as that. You, our customers, wrote it. You can begin to use it at any time your plans have reached the specification stage. Just say when.

**THE F. W. SICKLES COMPANY
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SOME SICKLES FIRSTS

1. 1933—Dual Mica Trimmers*
2. 1936—Silver Cap. Condensers*
3. 1940—Low-loss "Ripple" Loops*
4. 1941—Midget I.F. Assemblies
5. 194V—More Coming

* Patented



Radio and Electronic Specialties for Today and Tomorrow
SICKLES



COLLINS AUTOTUNE*

The Key to Precision Control

THE Autotune was conceived and engineered by Collins many years ago. It was the result of a growing dissatisfaction with slow, haphazard methods of tuning radio equipment and a persistent effort to improve them.

What is it? How does it work?

The Collins Autotune head shown above is a mechanical device for turning a control shaft and stopping it precisely at any one of several pre-determined positions.

The Collins Autotune system consists of a number of Autotune heads, all driven by a single electric motor, each quickly and simultaneously repositioning a separate and non-interrelated tuning shaft to new settings chosen in

advance by the operator. At the touch of a button or flip of a dial, the Collins transmitter or receiver is thus completely and exactly tuned to the wanted channel in a matter of seconds.

Collins communications equipment, Autotune controlled, was adopted by American Airlines, Braniff Airways, Tropical Radio Telegraph Co. and others long before the war. Reliability has been demonstrated through the years under all service conditions.

The Collins transmitter design and the Autotune have proved so advantageous to the Armed Services that military authorities have requested other large companies, in addition to Collins, to build them. The Collins Radio Company, Cedar Rapids, Iowa.



*U. S. Patents issued and pending.

SMALL!

*The G-E
Switchette*

**Don't
handicap
your important
designs for lack of
a SMALL electric
switch**



BECAUSE of its unusually small size and light weight, its lightning-fast snap action, and its long life, the G-E Switchette is becoming more and more popular with designers for circuit control where space is at a premium.

Switchettes are available in ratings up to 10 amperes at 24 volts d-c (230 volts a-c), are provided with solder-lug terminals for wiring. They meet government specifications covering corrosion and vibration resistance, and operate at altitudes up to 50,000 feet and in ambient temperatures from 200 F to -70 F.

More than 200 modifications have already been developed to meet special circuit requirements and to fit into special mechanical arrangements. Dimensions, operating characteristics, and ordering directions for standard Switchettes and many typical modifications are given in our new catalog, No. GEA-3818C. For your copy, mail the coupon. If you don't find the forms you need in the catalog, our engineers will be glad to work with you in adapting Switchettes to meet your requirements.

GENERAL  ELECTRIC

Buy all the BONDS you can — and keep all you buy

● Here's an inside view of the tiny, versatile G-E Switchette, enlarged to show you the double-break contact construction, which makes possible many ingenious wiring arrangements to solve tricky circuit problems. This is a standard form for controlling one normally open and one normally closed circuit. Variations of this arrangement are available to provide control of a single circuit, either normally open or normally closed. Other modifications include a form for simultaneously opening two circuits and closing one, or vice versa, also single-break forms for more sensitive operation.



SWITCHETTES

GENERAL ELECTRIC COMPANY, SECTION B676-141
SCHENECTADY 5, NEW YORK

Please send me Bulletin GEA-3818C giving dimensions, ratings, and operating characteristics of Switchettes

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*May we cooperate with you on design savings
for your applications . . . war or postwar?*

ELECTRONIC INDUSTRIES

Including INDUSTRIAL ELECTRONICS

O. H. CALDWELL, EDITOR ★ M. CLEMENTS, PUBLISHER ★ 480 LEXINGTON AVE., NEW YORK (17), N. Y.

"FM" Has Three Meanings

Confusion between definitions sometimes leads to sharp arguments among engineers. The letters "FM", for example, have come to have three distinct and different meanings. These are: 1. The **bare phenomenon** of modulation by frequency changes in a carrier. 2. An **improved technical system**, like "Armstrong FM," with its limiters, etc. 3. The **present complete broadcast service at 42 to 50 mc** with its advantages of spectrum position, freedom from interference, high fidelity, choice musical programs, etc. When the engineer talks about FM he usually means Nos. 1 or 2. When a listener uses the letters, he is usually referring to the complete present-day service whose manifest merits may be only partly attributable to the other technical definitions of FM.

Television-Network Experience in the Making

That television networks eventually will come into use because of their economic necessity is sure. And it appears now as though the manner in which such nets will operate, whether over wire circuits or through the ether, may be definitely determined in the not too far distant future. AT&T and the Bell Labs currently have both coaxial-cable and uhf-radio link projects in the works, which should turn up much useful information. With the experience gained from GE's Schenectady-New York link, and Philco's Philadelphia relay plus the additional experience to be gained through the proposed GE-International Business Machines Corp. arrangement reported in the news columns of last issue, engineers should have plenty of data upon which to base decisions.

Suppression

Your editors believe in few types of suppression, but one of them is auto-ignition noise! It's a gruesome fact that many television heroines are being slashed to cross-sections just as they're about to live happily ever after. With increasing use of uhf bands postwar, the spark-plug racket could be a big problem.

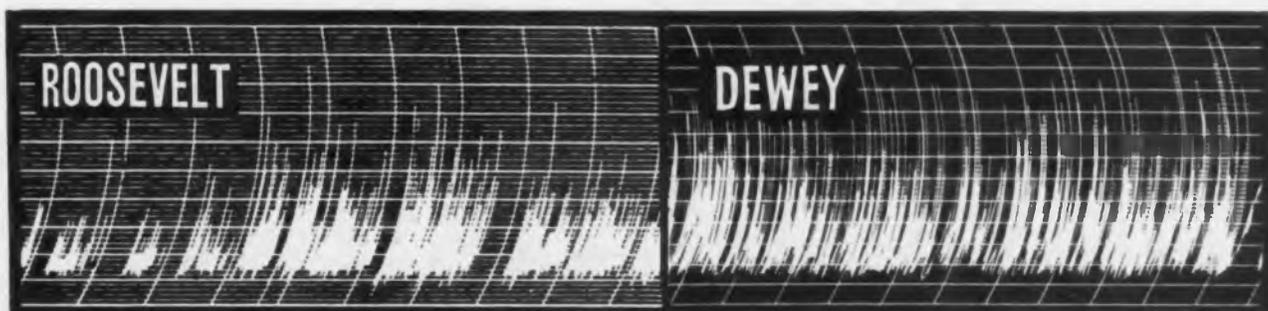
All automotive equipment being manufactured now for military use is interference-free. Radio noiselessness is being achieved on a mass production basis at no cost in engine efficiency. There will never be a more psychological moment than the present for concerted effort on the part of FM, television, and uhf communications interests to take steps insuring that no postwar trouble-spitters roll off the production lines.

Checking Across a Million Lt-Yrs!

And now the phototube reaches across unthinkable empty space and answers the old controversy as to whether the far-flung spiral arms of distant galaxies "lead" or "trail" the rotation of the main galactic masses. On page 37 of our March issue appeared a splendid photo of the great Andromeda galaxy—nearest to our own Milky Way, but still a million light-years distant! Spectrometer observations on its right and left apexes have long revealed which apex was turning toward us, which apex receding.

Still we had no way of determining which long side of the ellipse was tipped nearer to us, and so the real direction of the galaxy's rotation remained in doubt. But now Dr. Joel Stebbins photoelectrically detects a slight difference in tint between the two halves of the ellipse, implying that the redder half is further off. This—interpreted with the apex known to be approaching—now definitely confirms the view that the galaxy rotates with its great arms trailing!

The Candidates' Voices as Recorded on "Network-Level" Meters
Engineers of NBC apply Esterline graphic instruments to speeches of the Presidential contenders



SERVICING AIRBORNE

by GILBERT SONBERGH

Associate Editor

Maintenance of air and ground radio and electronic equipment by Signal Corps and Air Technical Service Command

● Military radio, radar, and other electronic equipment and particularly airborne apparatus presents a major, large-scale maintenance problem. In spite of the best design, fabrication, and installation that the state of the art and the magnitude of Uncle Sam's pocket-book permit, airborne radio equipments in combat use can hardly be expected to stand up as well as home receivers in bedside use. There are two basic causes for the relatively high rate of equipment failures.

First and foremost, airborne radio equipment is subjected to conditions of operation beyond the wildest pre-war nightmares of the industry's

set designers. In spite of everything that has been said and done about it, vibration is still the number one enemy of aircraft radio, with the familiar humidity problems of ascent and descent battling a close second.

The enormity of the Army's radio repair task can best be conveyed by statement of the fact that the B-29 Superfortress* carries just about one ton of electronic equipments—twenty or more individual items. Just a few horsepower out of the many thousands developed by this giant's four motors will, if dissipated in the radio equipment, cause some tube or com-

*See "Electronic Industries" for September

ponent to give up the ghost.

Second reason for the magnitude of the Army's servicing program is the speed and volume of production demanded by the procuring authorities. Engineers, factory girls, machines, and the wakefulness of inspectors have their human limits, and the penalty for exceeding them is major maintenance problems.

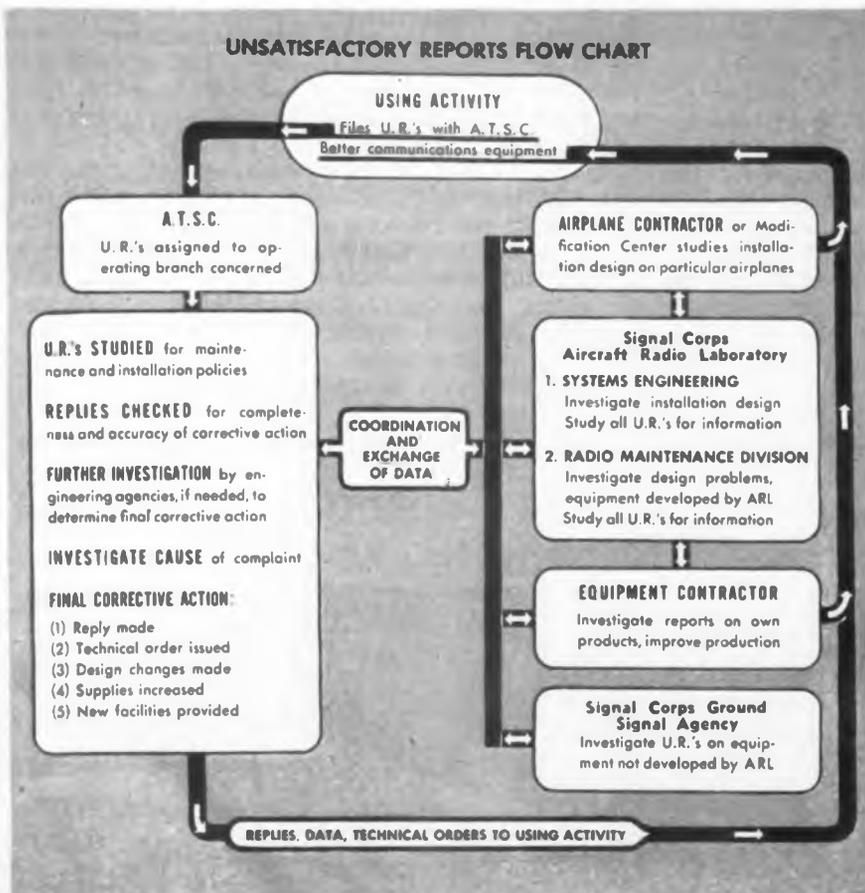
On the credit side of the ledger, the industry has, all in all, done its "impossible" job very well. In 1941, American aviation was technologically "grounded." Aircraft radio was almost never used above 10,000 feet. Airspeeds, and "G's" generated in turns, were a fraction of today's rates. Recoil of airborne 75mm. cannon was yet in the future. The industry's success in designing and manufacturing new equipment to meet these challenges must be chalked up to its everlasting credit.

Aircraft radio maintenance

Administration of the vast servicing program on airborne equipment is headed up by the new Air Technical Service Command, one of six Commands in the Army Air Forces. The ATSC, created September first, combines the former Materiel Command and the Air Service Command. The ATSC, headquartered at Wright Field, Dayton, Ohio, is organized around six divisions: Engineering, Procurement, Readjustment, Supply Maintenance, Personnel and Base Services.

Overseas aircraft radio repair facilities under the maintenance division are divided into four types or levels, conveniently referred to as "echelons of repair." The first or "A" echelon is aboard the plane itself, in the air, perhaps over enemy territory. The radio operator is trained to change tubes, repair external broken connections, make screwdriver tuning adjustments, etc. He is not charged with any "repairs" in the conventional sense, although under combat conditions many of these men have done remarkable things. Often the radio operator is a former "ham," who well understands the operating principles of his equipments, and,

Simplified diagram of method by which Air Technical Service Command handles Unsatisfactory Reports on radio-electronic equipment failures overseas. UR data is used in many ways



RADIO

what's more, is thoroughly in love with his work.

The second, or "B" echelon of repair may be a tent, a hut, or a room in a permanent building on the edge of the airbase. The operating personnel, whether one man or half a dozen, know enough about their equipment to make all minor repairs such as replacement of defective resistors, condensers, coils, etc., which do not require great theoretical knowledge or extensive test equipment.

A further responsibility of this second echelon is the daily pre-flight check of all radio, and other electronic equipments on each plane. Each receiver is tested for pickup of a signal from a signal generator of appropriate type, used on the ground near the plane. Each transmitter is checked in a similar manner with suitable receiving or monitoring equipment. At advanced air bases, personnel and facilities of the second echelon are generally very limited, with the result that only very easy repair jobs are undertaken. Electronic units badly damaged in combat or inoperative due to serious electrical or mechanical defects are sent back of the lines to the third or fourth echelon.

Mobile service units

The third or "C" echelon of repair is generally, although not always, a mobile unit. Fairly extensive repair and servicing equipment is installed in a glider or airplane specially allocated to this purpose, or in a van or light truck. Such a unit stocks more spare tubes and parts, test equipment, and servicing "know-how" than at the air-base installation. Each unit constantly makes the rounds of three or four front-line air bases, performing all but the most difficult repairs and adjustments.

The fourth or "D" echelon of repair is the supply depot for a theater or part of a theater of operations. Servicing facilities at such a depot constitute final headquarters for damaged or defective equipment received from ten to fifteen major air bases. This, a relatively permanent installation, stocks every

ELECTRONIC INDUSTRIES • October, 1944



Daily preflight check on transmitter and receiver field strength, sensitivity, and frequency



"Second echelon" repairman, somewhere in France. Small plane spots artillery targets and results



A rough and ready Signal Corps repairman holding forth in a tent. Note soldering iron at left

ATSC services equipment in ground-air use. Control tower of a South Pacific air base





Sign over door: "COMMUNICATIONS". This primitive hut, whose radio servicing facilities are pictured in the interior view at right, points up the need for reliable electronic equipment. Photos made at an air base of the 14th Air Force, illustrating second grade "second echelon" facilities



Left—The "first echelon". Radio operator himself can tune up, replace tubes, and make "screwdriver adjustments" in his radio gear. Right—A third echelon stationary radio repair base, showing somewhat larger stocks of replacement tubes and parts available. Here servicing is an exact science
Below left—Signal Depot Repair, Base Section, Australia. Personnel is specialized. Instrument man repairs an rf ammeter. Right—When Eisenhower needed 1000 O-1 M.A. meters in a hurry, ARL supervised conversion in Dayton of a stock of Model 301 voltmeters, using photo-printed O-1 scales





Left—Mobile radio repair truck in New Guinea—the "third echelon" type of facility, with more and better test instruments than air base echelons. Right—The radio-electronic repair facilities and personnel of Goodenough Island shown "doubling in brass" on a resalitrant movie projector

conceivable type of spare part for the aircraft and the airborne radio, has all types of radio test instruments, some machine-shop facilities, and trained personnel equal to any type of repair job met with in the field.

Repairs on home fronts

The facilities for repair of equipment still in the USA are similar in general to the overseas facilities. Some idea of the size of the third and fourth echelons of repair may be conveyed by the fact that there are but twelve of the major fourth echelon depots in the USA, and approximately three hundred mobile or other units corresponding to the third echelons overseas.

As is well known, there are close ties between the Army Service Forces' Signal Corps and the Army Air Forces' Air Technical Service Command. In overseas theaters as well as in Continental USA, many of the service echelons are partially staffed with Signal Corps personnel. At Wright Field, Dayton, Ohio, the "eagle's nest" where new planes and equipment are "hatched," the Signal Corps Aircraft Radio Laboratory serves in a sense as liaison between the Signal Corps and the AAF Commands concerned with airborne radio equipment, and between both of these and the industry's engineering and production personnel.

"ARL" is staffed with hundreds of the best brains of the electronic engineering profession, both in uniform and out. Some make trips through combat areas to obtain field experience reactions. ATSC frequently hires industry engineers on six-month contracts for special work, here and overseas, to supervise the installation of new types of equipment and train operators and repairmen to handle it effectively.

The various levels of ATSC repair installations confine their work in general to Air Forces equipment. In the airborne category, this includes all types of communications

equipments, the many electronic navigational aids and "Gibson Girls."

On the ground, the ATSC is charged with the repair and maintenance of the stationary complements of the communications and navigational systems.

In the USA, whenever a piece of electronic apparatus requires attention a Field Service Report is made out. Such reports cover everything from a microphonic tube replacement to a complete overhaul of a set. Information concerning equipment failures is carefully tabulated, in terms of radio unit types and of component part types, for study and recommendations of changes in engineering design, installation methods, production methods, etc.

Correlated with information on the numbers of particular electronic units in service, this tabulated information shows at a glance which parts of which sets made by which manufacturers habitually break down in use, and where they break down. An interesting and useful result of this work is the knowledge that certain parts of certain sets give endless trouble in climate "A," whereas certain other parts of the same sets will habitually act up in climate "B."

Armed with the facts, the Aircraft Radio Maintenance Division of the Aircraft Radio Laboratory is able to make cogent recommendations for changes. If a certain capacitor or resistor in a receiver requires replacement five hundred times in a few months, while comparable components in other makes or types of receivers require only ten or twenty replacements, something is obviously wrong with that condenser or resistor or the way in which it is being overworked.

In continental and overseas service the "UR" or Unsatisfactory Report form is filled out, sent back to the ATSC at Wright Field, and handled basically in the manner shown in the accompanying chart. In general, UR's cover recurring

defects caused by poor electrical design, or mechanical installation and mounting problems, and damage due to unforeseen conditions of service. Troubles result from all manner of unexpected causes. When unexpected defects graduate to the expected class, as tabulated from the thousands of UR's, basic changes may be made in design, production, or maintenance practices.

Every UR is answered within a matter of hours, instructing the reporting service echelon in handling that or subsequent similar cases. A careful record of all UR's is maintained at ATSC headquarters. When UR's involve defects in design or construction of equipment, the Aircraft Radio Laboratory takes the matter up with the manufacturers involved, within a maximum of twenty-one days.

The end result is, basically, that our fighting AAF receives better equipment, better airplanes and better combinations of the two, together with information, orders, and other data to enable them to do a better job in the war theaters. Moreover, the summarized results of all of these data enable the ATSC to specify required stocks of spare parts and equipment without either going overboard or endangering the success of military operations with "too little, too late."

Typical troubles

Most planes carry a number of radio equipments and require several antennas. However, combat airplanes also carry guns. Unfortunately, the best antenna position for desired radiation characteristics may also be the best position for being shot off by the plane's own guns. With ever-increasing range of fire-power being built into the gun equipment (without always consulting the radio divisions) this has been a large problem. Still on antennas, the undesired mechanical resonance of some of the supports

(Continued on page 210)

CIRCULAR AND POLAR SWEEPS

by RALPH R. BATCHER

Consulting Editor

Part II — Surveying methods whereby oscillographic tests on rotating mechanisms are best handled

● Oscillographic studies in many industrial processes have proved of great value, and such methods are becoming standardized for many kinds of tests. The application of the common processes that have proved of value in communication and electrical laboratory research, are useful in some cases, but problems that are peculiar to mechanical engineering design have many unusual angles, especially when rotating machinery is considered.

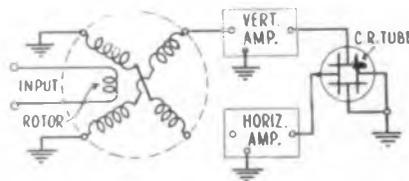
The value of a rotatable transformer for certain oscillographic studies of rotating machinery was suggested in Part I.* It was shown, that when the unit is rotated at a constant speed, with its rotor supplied with a constant current as in Fig. 8, a polar diagram is produced on a cathode-ray screen. In view of its light weight in setting up such a unit, it is easy to synchronize its speed with that of the mechanism under test. If direct mechanical coupling is not advisable it can be driven easily by any of the common forms of synchronous indicators (Telegon, Selsyn, Autosyn, etc.), or by flexible shafts coupled to the prime mover.

Follows speed changes

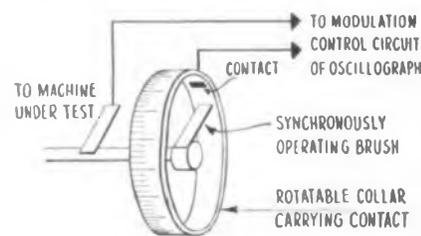
When checking variable speeds, several interesting properties are to be noted. In many types of rotating machinery, momentary changes in speed occur throughout a revolution, such changes being either of a recurring or intermittent nature. In either case, it may prove desirable to study the position of the speed variations on the cycle and their amplitude.

A time base of circular form has the advantages that no time is lost during the flyback, and that the position of the spot is directly established by the position of the mechanism during rotation.

When a linear sweep is used in oscillographic studies, it is an easy matter to trigger off the sawtooth oscillator at a particular point in each cycle. Both the spot and the machine itself thereafter function independently until the next synchronizing pulse comes along. This



In Fig. 8 (above), the connections from synchronously driven transformer to vertical and horizontal deflection system are given. The production of a beam modulating pulse as in Fig. 9 (below), gives a marker point at a known point in a revolution



common method has the advantage of simplicity and if the machine speed does not change appreciably during a revolution, has fair accuracy where more precise timing studies are needed.

Certain tests have been described in current literature where a number of momentary contact closures are arranged throughout a cycle. These are used to modulate the intensity of the oscillogram trace, giving marker points at known positions along the cycle. A variation of this method, one that permits making a time calibration on a circular time base type of oscillogram, is often used in cases where accurate recurrence of the waveform results during each cycle. Here a single contact is arranged to be adjustable as to its relation to the shaft of the driving mechanism, as in Fig. 9. The latter is coupled to the rotating contact, which intensity-modulates a single spot on the oscillogram. Therefore the position of this spot bears a direct relation to the position of the fixed contact on the calibrated ring. In this way the exact position of each unusual occurrence during the cycle can be ascertained directly. Repeating the test at a number of points on a revolution provides angular calibration.

The simple application of direct current to the rotor of a device, as in Fig. 6,* produces the circular time base. There remains still the problem of producing the extra radial excursions that produce the oscillogram. This is now easier than with any other arrangement, since connecting the waveform potentials under test to the rotor instead of the direct current source, will automatically produce radial movements of the cathode-ray. Quantitative results can be obtained only under the condition that either the speed or the rotor input remains unchanged. When both change at once, a product term makes radial amplitude measurements less reliable, but even here, a more distinctive qualitative picture often results. Where only small variations in speed occur the error is not large however, and is usually ignored. For accurate determinations, the speed variations can be determined from the same oscillogram and the results interpreted accordingly. This in effect results in a dynamic calibration curve of the system.

Time markers

To measure time intervals one of the most useful methods makes use of the modulating grid of the cathode-ray tube. Then the spot intensity is altered at definite intervals by means of a standard audio oscillator, to give timing dots along the periphery of the oscillograms. It is usually noted that the rate of change of any ordinary surge or wave obtained from some sort of pickup applied to an industrial device is more rapid than any rate of change of the speed of the rotor of such a transformer, so that in such cases the radial excursions are essentially proportional to the surge rate.

A more important error in some circuits comes from the dynamic loading effects of the rotatable transformer primary. If this rotor, shown in Fig. 8, is operated from the plate circuit of an amplifier tube, the reactance of that rotor will alter the linearity of the secondary's output with respect to speed.

However, these units can be ob-

*Electronic Industries, Sept. 1944.

tained with high impedance (and incidently high Q) circuits, and with a mu-metal magnetic circuit so that efficient operation in electronic circuits is assured. Certain types can be used at high audio frequencies, on account of the effective use of special constructional principles and materials.

Another device which is adaptable to oscillographic studies, in both mechanical and electrical laboratories is the Differential Circuitrol (or Differential Selsyn, etc.). This unit can be obtained with either a two-phase or three-phase field, with a two or three-phase rotor to match. In addition to its normal application in complex control problems, it can be utilized in the study of multiphase motor control as an oscillographic accessory. A photograph of the balanced windings of a Circuitrol (Kollsman) rotor of the differential type is shown in Fig. 10.

Tandem operation

The variety of industrial problems that are being analyzed by electronic methods (particularly those using the cathode-ray oscillograph) include many that require special methods. As shown in the previous article, when direct current is applied to the rotor, the output consists of two voltage waves (90 degrees out of phase with each other) whose amplitude depends upon the moment to moment speed of the rotor. If this output is applied to the rotor of a second rotatable transformer unit connected to the same driving mechanism, with a certain angular alignment between their shafts, one transformer secondary winding will have a flux rate-of-change proportional to $\sin^2 \alpha$, whereas the other winding delivers a component proportional to $\sin \alpha \cos \alpha$, which is equivalent to a voltage wave having twice the frequency. An oscillogram resulting from these potentials (assuming constant speed) has the appearance of a circle with its periphery intersecting the origin, as in Fig. 4e. This combination, however, would find little value in industrial oscillography. Several basic relations must be considered with such setups. A rotatable transformer delivers two 90° voltages, which are proportional to the flux rate-of-change. The latter depends upon the character of the emf applied to the rotor (or primary) and upon the speed of rotation. The fact that the spot on a cathode-ray tube will follow a circular trace, when the circuit of Fig. 8 is used, is due to the ability of the oscillograph to show the instantaneous resultant of 90° voltages (and 90° conditions only, since the plates are at right



Fig. 10—Rotor of a two-phase (type 871) rotatable transformer which can be used in conjunction with a two-phase field for oscillographic tests

angles). It must be kept in mind that nowhere in the system illustrated, will a resultant potential appear, the two voltages being kept in separate circuits at all times.

If it were possible to obtain a potential that was the equivalent of the amplitude of this radius vector by electronic circuits, other than with the visual oscillograph, such an output could be applied to the rotor of a second transformer, operated in tandem on the same drive shaft, and an acceleration curve would result. In this application a differential unit would prove of value.

In view of the number of variations in speed that are possible, it is tedious to analyze general problems mathematically. Assume that a machine shaft's speed increases and then decreases at a sinusoidal rate during a particular 10 degree interval of a revolution. The output of a single rotating transformer unit, fed by direct current would show as a temporary flurry on the periphery of an oscillogram since both the radial and angular distances are affected by the change. The speed, which is the rate-of-change of position, is indicated by radial distances at all times, since points on the periphery correspond to physical positions of the shaft, rather than equal intervals of time.

It is the more usual procedure to apply a current to the rotor having a waveform proportional to some effect to be measured, occurring in the machine under test, giving polar oscillograms, a few typical forms being shown in Fig. 11.

By using small Selsyn, Telegon, etc., type motors as sine wave generators, coupled to various parts of a power system, it is possible to measure momentary speed differences in terms of frequencies. In this way slippage in belts, clutches, etc., can be determined, or the slip-

page in an induction motor. These circuits are in general useful only in determinations of mean speeds and frequencies and are of little value in studying speed variations during a single revolution.

A synchronous generator that is useful in delivering a frequency proportional to mean speed of a less expensive type than those described above, makes use of one of the ordinary synchronous timing motors used in instrument chart drives, etc. A motor of the Hayden type gives eight cycles per revolution (if not geared) and does not need to be excited. Other types may need a small amount of field excitation, which is usually easily accomplished by a small permanent magnet "stuck" at an appropriate point on the field structure.

Sine wave generator

Such a motor delivers a sinusoidal voltage output of sufficient strength to supply the rotor of a rotatable transformer, of the type described above. This latter is driven at the same or some other speed, by some other part of the machine under test, and gives an output that is fed to the deflection amplifiers of an oscillograph.

A petal-shaped oscillogram results, of the types shown in Figs. 11 and 12. It will be evident that such a diagram is difficult to analyze unless a large, well-focused oscillogram is obtained. Actually the oscillogram is like that obtained with a double rotator circuit frequently used for the comparison of two frequencies. Actually the latter is the electrical counterpart of the mechanical arrangement of Fig. 8.

One form of this circuit, shown in Fig. 13 utilizes a phase-shifting combination $R_1 C_1$ to provide a circular trace rotating at frequency f_1 , and a circuit $L_p R_2$ to give another circular trace at the rotary speed of f_2 . If the two rotations are in the same direction the loops or cusps point inward, whereas if the rotations are opposing they turn outward.

The number of cusps in either case represents the exact speed ratio indirectly. If the ratio is equal to an integer, a simple figure results, with the spot successively tracing each lobe without skipping

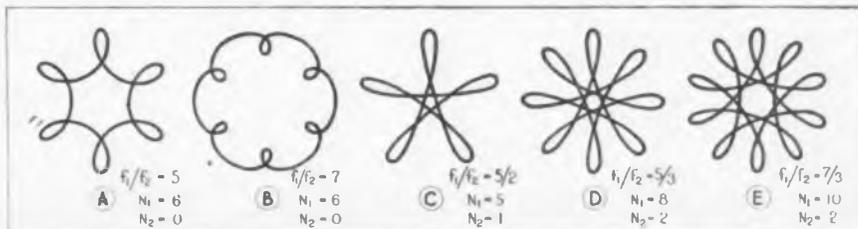


Fig. 11—Fundamental shapes of "roulette" type diagrams useful in frequency and speed comparisons

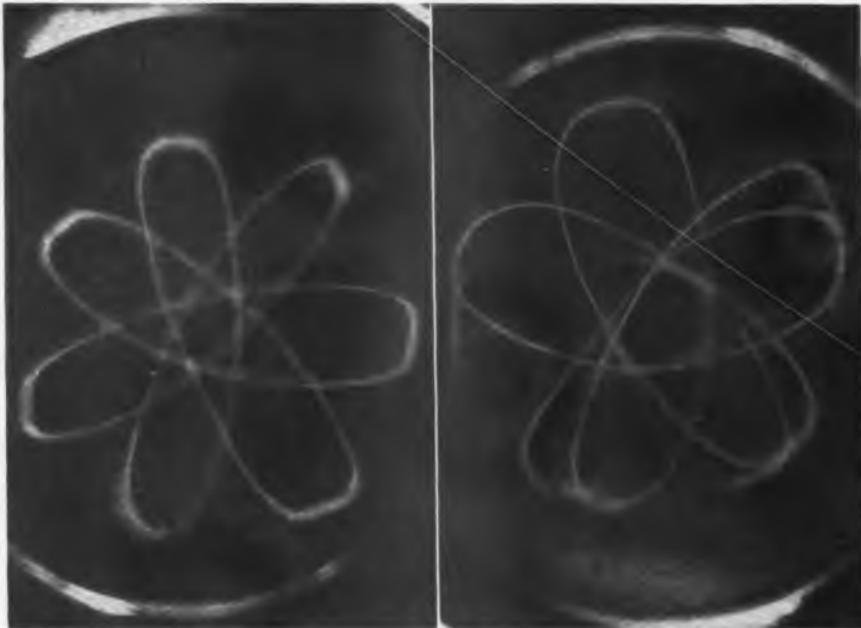


Fig. 12—At left, an oscillogram of speed ratio (8:1) of two parts of a single machine. At right, a similar test showing recurrent slippage of a belt, when its joint passed over a small pulley

any intermediate ones, Figs. 12A and B. If the spot traces the lobes alternately or according to some other order, a non-integral frequency ratio is present.

A convenient rule uses the relation based on a count of the number of petals on the diagram, which is designated by N , and then a count of the number of petals N , skipped over by the trace when it finishes one petal and starts another. The relation then holds:

$$f_1/f_2 \pm 1 = N_i/(N_s + 1)$$

This relation is frequently easier to apply than the one stated above, since it may be possible to magnify a portion of the oscillogram even to the extent of having part of it extend beyond the area of the screen, by increasing the deflection amplification of the oscillograph, and thus permit more accurate counts.

Frequency comparison

Fig. 12 illustrates actual oscillograms obtained with the equipment of Fig. 5°. Both are of the type shown in 11B and the ratio is found using the minus sign in the above formula. Other types which show sharper lobes (Fig. 11C, etc.) would use the plus sign in the formula. Fig. 12B shows the result of momentary changes of speed at points of a revolution.

It is here where small differences in frequency must be measured. This is a difficult job in cases where but little lost motion or slippage occurs, when measurements must be made of frequencies of the order of one cycle per second, or less. Moreover, in many cases the loss

is irregular, as when belts are used.

A basic system that proves of value for these tests was mentioned in Part I, and requires the accurate suspension of the frame of a rotatable transformer on bearings so that it is free to rotate at the full speed of the machine. Slip-ring contacts are necessary to bring out all connections to a fixed terminal block.

Now if the rotor is held still, the output is in every way identical to a fixed field-moving rotor mounting. However, the rotor is turned by a flexible shaft coupling to another part of the mechanism where a change in speed occurs. The rotor, if excited from a dc source, delivers a potential varying at the speed of the slippage frequency, or if excited by a higher frequency audio tone delivers that tone modulated at the lower frequency. This modulated tone can be studied on an oscillograph or can be amplified and rectified to operate a magnetic cycle counter or other type of recording instrument.

The capabilities of an oscillograph in delineating vector effects or the resultant of two out-of-phase electrical potentials are well known. A rotatable transformer also finds a use in this application, and may

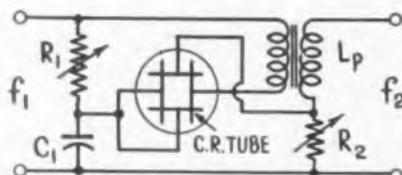


Fig. 13—Double rotator circuit for the study of frequency ratios, producing oscillograms of the type shown in Fig. 11.

be combined with an oscillograph to determine the resultant of several quantities, in problems operating at a single mean frequency.

If two potentials are applied, through suitable impedance converters or amplifiers to the field windings of a rotatable transformer, the rotor will deliver an output voltage that delineates their resultant at any point, when the rotor is turned through a revolution. This, in turn, can be shown on an oscillograph screen, with its vector relation with some other factor, or even with respect to the resultant from the output of the rotor of another rotatable transformer through which the effects of two other factors are resolved.

The versatility of these devices have made them useful in a great many ways in electronic circuits. As a contactless mixer it can produce an adjustable ratio of intensities of two signals to an amplifier. While it cannot be expected to deliver the true "resultant" of two political speeches it can be found to function in other ways.

Its almost effortless ease of rotation makes its positioning a simple job, with some other type of motor operated by any one of the numerous control circuits in use.

Animal Electricity

Two methods for separating eggs that will hatch from eggs that won't, now being developed by scientists of Cornell University, depend on the measurement of "animal electricity" in hatching-eggs and gaging the physical and chemical changes in newly laid eggs by electrical effects in a radio frequency field.

The two methods on which work is now continuing are: measurement of life activity in the embryo area, or blastoderm; and measurement of physical and chemical changes in newly laid eggs by means of a radio frequency field.

By the first method, the "animal electricity" in the blastoderm, has been measured in dissected eggs and found to be different in fertile and infertile eggs. To make this difference measurable in unbroken eggs, attempts are being made to stimulate the living part of the egg to increase this difference. Treatment with a certain dosage of X-rays has proved promising.

In the second method of measuring changes in eggs by conductivity and bio-electric effects in a radio frequency field, it is now possible to observe differences between fertile and infertile eggs in groups of 8 or 10. If this method can be improved to detect differences between individual eggs, it will be practical.

BRIEF CASE TRANSMITTER

by J. R. DUNCAN

Engineering Department, The Crosley Corp.

Battery powered communications equipment developed solely for CW telegraph work weighs but 16 lbs.

● Most engineers are familiar with much of the born-of-the-war communications equipment used by the armed forces, of which the "walkie-talkie" and the "handi-talkie" are among the most frequently publicized and best known. But the Army uses many other types of portable equipment among which this so-called "brief case transmitter" is interesting because of its small size and light weight and because it was developed entirely for CW telegraphic communication. The equipment, consisting of a separate transmitter and receiver that can be carried together in an ordinary brief case, was produced by the Crosley Engineering Department on a development order from the Signal Corps. The specifications consisted almost entirely of maximum dimensions, and the frequencies to be covered. The result represents a somewhat unusual design, though the circuits are straight-forward in every respect and do not include any startlingly new ideas.

The total weight of both units complete with batteries is 16.4 lb. (transmitter 9 lbs., receiver 7.4 lbs.). The overall size of each unit is $11\frac{1}{2} \times 9\frac{1}{4} \times 1\frac{1}{2}$ in. Such portability is obtained by a sacrifice in

working range; however, excellent results are obtained when it is possible to operate according to a pre-arranged plan. Results with this type of equipment are unpredictable since antenna installations and locations are always changing. Reception may be good over several hundred miles but the transmitter range is more apt to be under ten miles.

MOPA circuit

The CW transmitter employs three 3S4 tubes, one as a master oscillator and two in parallel as the power amplifier. A frequency range of from 2.35 mc to 6 mc is obtained through the use of two bands: LO band, 2.35-3.95 mc and HI band, 3.95-6 mc.

The power delivered to the antenna circuit is approximately 1 watt on the LO band and .75 on the HI band.

The power supply is a single dry battery containing three sections: A=1.5V, B=180V, and C=45V. This battery has a life of approximately three hours when operated three minutes ON and three minutes OFF. This life will be increased if there are longer OFF intervals.

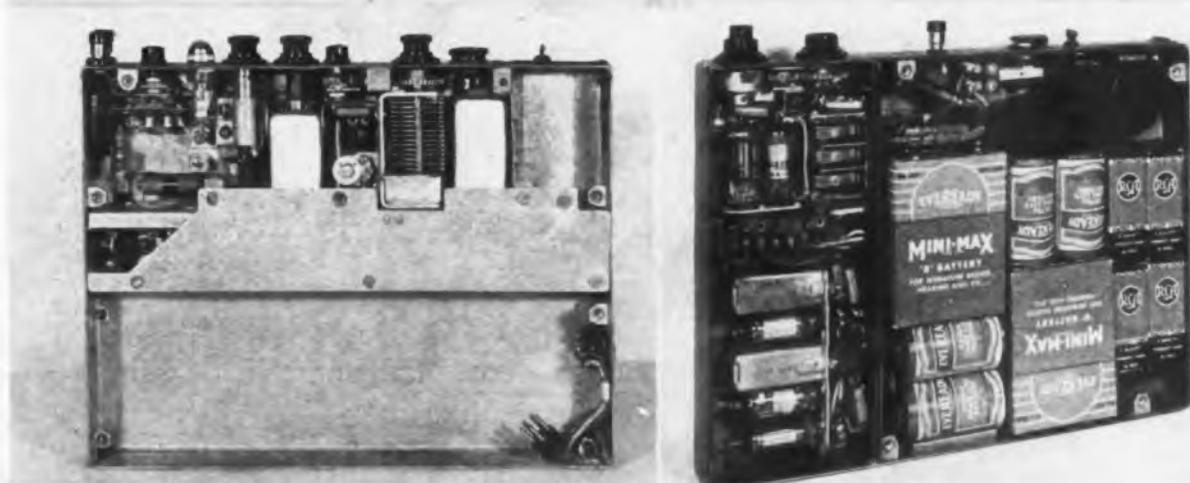
An additional socket is provided in the left side of the case to allow the use of an external power supply.

Two wires, each 25 ft. long, serve as antenna and counterpoise. The antenna circuit can be tuned to an antenna having a capacity of 20 mmf to 80 mmf. Coupling of the antenna circuit to the power amplifier tank is obtained through a variable mutual inductance. Tuning of the antenna is accomplished through the combined action of a permeability tuned inductance (ANT TUNING) and a switch (ANT SELECTOR).

Optimum tuning of the antenna circuit is indicated by maximum brilliancy of the ANT POWER bulb. This is a Mazda S49 tuning indicator connected across 3 ohms to A+ in the low side of the antenna circuit. The filament of this bulb is kept glowing at a minimum by the A battery, thereby increasing its sensitivity.

The power amplifier tank circuit uses two coils in series for the low frequency band. For the high frequency band, turns are shorted on one of the coils. Two additional coils (wound on the same form) are used for neutralization. The number of turns, and mechanical position is such that neutralization

These two views show (left) the transmitter with extra shield and battery, which fits in lower compartment, removed and (right) the receiver with the covers removed showing location of tubes and batteries. Spare set of batteries and tubes is carried. Headset accessible from front





Relative size of the equipment and the reason for its designation as a "Brief Case" set become apparent from these pictures which show the extremely compact construction of transmitter and receiver, shown separately at the right and packed together in a brief case of ordinary dimensions

is possible for either of the two bands with approximately the same setting of the 13 mmf neutralizing condenser.

The oscillator circuit is a Hartley with grounded anode. Two oscillator coils are used: one for the low frequency band, and both in parallel for the high frequency band. The main frequency adjustment is obtained by a two section variable condenser; one section tunes the oscillator coil and the other the amplifier tank circuit. Keying is accomplished by blocking the oscillator grid by a high negative bias. The unit was constructed to be

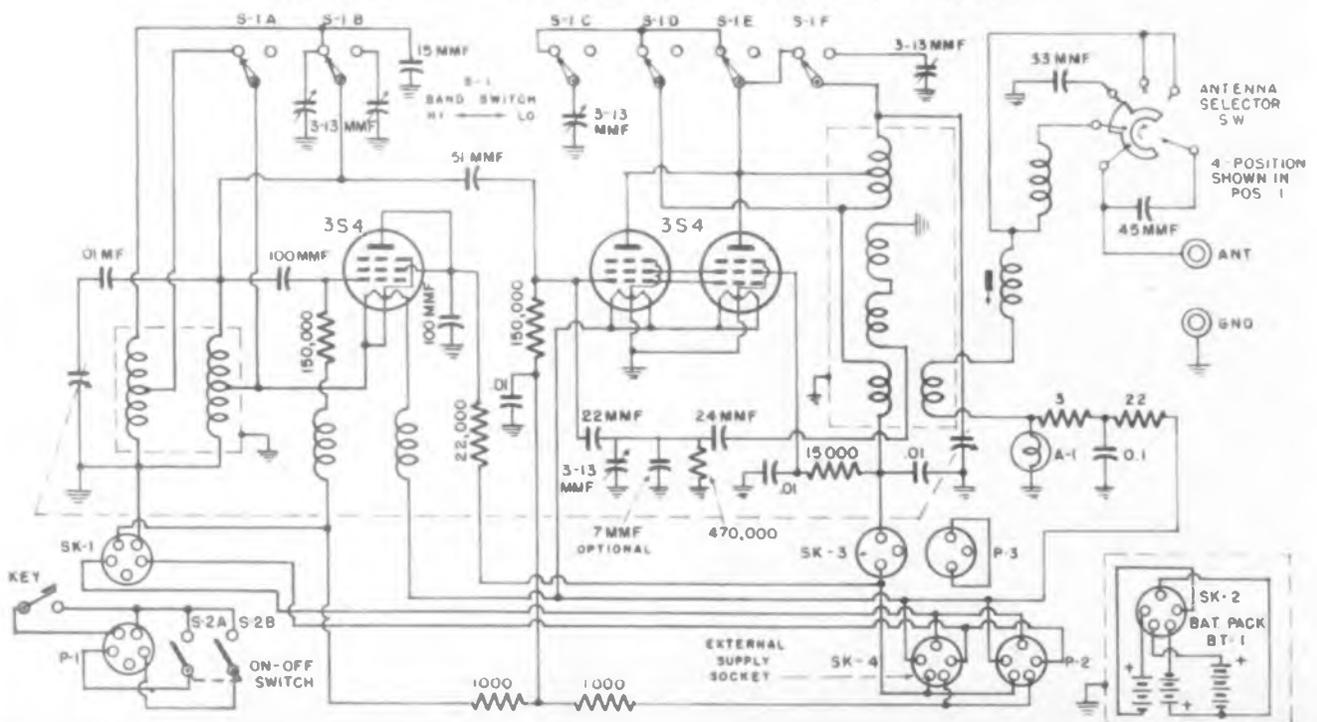
splash-proof. The case is steel with copper and electrolytic tin plating. The finishes are clear lacquer spray inside and olive drab outside. The lid is divided into two parts, each of which is held in place by machine screws and elastic stop nut tabs. The battery section may be opened without disturbing the rest of the unit. A small compartment is built into one end of the front to provide storage space for the antenna, counterpoise, allen wrench, and a spare tube.

The section containing the oscillator and power amplifier cir-

cuits affecting frequency is shielded additionally by a plate fastened to the main chassis. All three tubes are enclosed by this shield. A special plug is provided in the plate and screen supply to the power amplifier tubes; this plug is removed to open the B+ to the power amplifier during neutralization procedure.

The frequency dial is calibrated in megacycles and coupled to the tuning condenser shaft through a spring-loaded split-gear to prevent back lash. Change in both the antenna coupling and tuning is accomplished by a special lead-and-

Wiring diagram of the "Brief Case" transmitter which uses three tubes in a MOPA circuit



follow cam arrangement. This provides either forward or backward motion of the tuning element in a plane perpendicular to the controlling dial.

The key is a specially designed midget type, and contains the ON-OFF switch of the set. During use it is plugged into a jack (normally closed) on the front of the transmitter. It can be operated with its base as a conventional key on a flat surface; or the base may be removed and the key worked from the pocket of the operator.

The receiver is a two-band superheterodyne employing five tubes: 1-T-4 (RF amplifier), 1-R-5 (Det. and Osc.), 1-T-4 (IF Amp.), 1-S-5 (2nd Det. and 1st AF), and 1-S-4 (audio output). The power supply consists of one 67½ volt "B" battery and two 1½ volt "A" batteries. A single unit featherweight headset (12,000 ohms) and a ten foot antenna complete the necessary accessories. However, a spare set of tubes and batteries is provided and is carried in the set next to the battery compartment. The set is turned on by plugging the headset in a jack on the front panel; this closes "A" and "B" circuits.

The tuning range of the receiver is from 1970 to 6050 kc. This is accomplished by the use of two bands: Low (LO) 1970-3480 kc and high (HI) 3400-6050 kc. The IF is tuned to 455 kc. The receiver sensitivity is 20 microvolts or better at the antenna post for 1 milliwatt audio output.

The one stage of tuned RF makes possible a signal-to-noise ratio of



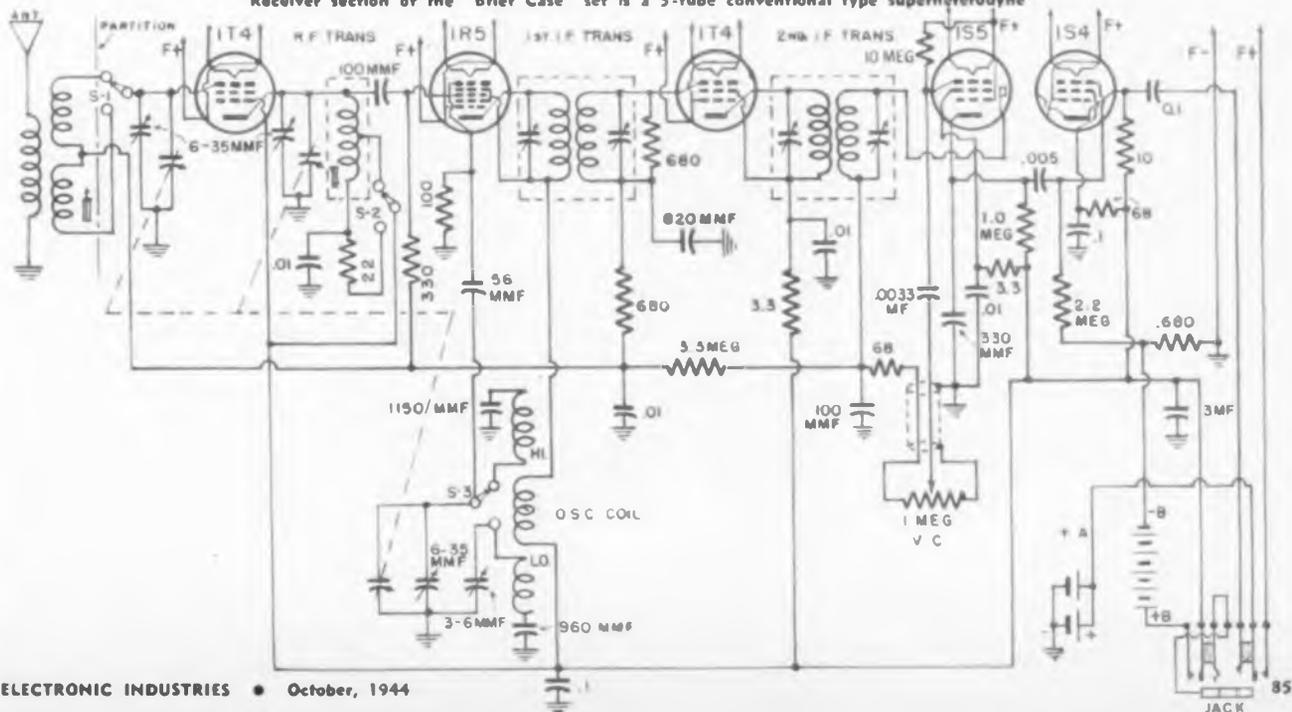
Two models originally were made, this being one of the first in which the battery was carried in a separate case that could be slipped into a slightly over-sized pocket. Note loop on receiver.

4 to 1 (power ratio) for 10 microvolts at the antenna. In addition it improves image rejection, and increases the overall gain. Image attenuation varies from 50 db at 20 mc to 34 db at 5.8 mc. The overall selectivity is not less than 6.2 kc at 2X and 60 kc at 1000X. The power output is 13 milliwatts maximum or 10 milliwatts for approximately 10 per cent distortion. (Measured with 12,500 ohm resistance load at output with full battery volages). It is possible to increase the maximum output by a change in the output bias voltage. However, this would be at a cost in "B" battery life. The current

consumption for the unit is as follows: Fil. 3 amp at 1.4V, plate 10.0 MA (max.).

The general construction and finishes of the receivers are the same as for the transmitter. All circuit components, with the exception of the antenna coils, output jack, volume control, and the 3 mf by-pass condenser are mounted on two chassis. A specially constructed 3-gang tuning condenser tunes the antenna, RF and oscillator circuits. The band switch is operated by a small knob concentric with the volume control dial. The switch is a composite of three SPST sliding contact switches.

Receiver section of the "Brief Case" set is a 5-tube conventional type superheterodyne



THE CYCLOTRON—ATOMIC

Atom smashing and production of artificial radioactive substances point to great industrial uses

● The Department of Terrestrial Magnetism of the Carnegie Institution of Washington has housed in one of its laboratories a huge instrument designed for research in nuclear physics and allied sciences. This instrument is called a cyclotron, and, with the one at the University of California at Berkeley, is one of the two largest in the world. There are over twenty of these instruments in the research organizations of this country, all roughly following the basic design of its inventor, Dr. E. O. Lawrence, who received the Nobel Prize in 1940 for its development.

Ion accelerator

A cyclotron is a positive ion accelerator in which the magnetic field of a powerful magnet forces the ions into a circular path. This path becomes a spiral if, in successive steps—one for each half revolution of the ions—an electric field from a radio-frequency source is utilized. This radio-frequency supply produces an alternating voltage on two semi-circular electrodes or "dee's" which are enclosed in an evacuated chamber placed between the poles of a magnet. These electrodes are hollow and have the same shape as if a large flat pill box were cut across a diameter and then both sections slid apart the distance of a few inches.

At the center of this gap thus formed is an ion source in which a tungsten filament is heated, emitting electrons which in turn are accelerated by an electric field to produce ions in the gas surrounding the filament region. This gas is introduced through the filament assembly and in most cases is deuterium (heavy hydrogen). After ionization the positive ion, namely a deuteron, is acted upon by the magnetic field and the radio-frequency voltage in the following manner.

Assume one of the electrodes to be at a negative voltage peak of the radio-frequency cycle, while the other one would be at the positive voltage peak. A positive ion will then be drawn over from the ion source to the negative electrode and, at a small velocity, will pass into the hollow interior. In this region no electric field exists and the charged particle, the deuteron, is only acted upon by the magnetic

The Carnegie Institution of Washington was founded by Andrew Carnegie to encourage in the broadest and most liberal manner investigation, research and discovery, and the application of knowledge to the improvement of mankind. The Department of Terrestrial Magnetism, under the direction of Dr. J. A. Fleming, is a part of this Institution, charged with the purpose of investigating the magnetic and electric conditions of the earth and its atmosphere. The cyclotron is the latest important acquisition of the laboratories of this Department, and was engineered and built by a group of physicists and engineers.

Many investigations have branched out from the work of the Institution and much basic scientific knowledge has been published during over forty years of its existence. In fact the subjects investigated over the years have been so well planned that over 90 per cent now is proving of primary importance to the military program.

All radio engineers know of the great amount of important knowledge gained about sunspot-activity and its effect on communications, from data correlated by this group. Among other things all forms of navigational compasses have received attention. The Department had charge of the magnetic survey ship, the Carnegie, during its many trips.

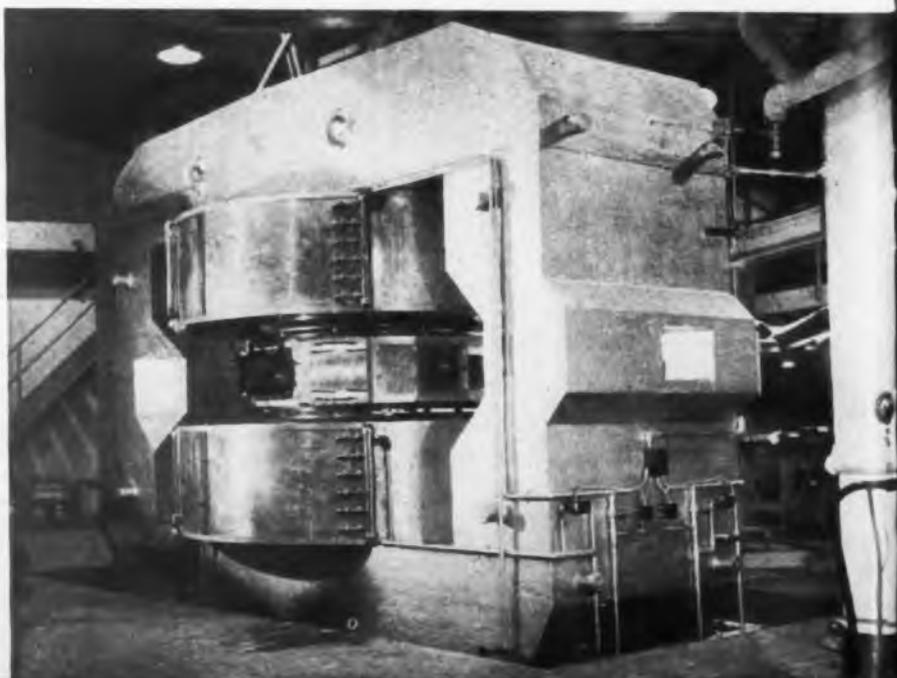
field which exerts a force at right angles to the direction of motion of this ion. This results in a semi-circular path inside the electrode.

The ion has not experienced any force from the radio-frequency voltage during its travel inside the hollow electrode. The voltage, however, on these electrodes has now changed, so that the negative electrode is now at a positive voltage peak while the opposite one has become negative. The ion, however, has now reached the gap between the electrodes and is attracted by the negative electrode into which it enters with an increased velocity. This is due to the gain in kinetic energy it acquired by the voltage difference between the electrodes, which results in the ion describing a larger semi-circle until it reaches the gap once again. Again the sign of the electric field has changed so that the ions are attracted by the first electrode and so on, the spiral increasing until the ions reach the periphery of the "dee's."

Each time this deuteron passes across the gap between the "dee's" it gains an increment in kinetic energy equal to the charge on the ion multiplied by the radio-frequency voltage between the electrodes. Thus, in a single complete revolution the gain in energy will be twice the "dee" voltage multiplied by the ion charge.

