APRIL · 1944

electronics

A McGRAW-HILL PUBLICATION

electronics

APRIL • 1944

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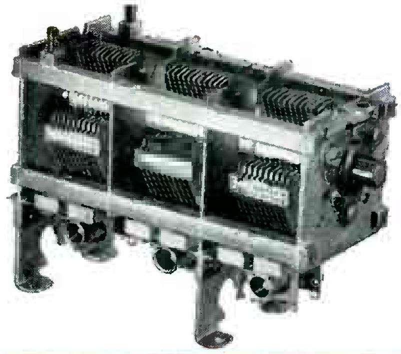

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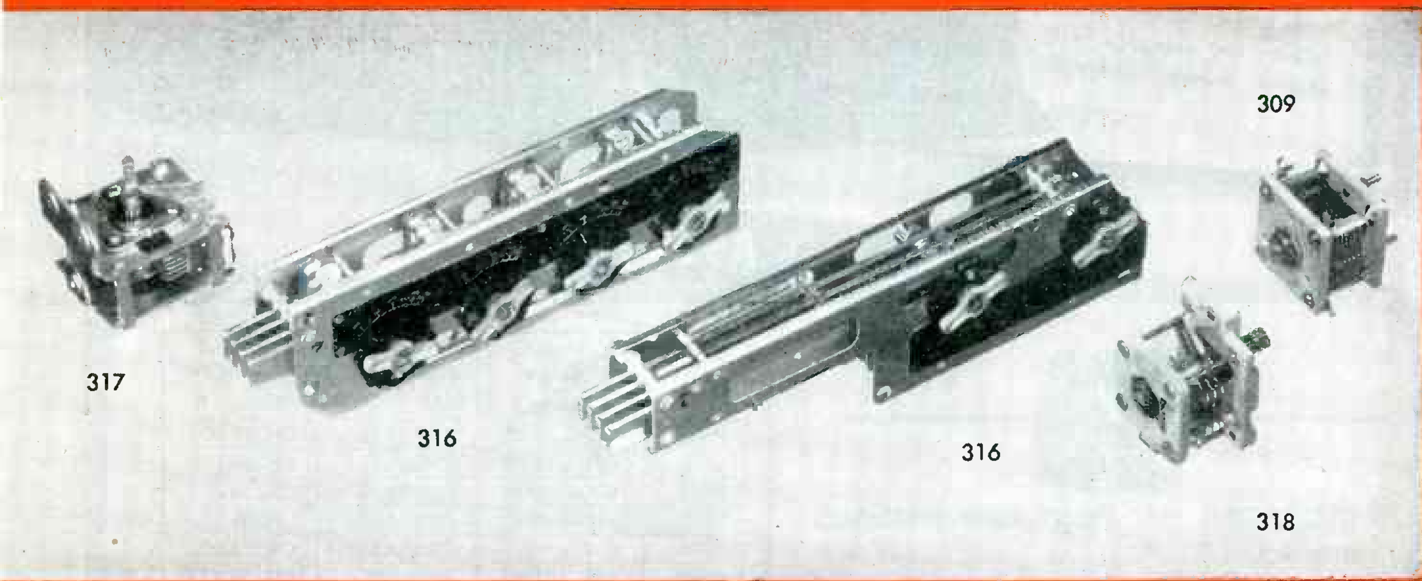

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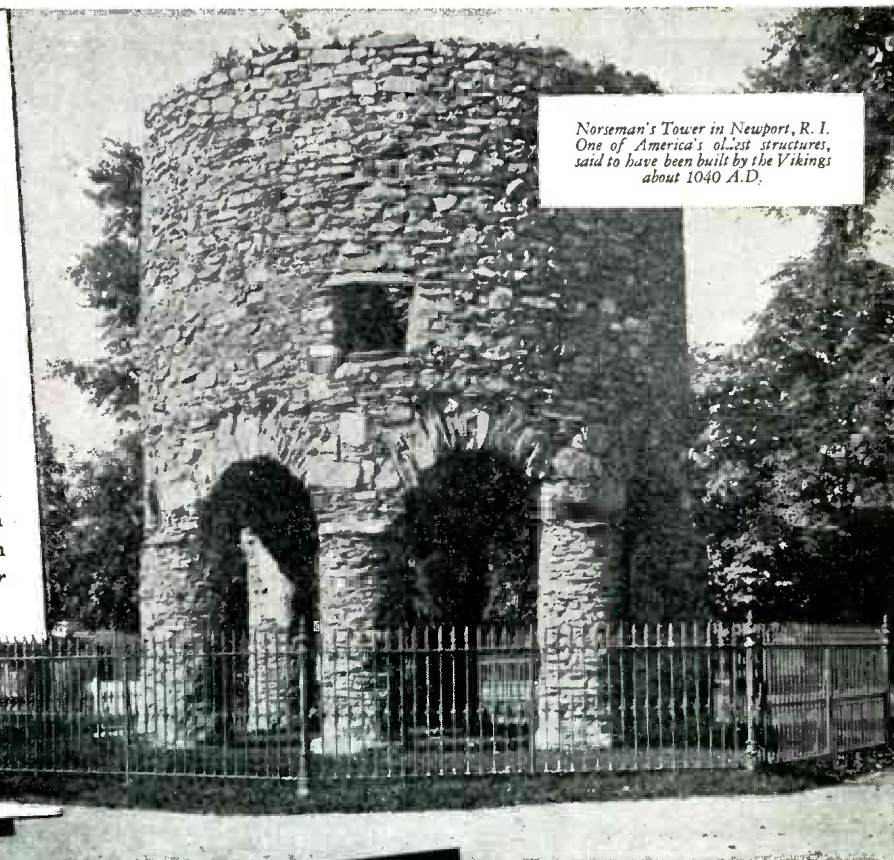