According to the laws of the motion of electric charges in a magnetic field, the angular velocity of a particle is a characteristic of

General view of Carnegie Institution cyclotron showing specially cast steel pole structure, field coils and "Dee" chamber in magnetic gap at the center. Field current is precisely regulated



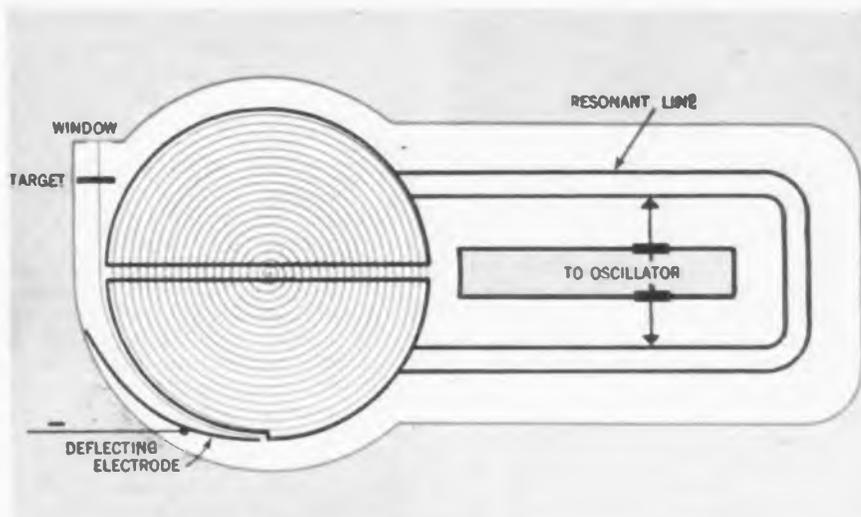
RESEARCH INSTRUMENT

This particle and of the field intensity, being proportional to this intensity but independent of the linear velocity of the particle. So each revolution of the ions takes the same time, let us say 0.1 millionth of a second for a deuterium nucleus (the positive ion) in a magnetic field of 13,000 gauss. This makes possible the use of a conventional radio frequency generator operating at about 10 megacycles to supply the accelerating voltage. But as several hundreds of individual accelerations are required for the ions to reach the periphery of the "dees" the coincidence between angular velocity (in revolutions per second) and the radio-frequency (in cycles per second) has to be achieved within a few tenths of a per cent. This coincidence is called "resonance," and is conveniently obtained by adjusting the current in the magnet. When the right value is found, the sudden sharp appearance of an intense ion current shows the "resonance."

Artificial radio activity

The final velocity of the ions is the same as the velocity which would be produced by a static voltage equal to several hundred times the voltage of the radio-frequency field. This resulting voltage may be as great as 10 or 15 million volts, and can be used to represent the speed or kinetic energy of the ions.

One of the most important applications of these high energy ions is the production of artificial radio-



Basic sketch of the radio frequency system connected to the "Dees", which by resonance builds up the ions' velocity successively during many revolutions before they are withdrawn through the target

active substances. It is a fundamental concept of matter that atoms of any element are made up of a central nucleus surrounded by electrons. This nucleus is extremely small relative to the size of the atom (100,000 times smaller in diameter) and has a positive electric charge, so that the positive nuclei and the negative electrons together form a neutral atom. This positive charge concentrated in the extremely small nucleus results in an enormous repulsive force to another positive nucleus directed toward it.

With the aid of the ion accelerator one can produce a "beam" of such incidence atomic nuclei hav-

ing enough speed to overcome these repulsive forces and penetrate into the nuclei of the atoms composing the "target." The result is a "nuclear reaction" leading to new chemical isotopes. A number of these are unstable, that is, radioactive, and they change progressively into other elements with the emission of powerful radiation, just as the natural radioactive elements of the radium family.

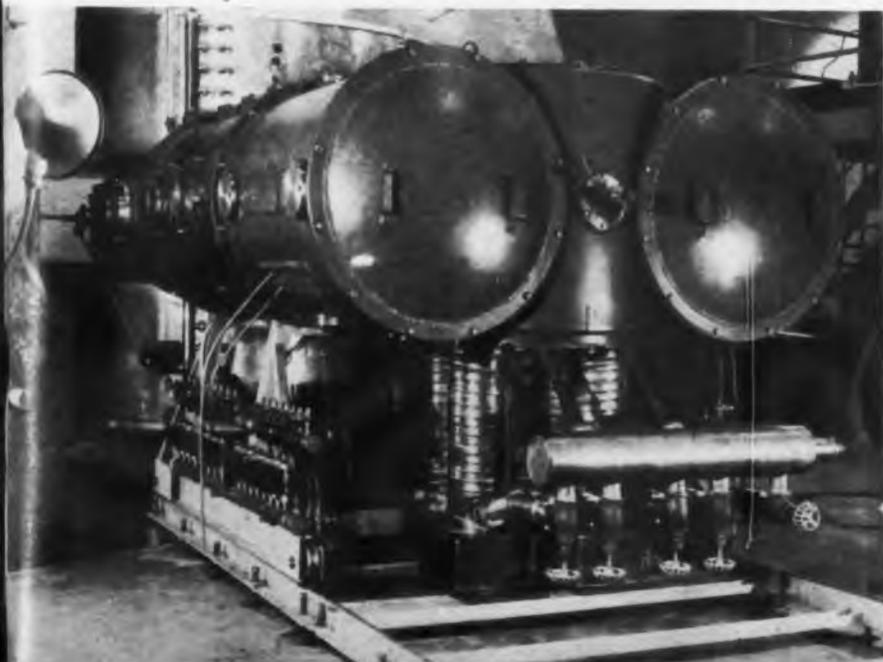
The narrow beam hitting a "target" placed between the "dee's" represents a flow of energy of several kilowatts which is converted into heat, except for a very small fraction. This heat, concentrated on a small area, is removed by water cooling. Nevertheless, the surface of the target may reach a very high temperature, particularly because the necessity of a good vacuum makes air cooling on the target surface impossible. Also a number of products, such as volatile organic materials, cannot be bombarded in vacuum.

Target bombardment

In this case it is necessary to take the beam first out of the "dee's" through a "slit" in their peripheric wall and then out of the vacuum chamber, through a thin aluminum foil window 0.001-in. thick. This window reduces the beam energy by about 0.5 million volts (for deuterons). To avoid melting the foil, in spite of the possible air cooling on one of its surfaces, it is necessary to spread out the beam in a wide area.

All these requirements are met

Radio frequency resonant line which is evacuated, together with the "Dee" chamber, with vacuum system. Assembly, mounted on rails, can be moved away from magnetic field for adjustment





Home of control equipment of Carnegie Institution cyclotron, and the associated laboratories. Cyclotron is in adjacent underground vault

by using an auxiliary electrode called a "deflector." This deflector is located on the outside of the "dee," parallel to the vertical peripheral wall so as to make a narrow channel between the "dee" wall and thin electrode. A negative potential of seventy to one hundred thousand volts applied to the electrode deflects the beam of deuterons away from the "dee" and redirects it through the aluminum foil window. On the far side of this window can then be placed the target to be bombarded.

The large 60-in. cyclotron of the Department of Terrestrial Magnetism is housed in a special building designed primarily for the operation of this instrument and research programs to be carried out. This building contains all of the control equipment and the auxiliary apparatus for many research projects but the cyclotron itself is buried 10 feet underground, in a mound at the right of this building (not shown).

Construction details

The most imposing feature of the instrument is the two hundred ton Armco magnet which is excited close to saturation by a 150 kilowatt motor generator. The generator is shunt-wound and separately excited for a close control of the magnet current.

The vacuum chamber housing the "dees" and in which the acceleration of particles is to be accomplished is made from 1½ in. thick aluminum alloy. Five in. Armco-iron lids are used on this vacuum chamber in order to reduce the air gap of the magnet and thus give a magnetic field higher than could be obtained if non-magnetic lids were used.

The chamber (above), about 60 inches in diameter, in which atomic particles are accelerated, is surrounded by the heavy magnet. This magnet is made up of four iron castings, the largest weighing more than 50 tons. This view is a close-up of the target end of accelerating chamber. (Below) The cyclotron itself weighs over 225 tons. It has height of more than 12 feet, and is 30 feet long and 20 feet wide. The cyclotron, with all research accessories and the building that houses the equipment and instrument shop took four years to build, and cost about \$500,000

Four 8-in. oil diffusion pumps connected in parallel exhaust the entire system into a large Kinney mechanical pump having a displacement of 34 cu. ft. per min. Measurements on the oil diffusion pumps showed that each pump has a speed of 2,000 liters per second. The whole arrangement of pumps, line, etc., can be rolled away from the magnet using an aligned track, as shown. The pressure in the cyclotron can be maintained with these pumps at about 5×10^{-6} of a millimeter of mercury.

The radio-frequency system consists of an exciter and a power amplifier, the exciter being driven by a master oscillator having a frequency stability of better than 1,000 cycles per second when working at a frequency of the order of 10 mc.

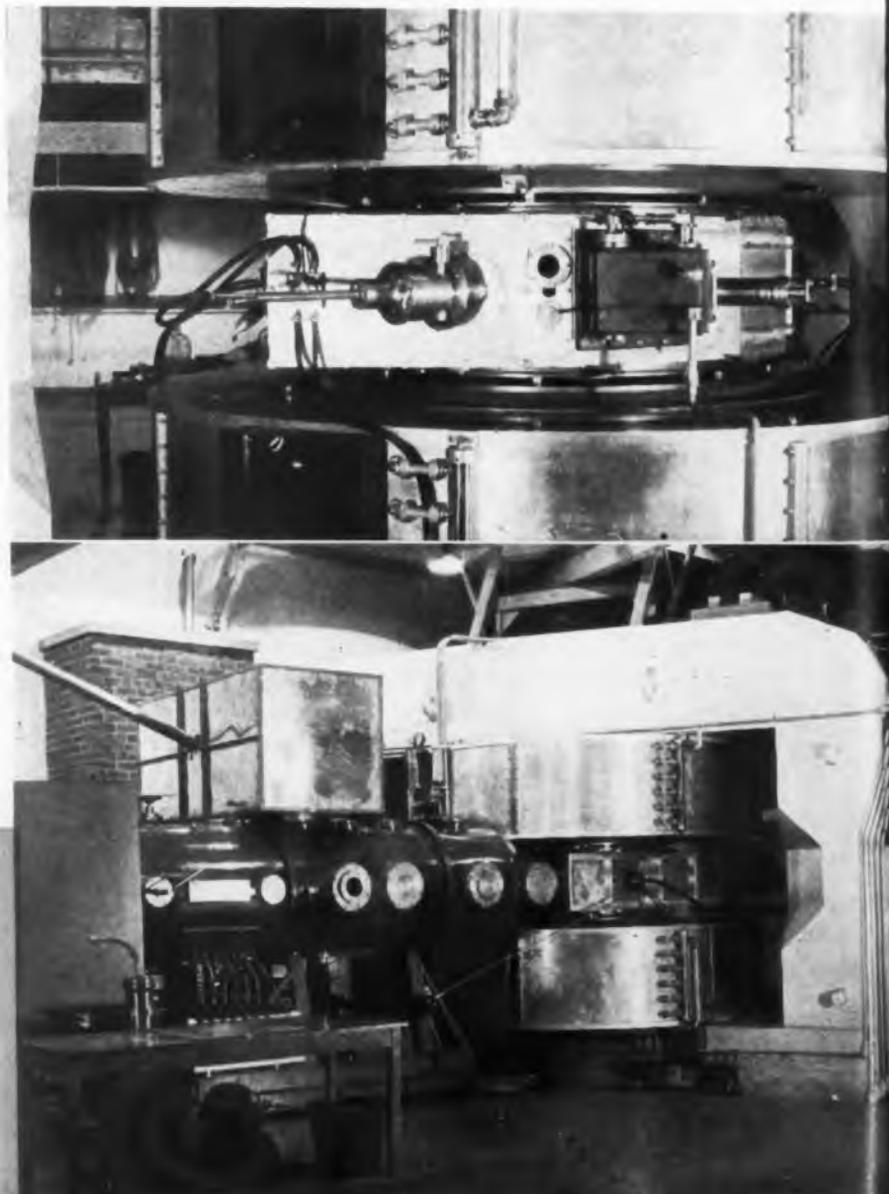
The final stage of the exciter is a pair of 833-A tubes operating in push pull. The tank circuit of this stage is fed to a 893 driver stage which in turn feeds into the final stage of the power amplifier oper-

ating at 10 megacycles. The final stage consists of two 893 water cooled tubes with a plate voltage of about 20,000 volts dc.

Remote control

A resonant line couples the tank of this power amplifier to the resonant circuit. The latter consists of the "dees" and the "dee" line and the associated vacuum chamber housing these components. The magnetic field is kept constant by a vacuum-tube circuit controlling the current through the magnet. Resonance is obtained between the magnetic field and the radio-frequency voltage by varying the frequency of the radio-frequency system while keeping the magnetic field constant. This variation is done electrically from the control desk by a method which changes the capacity of the resonant circuit.

All of the controls are housed in this control panel and desk, which is located in a control room some distance away from the cyclotron



itself. The magnet and the majority of the cyclotron components are housed in an underground room having more than ten feet of earth completely surrounding it. Entrance is through a pair of 12,000 lb. concrete doors which are shut when the cyclotron is in operation. This earth shielding and heavy doors protect the personnel from the radiation produced when the cyclotron is in operation.

Electrical circuits are all operated from the control desk and are interlocked so that they may be operated only in the proper sequence and protect the apparatus against overloads, failure of the cooling system or vacuum systems, or inoperation of the electrical supplies. This interlocking is accomplished by means of a number of contactors, relays, and various types of small switches and protective devices, some of which are shown on the panels in the cabinets behind the control desk and others in the rectifier room. The latter shows part of the trans-

formers and rectifiers used in the radio frequency system. All operations associated with interlocks are indicated by small lamps on the control desk.

The question may be asked why all the bother? What will ionic bombardment do for the medical science—or for any other science? One active form of research uses the beam of high velocity ions to bombard atoms of the various elements to produce atomic transmutations. A water-cooled target is used for this purpose, so that it does not melt by the action of the intense ion beam projected against it.

Ionic bombardment

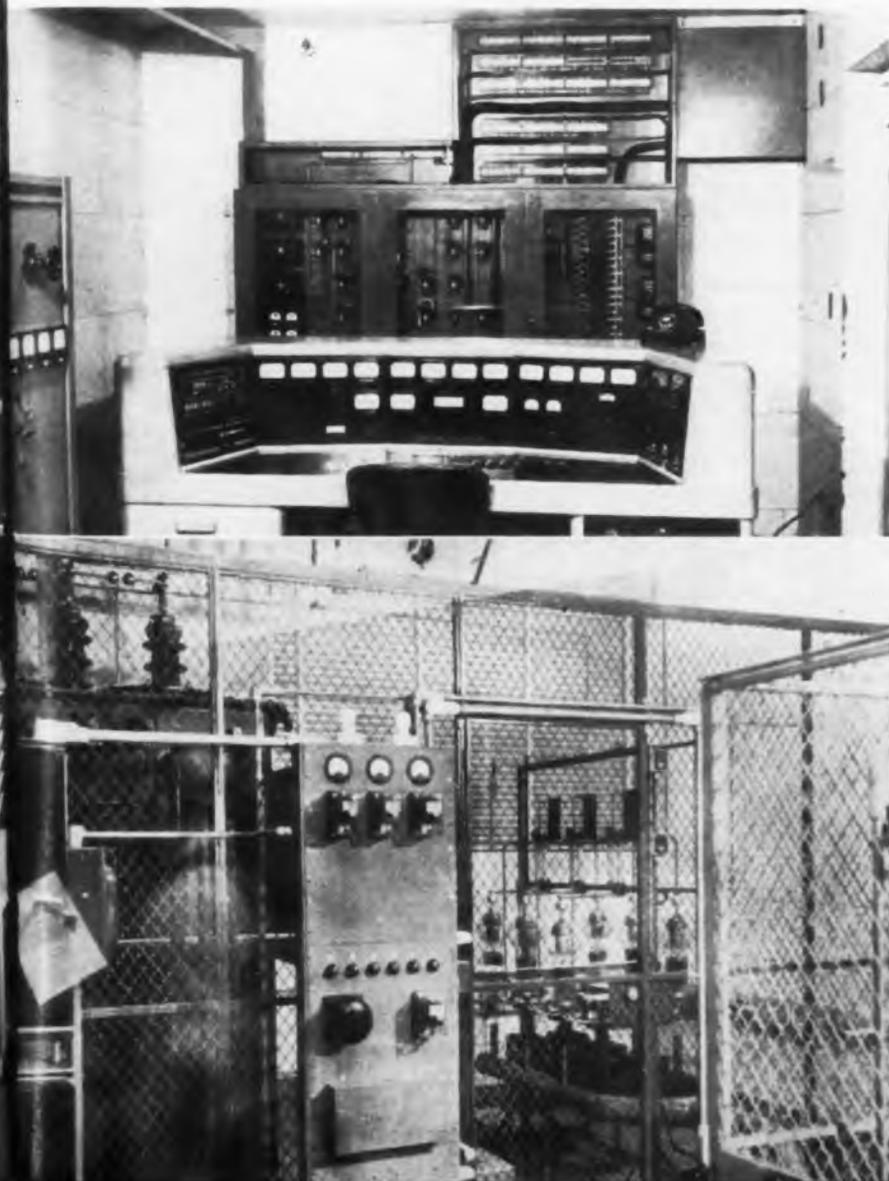
In view of the large number of ions in the beam many ions strike the nuclei of some of the atoms comprising the target. This action results in production of a radioactive atom accompanied by ejection of neutrons or protons. Each radioactive atom thus produced

may at some time later eject an electron or a positron in order to settle down as a stable atom. In this manner radioactive phosphorus has been produced which is highly useful in biological studies as a tracer agent or for therapy. Ordinary phosphorus (this has an atomic weight of 31) is bombarded with deuterons with the ejection of a proton producing a radioactive phosphorus isotope with a weight of 32. This phosphorus has a "half-life" of several weeks. That is, in this time half of the radioactive atoms will have emitted a beta ray and will have become stable atoms. In the next two weeks half of the remaining radioactive atoms will have gone through the same procedure. The half-lives of the various elements may be as long as thousands of years or as short as a fraction of a second.

Nearly all of the elements in the periodic table may now be made radioactive. Detecting apparatus, using electronic principles, has been developed that is sensitive enough to detect single radioactive atoms even though they are present to the extent of one in a million-billion normal atoms. These "tagged" atoms can be introduced in a body as tracers, and their movement throughout the body can be followed. This is opening up many new fields for experimentation in physical, chemical, and biological research. Radioactive phosphorus, iodine, sulfur, potassium, sodium, and other artificially activated salts are being used in this way in investigations concerning the treatment of malignant diseases. Direct radiation by fast neutrons is being compared with that of natural radium for therapy applications.

Hundreds of stable isotopes have been found in nature, and many hundreds of others have already been produced by bombardment processes. The importance of the role of this equipment in industry can hardly be imagined at this time, as there are so many known but unexplored possibilities that have come out of present research.

(Above) Control console from which all parts of operation can be initiated and observed. Interlocks and safety features which have been engineered and constructed with greatest precision are to be found in all vital parts of the circuit. Part of control relays, etc., are in cabinet at rear. Additional controls are in rectifier room, part of which appears in lower photograph. Since no one can ever see the cyclotron in operation with safety, all operational characteristics are studied by their effects on associated equipment. Master switches on doors leading to the powerful high-voltage parts of the laboratory automatically cut off all power when these doors are opened, to prevent accidents to anyone happening to be in the laboratory while the power is on



CATHODE FOLLOWER CIRCUIT

by WILLIAM MOULIC

Associate Editor

Basic relationships of cathode loaded amplifiers including mathematical and graphical calculations for voltage

• The use of a vacuum tube as an impedance transformer is well known. The basic circuit for this type of operation is the same or similar to that of Fig. 1. The output voltage E_o of the vacuum tube stage appears across the parallel combination of a load impedance and cathode circuit impedance. These impedances may, of course, be simple or complex. The plate circuit of the vacuum tube is at ground potential as far as the signal current is concerned. This is

accomplished by the low reactance capacitor C. One hundred per cent negative feedback is employed since the entire output voltage E_o is series opposing with the applied signal E_s . The available grid voltage E_o is, therefore, $E_s - E_o$.

The equivalent AC circuit for the conventional cathode follower stage is shown in Fig. 1B. The inter-electrode tube capacitances are shown connected across the various sections of the circuit. The grid to plate capacitance C_{op} is shunted di-

rectly across the input terminals along with the series combination of the grid to cathode capacitance C_{GK} , and the plate to cathode capacitance, C_{PK} . The input circuit loading is due primarily to C_{GK} and would, therefore, be less severe when a pentode or other screen grid tube is used. In the output circuit the plate to cathode capacitance is across the load but since this is usually a low impedance circuit the effects on frequency response would be small.

In the following formulas given in Fig. 2 and Fig. 4, the load impedances are considered to be simple, that is, pure resistance and the effects of the inter-electrode capacitances are ignored. Where the frequencies involved are such as to make the inter-electrode capacitances as well as other straight L and C combinations important, the complex impedance combinations can be employed in the equation in place of the resistance components given.

The amplification or voltage gain of the cathode follower circuit, as given in Fig. 1, is always slightly less than 1. This is obvious from examination of the circuit wherein the voltage E_s must always be greater than E_o by the grid voltage E_o . As a voltage amplifier, the cathode follower will produce the same gain as a hypothetical tube having an amplification factor $\mu' = \mu / (1 + \mu)$ and a plate resistance $R_p' = R_p / (1 + \mu)$. The output voltage E_o is given by equation 1 in Fig. 2. Where the plate resistance R_p is large in comparison with the parallel combination of R_k and R_L the voltage output is given by equation 1A. The effect of the 100 per cent feedback used in cathode followers is to reduce the apparent amplification factor to approximately 1 and to divide the AC plate resistance of the tube by a factor $1 + \mu$.

The output impedance of a cathode follower stage is that impedance looking back toward the tube from the load R_L . This value is given by equation 3 in Fig. 2. The general expressions for the load current I_L flowing through the

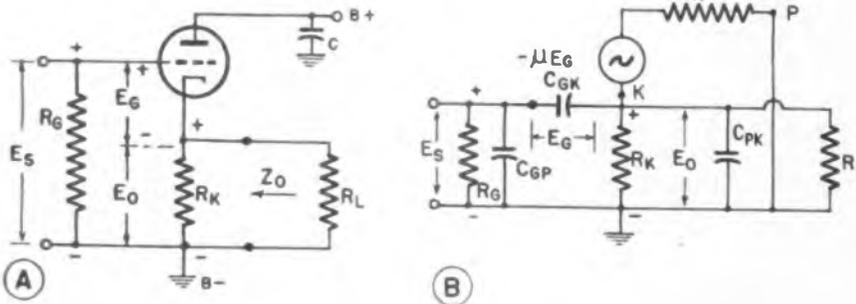


Fig. 1 (Above)—Simplified circuit of cathode follower used as low output impedance voltage amplifier. Capacitor C grounds plate for all signals. Equivalent circuit at B. Fig. 2 (Below)—Gain, output impedance, current, and voltage relationships for linear operation of Fig. 1

CATHODE FOLLOWER VOLTAGE AMPLIFIER EQUATIONS	
OUTPUT	MATCHED IMPEDANCE
$E_o = E_s \cdot \frac{\mu' Z}{R_p + Z}$ (1)	WHERE
$E_o = E_s \cdot \frac{G_m Z}{1 + G_m Z}$ (1A)	$R_L = Z_o = \frac{R_p \cdot R_k}{R_p + (1 + \mu) R_k}$
WHERE	$I_L = \frac{G_m \cdot E_s}{2}$ (6)
$\mu' = \frac{\mu}{1 + \mu}$	$E_o = E_s \cdot \frac{G_m \cdot R_L}{2}$ (7)
$R_p' = \frac{R_p}{1 + \mu}$	$\alpha = \frac{G_m \cdot R_L}{2}$ (8)
$Z = \frac{R_k \cdot R_L}{R_k + R_L}$	$G_m =$ TRANSCONDUCTANCE IN MMOS
GAIN	$R_p =$ AC PLATE RESISTANCE OHMS
$\alpha = \frac{E_o}{E_s} = \frac{\mu' Z}{R_p + Z}$ (2)	$\mu =$ AMPLIFICATION FACTOR
OUTPUT IMPEDANCE	
$Z_o = \frac{R_p \cdot R_k}{R_p + R_k} = \frac{R_p \cdot R_k}{R_p + (1 + \mu) R_k}$ (3)	
LOAD CURRENT	
$I_L = \frac{E_o}{R_L} = E_s \cdot \frac{\mu' R_k}{R_p (R_L + R_k) + R_k R_L}$ (4)	
TRANSFER ADMITTANCE	
$Y_T = \frac{I_L}{E_s} = \frac{\mu' R_k}{R_p (R_k + R_L) + R_k R_L}$ (5)	

load R_L and the transfer admittance Y_T are given by equations 4 and 5. In the case of a matched impedance where R_L is equal to the output impedance Z_o , the load current, output voltage and the stage gain are given by equations 6, 7 and 8 in Fig. 2.

The cathode follower is also useful as an output stage or power amplifier particularly since the load impedance normally used in output stages is low. When the cathode follower is used as a power amplifier to drive a dynamic loudspeaker, the low impedance which the speaker voice-coil sees looking back toward the stage provides a high degree of damping which improves overall performance.*

Fig. 3 is the cathode follower used as an output stage in which the output transformer T reflects the load resistance R back to the cathode circuit, this reflected load being shown as R_L . In the equivalent AC circuit of Fig. 3B, only the AC reflected load R_L is considered, losses in the transformer and so forth being neglected.

The power output from such a stage in terms of the signal voltage E_s , is given by equation 1, Fig. 4. The power output in terms of the voltage between grid and cathode E_{GK} is given by equation 2 and this is identical with the power output that would be delivered by a tube operating in a conventional manner, that is, with the load impedance in the plate circuit and no feedback. This is apparent since the tube does not know what type of circuit it is operating in and, therefore, for the same voltage E_{GK} , it will deliver the same output in any circuit other things remaining the same. As a cathode follower the load resistance R_L can be made equal to R_p in which case the power output is given by equation 3 in Fig. 4. If equation 1 of Fig. 4 is differentiated with respect to R_L , and equated to zero, it is found that the maximum power is delivered, for a given signal voltage E_s , when $R_L = R_p / (1 + \mu)$. This is in keeping with the general idea that a load resistance is equal to the internal resistance of the generator for maximum power when it is recalled that as far as the input signal E_s is concerned the tube has an internal plate resistance of $R_p / (1 + \mu)$.

The conventional plate characteristic curves given in tube data books can be used to predict performance of the tube as a cathode follower. If the plate voltage scale of the particular characteristic in question is divided by a factor of $1 + \mu$, the resultant curves are those

(Continued on page 178)

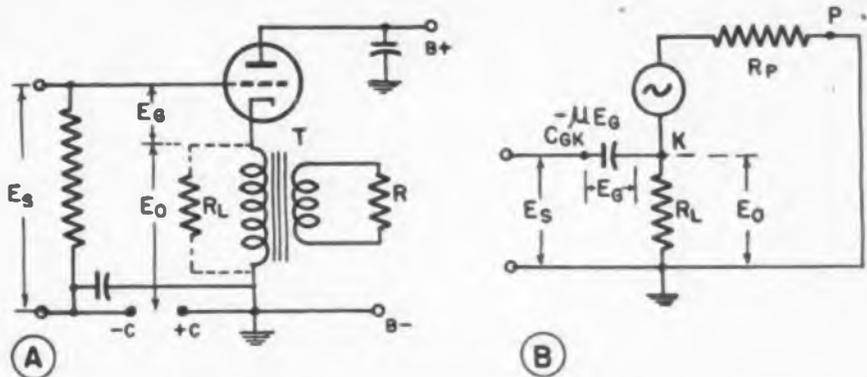


Fig. 3 (Above)—The cathode follower as an output stage and equivalent circuit at B. Ideal components and linear operation is assumed. Fig. 4 (Below)—Power output equations for linear operation of cathode follower

CATHODE FOLLOWER POWER AMPLIFIER EQUATIONS

① $P_o = \frac{E_s^2 \mu^2 R_L}{[R_p + R_L (1 + \mu)]^2}$

② $P_o = \frac{E_{GK}^2 \mu^2 R_L}{(R_p + R_L)^2}$

③ $P_o = \frac{E_s^2 \mu^2}{R_p (2 + \mu)^2}$
WHERE $R_L = R_p$

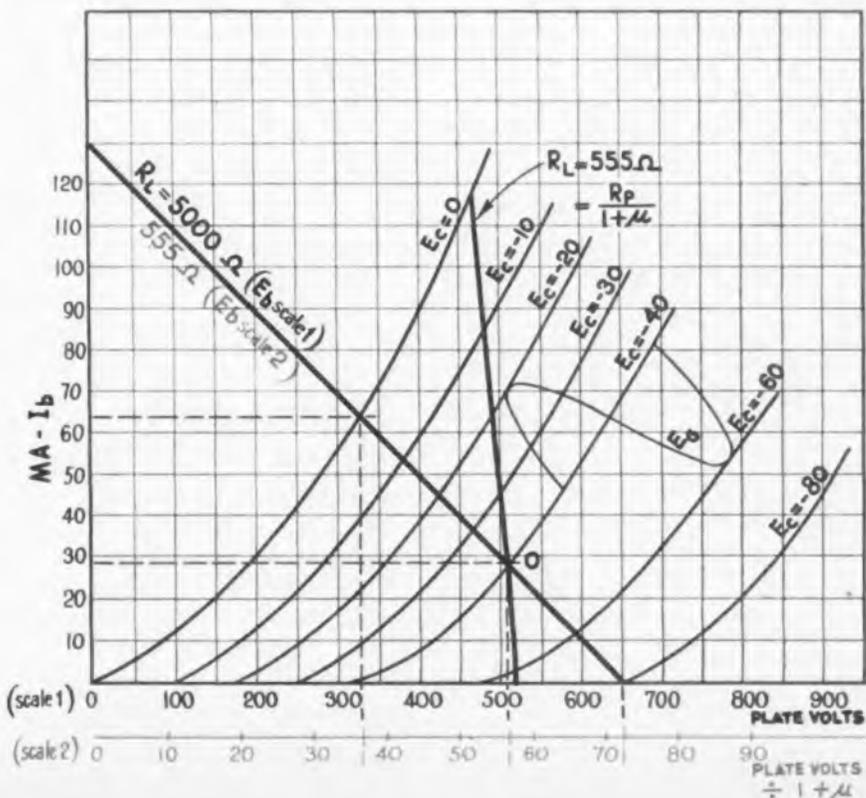
④ $P_o = \frac{E_s^2 \mu^2}{4 R_p (1 + \mu)}$
WHERE $R_L = R_p = \frac{R_p}{1 + \mu}$

⑤ % REMAINING DISTORTION = $\frac{(R_p + R_L) D}{R_p + R_L (1 + \mu)} \times 100$

⑥ % REMAINING DISTORTION = $\frac{D}{2} \times 100$

WHERE $R_L = \frac{R_p}{1 + \mu}$
D = ORIGINAL DISTORTION

Fig. 5—Plate characteristic of type 801 showing method of dividing plate voltage scale by $1 + \mu$ to give dynamic operation characteristics of cathode follower. Static values must be taken from normal scale



*Cathode Follower Output Stage, C. J. Mitchell—Wireless World, April 1944

PRECISION LEVELING

by PAUL BENNETT

Electronic equipment used to insure accuracy in alignment of aircraft tool dock to within limit of .0005 in.

● The degree of accuracy with which certain large jigs may be laid out depends on the precision with which the tooling dock, or three-dimensional surface plate, has been leveled. There are available precision levels with an accuracy of about one thousandth inch per two feet of length, and optical methods may sometimes be used up to a few feet with a comparable accuracy, but far better means must be employed to obtain very good accuracy over distances of 15 ft. and more.

This problem arose when the Aircraft Engineering and Design Co. of Beverly Hills, California, was installing a new tooling dock at what was then the Vega Airplane Co. The main part of this dock consists essentially of a framework supporting two rails with precision ground surfaces, 25 ft. long and 10 ft. apart. These rails support a carriage by means of which a point may be located in space, relative to the dock or some other point, by measuring along the rails, across between them, and vertically from them.

The rails were made in 4 ft. sections, individually machined and ground. After wedging and clamping them in position on the frame, they were "frozen" into place with cerro-matrix, a metal with a low melting temperature. Before this final operation, it was required

that all sections be in the same level plane within one-half thousandth inch.

In order to establish a reference plane, use was made of mercury pools, identical in shape and size, one placed at a reference point, the other at various points as they were leveled. The pools were connected with flexible tubes, a reservoir with an adjustable plunger being used to regulate the height of the mercury surface. The reference point chosen in this particular case was the first section set into place.

Precision requirements

Having established a reference level, a means was sought to transfer or measure from this to the surfaces being leveled. Electrical contact with the surface of the mercury is impractical for at least two reasons. First, a measurement closer than about one thousandth is difficult to make in this way, due to the pressure needed for contact with the mercury. Second, it is desirable to have an easily obtained indication of the actual distance above the reference plane in order to facilitate adjustment of the surfaces to the proper level.

This was accomplished by supporting a plate above the surface of the mercury in each pool, and measuring the capacity between

the plate and the mercury. The plate size was chosen to give a capacitance of about 100 mmf at a distance of .020 in. By using a small level across the surface being leveled, it is quite easy to avoid errors arising from non-parallel surfaces.

It will be seen from Fig. 1 that the measuring circuit used is a simple series resistance-capacitance bridge circuit. Except for slight readjustments of R_1 at various mercury levels, the bridge is always balanced in the same proportions, since a decrease in the capacity due to moving the mercury and the capacity plate farther apart is compensated for by adding an equal increment with the calibrated variable condenser. In order to make the instrument easier to use, the condenser dial is calibrated directly in thousandths of an inch. Adjustment at one point is accomplished by substituting for the mercury pool a precision ground block of steel of such dimensions that it forms a gap of .020 in. between itself and the capacity plate. With the main dial set at .020, the bridge is carefully balanced by means of C_1 (Fig. 1), varying R_1 to obtain a precise balance.

Since the capacity between the mercury and the capacity plate varies inversely with the distance between them, the increments in

Fig. 1—Fundamental measuring circuit for precision leveling

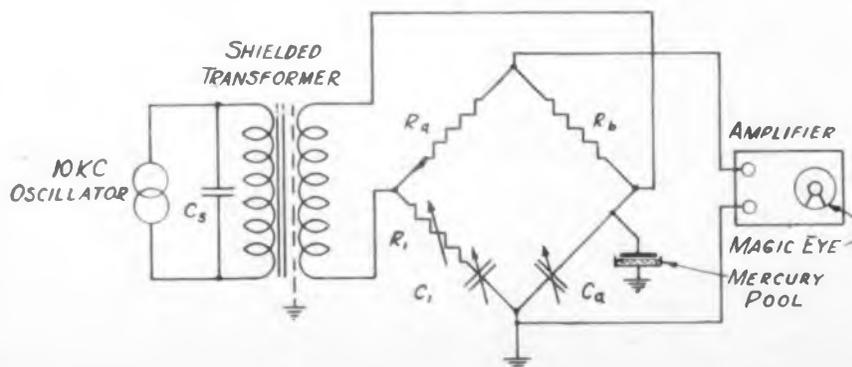
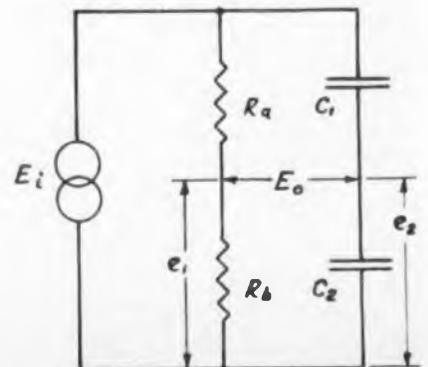


Fig. 4—Equivalent bridge circuit



capacity to be obtained from C_1 become smaller as the distance is increased, thus crowding the divisions at one end of the dial if this condenser has semi-circular plates. This effect is still worse if the conventional straight-line-frequency type of condenser is used.

However, by using a condenser with semi-circular plates and having an incremental capacity of about 340 mmfd, and operating it in series with a fixed padding condenser of 150 mmfd, a scale substantially linear is obtained having the one-thousandth in. divisions about two-tenths inch apart around a $4\frac{1}{4}$ in. dial. This covers a total range of from 0.016 to 0.050 in.

The shielded transformer serves a dual purpose. It is used not only for an isolated source for the bridge circuit, but also as the tuned circuit which determines the frequency of the oscillator, and to suppress harmonics. This last is necessary because the various arms of the bridge usually contain some inductance which will cause the balance at a harmonic to be other than that at the fundamental. The frequency used is about ten kilocycles. The transformer is electrostatically shielded to avoid capacity coupling between the oscillator and any part of the bridge.

It is not necessary to keep the capacity between the output winding of the transformer and ground particularly small, since each instrument is calibrated with its own transformer, but it is essential that the existing characteristics do not change over a period of time or with normal temperature changes, as this would affect the dial calibration.

In Fig. 2 is shown the oscillator circuit. The plate load of the oscillator tube is the parallel-tuned primary of the bridge transformer, with the plate coupled to the grid through the phase-shifting network $C_2R_2C_3R_3$. The loss through this network is adjusted to the point at which stable oscillation is just maintained.

Fig. 3 shows the circuit of the null detector. In operation, the output voltage from the bridge is fed to the grid of the amplifier tube. The output from the plate is rectified by the diode plate in the same tube, charging the condenser C_8 , thus applying a negative voltage to the grid of the magic eye tube through the resistor R_6 , filtered by C_7 .

A negative voltage applied to this grid causes the shadow angle to decrease, showing the bridge to be unbalanced. Bridge balance is obtained when the shadow angle is maximum. The sensitivity control R_4 is provided since the voltage

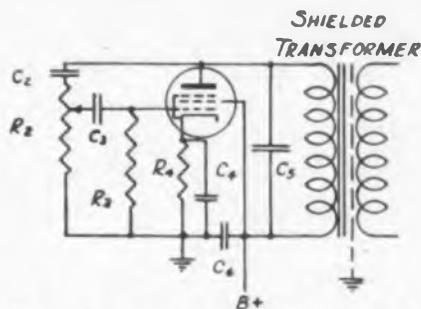


Fig. 2—In the oscillator circuit, plate load is the parallel tuned primary of bridge transformer

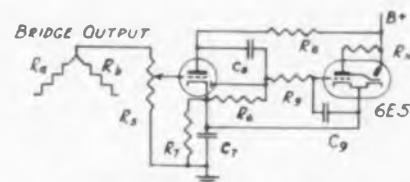


Fig. 3—Circuit of the null detector

sensitivity of the detector is high to facilitate precise adjustment, while a low sensitivity is required when the bridge is considerably out of balance, the sensitivity being advanced as balance is approached. The voltage gain of the amplifier is approximately 50, while the diode rectifier responds to the peak of the output signal. Therefore the bias applied to the grid of the magic eye tube is approximately equal to 50 times the peak voltage from the bridge output applied to the grid of the amplifier tube.

Considering Fig. 4, it will be seen that the bridge output voltage is the difference between the voltages across R_6 and C_7 . Thus, if E_1 = voltage across bridge transformer secondary, and E_2 = voltage output from bridge, then

$$E_2 = E_1 \left[\frac{R_6}{(R_6 + R_7)} \right] - E_1 \left[\frac{C_7}{(C_7 + C_8)} \right] \quad (1)$$

With $R_6 = R_7$ by design then (1) becomes

$$E_2 = E_1 \left[\frac{1}{2} - \frac{C_7}{(C_7 + C_8)} \right] \quad (2)$$

When $C_7 = C_8$, $E_2 = E_1 \left(\frac{1}{2} - \frac{1}{2} \right) = 0$, and the bridge is balanced. It was explained earlier that the plate size was chosen so that the capacity of it to the mercury pool is 100 mmf when the space is .020 in. Since the capacity is inversely proportional to the distance, a decrease in the distance to .0002 in. will increase this capacity by about 1 mmf. The stray capacity encountered in the bridge transformer and the wiring is about 100 mmf in parallel with the mercury pool capacity, or 200 mmf total. This stray capacity is quite constant. Thus, for a change of .0002 in. we have a change in C_7 of 1 mmf, or an increase from 200 mmf to 201 mmf. Substituting in (2), we have

$$E_2 = E_1 \left[\frac{1}{2} - \left(\frac{200}{401} \right) \right] = .00125 E_1$$

Since this voltage E_2 is applied to the grid of the amplifier, the bias applied to the magic eye tube is:

$$50 E_2 \text{ PEAK} = 50 (.00125 E_1 \text{ PEAK}) = .0725 E_1 \text{ PEAK} \quad (3)$$

An inspection of the characteristics of the 6E5 tube shows that a negative bias of 1 volt will close the shadow angle by ten to twenty degrees, an amount easily observed. In order to obtain such an indication with .0002 in. divergence, E_1 must be of such a value that

$$.075 E_1 \text{ PEAK} = 1 \quad (4)$$

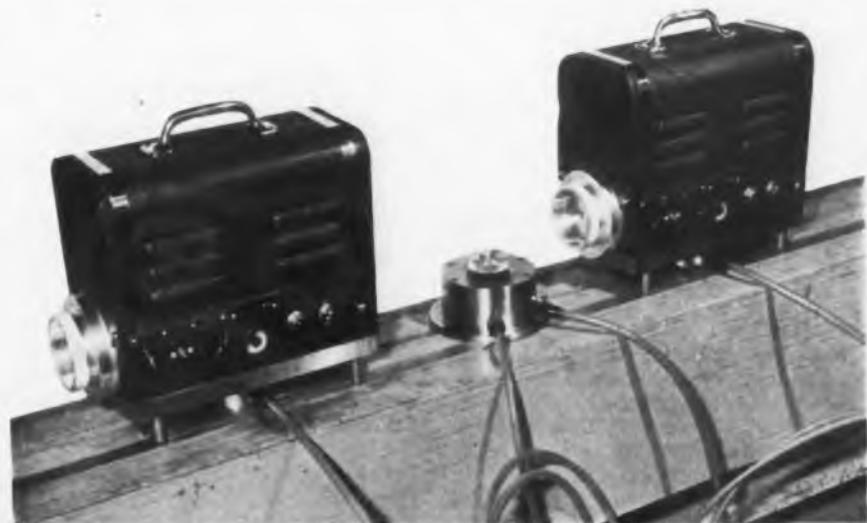
$$\text{OR } E_1 \text{ PEAK} = 13.8 \text{ VOLTS PEAK} \quad (5)$$

It is quite easy to obtain more than this with good waveform, using the circuit shown.

In actual practice it has been found quite easy to observe a five degree change in shadow angle, so that it is possible to detect a divergence of .0001 in., which is several times the sensitivity required in this particular instrument.

(Continued on page 206)

General appearance of two of the electronic leveling instruments as set up for making measurements, the mercury-pool capacitor being shown in the center



LATIN-AMERICAN



Rio de Janeiro, second largest city in South America, has upward of a million home receivers and represents a great market for development

● What is the nature of the Latin American market and what prospects does it have for the radio industry? Taking the physical considerations first, the territory we are dealing with is divided into three main areas: South America, Central America and Mexico and the Caribbean islands.

To afford some idea of the areas and distances involved, Brazil alone is larger than the United States plus another Texas. If you could stretch the Republic of Chile across the United States from coast to coast, it would dangle over in both oceans. Tiny Uruguay, the Rhode Island of South America, has a greater area than New England.

Latin America has a total population of 131,251,725, almost equal to that of the United States, but in an area two and a half times as large. Spanish is spoken in all the countries except Brazil, where Portuguese is spoken. The small French, Dutch and British colonies use the languages of their own nationals.

Industrial revolution

Stimulated by war needs and shortages, many new industries have been developed in Latin American countries, and old ones expanded. Many U.S. manufacturers are planning, or have already established, branch factories in Brazil, Mexico, Argentina, and other countries.

The significance of this is that industrialized nations demand the high-quality commodities, products and appliances in which the United States excels. In normal times, the industrialized countries form the best export markets for the U.S. Thus, in an industrialized Latin America, the market for a wide range of imported, manufactured products now confined to perhaps 25,000,000 people, will be vastly expanded.

The basic influences which are creating new and growing markets in Latin America for radio and other products are: (A) new local industries; (B) diversification of production; (C) wider distribution of income; and (D) extensive government programs for the development of resources. Industrialization, coupled with the efforts of governments to raise living standards, will result in wider demand for the necessities and luxuries of life.

In any assay of the Latin American markets, it should be borne in mind that there are no fully dependable statistics, and figures will vary, even when they come from official sources. In the study of the Latin American radio field, there are three important factors:

1. Low Saturation: In each country, there is a wide difference between population figures and the number of radio sets in use. The limiting factor is not population,

but purchasing power. There are still millions of people, white, black, and Indian, with only bare subsistence means, whose entire income must go for food and shelter. As living standards rise, however, new customers are created and in recent years governments in every country have done much to improve living and working conditions.

2. Illiteracy: Because of the high illiteracy rates, business and government depend on radio to reach the masses of the people. In many communities, loudspeakers in the parks and plazas are set up to bring information, entertainment and educational programs to as many people as possible. In Argentina and Mexico, messages may be recorded at the post offices for transmission by mail, for the benefit of the illiterate. Up to the outbreak of the war, extended time payments and "radio clubs" were the rule for reaching these low-income groups.

3. Hydro-Electrification: Practically every country is developing extensive programs for hydro-electric power because of the general lack of coal. Previously, in rural areas especially, no electricity was available. In other districts, electricity is available for a few hours only at night. As more power plants are installed, more radio sets and other home appliances will come into use and governments are mak-

MARKETS for HOME RADIO



These towers in the Andes are those of Cia Radio Boliviana, at La Paz

ing efforts to provide power for both home and industrial use.

These three influences, applied to a condition of improved purchasing power, will create better markets for every branch of the radio industry. Following is a brief summary of conditions in the major individual markets which provides some basis for postwar expectations:

Mexico

Mexico ranks high as a radio market. It is a mining and agricultural country and its economy has long been maintained principally through the export of its minerals. The war has greatly stimulated the export of these strategic materials. A large number of projects has been started by the government to develop the country's resources and to help raise the people's living standards.

Mexico, at present, is accumulating extraordinary buying power and activity in mining and other strategic industries has expanded internal purchasing power and trade. The republic has about five hundred electric plants but less than 5 per cent of the surveyed hydro-electric capacity of Mexico has been harnessed. However, the Federal Electricity Commission reported that \$2,500,000 will be spent for electrification in 1944 alone.

With a population of over 19,900,-

000, latest reports indicate that there were about 650,000 to 700,000* radio sets in use in Mexico in 1943. As an indication of postwar possibilities, it is noteworthy that the Azcarraga interests, which dominate the entertainment industry, broke ground last fall for the building of "Radiopolis," Mexico's Radio City. Network broadcasting has made great strides in Mexico, and the country is noted for its abundance of radio talent. Transcriptions and records are also made locally by branch plants of American manufacturers.

South America

The South American countries have varied and valuable resources which will be benefited by expanding highway, railway and airplane services. Each country is improving its internal communications, according to the availability of equipment and materials. At the end of the war, this activity will be stimulated.

Hydro-electric power is at the top among the projects for immediate and postwar attention because South America has little or no coal and there is no petroleum available in some of the highly industrialized areas.

Cuba

The size of the Cuban market depends on the quantity of sugar



Statistics covering number of home receivers in use in Latin America are difficult to obtain but these are believed reasonably accurate. See footnote appearing on page 212

sold in foreign markets. Since 1941, the general prosperity of the island has raised standards as a whole and, with the return of shipping to normal, American sugar consumption after the war will keep business in Cuba at a high level.

Cuba now has 210,000 radio sets for a population of 4,750,000. The island is overrun with radio stations—there are 35 in Havana alone—with unstable broadcast frequency variations and excessive commercials. The widespread public interest in radio is indicated by the number of radio “fan” publications in existence.

Brazil

Brazil is definitely on its way to a firmer and more stable economy. It has made marvelous gains in the last few years and has achieved wide industrial development. At the end of 1943, stocks of gold and foreign exchange totalled more than half a billion dollars. It is the largest buyer of U.S. goods among Latin American countries and we supplied 50 per cent of all its imports in 1942.

For workers in its many new industries, the country has drawn heavily on the low-income population, thereby contributing to the rise in general purchasing power.

Brazil is sixth among the nations of the world in potential hydro-electric energy. The Brazilian Minister of Finance recently estimated that the present deferred demand for imported machinery and equipment amounted to \$90,000,000 and for durable consumer goods, such as radio and refrigerators, \$25,000,000. These estimates were based entirely on prewar consumption and do not allow for any accelerations which might reasonably be taken into account.

The number of radio sets in Brazil is estimated at varying figures up to one million*† (1942). Two years ago, Radio Nacional, one of the largest and most important stations on the continent, was inaugurated by the government in Rio de Janeiro, and there are good stations in Sao Paulo, Porto Alegre, and other cities along the coast.

"In the final analysis, foreign trade after the war hinges to a great extent on what business men do about it. There is nothing automatic about any market. Much depends on the ingenuity, aggressiveness, resourcefulness, planning and marketing intelligence of individuals. In the long run, trade promotion and constructive advertising are just as important as governmental support through international agreements and other measures."

—Bureau of Foreign and Domestic Commerce, "Foreign Trade After the War"

As already mentioned, the Brazilians speak Portuguese. They can also understand Spanish, but they prefer American business men to conduct business and correspondence in English, in all cases where the Americans are not familiar with Portuguese, written or spoken.

Chile

The radio-export picture in Chile is not so clear because of the uncertain prospects for its nitrate and copper industries after the war. This has led the government, however, to encourage industrialization and hydro-electrification. Extensive electrification during the next few years will lead to increased demand for electrical machinery and household equipment and appliances.

In 1943, there were 200,000 radio sets in use by a population of 5,600,000. Just prior to the war, one American branch factory dominated the market through the extensive sale of low-price three-tube sets.

Peru

Peru's present economic stability, satisfactory financial condition and rising standards of living make it a good postwar market.

Its reserves of gold and exchange are three times as great as in 1941. Nearly 1,200 new firms have already been established in the country in a variety of industries. The new fishery and fish-canning industries will create a heavy demand for refrigeration equipment. Increased hydro-electric power throughout the nation has created new users of electric equipment of all kinds.

Peru has 6,500,000 people with only 68,000 sets (1942) in use, so that there is ample room for improvement as per capita income increases.

Colombia

Colombia offers an excellent postwar market. Its economy has been well maintained during the war. Its industrial needs have led to the creation in the government, of the Colombian Industrial Development Institute.

A hydro-electric survey recently conducted estimates an immediate need for over \$8,000,000 worth of electrical generating equipment.

Colombia has 9,600,000 people with only 160,000 radio receivers and this disproportion should be greatly reduced when sets again become available.

Venezuela

Venezuela, like Colombia, is in a strong position financially, with virtually no public debt, large revenues, and a good store of foreign exchange. The government is carrying out a five-year public works program to further economic development. Its effect will extend well into the postwar period and create a continuing demand for new products and supplies.

A 1943 estimate places the number of radio sets in use at 138,000, by a population of nearly four million. (Continued on page 212)

Left is shown the master control room for the 50-kw RCA transmitter at Radio Nacional in Rio de Janeiro. Right is shown what is described as a typical scene in a Mexican household which gets much of its news by radio. Mexico rates high as a potential market for radio



SHOULD FM SETS BE RATED?

What can, or should, be done to certify the manufacturer's adherence to real FM principles to safeguard the public?

● For a number of years the public has been told about the advantages of the new FM radio service,—static free, high fidelity, non-interfering, and with other features that make it indispensable in locations where these factors are of value. On the strength of these claims, new bands have been placed at the disposal of the broadcast industry, and hundreds of new stations are being built or are planned to use FM methods.

It is up to the industry as a whole to keep faith with the public in justifying the claims for FM service, and to see that it doesn't turn out to be just a "come-on" for "just another type of receiver."

As most everyone knows, there are numerous makeshift circuits that will convert FM signals to give results of a kind, but without adding any of the benefits of the system. Even so, the sets in which such makeshifts are used might be called FM receivers. The question is whether the industry can risk losing a whole field of activity by failure to keep the public informed as to what is and what is not true FM reception.

Trick circuit dangers

There will doubtless be many sets promoted by organizations that have little reputation to lose anyway and that will have but little justification for the FM tag except that they will tune to that particular series of wavelengths. These receivers will have some sale as long as enough legitimate sets are sold to keep the majority of public buyers aware of the genuine value of real FM service.

It therefore seems imperative that there be some system of rating FM receivers as to merit, this rating being based on some weighted formula prepared by engineers. It should be administered by the RMA alone, or jointly with the FM Broadcasters, Inc., or by some other general group that is interested in the welfare of this part of the industry, perhaps the RTPB. In our system of industrial democracy no force can be (or should be) used to enforce this submission of models for evaluation, except that the announcement of the fact that a certification has been given a

certain model gives the buyer a sense of security that he will get true FM service value with that model.

This implies a certain degree of "grading" or "labelling" both of which have a nasty sound to many people, but this connotation is not necessary. What is meant is that a set has been submitted to some responsible body and that all factors having a bearing on FM re-

ception have been considered by an examining laboratory as to this adherence to FM principles. The details of the evaluating system would be a controversial matter, but they would not prove impossible, if engineers could tackle the problem alone. A complete evaluation might involve too elaborate a setup should the formula consider, for example, these things, many of

(Continued on page 214)

WHAT SOME ENGINEERS THINK:

"I sincerely hope that you will do what you can to point out to the trade the importance of giving the purchaser the full facts about the type of set he is buying, and the lack of wisdom, not to mention the dishonesty of selling counterfeit sets under the reputation that has been built up by the performance of real FM sets."

"The only answer so far suggested by people interested in good FM equipment is that of education and the individual checking of FM receivers by broadcasters and, when complaints are made as to the quality of reception, to inquire from the owner of the receiver as to the particular make and model and, if it is one which is known to be deficient in FM operation, to plainly state the facts to the owner. This has already been done in the past and, unless FM receivers are made in accordance with good FM engineering practice, this may continue in the future and serve as a restraint on manufacturers putting out spurious FM radio sets."

"I do not see how you can rate FM receivers or why it is necessary to rate them. The better receivers can out-demonstrate the cheap or inferior models and will sell themselves much as the better AM receivers have finally set the standards of acceptance."

"Unfortunately, different users place different values on the different characteristics of a set. One user may want FM so he can get certain stations nearby where

there is a scarcity of standard broadcast signals. Another may want it for dependable reception during electric storms. Another may want it for high fidelity local reception where noise level and range are of no consequence."

"The free forces of competition, even if sometimes abused and perverted by misrepresentation, offer a better controlling force so far as product quality is concerned than would a rigid grading and labelling system in a field of the nature and state of development of FM operation."

"The need for something in the way of minimum set standards has been recognized elsewhere and the issue has received some publicity directed toward set jobbers. It may be done somewhere along the line in the AM-to-FM transition. It may be done by the manufacturers themselves. The retailers may do it by refusing to handle those sets which are not up to standards. It may be that in the end the public may have to be the judge at the public's expense. And woe be unto the set manufacturer who lets the set buyer pay for that kind of lesson."

"There is a real danger that many FM sets will be brought out which are not true FM sets and will not take full advantage of the system. For such a checking system to work, it would have to have the approval and encouragement of all of the major manufacturers in the industry. Secondly, it would have to be widely publicized or it would mean nothing to the public."



Earthquake recorder is set up in six by twelve foot room in basement of residence. Photo shows galvanometer, amplifier, voltage regulator and timer

EARTHQUAKE RECORDER

Equipment for continuous observation of seismic waves utilizes electronic amplification and smoked paper recording to eliminate expensive photographic technic

• Development of a simplified type of earthquake recorder, utilizing electronic amplification of tremors in the earth's crust, was reported at the American Geophysical Union, Washington, D. C., on June 3. The device, developed by Fred Keller of New Kensington, Pa., has been in operation for the past three years and has recorded practically all of the "quakes" that have been reported by the U. S. Coast and Geodetic Survey.

The equipment consists of a specially designed seismometer, a mirror-galvanometer, three stage

amplifier, and a recording galvanometer making a continuous trace on smoked paper carried on a slowly rotating drum.