Norseman's Tower in Newport, R. I. One of America's oldest structures, said to have been built by the Vikings about 1040 A.D.

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1500	600—1500	CN35A152	CN35B152
2000	600—1500	CN35A202	CN35B202
2500	600—1250	CN35A252	CN35B252
3000	600—1000	CN35A302	CN35B302
4000	600—1000	CN35A402	CN35B402
5000	600— 800	CN35A502	CN35B502
6000	600— 800	CN35A602	CN35B602
7000	500— 700	CN35A702	CN35B702
8000	500— 700	CN35A802	CN35B802
10000	400— 600	CN35A103	CN35B103
20000	200— 300	CN35A203	CN35B203
30000	50— 150	CN35A303	CN35B303
40000	50— 100	CN35A403	CN35B403

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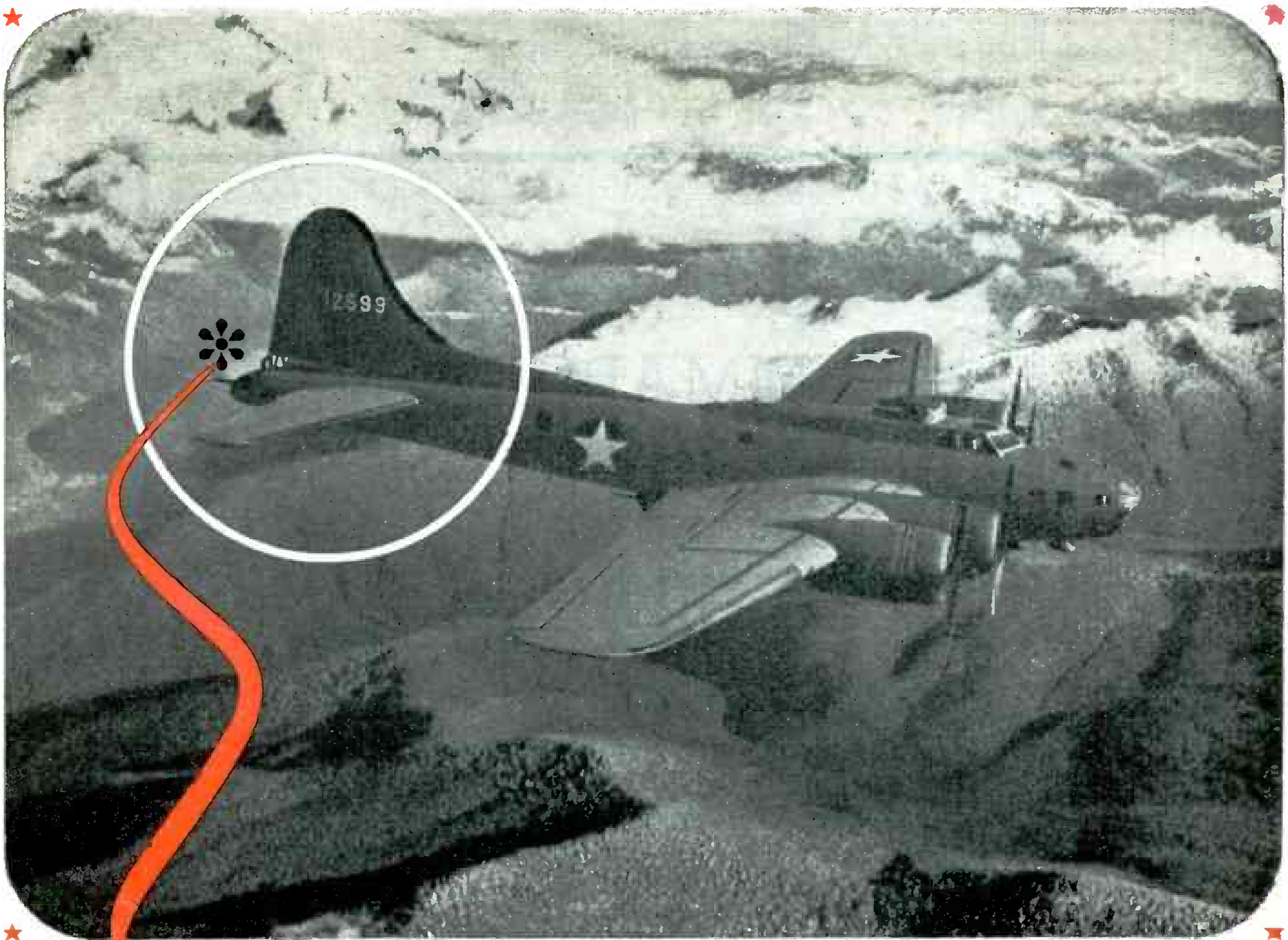
A SMALL PART IN VICTORY TODAY   A BIG PART IN INDUSTRY TOMORROW



How does a Bomber Pilot

COMMAND TONS OF PRESSURE WITH POUNDS OF EFFORT?

YOU'VE seen a heavy bomber change direction in the air—climb, bank or nose down. It looks easy, although the airstream is actually piling tons of pressure against the rudder and tail surfaces.

It even looks easy in the cabin, as you watch the pilot handle his controls. And it is easy, because a little trick called an "amplidyne"—which steps up electrical power input to the control motors about 10,000 times—is doing the work for him.

This mechanism, a development of one of the nation's largest electrical manufacturers, depends upon the special properties of an Allegheny Ludlum Electrical Steel to achieve its results. Into the steel, as it must be in the amplidyne itself, is built reliability, uniformity and stamina.

Although important, this is only one of the dozens of wartime electrical devices to which Allegheny Ludlum Electrical Alloys have lent desirable qualities of magnetism, high permeability, or high resistance. The list covers control, detection and communications equipment for all the services.

For engineers and production men desiring certified technical information on these special alloys, write for a copy of the *"Electrical Materials Blue Sheet"* or for the assistance of our Technical Staff.

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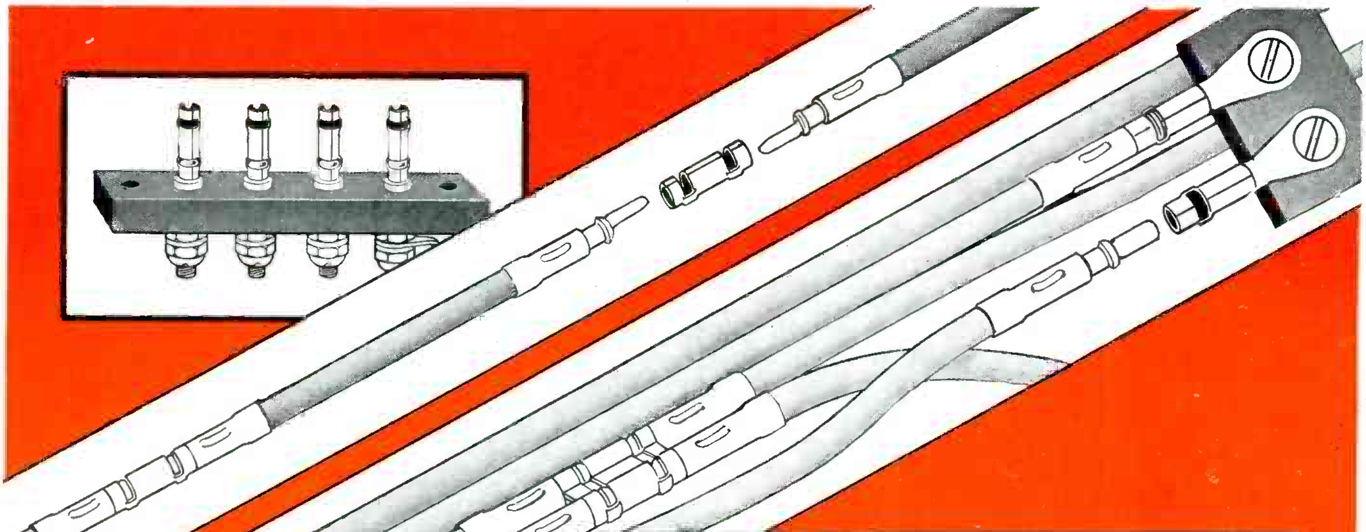
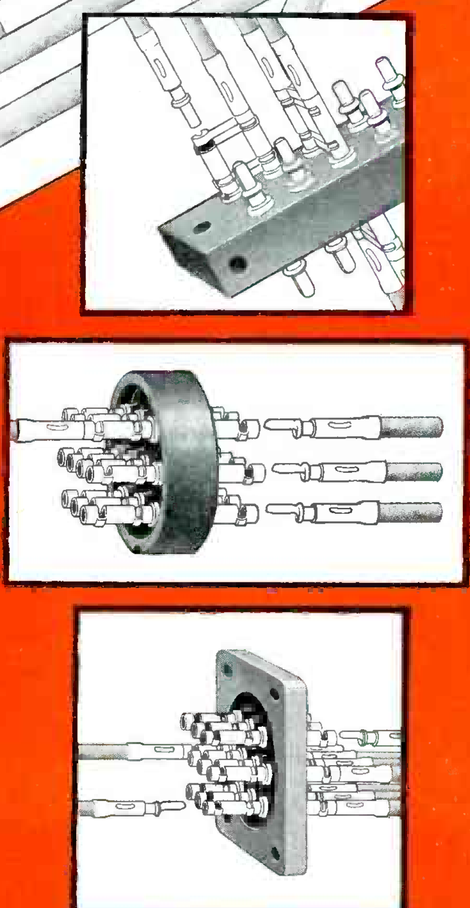