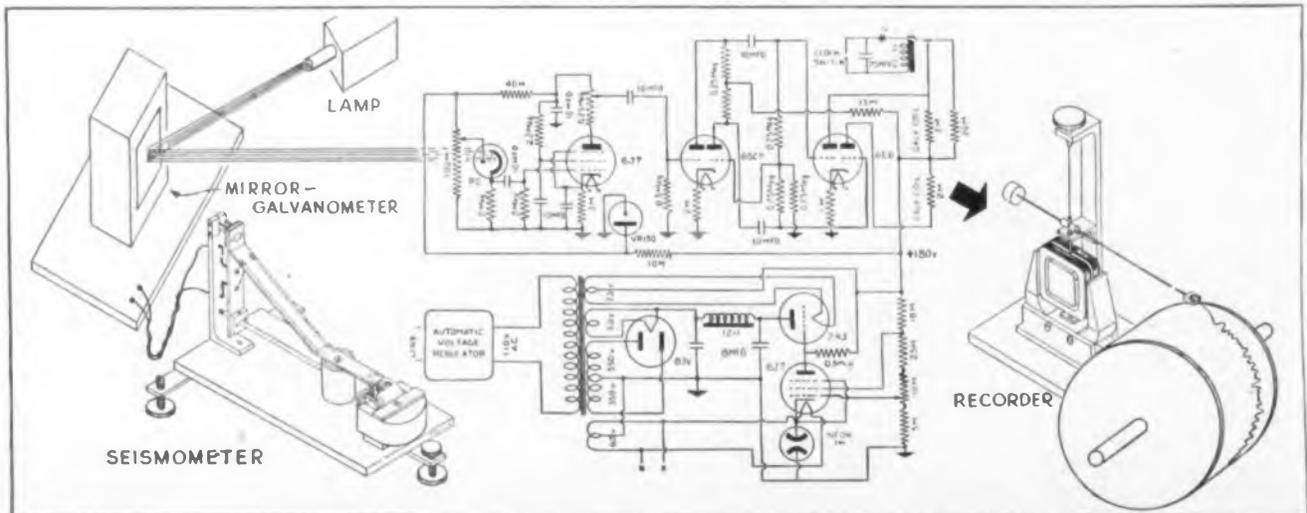
The seismometer consists essentially of a large mass rigidly attached to a coil so suspended and damped as to maintain itself relatively immobile. Earth vibrations move a powerful Alnico magnet whose field cuts the turns of the coil, inducing slow alternating currents corresponding to the seismic waves. The suspension or upper hinge of the seismometer consists of two hard brass foil strips. The

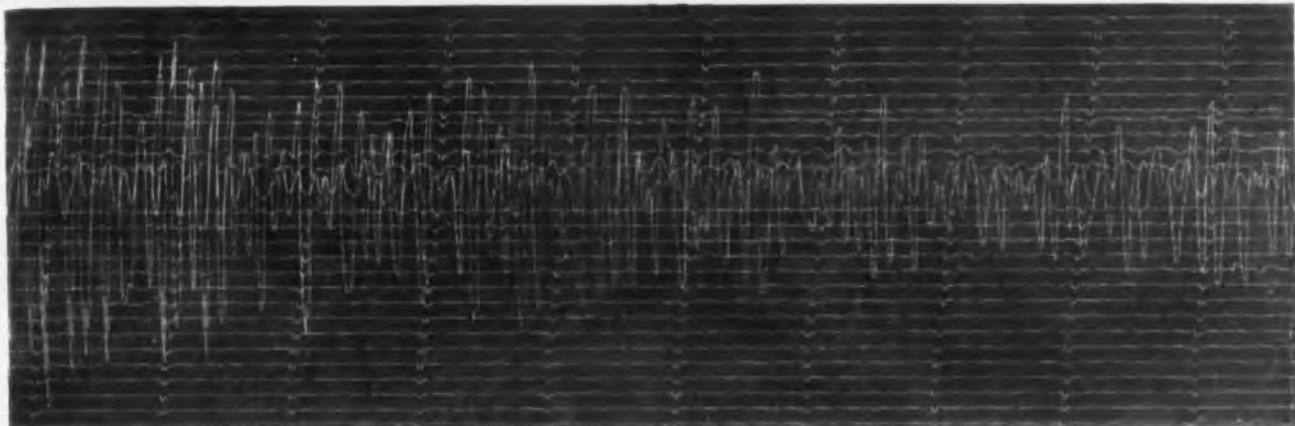
element immediately below is a pivot in a jewel cup bearing.

The coil is wound of 250 turns of No. 32 enameled wire and has a resistance of 14 ohms. When properly adjusted, the seismometer achieves a period of ten to fifteen seconds with good stability.

Output of the seismometer in the Keller equipment is fed to a long period, type P, Leeds and Northrup mirror-galvanometer through a suitable network to provide the desired damping ratio. By operating the seismometer and galvanometer at periods of 10 and 12 seconds, re-

Diagrammatic layout of entire apparatus. Low-level seismometer output actuates sensitive mirror-galvanometer, deflecting light beam and causing phototube illumination to follow slow waves of earth-motion. Amplifier with phase inverter drives stylus of recording galvanometer





Typical record of nearby earthquake, recorded in New Kensington, Pa., at 10:06 pm on April 15, 1941. Epicenter about 2000 miles distant

spectively, the damping ratio obtained is about 0.6.

This is similar to the conventional system of earthquake recording which, through optical means, magnifies the movements of the mirror galvanometer for recording on photographic paper. The expense of the photographic material and the inconvenience of subsequent development, fixing, and washing is obviated in the present system by the use of electronic amplification of the mirror-galvanometer movements and direct mechanical recording on smoked paper.

A sharply defined beam of light impinging on the mirror is reflected to a conventional phototube in such a way that the "at rest" position of the seismometer causes fifty per cent illumination of the cathode. Seismic waves thus cause greater or lesser illumination of the cathode, producing a large voltage wave in its load circuit corresponding more or less exactly to the movement of the earth's crust. To provide a constant amount of no-signal light flux on the cathode, a magnetic type voltage regulator is incorporated in the power supply. Output of the phototube is stepped up by a single pentode stage, operating from its own voltage regulator tube to avoid variations which might result from feedback from the two following stages. A twin triode is used as an amplifier and self-balancing phase inverter in the conventional circuit. This tube, a 6SC7, is designed specifically for phase inverter service for highest gain and low residual hum. Its output excites the power amplifier, a twin triode 6E6, feeding the push-pull coils of a specially built recording galvanometer.

The power supply for the exciter lamp and amplifier circuits operates from a constant voltage transformer as a precaution against line voltage fluctuations. As a further precaution, the power supply incorporates a special electronic voltage regulator using a 2A3 as an

automatically adjusted variable series resistor in the positive leg of the filter output. A sharp cutoff pentode, type 6J7, adjusts the bias on the series tube in response to filter output voltage variations. A 1-watt neon lamp serves to provide fixed bias on the pentode.

The total magnification of the system is 500 to 1,500 times, adjustable by the gain control or by the intensity of the exciter lamp illumination. The exciter lamp is a 6-8 volt pilot lamp operated at 4-5 volts for long life.

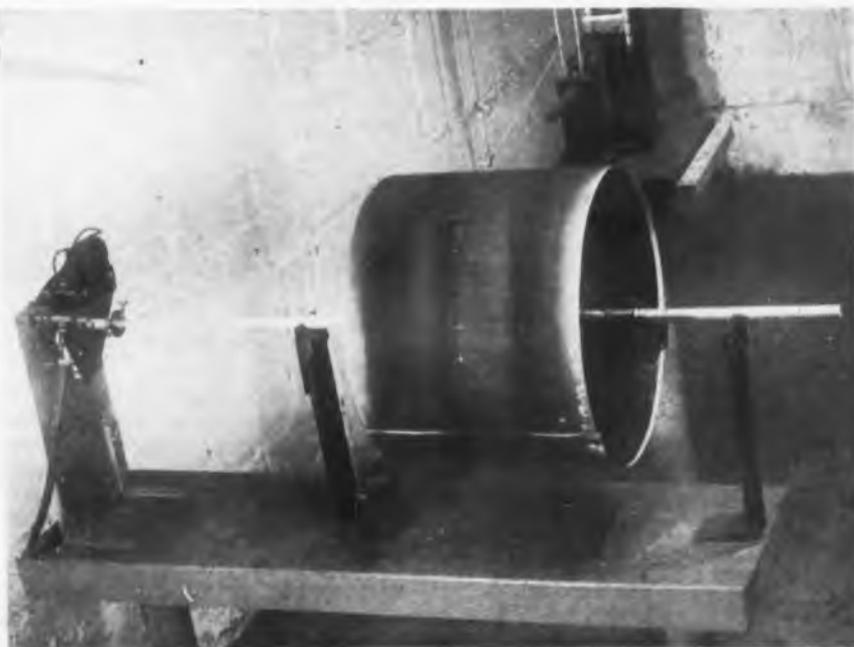
Satisfactory response to long wave teleseisms is obtained by using extra large capacity coupling condensers throughout the amplifier circuit. Power requirement of the entire system is about 75 watts.

Output of the 6E6 drives the recorder, a large galvanometer consisting of two push-pull coils rotating in a magnetic field and carrying the recording stylus. Each coil

consists of 2000 turns of No. 40 dsc wire having a resistance of 2000 ohms. The coils are suspended in the field of a large Alnico magnet by a 0.025-in. diameter Nichrome wire with just enough torque to overcome the friction of the stylus on the smoked paper. The 15-in. counterbalanced arm carrying the stylus is attached to the rotating element, which is restrained from lateral movement by ring bearings.

The smoked paper chart, 8½ by 33-in., is mounted on the 10.2-in. diameter drum as shown. The drum is revolved once every 30 minutes by a 4-watt electric chart clock, giving a linear chart speed of about one inch per minute. The drum is mounted on a lead screw which has eight threads per inch to provide translation. Fastbrite E copy paper is used for the charts. After the recording is removed, a quick dip in alcohol-thinned shellac permanently fixes the smoke coating. — G. S.

Recording unit consists of specially built galvanometer, 15-in. stylus, and drum carrying smoked paper. Drum is driven by 4-watt electric clock at two revolutions per hour.



MILLION VOLT X-RAYS

by HERBERT MERMAGEN*

Application of supervoltage X-radiation for non-destructive inspection permits extended thickness range

● Prior to the year 1939 X-rays were used essentially as an aid in the field of medical diagnosis as well as for therapeutical treatment of malignant diseases. It is only recently that this type of radiation has been used extensively by casting and welding industries for the purpose of nondestructive inspection.

Some 45 odd years of experience in the medical application of X-rays have been of immense service to the expeditious growth of its counterpart in industry, which has also received an added impetus due

to the exacting inspection requirements engendered by our war effort. In round figures the number of industrial X-ray units installed in factories throughout the country has been increased from about 100 in 1938 to more than 2,000 in 1943.

Such rapid progress in the radiology of ferrous and non-ferrous materials brought about a phase of necessary redesigning of already existing equipment to cope with the intensive and severe operation of industrial X-ray machines. The important changes also resulted in the development of much higher voltage units than were heretofore in use, and these new supervoltage X-ray generators were presented to industry in mobile and flexible forms. The new supervoltage X-ray equipment provided a full answer to the country's imperative defense needs which demanded accurate as well as high speed methods of inspecting large castings, pressure vessels, and weldments.

The first practical million volt industrial X-ray machine was introduced in October 1941 by the General Electric company. Design as well as construction of this unit had been in progress for about four years and during that time several units had been operated for the better part of 12 months, demonstrating and proving conclusively their practical usefulness. At the present time there are 33 million volt X-ray units in use, the majority installed in industrial establishments. The million volt laboratory at the University of Rochester, however, is the only one which is operated by a University in cooperation with industry.

The fundamental design of the million volt X-ray unit differs greatly from the familiar lower voltage X-ray generators. The voltage increase of this unit was made possible by the practical applications of three entirely new developments. These three new developments may be summed up as (1)

application of resonance circuits in the transformer design, (2) advancement of X-ray tube design making possible a sealed off multi-section million volt X-ray tube, and (3) the discovery of a new insulating material which is the commonly known freon-12 refrigeration gas. A short description of the mechanical as well as the electrical details should prove interesting to the electronic engineer, and also serves as an adequate introduction into the field of million volt radiography.

The X-ray transformer itself is a coreless transformer consisting of a flat pie wound primary coil which is situated at the lower portion of the tank, and two secondaries, one which supplies the high voltage to the X-ray tube, the other being the source of current for the filament which is situated in the top of the X-ray tube.

The secondary coil arrangement is such that twelve individual sections feed twelve so-called accelerator sleeves of the X-ray tube, which is located in the space commonly

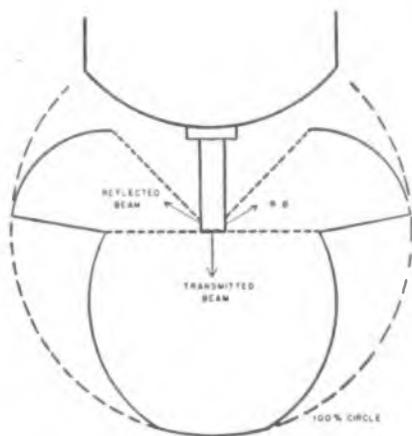
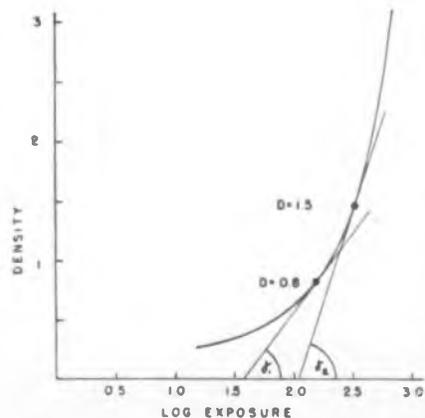


Fig. 1 (Above)—Spherical distribution of million volt X-ray beam. Fig. 2 (Below)—Characteristic of film for radiography



* Manager, Industrial X-ray Laboratory of the University of Rochester.

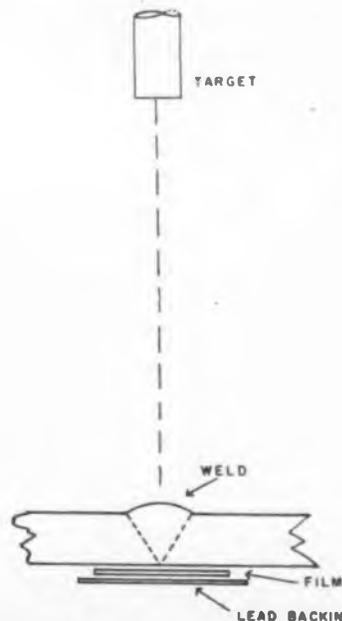


Fig. 3—Schematic set-up of arrangement for radiography of various types of welds

used for an iron core. Sufficient spacing between the individual flat sections of the secondary coil facilitate both insulation of the high voltage generated by these coils as well as cooling by means of circulation of freon gas between the interspaces.

This type of construction accounts for potential distribution with safe restriction of voltage gradients along the X-ray tube. The waveform output is sinusoidal since the entire transformer assembly operates at a resonance frequency of 180 cycles per second. Since the X-ray tube is a self-rectifying device, only the positive half-cycle of the applied alternating current is used in the production of X-rays.

In comparison with lower voltage X-ray units operating from standard iron core step-up transformers, and in cases where the X-ray tube itself becomes the rectifying mechanism of the circuit, it is found that the inverse voltage applied to the X-ray tube may be as much as 30 per cent higher than the forward voltage through the tube. This inverse voltage accounts for a restriction of operating values which, if exceeded, may damage the X-ray tube or puncture the high voltage cables.

In the resonance transformer type of X-ray generator the ratio of alternating exciting current in the transformer to the useful pulsating direct current through the tube is maintained at a high value; in actual figures the oscillating current amounts to about 52 milliamperes ac, while the maximum direct current through the tube is limited to 3 milliamperes. This high ratio of oscillating current to direct current accounts for an inverse



tive in its advantage over previous high voltage tubes, which depended on an elaborate vacuum system which had to be in continuous operation. As the second feature, the total length of the tube in comparison to older tubes for similar voltages is only five feet six inches.

The actual high voltage section comprises only thirty inches of alternate insulating sections and electron accelerator sleeves. The target of the X-ray tube is situated at the far end of a brass sleeve and constitutes a tungsten disk 1/16 in. in thickness which is locat-

Fig. 5 (Left)—Laboratory arrangement of equipment for radiography of turbine casting
Fig. 6 (Below)—Disposition of equipment as used for inspection of large hydraulic cylinder

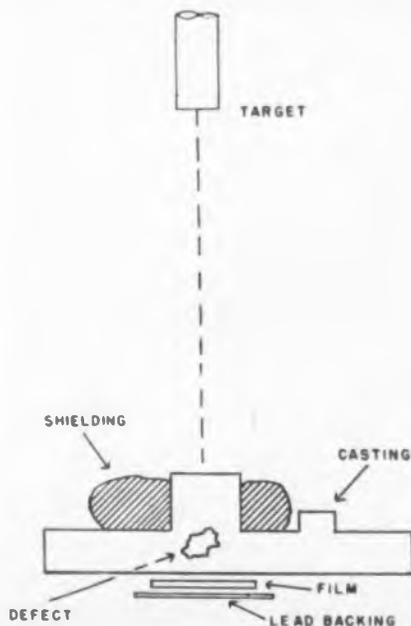
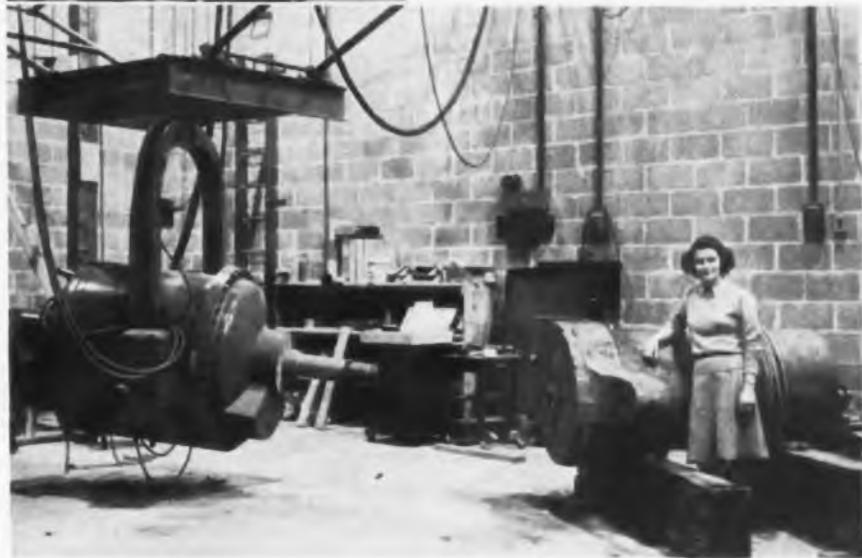


Fig. 4—Schematic of method of shielding part of a casting to limit inspection area

voltage across the tube which is seldom higher than 5 per cent of the forward voltage applied to the X-ray tube.

The power requirements for this X-ray generator are satisfied by a motor generator, i. e. a synchronous 3-phase motor drives a 180 cycle alternator. During operation the output from the alternator is varied by means of a motor controlled potentiometer in the direct current field circuit of the alternator. This type of control provides smooth regulation of the output voltage for the X-ray transformer. The synchronous motor drive also provides complete independence from any powerline voltage fluctuations.

The million volt X-ray tube incorporates several features which made it possible to adapt the tube in a mechanism which is easily flexible and mobile. The first prominent characteristic is the "sealed off" tube, a feature distinc-

ed perpendicular to the stream of electrons. This position of the target is unusual in comparison to targets in lower voltage tubes, which usually are placed at angles from 15 to 45 degrees against the electron stream.

Electrons are produced by the filament, located in the upper portion of the tube, and consisting of a spirally wound tungsten wire. As mentioned above, the current for the excitation of this filament is obtained from the uppermost section of the secondary transformer coil. Regulation of the filament current is accomplished by an iron core inductance, the reactance of which is mechanically controlled by a reversible motor.

The electrons from the filament are accelerated by twelve successive sections of accelerator sleeves. The potential between successive sleeves amounts to 87,000 volts at maximum operation. When the electron stream has passed the

twelfth sleeve an electron velocity of 1,000,000 volts has been imparted to this stream, which is at this point free to expend its energy in the production of X-rays at the target.

However, since this stream of electrons cannot be focused as in lower voltage X-ray tubes by means of a filament cup due to the length of the million volt X-ray tube, focusing is accomplished by a "focusing coil," situated just beyond the twelfth accelerator sleeve. A direct current flowing through the focusing coil produces an action similar to an optical lens in that it focuses the electron stream at a predetermined area on the target surface. The change in focusing coil current makes it possible to change the size of the focal spot.

With the general assumption that a tungsten target can withstand a power of 200 watts per square millimeter, the focal spot of this X-ray tube can be changed from approximately 2 millimeters to 10 millimeters in diameter. These changes in focal spot size adequately satisfy the power distribution of electrical energy on the target as well as permit selection of the smallest permissible focal spot for best definition in the resulting radiograph. A water cooling system surrounding the target adequately removes extensive heat.

The construction of the target permits the use of a spherical distribution of X-rays in contrast to the conical beam of X-rays obtained from lower voltage X-ray tubes. Two specific types of X-ray beams are available, one so-called transmitted beam which has as its primary direction that of the initiating electron stream, and a reflected beam which is comparable to the reflected beam from lower voltage X-ray tubes.

Fig. 1 illustrates the foregoing and also shows the approximate X-ray intensity variation at different radiation angles. These X-ray intensity variations are due to the change in X-ray absorption within the target since the length of the path traversed by X-rays through the target depends on the exit angle through the tungsten disk.

The usual insulating material found in most high voltage X-ray transformers, namely oil, is replaced in the million volt X-ray unit by freon gas maintained at 60 lb. pressure. Freon gas has an unusually high breakdown resistance to high voltage, and besides this feature is very light in weight. A weight comparison of this gas to the usual transformer oil is as follows: About 10,000 lb. of oil would be required to provide adequate insulation as against about 150 lb.

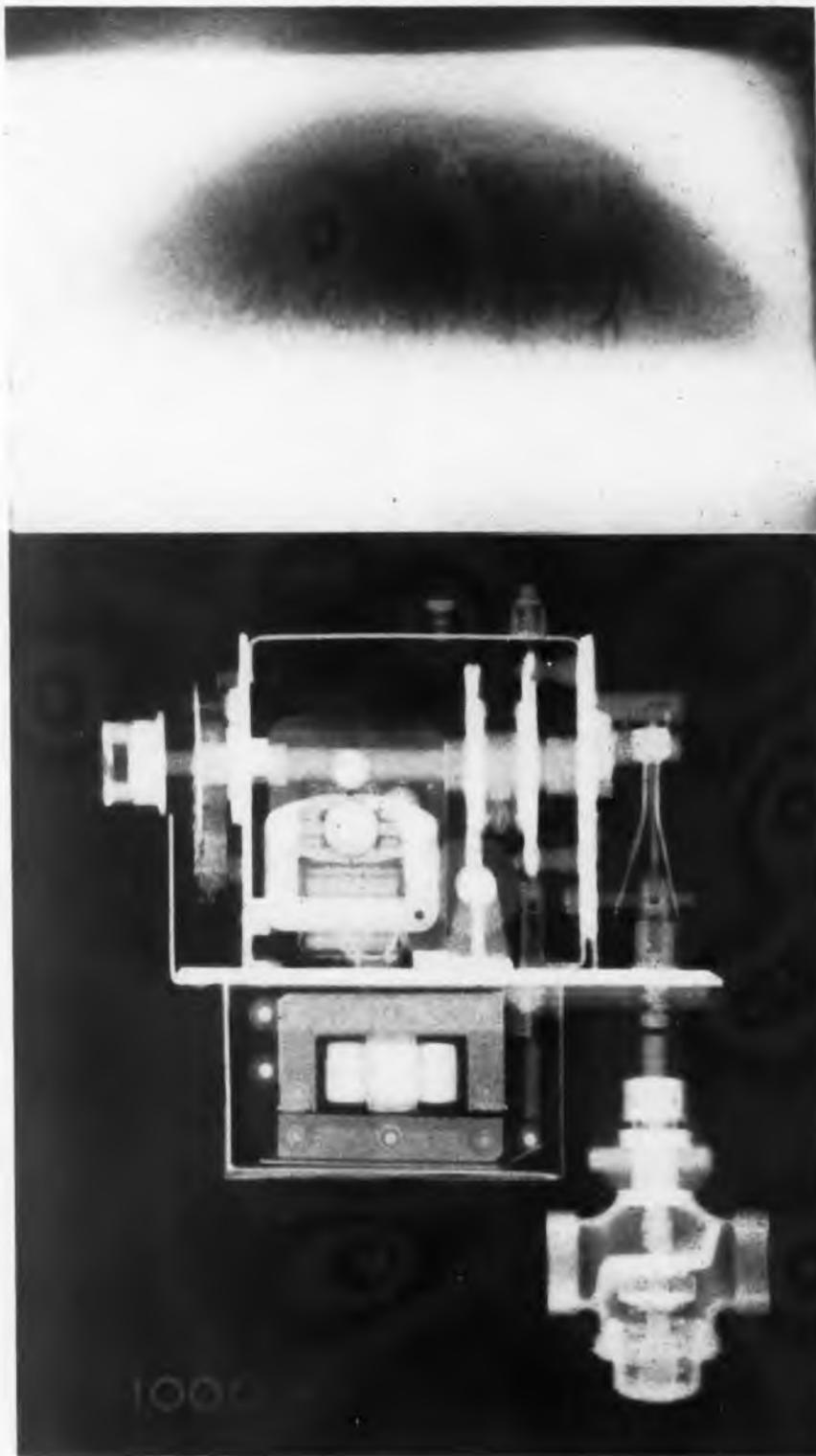


Fig. 7 (Above)—This radiograph, made at one million volts, shows a section of a steel casting four inches thick and reveals a large area where excessive shrinkage has occurred. Fig. 8 (Lower)—Illustrating the uniform penetration of all parts within the mechanism when radiographs are made of a complicated composite machine

of freon gas which quantity affords the same insulating qualities as oil. This factor of weight again makes it feasible to construct this million volt unit with relatively small dimensions.

Flexibility of the tank, which measures only five feet in height

and three feet in diameter, is achieved by a system of hoisting and tilting mechanisms, suspended from a specially designed bridge crane.

In operation the unit is capable of producing X-rays from 800 to 1,000 kilovolts, with a current range

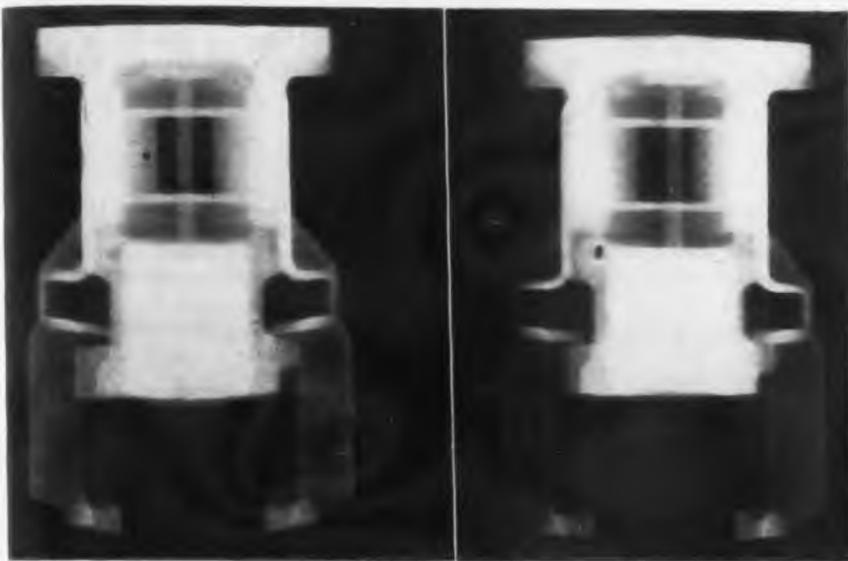


Fig. 10—Comparison showing the relative effectiveness of X-rays at 800 KVA and 1000 KVA, the latter, at the right, showing slightly better penetration and detail

from one microampere to three milliamperes. An interesting comparison is found in the X-ray energy output as compared to energy from radium. At full capacity, i. e. 1000 kv and 3 milliamperes, the X-ray output of this unit in terms of radiation energy is approximately the same as 125 grams of radium (not milligrams). This tremendous power has contributed to a radical change in radiography of heavy sections by means of the million volt X-ray radiation. Where formerly exposure times with radium for a six inch section of steel might have run as long as 40 hours, exposure times with the million volt unit have been reduced to approximately 30 minutes for the same thickness of steel.

Time saving

Although this comparison is only relative, it illustrates the tremendous time saving which is accomplished when million volt X-rays are used for radiography instead of radium. This, however, does not imply that million volt X-rays entirely replace the usefulness of radium for non-destructive inspection purposes, since there are many occasions where it becomes impractical if not impossible to use anything but radium for the job on hand. This is particularly true of completed and installed structures where space availability as well as transportation difficulties exclude the use of any X-ray equipment.

Of the multitude of recording media available for X-ray uses, X-ray film is used for million volt radiography in preference to other modes of X-ray recording. Several types of X-ray film are at the disposal of the technician of industrial laboratories and each type of film has its specific usefulness. The

classification of these types may be briefly summed up as (1) low speed, (2) medium speed, and (3) high speed films.

Since the grain size of film is dependent on speed factors, and also since radiation from million volt X-rays seems to enlarge the apparent grain size, it becomes of importance to select the correct type of X-ray film for use with million volt equipment. Briefly, a high speed film will result in large appearing grains as compared to the much finer grain in a slow speed film. It becomes desirable, therefore, to employ a type of film for million volt radiography with relatively low speed and resulting fine grain structure for maximum detail differentiation. The slow speed films usually are capable of producing higher contrast than films with very high speed, and this higher contrast is definitely of great assistance when working with X-rays of million volt or higher. The reason for the desirable high film contrast is seen in the reduced subject contrast occurring at high voltage radiation and can be explained from observations of the change in absorption coefficients.

When X-rays are absorbed in

materials, the absorption follows the usual exponential law

$$(1) I = I_0 e^{-\mu x}$$

where I = intensity of transmitted beam through the material, I_0 = initial intensity from X-ray tube, e = basis of natural logarithm, μ = absorption coefficient of the material, and x = thickness of the absorbing material. The above equation is stated for the case of a uniform material. If, however, the X-ray beam traverses a material which contains a defect, the transmitted X-ray intensity through the region of the defect may be expressed as:

$$(2) I_1 = I_0 e^{-\mu(x-x_1) - \mu_1 x_1}$$

where μ and x represent absorption coefficient and thickness respectively of the basic material, and μ_1 and x_1 are the absorption coefficient and thickness of the defect. By combining the equations (1) and (2) the subject contrast is given by

$$(3) \log \frac{I}{I_1} = \log \frac{e^{-\mu x}}{e^{-\mu(x-x_1) - \mu_1 x_1}}$$

Since the photographic effect obtained on the X-ray film depends for its contrast range on the difference in transmitted X-ray intensities, it stands to reason that with high subject contrast a high photographic contrast will be the result. But, since the absorption coefficient for materials depends also on the wavelengths of the incident primary X-ray beam, it can be seen from the table below that the subject contrast definitely becomes less as the wavelength of the X-ray beam is decreased or the voltage applied to the X-ray tube is increased.

Thus, for practical application, it is observed that at energizing voltages of a million volts the absorption difference of materials such as carbon* and iron is greatly reduced as compared with coefficients at lower voltage X-rays, with the ultimate result of low subject contrast between steel as parent material and a carbon containing defect.

This relatively low subject con-

(Continued on page 200)

*Carbon is used in this example since values for absorption coefficients of air are not available.

Table of Absorption Coefficients

KV	Shortest Wavelength	C	Al	Fe	Cu	Pb
100	0.123	0.345	0.47	2.87	4.05	57.0
200	0.075	0.322	0.396	1.72	2.22	25.3
400	0.031	0.218	0.251	0.74	0.89	4.18
1000	0.02	0.133	0.152	0.43	0.48	0.736

IDEAS AND METHODS FOR

1 WIRING HOOK aids manufacturing, inspection, or servicing operations. Device developed at Hallicrafters, Chicago, helps hold wires in place while soldering or assembling



2 TAKING WORK to the electric screwdriver instead of vice versa is the method shown here in sub-assembly of a receiver rf section at Hallicrafters. Electric screwdriver in this case is a drill fitted with a cup-shaped rubber friction drive screw bit, here applied to screws which hold the coils in place. "C" clamp holds drill and permits easy removal or readjustment



5 GAS CRACKER solves big problem in tube degassing at Tung-Sol plant. Reducing atmosphere is produced from city gas by unique set-up. See page 172

6 ENGINEERING ODDITY is this home-grown machine at plant of Carter Motor Co., Chicago, to wind tape on closed circular field coils. Bobbin winds tape on half the coil and loads itself with half the tape. "Unraveling", it completes the job



RADIO-ELECTRONIC PLANTS

3 MORALE BUILDER for plant workers as well as those "on leave" with Uncle Sam is this adding machine paper holder on bulletin boards about Bell and Howell plant, Chicago. Daily "round robins" are sent to servicemen. Response and that of workers has been mild sensation

4 SAFETY STOP on filament voltage control saves fifty to a hundred tubes at a crack in aging racks at Tung-Sol, Newark, N. J. Operators previously were able to advance aging rack voltage too far, which often happened inadvertently. Universal type adjustable stop for all tube types now keeps transtat knob within safe limits



7 PINHOLE DETECTOR for enameled wire was developed at North American Phillips Co., Dobbs Ferry, N. Y. Wire runs through two mercury pools held at 500 volts dc. Any conduction actuates electronic relay and counter. Checks lengths 1/4 to 8-in., or continuously

8 ORDERLY NATURE of an EI editor prompted sticking legible numerals on backs of all past issues, in slanting rows, with different color for each year, for instant availability. The numbers call attention to themselves like lights in a blackout if replaced incorrectly. EI may use idea next year



BALANCING PRODUCTION

Plan under which WPB has broken bottlenecks, eased the burden on component makers and shortened delivery time

● Admittedly, the Radio and Radar Division of the War Production Board has done an excellent job of work in scheduling production of military electronic requirements and in stepping up output to the point where manufacturers are now turning out needed equipment

at the rate of 1200 per cent of peacetime requirements. And there is still much to be done, for despite recent military successes the curve of production is **up**, not down.

In the meantime WPB has had troubles. Prominent among them, and the latest now to appear prac-

tically licked, has been the vital necessity of equalizing the production load upon component manufacturers. Supplementing that problem has been the reluctance of end product manufacturers to place orders with the components people for their entire requirements on any given project, all at once.

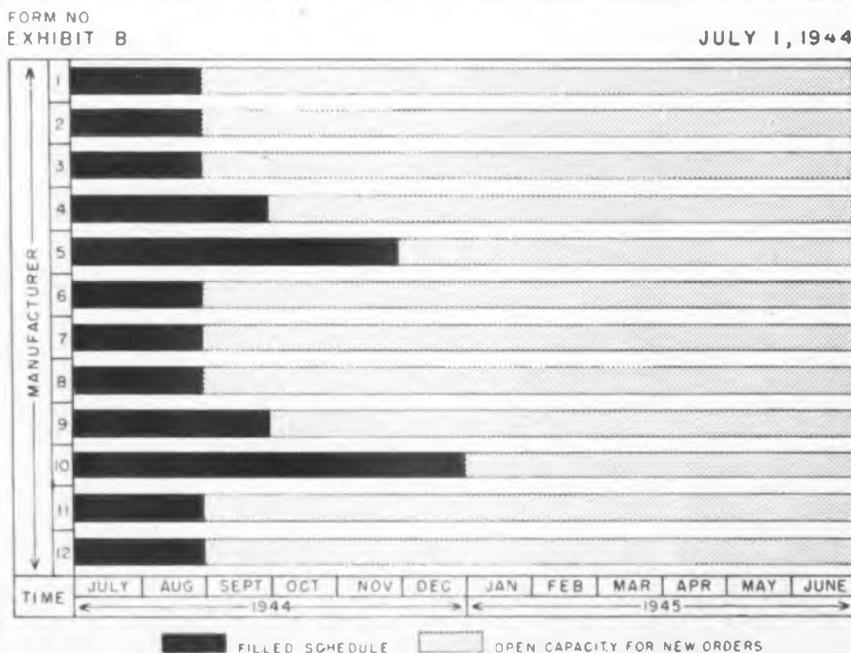
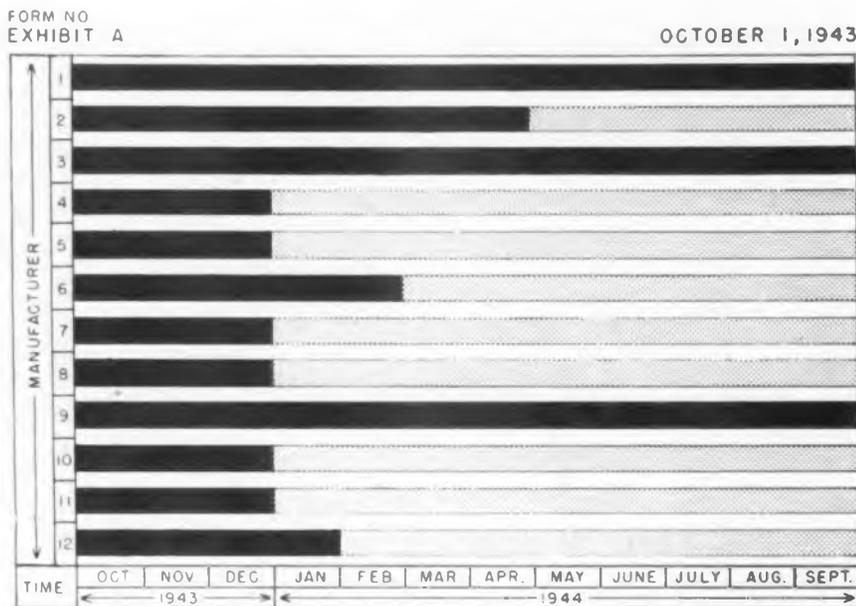
The two problems, manifestly, are closely inter-related; one hangs on the other. The first, involving equalization of the load on component manufacturers, hinges on accurate knowledge of many factors including the manufacturer's own estimate of his production possibilities, his actual production achievement which may be and frequently is considerably less, his backlog of orders on hand, the date (in the light of these other factors) when he will have production facilities available; in other words, when he can accept new business with something more than a reasonable prospect of being able to live up to delivery schedules.

The second part of the problem, having to do with the desirability of end product manufacturers placing orders at the same time for ALL needed components to complete a given project, is to some extent a matter of educating the prime contractor, to a much greater extent a matter of providing him with accurate facts and figures and names of all available sources of supply.

Hand-to-mouth ordering

There are any number of reasons why prime contractors have been living virtually from hand to mouth in placing orders for components, and many of them can be traced to sketchy information regarding sources of supply. Fear of cancellations also has been an impelling factor. Aside from this, every contractor has friends to whom he has given business for years and to whom he likes to give business. He may want to protect that manufacturer against the possibility of having to cancel, so he slips him part of the order without any very definite knowledge of whether he is going to get the goods or not and with the thought that he will place the rest of the order in the same place, or elsewhere, when the time comes.

Fig. 1—Upper portion of the chart shows conditions as they existed before the provisions of Scheduling Order M-293 became effective. Lower portion shows improvement effected



LOADS

One result of such piece-meal ordering has been that component manufacturers have had no way of accurately gaging what is coming up, hence cannot themselves plan for requirements and thus a bottleneck is passed along down the line.

It has been the very widespread existence of such customs that has in large measure been responsible for some of the critical bottlenecks that have slowed production in some cases to the stopping point. Obviously, it does no prime contractor any good at all to place a sizable order for components with manufacturer A, with whom he has been doing business for years and whom he likes personally, unless the manufacturer can produce the goods in sufficient quantity and in time for the contractor to complete his project and make deliveries on schedule.

In this particular case, if the component manufacturer accepts the order, which he may do even though already well loaded up, one of two things will happen: Some other manufacturer's order is going to be put aside temporarily, thus holding up his production, or our contractor himself is going to be held up, a fact which he may not discover until it is too late to do much of anything about it.

Some component manufacturers wittingly or unwittingly have aggravated this trouble by freely accepting business when their own records should reveal that to do so would be hopeless, not to say stupid. Friendship plays a part here, the desire to do a business favor, the unwillingness to let a pal down. In other cases it may be just plain greed for a tremendous backlog. In any case, the result has been the same.

Balancing the load

Some time ago WPB let it be known that a vigorous attack was being made on these two critical problems with a view to adopting means which would result in more equitably balancing the load on component manufacturers, the ultimate object being the stepping up of production to equal the 16 per cent increase which the current fiscal period, ending next July, must go ahead of the last.

The manner in which the problem was approached, and the re-

AVAILABLE CAPACITY, BY MONTH, FOR SCHEDULING APPLICATIONS FOR RADIO AND RADAR COMPONENTS										
MANUFACTURER	CATEGORY	MONTHS	SEPT.	OCT.	NOV.	DEC.	1943		1944	
							JAN.	FEB.	MAR.	APR.
Variable composition	15	UNITS								
A		500	150	170	500	500	500	500	500	500
B		300	250	200	200	275	275	275	275	275
C		577	457	475	700	700	700	700	700	700
D		152					51	135	135	135
E		212					101	200	200	200
F		25.5								11
G		290			171	201	200	200	200	200
TOTAL		1906.2	863	1175	1576	1671	1410	1936	2070	2021

Fig. 2—Available Capacity report of a typical component showing facilities available

sults that have been achieved under the able direction of Harvey Rockwell, Chief of the Components Section of the Radio and Radar Division of WPB, serves as an illuminating example of the very great

help that can come to manufacturers through the routine filing of reports, no matter how hateful that chore may be.

Bearing in mind the two principles—

(Continued on page 194)

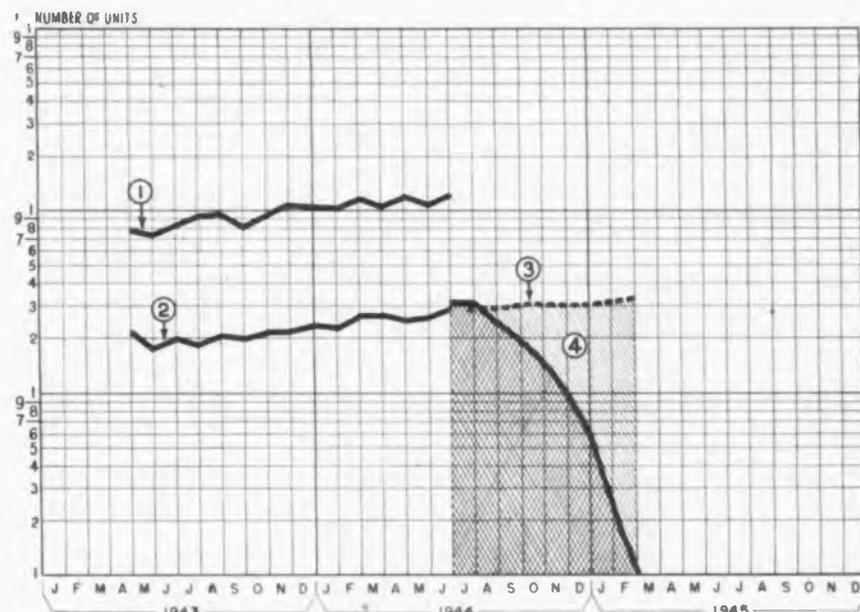
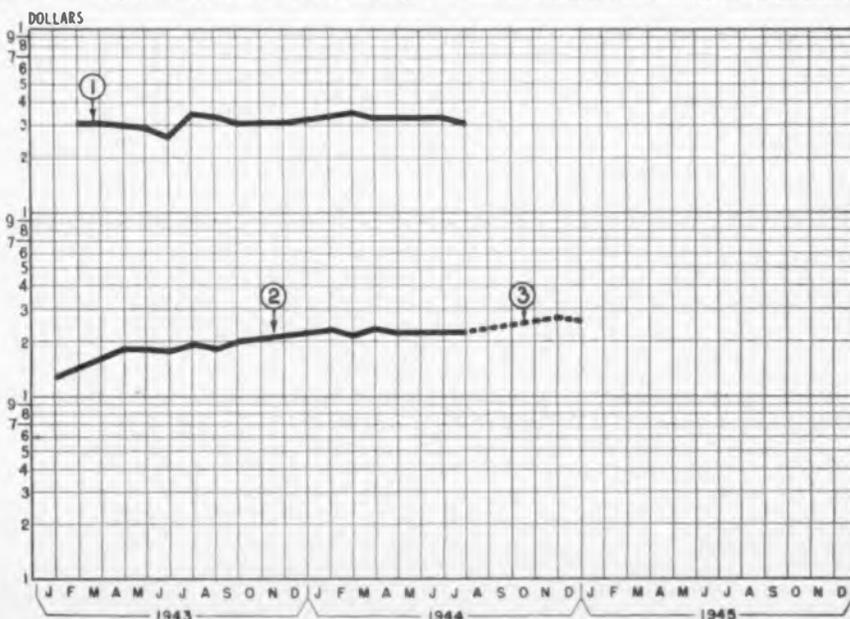
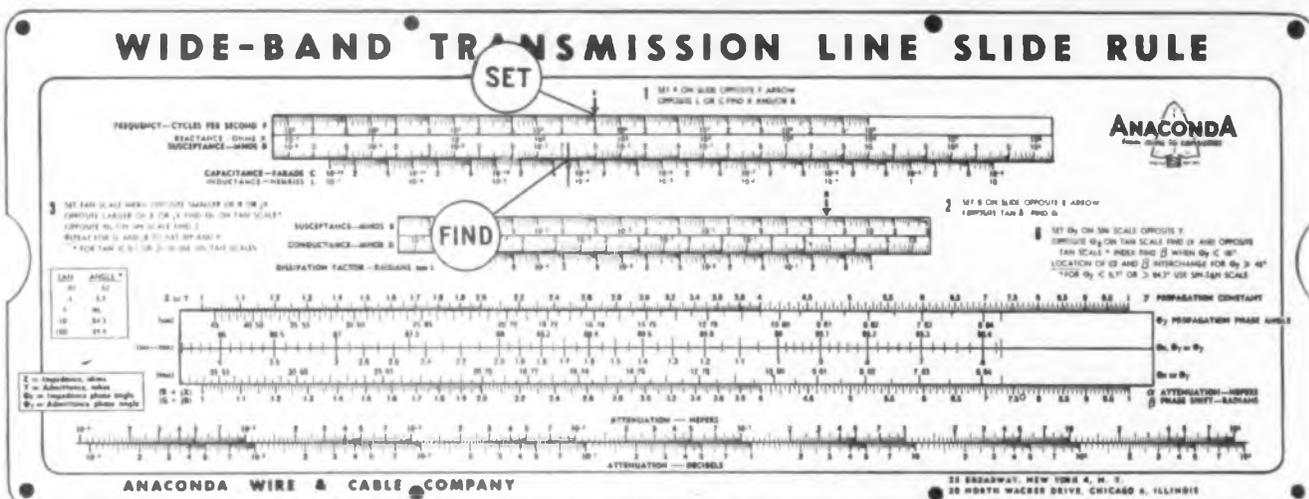


Fig. 3—Typical Component Production Trend chart showing: 1—Total unfilled orders; 2—Actual shipments by manufacturers; 3—Estimated requirements; 4—Unshipped orders

Fig. 4—End Equipment Production Trend showing: 1—Unfilled orders; 2—Shipments; 3—Requirements





Front of the transmission line slide rule with the slides set for the solution of a reactance problem

LINE CHARACTERISTICS

by E. W. GREENFIELD*

● Transmission of electrical energy along lines or cables is now carried out over a tremendous frequency range from power transmission which utilizes the low frequencies from 25 to 300 cps to radio devices which utilize frequencies up to 15,000 megacycles and higher. Present highest electrical transmission frequencies are only some two decades short of the long wave infrared spectrum.

Obviously the behavior of an electrical transmission line as a means of transmitting energy is most importantly dependent upon the frequency of that energy. In the first place, a line is electrically long or short dependent upon the frequency of the transmitted energy. For air-insulated lines at 60 cycles any line less than 3,500 miles in length is electrically short; while at 3,000 megacycles a line length of only 10 cms. would be short.

The two most important characteristics of a transmission line are its propagation constant (γ) and its characteristic impedance (Z_0). The first represents the change in magnitude and phase of the propagated wave as it passes along the line; the second represents the ratio of voltage to current at any particular point within the line. These two characteristics are necessary to adequately describe the transmission line as a means of transferring electrical energy from point to point. Hence, the basis for all line calculations is a complete knowledge of these two characteristics.

A smooth transmission line or cable may be regarded as representing the ideal condition for uniformly distributed electrical parameters. These parameters are the familiar series resistance (R) and inductance (L); and the shunt conductance (G) and capacitance (C). Transmission-line theory gives the relation between these distributed-line parameters and the propagation characteristics. Knowing R , L , C and G , the complex propagation constant and the complex characteristic impedance may be derived. From these, the attenuation, the phase shift, the velocity of propagation and the propagation wavelength can be readily computed.

For a matched transmission line carrying electrical energy from a source to a load, the above computations contribute all the information required to completely describe the behavior of the line. For the mismatched transmission line, reflections take place at the line terminations which cause standing waves, resulting in additional attenuation, alteration of input and output impedances and voltage and current distribution; and the power delivered into the load is decreased. Under such circumstances, the propagation constants alone cannot completely describe the line's behavior but must be taken together with the impedances of source and load. The loss for the mismatched line is termed "insertion loss" and

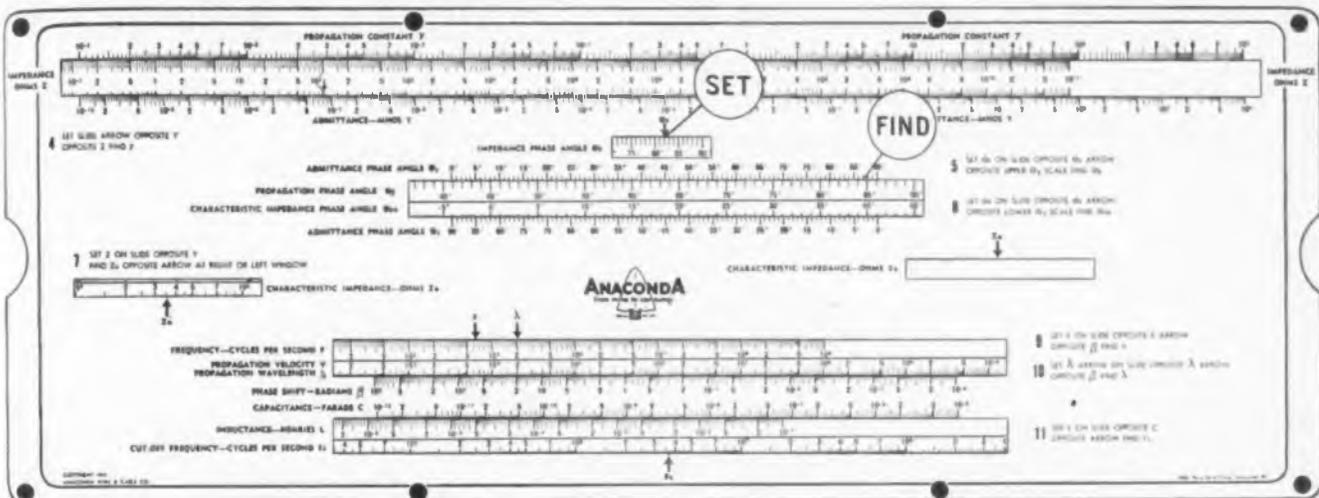
it is always greater than the inherent line losses.

The chief purpose of the slide rule described is to quickly evaluate the complex propagation constants, γ and Z_0 , from the line parameters, R , L , C and G . In other words, the slide rule evaluates the interrelation between propagation constant and its phase angle and characteristic impedance and its phase angle on the one hand with the per unit resistance, inductance, capacitance and conductance on the other hand. The slide rule also determines attenuation, phase shift, velocity of propagation, wavelength; and, on loaded lines, cut-off frequency when desired.

In making transmission-line calculations, the engineer is quite frequently confronted with the problem of determining the line characteristics from the distributed parameters. The parameters may be given either as design values or obtained by measurements. The characteristics are wanted because they determine how the energy is propagated. It is this fundamental importance of the characteristics which prompted the design of the slide rule; to permit their easy evaluation from the parameters. However, the inversion of the process is of practical importance: to obtain for specified line characteristics, the parameters and to design a transmission line which meets them. The slide rule is equally well adapted to this problem also.

Fig. 1 shows the front face of the transmission-line slide rule and

*Engineer in charge, Electrical Laboratory, Anaconda Wire & Cable Co., Hastings-on-Hudson, N. Y.



Back of transmission line slide rule arranged for determining phase angle of the propagation constant

opposite it the back face. The rule measures 13¼ in. by 5 in. overall and can be made either in plastic material or paper. A mass produced but accurate and durable form of the rule has been prepared, using heavy varnished paper.*

There are a total of thirty scales engraved on the rule. All scales, with the exceptions noted, are logarithmic and consist of many decades. Two sizes are used for these, one about ⅓ in. in length, the other about 1¼ in. long. The (R + jX) or (G + jB) and Z or Y scales are logarithmic but consist of one decade about 10 in. in length. The (sin), (tan) and (sin-tan) scales are the usual angle-type scales, but so laid out as to simplify vector solutions. The θ_z , θ_x , θ , and θ_{so} scales are linear.

Printed on the faces of the rule adjacent to the appropriate scales are concise instructions for the manipulation of each slide rule operation. A five-color separation scheme serves to adequately differentiate the various scales, designations and instructions.

Table I gives in condensed form the scope and principle of operation of the slide rule. Knowing the values for the line parameters, R, L, C, tan δ (dissipation factor) and the frequency (F), the slide rule solves for the line characteristics in a number of successive steps as indicated for each line characteristic in the tabulation.

It is noted that all line parameters and characteristics (with the exception of Z_0) are given per unit line length. This unit length may be selected optionally depending upon the physical length of the line. For any selected unit length,

*A substantially constructed slide rule of the type described, together with a 30-page instruction manual on its use, is available to engineers without charge from the Anaconda Wire & Cable Co., 25 Broadway, New York, N. Y.

the velocity of propagation will come out in multiples of the selected length per second; the wavelength will also be in multiples of the unit length.

In general, the line parameters R, L, C and G are available from design information. Where they are not so given they may be computed in the usual way from line physical dimensions and materials. The significance of each of these parameters is given below:

Series Resistance (R) is the alternating-current resistance of the looped conductors plus the radiation resistance of the line, if the latter is not negligible. For an open-wire line above 500 K. cps, the radiation resistance is generally not negligible. For coaxial lines terminated properly, the radiation

resistance can always be neglected. At high frequency the effective resistance is largely controlled by skin effect.

Series Inductance (L) is the self inductance of the line at the operating frequency. It includes both internal and external inductance and is thus, besides configuration, a function of the permeability of the conductors and medium. For high frequencies where skin effect predominates, the internal self-inductance becomes negligible. Proximity effect (closely-spaced conductors) tends to decrease inductance, but its net effect is generally very small.

Shunt Conductance (G) is the net alternating-current conductance shunting the line from conductor to conductor, including both

(Continued on page 216)

All line parameters and characteristics (with the exception of Z_0) are given per unit line length, which may be selected optionally depending upon the physical length of the line

SCOPE AND OPERATIONAL PRINCIPLES

LINE CHARACTERISTIC	UNIT	SYMBOL	EQUATION	SLIDE RULE PROCEDURE		
				OPERATION NO	SET	FIND
REACTANCE	OHMS/LENGTH	X	$2\pi FL$	1	F, L	X
SUSCEPTANCE	MHOS/LENGTH	B	$2\pi FC$	1	F, C	B
CONDUCTANCE	MHOS/LENGTH	G	$B \tan \theta$	2	B, $\tan \theta$	G
IMPEDANCE	OHMS/LENGTH	Z	$\frac{X}{\sin \theta_z} \tan^{-1} \frac{X}{R}$	3	R + jX	Z θ_z
ADMITTANCE	MHOS/LENGTH	Y	$\frac{B}{\sin \theta_y} \tan^{-1} \frac{B}{G}$	3	G + jB	Y θ_y
PROPAGATION CONSTANT	—/LENGTH	γ	$\sqrt{ZY} \left[\frac{\theta_z + \theta_y}{2} \right]$	4 5	Z, Y θ_z, θ_y	γ θ_γ
ATTENUATION	NEPERS/LENGTH	α	$\gamma \cos \theta_\gamma$	6	γ, θ_γ	α
PHASE SHIFT	RADIANS/LENGTH	β	$\gamma \sin \theta_\gamma$	6	γ, θ_γ	β
CHARACTERISTIC IMPEDANCE	OHMS	Z ₀	$\sqrt{\frac{Z}{Y}} \left[\frac{\theta_z - \theta_y}{2} \right]$	7 8	Z, Y θ_z, θ_y	Z ₀ θ_{z_0}
PROPAGATION VELOCITY	LENGTH/SECOND	v	$\frac{2\pi f}{\beta}$	9	f, β	v
PROPAGATION WAVELENGTH	LENGTH	λ	$\frac{2\pi}{\beta}$	10	β	λ
CUT-OFF FREQUENCY	CYCLES PER SECOND	F _c	$\frac{1}{\pi\sqrt{LC}}$	11	L, C	F _c

TUBES ON THE JOB

Measuring Projectile Velocities

Developed for the Aberdeen Proving Ground by RCA, an electronic time-interval counter was designed to measure time intervals on the order of one-hundredth of a second. Accuracy obtained is within a hundred-thousandth of a second. The research on this device was brought to fruition, and a practical device was made available to the military services through the work of Igor E. Grosdoff, RCA research engineer.

On the ranges at Aberdeen and at other arsenals, means are being provided for making velocity measurements on projectiles up to 240 mm., at the rate of hundreds of observations a day. Each range is equipped with two electrical coils, arranged so that a projectile will pass through them in succession. By magnetizing the projectile, a small current is generated in each coil as the bullet passes through. If the coils are 30 ft. apart, and the time between the two signals is one one-hundredth of a second, the bullet is traveling 3,000 ft. a second. The counter consists of three essential parts: an oscillator, a "gate," and the counter proper. The oscillator is crystal-controlled and delivers precisely 100,000 pulses each second. The gate, actually a vacuum tube circuit, passes these pulses into the counter, which

counts them and finally, when the gate is closed, shows by indicator lamps the number of pulses that have passed through.