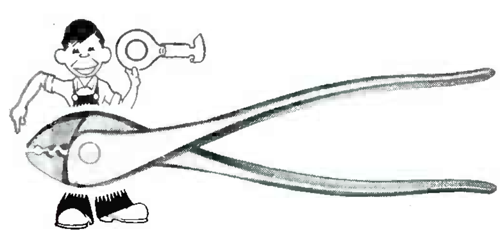
Infinite Possibilities

The T&B Sta-Kon Disconnect* *Way of Wiring* is opening up infinite new wiring possibilities for the electrical industry. It is based on new Sta-Kon fittings which connect, disconnect and re-connect wires #22 to #10 at will. As part of the Sta-Kon line, these fittings are installed with Standard Sta-Kon pressure tools in a matter of seconds. The resulting connection is electrically sound and mechanically perfect.

A few of the almost endless combinations that can be made with the essential T&B Disconnect Tip and Coupler are shown here.

Our Engineering Department is constantly working out special designs of particular combinations for electrical manufacturers. What are your requirements? We invite you to send them to us for study and workable suggestions.

*Pat. Pending



T&B Disconnects are installed with the same tools which install the familiar Sta-Kon Terminals.

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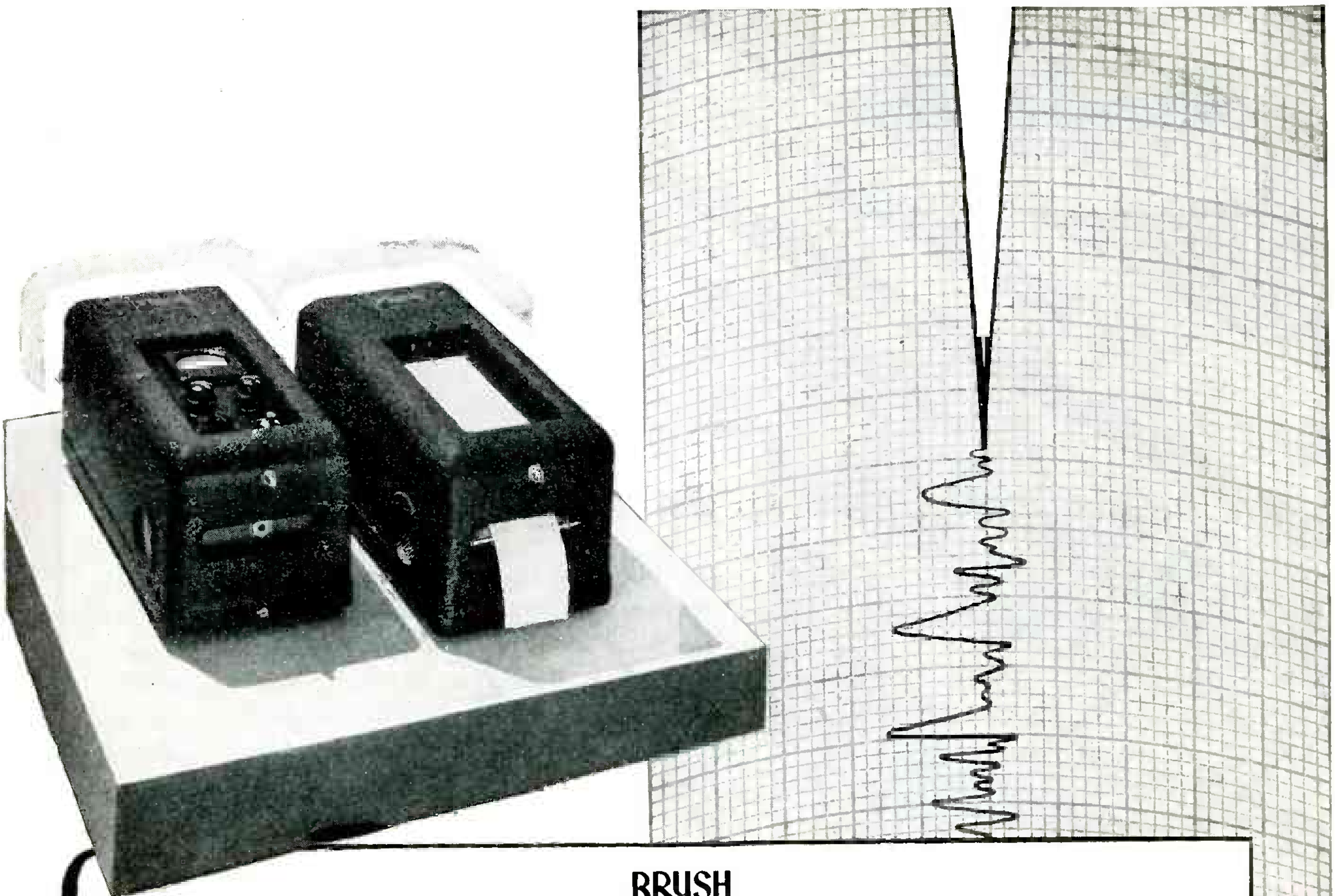

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● This instrument directly and instantaneously records mechanical or electrical fluctuations up to 120 cycles per second. With appropriate electro-mechanical pickup or direct electrical coupling, it accurately records vibrations, pressure changes, dynamic strains, time intervals, transients, and the like. In war and the peace to come you will find this Brush product doing an important job.