In operation on the firing ranges, the counter's gate is opened by the electrical signal from the first coil as the bullet passes through it, and is closed again by the impulse from the second coil. The operator records the time of flight between coils and computes the velocity. It is noted down along with the record of the particular gun and projectile being tested, for subsequent analysis by ballistics experts. The operator then touches the reset button and is ready for the next shot, all in a matter of a few seconds.

The importance of such fine measurements becomes apparent when it is remembered that if all shells from a gun leave the muzzle with the same velocity they will all fall in the same spot. The effectiveness of the fire will depend only on the skill and aim of the gunner.

10 kc Two-way Stretch

Sonic waves have now been assigned the job of appraising women's hosiery yarns.

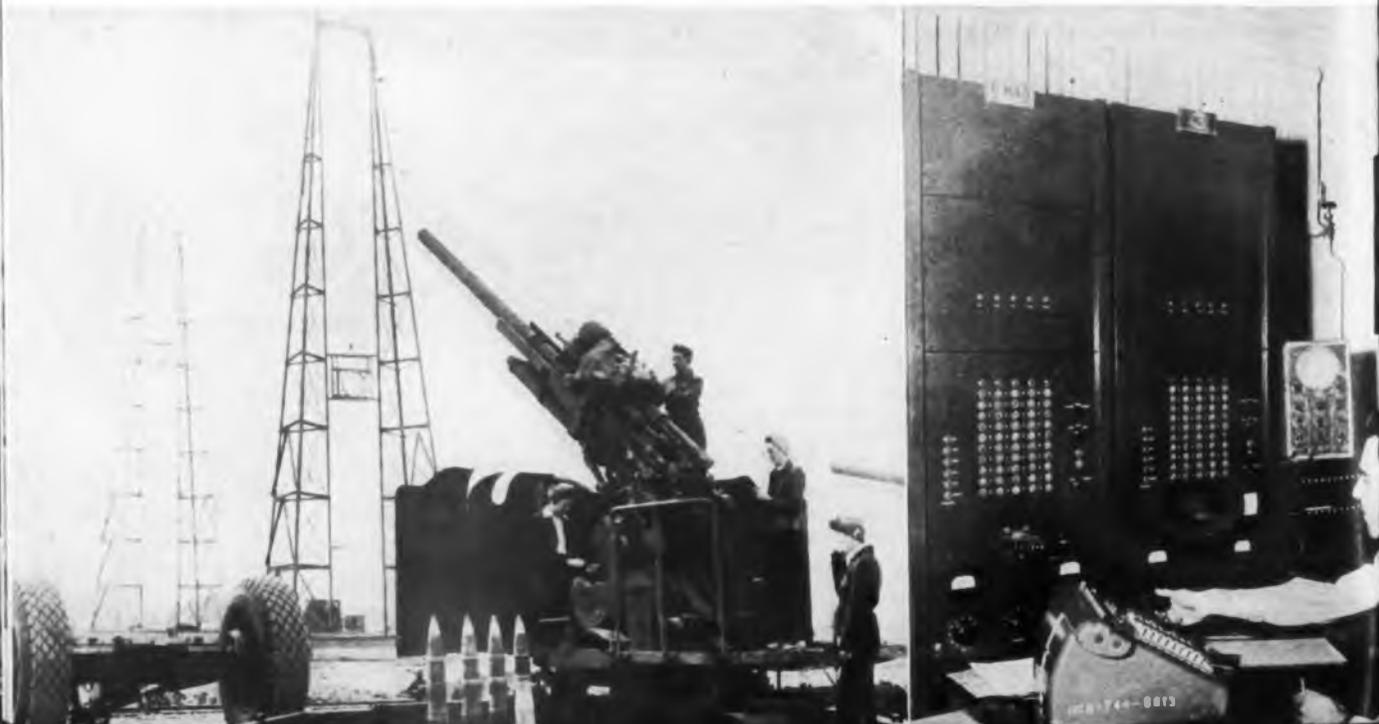
Specifically, the problem was to measure accurately the elasticity of the fibers. This is a factor of importance to the wearers of stockings and stretchy articles like garters and girdles, as well as to

the users of automobile tires! But exact knowledge of the degree of elasticity is even more important to the manufacturers of these articles and of many textile products which are not obviously elastic in themselves. Elasticity of any yarn must be taken into consideration in adjusting the looms or knitting machines.

Experiments were carried out on textile yarns—linen, rayon, nylon, and wool—and on various types of cellophane. Drs. J. W. Ballou and Shirleigh Silverman did the work while connected with the Rayon Technical Division of the DuPont Company, Wilmington, Delaware. Dr. Ballou is now at the Underwater Sound Laboratory at Harvard, and Dr. Silverman at the Johns Hopkins Applied Physics Laboratory at Silver Springs, Md., on government work.

The specific property measured by the 10 kilocycle sound waves is expressed as Young's modulus of elasticity, which indicates the extent to which a material is elongated when a stretching force is applied. The usual method of measuring this factor in fibers has been to hang a weight on the fiber and note the load required to bring about a certain amount of stretch. But this slow application of the force or load often not only produced elastic stretch but also permanent deformation, which invalidated the results.

Typical set-up, shown at left, for bullet speed tests using magnetized projectiles at Aberdeen Proving Ground, Maryland. Right—Chronograph room at the Michaelson Branch where muzzle velocities are recorded. Equipment is a pulse generator, an electronic gate, and integrating circuits



To find the value of the elastic component alone it is necessary to apply a small force rapidly—in other words, stretch the material so little and so quickly that it doesn't have time to get permanently out of shape. Passing sound through the fiber or film does just this. It causes the material to go through rapid stretching and recovery as it vibrates. This application of sound, the DuPont scientists said, had been previously used by two other investigators, Meyer and Lotmar, but in a less versatile form.

Since velocity of sound through any medium is determined by its density and its modulus of elasticity, it is necessary only to find out how fast sound passes through the test material (the density of which is already known) to calculate its elastic modulus. The Rayon Technical Division apparatus, therefore, is set up to measure the velocity of sound through the fiber or film.

To one end of a horizontal bar of steel about eight inches long, the test fiber or strip of film is fastened. The other end of the material is strung over a pulley and held taut by a weight. When the audio oscillator is turned on, the steel bar vibrates at the 10-kilocycle frequency. The sound energy passes along through the test fiber or film, which in turn vibrates like a violin string. The wavelength of these vibrations is accurately measured with a sliding crystal and this figure, with the frequency enables calculation of the velocity of the sound.

The method, Drs. Ballou and Silverman said, gives elastic modulus values two or three times those obtained with the slow loading or static method and more closely reproduces the type of strain which will be imposed on many materials in actual use, such as the fabric and the rubber going into tires. Here the load or flexure is applied very rapidly to each part of the tire, as it revolves along the road at high speed.

The set-up is so simple that it can be placed in a closed chamber for measurement of the modulus under a wide range of temperatures and humidity.

Continuous Heat-Treating

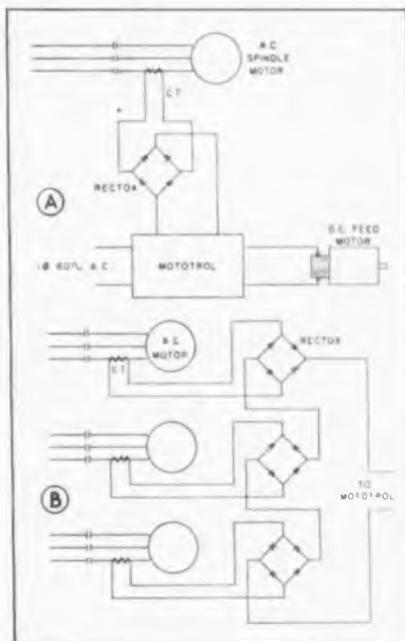
A production line installation of high speed, continuous heat treating equipment has been made by Federal Telephone and Radio Corp., Newark, N. J. The application demanded case hardening of bearing pins 2½-in. long by ½-in. diameter to a depth of .025-in. as they were fed automatically through a glass tube at the rate of 75 per minute.

The surface of each part is heat-

ed above its critical temperature in less than one second by the 5 mc energy. Unhardened parts are fed into the tube from a hopper. A continuous flow of water serves as the quenching medium.

Surface hardness developed is Rockwell C 60—above file-hardness. The pins are finish-ground before heat treating, from chromium molybdenum steel stock NE-9442. The work coil used is a single layer, approximately one inch long by ¾-in. in diameter, consisting of five turns of small copper tubing.

Machine Tool Load Control



Load control circuits for single and multiple spindle drives.

A milling machine is a logical candidate for load control to increase production and reduce cutter breakage. When making a roughing cut on a casting, milling a slot in an irregular shaped piece, etc., the rate of removing metal will vary, and the load on the cutter and cutter motor will vary approximately in proportion.

To avoid breaking the cutter or overloading the motor, depth of cut and rate of feed must be set for the worst condition that will be met in the cutting cycle.

Maximum loading generally lasts for a small portion of the total cycle, and the rate of metal removal is low.

The load on the cutter can be maintained nearly constant by automatically adjusting the feed speed to compensate for the varying depth of cut or hardness of the material. Westinghouse has

developed a very simple arrangement which measures the load on the ac spindle motor and automatically adjusts the feed motor to maintain the load on the spindle motor to some predetermined value. The scheme has been worked out for either ac or dc motors on the spindle, and adjustments can be made easily by the operator to adjust the load on the spindle motor and also to limit the maximum feed speed if this is desirable.

The basic scheme when using an ac spindle motor is shown at A. A current transformer is connected in one phase of the motor and its secondary output feeds a rectox unit. The resulting dc voltage is roughly proportional to load, and it is used as a regulating voltage in the control system of the feed motor, to vary the feed speed.

If the ac motor is of such design that current is not proportional to load, or if it is desired to adjust the load over a wider range, a slight variation in the circuit supplies a control voltage proportional to the kw input of the motors rather than the current, providing a more exact measurement of cutter load.

The circuit at B is modified to be used on machines with any number of milling cutters. The outputs of the rectox units are connected in series. Tests show that the current flowing in the output circuit is always proportional to the maximum load on any one of the motors. With this connection, the feed motor is regulated to automatically maintain the desired load on at least one of the cutter motors at all times, and the remaining cutters may be carrying any load from no load up to full load value.

Although it is normally assumed that all motors are of the same size, the scheme will work equally well for motors of different sizes, as the variation in size can be compensated for by changing the current ratio of the current transformers. Also, the maximum load that any one motor can carry can be independently adjusted to compensate for different size cutters that may be used from time to time on a given spindle.

It is an easy matter to remove the automatic load control scheme from operation by throwing a small selector switch which returns the feed drive to conventional arrangement and allows the machine to run at some fixed speed only. This system is a simple and reliable scheme of load control that will undoubtedly result in greater production on any type of machine tool where a variable feed speed is permissible.

SURVEY of WIDE READING

Electronic news in the world's press. Review of engineering, scientific and industrial journals, here and abroad

A Chart for Rhombic Antenna Design

W. G. Baker (A.W.A. Technical Review, Sydney, Vol. 6, No. 4, 1944)

A chart has been prepared for the design of rhombic antennas to solve such problems as: the best antenna dimensions for given wavelength and given angle of elevation, the angle of maximum radiation for given wavelength and antenna dimensions, and the wavelength of maximum radiation for given antenna dimensions and given angle of elevation. The results apply only to horizontally polarized signals propagated in the vertical plane containing the principal diagonal of the rhombus.

The chart is based on the equation:

$$E = \frac{480 I \cos \alpha}{R \frac{(1 - \cos \beta \sin \alpha)}{\sin \frac{2\pi H \sin \beta}{\lambda}} \sin^2 \frac{4\pi L}{\lambda} (1 - \cos \beta \sin \alpha)}$$

where

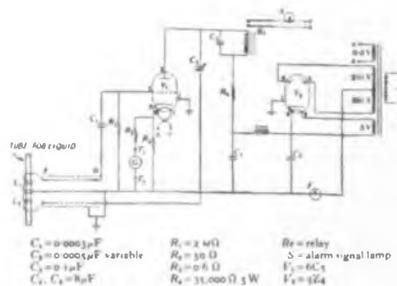
- E = field strength in mV/meter
- R = distance in km, measured along the sky line
- α = half the angle of the rhombus at the end of the minor diagonal; angle of tilt
- β = angle of elevation above the horizontal
- I = antenna current in amperes
- L = length of side of the rhombus in meters
- H = height above ground in meters
- λ = wavelength in meters

The optimum conditions for the various cases are found by suitable partial differentiation of this equation, and the chart permits ready numerical evaluation of the expressions so obtained. An additional nomogram gives the field strength if all relative data are known.

Electronic Indicator for Liquid Separation

J. W. Broadhurst (Journal of Scientific Instruments, London, June, 1944)

In the course of plant operation an immiscible mixture of a heavy oily organic liquid and an acid are separated by allowing the constituents to settle out in a vessel and then drawing off the bottom oily



Device to indicate whether conducting or non-conducting liquid passes in tube at left

layer by means of a dip pipe, the problem being to arrest the process as soon as acid is drawn over. To establish the right moment, the oscillator shown has been built.

The liquid in the glass tube is used as the core of coils L_1 and L_2 in the tuned circuit of the oscillator. The circuit is adjusted to oscillate while air or a non-conducting liquid such as oil is passing through the glass tube and to stop oscillating, due to eddy current loss, when the conducting acid enters the tube. Millivoltmeter G in the cathode lead of the oscillator tube indicates whether or not oscillations are present. On occasions a less sensitive set-up is required and it is sufficient to work on the relay R_e , the millivoltmeter being disconnected by removal of the plug T_1, T_2 . Oscillator frequencies from 1 to 10 megacycles have been used.

With the instrument critically set, 25 c.c. of hydrochloric acid (approximately 100 g./l.) in a $1\frac{1}{4}$ in. diameter tube inserted inside the sight glass causes a change in the plate current of 0.5 ma, larger masses of acid throwing the instrument completely out of oscillation as they approach the coils.

Space Charge Theory

W. E. Benham (Wireless Engineer, London, July, 1944)

The energy content and dielectric constant of electron space charges in a plane, space-charge limited diode, considered as a capacitor, is investigated. The known value of the dielectric constant, $3/5$, is confirmed without resort to the use of transit time dynamics.

The total energy of the condenser-diode is found to be equal

to $5/3 \times W_e$, where W_e is the energy of the empty condenser when no space charge is present. There is an energy difference of $10/15 \times W_e$ between the empty and the space-charge diode condenser. $8/15 \times W_e$ of this additional energy is realizable as kinetic energy of the electron stream, $1/15 \times W_e$ appears as energy stored in the diode condenser. Another $1/15 \times W_e$ is stored as mutual electrostatic energy of the space charge electrons; i.e., were the electrons to scatter under the influence of their mutual repulsion alone, they would acquire a total kinetic energy of $1/15 \times W_e$.

HF Induction Heating for Thin Cases

V. W. Sherman (Metals and Alloys, June, 1944)

Methods and results of the hardening of 0.010 in. layers on the surface of hardenable steel by induction heating are discussed in general; a particular example is described. The internal layers are neither softened, nor weakened, nor tempered. Special applications suitable for the method are enumerated.

Transient Response in FM Systems

D. A. Bell (Philosophical Magazine, London, March, 1944)

Square wave modulation is assumed to be applied both to an amplitude-modulated and a frequency-modulated system, in each of which the bandwidth is limited by a single parallel-resonant circuit tuned to the carrier frequency (see Fig. 1); the responses are computed.

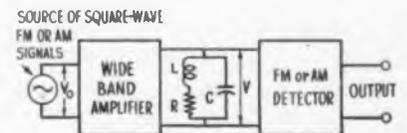


Fig. 1—Schematic diagram of FM and AM circuits studied as to their square wave response

For the AM wave the ratio of the voltage V across the resonant circuit to the applied square-wave amplitude V_0 as a function of time will be: $V/V_0 = 1 - e^{-\omega t/2Q}$, where ω is the signal frequency as well as

"Ham" Radio and

HYTRON

PAST



THE radio amateur trained himself during peace to be invaluable to the Nation during war. Specializing on tubes exclusively designed for ham radio, Hytron when war began was prepared for immediate and direct conversion to war production. Hytron transmitting and special purpose tubes proved by the ham were ideally suited—with little or no changes—to military applications. Years of practical experience made Army and Navy specialists of radio amateurs overnight. Peacetime tools of these same hams, Hytron tubes joined immediately this new fighting team.

. . . . PRESENT

HAMS with the Services in all parts of the world know the war job Hytron is doing. High-speed receiving tube techniques plus know-how derived from special purpose engineering of tubes for the amateur, make possible a flood of dependable Hytron radar and radio tubes to these fighting ex-hams and potential hams. Proud of winning the Army-Navy "E" for its performance on a huge production job, Hytron is also proud of its ham friends who are transforming innocent-appearing Hytron tubes into deadly weapons.



FUTURE



THERE should be no concern about adequate post-war amateur frequencies. Excellent wartime performance on far-flung battle fronts has made for ham radio many enthusiastic and influential friends. The ARRL reports that it looks forward with absolute confidence to the opening of new frontiers in expanded frequency ranges to be made available to the post-war amateur. Hosts of hams will return to their old friend, Hytron. For the more familiar lower frequency bands—the very high frequencies—or the new superhighs—their choice will be Hytron.

OLDEST EXCLUSIVE MANUFACTURER OF RADIO RECEIVING TUBES

HYTRON

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BUY ANOTHER WAR BOND

SURVEY OF WIDE READING

the resonance frequency of the circuit.

Each frequency transition in the FM square-wave-modulated system is analytically represented by the application of a signal equal and opposite to the previously applied signal and of another signal of equal amplitude but of the new frequency. The net result is a change in frequency without a change in amplitude of the applied signal, expressed as the sum of two amplitude changes which can be dealt with by known technic.

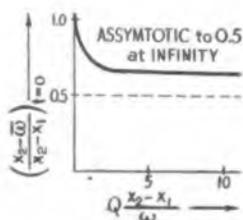


Fig. 2—Initial response of FM circuit to square wave input as a function of Q times the relative width of the square wave

For the evaluation of the formulas it is assumed that the Q of the circuit is large and that the frequency of the modulated carrier is equal to the resonant frequency of the circuit. Also, in wide band frequency modulation, the difference between the two frequencies x_1 and x_2 of the modulated carrier, respectively, and the center frequency, $w = \frac{x_1 + x_2}{2}$, will be so great

that it is outside the range of the audio-frequency amplifier so that variations at this frequency may be neglected.

In the limiting case of a very small shift of applied frequency, w approaching x_1 , the initial output frequency of the circuit, w , approaches the applied frequency x_1 ,

and the initial response, $\frac{x_2 - w}{x_2 - x_1} = 1$.

At the other extreme, for wide fre-

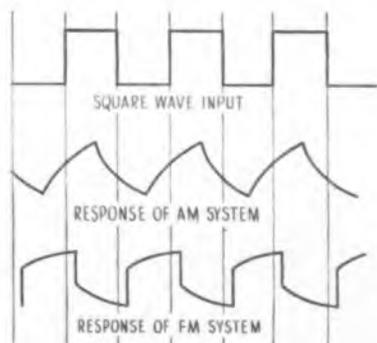


Fig. 3—Comparing performance of AM and FM systems

quency deviation, $\frac{x_2 - w}{x_2 - x_1}$ is asymptotic to 0.5, because the change of the applied frequency from x_1 to x_2 , where $x_2 - x_1$ is large compared with the bandwidth of the circuit, results in setting up a strong transition oscillation of the resonant

frequency $w = \frac{x_1 + x_2}{2}$ resulting in

an initial response of only 50 per cent (see Fig. 2).

Fig. 3 permits a comparison of the original square wave, the response of the amplitude-modulated system, and the response of the frequency-modulated system. The relation of the circuit bandwidth to the period of the square wave modulation is the same for both systems. It is apparent from the figure that the performance of the FM system is superior to the AM system as far as the reproduction of the original wave shape is concerned. If the frequency-modulation is not sufficiently wide band, a superposed oscillation of the frequency $(x_2 - x_1)/2$ will be noticed. Experimental results were found to be in good agreement with the theory.

Analysis and graphs, showing the phase and corresponding frequency distortion of a sinusoidal FM wave upon passage through a tuned circuit indicate high-order harmonics, which may be filtered out in the subsequent circuits.

Electric Properties of Ceramic Materials

H. H. Hauser (Journal of the Ceramic Society, June, 1944)

Previous results obtained by different investigators on the influence of temperature, frequency, and humidity on power factor and dielectric constant are reported. New tests of the dependence of the dielectric constant and the power factor on the humidity were carried out on rutile bodies formed at various pressures from 8 to 20 tons per sq. in.; five different states of humidity were investigated with the following results:

1. The dielectric constant as well as the power factor increases with the rise of forming pressure. The influence of forming pressure on the dielectric constant is insignificant compared with the influence on the power factor.

2. The influence of humidity is a function of the forming pressure and increases with increasing forming pressure. Although the power factor depends considerably on humidity, the dielectric constant is hardly affected at all.

3. The forming pressure does not seem to influence the power factor of samples in the dry state as much as of wet samples.

It is suggested that almost all changes of power factor in different relative humidities are connected with the surface resistance. It is a small film of water vapor in the surface of the test sample which adds a parallel resistance to the capacitor, the power factor being indirectly proportional to this parallel resistance.

The influence of humidity on the dielectric properties depends on the composition of the material, forming pressure, firing temperature and time, and surface condition; it is also dependent on the test frequency, temperature and air pressure during the test, and perhaps many other unknown components. This great number of variables offers explanation for the fact that measurements on dielectric properties of the same type of ceramic materials show entirely different results even though all measurements be made at exactly the same relative humidity.

X-Ray Technic

R. Taylor (Metal Progress, February, 1944)

A simple method is suggested to prevent off-focus radiation from an X-ray tube reaching the photographic film, whereby a sharpening of the recorded image is achieved. The source of secondary radiation, for instance the electrodes, the tube window, etc., is established by exposing a film through a small opening in a sheet of lead, the size of which allows passage of the primary beam only. If the picture of the opening is not satisfactory, filters, grids or screens are inserted at different places to reduce or eliminate secondary radiation.

Two Transmitters for Military Intercommunication

(Western Electric Oscillator, September, 1944)

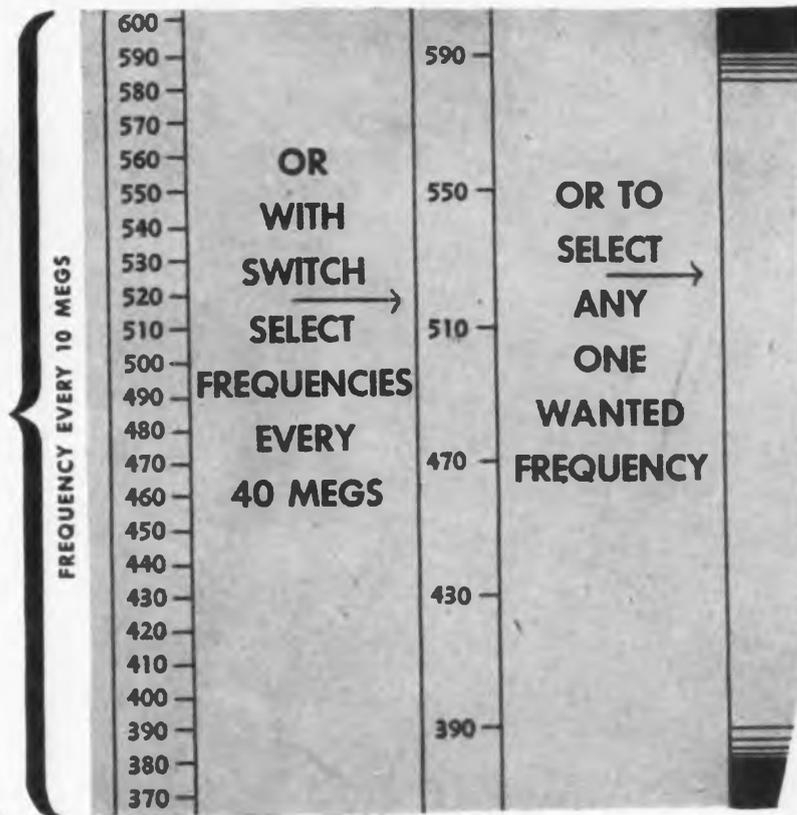
The SCR-508 tank set and the SCR-608 artillery set are similar, the only major difference being in the frequency range. Both transmitters use crystal control, push button frequency selectors and saturated iron core phase modulation coils. Crystal control is provided because these transmitters must operate in a relatively small area without interference. Eighty crystals are furnished with the tank set and 120 with the artillery set, one crystal being provided for each 100 kc step; 10 crystals can be simultaneously inserted.

(Continued on page 182)

the **NEW**, Secondary Standard
LAVOIE C-200 CALIBRATOR



**WILL PRODUCE
HARMONICS
FROM 10 TO 2000
MEGACYCLES
AND HIGHER
WITH QUARTZ-
CRYSTAL ACCURACY**



The LAVOIE C-200 CALIBRATOR...

1. Produces only harmonic frequencies of 10 megas up to 2000 megas or higher.
2. By means of a switch cuts out 10's and produces only 30's on the megacycle frequency range.
3. By means of the Identifier, selects any one frequency for purposes of identification.
4. Is equipped with a detector and amplifier on the panel for use with calibrating signal generators, etc., etc.

Write for detailed information.



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RADIO ENGINEERS AND MANUFACTURERS
MORGANVILLE, N. J.

Specialists in the Development of UHF Equipment

ELECTRONIC INDUSTRIES • October, 1944

WASHINGTON

Latest Electronic News Developments Summarized
by Electronic Industries' Washington Bureau

ARMY AIDING RECONVERSION—Radio-electronic manufacturers have been advised about the extent of the Army's cutbacks in military production by the Signal Corps in a series of conferences so they could plan for civilian reconversion. Expediting contract termination negotiations to facilitate speedy compensation settlements, the Signal Corps has formed teams of several hundred officers, experts in the Army contracts, auditing and appraisal, in the various procurement districts throughout the country—this number of termination officer staffs later was to be expanded substantially after V-E Day (Victory in Europe). Pattern for civilian conversion of the nation's "war-mushroomed" radio-electronic industry was carefully planned under direction of Major General William H. Harrison, Director of the Signal Corps' Procurement and Distribution Service.

V-E DAY CUTBACK TO BE OVERALL OF 30 PER CENT—While for most war production industries the military terminations upon the collapse of Germany is estimated at 40 per cent, the radio-electronic cutback will be an overall of 30 per cent, according to most authoritative estimates of armed services and WPB. The cutback percentage will not be the same in all lines of equipments, but will vary up and down on the basis of Army-Navy stocks on hand or projected for future combat use. (The Navy cutbacks are expected to be from 5 to 10 per cent.)

YARDSTICK FOR CUTBACKS—Yardstick of Army cutbacks is the decision to reduce stocks in reserve at signal depots from 90-day levels and the slashing of the wartime reserve (estimated needs for battle zones) by one-half. Production of certain critical military items will be continued at full tilt which will tie up a small number of companies from civilian production when the green light is flashed.

TRANSMITTERS FIRST; RECEIVERS RIGHT BEHIND—The starting gun of civilian production is slated to be in transmitters as the industry's plants will have to make a minimum of changeovers in their assembly lines and tooling from similar military production assignments. Receiving sets should get under way with speed, WPB authorities feel, but home broadcast receivers for any large production volume have to await the new FM-video allocations for their designing so this civilian production program in full force probably cannot be launched until late November or early December (if V-E Day comes in the near future).

CIVILIAN DEMAND OUTLOOK—For home receivers OPA Administrator Bowles has estimated a total value of approximately \$500,000,000 during the first year after the German victory and WPB Civilian Radio Chief John Creutz views production to be at a minimum of 10 to 15 million sets. Automobile production will make auto radio sets the next largest market.

TRANSMITTER BACKLOG—The broadcasting industry has at least \$30,000,000 in a backlog of pentup civilian orders for transmitters, including 150 additional FM stations at present indications and 50 television stations. Police radio systems will double, it is

forecast, although military surpluses may fit to some degree into use in that field.

AVIATION DEMANDS—Aviation with its tremendous expansion of domestic and overseas flying presents another important market, but the immediate civilian production demand probably will be curtailed by the war surplus apparatus. The many specialized radio services in safety, geophysical, emergency utility and other fields, together with the amateurs who are to go back on the air after victory, will have their equipment needs. The industrial, medical and scientific electronic requirements, which have hardly been scratched in their full potentialities, may prove, in the opinion of many observers, a real bonanza of postwar reconversion.

SURPLUS DISPOSAL PLANNING PROGRESSES—The delays in Congressional action on the Surplus War Property Administration legislation have retarded the establishment of the processes to have the different branches of the radio-electronic manufacturing industry handle the disposals of their various products through regular marketing channels. Then, too, the spectre of the anti-trust law as has been warned by Attorney General Biddle has arisen so that the present Surplus War Property Administration and its affiliated agencies, including the Defense Supplies Corporation of the RFC which is handling the arrangements with the radio-electronic manufacturers, have had to move very carefully in their negotiations.

MARKETING TROUBLES—Agreements under which the DSC designates the various manufacturers as agents of SWPA to market the surpluses with payment of commissions and reimbursement of storage and marketing costs have to be negotiated individually with each manufacturer instead of by industry groups. The major radio-electronic component group that has reached final agreement on the surplus disposal contracts is the tube industry which is now geared to market through civilian channels the first batch of Army surplus tubes, some 5,000,000 and with larger numbers to be released in the near future.

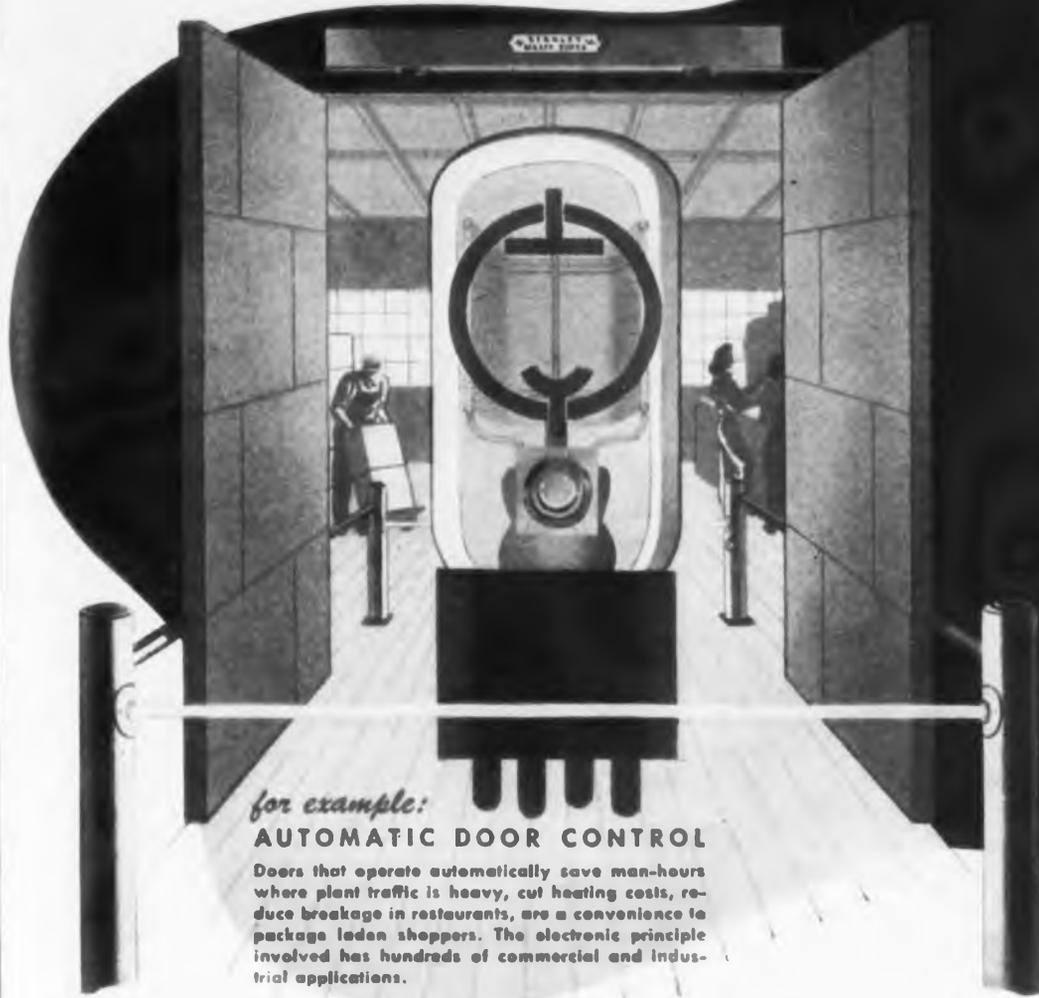
AIRCRAFT SURPLUS DISPOSAL—For aviation radio-electronic apparatus it has been decided there will be a central disposal point through the Aircraft Signal Agency at Dayton, O., and for marine radio equipment the Maritime Commission in Washington and through its field offices will handle the surplus marketing.

SHIFT TO AIR FORCES COMMUNICATIONS—Transfer of a substantial segment of Signal Corps' research and development, procurement and installation-maintenance activities to the Office of the Air Communications Officer of the Army Air Forces is in the making at War Department. One major shift of Signal Corps' operations to Air Forces would be entire Aircraft Signal Agency and Aircraft Radio Laboratory at Wright Field, Ohio. High-ranking Signal Corps officers also to be transferred to AAF.

National Press Building
Washington, D. C.

ROLAND C. DAVIES
Washington Editor

wherever a tube is used...



for example:

AUTOMATIC DOOR CONTROL

Doors that operate automatically save man-hours where plant traffic is heavy, cut heating costs, reduce breakage in restaurants, are a convenience to package laden shoppers. The electronic principle involved has hundreds of commercial and industrial applications.



PHOTO-ELECTRIC DOOR CONTROL

Above unit manufactured by General Electric Co., is a part of STANLEY "MAGIC DOOR" CONTROLS.

THERE'S A JOB FOR

Relays BY GUARDIAN

★ The "Magic Door" made by The Stanley Works of New Britain, Conn., uses a General Electric control unit which operates automatically at the approach of a pedestrian or vehicle. In this unit a beam of light focused on the cathode of a phototube causes a tiny current to flow. Enlarged through an amplifier tube this current operates a sensitive telephone type of relay such as the Guardian Series 405. Another phototube with an auxiliary relay, Guardian Series R-100, is employed to hold the doors open for anyone standing within the doorway.

The telephone type of relay is extremely sensitive and able to operate on the small current supplied through the electronic circuit. The auxiliary relay, Series R-100, is required to handle a greater current. It is a small, efficient relay having a contact capacity up to 1 KW at frequencies up to and including 28 megacycles. Contact combinations range up to double pole, double throw. Standard coils operate on 110 volts, 60 cycles, and draw approximately 7 V. A. Coils for other voltages are available. For further information write for Bulletin R 6.

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.



Series 405 Telephone Type Relay



Series R-100 H. F. Relay

GUARDIAN ELECTRIC

1622-L W. WALNUT STREET CHICAGO 12, ILLINOIS

A COMPLETE LINE OF RELAYS SERVING AMERICAN WAR INDUSTRY

WHAT'S NEW

Devices, products and materials the manufacturers offer



Miniature Oscillograph

A new self-contained, unusually compact, permanent-magnet oscillograph has been announced by the General Electric Co. This "baby" oscillograph is known as the Type PM-17-A1. Originally designed for a war application, it has now been adapted for general use. It is the world's smallest six-element unit and consists of three principal systems: the optical system; the six parallel galvanometer channels; and the photosensitive-material transporting mechanism with internal motor and removable film holder, which are all enclosed within a light-tight metal case $4\frac{1}{2}$ by $4\frac{1}{2}$ by 14 in. The weight of the complete instrument is approximately 10 lbs. This new instrument makes it possible to obtain performance records on many equipments where the larger general-purpose type cannot be used because of space and weight limitations. It is designed to directly record small values of potential or current, such as the output of amplifying equipment. A wide range of potentials or currents can be recorded by the use of appropriate external resistors, instrument transformers, or shunts.

Coaxial Connectors

Coaxial connectors designed to meet the specialized performance requirements of high-frequency instruments are now available from the Diamond Instrument Co., Wakefield, Mass. A feature of Dico connectors is the precision silver-plating of their accurately machined brass bodies and beryllium-copper contacts, maintaining the close tolerances essential to permanently trouble-free operation, while guarding all surfaces against corrosion. Units comply in every particular with applicable Army and Navy specifications.

Ceramic Wire Insulation

Culminating seven years of continuous research, the Sprague Electric Co., North Adams, Mass., has evolved a process for depositing a thin ceramic (inorganic) coating on copper, nickel, and other types of wire. This new insulation has been trademarked as Sprague Ceroc 200. When applied to copper wire it maintains desirable electrical characteristics at a continuous operating temperature of 200 deg. C. as compared to the present limit of 105 deg. C. for conventional Class A insulations such as enamels, varnishes, and other organic materials. Space factor is extremely good, in that Ceroc 200 is thinly deposited on the wire. Typical space factor expressed in percentage of copper area to total cross-sectional area of finished wire is 96 per cent for AWG No. 21 wire, and 95 per cent for No. 24 wire

by comparison with 69 per cent and 59 per cent, respectively, for other types of insulation that might be used for similar high temperature applications. An important allied feature is the high degree of thermal conductivity of Ceroc 200. Both because of the highly favorable space factor and the ceramic composition of this insulation, coils wound with it dissipate heat rapidly. There is little or no tendency toward the development of hot spots which would nullify a large percentage of the high temperature gain that might otherwise be expected.

The preferred thickness of Ceroc 200 is $\frac{1}{4}$ mil. Moreover, the coating is extremely uniform and makes for smooth, level winding in a minimum of space. Present preferred wire sizes for applying Ceroc 200 are from 7 to 30 mils in copper wire (No. 40 to No. 21 AWG) and from $1\frac{1}{2}$ to 12 mils (No. 46 to No. 28) in nickel wire. Ceroc 200 is sufficiently flexible that round coils can generally be wound satisfactorily on existing equipment. In the case of rectangular coils or motor armatures, however, winding technique may require modification to assure that the wire is not stretched more than 10 per cent.

Oscilloscope

DuMont has developed a new type of cathode ray oscilloscope (Model 248) designed to provide for the accurate observation and study of micro-second impulses containing frequency components as high as



10 mc. Either transient or recurrent phenomena can be displayed and the instrument has been designed to accommodate phenomena of inconstant repetition rate. The leading edge of short pulses is not obliterated and the accelerating voltage is sufficient to permit study of extremely short pulses with low repetition rates. Timing markers are available for quantitative or calibration purposes. Salient features of the instrument include: A wide band vertical axis amplifier usable to 10 mc.; 4,000 volts accelerating potential; an extremely flexible time-base generator to display signals which heretofore required special sweep circuits; a delay network permitting observation of the entire waveshape of short duration phenomena; a timing oscillator for quantitative analysis; a trigger output signal useful for synchroscope applications. Manufacturer is Allan B. DuMont Laboratories, Inc., Passaic, N. J.

Induction Hardening

A general-purpose two-station hardening and quench table used in connection with high-frequency induction heating generators is made by Induction Heating Corp., 389 Lafayette St., New York. Arranged with quick change coil connections so that jobs can be set up in 2 to 3 minutes to change a heating coil, it is only necessary to make two coupling connections to



the leads located at each outlet station. The equipment can be used either as a single purpose unit, using two identical fixtures, or it will serve as a general-purpose table. Initial timer is provided so that when a new part or new job is to be induction treated, the heating time will be recorded. The table is also equipped with a master 3-stage timer which automatically controls the heating and quenching positions of the cycle. The hardening table is equipped with a full-length sink and has two large drains for carrying off the water. Two rotary-driven spindles are provided for use in connection with the hardening of parts such as gears.

Cables for UHF

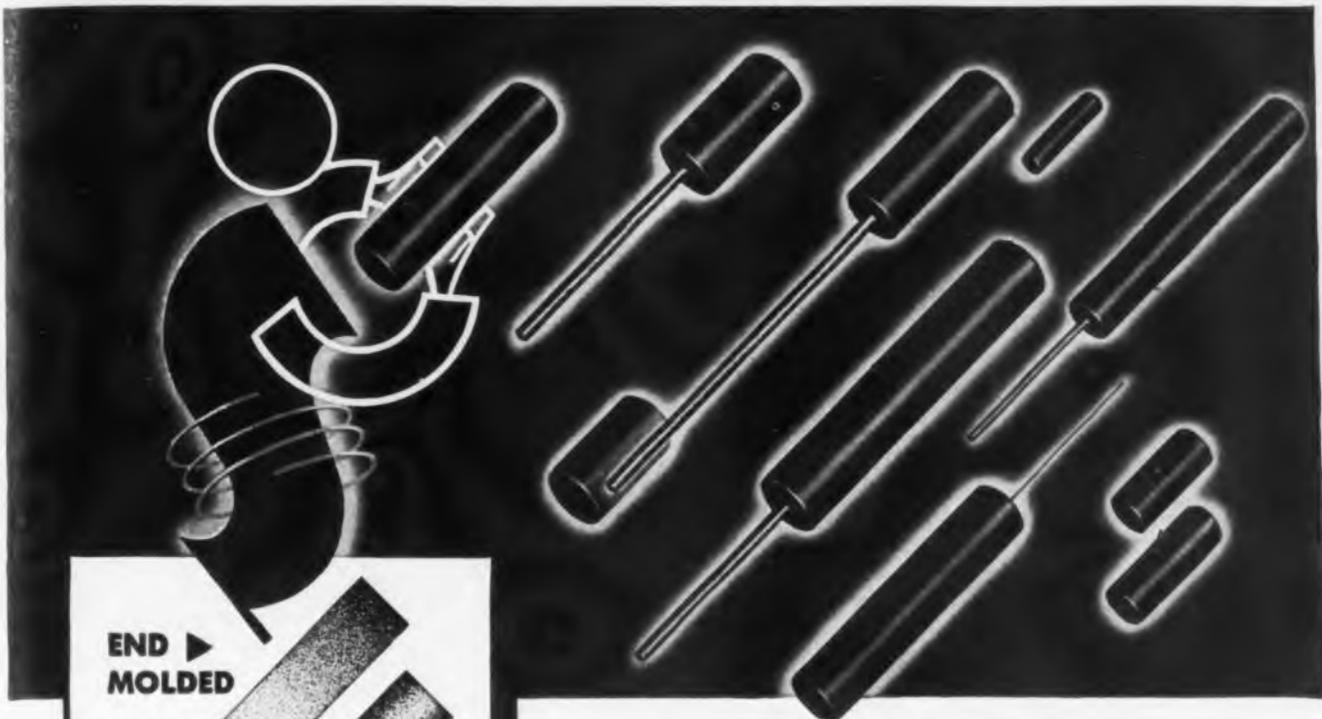
New sizes and types of solid-dielectric coaxial cables, used in ultra-high-frequency radio and radar equipment for the armed services, have been added to the line of cables manufactured by the Intelin Products-Division of Federal Telephone and Radio Corp., Newark, New Jersey, associate of International Telephone and Telegraph Corp. Cables are manufactured in five basic types: Coaxial, dual-coaxial, twin-conductor, coaxial air-spaced and spiral delay. Designed, generally, for 50 to 70 ohms impedance, the cable selected is predicated upon power requirements or power loss limitations. Coaxial lines include sizes from $\frac{3}{16}$ in. outside diameter to and including cables over 1 in. in outside diameter. Standard designs include single and double-braided constructions with standard and armored covering. Dual-coaxial lines have been developed to fill the need for parallel circuits having a high degree of electrical



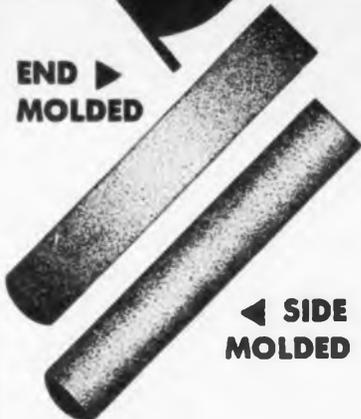
balance. Twin-conductor lines, sometimes called "Twinax" are balanced shielded pairs, usually somewhat smaller than dual-coaxial lines, and provide nearly as good an electrical balance. For low capacitance requirements, Federal has developed a line of coaxial air-spaced cables which can be made in any required length and which have capacitances as low as 8 micromicrofarads per foot.

(Continued on page 126)

SIDE-MOLDED IRON CORES



END
MOLDED



SIDE
MOLDED

This diagrammatic illustration shows how conventional cores, molded by applying pressure to the ends, results in a dense grouping of iron particles at these points. In side-molded cores, however, any density resulting from molding pressure extends evenly along the entire length of the core, assuring uniform permeability with respect to length.

Uniform Permeability with Respect to Linearity

Use in many applications has shown Stackpole side-molded iron cores outstandingly superior to conventional end-molded cores for permeability tuning in the broadcast bands. Similar side-molded units are now available for short wave frequencies including television and frequency modulation.

As the name implies, cores of this type are molded by applying pressure from the sides rather than from the ends. The resulting units show very little variation in density or permeability with respect to length, thus assuring a high degree of uniformity.

WRITE FOR CATALOG! Other Stackpole Iron Core types include both standard and high-frequency types; insulated types; iron cores for choke coils, etc. Our new Catalog RC6 describes these as well as fixed and variable resistors, and our complete line of inexpensive line, slide, and rotary-action switches.

STACKPOLE CARBON COMPANY, ST. MARYS, PA.

STACKPOLE

IRON CORE HEADQUARTERS

★ TELEVISION TODAY ★

New Developments in the Video Field

Tele Coming Sooner

With 76 applications for television broadcasting stations on file with the Federal Communications Commission, approximately 50 million people throughout the country may have sight-and-sound broadcasting six months to two years sooner than even the most optimistic previous estimates, according to Thomas F. Joyce, of Radio Corp. of America. This forecast, he told the National Association of Broadcasters' war conference here, is based on the supposition that the FCC would grant all these licenses and that television equipment can be manufactured and installed rapidly enough.

Turning to the question of whether present-day television standards are satisfactory, Mr. Joyce declared that the people who now own television home receivers should be considered as best qualified to answer that question. He then revealed the results of recent attempts to re-purchase at a liberal price television sets now in the hands of the public.

Out of 36 owners approached, Joyce declared, only one agreed to sell his set, many refusing to consider any offer while others set re-purchase prices ranging up to \$1,500 for receivers which were purchased five years ago for \$395.

TBA Chooses Channels

Late in August Board of Directors of the Television Broadcasters Association, meeting in Schenectady, unanimously adopted resolutions setting forth the principles which it considers "the major premises involved in the matter of allocations." They are:

- "1. The Board of Directors of the Television Broadcasters Association, Inc., is convinced that the public interest requires that television be allocated 30 six-megacycle channels as nearly contiguous as possible, starting at approximately 40 megacycles and extending the frequencies not in excess of 250 megacycles.
- "2. It further is convinced that the public interest requires that television be allocated 30 sixteen to twenty megacycle channels as nearly contiguous as possible, starting at approximately 400 megacycles and extending the frequencies not in excess of 2,000 megacycles.

"3. It further is convinced that adequate relay channels such as suggested in the Radio Technical Planning Board's report of Panel 6, should be allocated to television service."

Video Studio



Radio executives who gathered in Chicago for the annual NAB War Conference saw this model television studio designed and exhibited by the Austin Co. Samuel Woodworth, owner of WFBL (Syracuse), Austin's P. C. McCabe and GE's J. D. McLean look into the layout which contains a large and two small studios, one of them with sliding stages 44 feet long, the two small studios being served by a common control room

Tele for the Cops

Television, coupled with other postwar developments, will be used in the not-too-distant future as powerful aids of police, Frank J. Wilson, chief of the United States Secret Service, said last month at the 51st annual conference of police chiefs, held in Cleveland.

Television, he said, will lend itself particularly to the protection of the public, not only by carrying pictures of criminals at large, but in promoting public education against traffic danger, against sports which promote juvenile delinquency and other menaces.

TBA Conference Dates

First annual conference of the Television Broadcasters Association (headquarters, 500 Fifth Ave., New York) is slated for December 11 and 12 and will be held in New York. Dates originally were set for December 7 and 8. Location is still Hotel Commodore.

Theater Television

Television theater service may become a necessary corollary to television broadcasting to the home. T. A. M. Craven, former FCC commissioner, stated at the NAB convention last month. Experience in foreign countries indicates that the public may become interested in viewing television in a theater. This indicates potential commercial possibilities for such service.

*Title registered U. S. Patent Office.

Television Broadcasters Association Directors Pose



When TBA Directors visited General Electric's WRGB in Schenectady late in August, this picture resulted, the gentlemen being: Paul Raibourn (Paramount); F. J. Bingley (Philco); R. L. Gibson (GE); A. B. DuMont (DuMont); Worthington Miner (CBS); B. W. Cruger (GE) but not a director; J. R. Poppele (Mutual); Will Baltin, secretary-treasurer of TBA

QUICK-REFERENCE CHART MINIATURE TUBES

RCA

BASIC DATA FOR DESIGNERS ON RCA'S WIDE MINIATURE LINE



TYPE NO.	DESCRIPTION	APPLICATION DATA AND SUGGESTED USES	FILAMENT OR HEATER			MAX. RATINGS			TYPICAL PLATE MA.	TRANSCONDUCTANCE at max. plate volts (μmhos)	LIST PRICE
			VOLTS	AMPERES	TYPE	PLATE VOLTS	SCREEN VOLTS	TOT. CATH. MA.			
1A3 ^a	H-F DIODE	For discriminator in FM receivers and in measuring equipment. Resonant freq., 1000 Mc.	1.4	0.15	H	330 _o	—	0.5 _g	—	—	\$1.15
1L4 ^a	R-F AMPLIFIER PENTODE	For use where sharp cut-off characteristic is required—no external bulb shield needed.	1.4	0.05	F	110	90	6.5	4.5 _c	1025 _c	1.15
1R5 ^a	PENTAGRID CONVERTER	Has conversion transconductance of 300 micromhos at 90 volts on plate.	1.4	0.05	F	90	67.5	3.5	1.6	—	1.15
1S4	POWER AMPLIFIER PENTODE	Capable of handling audio power output of 270 milliwatts.	1.4	0.10	F	90	67.5	9	7.4	1575	1.15
1S5 ^a	DIODE-PENTODE	Combined diode and a-f pentode providing high voltage gain.	1.4	0.05	F	90	90	4.5	1.6	625	0.95
1T4 ^a	SUPER-CONTROL R-F AMPLIFIER PENTODE	Useful as r-f or i-f amplifier—no external bulb shield needed.	1.4	0.05	F	90	67.5	5.5	3.5	900	1.15
2D21	THYRATRON (Gas-Tetrode)	For relaying. Will operate directly from high-vacuum phototube.	6.3	0.6	H	1300 _o	—	100 _{d,g}	—	—	3.75
3A4 ^a	POWER AMPLIFIER PENTODE	Can handle a-f output of 700 milliwatts, or r-f output of 1.2 watts at 10 Mc.	2.8 _s 1.4 _p	0.1 0.2	F	150	90	18	13.3	1900	0.75
3A5 ^a	H-F TWIN TRIODE	Has Class C output of about 2 watts at 40 megacycles.	2.8 _s 1.4 _p	0.11 0.22	F	135	—	5 AF 30 RF	3.7 _c	1800 _c	1.30
3Q4	POWER AMPLIFIER PENTODE	Can handle relatively high audio output of 270 milliwatts.	2.8 _s 1.4 _p	0.05 0.10	F	90	90	12	9.5	2150	1.15
3S4 ^a	POWER AMPLIFIER PENTODE	Similar to Type 1S4 but has filament arrangement for either series or parallel operation.	2.8 _s 1.4 _p	0.05 0.10	F	90	67.5	9	7.4	1575	1.15
6AG5 ^a	R-F AMPLIFIER PENTODE	Has sharp cut-off characteristic and high transconductance—useful up to 400 Mc.	6.3	0.3	H	300	150	—	7.0 _o	5000 _o	2.15
6AK6	POWER AMPLIFIER PENTODE	Can handle a-f power output of 1.1 watts.	6.3	0.15	H	300	250	—	15 _f	2300 _f	1.10
6AL5 ^a	TWIN DIODE	High-perveance detector for wide-band circuits. Tube drop, 10 volts at 60 ma. per diode.	6.3	0.3	H	420 _o	—	9 _{b,g}	—	—	0.75
6AQ6 ^a	DUPLEX-DIODE HIGH-MU TRIODE	For use as a combined detector, amplifier and avc tube.	6.3	0.15	H	300	—	—	1.0 _o	1200 _o	1.50
6C4 ^a	H-F POWER TRIODE	Has Class C output of about 5.5 watts at moderate frequencies and 2.5 watts at 150 Mc.	6.3	0.15	H	300	—	25 RF	10.5 _o AF	2200 _o	0.90
6J4 ^a	U-H-F AMPLIFIER TRIODE	For use primarily as grounded-grid amplifier at frequencies up to about 500 Mc.	6.3	0.4	H	150	—	20	15	12000	8.35
6J6 ^a	TWIN TRIODE	Useful as mixer at frequencies up to 600 megacycles. Also useful as oscillator.	6.3	0.45	H	300	—	30 RF	8.5 _b AF	5300 _b	1.85
9001 ^a	DETECTOR AMPLIFIER PENTODE	A sharp cut-off pentode for use as an r-f amplifier or detector in u-h-f service.	6.3	0.15	H	250	100	—	2.0	1400	2.50
9002 ^a	DETECTOR AMPLIFIER TRIODE	Has moderately high amplification factor. Useful as u-h-f detector, amplifier, oscillator.	6.3	0.15	H	250	—	—	6.3	2200	2.00
9003 ^a	SUPER-CONTROL R-F AMPLIFIER PENTODE	Remote cut-off pentode useful as mixer or as r-f or i-f amplifier in u-h-f work.	6.3	0.15	H	250	100	—	6.7	1800	2.50
9006 ^a	U-H-F DIODE	For u-h-f service as rectifier, detector, or measuring device. Resonant freq., 700 Mc.	6.3	0.15	H	750 _o	—	5 _g	—	—	1.50

a—Peak inverse volts c—At 90 volts on plate (and screen) e—At 250 volts on plate g—D-C output Ma. p—Filaments connected in parallel
 b—Per unit d—For an averaging period of 30 sec. f—At 180 volts on plate and screen s—Filaments connected in series

^aArmy/Navy Preferred Type.

HERE is a condensed story on the complete line of RCA miniatures. Miniatures—you will recall—were an RCA development back in 1940 when that famous quartet, the 1R5, 1S4, 1S5, and 1T4, put "personal" portables on the map. War demands have speeded the development of miniatures so that today 22 RCA types are available. Note that 18 of the 22 are on the Army/Navy Preferred Type List; of these 22 tubes, 21 were developed by RCA! When you have a tube application problem, turn to RCA engineers. Remember, the Magic Brain of all electronic equipment is a Tube, and the fountain-head of modern Tube development is RCA.

Copies of this advertisement for reference are available on request. Write to: RADIO CORPORATION OF AMERICA, 737 South Fifth Street, Harrison, N. J.

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RCA VICTOR DIVISION • CAMDEN, N. J.

ASSOCIATION NEWS

Expect Thousand at Equipment Conference

It is expected that more than a thousand persons will attend the Electronic Parts and Equipment Industry Conference in Chicago, latter part of this month. The gathering is to be held in the Stevens Hotel, October 19 to 21 inclusive, under the sponsorship of the Association of Electronic Parts and Equipment Manufacturers (formerly the Sales Managers Club, Western Division), the Sales Managers Club (Eastern Division), National Electronic Distributors Association and the Parts Division of the Radio Manufacturers Association. While there will be booths for manufacturers, these are only conference booths, where manufacturers can meet with jobbers and others, for visits and discussions, but no merchandise, displays, decorations or other trimmings are permitted. This is not an exposition or show, but simply a conference. Correspondence regarding registration and other details should be addressed to the Electronic Parts and Equipment Industry Conference, P. O. Box 5070-A, Chicago 80, Ill.

NAB Conferees See Television Above 100 mc

As might have been expected, FM and television discussions practically dominated the National Association of Broadcasters convention last month in Chicago, with an added fillup being given to interest in facsimile which has made considerable progress and gives promise for commercial applications. Both FCC Chairman J. Lawrence Fly and former commissioner T. A. M. Craven both opined that FM would beat television to the public and that television might well look to a spot in the spectrum above 100 mc for high fidelity, wide band service. Commander Craven, who now is vice-president of the Iowa Broadcasting Co., thought, though, that it might take 10 years for the evolutionary development of various high frequency broadcast services. A newly elected Board of Directors, considering frequency matters, contented itself with going on record in favor merely of sufficient channels to insure the finest system of mass communication possible, made no specific recommendations. John V. L. Hogan, facsimile exponent, told the delegates that the "radio printing press" has improved to the point where it is now possible to deliver

a picture of 48 square inches, or 1,000 words of text, in a minute. A 60,000 word book might be reproduced in the home in an hour, he said. Next NAB conference is to be held in New Orleans in 1945.

Rochester Program

The program for the Rochester Fall Meeting, sponsored by members of IRE and the RMA Engineering Department has been completed and as usual is spread over two days, November 13 and 14. Meeting place is the Hotel Sheraton, formerly the Sagamore. Following is the program:

Monday, Nov. 13

The Reactance Theorem for a Resonator, W. R. McLean, Polytechnic Institute of Brooklyn.
Resonant Cavity Method for Measuring Dielectric Properties at Ultra-High Frequencies, C. N. Works, T. W. Dakin, F. G. Boggs, Westinghouse Elec. & Mfg. Co.
RCA Laboratories at Princeton, E. W. Engstrom, Radio Corp. of America.
Low Frequency Compensation of Multi-Stage Video Amplifiers, M. J. Larson and A. E. Newton, Stromberg-Carlson Co.

(Continued on page 186)

Conventions and Meetings Ahead

American Society of Mechanical Engineers (Ernest Hartford, 29 West 39th Street, New York) Annual Meeting, November 27-December 1, New York.

Rochester Fall Meeting, November 13-14 Sheraton (formerly Sagamore) Hotel, Rochester, N. Y.

National Electronics Conference (B. Dudley, 520 N. Michigan Ave., Chicago), October 5-7, Medinah Club, Chicago.

Electrochemical Society (Colin G. Fink, Columbia University, New York City), Fall Meeting, October 12-14, Hotel Statler, Buffalo, N. Y.

Society of Motion Picture Engineers (J. Haber, Hotel Pennsylvania, New York), Semi-annual Fall Conference, October 16-18, Hotel Pennsylvania, New York.

American Welding Society (M. M. Kelly, 29 West 39th Street, New York City), Oct. 16-19, Hotel Cleveland, Cleveland, Ohio.

American Society for Metals, October 16-20, Cleveland, Ohio.

Society for Experimental Stress Analysis (Central Square Station, Cambridge 39, Mass., P.O.B. 168), 1944 Fall Meeting, October 17-20, Carter Hotel, Cleveland, Ohio.

National Conference Program Completed

With a dozen papers added to the already long program for the National Electronic Conference at Medinah Club, Chicago (Oct. 5, 6 and 7) the schedule for the gathering, which has been styled "a national forum on electronic developments and their applications," is complete. The Conference is sponsored by AIEE, IRE and CTS (Chicago chapters), together with the Illinois Institute of Technology and Northwestern University. Papers which have been added to the program (published in the August issue of *Electronic Industries*) are:

Power Applications

Electronic Motor Control, by J. B. Dalton, General Electric Co.

Medical Science

The Electrocardiograph in Physiology and Medicine, by Dr. L. N. Katz, Michael Reese Hospital.

(Continued on page 130)

Electronic Parts and Equipment Industry Conference (H. Clough, Belden Mfg. Co., Chicago), October 19-21, Stevens Hotel, Chicago.

Optical Society of America (A. C. Hardy, M.I.T.), October 20-21, Hotel Pennsylvania, New York.

National Electrical Manufacturers Association (W. J. Donald, 155 East 44th Street, New York), October 23-27, New York.

American Mathematical Society (531 West 116th Street, New York), October 28, New York.

Society for Measurement and Control, October 31, 2 Park Avenue, New York City.

Society of Rheology (R. B. Dow, Aberdeen Proving Ground, Maryland), November 17-18, New York.

Television Broadcasters Association, Inc. (500 Fifth Ave., New York 18, Room 1038), first annual conference, December 11-12, New York City, Hotel Commodore.

American Institute of Electrical Engineers (H. H. Henline, 29 West, 39th Street, New York), Winter Technical Meeting, January 22-26, New York.

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A MOMENTARY
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A SMALL "MEMORY-TYPE" RELAY
with R-F INSULATION

Originally designed for aircraft services, this new Struthers-Dunn 50XBX "Memory" Relay is ideally suited for numerous other applications as well. It is of two-coil, latch-type construction, having radio frequency insulation on its double-pole, double-throw main contacts. These contacts operate immediately upon receipt of a momentary impulse from a push button, limit switch, or any other source of brief or extended impulses.

The coils are practically universal in that they will operate on voltages as low as 12-volts D.C. Since they are in the circuit only momentarily, they cannot overheat on much higher voltages, nor will they hum or overheat on A.C. as each coil may be connected to de-energize itself as soon as it has performed its function.

Struthers-Dunn Type 50XBX "Memory" Relays will operate in any position, are shock-proof to 10 G's, and set new standards of efficiency on applications where the contacts must "remember" unflinchingly which coil was last energized—by remaining latched in position until they are released by energizing the other coil.

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Types :		PL		
50-A	61	74	114	150
54	62	76	119	159
55	63	77	120	160
56	64	104	124	291-A
58	65	108	125	354
59	67	109	127	
60	68	112	149	

PLP		PLQ		PLS	
56	65	56	65	56	64
59	67	59	67	59	65
60	74	60	74	60	74
61	76	61	76	61	76
62	77	62	77	62	77
63	104	63	104	63	104
64		64			

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Remler is equipped for the mass production of many types of radio and electronic devices from humble plugs and connectors to complete sound amplifying and transmitting systems. Ingenious production techniques contribute to Remler precision, reduce costs and speed up deliveries. • The Axis is on the run and final Victory is in sight. Let us help you finish the job.

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RETURNS WILL
TELL YOU**

**PREFERRED WITH
AIRBORNE
EQUIPMENT**

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... NO SEPARATE
METAL ENCLOSURES
NECESSARY**

**COMPACT...
PERMITTING A
FINER RADIO IN A
SMALLER CABINET**

**PREFERRED
BY A MAJORITY
OF RADIO SET
MANUFACTURERS**



1934 introduced the first metal receiving tubes. In seven short years prior to Pearl Harbor over seven and one-half million new radio receivers were equipped with this finer Ken-Rad product.

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RECEIVING TUBES
INCANDESCENT LAMPS
FLUORESCENT LAMPS

WHAT'S NEW

(Continued from page 118)

3,000-Volt Dynamotor

Carter Motor Co., 1608 Milwaukee Ave., Chicago, has added a new dynamotor providing 3,000 volts dc at 0.05 amp. to be run from a 12-volt dc to 115-volt dc primary source. The unit is 11½ in. long, 4½ in. diameter and 5 in. high and weighs less than 18 lbs. without filter. Outstanding features are: special laminations and special type insulation which is capable of withstanding the



very high voltage without breakdown. It is possible to furnish the unit with two 1,500-volt, 0.05 ampere outputs, instead of the 3,000-volt one. Because of the high voltage and the tendency towards sparks and corona effects, the ends of the unit, where the brushes are located, are enclosed in explosion-proof covers enabling the use of the unit in gaseous locations such as near airplane engines, in mines, and other similar positions.

Plating on Plastics

Manufacture of intricately designed commutators using metal plating on plastics is being done by the Metaplast Co., 205 West 19th St., New York. It is possible to precisely mold various and odd-shaped thermo-setting or thermo-plastic commutators by molding-in or machining grooves and depressions wherever contact surfaces are desired. These grooves and depressed areas are then built up flush with the non-conductive surface by Metaplating silver or any other desired metal. The commutating surface is then ground mirror smooth, which affords a one-piece unit of conductor and non-conductor in any shape or type desired with practically any commutating contour at an enormous saving in time, labor and cost.

Voltage-Breakdown Tester

A quick means of testing voltage breakdown of materials is provided by the Type P-3 voltage breakdown tester made by In-



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dustrial Instruments, Inc., 17 Pollock Ave., Jersey City, N. J. Operating range of instrument is 0 to 10,000 volts dc, or 0 to 8,000 ac. A lower range instrument, Type P-1, with sloping panel, has a range of 0 to 4,000 volts dc, or 0 to 3,000 volts ac. The voltage is continuously variable over the entire range. The tester operates directly from 110-130 volt 50/60 cycle ac. Breakdown is indicated by a red signal light, while the built-in meter indicates the direct-reading voltage. Current-limiting resistors safeguard the equipment in the event of a dead short, by limiting the current to approximately 50 milliamperes. To speed up production testing, drawer-switch type fixtures are available. These fixtures have a jig to take given components or materials, and when the drawer is closed the voltage is applied, with safety for the operator. The tester is housed in a fine-grained crackle-enamel metal cabinet measuring 16 x 21 x 28 in.

Magnetic Cutterhead

A new magnetic cutterhead, type 541, is now in production by Fairchild Camera & Instrument Corp., New York. Due to basic design features, it is possible to record at unusually high volume levels with little increase in distortion. At 98 lines per inch, the cutterhead is capable of fully modulating the groove. In the Fairchild cutterhead effective damping has been achieved through the use of exceptionally long cushion blocks and a positive means of adjusting the armature in correct balance, which is possible without disassembling the cutterhead. The frequency response, as revealed by the light method of measurement, shows limits of plus or minus 2 db. from 30 to 8,000 cycles. With only a moderate amount of equalization, the normal efficiency can be further extended. The unit is mounted in an especially designed adapter which attaches to the mounting casting on the carriage assembly with one bolt, making the cutterhead available as an addition to existing equipment. An important feature is the sapphire advance ball, with which the adapter is provided. The ball is on a swivel type mount which can be adjusted instantly to permit in-out or out-in direction of cut without additional parts or special tools. The depth of cut is quickly, accurately set by a positive micrometer-threaded screw adjustment. The entire mechanism is designed to reduce to a minimum the danger of failure due to shaving troubles. Distortion: Less than 1 per cent 400 cycles. A recording of a 400-cycle note was made at a recording level of plus 18 db. (reference .006 watts) to produce a stylus velocity of 2.5 in. per sec. Playback was made with a Fairchild dynamic pickup. The overall distortion including cutterhead, amplifiers, pickup and acetate record was 1.7 per cent. Impedance: 500 ohms. Audio power required: 0.6 watts (plus 20 db.).

Aligning Tool

A new tool for precision alignment of padding condensers has been developed by General Cement Mfg. Co., Rockford, Ill. The tool T1-207 is constructed of two basic parts molded from Durez plastic. A scientifically designed barrel with small knurled head accommodates a spring controlled plunger with a larger control knob. The barrel is hexagonal shaped in its working end to accommodate the condenser adjustment lock nut. The plunger has a metal insert in its lower end resembling a screw driver tip. The spring prevents the plunger tip from protruding beyond the hexagonal end of the tubular barrel. Minute adjustment is made by the plunger when it is pushed forward to mate itself into the cloven pin end of the condenser adjusting screw. Movements of magnitude and direction are indicated by the arrow engraved on the control knob end.



Constant Output Transformer

This constant voltage transformer is indicative of the general trend towards built-in automatic voltage regulation of filament supplies in army and navy electronic equipment. The hermetically sealed unit, designed for chassis mounting, is rated at 6.3 volts, 17 va output and will maintain that value within 1 per cent regardless of line voltage variations as great as 12 to 15 per cent. Many other new designs in constant voltage transformers are made by Sola Electric Co., 2525 Clybourn Ave., Chicago 14, Ill.

Silver on Aluminum

Silver may now be deposited electrolytically on aluminum or aluminum alloys by means of a simple method, known as the Preplate Process, a development of the Technical Processes Division of Colonial Alloys Co., Philadelphia. Silver deposits of considerable thickness can go directly onto the aluminum surfaces, or follow a copper, nickel, zinc or cadmium deposition.

Quartz Processing

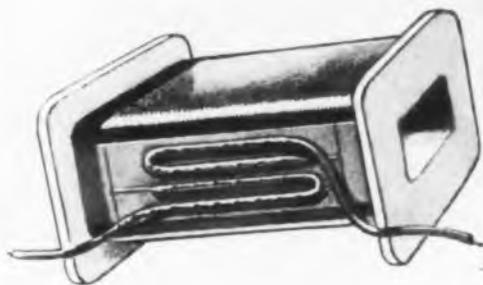
F. & M. Sales Co., 1054 Cahuenga Blvd., Hollywood, Calif., has developed a new line of improved slide tables for the processing of quartz crystal wafers. These improved orientation heads provide an improved method of handling the mother quartz coming to the saw through the use of interchangeable work-holding plates upon which the quartz is cemented and placed in exact register with reference to the abrasive saw. The work-holding table carrying the work-plate may be tipped in any direction. The orientation head to which the work-table is pivoted may be rotated throughout a complete circle by means of accurately cut worm and worm-gear, with orientation controlled within 1 minute of arc in either direction without back-lash. Movement of both the longitudinal and transverse slides is by means of accurately cut lead screws furnished with micrometer dials reading in one-thousandths inch, which allows of precise positioning of the quartz under the saw. Lead screws have been enclosed within the slides for greater protection, while the working surfaces of the slides have been inverted to remove them as far as possible from contact with the abrasive solution.



ELECTRONIC INDUSTRIES • October, 1944

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resists the
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The logic behind the growing use of Lumarith insulation is extremely simple: The primary cause of the free-acids associated with electro-chemical corrosion is moisture. Lumarith resists moisture, and contains no materials which combine with moisture to form free acids.

Besides, Lumarith doesn't promote that built-in hazard common to much electrical insulation—organic decomposition.

Even where corrosion ordinarily is severe—as with coils on positive D.C. under moisture conditions—Lumarith is dependable. It is outstanding for high dielectric strength and its high softening point (146–177° C. depending on formulation) makes it applicable in many types of coils.

How is Lumarith available? Films, sheets, rods, tubes and molding materials. Films are furnished plain or with special mat finish, easy to see and

slippage-resistant — advantages winders appreciate.

You'll want a copy of "Lumarith for the Electrical Industry." Send for it now. Celanese Celluloid Corporation, a division of Celanese Corporation of America, 180 Madison Avenue, New York 16, N. Y.

Data—	Softening Point	Dielectric Strength
P903	146° C.	2800–3300
P904	177° C.	2800–3300

P904 can be baked 8 hours at 140° C. in a coil.

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WILCO JACKETED TUBING

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- 2. Lower cost per square inch of MYKROY in the 19 $\frac{1}{4}$ " x 29 $\frac{3}{4}$ " sheet makes possible a saving of 33 $\frac{1}{2}$ % in usable material, considerably reducing the cost per fabricated unit.**
- 3. Better cutting efficiency in the new plate lowers unit cost still further and permits employing the superior insulating properties of MYKROY in a broader range of electronic applications.**

All fabricators of glass bonded mica materials should seriously consider the use of these larger plates to reduce costs and amount of time required in filling their orders. Ready for Immediate Delivery. Most thicknesses carried in stock.

WRITE FOR MYKROY SHEET BULLETIN #102

Just off the press, Bulletin #102 is a complete engineer's data book which combines practical data with a brief account of the dramatic story behind the development of the 19 $\frac{1}{4}$ " x 29 $\frac{3}{4}$ " sheet. It is replete with working data and comparison charts on the various sizes of MYKROY sheets. Write for your copy NOW!



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4916-22 W. Grand Ave., Chicago 39, Ill.

PIONEER MANUFACTURERS OF PERMANENT MAGNET DYNAMIC TRANSDUCERS

CONFERENCE PROG.

(Continued from page 118)

Applications of High Frequency Phenomena in Medicine, by H. L. Holmquist, General Electric X-Ray Co., and Northwestern University.

Industrial Electronics

The Electron Tubes of Industry, by Dr. C. S. Roys, Illinois Institute of Technology.

A Survey of the Field of High Frequency Heating, by M. J. Malers, Commonwealth Edison Co.

Radio

Frequency Modulation in Portable and Mobile Communications Equipment, by D. E. Noble, Galvin Mfg. Co.

Theoretical Electronics

Interpretation of Ultra-High Frequency Tube Performance in Terms of Equivalent networks, by Dr. F. B. Llewellyn, Bell Telephone Laboratories.

Tube Developments

Some Notes on the Design of Electron Guns, by A. L. Samuel, Bell Telephone Laboratories.

Aeronautical Applications

Aircraft Electronic Applications, by A. P. Upton, Minneapolis-Honeywell Regulator Co.

Industrial Radiography

Ultra-High Speed X-Ray, by Dr. C. M. Slack, Westinghouse Electric & Mfg. Co.

Telephone Applications

Recent Electron Tube Developments in Telephone Systems, by S. B. Ingraham, Bell Telephone Laboratories.

Electron Theory

Recent Researches and Postwar Radio, by Dr. G. C. Southworth, Bell Telephone Laboratories.

Industrial Applications

Some Applications of Electronic Equipment to Design and Materials Testing, by Dr. R. O. Fehr, General Electric Co.

14,000 Police Radio Stations in Operation

The extent to which radio communications facilities are being used by the police of the United States is indicated in a statement made by Capt. Donald S. Leonard, International Association of Chiefs of Police, before the State Department hearing in Washington middle of August. He pointed out: "There are about 2,000 fixed stations and 12,000 mobile stations in police service. About 900 stations are operating on 30 medium frequencies between 1601 and 2490 kc."

AMPHENOL

Electronic Connectors and Parts

FLY WITH THE B-29's

● Even counting all the days—and nights—put into planning and preparation by designers, builders and suppliers, B-29 still represents a miracle in achievement—the number of days still seem far too few for the undertaking.

Built to carry loads beyond former limits, at speeds never before considered, and safeguarded as no fighting plane before it, the Super-Fortress history-maker represents a new high in co-ordination between those who plan and those who build.

Leaders among manufacturers—known for quality of products and ability to deliver on schedule the various types of equipment needed, were asked to pledge their co-operation in this twenty-four hour a day job. Amphenol is proud to have been chosen to furnish the electronic connectors and parts for this great weapon.

Engineers in these plants from coast to coast worked simultaneously in designing parts that would meet the requirements set. Each production department set up a time table of the dates on which it would make first and subsequent deliveries. And B-29 progressed by the clock.

The first take off was on schedule. Japan was bombed on schedule. And today, American flyers have a marvelous weapon which gives their talents full play.



● SEND FOR THIS BOOK. Twenty-four illustrated pages of suggestions on dependable wiring—directly from the benches. These are things that other practical men have worked out and by which you or your wiring department can benefit. Send for a copy—you will enjoy reading it.

Depend upon

AMPHENOL

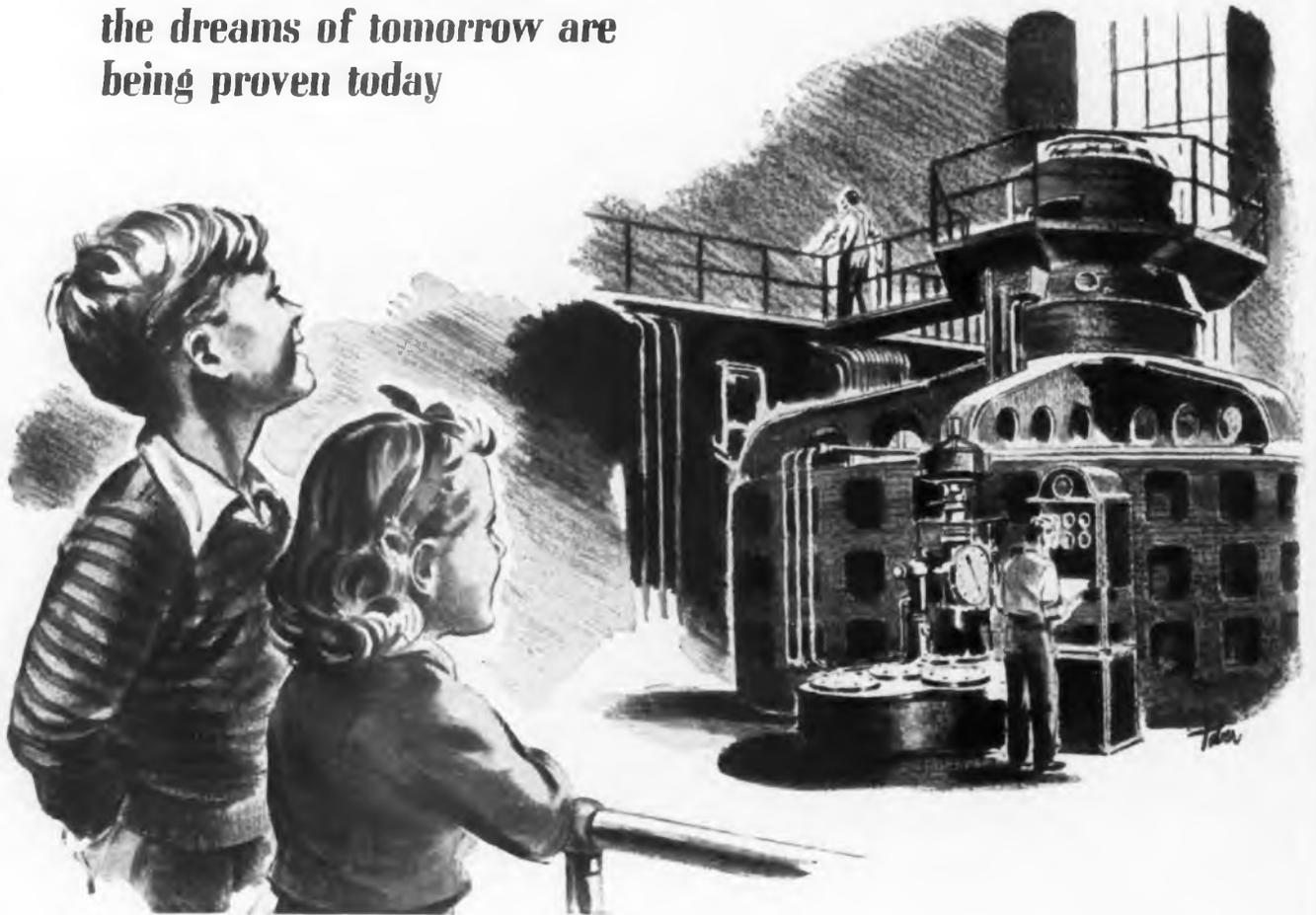
Quality

AMERICAN PHENOLIC CORPORATION
1830 S. 54th Avenue, Chicago 50, Illinois
IN CANADA · AMPHENOL LIMITED · TORONTO

Makers of Connectors (AN, British, UHF), Fittings, Conduits (Flexible Metal and Plastic), Cable Assemblies, UHF (RG) Cable, Radio Parts, Plastics for industry.

WHERE TOMORROW MEETS TODAY

*In Canada's Industrial plants
the dreams of tomorrow are
being proven today*



CANADA is growing up—fast! Canadian industries are developing new skills—mastering jobs never tackled before. Today, in every corner of the globe, the products of Canadian industry work and fight for Victory.

A new, virile and progressive firm on the Canadian scene is Small Electric Motors (Canada) Limited. This rapidly expanding organization is heavily engaged in producing electrical equipment of advanced design for the Navy, Army and Airforce. The experience and skill of these war days will tomorrow be applied to the development of peace-time goods.

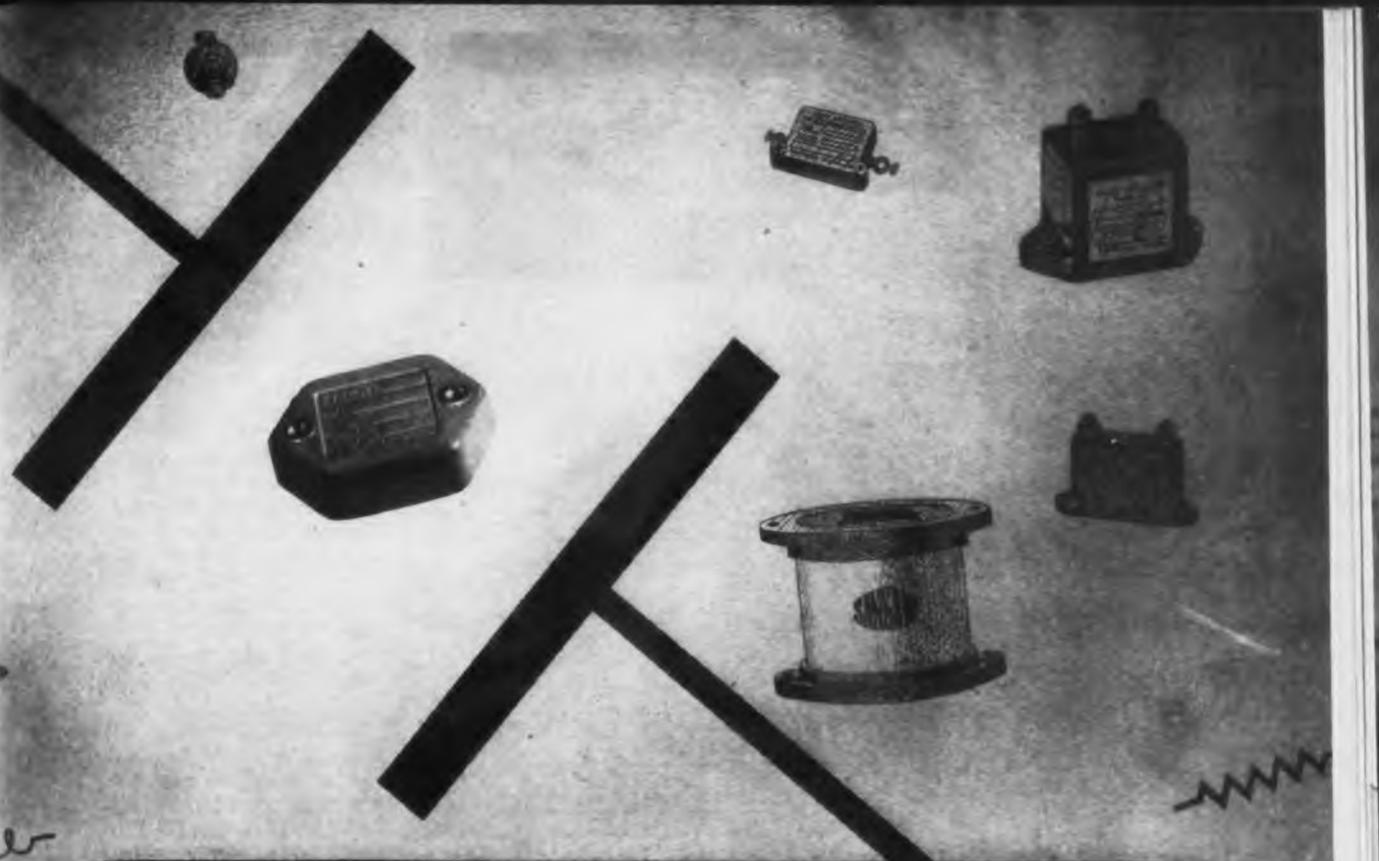
Yes, the research, the inventive genius and the vision now employed, night and day, will be reflected in the future. At Small Electric Motors the ground work is already laid. Indications are that the scientific developments of our engineering and technical staffs can be counted upon to discharge many significant tasks in the electrical field of tomorrow.

**DESIGNERS
AND MANUFACTURERS
Of All Types of Precision
Electrical Apparatus
Including:**

*D.C. & A.C. Motors for
Specialized Purposes
Aircraft Generators
Aircraft Engine Starters
Alternators
Motor Generators
Electric Pumps
Motors with Governors
Gyros, etc.*

SMALL  Electric Motors
(CANADA) LIMITED

L E A S I D E • T O R O N T O • C A N A D A



Sangamo Capacitors Can Take It!

Sangamo Type A capacitors have been manufactured continuously since 1925. As the first mica capacitor to be moulded in bakelite, it has been incorporated into the designs of many transmitters and receivers. Designated under the War Standard as Case Styles CM55 and 60, this unit is available in all characteristics from B through F and in the entire range of voltages and capacities listed in these standards. While comparatively small in physical size, the "Type A" has been called upon to do an exceedingly big job in low-powered, medium, and quite often in high-powered transmitters, where the ability of a capacitor to stand up and handle comparatively large amounts of RF current is of paramount importance. The continued application of the Type A capacitor in these transmitters is adequate proof of its ability to meet these requirements. Manufactured under War Standard specifications calling for severe immersion tests, extreme temperature ranges, definite retrace or drift characteristics, this capacitor is an outstanding example of the advanced engineering design and manufacture inherent in the entire line of Sangamo Mica Capacitors.

SANGAMO ELECTRIC COMPANY
SPRINGFIELD, ILLINOIS



SPARE PARTS BOXES

Made as per specification—42 B 9 (Int) for shipboard use,
Electrical and Mechanical. Navy grey finish.
Immediate Delivery.



No. 1025-1
12" x 6" x 6"

24 STOCK SIZES			
Number	Length	Width	Height
1025-1	12	6	6
1025-2	12	9	6
1025-3	12	12	6
1025-4	12	9	9
1025-5	18	9	6
1025-6	18	9	9
1025-7	18	12	9
1025-8	18	6	6
1025-9	18	15	9
1025-10	18	12	6
1025-11	18	15	12
1025-12	18	12	12
1025-13	18	18	12
1025-15	24	15	12
1025-16	24	15	15
1025-17	24	18	12
1025-18	24	18	15
1025-19	24	18	18
1025-20	24	12	9
1025-23	30	15	9
1025-14	30	15	12
1025-22	36	12	9
1025-21	42	9	9
1025-24	42	12	9

WRITE FOR PRICE LIST

No. 1025-11
18" x 15" x 12"
(Partitions extra)

Cole Steel
office equipment
will again be available
after the war

COLE

STEEL EQUIPMENT COMPANY

349 Broadway, New York 13, N. Y. Factory: Brooklyn

R. R. Radio

Kansas City Southern Lines recently inaugurated America's first main line railroad radiotelephone communications system. Designed and built by the Aircraft Accessories Corp. of Kansas City, this new system provides conductors and engineers on moving trains voice communication with each other—with other trains—with wayside stations and with dispatchers and other railroad offices.

The new communications system, tested on the Kansas City Southern for the past eight months, is now installed and in daily use on the Railway between Kansas City, Missouri, and Shreveport, Louisiana—a distance of 560 miles. It is of the type which confines the modulated carrier to the immediate vicinity of the railroad right-of-way and does not interfere with radio sets, telegraph or telephone lines.

Railroad communications experts who have seen the new equipment in use say that it opens a new and amazing era in railroading and predict that communications systems of this type will shortly be in nationwide use by the railroads.

R.P.I. Honors Du Mont

During its 120th commencement exercises, Rensselaer Polytechnic Institute conferred the honorary degree of Doctor of Engineering upon Allen B. Du Mont, President of the Allen B. Du Mont Laboratories, Inc., of Passaic, N. J., and graduate of the Class of 1924. Mr. Du Mont was cited particularly as "a pioneer in the development and use of the cathode-ray tube, which today is the heart of the weapon, radar."

40th for Lenz

It was 40 years ago that the Lenz Electric Mfg. Co. was organized in Chicago; that organization and the subsequent growth of the company, which remains under the active direction of its founder and president, J. Mayo Lenz, was celebrated in August. Today the company occupies a five-story plant, has just completed a three-story annex.

Lafayette Enlarges

Lafayette Radio Corp. (now Concord), 901 W. Jackson Blvd., Chicago, has added the entire 5th floor where additional warehousing facilities together with the kit and cable department will be located. The company has installed a teletype connection with the call-letters "CG-320."

Here's VARIABLE CONDENSER Efficiency!

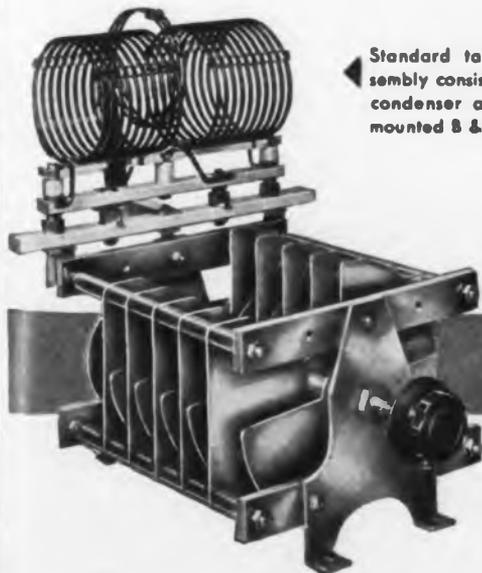
- Perfect electrical design symmetry.
- Built-in neutralization.
- Unexcelled mechanical construction.
- Built-in coil mountings with lead lengths at an absolute minimum.
- Half the length of conventional dual condensers.
- Unexcelled for use in balanced single-ended or push-pull circuits.



▲ A B & W heavy-duty Condenser with 1/8" plates.

▲ Typical standard Type CX Condenser with 1/16" plates.

◀ Standard tank circuit assembly consisting of B & W condenser and integrally mounted B & W coil.



Write for new Catalog 75-C on B & W Type CX heavy duty variable condensers

AIR INDUCTORS-VARIABLE CONDENSERS
ELECTRONIC EQUIPMENT ASSEMBLIES



BARKER & WILLIAMSON
Dept. EL-104, 235 Fairfield Ave., Upper Darby, Pa.

Export: LINDETEVES, INC., 10 Rockefeller Plaza, New York, N. Y., U. S. A

You'll Want this New
JAMES KNIGHTS
 "Crystal Controlled"
Frequency Standard



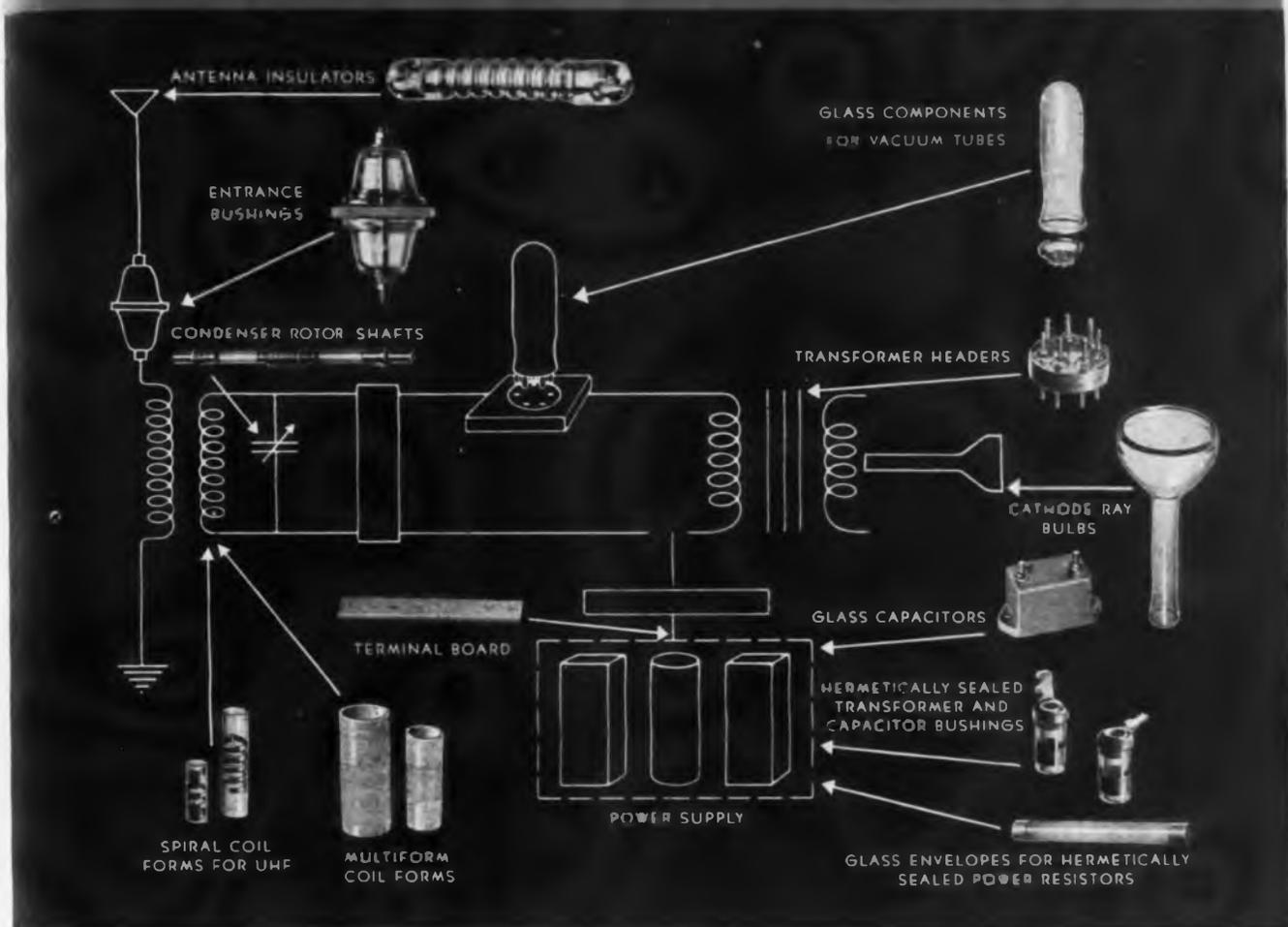
This is the ideal secondary frequency standard to check frequency of oscillators and transmitters, to calibrate and align receivers, etc. Can be used by the crystal manufacturer to check frequency standards for production. Useful many ways in the electronic laboratory or factory. Provides output up to 40 megacycles at 1,000, 100 and 10 kilocycle intervals. Complete cost only \$59.50. Descriptive catalog sheet on request.

BUY WAR BONDS FOR VICTORY!

The JAMES KNIGHTS Co.
 SANDWICH, ILLINOIS

CRYSTALS FOR THE CRITICAL

ARE YOU LETTING GLASS HELP YOU ALL IT CAN?



IT wouldn't be surprising if you aren't familiar with everything glass is doing in electronic equipment today. Progress has been rapid. In the above "circuit", for example, you'll find it on the job in (twelve) vital places. At Corning right now we're making a lot of other electronic glassware that we can't show. After the war we'll tell you all about it.

It's no accident that a major part of the electronic glassware in use got its start at Corning. We've dug in on some tough ones and ferreted out solutions. They told us we couldn't solder metal to

glass — they needed glasses with a coefficient of expansion practically equal to that of fused quartz — they needed something to take the place of mica in capacitors — Corning Research found the answers to these and many other electronic problems.

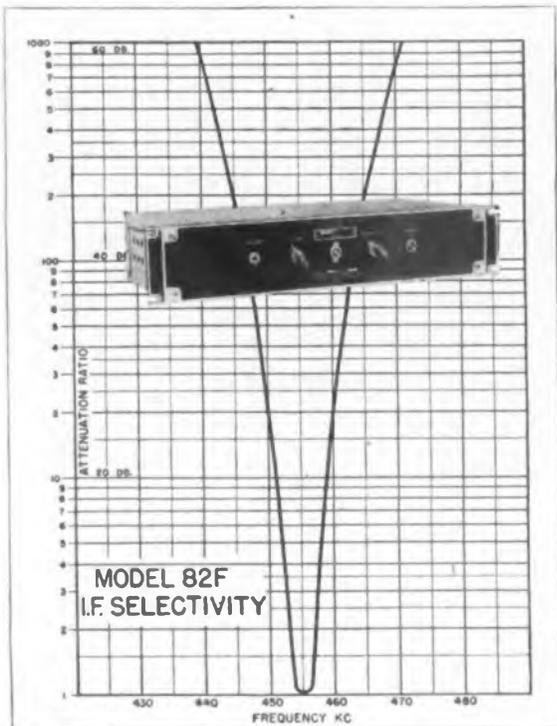
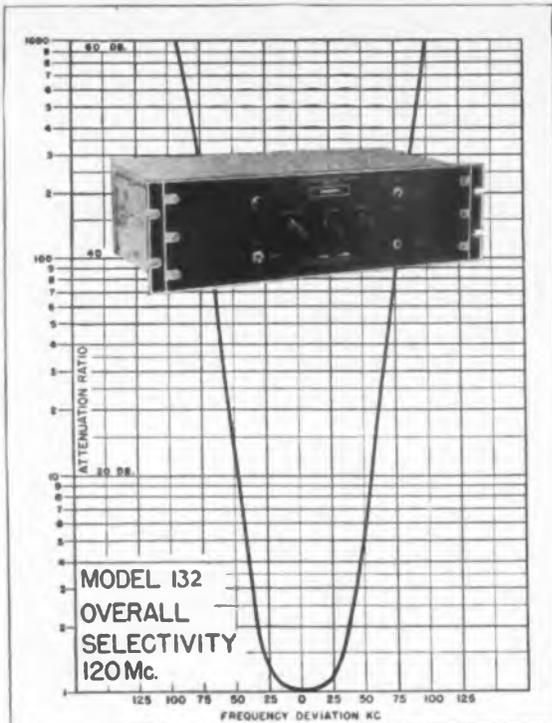
Our 250 glass experts—the men behind "Corning Research"—our facilities and all our knowledge of glass are at your service. Write for a copy of an informative new booklet "There Will Be More Glass Parts in Postwar Electrical Products." Address Electronic Sales Dept. I - 10, Bulb and Tubing Division, Corning Glass Works, Corning, N. Y.

CORNING
means
Research in Glass

Electronic Glassware



"PYREX" and "CORNING" are registered trade-marks of Corning Glass Works



THE radio telephone receivers illustrated above are of the fixed tuned, crystal controlled, superheterodyne type, for aeronautical ground stations, airport control towers, police radio stations or point-to-point service.

We invite your inquiries as to use of these receivers in conjunction with your present or post-war planning. Our facilities are at your service, whether you need complete transmitters, receivers, or some electronic component which we can help design and manufacture for you.

COMMUNICATIONS COMPANY, Inc.

Manufacturers of Radio and Electronic Equipment

CORAL GABLES  34, FLORIDA

Performance

Comco Receiver MODEL 132

Frequency Range:
100 — 156 Mc.

Image Ratio:
300 to 1 (50 db.)
at 100 — 128 Mc.
100 to 1 (40 db.)
at 128 — 156 Mc.

A.V.C. Action:
Constant within 3 db.
from 100 microvolts
to 100,000 microvolts

Sensitivity:
7.5 microvolts 30%
modulated for 6 mw.
output

Signal-to-Noise:
13 db. at 7 microvolts
Input 30% modulated

Comco Receiver MODEL 82-F

Frequency Range:
2.0 to 8.0 Mc.

Image Ratio:
50,000 to 1 (94 db.)
at 2.5 Mc.
55,000 to 1 (95 db.)
at 3.6 Mc.
45,000 to 1 (93 db.)
at 4.8 Mc.
10,000 to 1 (80 db.)
at 6.5 Mc.

A.V.C. Action:
Constant within 3 db.
from 10 microvolts to
1 volt

Sensitivity:
3 microvolts 30% mod-
ulated for 50 mw.
output

Signal-to-Noise:
9 db. at 3 microvolts
Input 30% modulated

Bendix to Enter Home Radio Field

The Bendix Radio division of Bendix Aviation Corp. will for the first time manufacture and market a line of home radio sets as soon as the military situation permits. Home radios will be manufactured in the company's plants in Baltimore. The home radio program will mark Bendix Aviation Corp.'s first entry into the consumer manufacturing field, in addition to its variety of scientific equipment for aircraft, automotive, marine and other industries.

PW Executive Offices Moved to New York

To facilitate administration of its communications, manufacturing, research and other activities, executive offices of Press Wireless, Inc., world's largest carrier of radio press dispatches, radio photographs and radio program material, were moved from Chicago to New York City, September 1. The new headquarters are at 1475 Broadway, where the company now occupies several floors. The executive offices had been located in Chicago since the company was established, July 5, 1929.

Segel Expands

Henry P. Segel, field engineer and manufacturer's representative, Boston, Mass., has opened a branch office in Hartford, Conn., to improve coverage of Connecticut, Western Massachusetts and Vermont. "Postwar," declares Mr. Segel, "New England is likely to become not only one of the great markets for electronic equipment, but also a major source of supply."

Conference Chairman



H. W. Clough, Vice President of Balden Mfg. Co., Chicago, who is General Chairman of Electronic Parts and Equipment Conference to be held in Chicago, Oct. 19-21



HIS PROBLEM IS ALSO YOURS...

Right now he is looking for a target for one of his deadly "tin fish." But on his watch below he probably wonders what the postwar world back home will be like . . . and what kind of place it will have for him.

That's his problem . . . and ours, too. For Industry must be ready to absorb the boys as they are mustered out of the Service.

This means planning for conversion to peacetime production . . . designing new products . . . developing better methods and processes. The WPB has encouraged such thinking . . . has even released material for experimental and development work.

TODAY is not a day too soon to start!

★ BUY MORE THAN BEFORE... BONDS



The modern miracles of Electronics, feverishly developed for the machines of war in the past few years, may readily prove applicable to your plans for the future. Look ahead, and go ahead with Electronics at the controls!



MAGUIRE INDUSTRIES, INC.
ELECTRONICS
division

MAGUIRE INDUSTRIES, INC., GREENWICH • STAMFORD • BRIDGEPORT • NEW MILFORD • NEW YORK

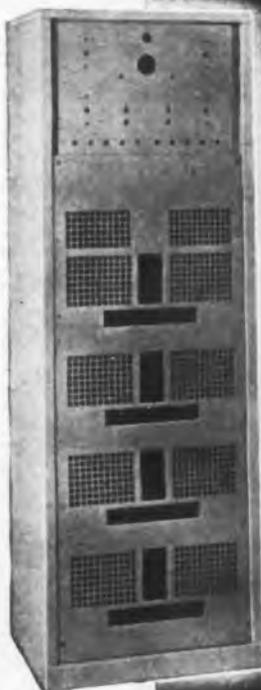
ELECTRONIC INDUSTRIES • October, 1944



BY POPULAR REQUEST

KARP

RAISES ITS
BANNER OVER
NEW TERRITORY



Demands for KARP quality, service, and deliveries have made it necessary for us to establish KARP sales representatives in many different parts of the country. If you are looking for:

- sheet-metal specialists capable of handling highly intricate as well as simple construction jobs.
- engineers with the experience and knowledge for complete redesign problems.
- made-to-order products at competitive prices with fast deliveries.

... consult our sales representatives wherever the KARP flag flies on this map ... your request addressed to our home office will bring him to you. We create to your individual order:

Cabinets	Boxes	Frames
Panels	Cases	Mounts
Chassis	Racks	Enclosures

See us at the October Electronic Conference,
Stevens Hotel, Chicago, Booth 57.

KARP METAL PRODUCTS CO., INC.

140 30th STREET • BROOKLYN 31, N. Y.

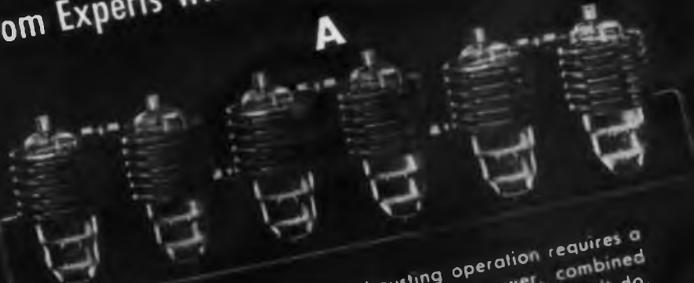


KEEP BACKING THE ATTACK ALL THE WAY TO BERLIN...BUY WAR BONDS



TAKE A LESSON IN HIGH FREQUENCY HEATING

From Experts Who Have Been Building High Frequency Heaters SINCE 1921



This electronic tube exhausting operation requires a definite number of kilowatts of power, combined with a specific frequency. "Nearly right" won't do.



while this rapid surface hardening operation requires an entirely different amount of power, together with a different, predetermined frequency.



This job of heating the glue between layers of plywood requires still another totally different combination of power and frequency. Unlike A and B this is not induction but dielectric heating—in which the heat is generated within non-metallic substances.

LESSON:

Virtually every application of high frequency heating demands a different power-and-frequency combination. Many users buy costly "misfits". Each installation should be designed and built for its particular application. There is no such thing as an all-purpose model.



We're pioneers in high frequency heating with 23 years of valuable knowledge and experience—at your service. What we have learned about heater unit circuits can prevent you from making costly errors in equipment selection and application.

Our extensive line of equipment offers you the widest range of power and frequency combinations. Choice is not limited to "standard" units. Let a pioneering *specialist* solve your heating problems by giving you exactly the right installation for your applications. It will pay you to get in touch with us before you choose ANY high frequency heating unit. Write us today.

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:

- 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

Designers and Builders of High Frequency Converters Since 1921
ELECTRONIC INDUSTRIES ■ October, 1944



... Battle-Tested!

Before a Stancor Transformer is shipped, it is "certified for service" by engineers whose tests simulate actual conditions in the field... Because "Stancor" is battle-tested—right in our extensive laboratories—it has covered itself with glory on the battlefield. This is your assurance of the efficient performance of Stancor Products to which you may confidently look when the domestic market returns.

STANDARD TRANSFORMER CORPORATION
1500 NORTH HALSTED STREET • CHICAGO 22, ILLINOIS

General Electric Plans "Electronic Park"

General Electric's Nela Park in a Cleveland suburb is shortly to have an "electronic Park" counterpart. All General Electric Co.'s Electronics Department activities, under the direction of Dr. W. R. G. Baker, will be centered in an industrial development on the outskirts of Syracuse, N. Y., near Liverpool. At present, G-E's activities in electronics are carried on in several cities, and it is the company's desire to put them all in one plant. It is expected construction of the plant on a 150-acre plot will begin as soon as wartime restrictions are lifted. Size of the development will be about one-fourth the area occupied by the Schenectady Works of the company, and it is estimated that 18 months from the time the government gives the go ahead signal the plant will be ready.

Rauland adds Visitron

The Rauland Corp., Chicago has purchased the phototube division of GM Laboratories, Inc., Chicago, which makes the "Visitron," phototube line. Two years ago Rauland purchased American rights to all patents and processes of the British-Gaumont electron tubes. "Visitron" phototubes are now in production at Rauland.

General Radio Moves

General Radio Co. has occupied its new office building at 275 Massachusetts Ave., Cambridge, Mass., releasing space formerly used as headquarters for production facilities. The new office is next door to the manufacturing plant.

Returns to Taylor



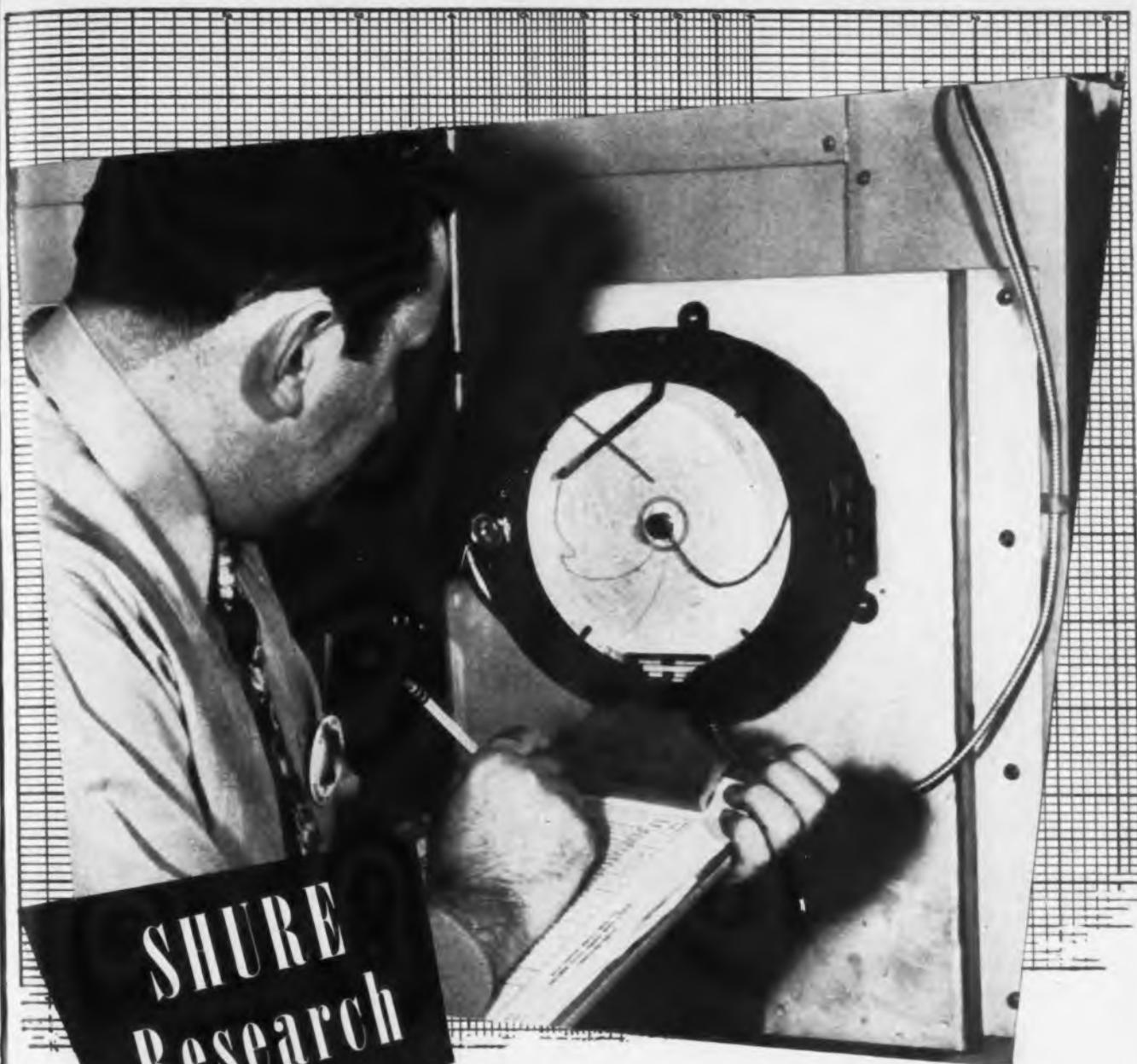
Rex L. Munger (W9LIP of amateur radio fame), has returned to his old post with Taylor Tubes, Inc., 2312 Wabansia Ave., Chicago, as sales and advertising manager after serving for 2½ years with the Douglas Aircraft Co. in Africa and the Middle East as technical adviser and representative.

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**SHURE
Research**

... in Low and High Temperatures

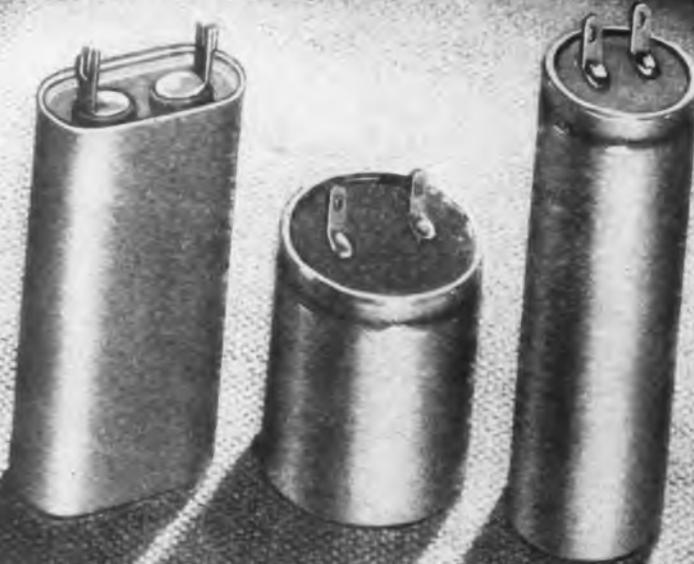
There is a range of 210 degrees between the prevailing temperatures at the Equator and the Arctic Circle. Yet microphones must operate unflinching, whether used at New Guinea or Murmansk. Shure Research, in heated chambers and dry ice temperatures, assures our armed forces Microphones that will bring the message through under any temperature condition. It's the same Shure Research that assures you a better postwar product.

SHURE BROTHERS, 225 West Huron Street, Chicago
Designers and Manufacturers of Microphones and Acoustic Devices



CAPACITRON *Quality*

Enters the FLUORESCENT Field!



✓ Check These CAPACITRON Features

1. Designed and built for long and satisfactory life at 85°C.
2. Dried, impregnated, filled and sealed without contact by human hands... thus avoiding all possibility of body acid contamination.
3. Less than 2% power factor at operating voltage and temperature.
4. Condensers are mechanically sealed and do not depend on solder... eliminating the possibility of oil leaks at high temperatures caused by "solder-blow"
5. Available for acceptance in UL and ETL approved ballasts.

OIL-IMPREGNATED CAPACITORS FOR ACTUAL BALLAST REQUIREMENTS

All fluorescent type Capacitrons are designed, tested and production supervised by a specialized division of our General Engineering Department.

This group of fluorescent lighting men can supply you with economical standard and special capacitor designs for long life ballast on years of actual field experience. They will gladly assist ballast manufacturers with practical design suggestions and life tests on complete ballasts. Why not consult with them now!

Telephone: MICHigan 9656

The **CAPACITRON Company**
318 West Schiller St. Chicago 10, Illinois

Why *Norelco* Tubes give uniformly high performance

INSPECTION by X-ray is only one of the many rigid tests applied to NORELCO electronic tubes. Misalignment of elements and similar internal faults, which cannot be seen by close visual inspection, may still permit a tube to function. Spot radiographic inspection by Searchray guards against such "invisible" defects creeping into production runs, thus assuring tubes of high performance and long life.

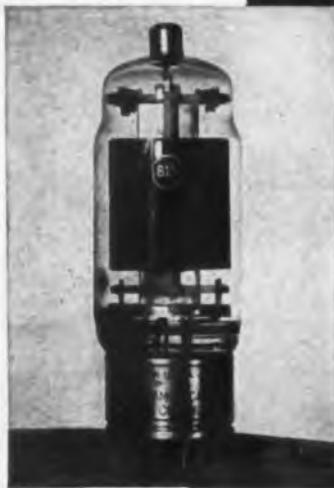
Typical of the thoroughness of our inspection methods on certain tests is the use of Searchray, the self-contained, rayproof, shockproof, easily operated industrial X-ray apparatus designed and developed by North American Philips. In keeping with this organization's traditional watchfulness over the quality of its products, we make our own X-ray tubes, as well as fine wire for tube manufacture and diamond dies for our own fine wire drawing. These many tests and exacting quality control are reasons why NORELCO electronic tubes, with their consistently uniform characteristics, high performance and long life, should be your choice for postwar industrial use.