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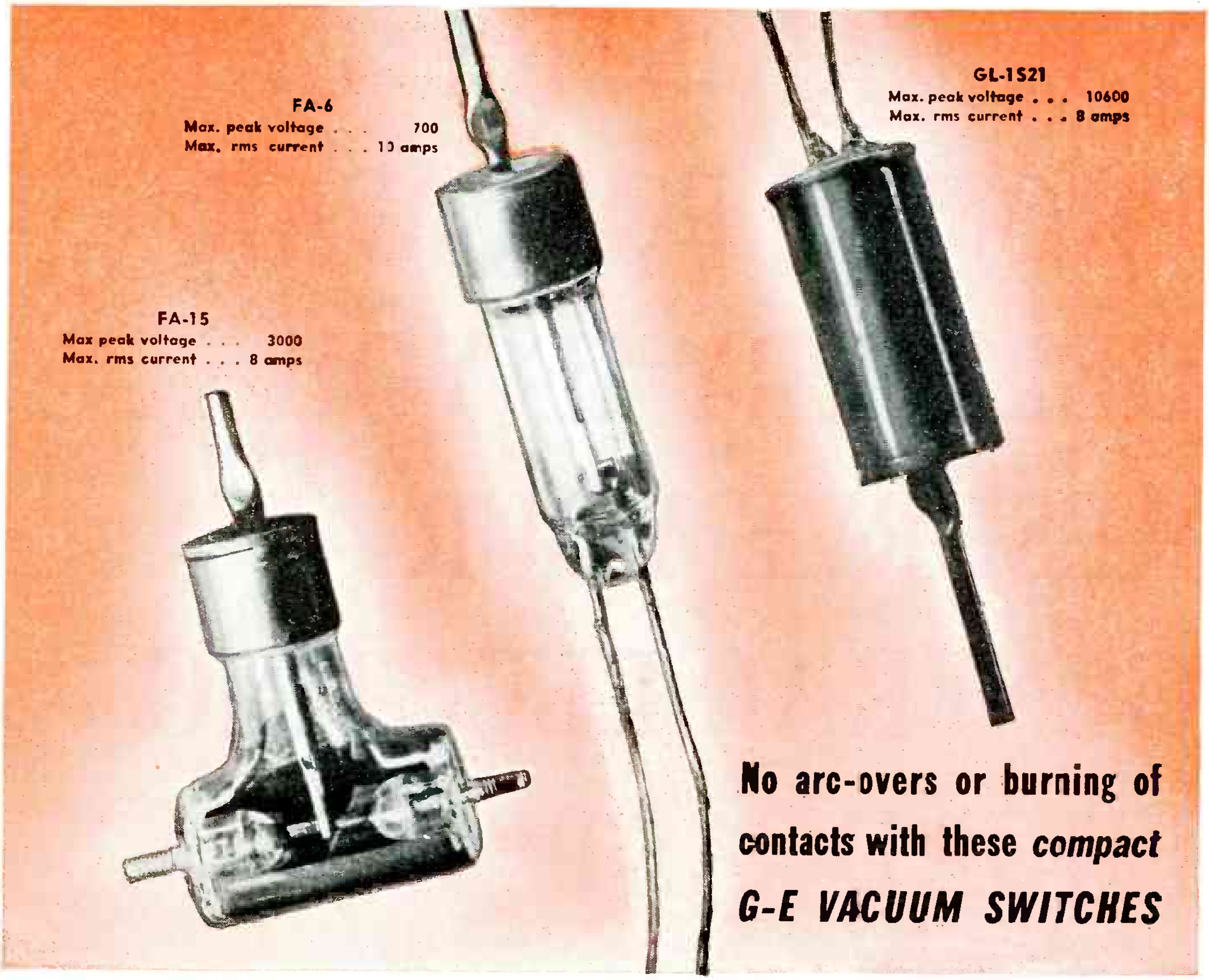


another G·E electronic FIRST!

SINCE the contacts of these G-E switches are mounted in a vacuum, they are virtually free from the effects of corrosion and arcing. They are protected against dirt, oil and water, and require no maintenance.

Vacuum-type construction means: (1) Safety that makes these switches especially applicable for installations where gaseous or dust-laden atmospheres are a fire and explosion hazard. (2) High current rating for their size. (3) The switch produces clean, vibrationless circuit-breaks at any speed — whether twelve or twelve hundred a minute. *A hundred million or more contacts* during its lifetime are not unusual when operated within proper limits. . . . These features lead the procession of advantages in this new type of switch — which G.E. was first to develop and manufacture.