Although all the tubes we produce now go to the armed forces, we invite inquiries from prospective users. A list of tube types we are especially equipped to produce will be sent on request.



Let us send you our booklet telling the story of North American Philips. Behind this company is a team of outstanding electronic engineers, headed by one of America's leading physicists, and coached by a group with world-wide experience resulting from fifty years of research and development. Today we work for Victory; tomorrow, our aim will be to serve industry.

NORELCO PRODUCTS: Quartz Oscillator Plates; Amplifier, Transmitting, Rectifier and Cathode Ray Tubes; Searchray (X-ray) Apparatus, X-ray Diffraction Apparatus; Medical X-ray Equipment, Tubes and Accessories; Electronic Measuring Instruments; High Frequency Heating Equipment; Tungsten and Molybdenum products; Fine Wire; Diamond Dies.



Stretched radiograph of a defective NORELCO Type 613 tube taken by a NORELCO Model 150 Searchray, showing fractured filament end, on the left side, a misalignment of control and screen grids, as revealed through the surrounding graphite plate.

A NORELCO Type 613 Beam Power Transmitting Tube.

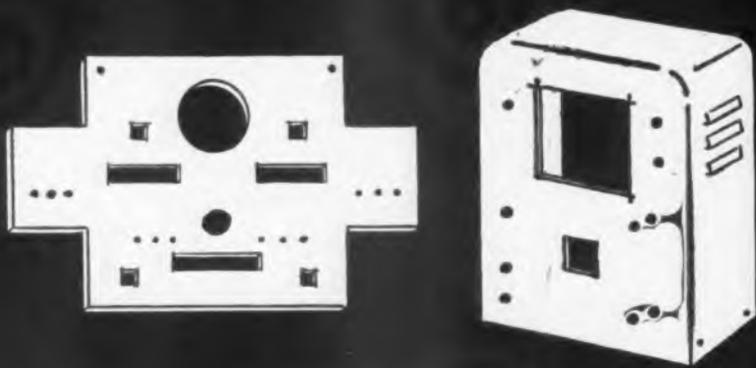


When in New York, be sure to visit our Industrial Electronics Showrooms.

Norelco ELECTRONIC PRODUCTS BY
Reg. U. S. Pat. Off.
NORTH AMERICAN PHILIPS COMPANY, INC.

Plant 30, 100 East 42nd Street, New York 17, N. Y.

Factories in Dublin, Penn., N. Y., Mount Vernon, N. Y. (Manufacturing); Lawrence, Mass. (Electronics)



What are Your

PRECISION METAL WORKING REQUIREMENTS?

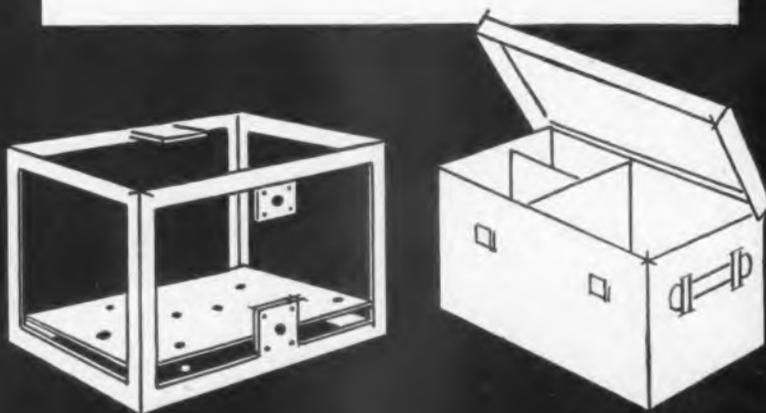
Do you require versatility—the ABILITY to do sheet metal work, stamping and fabricating—the ABILITY to build metal boxes and cases in a wide variety of sizes—to build cabinets, chassis, odd shaped flat pieces, strips, panels, housing, etc.? Do you require the ABILITY to do precision work to extremely close tolerance? What about the ABILITY of helping work out a design or design change that can save up to thousands of dollars and speed delivery of many weeks?

If the answer to any of the above questions is YES, write us for further information or consultation on specific jobs.

PORTER

METAL PRODUCTS COMPANY

490 JOHNSON AVE. • BROOKLYN, N. Y.



PERSONNEL

Elects New Officers

The Electronic Products and Equipment Manufacturers Association elected the following new officers on August 10, during the meeting at the Electric Club of Chicago: Chairman, E. G. Shalkhauser, Radio Mfg. Engineers, Inc., Peoria, Ill.; Vice-chairman, J. A. Berman, Shure Brothers, Chicago, Ill.; Treasurer, H. A. Staniland, Quam-Nichols Co., Chicago, Ill.; and Attorney J. Arthur Kealy, Executive Secretary Pro-Tem. Correspondence should be addressed to Office of the Secretary, Kenneth C. Prince, 77 West Washington St., Chicago, Ill.

Price Appoints

Price Bros. Co., Frederick, Md., pioneer manufacturer of relays, has appointed the following manufacturer's representatives: Gerald A. Ryan Co., Chicago; Bert A. Hansen, Buffalo; E. J. Wall, Lakewood, Ohio; L. R. Ward Co., Dallas; Fry & Roberts, Hollywood; Gail Halliday, Denver.

Several changes in the engineering department of the Weston Electrical Instrument Corp., Newark, N. J., have been made: **John H. Miller**, who has been assistant chief electrical engineer, has been promoted to chief electrical engineer. **Frank X. Lamb** has been made assistant chief electrical engineer. He formerly was a project engineer. **Karl M. Lederer**, formerly assistant chief engineer, is now assistant di-



Miller

F. Lamb

K. Lederer

rector of research. **W. N. Goodwin, Jr.**, continues as vice-president in charge of research and engineering. He relinquishes his post as chief engineer, but retains his present title of director of research.

Dr. A. M. Skellett has been appointed chief engineer in charge of research for the National Union Research Laboratories, Newark, N. J.

Harold W. Schaefer has been made assistant manager of the newly-formed Radio Receiver Division of the Westinghouse Electric and Mfg. Co. He will be in charge of the Division's engineering and production activities, under **Harold B. Donley**, manager of the Division.



CONSTANT LIGHT INTENSITY in the JONES & LAMSON comparator is maintained with built-in CONSTANT VOLTAGE

The Jones & Lamson Machine Company uses SOLA Constant Voltage Transformers as a "built-in" component of their Optical Comparators to obtain desired illumination with maximum lamp life. They have found that these transformers give consistently satisfactory results.

Because of the extreme brilliance required of these lamps, the filaments run very hot. By incorporating a SOLA Constant Voltage Trans-

former as a component part of the Comparator, illumination may be held at maximum values without danger of lamp disruption from line voltage fluctuations.

Hundreds of similar case histories emphasize the advantages of providing dependable, automatic voltage regulation *within* the equipment, rather than risk dissatisfaction and constant servicing by passing

this responsibility on to the user.

Automatic, self-protecting SOLA Constant Voltage Transformers instantly correct line voltage fluctuations as great as 30% to within $\pm 1\%$ of rated requirements. They have no moving parts, require no manual supervision. They are available in standard units from 10VA to 15KVA, or special units can be built to exact design specifications.

Constant Voltage Transformers

SOLA

To Manufacturers:

Built-in voltage control guarantees the voltage called for on your label. Consult our engineers on details of design specifications.

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Transformers for: Constant Voltage • Cold Cathode Lighting • Mercury Lamps • Series Lighting • Fluorescent Lighting • X-Ray Equipment • Luminous Tube Signs • Oil Burner Ignition • Radio • Power • Controls • Signal Systems • Door Bells and Chimes • etc. SOLA ELECTRIC CO., 2525 Clyburn Ave., Chicago 14, ILL.

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- Into the design and manufacture of ADC Transformers, Filters, Equalizers and related electronic equipment goes the determination of trying to do every job just a little better. We call it "compounding experience". This ambition to achieve perfection in all details is the momentum behind the ADC performance record. We are sincere in saying — "Let us help you when we can".

Catalog
Available

BUY WAR BONDS FOR VICTORY!

Russell H. Lasche has been appointed director of engineering and research for the Fairchild Camera & Instrument Corp., New York. Fairchild manufactures radio compasses, electrically operated gunfire control instruments, electric aerial cameras, fractional horsepower motors, sound equipment, and other electronic instruments.

J. R. Duncan, who has been engaged in television engineering since 1931, has joined the staff of station WLW as chief television engineer. Duncan's work in this field began soon after he was graduated from Oklahoma A. & M. College when he was employed by RCA at Camden. Here he spent four years in the engineering laboratories, working most of the time on television. From 1934 to 1938, he was employed by Philco for the development of television control circuits for receivers and studio equipment. In the spring of 1938 he went with the Midland Television Co., Kansas City, Mo., as Chief Television Engineer.

Leo Edelson, executive vice-president of the Induction Heating Corp., New York, has resigned to assume presidency of the Metroloy Corp., New Rochelle, N. Y.

F. Jerome Tone has been appointed vice-president in charge of sales of the Carborundum Co., Niagara Falls, N. Y. He succeeds Vice-President **Charles Knupfer** who has been assigned to special sales and executive activities. **Henry P. Kirchner** has been placed in charge of production; **Otis Hutchins** has been named Technical Director in charge of research and process control.

Leslie J. Woods, who joined Philco in 1925, has been named manager of the Industrial Radio Division of Philco Corp. with headquarters in Detroit, where Philco will continue to maintain special facilities to serve the automobile and aircraft industries.

Martin F. Shea, who has been connected with Philco since 1930, has been appointed assistant manager of the Industrial Radio Division, which will handle the development and sale of Philco automobile radio to the motor car industry and also sales of aircraft radio and radar equipment and other industrial electronic devices developed and manufactured by the Corporation.

Lafayette to Concord

Corporate style of the Lafayette Radio Co., unchanged for the 22 years the company has been doing business in Atlanta and Chicago, has been changed to Concord Radio Corp. Officers, personnel and business policies remain unchanged.



ANOTHER EXAMPLE OF

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» LELAND is more than a motor name plate. LELAND stands for *Creative Electrical Engineering*—the technical ingenuity to design and build a power unit for your specific application to deliver peak efficiency and performance.

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AIRBORNE POWER INVERTER—D. C. drive from aircraft electrical system, high frequency A. C. output up to 2,500 volt amperes used as power supply for electronic equipment.



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NEW BOOKS

The Physics of Music

By Alexander Wood, D.Sc., Fellow Acoustical Soc. of Amer., published by The Sherwood Press, Cleveland, Ohio, 1944, 255 pages, 110 illustrations, \$8.00. (Introductory price, subject to cancellation \$6.00.)

The author discusses that interesting territory between physics and music, that has until the last couple of decades, been a sort of no-man's land, the musicians wanting no part of any proposal that there were certain physical laws guiding the production of harmony, and the physicists firm in the belief that all musical effects could be defined by science.

This book presents the nature of sound in all aspects that relate to the musical arts: intensity, pitch, and those factors which produce harmonious tones. Since music is an important factor in the broadcasting field, this book giving the background of why things sound the way they do, may be of interest to many engineers. The subjects of scales and temperament, dissonance, and the harmonic output of common instruments, and many other physical and artistic effects are interestingly described. The book is well indexed and supplied with references to published works.

Conversion Factors and Tables

By O. T. Zimmerman, Ph.D., Prof. of Chemical Engineering, Univ. of New Hampshire and Irvin Lavine, Ph.D., formerly Professor of Chemical Engineering, Univ. of North Dakota, published by Industrial Research Service, Dover, New Hampshire, 1944, 262 pages, \$2.75

This book provides in one convenient volume, an accurate source of fundamental physical relationships as well as several thousand useful constants for the conversion of units. It covers most of the fields of engineering and physics. It is presented in a form that is easy to read, with large-faced, legible type and the lines spaced sufficiently far apart to be read without undue strain.

Physics of the 20th Century

By Pascual Jordan, published by Philosophical Library, Inc., New York, 1944, 185 pages, \$4.00.

The book is addressed to anybody who takes a serious interest in the progress of modern physics:

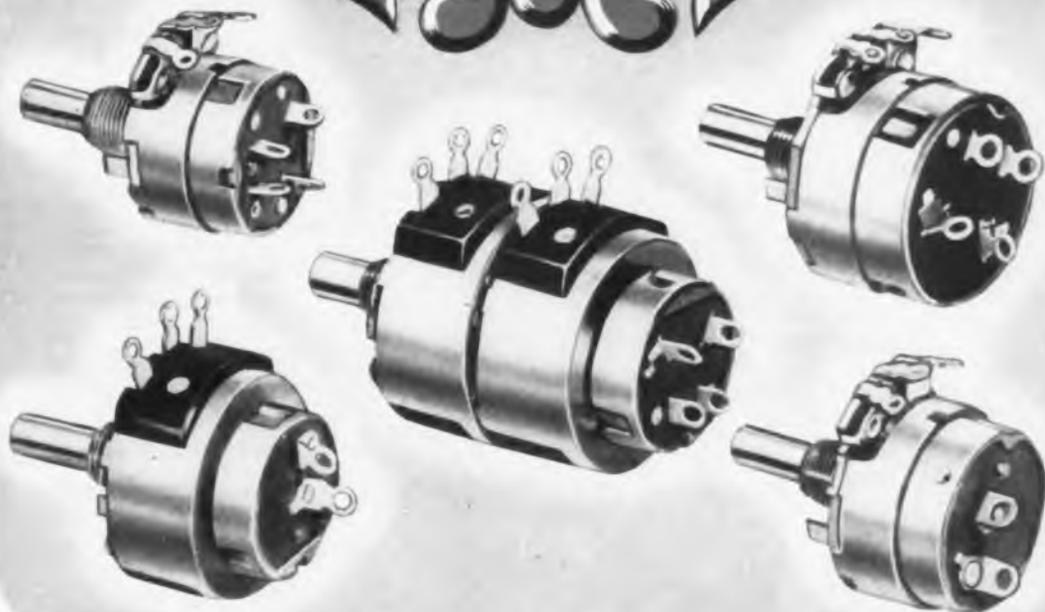
"I was anxious to aid in the gradual removal of misunderstandings of the newest developments in



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physics displayed by many laymen. Continuation of such misconceptions can lead to disturbing confusion. Thus, in the public mind, entire chains of misunderstandings have arisen through fallacious combination of objective scientific questions with wholly different, e.g., purely personal ones."

In the opinion of the reviewer, this is one of the best books, if not the best book, on the subject, that can be understood and enjoyed by physicists and laymen alike. It will most certainly contribute to the clarification of physical concepts and theories in the minds of non-physicists, it will further a thorough understanding of some of the problems and difficulties involved, and it will give great pleasure to any physicist reader. Written by an authority on the subject, it is clear, precise in its wording, and though not introducing any mathematics, accurate in its statements, which means achieving the almost impossible.

Classical mechanics, modern electrodynamics, and molecular physics are covered; philosophical aspects are introduced and their relation to some propositions of modern physics is discussed.

NEW BULLETINS

Oscillographic Photography

A special bulletin has been prepared by the Eastman Kodak Company on the Photographic Materials available for use with oscillographs, cathode-ray tubes and similar recording instruments.

This bulletin gives recommended emulsion materials and their handling technic for a variety of oscillographic problems, using either the galvanometric reflections or cathode-ray arrangements. The information should also be of interest to those interested in photographing television images. It can be obtained from their Rochester 4, New York address.

Speaker Monograph

Dependable and useful information on the selection, installation and use of loud speakers and reproducers, can be obtained from the first of a series of technical monographs in the field of acoustics prepared by Jensen Radio Mfg. Co.

The first of the series, "Loud Speaker Frequency Response Measurements," is ready now. This monograph points out both the wisdom and the fallacy of using frequency response curves in judging the performance of loud speakers and how the same loud speaker may, quite correctly, produce dif-

ELECTRONIC INDUSTRIES • October, 1944

Federal Tubes...

come CLOSER to the

PERFECT VACUUM



Here is one of the double aisle exhaust banks where 16 high power tubes can be exhausted at one time, each with individual control.

Federal Telephone and Radio Corporation

Newark 1, N. J.



Always in the forefront of tube research and development, Federal makes another advance and now has added exhaust units of entirely new and original design to its production equipment.

This latest Federal achievement produces a tube that is substantially closer to the perfect vacuum—a tube with greater efficiency and longer life.

Arranged in banks of eight and operated with identical control equipment, these units exhaust uniformly every size of Federal tube—assuring a consistent and high standard of quality.

For any communication and industrial power tube need, turn to Federal now—test its reputation that “Federal always has made better tubes.”



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We are proud of the all important contribution that you have been making to Your Country's winning of the war and want you to know that jobs are waiting for you when you return to C.T.C.

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CHICAGO, 18



NEW BULLETINS

ferent results in the shape of a curve depending on the methods and the circumstances with which the measurements were made.

Future issues will treat generally the subject of proper selection, use and operation of loud speakers and loud speaker systems in the interest of improved sound reproduction.

Communications Components

Reproducing many of the advertisements that have helped to make its name well known throughout the communications industry, E. F. Johnson Co., Waseca, Minn., thus distributes in a 20-page booklet a fairly complete catalog of its many products. The booklet, though, is not intended as a catalog, but rather as a partial record of the company's many war activities, as the title, "Johnson in War and Peace," indicates.

"Highways of the Air"

"Highways of the Air," a new review of fact and opinion on the importance of radio in aviation, has been issued by Radio Receptor Co., Inc., of 251 West 19th St., New York 11, N. Y.

The initial issue of "Highways of the Air" contains an article on the Army Airways Communications System by Lt. Walter W. Fawcett, Jr., illustrating the mechanics of radio in the operation of the military airways; "Airways and Ground Facilities of the Future" by Wm. A. M. Burden, Ass't. Secretary of Commerce; "Radio in Aviation" by Charles I. Stanton, Civil Aeronautics Administrator, and the fifth reprint of the original edition of "Highways of the Air," plus many well-defined illustrations and diagrams.

WE Oscillator

On September 1st a Western Electric publication, well known to the radio industry before the war as Pick-Ups, appeared under the new title, The Western Electric Oscillator. Including a bright cover done in the war theme by artist Paul Rabut, the publication presents 36 pages of technical and allied information of interest to broadcasting and electronic people. The lead story, "Radio Fights Its First War," by George de Mare, tells definitely how the men and women of the profession are standing up to their wartime responsibilities. The article is based on a comprehensive survey of individual broadcasting stations throughout the nation. Other titles include "FM Goes to War," "You Can't Win a War Without Radio," "AT&T Plans for Television" and

HERMETIC SOLDER-SEALING

MAKES PRESTITE

TERMINAL BUSHING

Leakage-proof



ACTUAL SIZE

High altitudes . . . humidity condensation . . . thermal shocks . . . cannot affect the performance of Solder-Sealed apparatus. The 100% hermetic bond assured by the metal-to-PRESTITE seal assures trouble-free service of terminal bushings.

The bushing consists of a PRESTITE tube on which are Solder-Sealed a terminal cap and a stud. Similar bushings are available without hardware for Solder-Sealing to other parts on the manufacturer's own production line.

Solder-Sealed PRESTITE assemblies offer immediate help to manufacturers in many available standard forms. They also open up many new and added possibilities in postwar uses. For complete information, send for booklet B-3244. Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., Dept. 7-N.

J-05142

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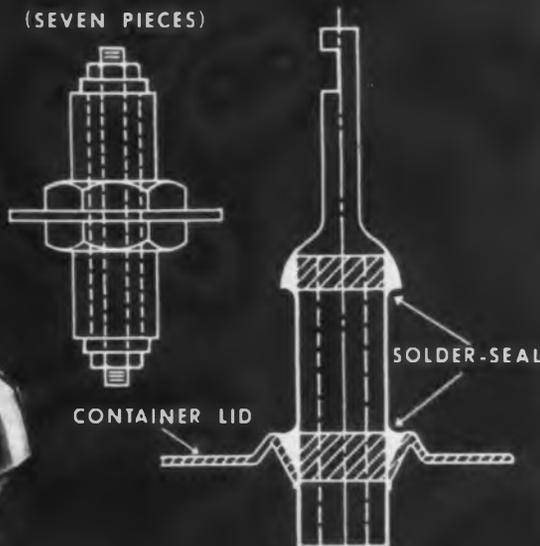


DYNAMOTORS
RECTOX RECTIFIERS
INSULATING MATERIALS

ELECTRONIC INDUSTRIES • October, 1944

OLD WAY

(SEVEN PIECES)



NEW WAY

(ONE PIECE . . . HERMETICALLY SEALED)

Other PRESTITE methods of taking leads through partitions



APPARATUS ENCLOSED SOLDER-SEAL BUSHING—combination insulator, cover and terminal board—has a hollow construction which permits placing small devices inside.

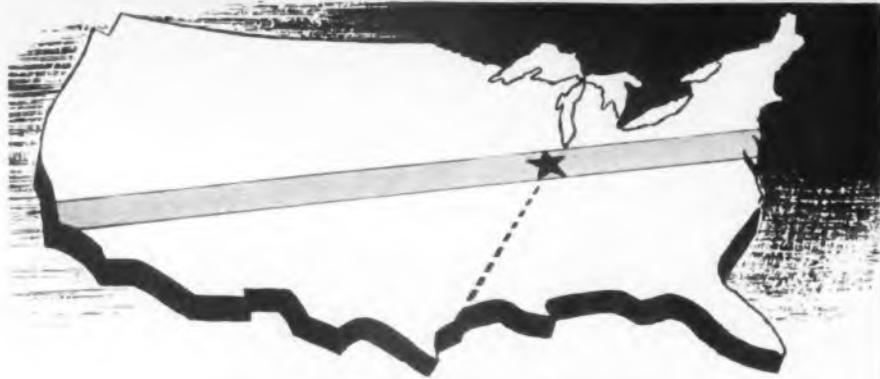


SOLDER-SEAL ASSEMBLY—for vibrator packs, but can be used in similar apparatus, combining jack and terminal board.



SOLDER-SEALED BUSHING—for use with thicker gage covers of larger size transformers and capacitors. Bushing is Solder-Sealed to a metal ring which is soldered to the container cover.

PRESTITE is a dense nonporous ceramic compacted under high pressure and vacuum by the patented PRESTITE method of manufacture. This eliminates minute air pockets in the material, thus minimizing distortion in voltage gradients and eliminating internal corona discharges. PRESTITE is impervious to moisture and all chemicals except hydrofluoric acid. The quality of PRESTITE is consistently uniform, thus eliminating the need for the exaggerated safety factors common in other ceramics.



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Cells	Speakers	Power Supplies
Sockets	Receivers	Converters
Photo Cells	Training Kits	Generators
Batteries	Code Equip.	Chargers

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RADIO**

NEW BULLETINS

"Seventy-Five Years of Pioneering by Western Electric," a two page spread of historic pictures starting with the founding of the company and extending to its 75th Anniversary this year. In addition to a profusion of interesting photographs done in the modern vein, the publication contains a dramatic spread of four full-page pictures in color.

Small Motors

Three new products are illustrated and described in a set of catalog sheets issued by Eastern Air Devices, Inc., 585 Dean St., Brooklyn, N. Y. These are a 1/50 hp single phase 60-cycle capacitor induction motor in two styles; and a 115-volt 60-cycle centrifugal blower unit which delivers 110 cu. ft. per min.

Switch Handbook

A 24-page "Handbook of Precision Switches" has been issued by Mu-Switch Corp., Canton, Mass. In addition to illustrating and describing the design and operation of the company's small limit switches, the booklet gives data on typical installations. Included are X-ray dimensioned charts.

Fiber Parts

A six-page compilation of concise information to facilitate the correct specification of both phenol fiber and vulcanized fiber in parts fabrication has been published by N. S. Baer Co., 9-11 West Montgomery Pl., Hillside, N. J. Complete with properties and characteristics pertaining to each material, the brochure includes a comprehensive listing of standard grades, tables governing electrical and mechanical strength, moisture absorption, etc.

Processing

Expanded facilities for winding, assembling and other processing operations have been made by H. W. Tuttle & Co., Adrian, Mich., and those new facilities are told of in a new bulletin, "Let Us Help You Build a Better Product."

FM for Canal Zone

A new two-way FM radiotelephone communication system has been installed in the Panama Canal Zone by Galvin Mfg. Corp. The system is being used by public administrators of the Canal Zone to police, both Pacific and Atlantic areas, in this vital artery of transportation. The equipment provides instant communication throughout the length of the Canal.

NO FRAYED ENDS
NO FRAYED NERVES

**WHEN YOU USE BH
 FIBERGLAS SLEEVING!**



*Here's an Insulation that Handles Easier,
 Cuts Cleaner and Saves Time*

IF you're exasperated by ordinary sleeving that frays on the ends, works stiffly and doesn't hold up in use . . . then you'll certainly want the low-down on BH *Extra Flexible* Fiberglas Sleeving! For this is a really *flexible* and definitely *non-fraying* sleeving—built around the excellent insulating qualities of Fiberglas by an *exclusive* BH process.

Fiberglas, you know, is moisture-resistant, high in dielectric and tensile strength and is shunned by fungus growths and unharmed by most chemicals. "Punishment" tests prove that BH *Extra Flexible* Fiberglas Sleeving has even more advantages. It is *permanently* non-fraying and non-stiffening. It won't burn because both yarns *and* impregnation are non-inflammable. And it lasts indefinitely without cracking or rotting.

Assembly and repair men say BH *Extra Flexible* Fiberglas Sleeving is a pleasure to handle and a sure bet for long life in the most severe service. So why tolerate a less efficient sleeving any longer? BH is available in all standard colors and all sizes from No. 20 to 3/8", inclusive. Write for samples today and make your own comparison!

**BH EXTRA FLEXIBLE
 FIBERGLAS SLEEVING**

2 WAYS BETTER



THIS



NOT THIS

NON-FRAYING



THIS

NOT THIS

NON-STIFFENING



NON-BURNING IMPREGNATED MAGNETO TUBING • NON-BURNING FLEXIBLE
 VARNISHED TUBING • SATURATED AND NON-SATURATED SLEEVING

BENTLEY, HARRIS MANUFACTURING CO.

Dept. I, Conshohocken, Penna.

Speakers And Transformers

Consolidated Radio Products Co. has complete modern production and engineering facilities to supply the finest radio speakers available. Speakers can be furnished in the following ranges:

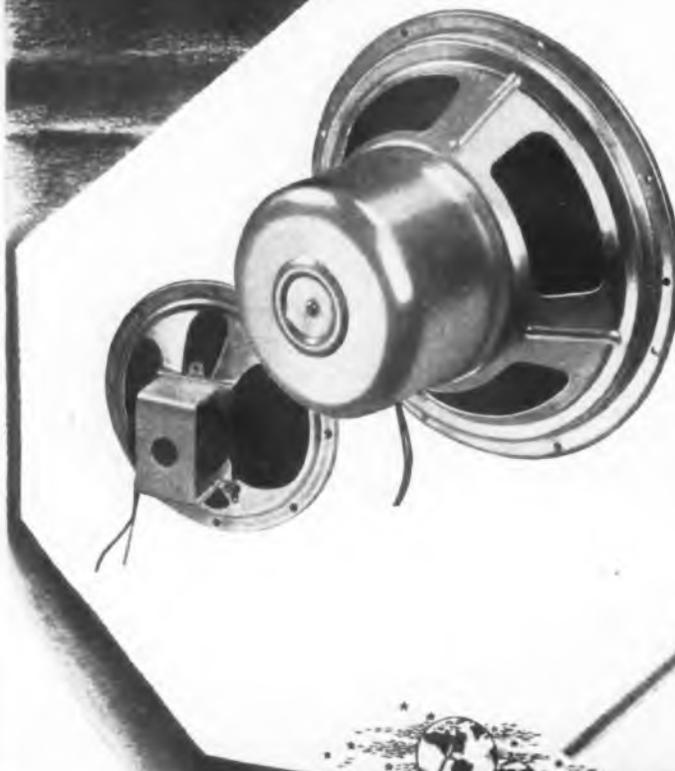
Dynamic Speakers from 2 inches to 18 inches

Permanent Magnet Speakers from 2 inches to 18 inches

Headsets

Consolidated Radio is also a nationally known manufacturer of small and medium transformers including Pulse Transformers, Solenoids and Search Coils.

Engineering service is available to design transformers and speakers for special applications, or to your specifications.



Electronic and Magnetic Devices
CONSOLIDATED RADIO

Products Company
350 W. ERIE ST., CHICAGO 10, ILL.



AMATEUR RADIO

The "Proving Ground" of Radio Communications



America's "Hams" of yesterday are today her key Communication Officers, Radio Engineers and Radar Specialists . . . they are the men who design, build and operate the equipment. Their achievements are contributing heavily to the great victories we are winning on the battlefields, in the air and on the oceans. Their superiority in numbers, plus their wide basic knowledge and experience, is one of the most valuable aids toward total Victory.

Taylor Tubes is proud of its close and lengthy association with the advancement of Amateur Radio. The inception of our business was based on the idea of making "More Watts per Dollar" tubes for Amateurs. When Frank Hajek marketed the Taylor 866 at \$1.65, the competitive price was \$7.50. In the years following, Taylor Tubes carried on with its program of "More Watts per Dollar" tubes and in doing so made it possible for thousands of Amateurs to build better Rigs.

When Victory is achieved, Amateur Radio will again be the *Proving Ground of Radio Communications* and Taylor Tubes will continue its leadership in Tube Value.

"More Watts Per Dollar"

NEW 1944-45 TAYLOR TUBE MANUAL!

Don't delay—get your copy NOW! A new edition of this famous manual has just been published. Ask your TAYLOR TUBE DISTRIBUTOR for one FREE—or send 25¢ in coin or stamps to Taylor Tubes, Inc.



Frank J. Hajek, Pres.
W9ECA



Jim Filmer, V.P. Chief Eng.
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Rex L. Mungar, Sales Mgr.
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Taylor **HEAVY CUSTOM BUILT DUTY** Tubes

TAYLOR TUBES INC., 2312-18 WABANSIA AVE., CHICAGO 47, ILL.

POWER RESISTOR DECADE BOX



Covers resistance range of 1 ohm to 999,999 ohms.

★ Each decade dissipates up to 225 watts. Green-ohms (wire-wound cement-coated power resistors) used throughout. Glass insulated wiring.

★ Six decade switches on sloping panel.

★ Maximum current per decade: 5, 1.5, .5, .15, .05 and .005 amp.

★ Attractive frosted-gray metal case. Etched black-and-aluminum panel. Dual binding posts for left- and right-hand duty.

★ Grille at bottom and louvers at side for adequate ventilation. Baffle plate protects switch mechanism against internal heat.

★ 13" long, 8 1/2" deep, 5 3/4" high. Weight, 11 lbs.

★ Since its introduction several years ago, the Clarostat Power Resistor Decade Box has become a "must" among busy engineers, laboratory workers, maintenance men and others. Especially so during the hustle and bustle of war work.

Definitely in a class by itself. There's nothing else just like it. Note that it is a power resistor decade box. That means the introduction of the correct resistance value for any circuit or application, for use under actual working conditions, at the mere twist of the knobs. The resistance which provides the correct operating conditions is then read directly off the dials. No calculations required. No guesswork. No time-consuming routine. No wonder the Clarostat Power Resistor Decade Box pays for itself in short order.

★ Write for literature . . .
Descriptive bulletin sent on request. Likewise literature on controls or resistors in which you are particularly interested. Let us quote on your requirements.

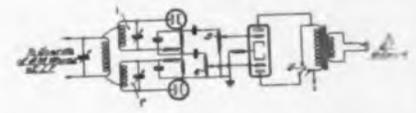
Controls and Resistors

CLAROSTAT MFG. CO., Inc. • 285-7 N. 6th St., Brooklyn, N. Y.

NEW PATENTS ISSUED

Eliminating Beat Note with Adjacent Carrier

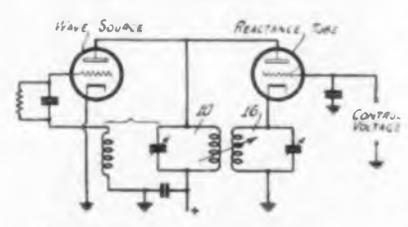
The heterodyne wave obtained when an interfering carrier is located so near the desired carrier that an audible beat note is produced is eliminated. It is shown that this heterodyne wave is amplitude and frequency modulated, and that these two modulations are of proportional magnitude for close carrier frequencies. The method proposed consists in separately detecting both modulations and so combining them in the final circuit that they cancel out. In the embodiment shown, the detected frequency modulation of the heterodyne wave is developed across resistor 5; the detected amplitude modulation of the heterodyne



wave and of the desired carrier (which contains amplitude modulation only) is developed across resistor 4, as will be apparent upon a study of the circuit, assuming resonant circuits 1' and 1" to be oppositely and equally mistuned with respect to the intermediate frequency. The phase relation of the two waves can be reversed by means of switch S. Method and apparatus are explained in detail. M. G. Crosby, RCA, (F) Nov. 25, 1941, (I) June 13, 1944, No. 2,351,191.

Reactance Tube Network

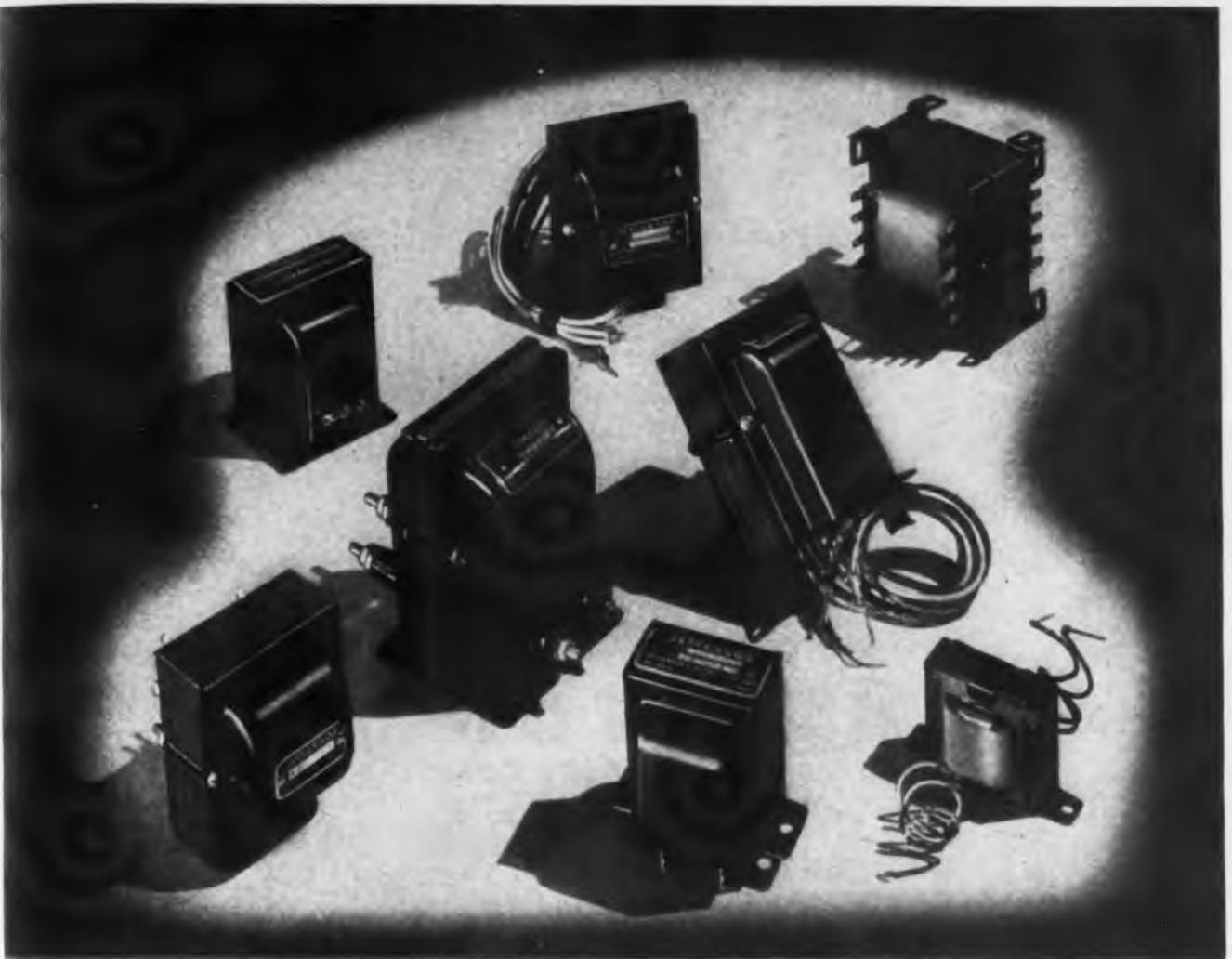
It is the object of the invention to provide a reactance tube capable of producing relatively large values of susceptance by avoiding the loss in the conventional phase-splitting circuit. Oscillator tank circuit 10 is coupled to the tuned cathode circuit 16 of the reactance tube, thereby inducing a relatively large voltage of quadrature phase upon the cathode of the reactance tube. The plate current of the reactance tube, feeding back into the oscillator tank circuit, provides the effect of susceptance across the oscillator tank; the magnitude of this susceptance depends upon the transconductance of the reactance tube and con-



sequently upon the control voltage. Grid and plate connections may be interchanged so that the tank voltage is applied to the reactance tube grid and circuit 16 coupled back to the oscillator tank. For use with wide frequency variations, the impedance of the cathode circuit 16 is made a substantially pure resistance over the range by suitably connecting a filter between the cathode and ground. W. van B. Roberts, RCA, (F) June 3, 1942, (I) June 13, 1944, No. 2,351,368.

Oscillator Circuit

Compensation for a change in oscillator frequency with a variation in the supply voltage is intended. The change in oscillator frequency is caused by the inevitable resistance of the oscillator tank coil 4. Due to this resistance, the voltage fed back to the control grid will not be exactly 180-degree out-of-phase with the plate voltage, but have a small component which lags the



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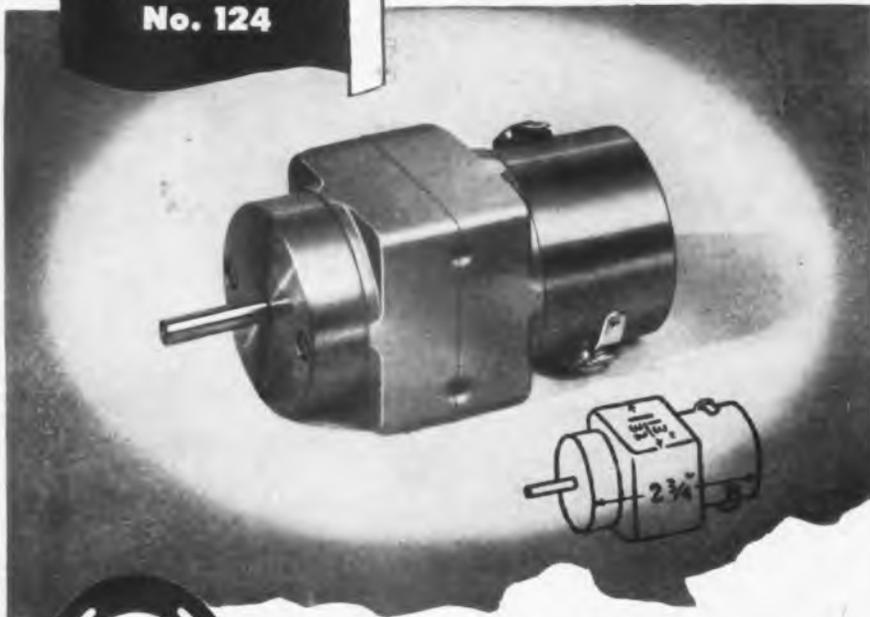
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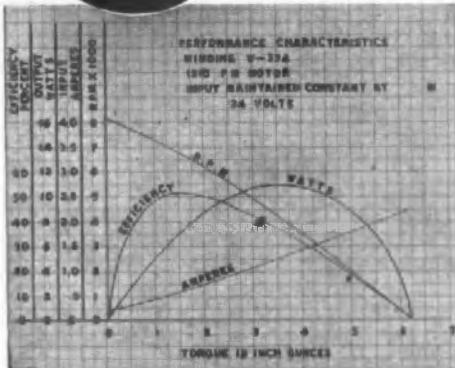
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Torque at 4500 RPM (in. oz.)	3.5
Lock Torque (in. oz.)	6
Volts Input (min.)	5
Volts Input (max.)	32
Temperature Rise Int.	50°C
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Length less Shaft	2 3/4"
Overall Diameter	1 1/2"

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plate voltage by 90-deg. Consequently, tube 1 will act as a reactance tube across tank circuit 4,5. The smaller the transconductance of the tube, the higher becomes this effective reactance. Thus, if variation of the plate supply voltage alters the transconductance, it will alter this effective reactance and hence alter the natural frequency of the system. This effect can be compensated by the introduction of a small 90-deg. leading voltage developed across unbypassed resistance 2 between the suppressor grid and ground. The alternating plate voltage may be considered as being impressed upon this resistance by means of the internal tube capacitance between the

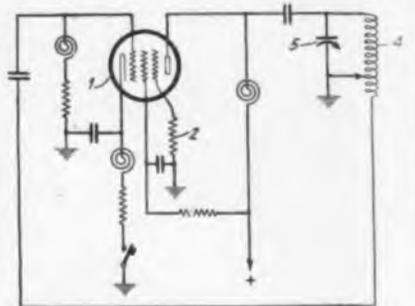
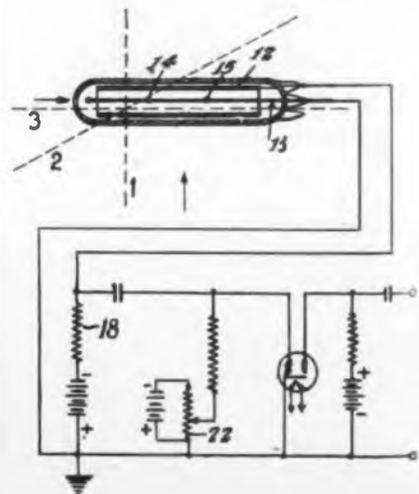


plate and the suppressor grid. Since this capacitance is small, the suppressor grid voltage will lead the plate voltage by approximately 90-deg., introducing a reactance of opposite sign to that originated by the control grid voltage. It has been established by experiments that, for suitable resistance values for resistor 2, the oscillator frequency is substantially independent of supply voltage over a rather large range of voltage variation. W. van B. Roberts, RCA, (F) Oct. 25, 1941, (I) May 30, 1944, No. 2,349,885.

Directional Geiger Counter

In a conventional Geiger-Muller counter, consisting of anode 13 and cathode 12, a discharge takes place when an ionizing particle traverses the space between the two electrodes. The discharge can be quickly quenched so that each successive ionizing particle produces a separate, short discharge. The invention is based on the discovery that the discharge can be localized to a section of the tube interrupting the continuity of the exposed anode surface, for instance by fusing small glass beads 14, 15 on the anode. If an ionizing particle passes through the space juxtaposed to only one section of the anode path 1 in the diagram, then the discharge initiated by the particle is confined to one section of the anode and is of a certain fixed magnitude. If the particle passes through two sections, path 2, it initiates discharge





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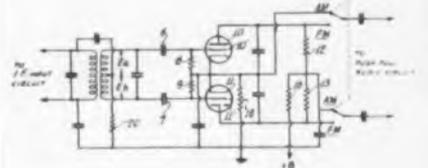
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NEW PATENTS

in both sections and the magnitude of the discharge is about twice that obtained when the particle passes through only one section. If the particle passes through all three sections, path 3, the magnitude of the discharge is about three times that obtained when the particle passes through only one section. It will be seen that the magnitude of the voltage developed across resistor 18 will depend upon the direction of travel of the ionizing ray. Obviously, the following circuit may be designed to record or indicate either one, two or all three possible voltage values, for instance by suitably adjusting potentiometer 22. A different number of anode sections may be employed. H. G. Stever, California Institute Research Foundation, (F) July 21, 1941, (I) June 20, 1944, No. 2,351,845.

AM-FM Detector

At the intermediate frequency, the rectified voltage across resistor 8 is equal to the rectified voltage across resistor 9, and the voltages will be proportional to the input amplitude. For a different frequency, the phase relationships between voltages E_8 , E_9 , respectively, and the voltage across resistor 20 will change, resulting in unequal voltages across resistors 8 and 9. Grids 10 and 11' act as diode detectors supplying bias for the triodes 10 and 11. For FM input the current through resistors 16 and 18, being the sum of the currents through



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tubes 10 and 11, remains constant, while the currents through resistors 12, 13, being the currents through each individual tube, vary in opposite directions. Hence a varying voltage, corresponding to the difference in these currents, will appear across resistors 12, 13, and is applied to the following push-pull circuit. Amplitude modulation will cancel out at the FM terminal; capacitors 6 and 7 are so chosen as to give the proper time constant to secure deemphasis according to frequency modulation standards. For amplitude demodulation, the voltage across resistors 16 and 17, corresponding to the sum of the currents through tubes 10 and 11 and varying with input amplitude will be applied to the following push-pull circuit. W. D. Houghton, RCA, (F) Feb. 10, 1942, (I) June 13, 1944, No. 2,351,212.

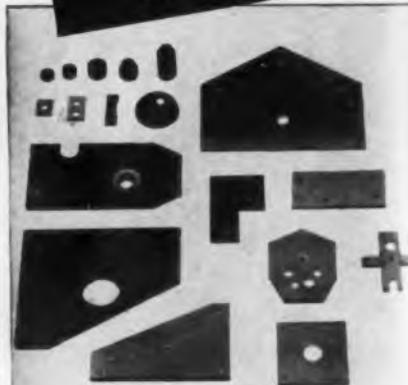
Pressure Indicator

The apparatus was designed to measure the pressure developed in a gun, which may increase by as much as 60,000 lbs./sq. in. within 0.005 second. The instrument includes a piezo-electric crystal converting the pressure into an electrical charge which is then amplified, rectified and used to charge a capacitor. The capacitor is maintained charged for a long enough period of time to make the reading on the associated electron tube voltmeter bridge. C. I. Bradford, Remington Arms Co., Inc., (F) Aug. 30, 1941, (I) June 6, 1944, No. 2,350,515.

FM Receiver

The incoming signal is applied to control grids of converter tubes 13 and 14. In tube 14 it is heterodyned with the output of constant-frequency, local oscillator 12; transformer 16 superimposes a phase-shift, which is a function of the frequency, on the frequency-modulated, heterodyned wave. This frequency and phase-modulated inter-

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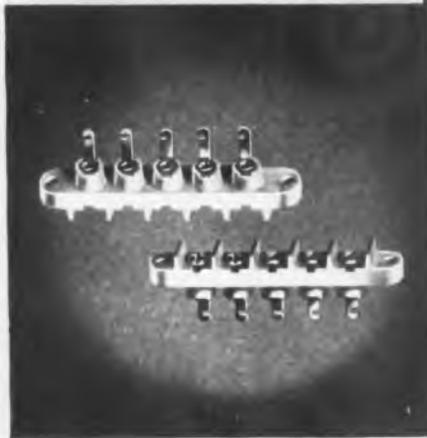
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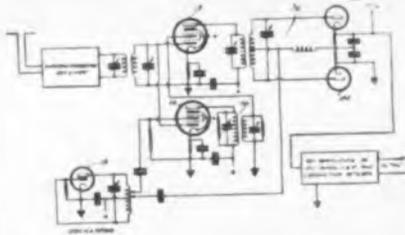
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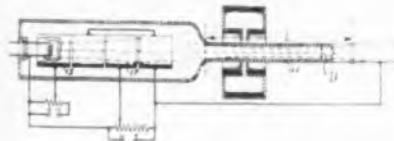
NEW PATENTS



mediate-frequency wave is again heterodyned with the incoming signal in tube 18 so that the original frequency modulation cancels out and a phase-modulated wave having a constant frequency equal to that of the local oscillator 15 is obtained. The phase modulation is then detected by circuit 36 and diodes 38 and 39. M. G. Crosby, (F) March 13, 1942, (I) June 13, 1944, No. 2,351,192.

UHF Tube

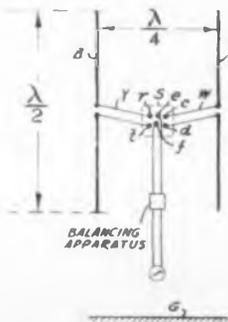
Optimum conditions for the passage of an electron beam through a narrow tube 11 without impinging on the walls of the tube are computed, taking into account the mutual repulsion of the electrons which cause spreading of the beam. It is shown that the maximum current I is equal to $3.87 V^{3/2} (D/L)^2 \times 10^{-9}$, and that it will occur when the beam just fills the end cross section of the tube and when the minimum cross section of the beam is located at the mid-point of the tube. V is the voltage at which the electrons are projected into the tube and D and L diameter and length of the tube as indicated in the diagram. In any particular case, D, L and V are fixed by the intended use and dimensions of the tube.



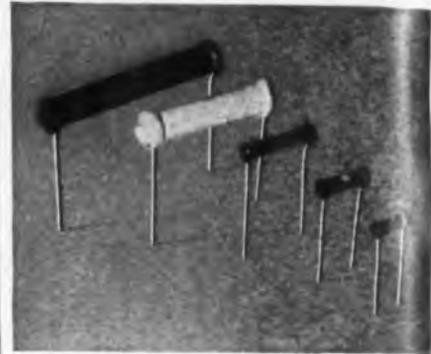
and the invention proposes to realize the maximum current conditions (i.e. beam diameter at tube entrance equal to tube diameter, and minimum beam diameter located at the mid-point of the tube) by a suitable choice of the potentials on electrodes 15 and 17. Obviously, other electron lens systems may be used and adjusted to meet the requirements. To establish the shape of the electron beam, the walls of the tube and its end sections may be coated with fluorescent material or a small amount of inert gas may be left in the tube which will glow in the path of the electron beam. F. Gray, Bell Telephone Laboratories, (F) July 29, 1941, (I) June 20, 1944, No. 2,351,757.

Radio Beacon

Antennas A and B alternately act as transmitter and reflector, respectively, so as to provide two different signals adding to one continuous signal for equidistant points K and H; curves D and C represent the directional characteristics for the two



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759-A	1/2	33 Ohms to 15 Megohms	3/4"	1/4"
766-A	1	47 Ohms to 15 Megohms	1 1/8"	1/4"
792-A	3	22 Ohms to 150,000 Ohms	1 3/8"	15/32"
774-A	5	33 Ohms to 220,000 Ohms	2 3/8"	15/32"

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763-CX	1/2	1 to 47 Ohms	3/8"	7/32"
759-CX	1	1 to 33 Ohms	3/4"	1/4"
766-CX	2	1 to 47 Ohms	1 1/8"	1/4"
792-CX	4	1 to 22 Ohms	1 3/8"	15/32"
774-CX	6	1 to 33 Ohms	2 3/8"	15/32"

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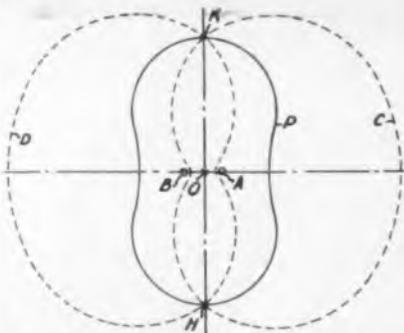
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states of transmission, respectively. Change-over switch S connects the transmitting antenna to the balancing apparatus and the signal source, while the open-ended feeder, Y or W, respectively, connected at the center of the reflecting antenna, is of suitable dimensions to make the equivalent electric length of the reflecting antenna a little more than half a wave length long so that it has an inductive reactance. To avoid any interruption in the equidistant signal and consequent clicking of the receiver, the contact points c,d and r,t are made of adjustable spring metal and the distances between them and contacts e,f are so adjusted that there will be a short interval of time of simultaneous contacting with both couples, c,d and r,t, during the movement of the contacts e,f from c,d to r,t and vice versa. The curve P corresponds to the polar diagram when both antennas are excited by equal voltages. For the same input, the field intensity of polar curve P will be stronger than that of polar curves C and D in the direction OK and OH. Balancing apparatus is inserted to equalize the field intensity of the polar curve P to that of polar curves C and D in the direction of KOH so that clicking is completely avoided. H. Matsudaira, Alien Property Custodian, (F) Jan. 14, 1941, (I) May 30, 1944, No. 2,349,976.

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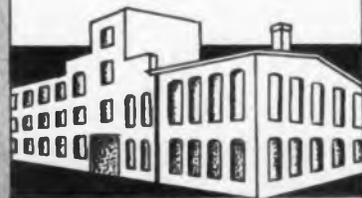
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To many engineers every circuit is a separate problem; any change in a given circuit requires a new analysis. Generally, this analysis is based on the fundamental relationship known as Kirchoff's and Ohm's Laws. In a previous article in "CREI NEWS" we presented a simplification known as Thevenin's Theorem by means of which much arduous computation could be avoided and often a much simpler physical picture obtained. Now, a series of articles titled, "Circuit Equivalents" will present further material and viewpoints to enable the engineer to simplify circuit computations.

Part I, in the October issue of "CREI NEWS," will deal with such preliminary matters as the meaning of impedance function, the classification of networks, the meaning of circuit equivalents and the requirements for two-terminal and four-terminal equivalents.

You will find this material interesting as it represents a discussion of networks from a somewhat different viewpoint from that found in the usual text books. It is not a mere recitation of certain theoretical facts, but instead, it is a demonstration of the application of such rules to practical circuit problems encountered by the radio engineer.

These articles are available free of charge. Simply write to the Institute and request the October issue of "The CREI NEWS" containing the article on "Circuit Equivalents."

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DEGASSING

(Continued from page 104)

The surfaces of metal tube parts such as grids and plates are pitted with microscopic pores that have a passionate attachment for dirt, oil and gas molecules picked up during the metal processing operations. These foreign molecules are impossible to dislodge by ordinary methods as they are held tightly to the metal by the molecular attraction exerted by the surface metal molecules on the molecules of the foreign substances. This physical property is known as adsorption.

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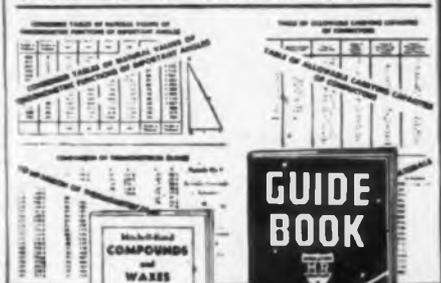
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BEGASSING

(Continued from page 172)

their efficiency in the radio tube. The cleaned parts must be used within twenty-four hours or they again become contaminated by gas and dirt molecules attracted to the metal surfaces by molecular adsorption.

Originally the reducing atmosphere used at Tung-Sol to shut oxygen off from the metal parts in the furnace was hydrogen, H₂. The drawbacks to hydrogen were many, among them cost, tendency to explosion unless handled carefully, and the trouble involved in handling and storing the massive metal gas cylinders.