Simple, compact, and easily installed in any position, G-E vacuum switches are ideal where space is at a premium (as in airplanes). No self-contained coils: no auxiliary contacts or relays required! Movement can be obtained from the mechanism to be controlled (often through a cam or thermostat), or from any other apparatus to suit the user's application. They may be operated by air or liquid bellows, rod-linkage system, or other means. Movement is transmitted to the contacts through an operating arm fulcrumed in a flexible diaphragm and requiring only a minute operating force.

Typical applications: Limit switches. Thermostatic controls. Inertia-controlled devices. Radio antenna switching. Radio transmitter tank-coil assembly switching. Stratospheric applications.

SEND FOR BULLETIN ET-1—*"G-E Vacuum Switches."* Contains additional information, and shows regularly available types and ratings. For special requirements, consult G-E electronic tube engineers. Address *Electronics Department, General Electric, Schenectady, New York.*

G-E TUBES ARE "FIRST" IN INDUSTRY, TOO! The sturdy steel-jacketed G-E sealed ignitron, for example, supplies the heavy current required for high-speed resistance welding. Ignitron rectifiers are widely used instead of rotating machinery. They are easier to maintain and lower in operating cost.

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

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

GENERAL ELECTRIC

161-C4

The General Electric

EQUIPMENT-RESERVATION PLAN

For post-war priorities on FM and AM broadcasting equipment

LARGE as is the amount of broadcast equipment already on reservation with General Electric, the tremendous war-geared G-E manufacturing facilities can produce *all* this reserved equipment for quick post-war delivery. Even twice this amount can be built within practically the same time if we know *now* what will be required and can plan for its production.

General Electric has the plant, the machines, and the skilled engineering and factory personnel, to swing into peacetime production virtually overnight. No extensive reorganization of production methods will be necessary at G.E. . . . since much of the equipment needed for commercial broadcasting is in the same basic pattern as that which today is proving its high standard under the acid tests of war.

Prompt post-war delivery is only one of the benefits you gain by reserving your G-E broadcast equipment NOW.

Your contact with us will enable you, your staff, and your consulting engineer to develop the details of your post-war station during the period before new construction is authorized. Then, you will be fully prepared to proceed with the building of your station.

General Electric can help you in any of the three broadcasting fields: FM—TELEVISION—or AM. You can benefit from exclusive G-E developments such as the FM circular antenna or the S-T relay system which permits you to establish your station for maximum coverage . . . your studio for maximum convenience. You can obtain from G-E *any* broadcast equipment, either station or studio, together with associated equipment for FM, AM, or television. No other manufacturer can offer such complete system experience and "know how."

Come to Schenectady and See for Yourself!

General Electric operates five proving-ground broadcasting stations at Schenectady — AM, International Shortwave, FM and Television. Broadcasters and prospective broadcasters are invited to inspect these facilities and discuss their problems with our station personnel.

• **WRITE for your copy of the G-E Equipment-Reservation Plan,** and application forms. *Electronics Department, General Electric, Schenectady, New York.*

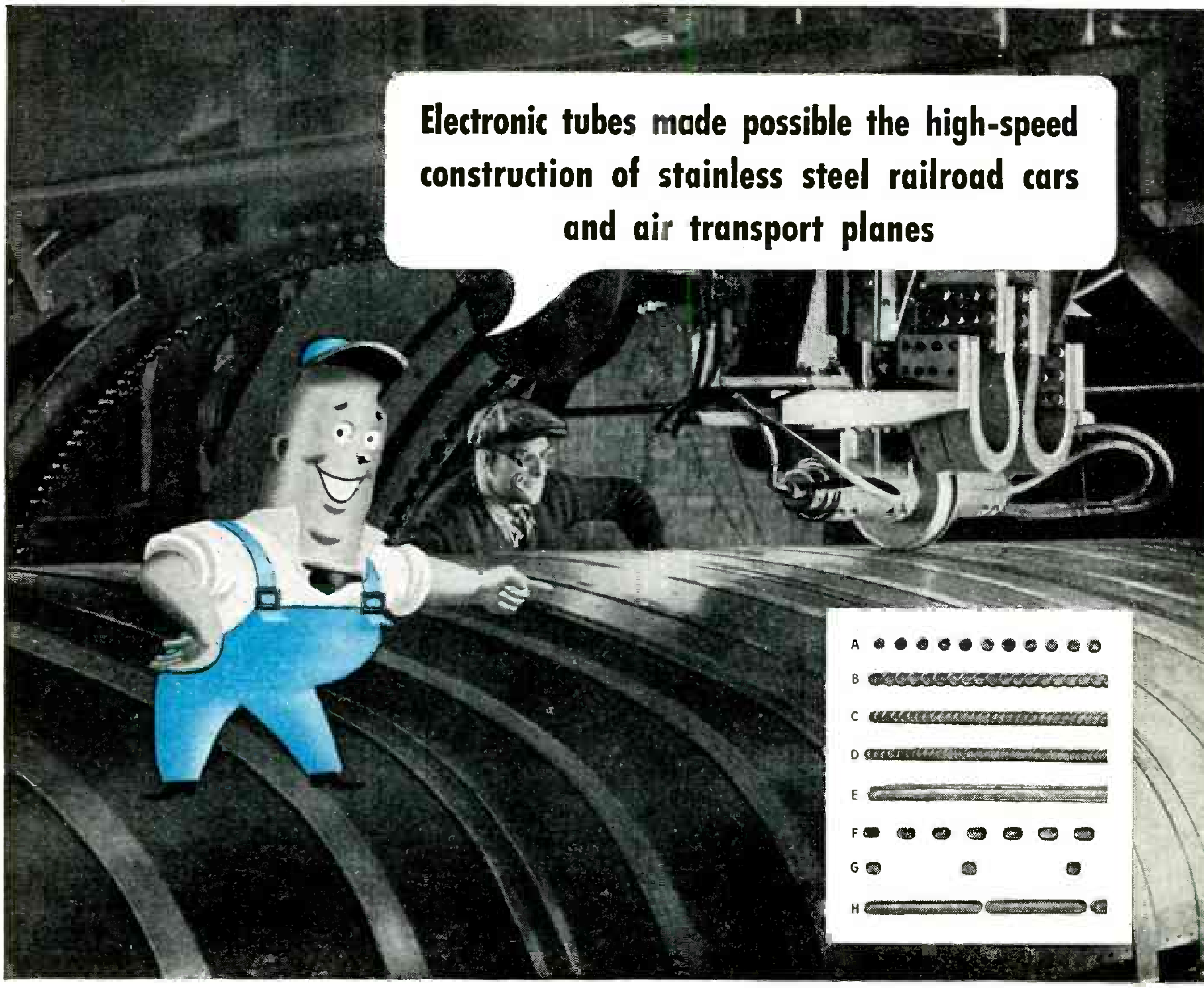
• *Tune in General Electric's* "The World Today" *and hear the news from the men who see it happen, every evening except Sunday at 6:45 E.W.T. over CBS network. On Sunday evening listen to the G-E* "All Girl Orchestra" *at 10 E.W.T. over NBC.*

ANTENNAS • ELECTRONIC TUBES • RECEIVERS

FM - Television - AM

Come to G.E. for all three!

No. 12 IN A SERIES EXPLAINING THE USES OF ELECTRONIC TUBES IN INDUSTRY



The G-E ignitron controls the power.
The G-E thyratron does the timing.

UNDER electronic control, as developed by General Electric electronic engineers, resistance welding has become a high-speed, precision operation that is making yesterday's impossible jobs a routine part of today's production.

With G-E ignitrons controlling the heavy surges of power required, and G-E thyratrons switching them on and off at lightning speed, seam welds can be spotted at any desired distances apart or brought together in an overlapping or solid line. Operations may be performed at any desired speed up to 1800 or more welds per minute — with exactly the right amount of heat applied at exactly the right spot.

Practically all metals can be electronically spot-welded together, or to other metals — in thicknesses ranging from tissue-thin nickel-copper alloy, 40 millionths of an inch thick, to laps of half-inch steel.

Main illustration shows stainless steel sheets being welded to railroad-car framework. Welder is double-wheel electrode type. Inset illustration shows typical seam welds made at approximately 7 feet a minute: (A to E) from 1⅔ to 21 spots to the inch; (F) essentially equal on-and-off periods; (G) long-off-short-on period; (H) short-off-long-on period.

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• *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.*

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Three Basic Reasons Why

Temco Equipment Excels

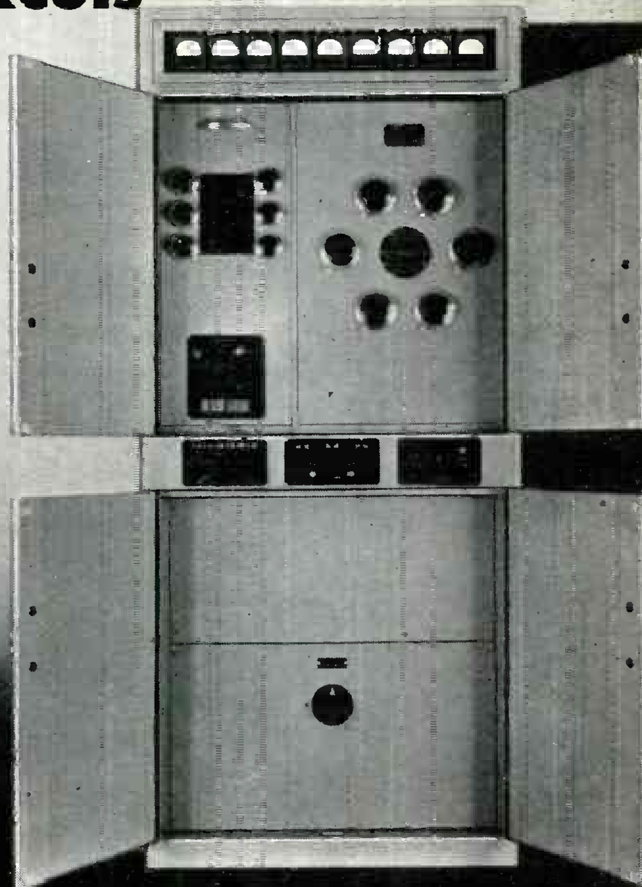
Behind the consistently dependable performance of Temco Transmitting Equipment stand these 3 fundamental factors:

1 Engineering that is a step in advance of today's needs.

2 Component parts whose trade names stand for leadership in their various specialized fields.

3 Workmanship standards, throughout every stage of manufacture, that insure maximum operating efficiency under widely varying extremes of conditions.