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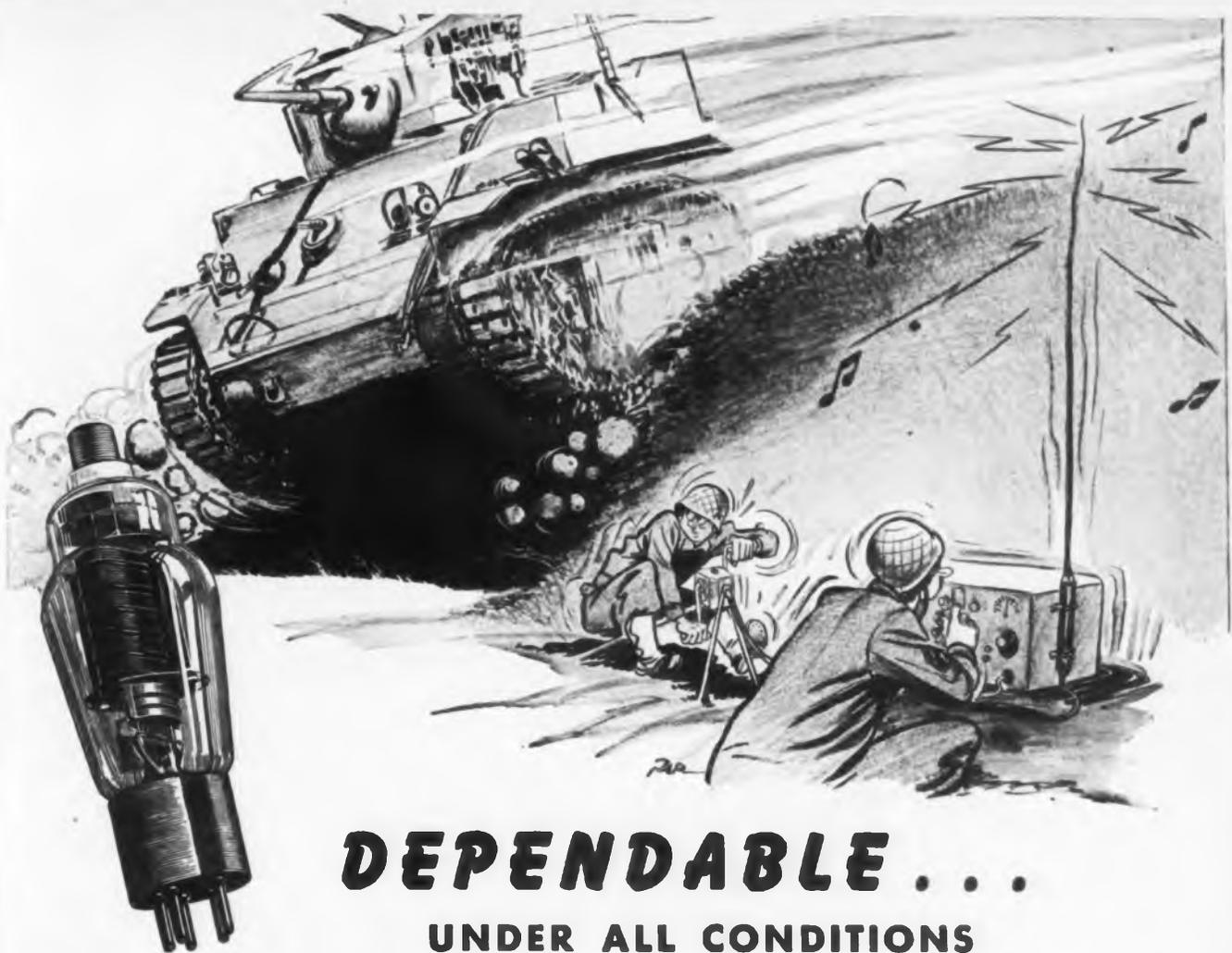
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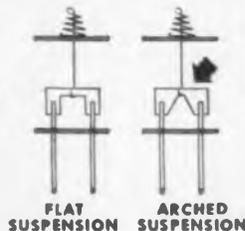
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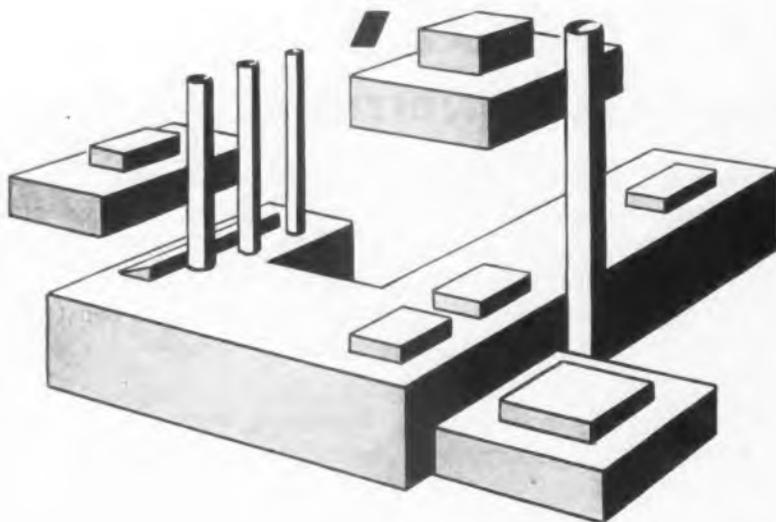
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DEGASSING

(Continued from page 174)

of raw gas and an insufficient supply of air are passed into the reaction retort of the converter and ignited with a spark plug in the presence of a catalyst. The gas consumes all the oxygen present in the air mixture but is itself incompletely consumed. The resulting burned mixture contains moisture, carbon monoxide, CO (the chemically active reducing gas in a proportion of about eight per cent), small quantities of carbon dioxide, CO₂, plus the inert gases such as nitrogen remaining from the atmospheric air after the oxygen was reduced out of the mixture. The large proportion of inert gases keeps the mixture from exploding and has no harmful effect on the metal parts being degassed in the furnace. Any sulphide compounds present are removed by a special filter as they are harmful to tube performance.

The converter operates continuously while the degassing furnaces are in operation and can be adjusted to their rate of consumption of gas for most economical operation. Suitable outlets are provided for the small quantities of gas that are forced out of the furnace and they are burned at the outlets as carbon monoxide is poisonous.

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CATHODE COUPLING

(Continued from page 91)

of a hypothetical tube whose amplification factor $\mu' = \mu / (1 + \mu)$ and plate resistance $R_p' = R_p / (1 + \mu)$.

The average plate characteristics for the type 801 are given in Fig. 5. The μ for the 801 is 8. A second plate voltage scale divided by $1 + \mu$ is also drawn. Two load lines are drawn through the operating point O. One is for a load of $R_L = R_p = 5000$ ohms. The other is $R_L = R_p / (1 + \mu) = 555$ ohms.

Assuming a peak AC grid voltage of 20 volts, the power output calculated from the curves in the case of $R_L = 5000$ ohms is:

$$\frac{(0.044 - 0.012) (590 - 430)}{8}$$

= 0.64 watts

The second harmonic distortion in this condition is about 1.5 per cent.

For $R_L = 555$ ohms, the power output:

$$\frac{(.063 - .003) (524 - 495)}{8}$$

= .218 watts

The distortion in the last case is about 8.5 per cent.

The power output and distortion figures for the two values of load resistance are based on using the tube as a conventional amplifier, and not as a cathode follower.

The 5000-ohm loadline is also a

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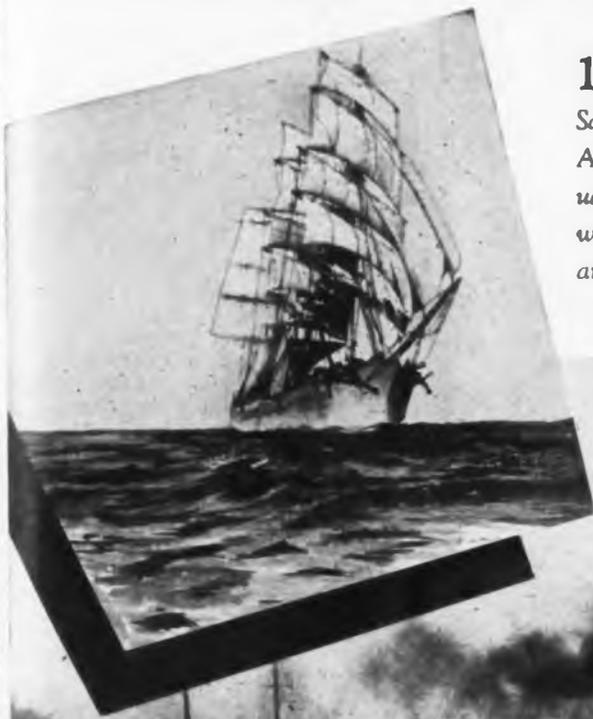
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555-ohm loadline when the lower plate voltage scale is considered. This is because the 555 ohm line and the voltage scale are changed by the same factor, $1 + \mu$.

The power output from the 801 as a cathode follower and with a load resistance of 555 ohms can be calculated using the original 5000 ohm line.

The power in this case is:
(65.5 — 47.8) (0.044 — 0.012)

8

= 0.071 watts

The power calculated by equation (4) in Fig. 4 also gives 0.071 watts. The value of E_b used in this equation is 14.1 rms. v. The peak value of this is 20 v., the same as used for the graphical power calculation. The reason for this value is that the graphical power calculation treats the cathode follower circuit as a special tube of low μ and R_p , but in a standard circuit in which $E_o = E_b$, that is, no feedback.

The required E_b for a given output can be found by equation 1 of Fig. 2. Where μ is large (10 or more) E_b is approximately $2E_o$.

As a summary, the cathode follower circuit provides up to 50 per cent reduction in distortion when used for a low impedance output stage. (Equation 6, Fig. 4.) Greater distortion reduction results when higher load impedances are used.



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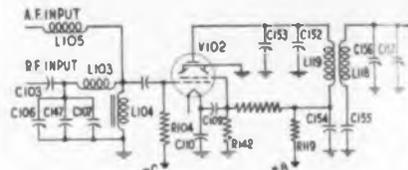
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ENGINEERING • DESIGNING • MANUFACTURING

WIDE READING

(Continued from page 114)

When a push button is depressed, a gang condenser tuning device selects the proper crystal and tunes the circuit to its frequency. The oscillator output frequency (f_x) passes through one stage of rf amplification and then, along with the audio frequency signals, is impressed upon a new-type modulation coil. The ninth harmonic of the crystal frequency ($9f_x$) is selected and impressed upon a frequency doubler. The doubler output ($18f_x$) excites a frequency tripler. The tripler output ($54f_x$) drives the power amplifier at the carrier frequency. The proper one of 10 pre-tuned antenna tuning condensers is selected by the gang-tuning control and connected to the antenna.



FM amplifier stage featuring modulated harmonic output

The modulation coil was designed by Bell Telephone Laboratories (U. S. Patent No. 2,311,796 to L. R. Wrathal, issued Feb. 23, 1943; see

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How the HT-4 took it at 134° in the shade . . .



The following is quoted from a letter marked "Somewhere in Libya" signed by an officer in an AACCS group, USAAF:

"The writer just spent a year in Persia. Most of the time along the Persian Gulf where it really gets HOT! We operated one of your HT-4-B Transmitters near a place called Abadan. The transmitter performed very satisfactorily under the most unfavorable conditions. I doubt that your engineers ever dreamed that one of your rigs would be called upon to perform in a place where for 5 days and nights the temperature never dropped below 117 degrees and in fact it got up to 134 degrees during the daytime, that is "in the shade" temperature, the humidity was high and the air salty. Actually the transmitter got much hotter than that as it was installed in a brick building and no air conditioning, not even an exhaust fan. The HT-4-B was used on voice and gave very little trouble. One day the piece of bakelite under the phone/cw switch caught on fire but this was easily repaired. During the so called winter season, the temperature actually got as low as 36 degrees one day, we had a little trouble with mice crawling under the rig, which was set up on two 4x4 wooden sleepers. It seems the mice liked the heat and they would crawl up under the transmitter and get lodged in between the rectifier sockets and the frame when the operator switched on the transmitter the mice would fry, usually a fuse would blow but no other damage was done. We never did figure why the mice liked the Hallcrafters best. There were several other transmitters in the room but they always seemed to pick the HT-4-B; guess they were pretty smart mice!"

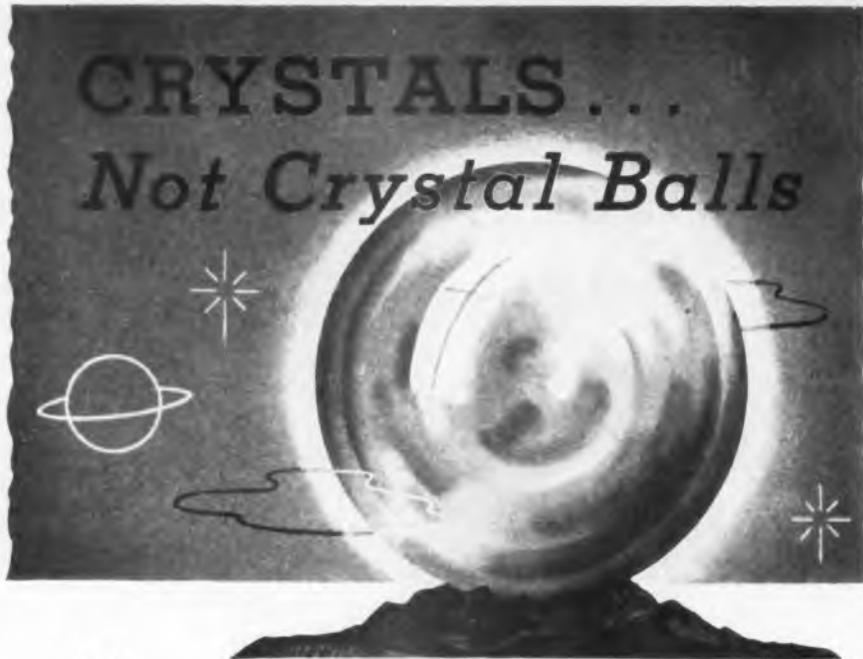
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E. I., April, 1943, p. 106) especially for these vehicular sets. Several-fold multiplication of the crystal frequency and modulation of the carrier wave by the audio signals are the duties of this new inductor coil. The rf input derived from the first radio frequency amplifier causes a current to flow through the parallel resonant circuit, consisting of a duo-lateral coil, the modulation coil L104 and a variable condenser operated by the push-button assembly.

The modulation coil becomes magnetically saturated at a much lower current than that in the resonant circuit. When the instantaneous rf current exceeds the saturation value, there is no appreciable increase of flux density, the inductance of the coil drops to a low value, and very little voltage appears across it. Between the saturation value and zero current the coil has a high inductance and a change in current causes a relatively large change of flux density, and a high counter-voltage is induced across the coil. The current through the modulation coil, therefore, produces sharp voltage peaks each half-cycle as the rf current wave passes through zero. The voltage peaks alternate in polarity each half-cycle and are evenly spaced in time. The peaks have a distorted

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Solvent	Heavy Enamel	HF Formex	Solvent	Heavy Enamel	HF Formex
Kerosene	Slight softening	No effect	10% sulphuric acid	No effect	No effect
Petroleum naphtha	Slight softening	No effect	1% potassium hydroxide	No effect	No effect
Toluol coal tar	Fails	Slight softening at 4000 hours	Freon F-12 gas	Fails	No effect
Alcohols (Methyl through octyl)	Fails	No effect	Cresol, plus alcohol	Fails	No effect
Xylol coal tar	Fails	Slight softening at 4000 hours	Ammonia	Slight softening	No effect after 72 hours
Acetone	Fails	No effect	Gasoline	Fails	No effect after 5000 hours
Trichlorethylene	Fails	75% softening	Asphaltic, or petroleum asphalt	Fails	No effect
			Benzine, plus alcohol, plus gasoline	Fails	Fails

Recommended Baking Practice

Varnish G-E No.	Thinner G-E No.	Specific Gravity at 21 C	Viscosity AV Centipoise at 21 C	Minimum baking time, hours			
				110 C	125 C	135 C	150 C
1678	1513	0.930	800	8-10	5-7	3-5	2-4
1679	1513	0.930	950	10-12	6-8	4-6	3-5
9535	9407	0.965	750	8-10	5-7	4-6	3-5
9550	Pet. Spts.	0.915	250	8-10	5-7	4-6	2-5

Baking temperature of 135 C or above is preferred for all of these varnishes. Flash point 60 F.

Buy all the BONDS
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FORMEX
MAGNET WIRE

GENERAL ELECTRIC

wave shape and contain many harmonics of the original crystal frequency.

When only rf is flowing through the modulation coil the peaks or pulses produced occur at regular intervals. However, by introducing a low frequency current flow through the coil in addition to the rf, the position of the peaks may be changed with respect to each other to cause phase modulation. Essentially what occurs is that the point of zero instantaneous current—which is the position in time at which the coil is not saturated—is moved along the rf wave. The positive and negative pulses, if radiated, would interfere with each other,

and for this reason the output of the modulation coil is passed through a rectifier which eliminates the negative pulses and produces phase modulated odd-order harmonics at its output. In the 508 set the ninth harmonic is chosen and multiplied from there to get a frequency 54 times the original crystal frequency.

Electron Spectrometer

M. Deutsch, L. G. Elliott, and R. D. Evans (Review of Scientific Instruments, July, 1944).

Theory, design, and application of a short magnetic lens electron spectrometer are treated. Essen-

tially, the electrons emitted by a radio-active substance are focused on a counter which indicates the intensity of the impinging electron radiation. The performance of the short magnetic focusing coil is studied, and appropriate techniques for the investigation of different type primary and secondary rays are described.

ROCHESTER PROGRAM

(Continued from page 122)

Trends in Receiving Tube Design and Application, L. R. Martin, Radio Corp. of America
Standardization of Capacitors for Civilian Equipment, J. I. Cornell, Solar Mfg. Co.
One Look Backwards—and Two Ahead, K. Jarvis, Sheridan Electric Corp.

Tuesday, Nov. 14

Report of RMA Director of Engineering, W. R. G. Baker.
Organization of Research in the Radio Industry After the War, Rupert MacLaurin, Massachusetts Institute of Technology.
Electronic Tube Trends, R. M. Wise, Sylvania Electric Products, Inc.
Silicone Products of Interest to the Radio Industry, Shailer L. Bass and T. A. Kaup, Dow Corning Corp.
Designing Thoriated Tungsten Cathodes, J. Dailey, Westinghouse Elec. & Mfg. Co.
Stag Banquet, F. S. Barton Toastmaster, Major General Roger B. Colton, speaker.

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The fourslide department of Accurate has turned out millions of wireforms, in hundreds of different shapes, for munitions, implements of war and peace-type products. Accurate engineering and mechanical ingenuity has solved many unusual and difficult wireform problems—the results of which were greater production, time and labor saved and minimum cost.

If you use wireforms, or will in your future plans, discuss them with Accurate—to your advantage.

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WCEM Electronic Exhibit

Middle of August West Coast Electronics Manufacturers Association staged a "closed" show of the war-intended products of its members. For two days factory engineers and executives had an opportunity to see what other factories were making, entertained local Army and Navy personnel.

New ASA Headquarters

Middle of last month American Standards Association moved into new and larger headquarters. The address now is Grand Central Terminal Building, 70 East 45th St., New York.

8 Video Applications Swell Total to 76

With applications for video stations totalling 76 now in FCC files, eight having been put in the works during week of August 30, Television Broadcasters Association expects start of a national service within months after the current freeze is thawed. Latest applicants are Blue Network Co. which seeks channels 15 in New York, 8 in Chicago and 8 in Los Angeles; the Yankee web wants channel 2 in Boston; Maison Blanche Co. seeks channel 1 in New Orleans; United Broadcasting Co. wants channel 2 in Cleveland; J. W. Birdwell would like channel 1 in Nashville, Tenn.; Farnsworth Television and Radio Corp. wants to operate experimentally on channel 3 in Ft. Wayne.

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DIAMOND WIRE & CABLE CO.

Chicago Heights, Illinois

Manufacturers of electrical flexible cord, cables, and instrument wires for radio and appliances



How RTPB Is Widening Radio's Usefulness

By **O. H. CALDWELL**
Editor, Electronic Industries

Editorial for General Electric Review,
June, 1944

Imagine that, at intervals in the growth of a great city, a group of its best experts on all aspects of its complicated life and traffic, could be summoned together to plan and redesign the city's areas and arteries, so as to take into account all new developments and new needs of its citizens.

Regions that had become overcrowded could be expanded and congestion eased. Obsolete and outdated sections, little needed, could be reshaped and contracted, freeing precious groundspace for city functions now recognized as more vital. And the wide suburban areas into which in the future the municipality is bound to spread, could be laid out intelligently and scientifically in advance, instead of being left solely to the demands of enterprising individual developers.

If such a local “planning board” could go to work on any of our great American cities, reshaping areas and streets for the needs of 1944 (as well as 1950 and 1960), think what new conveniences of living, greater economies of business, and increased efficiencies of operation, would result.

Such intelligent and scientific technical planning of our municipal domains may not yet be possible. But it is exactly such study and redesign of our vital radio domain and channels that is now being performed by the Radio Technical Planning Board.

The organization of this Planning Board for radio has been along sound and democratic lines. First, all groups having a “stake in the spectrum” were invited to come together and discuss the broad outlines of the problems to be solved. These groups, whose representatives made up the Radio Technical Planning Board itself, include such diversified interests as the broadcasters, manufacturers, engineers, communications men, police operators, television specialists, motion-picture men, radio amateurs or “hams” and even railroad and taxicab organizations (which are now asking for radio channels).

With this broad background and basis for the interrelated radio problems to be solved, the technical situation was broken down in detail into a dozen or more functional brackets, designated as “panels.” Each such functional topic was then assigned to a pair of the very best engineers in that department of radio (as panel chairman and panel vice-chairman) with instructions to summon

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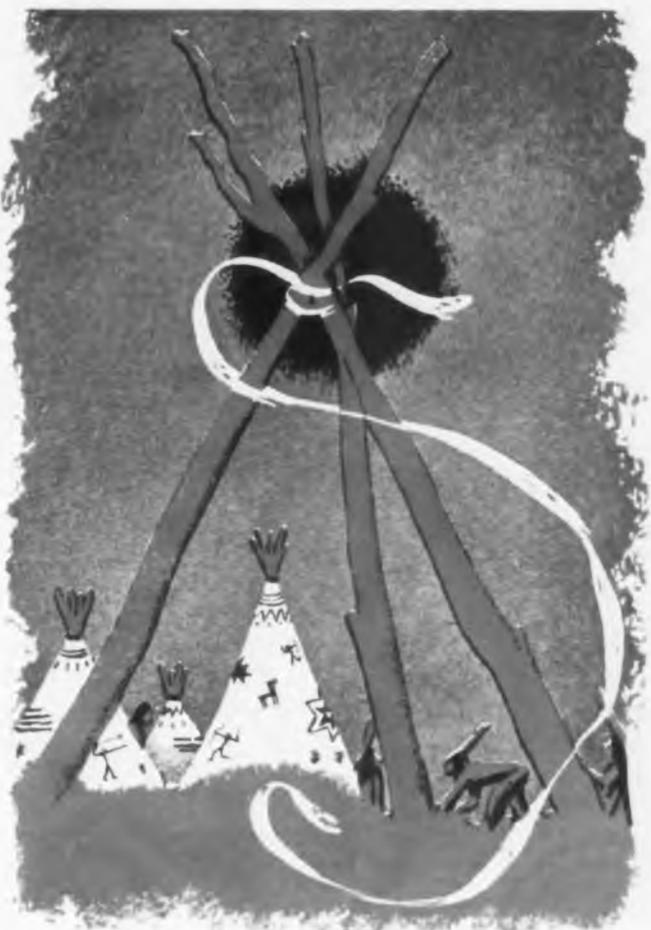


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to their assistance the most competent specialists to make up a "panel" organization which would be recognized by the industry as capable of giving the last word on the subject.

In this way panel memberships of 20 to 40 engineers each, have been built up, and the 13 panels are now at work bringing in their reports to the coordinating central body. In all, some 600 highly competent technical experts are thus engaged in replanning the radio spectrum, so as to get greatest usefulness for the new radio developments already in sight.

Anticipating future demands

The experts doing this invaluable work are among the most competent in the industry. Their panel and board leadership has been excellent.

Articles like that by Dr. Baker in the June, 1944, issue of the General Electric Review, are useful in helping to interpret the RTPB to men in radio all along the line, for every radio man in one way or another, has his own personal and precious stake in the radio spectrum. And RTPB's value will be even better recognized in coming years, as radio's marvelous expansion accelerates.

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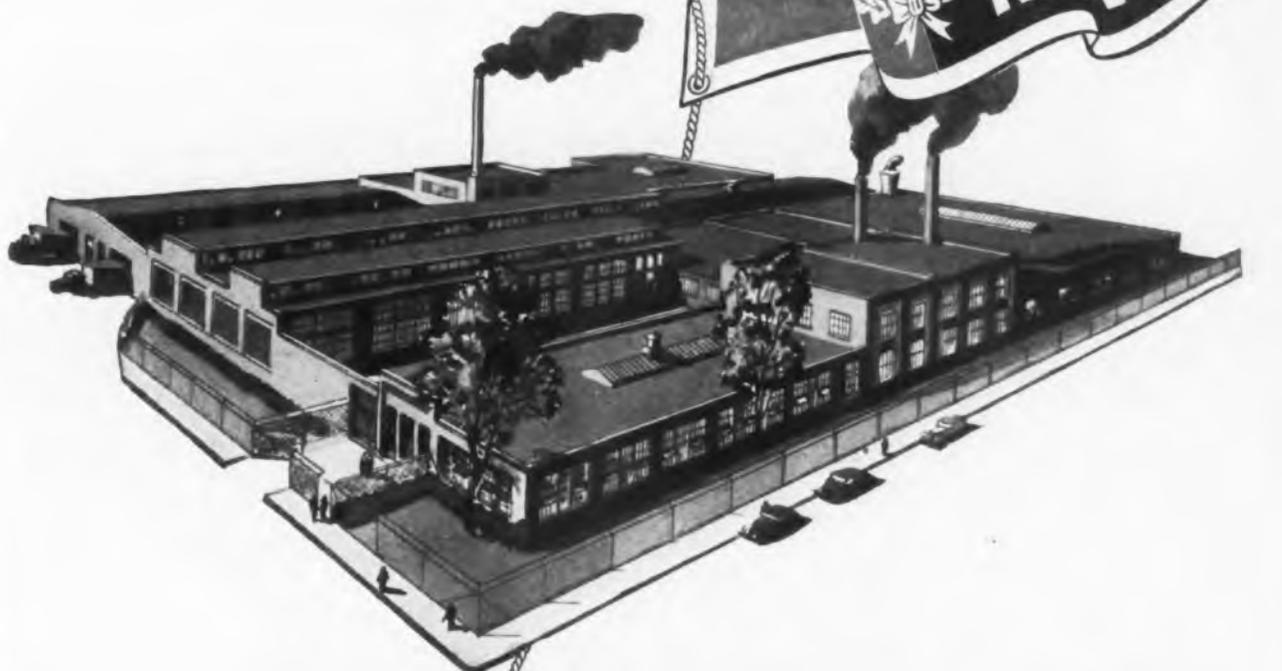
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RTPB Re-Elects Baker and Goldsmith

At a meeting of the Radio Technical Planning Board held at New York Sept. 14, Dr. W. R. G. Baker and Dr. A. N. Goldsmith were re-elected respectively chairman and vice-chairman for the coming year. Terms of other RTPB officials were also continued. During the technical discussion at the Sept. 14 meeting, plans were outlined for coordinating the views of the various RTPB panel chairmen which were to be presented at the FCC allocation hearings beginning Sept. 28 at Washington and are expected to continue for a number of weeks.

Wartime Civilian Receivers in Great Britain

"Practical Wireless" reports the following statements by the Radio Manufacturers' Association of Great Britain:

"First releases of the new wartime civilian receivers are likely to be made in the near future. A quarter of a million sets (175,000 ac Mains, 75,000 Battery) are to be made during the next twelve months by radio set manufacturers, all using the standard designs evolved by the Radio Manufacturers' Association in collaboration with the Board of Trade.

Material released

"The Government's desire was that the civilian listening audience should be, as far as possible, maintained. This has been partly achieved by the release of valves and components for repair work and by the trade's efforts in maintaining sets in service very much beyond their normal life. As a further contribution, the Government authorized the release of sufficient material for the production of 250,000 standard domestic receivers to be made and sold under conditions agreed between the industry and the Board of Trade.

"The ac model (195-250 v., 50 cycles only) uses a three-valve (plus rectifier) circuit, with frequency changer. IF stage, Westecor and pentode output, and delayed AVC is incorporated. No dc version is to be made.

Death Ray

Periodically some sort of a "death ray" shows up. It's a subject that has been more or less intriguing to a lot of people for a long time. Witness a reportorial note from one of the New York newspapers dated August 3, 1924—just 20 years ago: "Grindell Matthews, recently arrived from Europe, will be interviewed tonight at the Vanderbilt Hotel, New York, on the subject of his startling invention, the 'death ray.' Station WJZ will broadcast the interview directly from the hotel."

ALLEN H. GARDNER, President

Colonial Radio Corp. . . .

"The public knows only part of the splendid job electronic engineers have done during the war, and of the marvelous accomplishments that have been made in radio communications, because of the extremely secret nature of most of the developments. One of the results which can be mentioned now is the...



"TREMENDOUS INCREASE IN NEW USES FOR MODERN, VERSATILE VIBRATOR POWER SUPPLIES"

Yes, Mr. Gardner, many fields, after the war, will find E-L Vibrator Power Supplies the key to a host of new improvements in their products and services. The transit industry, radio, aviation, railroad, marine, electrical and electronic are just a few of the fields in which E-L equipment will do many important jobs . . . The most significant new E-L development is the perfection of an electrical current division circuit between vibrator contacts. This has made possible an enormous increase in output capacity, to as much as 1500 watts at present!

For the transit field, Electronic Laboratories offer four patented current conversion systems for fluorescent lighting in all types of vehicles. These systems will operate any type or size fluorescent lamp, either hot or cold cathode, as well as any number of lamps.

E-L is ready now to bring you the benefits of its tremendous wartime experience for two-way radio in planes, trains, transcontinental busses, boats and other fields . . . Multiple input and output units are available. Vibrator Power Supplies may be designed to supply any needed wave form. They are efficient and long-lived and economy is assured with the minimum of maintenance. E-L design engineering service will design a Vibrator Power Supply to meet specific requirements in size, weight and voltage.

E-L STANDARD POWER SUPPLY MODEL 619

This a typical unit for mobile or portable applications with such equipment as 5 or 10 meter shortwave rigs. Model 619 allows you to operate from regular 115 volt AC power line and then switch easily to a 6 volt DC battery. Characteristics: Input voltage, 115 volts 60 cycle AC and 6 volts DC; Output voltage, 6.3 volts AC at 100 ma. and 300 volts DC at 100 ma.; Output power, 55 watts maximum.

Dimensions: 9 1/4 x 5 3/4 x 6 in. lbs. Weight: 14 1/2 pounds



Write for further information of this and other power supply models with different inputs and outputs for a wide range of uses.

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PRODUCTION LOADS

(Continued from page 107)

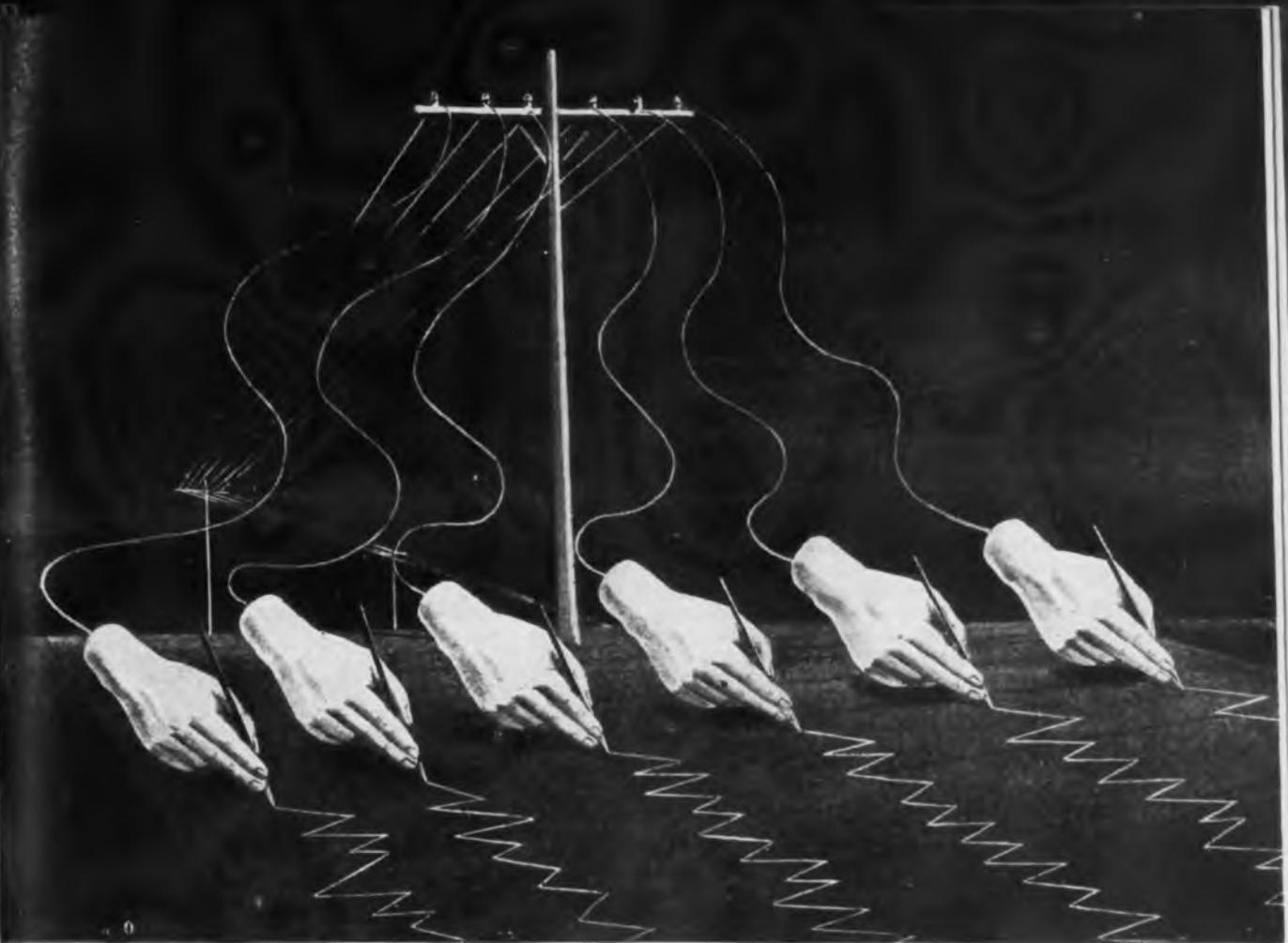
pal things WPB set out to do—(1) properly to balance the load among manufacturers supplying critical components to end product contractors, and (2) materially to shorten the delivery time interval on components—first step in the program was the issuance of General Scheduling Order M-293. As promulgated in April, 1943, this measure grew a full set of teeth and made mandatory the filing of reports by manufacturers of a long list of components starting with capacitors, resistors, transformers and such things and going right down the general category of critical parts and including various types of electrical instruments and test equipment.

These reports turned up definite information from which it was possible to get a clear picture of conditions as they existed, thus represented the most logical and businesslike approach to a problem that had production pretty well bogged down. The net result is that conditions have been so vastly improved that the delivery time interval for all but a few critical components has been reduced to 60 days instead of an invariable 90 days and in some cases a full year. In other words, end product manufacturers now can place orders for components and be assured of deliveries within a maximum of two months whereas before they never could be dead sure just when they were going to get them.

That picture is graphically shown in Fig. 1. The upper portion of the chart shows conditions as they existed on October 1, 1943, with three makers of critical parts so clogged with orders that they had no available capacity for a full year ahead, and the others requiring at least three months before they could accept any new business, some more than that. Contrasted with this were conditions on July 1, 1944, where most manufacturers now are able to promise deliveries within a 60-day period, and keep their promises.

How has the job been done? Well, consider Fig. 2, which will give a large part of the answer. This is a composite table and shows the available capacity, by months, of a typical critical component as revealed by reports turned in by seven manufacturers of the product. Note that in the case of manufacturer F, for example, there was no capacity available for a period of 10 months; manufacturer D could run full blast for six months before he could handle new business; manufacturer E needed five months to get into condition to make deliveries on new business.

Manifestly, there could be no point in an end product contractor



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Henceforth, the Lafayette
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The Lafayette Radio Corporation has, for 22 years, been one of the respected and well-known names in the field of radio and electronics. Our policies and our personnel, our reputation for integrity and outstanding service to our customers have enabled us to become one of the nation's great arsenals of radio and electronic equipment. During these critical war years, the Lafayette Radio Corporation has aided immeasurably in speeding the production of materials for Victory.

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Lafayette Radio Corporation

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265 Peachtree Street
ATLANTA 3, GEORGIA

giving orders to component manufacturers so well loaded up, and expect to get deliveries. Yet that is just what was being done, and conditions were rapidly getting worse.

End product manufacturers were continuing to load already well-loaded component producers largely because they didn't know any better—and neither did WPB until M-293 reports became available and a true picture could be prepared. With definite information available, it then became possible to shift orders from one manufacturer too well loaded to another who had capacity to handle the business and make scheduled deliveries. This automatically relieved the loaded up manufacturer, gave him additional capacity at a much earlier date, and gave the lightly loaded manufacturer some business that quite likely was pleasing to him.

Another reason for the existence of the condition as it was before WPB started to take steps had come about as a result of lack of information regarding sources of supply by end product makers. Even when they knew of all sources of supply they still had no means of knowing the condition of a given manufacturer's order books and hence had no way of knowing with any degree of certainty whether delivery schedules would be lived up to or not. (Continued on page 198)



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DESIGNERS AND MANUFACTURERS OF THE "Q" METER QX-CHECKER FREQUENCY MODULATED SIGNAL GENERATOR BEAT FREQUENCY GENERATOR AND OTHER DIRECT READING TEST INSTRUMENTS

(Continued from page 106)

At present, however, there is no reason for any such chaotic condition. In the first place, WPB knows exactly what goes on and thus is in a position to give advice. Secondly, all interested manufacturers also know what goes on, for all of them regularly receive reports from WPB listing available sources of supply and giving adequate information regarding available capacity.

Such information also is filed in all WPB field offices and is instantly available to interested manufacturers. In consequence there should no longer be any excuse for a contractor not knowing where to turn for a given product in a given time. In fact, WPB urges contractors to contact local WPB offices before placing orders for components.

In consequence of all these activities, conditions in the critical components industry have very considerably improved, and are steadily getting better. Fig. 3, which is based on the reports constantly flowing into WPB headquarters, shows one type of wall chart that is helping WPB executives to keep abreast of—or it might better be said quite a long way ahead of—military requirements. It shows that while there still remains a sizeable spread between unfilled orders and actual shipments, that spread is slowly but surely being cut down.



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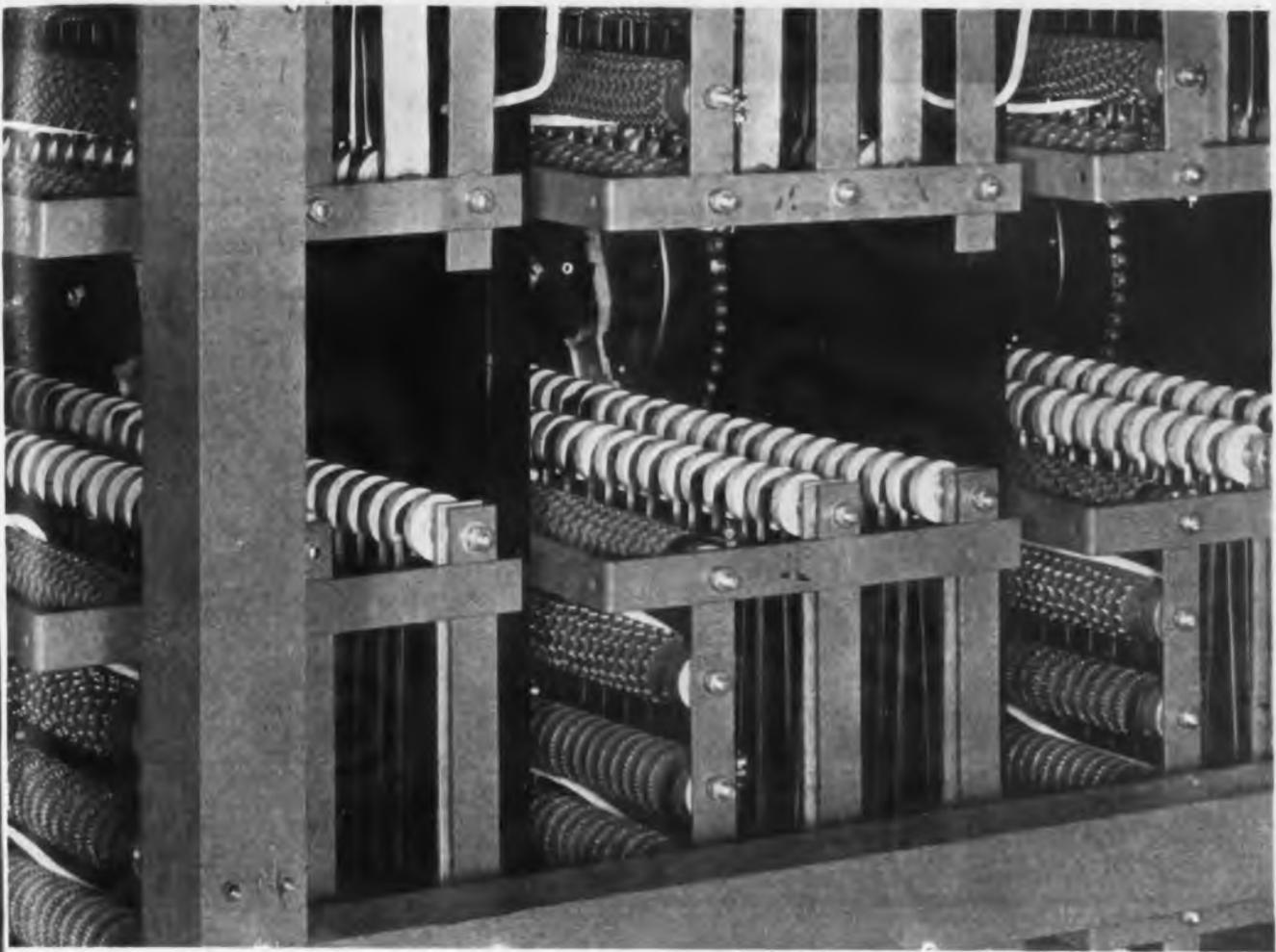
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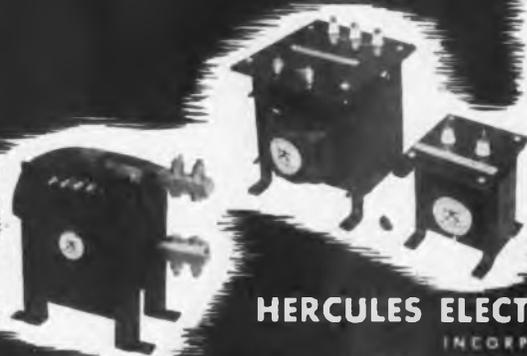
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MILLION-V. X-RAY

(Continued from page 103)

trast at million volt radiation of course will permit only a low photographic contrast to be recorded by the X-ray film, and it becomes imperative to choose a type of film whose characteristic feature is high inherent contrast availability. The usual densities to which industrial X-ray films are developed are found to be in the region of $D=0.7-0.9$ which incidentally seems to be the maximum sensitivity region of the human eye. From the characteristic curve of log exposure versus density (Fig. 2) it is found that the film is capable of rendering higher contrast at densities closer to 1.5 or even 2.0, and these densities are chosen with preference over the lower range for million volt X-ray inspection films.

For the practical application of million volt X-rays similar conditions for exposing a film through a material prevail as for radiography with lower voltage X-ray units. Several schematic diagrams illustrating the technique of placing the film, casting, and the tube are shown in Figs. 3 and 4. Photographs of actual set-ups in the laboratory (Figs. 5 and 6) may serve to further illustrate this radiographic technic.

Million volt radiography of uniform thickness specimens of welds presents little difficulty up to thicknesses of six inches of steel. However, in radiographing specimens such as irregular castings in which the thickness difference may have a range from one to six inches, it must be remembered that with million volt X-rays the same problem of shielding is evident as is encountered in the radiography of different thickness ranges with lower voltage X-rays. The term shielding applies to the procedure of preventing X-radiation from striking film areas located under considerably thinner sections than those under examination. Highly effective shielding material for million volt radiography is found to be very fine lead shot, which may be conveniently placed at the desired area in loosely filled canvas bags.

Some reproductions of X-ray negatives obtained with million volt X-rays are exhibited in Figs. 7 and 8. It would be impossible to show the many variations of radiographic possibilities with million volt X-rays and therefore only two of the most drastic extremes are presented. Fig. 7 represents a section of a steel casting four inches thick and shows an area of excessive shrinkage. Not only is the increased penetration of such high voltage X-rays valuable in extending the thickness range of materials to be inspected, but it also becomes a

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- Windings are made of either Nichrome or Advance wire, depending upon the resistance of the card to be wound.
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- The wiper, incorporating five contacts, is made of plated bronze, carefully buffed where electrical contact is made with the winding.
- Types 261, 276, 281, 292 and 296 incorporate an "edge" type wiper for closer tolerances.
- The shaft may be either bakelite, cold rolled steel suitably plated, or solid brass, depending on whether the instrument is to have a live or dead shaft.
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most versatile instrument for radiography of composite complex mechanisms such as shown in Fig. 8. This radiograph illustrates the almost uniform penetration of every individual part within the entire mechanism.

Attention should be called to the fact that a multitude of materials make up this control mechanism, such as steel, aluminum, fiber, and bronze. The tremendous latitude of range is further demonstrated by comparison of the bronze valve body at the lower right of the illustration and the relatively small diameter copper wire leading into the apparatus at the lower left side.

The difficulty of viewing the normally denser X-ray negatives produced by million volt X-rays must be compensated by a higher intensity of the viewing equipment. For this purpose high intensity illuminators are available which make use of high power photo-flood lamps, permitting transmission through film densities of D=2 and higher.

It has been mentioned that the useful kilovoltage range of the million volt unit extends from 800 to 1000 KVP. Although there is a 200 KVP difference, very little gain can be demonstrated concerning the contrast availability at the lower kilovoltage. This lack of a possible higher contrast at the lower range of the unit can be attributed to the very slight difference in minimum wavelength. Rough estimates of the minimum wavelength are expressed by:

$$\lambda \text{ min} = \frac{12.34}{\text{kv}}$$

and graphically this curve assumes the shape shown in Fig. 9. It is

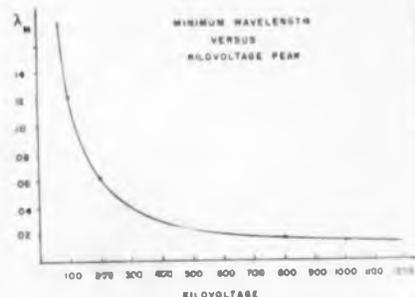
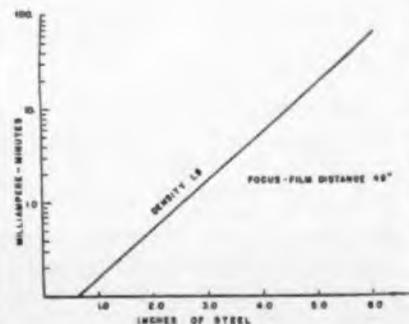


Fig. 9—Kilovoltage versus minimum wavelength

Fig. 11—Million volt exposure chart



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...and its power to see begins with Nickel

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Even with a fine optical microscope which can see objects as small as 1/84,000 of an inch long and magnify them 2,000 times, you could only make out the feathers as a fringed edge along the wing.

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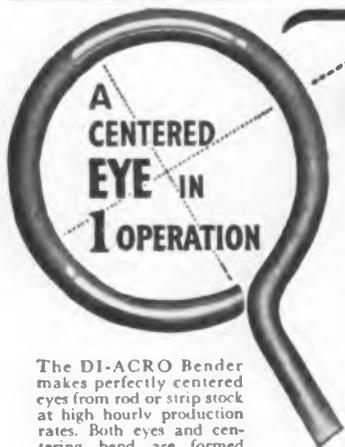
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seen that in the range of 800 to 1000 kv only a slight decrease of this minimum wavelength occurs. Practical proof of this phenomenon is illustrated in Fig. 10 where a composite casting consisting of aluminum, bronze, and steel has been exposed with 800 kv and 1000 kv X-rays. No sensational difference is observed in the contrast range of the two negatives. The absence of any contrast change can be directly explained by the relatively small change in absorption coefficients of materials for the voltages in question. This latter feature of million volt X-ray generators makes for a highly desirable operation at the single kilovoltage of 1000 KVP.

Exposure factors

Illustrated is a typical exposure chart (Fig. 11) for such a unit. All exposures are carried out at 1000 KVP and the only variable to be controlled by the technician is the term "Milliampere-Minutes" (product of milliamperes and time). Since there appears to be an optimum shortest focus-film distance which must be determined previous to the routine operation of this type of unit, this distance will appear on the exposure chart as a fixed quantity and is shown as being 48 in. Occasionally it may be desired to change this distance of the target to film and any such

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If your present limited quantity needs can be filled by any of our Standard Model Microphones, with or without minor modifications, please contact your nearest Electro-Voice distributor.

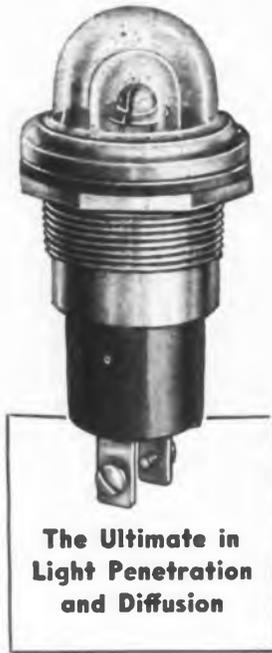
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$$\text{Intensity varies as } \frac{1}{(\text{distance})^2}$$

Summary

Equipment for Million Volt X-Radiography has been described and compared with lower voltage X-ray generators. It was demonstrated that except for a reduced subject contrast due to a change in absorption coefficients with lower wavelengths, the technic of Million Volt Radiography does not differ greatly from lower voltage radiography. The principal advantage of the application of supervoltage X-radiation for nondestructive inspection is the extension of thickness ranges of materials under test with greatly reduced exposure times.

PRECISION LEVELING

(Continued from page 93)

Changes of .5 per cent in any arm of the bridge will cause an error of about .0002 in. in reading, but this is easily corrected, due to the method of calibrating. It has been found that the bridge circuit components do not change by as much as this, so that recalibration is seldom necessary.

It might be well to point out that it is important to avoid any direct coupling between the null-detector circuit and any part of the oscillator or bridge circuit except through the sensitivity control, as any voltage so encountered would have to be counteracted by a phase-opposing voltage obtained by unbalancing the bridge, the amount of unbalance depending on the sensitivity setting. Since the detector must respond accurately to a voltage roughly one-thousandth that of the oscillator, a difference in level of 60 db, it will be seen that very good isolation is needed, considering that all circuits are contained in a box five by six by ten inches in size.

One difficulty encountered in operating the level was that of the mercury splashing up and sticking to the capacity plate, and of oxidizing on the surface, thus changing or destroying the calibration. This was overcome by adding a very thin film of oil to the surface of the mercury. It is essential to keep the thickness of this film exactly the same for both pools when adjusting two surfaces to the same plane, not because the weight of the oil changes the level of the mercury, but because the dielectric constant of the oil is over twice that of air, and the capacity increases faster due to this than it decreases due to the change in mercury level.

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faces being leveled, then a difference in oil level is not serious, since all surface levels are being referred to a common level, through a common medium. This is probably the most accurate way to use this system. The oil films are made substantially the same by carefully measuring the quantity of oil applied to the identical pools. It is impractical to completely fill the gap with oil, since it would then be difficult to control the weight of the oil, thus disturbing the mercury level.

To obtain these accuracies over distances greater than about 15 ft., it is necessary to correct for the effect of curvature of the Earth's surface. At a distance of about 40 ft. (such a distance as is encountered between the center of an eighty foot tool dock and each corner) the error becomes approximately .001 in. This error varies as the square of the distance, being only about .0001 in. at 14 ft., and therefore is negligible in a 25-ft. dock.

The installation of the 25-ft. dock was completed several months ago and the same company is at present installing a 60-ft. dock in another California airplane factory and another dock, 80 ft. by 15 ft. wide, in Texas. Even larger ones are anticipated, with the job of leveling which loomed large and difficult at first now being almost the easiest job of all.

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AIRBORNE RADIO

(Continued from page 79)

with the plane's vibrations has brought mountains of UR's and requests for new antennas.

In high altitude, intense cold flying, many crews have had the experience of seeing a radio equipment turn into unintentional armament. Electrolytic condensers, now little used, had a way of exploding violently under certain conditions.

Carefully canned or potted assemblies are still found to be susceptible to destructive breathing effects under rapid changes of pressure or temperature. Moisture condensation and blowing or spreading out of the potting compound (particularly if it contained imprisoned air bubbles) result in Unsatisfactory Reports.

Arc-over in plugs, jacks, and other parts of high voltage equipment has in the main been anticipated by design engineering, but the problems reinstate themselves as new motors, superchargers, and other aircraft improvements push the fighting ceiling ever higher. Since the upper limit is still in the blue, designs of future equipment will call for near-vacuum operation, or the equipment will have to be pressurized and sealed.

With the accent going from Europe to the South Pacific, tropicalization has assumed the proportions of a major industry problem. Little radio or other electronic equipment will operate satisfactorily after it has "grown a beard" or become choked up with any of the many types of molds. UR's from tropical theatres have resulted in endless study of these problems. Some fungicides will resist one type of mold only to feed another. UR's told the story that selenium rectifiers shipped to war theaters in the same cartons with equipment protected with a mercuric-fungicide no longer rectified!

Another essential service performed by the Unsatisfactory Reports is to decide tactical and installation questions. Very often, same communications and other sets are installed in single-seater fighters as in radioman-equipped bombers. A fighter pilot is chosen for his flying, not radio operating propensities, and his electronic equipment really has to be of the push-button genre. The ex-ham bomber radio operator has, relatively, plenty of time to load up and tune his transmitter to resonance with whatever antenna he is able to use, but the fighter pilot has no leisure for such niceties. The more automatic the equipment, the greater the tactical use to which it will be put. Apparatus carried in the plane and not used because "it's too much trouble" might much better not have been built.

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S.A. MARKETS

(Continued from page 96)

The five republics of Central America, Guatemala, Honduras, El Salvador, Nicaragua, and Costa Rica, have a combined population of about 8,000,000, and a foreign trade volume in 1941 of about \$116,000,000.

These countries are air-minded and their location on the direct route from Mexico to South America will prove beneficial. The Pan American Highway, also, will bring their markets closer for the interchange of products and services.

Population and radio figures for each of these five countries are:

	Population	Radio
Guatemala	3,410,000	40,000*
Honduras	1,154,000	12,000
Salvador	1,860,000	10,000
Nicaragua	1,013,000	6,000*
Costa Rica	670,000	25,000

It is interesting to note, in these five markets, the varying ratio between population and radio receivers in use in each country.

*Statistics from different sources are difficult to reconcile. The author's figures compare thus with data compiled by the North American Philips Co.:

Country	Author	Philips
Mexico	650,000	450,000
Brazil	1,000,000	750,000
Guatemala	40,000	20,000
Nicaragua	6,000	2,500

†A later survey, conducted for Readers Digest, puts number of radio sets in use in Brazil at 2,590,000 in 1940.



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RADIO RADAR TELEVISION SET ENGINEER for specialized export organization. Must be capable of analyzing sets to establish bill of materials, know sources of supply, suggest circuit modifications when necessary, etc. Knowledge of a foreign language, especially Spanish, extremely helpful. Experience with a set designing laboratory or manufacturer necessary. State fully experience, age, etc. Enclose non-returnable recent photo. Box A-9.

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POSTWAR RECEIVERS

(Continued from page 97)

which concern any modulation system:

- Signal to noise ratio
- Drift
- Image rejection
- IF rejection
- Noise suppression
- Sound power output
- Band width
- Basic sensitivity
- Non-linear distortion
- Ease of tuning

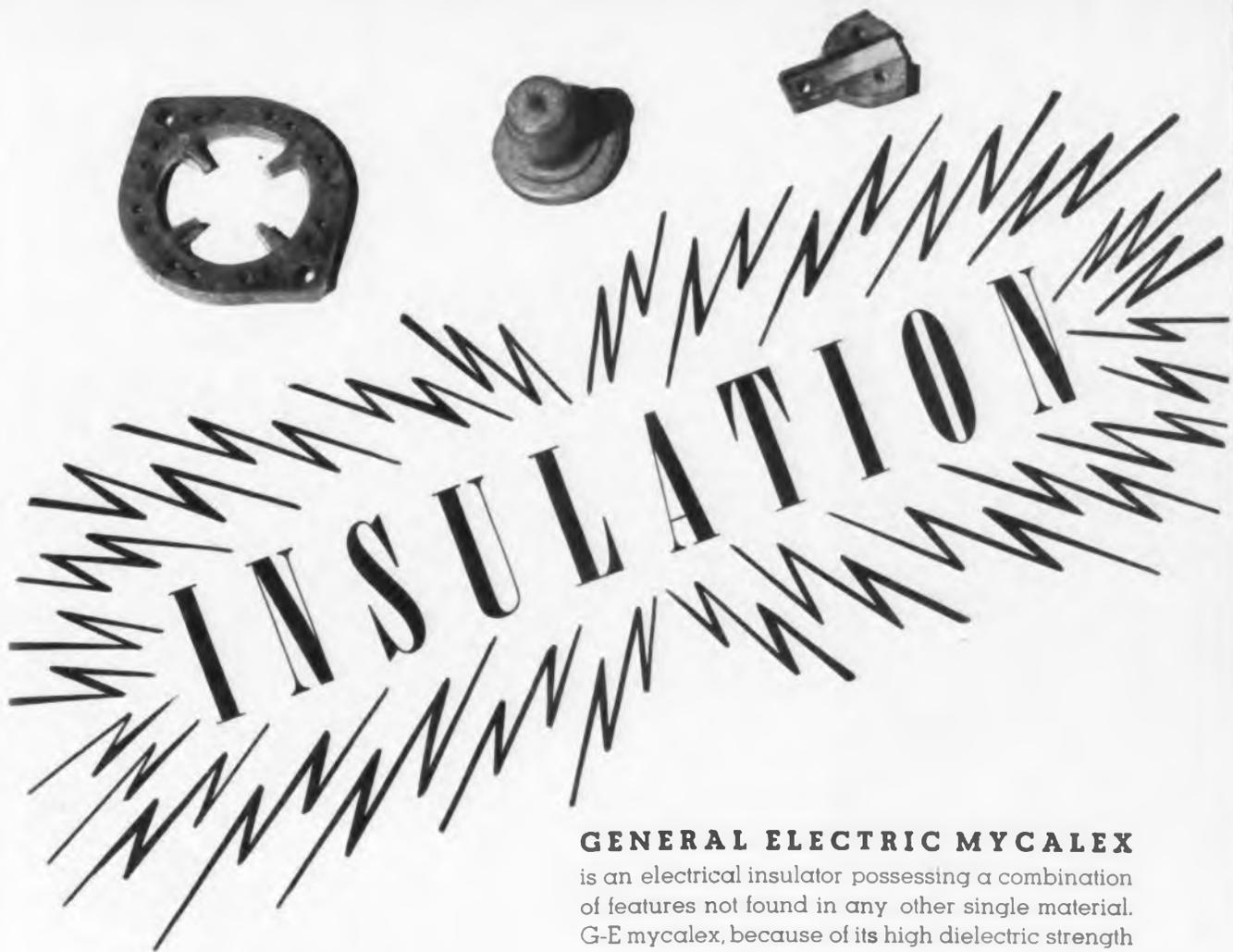
On the other side of this picture, it happens that some sets may prove satisfactory in locations in noisy but high field strength locations, whereas others would serve best in quieter districts with a lower signal level. While there might be an ideal FM receiver that would work anywhere, it would be expensive and contain features that would never prove their worth in particular locations.

It is extremely important that the plan should not consider the ways and means of accomplishing these matters, or the system of circuits used. These matters are solely up to the designing engineers and their ingenuity.

Here it is well to avoid any discussions as to whether it is the trees or the bushes that make the forest. By FM the public refers to a new broadcast service having reputed advantages, and requiring receivers operable in the "FM band." Whether or not the advantages of this service are due to modulation principles or to features having to do with that part of the spectrum, makes little difference as far as the public's buying habits and the income to be derived by the industry are concerned if such service is honestly delivered.

Fundamental tests

The most important part of the test is to ascertain whether the demodulating method insures that FM reception is handled better than a certain passing level. It may, upon analysis of all factors, prove sufficient to ascertain whether the set does or does not meet the fundamental tests as to whether it is an FM receiver, leaving out all the technical factors of an engineering nature. This would simplify checking and would permit the submission of sealed receivers, should some manufacturer be hesitant to submit details of a forthcoming line to an outside board of review, before he is ready for public submission. If a dozen radio receiver manufacturers (or even less) would subscribe to some such system it can be assumed that some authoritative group would undertake to set up the process of carrying it out. — R.R.B.



GENERAL ELECTRIC MYCALEX

is an electrical insulator possessing a combination of features not found in any other single material. G-E mycalex, because of its high dielectric strength and low power factor, is ideally suited for use as a high frequency insulator in radio equipment and for ignition assemblies in high altitude aircraft. Arcs occurring at high altitudes do not cause permanent conductive tracks.

Because intricate shapes may be molded with G-E mycalex with "molded-in inserts", because these parts are made to extremely close tolerances and because their dimensional stability is high, G-E mycalex is a superior material for assemblies which must stand up under severe operating conditions. Although G-E mycalex can be drilled, milled, and ground, these operations are seldom necessary due to the fact that parts can be molded to shape.

For further information write section O-252, One Plastics Ave., Pittsfield, Mass.

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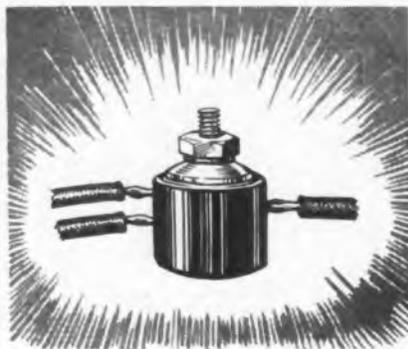
216

SLIDE RULE

(Continued from page 109)

direct leakage across and through the insulating supports and in-phase currents resulting from dielectric losses in the insulation. Conductance is thus a critical function of the insulating material of the line and of any external condition, tending to alter the dielectric properties of this insulation (corona, ionization included). For all but a few materials such as quartz, polystyrene, and gases, etc., the shunt conductance increases with frequency going through one or more maxima and may become very large in the UHF region. Where power factor of the line is specified rather than conductance, it may be readily converted to dissipation factor ($\tan \delta$) and the slide rule used to convert this to conductance.

Shunt Capacitance (C) is the direct capacitance between conductors plus any earth or shield capacitance linking both conductors. Thus, besides configuration, the most important factor affecting shunt capacitance is the dielectric constant of the insulating material between conductors. The dielectric constant may have any value between 1 and 6 (for some solid insulating materials) and in general decreases somewhat with increase of frequency.



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Quicker diffusion and more uniform distribution of heat in these anodes prevent hot spots that cause warping and shrinkage of the anode material . . . minimize possibilities of strains, cracks and electrolysis . . . keep associated tube parts cooler . . . reduces primary and secondary emissivity from grids and supports . . . greatly lessen possibility of tube damage from severe overloads . . . permit successful operation at higher frequencies . . .

Because of their greater heat dissipating value, SPEER Graphite Anodes make possible greater uniformity in tube manufacture and performance.

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- Increase allowable plate power dissipation.
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- Allow wide latitude of anode design.

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KEEPS MOTOR SPEED CONSTANT WITH VARYING LOAD

Once the operator selects a speed, the Weltronic Motor Control automatically maintains the motor speed with electronic precision. Both rapidly changing and wide-range loads are instantly compensated for, as though anticipated by the control, providing vastly closer speed regulation than is possible with either AC or DC conventional drives.

Operating any standard DC shunt motor at rated horsepower from AC lines, speeds from a few rpm to approximately twice basic motor speed may be obtained by the adjustment of a single stepless dial—and that speed held constant.

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Ask for Bulletin No. WTM-44

Weltronic

COMPANY

DETROIT 19, MICH.

CAA Modernizing UHF Aviation Ranges

The original aural uhf aviation ranges, established in 1940 by the Civil Aeronautics Administration on the experimental airway between New York and Chicago, are being modernized with the new CAA visual-aural equipment, reports Thomas B. Bourne, Director of Federal Airways.

Chief pilots of the commercial airlines in cooperation with the Army and Navy and the CAA have conducted experimental flight tests of the localizer established by the Bureau Airways in New England to determine the efficiency of the localizer unit of the instrument-landing system. The results of these flights may determine the type of instrument-landing system to be employed throughout the entire United States.

The postwar plan of establishing the instrument-landing system to extend its facilities to the itinerant, small operator and private pilot has been under discussion as the cost of the installation of the receivers is prohibitive to the pilot operating a single small plane. In connection with this postwar plan, Mr. Bourne stated that in determining the type of air moving facilities to be employed in the future, the itinerant pilot must be considered and he should be permitted to use a single cheap receiver for his navigation. It would then appear that employment of the radio range system, be it intermediate or ultra-high-frequency, is the answer to the overall problem as far as air navigation is concerned.

Although instrument - landing systems, using the radio-electronic "localizer", are at present being installed for military use only, general application to civilian operation is awaiting the end of the war. This improvement for the Federal Airways, as announced by the CAA, is slated to be installed in all the busier airports of the country and the equipment is being manufactured by eight or ten communications manufacturing companies.

Under this improved system, the pilot establishes direction toward the airport on a "runway localizer" beam at a predetermined altitude some distance beyond an outer marker. This predetermined altitude is maintained until a "glide path" is intercepted. Radio electronic equipment for the "glide path" portion of the system is now being developed and is expected to be available by the time the civilian systems are installed, according to CAA.

Explaining the improved system, CAA officials point out that with the present system of electronic

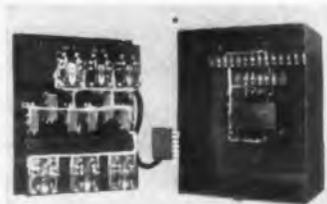


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Write for Bulletin No. WTT-44

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By lighting dark areas and danger points, eliminating reflected glare, reducing eye-strain and fatigue, Dazor Floating Lamps help to check accidents at the source.



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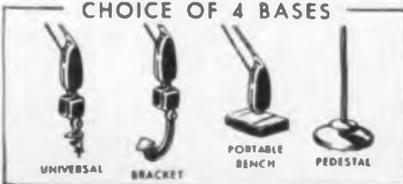
Dazor Floating Lamps deliver productive, economical light. Option of fluorescent or incandescent lamps and 4 base types provides a correct fit for each installation.

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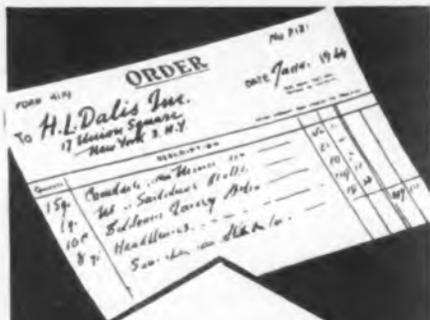
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modulation, it is possible to adjust a station completely in a matter of a few hours, as compared with several days with the previous systems. This, in turn, facilitates maintenance, which also makes the entire system correspondingly more reliable.

To insure the maximum reliability of the instrument-landing system as a whole, every portion of it is now completely monitored and controlled by an operator in the control room, CAA experts stated.

All the equipment involved has in turn been designed to be stable under a range of ambient conditions much wider than will be encountered in actual practice to assure adequate working facilities under normal conditions. Simple horizontal aircraft antennas are used to receive horizontal polarized signals from the localizer, as horizontally polarized waves rather than vertical have been adopted.

Spy-Electrons, and California's Cyclotron

• The perfection of the cyclotron, or "atom smasher," by Dr. E. O. Lawrence and his associates of the University of California at Berkeley, made possible the production of radioactive materials in sufficient strength and quantity for experimental use. Subsequent development of detection instruments made the new tool complete, and the discovery of artificial radioactivity by the Curie-Jolietts in 1934 marked the beginning of a new era in physiological research methods.

Radioactive isotopes of all known elements can be produced now. In chemical, physical or biochemical systems these isotopes behave exactly like the stable element. They do, however, disintegrate, emitting subatomic particles whose intensity can be measured with an electrometer or a discharge counter of the Geiger-Mueller type. Because the radioactive isotope is indistinguishable chemically from its stable partner but detectable electrically, it provides the first satisfactory method for tracing the travels of nutrients and poisons in the normal living organism and has been especially helpful in the field of physiology.

Short "half-lives"

Like all research methods, this apparent master-key to the secrets of metabolism has limitations. The radioactive isotope is characterized by a half-life, the time taken for half the atoms present to disintegrate. Although there are over 350 radioactive isotopes, many have half-lives too short for any but the briefest experiment, or they emit subatomic particles at rates too small to measure. Unfortunately, those include carbon, hydrogen,

oxygen and nitrogen, the elements most concerned in biochemical reactions.

For instance, there are two radioactive isotopes of carbon, one with a half-life of 20.5 minutes and the other about one thousand years. The former is too short-lived, and the latter too weakly radioactive. There is hope, however, that more sensitive detecting devices may be developed for the satisfactory use of the longer-lived radioactive isotopes, such as the thousand-year carbon. In the meantime an alternative, although less simple, method is available for carbon, as well as hydrogen, nitrogen and oxygen. Most of the elements have several stable isotopes, differing from each other only in the weight of their atoms and distinguishable from one another by a mass spectrometer. For example, ordinary nitrogen is a mixture of two isotopes having atomic weights of 14.0 and 15.0. By special separation processes the normal ratio of abundance of the two isotopes can be altered, and organic compounds prepared from the "heavy nitrogen" are available.

This research method, expected to confirm or revolutionize many physiological theories, has already made some interesting revelations. One of the most striking is the re-

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*Our index gives the complete listing—yours for the asking if you are in N. E.

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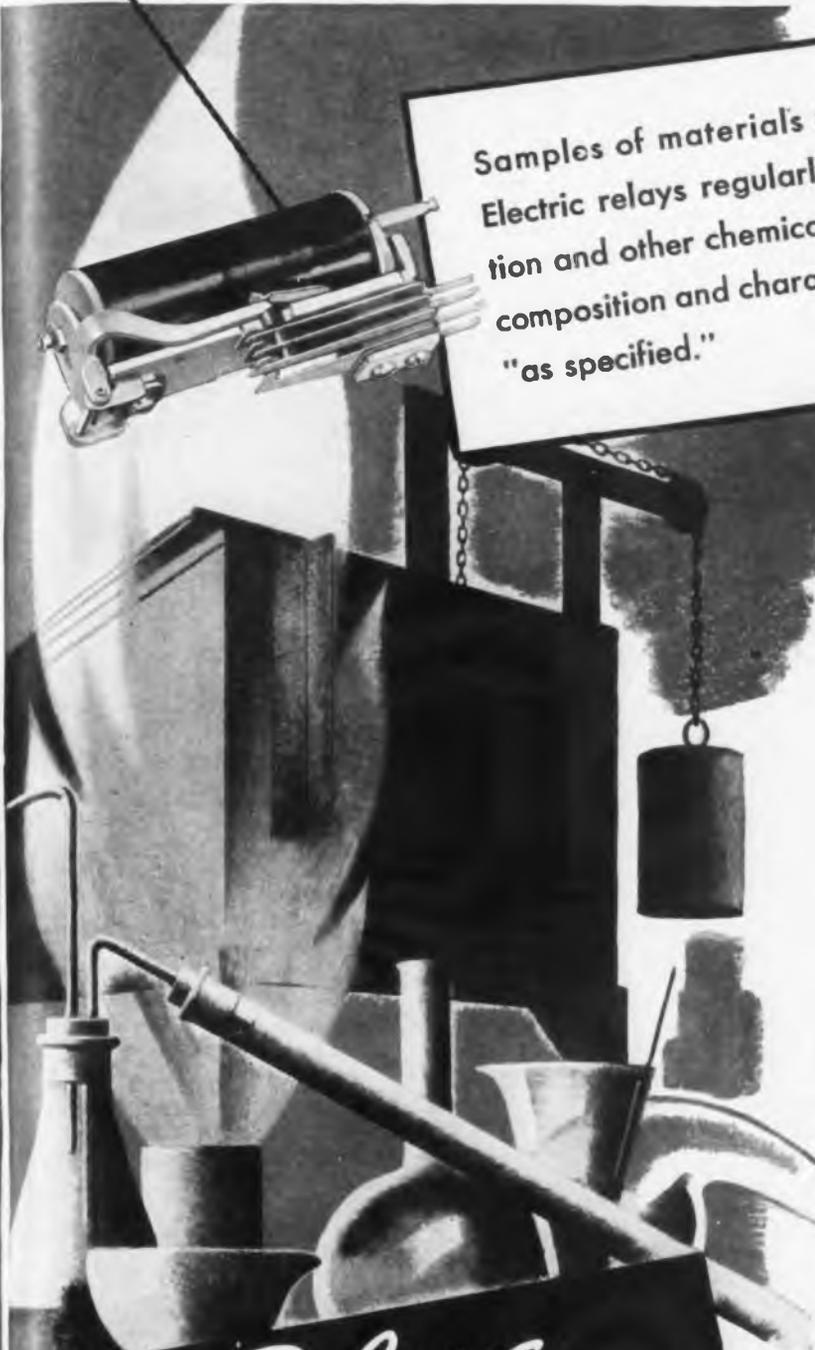
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It may seem a simple matter—this job of selecting the right materials for making relays; but—

Automatic Electric designers know better. They know that correct design is only the beginning—that materials must also meet exacting standards, or performance will suffer. That is why they insist that quality control must begin in the laboratory.

When you need relays, call in the Automatic Electric field engineer. He can show you how quality pays, in longer life, better performance. In the meantime, for a preview of the Automatic Electric line, write for Catalog 4071.

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Most recent of fungus resisting materials, and one of the first of the baking types is DOLPH'S SYNTHITE PG-4-FC Clear Baking Varnish. This grade is excellent for use in vacuum impregnation of transformer and stator coils as well as armatures.

Through the use of our modern laboratory facilities, we are in a position to treat some of your newly designed electrical units which require varnish insulation. Upon completion of this experimental work, a report will be issued covering the treatment cycles followed and recommendations made accordingly. Of course this service is offered without any obligation on your part.

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lately rapid rate at which complex reactions occur in the body. Using radioactive iron, the course of iron in normal and in anemic animals has been studied exhaustively, disclosing new information on iron metabolism. In normal health the body clings to its iron, absorbing and excreting very little. In an anemic state, however, it absorbs iron rapidly. In such cases the iron is absorbed more completely from the gastrointestinal tract, transported to the blood-producing centers and there quickly made into hemoglobin. New hemoglobin, containing radioactive iron, is detectable in the blood of anemic dogs only four hours after administration.

Much has been learned of the functions of healthy and diseased thyroid glands through the use of radioactive iodine. Both are found to take up iodine from the blood stream within a few minutes after administration. However, uptake is much greater in the case of an enlarged gland. In both, the fractional uptake of iodine increases as the dose size diminishes. In humans with toxic goiter, the thyroid gland will absorb practically the entire dose if of one milligram or less.

The applications of tagged atoms to biological and medical research are limitless. With radioactive sulfur the rate of vitamin B₁ utilization and excretion in the human body has been studied. Radioactive carbon has been used to follow carbohydrate metabolism. More recently, radioactive iodine has made possible a study of insulin absorption in so-called insulin-resistant diabetics.

In the field of plant physiology the radioactive tracing method is throwing new light on the complexities of the process of photosynthesis, which has been puzzling scientists ever since Aristotle's day. It has already been used to determine absorption rates and distribution of nutrients within the plant. Further experiments using radioactive elements have helped clarify the complex passage of mineral solutions through the absorbing and conducting tissues of plants.—*Industrial Bulletin of A. D. Little & Co., Massachusetts Institute of Technology, Cambridge, Mass.*

LETTER TO THE EDITOR

Editor, Electronic Industries:

In discussing the trend of probable postwar developments in electronics, I feel that the following thoughts might be of interest and believe it to be worthwhile to discuss the questions, especially those of the postwar patent situation, in some sort of an open forum.

I am starting with the following assumptions:

- (a) That a relatively great number of Companies and individuals are trying at present, or will try in the future, to develop electronic devices.
- (b) In connection with the war effort Government and private research organizations are at present working in the same field without disclosing their results.
- (c) Inventors in Allied and Neutral countries are covering the same field.
- (d) Our enemies do the same.

Thus the work of the four groups can be subdivided in "U.S.A." and "outside U.S.A." activities.

The inventor in U.S.A. belonging in group (a) finds himself at a loss to know:

- (1) What the other people have covered by pending patents (and in most cases he has neither the time nor the money to thoroughly investigate the prior art and the extent and strength of issued patents).
- (2) What has been done in those secret laboratories.

He will, therefore, when the war is over, either:

- (1) Go ahead regardless of patents and dissolve his Company overnight when the first infringement suits are filed against him (repeating the early experience of the Radio Industry).
- (2) Or be over-cautious and not dare to move until some test cases are somebody else's expense, are cleared.
- (3) Or he may find that all his development work is in vain because some of the "hush-hush" developments have matured into patents, although their publication was delayed for security reasons.

It is to be expected that there will be such a chaotic jungle of patent rights that most of the budgets for development will go into patent research and infringement suits instead of into product development work.

All this could perhaps be waved aside as belonging in the "just too bad" class if we were alone in the world.

It seems to me that in the concern about the rights of the individual inventor one forgets his duties towards the community to which he belongs.

Race for supremacy

As this community is in a technological race for supremacy with the non-community members the measures taken to protect the individual inventor actually retard his own and his community's advancement due to the competition on the outside. These outside competitors can develop those inventions and circuits published by him and pick the best out of a group of patents and developments to round out their own solutions.

As a result, our enemies, for instance, were in a position (subsidized by their Government) to



History of Communications. Number Eight of a Series

EARLY RAILROAD COMMUNICATIONS BY TELEGRAPH

Communication by telegraph was probably one of the first of the electronic arts which met with commercial success in America. Of constant interest to every boy in a small town, the telegrapher down at the depot was a hero — a man of great science. With the advent of faster locomotives, telegraphy was a speedy method of traffic control.

Today, and for the postwar period, the picture will include electronic voice communications for the streamlined trains which travel one hundred miles per hour. There must be a more flexible control via electronics, plus the added possibility of passenger luxury in radio telephones. Universal stands ready as an electronic manufacturer to serve in the era of applied electronics.

< Model 1700-UB, illustrated at left, is but one of several military type microphones now available to priority users through local radio jobbers.

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pick up the best solution of research anywhere in the world and to develop their combinations further.

This led, in many cases, to new inventions which for the small investment of \$30 they were able to patent and thereby stymie the technological developments of our Country.

In spite of the above, I am not arguing against patents in general and the answer is not a change of law restricting foreign inventors especially "enemy patentees" as we never can predict who will be our "enemies" in a possible future conflict, but a program which will, like in war time, make an exchange of patents in the industry possible even after the war is over.

Such a program must go beyond the making of individual license agreements which at best is time consuming and expensive.

I understand that the radio and automobile industry have found a partial or practical solution for this problem in patent pooling.

Protect patent interests

It seems to me that in the interest of all, a free discussion of this, I believe vital question, should be started at the earliest possible time, to avoid the danger of our developments in these important fields falling behind that of the outsiders and the danger that the benefits already possible for our industry should be delayed by the fear of and the actual interference of individual patent interests.

We should not forget the alibi of Hitler who claimed that his U-boat campaign was frustrated by one single Allied invention. Even if his claim is exaggerated it shows dramatically the potential of a well-timed development and as such important technological developments are not only emergency products but usually based on extended peacetime developments we must be sure that freedom for such developments is guaranteed in the interest of the community.

H. Ziebolz, Vice-President

Askania Regulator Co., Chicago.

Two-Way Radio for Cabs

America's first two-way taxicab radio system will be installed in Cleveland by the Yellow and Zone Cab Companies as soon as possible after the war, provided approval can be obtained from the FCC.

The proposal is being worked out by General Electric's Electronics Department and Cab Research Bureau Inc.

In addition to improved service, D. L. Chesnut, G. E. commercial engineer, reports that radio-equipped cabs would be very useful in emergencies growing out of fire, crime, accidents, etc.

"The taxicab industry in each major city," said Mr. Chesnut, "might draw up an agreement with that city permitting the police department to commandeer its radio cars and its headquarters station at any time that a major public disturbance should warrant."

Immediate contact

In a report to Jesse Smith, president of Yellow, Arthur B. McBride, head of Zone, and Daniel Sherby, treasurer of both companies, Mr. Chesnut said the radio system would make it possible to:

- (1) Establish contact with any cab instantly at any place in the city.
- (2) Eliminate all present unattended call boxes, with their direct line connection to cab headquarters.
- (3) Reduce "dead" mileage and thus conserve gasoline, rubber, and extend the life of the taxicab itself.

Present plans call for one main transmitter for the downtown area and two others to cover the rest of Greater Cleveland. Each transmitter would have four channels, with 100 cabs assigned to each channel.

Grinder Time-Control



Helping to make this grinder more automatic at General Electric's Lynn (Mass.) River Works is a small electronic time-delay relay (arrow) which times the period for grinding concentric bores in electric motor stators. One of many installed on grinding machines in this plant, the timer is preset so that after a certain period, depending on the amount to be ground and the size of the grinding wheel, it automatically stops the grinding operation.



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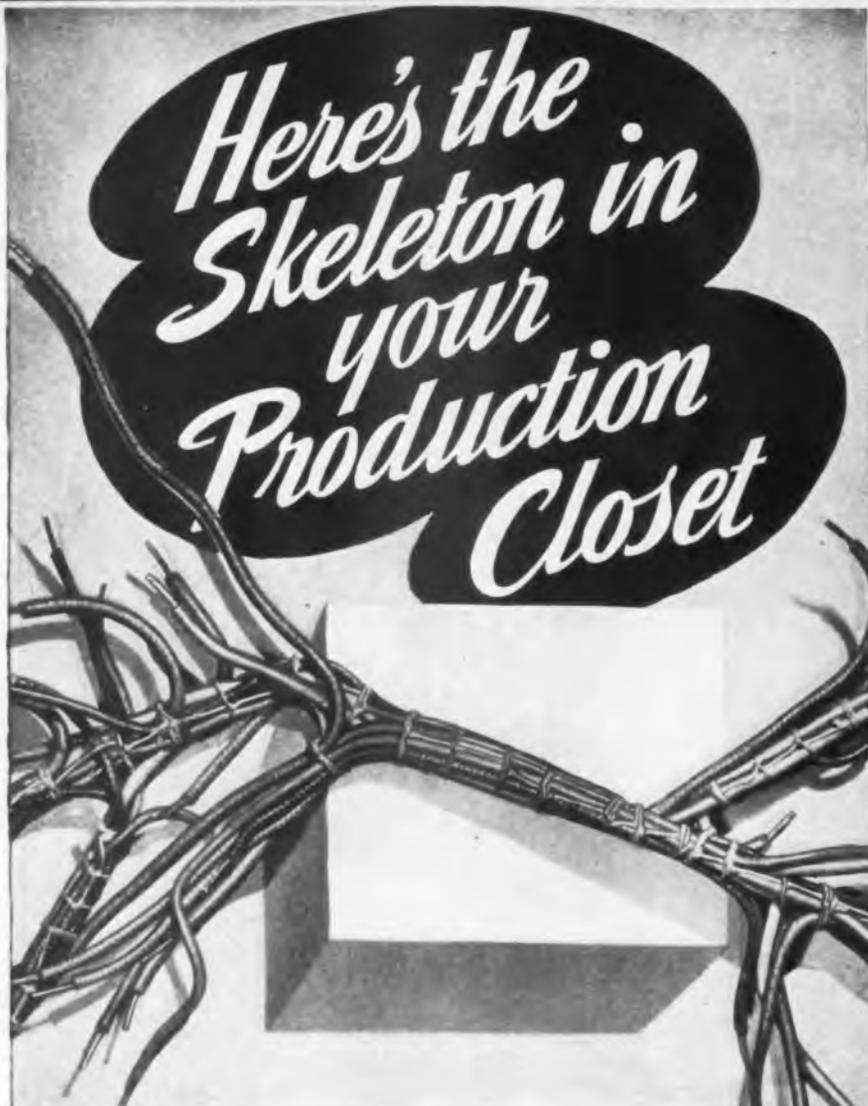
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FCC Considers Radio For the Railroads

Exploring a new field of radio communications that not only may provide another sphere of regulation but also presents a possible substantial future market for the radio-electronic manufacturing industry, the Federal Communications Commission during mid-September held almost a week's hearings in its investigation of the use of radio by railroads to increase train transportation safety and more efficient control and dispatching of railway operations.

The hearings were centered on the pros and cons of carrier induction systems, both wire and radio, and space radio with leading technical executives of a number of manufacturing companies as major witnesses in addition to railroad communications officials. The inquiry was launched as the result of requests by two leading Senators—Wheeler and Kilgore. The latter, who had conducted a two-day hearing by his War Mobilization Committee last February, emphasized at the FCC inquiry that the railroads weigh most carefully the present and postwar radio-electronic developments in their own postwar improvement programs, together with considering the usefulness of the military radio surplus equipment.

Urge uniformity

The railroad industry was urged to determine what frequency bands would be useful to it and to present such evidence for the coming FCC allocations. Probably the most important suggestion in the proceeding was that of FCC Commissioner E. K. Jett, who strongly advocated the railroads to coordinate all their communications systems to make them uniform throughout the nation and to decide upon the most efficient methods. From the aviation industry through President Rentzel of Aeronautical Radio came the thought that the railroads could well form a cooperative organization similar to his own for the coordination of communications, both in operating procedure and in equipment standardization.

Patents available

The American Telephone and Telegraph Co. and the Radio Corporation of America, the latter through Dr. C. B. Jolliffe, RCA Victor Chief Engineer, emphasized that their patents could be licensed on a standard basis to any responsible manufacturer or railroad without restrictions. Both Western Electric and RCA Victor are actively pursuing studies in railroad radio uses and are planning to en-

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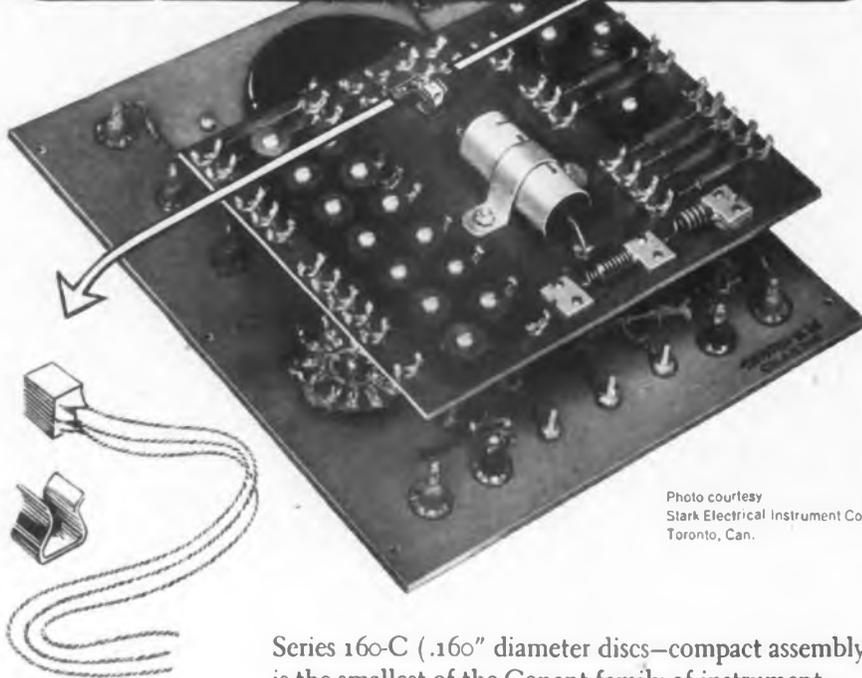


Photo courtesy
Stark Electrical Instrument Co.,
Toronto, Can.

Series 160-C (.160" diameter discs—compact assembly) is the smallest of the Conant family of instrument rectifiers. To attain the utmost in compactness these rectifiers have been stripped of all non-essential material. Not even a mounting bracket remains. (Weight—from 1.293 to 1.743 grams.) They are easily mounted, however, as illustrated above. Here the rectifier fits neatly into a midget fuse clip.

Such mounting permits the rectifier leads to extend in any direction by combining any of three positions of the rectifier in the clip with angular mounting of the clip. This greatly simplifies the job of assembly or replacement.

Complete protection from damage is provided for the rectifier assembly by the full metal case and a special moisture-proof seal.

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gage in that production field after the war. The A. T. & T. is ready to embark on furnishing radio-telephone service to moving trains, when needed.

Experiments outlined

Bendix Radio with six technical experts, headed by Vice-President and Chief Engineer, W. P. Hilliard, depicted its accomplishments in radio communications with a number of major railroads. General Electric and Westinghouse Electric & Manufacturing had engineering executives also give results of their experiments and installations in this field. Dr. Charles N. Kimball, Vice-President of Aircraft Accessories, Corporation, described the results of operating a radio carrier induction system on the 560-mile main line of the Kansas City Southern Railroad. President Robert A. Clark of the Communications Equipment and Engineering Co. viewed space radio as in the main the best medium for railroad communications, provided sufficient frequencies can be found, but felt that inductive radio was also very useful when wires were not more than 100 feet from the tracks.

Tests continuing

President William S. Halstead of the Traffic Communications Corp., who described in detail the tests by his company with a number of railroads and in government ordinance yards, declared that two-way radiotelephone using above 100 megacycles was best in terminal and yard operation and that radio carrier induction was proving a most practicable medium on railroad main lines, based on tests on the West Shore Division of the New York Central.

The Association of American Railroads through its Vice-President C. H. Buford in charge of operations and maintenance cited that the steam carriers had for some time been testing radio as a supplemental means of communications. He stated that the use of radios in tanks had demonstrated their ability to withstand shock and rough treatment so this lesson of the war was useful to the railroads.

Facsimile for records

John V. L. Hogan, President of Facsimile Inc., after relating the tests conducted by his concern with facsimile on the Rock Island Railroad, stated the progress of facsimile during the war, still in the state of being a military secret, was such that its status in 1940 can in no way be compared with postwar developments. He termed facsimile "the new record communication service."

Allocations Conferences Draw 50 Groups

More than 150 witnesses, both government and industry, are engaging during October in the planning by the FCC of the postwar allocations of the radio spectrum in hearings which started Sept. 28 and will last at least a month. The proceedings, which are all-important to the manufacturing side of the radio-electronic-radar industry for its postwar designing, production and marketing planning, are to produce the technical views of the leading experts from all phases of the communications, broadcasting and specialized radio fields with the most important basic technical evidence to come from the leadership and panel chairmen of the Radio Technical Planning Board.

Spectrum mapping

In the allocations studies, the FCC is cooperating with the State Department in mapping out the American position on the postwar radio spectrum in terms of services at the projected international tele-communications conference and is shooting for completion of the allocations plan by Dec. 1. The FCC hearings, at which the entire Commission is presiding, are being conducted by General Counsel Charles R. Denny, Jr. and Chief Engineer George P. Adair.

Broadcasters in force

Nearly half of the 50-odd groups participating in the allocations hearings were from the broadcasting industry, standard, FM, television and facsimile. The four networks, NAB, FM Broadcasters, Inc. and several regional networks are to testify. There will also be a large representation from the educational broadcasting field, together with spokesmen from projected religious and other special groups seeking FM networks. RMA, several manufacturers including Galvin, Stromberg-Carlson, Raytheon, Finch, were others who are testifying. Every important communications company—A. T. & T., RCA, Mackay Radio, Press Wireless, Western Union—is also appearing, while the aviation and police radio groups have a large list of witnesses. A number of utilities, fire and forestry services, amateurs and a large group from the medical field on diathermy and other similar radio uses were likewise listed. International broadcasting which was not given a separate band under the IRAC allocation plan is to present testimony from Walter S. Lemmon, Worldwide Broadcasting Corp. president, and from the OWI and CIAA.

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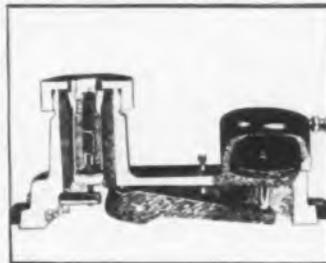
Work formerly requiring automatic or hand screw machines can now be done at much less cost through the combination of this new air chuck and any drill press. The Redmer Air Chuck is a collet air chuck using standard Brown & Sharpe type screw machine collets. The collet remains stationary, the opening and closing controlled by a sleeve action.

By using a collet as the chucking means, slight variations in the diameter of the work as frequently experienced with automatic and hand screw machine products can be permitted without sacrificing accuracy or concentricity. Thus accomplishing an important saving in time and cost.

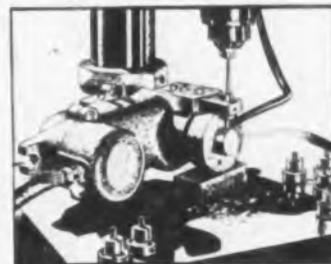
The air chuck is an ideal tool for holding parts for drilling, milling, slotting, burring, chamfering, boring, counter-boring, tapping, threading, reaming and other work where the machine operation should be concentric with the chucking surface. It is adaptable to many different jobs merely by changing collet and stop. This results in saving of valuable production metals and materials. The chuck will take any type work whether round, hex, square or rectangular, and permits full efficiency of the operator, as it is operated by a foot operated valve thus leaving hands free to load and unload—reducing fatigue and cutting unproductive time to a minimum.

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MILESTONES TOWARD THE ELECTRONIC ERA

How Benjamin Franklin Defined the Electron in 1749

by **ROBERT A. MILLIKAN**

Ph.D., Sc.D., LL.D.*

California Institute of Technology

No one can read Franklin's letters to Peter Collinson without being amazed by the fact that Franklin—without any previous training whatever in either the technic or the history of physics, and with almost no contact with what others were doing or had done—within two years of the time of his first experiment had acquired a keener insight into the fundamental nature of electrical phenomena, not merely than anyone had acquired up to his time, but even than any of his successors acquired for the next hundred and fifty years, when, about 1900, the scientific world returned essentially to Franklin's views.

The first letter, dated March 28, 1747, reads:

*"To Peter Collinson, Esq; F. R. S. London
Philadelphia, March 28, 1747*

"Sir,

"Your kind present of an electric tube, with directions for using it, has put several of us on making electrical experiments, in which we have observed some particular phaenomena that we look upon to be new. I shall therefore communicate them to you in my next, though possibly they may not be new to you, as among the numbers daily employed in those experiments on your side the water, 'tis probable some one or other has hit on the same observations. For my own part, I never was before engaged in any study that so totally engrossed my attention and my time as this has lately done; for what with making experiments when I can be alone, and repeating them to my Friends and Acquaintance, who, from the novelty of the thing, come continually in crowds to see them. I have, during some months past, had little leisure for any thing else.

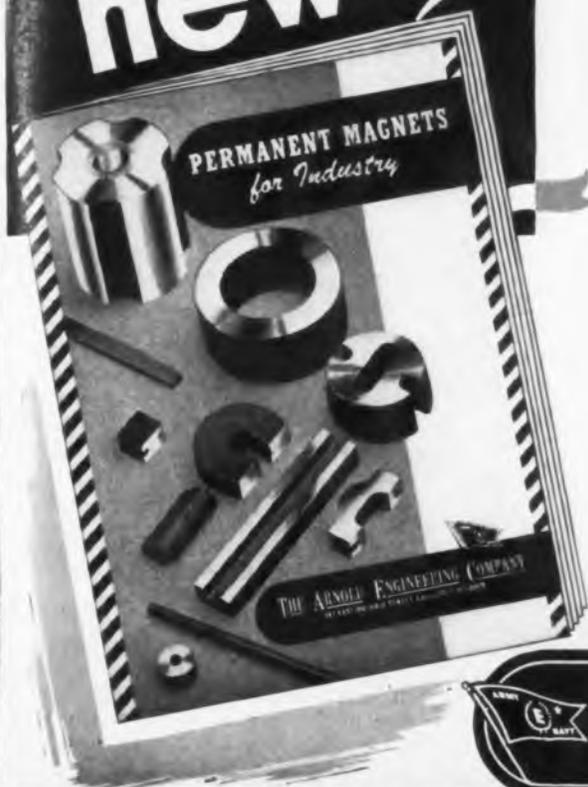
"I am, etc.,

"B. Franklin."

Now as to some of the experiments themselves. The very first one of them, done within a few months of the time Franklin first heard of electricity, contains the key to his invention of the lightning rod. Note from the following how skillfully and strikingly he arranges his electrostatic experiments by making the length of the suspension of the cork ball very long. After two hundred years of the development of electrostatics these experiments cannot be made more tellingly today than by setting them up and performing them ex-

*From an address before the Franklin Institute, Philadelphia.

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WRITE FOR BULLETIN No. 430

actly as Franklin directed, nearly two hundred years ago.

Discharge points

He writes, "The first is the wonderful effect of pointed bodies, both in drawing off and throwing off the electrical fire. For example,

"Place an iron shot of three or four inches diameter on the mouth of a clean, dry glass bottle. By a fine silken thread from the ceiling, right over the mouth of the bottle, suspend a small cork-ball, about the bigness of a marble; the thread of such a length, as that the cork-ball may rest against the side of the shot. Electrify the shot, and the ball will be repelled to the distance of four or five inches, more or less, according to the quantity of Electricity. . . . When in this state, if you present to the shot the point of a long, slender, sharp bodkin, at six or eight inches distance, the repellency is instantly destroyed, and the cork flies to the shot. A blunt body must be brought within an inch, and draw a spark to produce the same effect. To prove that the electrical fire is drawn off by the point, if you take the blade of the bodkin out of the wooden handle, and fix it in a stick of sealing-wax, and then present it at the distance aforesaid, or if you bring it very near, no such effect follows; but sliding one finger along the wax till you touch the blade, and the ball flies to the shot immediately."

Lesson of lightning rod

Here is where he learned that his lightning rod had to have a good ground in order to work at all. He continues:

"To show that points will throw off as well as draw off the electrical fire, lay a long sharp needle upon the shot, and you cannot electrise the shot so as to make it repel the cork-ball.

. . . Or fix a needle to the end of a suspended gun-barrel, or iron-rod, so as to point beyond it like a little bayonet; and while it remains there, the gun-barrel, or rod, cannot by applying the tube to the other end be electrised so as to give a spark, the fire continually running out silently at the point."

I can find no evidence that prior to Franklin the electrical properties of points had been discovered at all. He continues:

"The repellency between the cork-ball and the shot is likewise destroyed, (1) by sifting fine sand on it; this does it gradually; (2) by breathing on it; (3) by making a smoke about it from burning wood; (4) by candle-light even though the candle is at a foot distance; these

¹A straight three-foot glass tube as big as your wrist.

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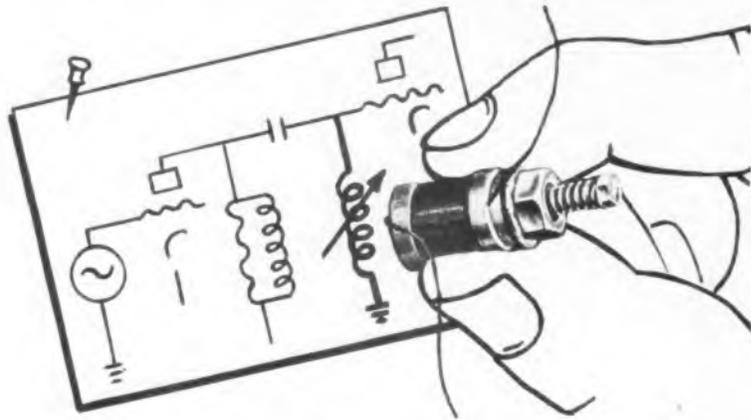


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do it suddenly. . . . The light of a bright coal from a wood fire; and the light of a red-hot iron do it likewise; but not at so great a distance.

"The light of the sun thrown strongly on both cork and shot by a looking-glass for a long time together, does not impair the repulsion in the least. This difference between firelight and sunlight is another thing that seems new and extraordinary to us." ("This different Effect probably did not arise from any difference in the light, but rather from the particles separated from the candle, being first attracted and then repelled, carrying off the electric matter with them.")

The insight shown in the three lines, in the parenthesis, above in which he correctly makes particle carriers (ions, we now call them) from the match do the discharging while sunlight produces no ions and therefore does not discharge, is unbelievably penetrating for a date two hundred years back, though the conception of neutral particles being first attracted and then repelled is of course definitely wrong.

Fundamental reasoning

The next experiment, with its interpretation, is probably the most fundamental thing ever done in the field of electricity. Get it exactly in Franklin's words:

"1. A person standing on wax, and rubbing the tube, and another person on wax drawing the fire, they will both of them (provided they do not stand so as to touch one another) appear to be electrified, to a person standing on the floor; that is, he will receive a spark on approaching each of them with his knuckle.

"2. But if the persons on wax touch one another during the exciting of the tube, neither of them will appear to be electrified.

"3. If they touch one another after exciting the tube, and drawing the fire as aforesaid, there will be a stronger spark between them than was between either of them and the person on the floor.

"4. After such strong spark, neither of them discover any electricity.

"These appearances we attempt to account for thus: We suppose, as aforesaid, that electrical fire is a common element (we now call 'electrical fire' electrons), of which every one of the three persons abovementioned has his equal share, before any operation is begun with the tube. A, who stands on wax and rubs the tube, collects the electrical fire from himself into the glass, and his communication with the common stock being cut off by the wax, his body is not again

THERE IS AN
ELEMENT OF SUPERIORITY
in the

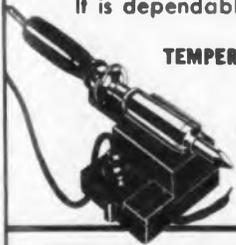
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Immediately supply'd. B (who stands on wax likewise), passing his knuckle along near the tube, receives the fire which was collected by the glass from A; and his communication with the common stock being likewise cut off, he retains the additional quantity received. . . . To C, standing on the floor, both appear to be electrised: for he, having only the middle quantity of electrical fire, receives a spark upon approaching B, who has an over quantity; but gives one to A, who has an under quantity.

"Plus" and "Minus"

"If A and B approach to touch each other, the spark is stronger, because the difference between them is greater: After such touch there is no spark between either of them and C, because the electrical fire in all is reduced to the original equality. If they touch while electrising the equality is never destroy'd, the fire only circulating. Hence have arisen some new terms among us: we say B (and bodies like circumstanced) is electrised positively; A, negatively. Or rather, B is electrised plus; A, minus. And we daily in our experiments electrise bodies plus or minus, as we think proper.—To electrise plus or minus, no more needs to be known than this, that the parts of the tube or sphere that are rubbed, do, in the instant of the friction, attract the electrical fire, and therefore take it from the thing rubbing; the same parts immediately, as the friction upon them ceases, are disposed to give the fire they have received, to anybody that has less."

Prophetic insight

Without doubt the most profound paragraphs in all of Franklin's letters are the following, written in 1749:

- "1. The electrical matter consists of particles extremely subtle, since it can permeate common matter, even the densest metals, with such ease and freedom as not to receive any perceptible resistance.
- "2. If anyone should doubt whether the electrical matter passes through the substance of bodies, or only over and along their surfaces, a shock from an electrified large glass jar, taken through his own body, will probably convince him.
- "3. Electrical matter differs from common matter in this, that the parts of the latter mutually attract, those of the former mutually repel each other. Hence the appearing divergency in a



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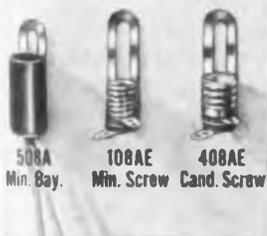


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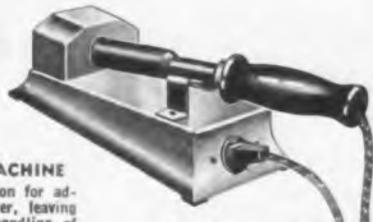


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stream of electrified effluvia.

- "4. But though the particles of electrical matter do repel each other, they are strongly attracted by all other matter.
- "5. From these three things, the extreme subtlety of the electrical matter, the mutual repulsion of its parts, and the strong attraction between them and other matter, arise this effect, that, when a quantity of electrical matter is applied to a mass of common matter, of any bigness or length, within our observation (which hath not already got its quantity) it is immediately and equally diffused through the whole.
- "6. Thus common matter is a kind of sponge to the electrical fluid. And as a sponge would receive no water if the parts of water were not smaller than the pores of the sponge; and even then but slowly, if there were not a mutual attraction between those parts and the parts of the sponge; and would still imbibe it faster, if the mutual attraction among the parts of the water did not impede, some force being required to separate them; and fastest, if, instead of attraction, there were a mutual repulsion among those parts, which would act in conjunction with the attraction of the sponge. So is the case between the electrical and common matter.
- "7. But in common matter there is (generally) as much of the electrical as it will contain within its substance. If more is added, it lies without upon the surface, and forms what we call an electrical atmosphere; and then the body is said to be electrified."

"One-fluid" or electron theory

In these paragraphs Franklin states with great succinctness what later became known as the Franklin one-fluid theory, and after 1900 was known as the electron theory. In his day, and for 150 years thereafter, it received very scant consideration in the old world, and the so-called two-fluid theory of Aepinus, put forward a little later, was universally taught in text books the world over up to the triumph of the electron theory in 1897 under the active leadership of J. J. Thomson, who himself pointed out that this electron theory was in essential particulars a return to the theory put forth by Franklin in 1749.

For Franklin's electrical matter consisted of extremely subtle mobile particles (now called negative electrons), which in order to make matter exhibit its common or neutral properties had to be present in each kind of matter (we now say in each kind of atom; but the

atomic theory had not been formulated in 1749) in a particular number, an increase in which number made it exhibit electrification of one sign, a decrease in electrification of the opposite sign. In Franklin's theory only one kind of electrical matter was mobile; the other sign of electrification appeared when the mobile kind was removed so that it could no longer neutralize the effect of the opposite kind which inhered in the immobile part of matter (i.e., in the nucleus).

End to two-fluid fantasy

The Franklin theory was mathematically identical with the two-fluid theory, but while the former was a definite and profound physical theory the latter was a hold-over from mediaeval mysticism. It came from the age of the so-called "imponderables"—an imponderable or weightless heat theory, the caloric—and the imponderable electric fluids. Such vague, tenuous, contradictory ideas were ill at home in the highly realistic, practical mind of Franklin. They were justified, like Faraday's lines of magnetic force, as analytical conveniences but not as physical realities. Franklin introduced a definite physical theory which rendered unnecessary such fantastic conceptions as two weightless and hence non-existent fluids introduced for purely ad hoc purposes, and then told to destroy each other, also for ad hoc purposes.

Modernizing Television

Much has been written and more said about the dire peril to the befuddled American public concerning the effect of changing "standards" of television picture transmission. John Q. had been told not to buy a television set 'til the year 2000 since "new developments just around the corner" would instantly make his set a worthless piece of junk.

A television receiver of the present type is an instrument of many parts; twenty some odd tubes, many coils, capacitors and resistors. These parts, the same that are in any radio, can be interconnected to produce a television set, a door opener, a hearing aid or any other electronic device. A change in standards cannot make obsolete these parts. A change may require a change in their arrangement or the substitution of others of different values; however let's look at the record.

About the time television looked as if it might get going commercially, recommendations were made to change standards to allow for future development. The changes ultimately sanctioned consisted of a picture standard of 525 lines and the use of frequency modulation

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While every precaution is taken to insure accuracy, we cannot guarantee against the possibility of an occasional change or omission in the preparation of this index.

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In place of amplitude modulation for the sound which accompanies the picture. How did these new standards affect the more than 5000 television sets then in use? Many set owners were not aware that a change had taken place.

Minor conversion expense

When the time is correct for increasing the number of picture lines to 800 or 1000 to make way for greater picture clarity it will probably be only necessary to change the value of two capacitors and four or five resistors. Even with a very great change in the number of picture lines and consequently the bandwidth, the necessary new parts would be made available at a very nominal cost. The cost to the set owner of such a conversion would be under \$10.

Civilian-Radio Sales to Total Billion Annually

"The radio industry and trade is now getting ready to produce and sell a billion dollars of civilian-radio products every 12 months, two to three months after Germany falls," declares Dr. Orestes H. Caldwell, former Federal Radio Commissioner, now editor of "Electronic Industries," who for many years has compiled the statistics of the radio industry. Dr. Caldwell's estimates, based upon studies made by his editorial associates on the magazines, "Radio and Television Retailing" and "Electronic Industries", follow:

	Value
16 million radio sets.....	\$ 733,000,000
60 million replacement tubes....	65,000,000
Repair parts	90,000,000
Batteries for 3 million portable radios	12,000,000
Phonograph records, 200,000,000	100,000,000
Total radio merchandise....	\$1,000,000,000

The figures assume that no substantial number of television sets will be distributed during the first sales. Within a few years, how-twelve months of civilian radio ever, annual television volume may be expected to duplicate in dollar volume that of radio sets—selling say one-sixth to one-quarter as many television units at prices averaging six to four times those of present radio sets.

Lear Plans Home Radio-Television

Following a three-day conference of executives early last month in Chicago, Lear, Inc., has let it be known that in addition to aviation equipment and some new industrial components, the company also will produce home radio and television receivers. An invitation pre-view showing is being readied.

We Don't Believe in Flag Waving!



RADIART has not publicized its outstanding contribution to the War Effort. All leading radio parts manufacturers were required to expand their effort for the Armed Forces. Recently it was necessary to open RADIART Plant #3 to further increase our production.

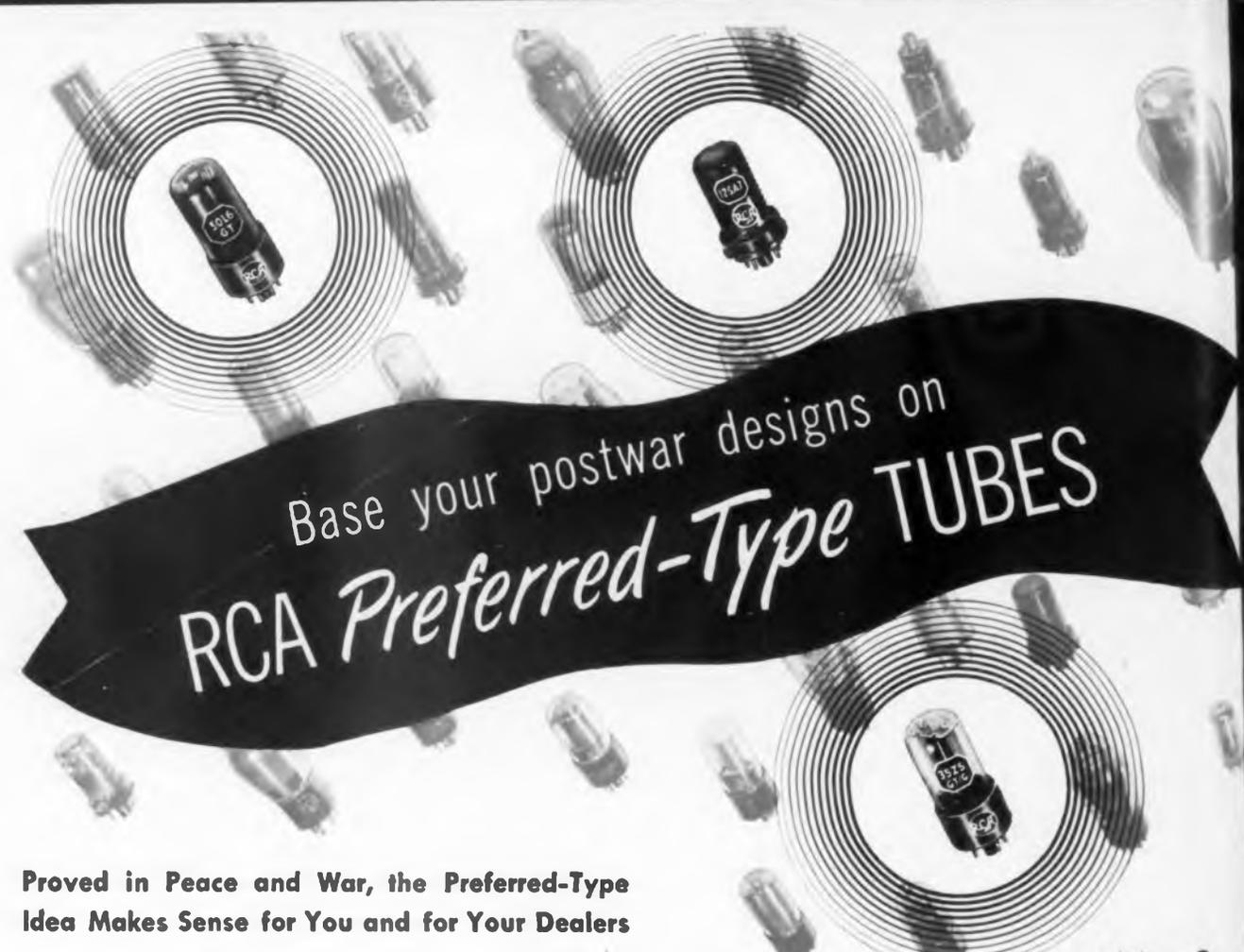
RADIART Quality has always been supreme . . . and it is being improved by exceptional engineering.

RADIART, through long range foresight, is today leading civilian Vibrator replacement production within WPB limitations! When peace comes RADIART Quality and Service will continue to make RADIART your best source for Replacement Vibrators.

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Base your postwar designs on
RCA Preferred-Type TUBES

Proved in Peace and War, the Preferred-Type Idea Makes Sense for You and for Your Dealers

WHEN you design a set around RCA Preferred-Type Tubes, you're sure of better tube performance. You also simplify tube ordering, warehousing and stocking...for yourself and for your dealers.

For RCA's Preferred-Type Tube Program aims at concentrating a larger demand and production on *fewer tube types*. Short manufacturing runs on too many types are highly inefficient...longer runs mean greater uniformity, better tube performance, and lower cost. And concentrating on fewer types reduces the number of tube types you, your distributors and dealers have to carry in stock.

That's why, when introduced in 1940, RCA's Preferred-Type Tube Program "clicked" almost overnight.

The value of the "preferred type" idea was quickly recognized not only by radio manufacturers and dealers, but also by our Armed Forces. Months before Pearl Harbor, the Joint Army-Navy Committee on Vacuum Tubes adopted an Army-Navy Preferred List of Tubes, and military equipment was designed around these tubes almost exclusively. This forward-looking policy simplifies military tube stocks, and insures speedy replacements of high performance tubes wherever our fighting men need them.

After Victory, RCA's Preferred-Type Program will continue to mean *better tubes...simpler stocks...lower costs*. So it will pay you to base your postwar designs on RCA Preferred-Type Tubes. If you already have specific tube complements in mind and would like to know if the tubes you need will be on the preferred list after the war, let us know what they are. Write to RADIO CORPORATION OF AMERICA, Commercial Engineering Section, Dept. 62-11-1, Harrison, New Jersey.

The Magic Brain of all electronic equipment is a Tube...and the fountain-head of modern Tube development is RCA!

More Uniform Quality



Lower Cost



Simplified Stocks



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