As to component parts, Temco always has used none but those of recognized high standards. Together with advanced electronic engineering and unsurpassed workmanship, these high calibre electrical parts help to comprise a trio of basic quality reasons why Temco performance invites comparison.



Above—Temco Model 1000 AG-CW-1000 Watt Radio Telegraph Transmitter for six frequency operation with motor driven band changing. Normal frequency range 2 to 16 Mc.

Left— Interior View, Temco Model 1000 AG-CW-1000 Watt Telegraph Transmitter, illustrating excellence of mechanical details.

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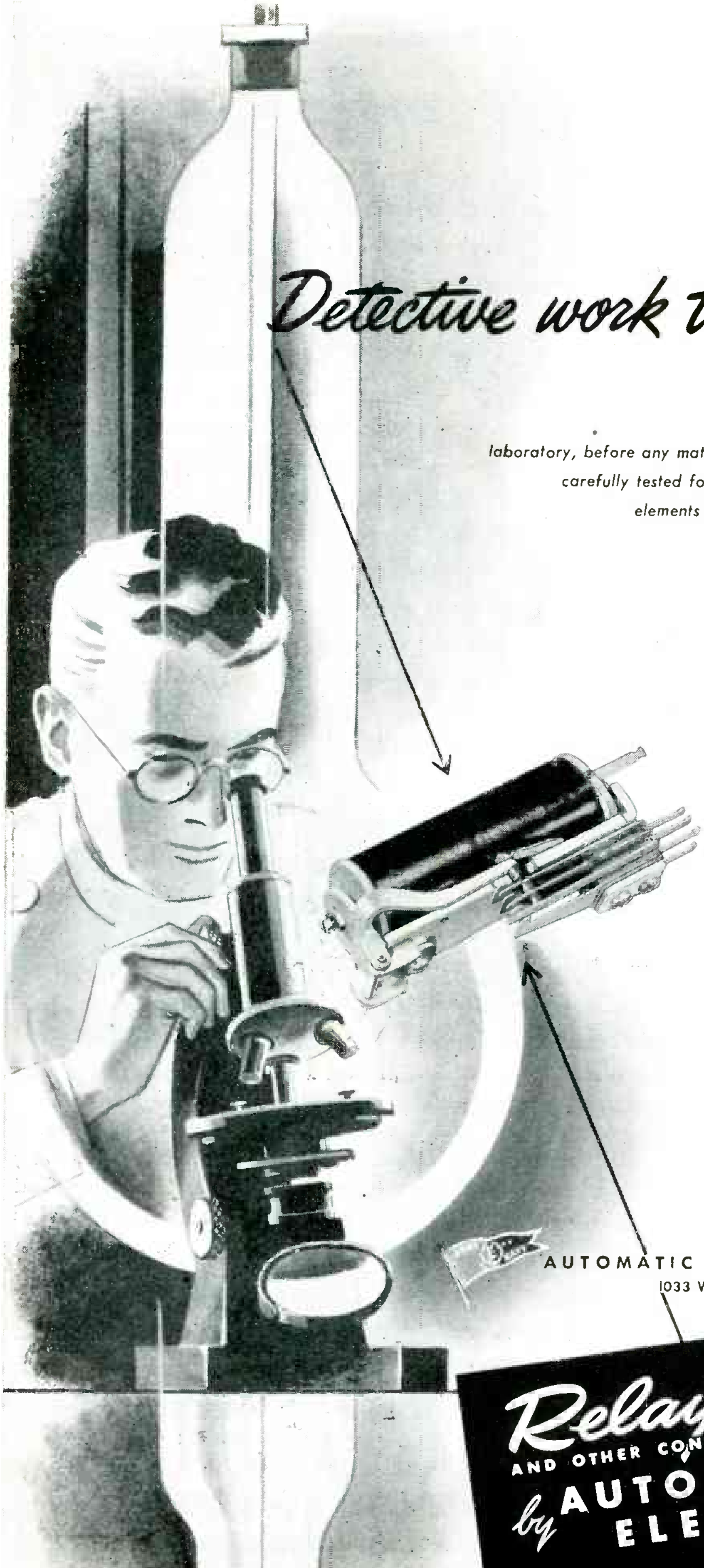

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You can make this experience work for you—by calling in the Automatic Electric field engineer. His job is to help you select the apparatus that will best meet your need. Call him in next time you are faced with an electrical control problem. Write for Catalog 4071.

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How Much Heat Will the 15-B Give? The new RCA 15-B electronic generator is rated at 15 kilowatts output. It will deliver up to about 50,000 B.T.U. per hour, depending on the load conditions.

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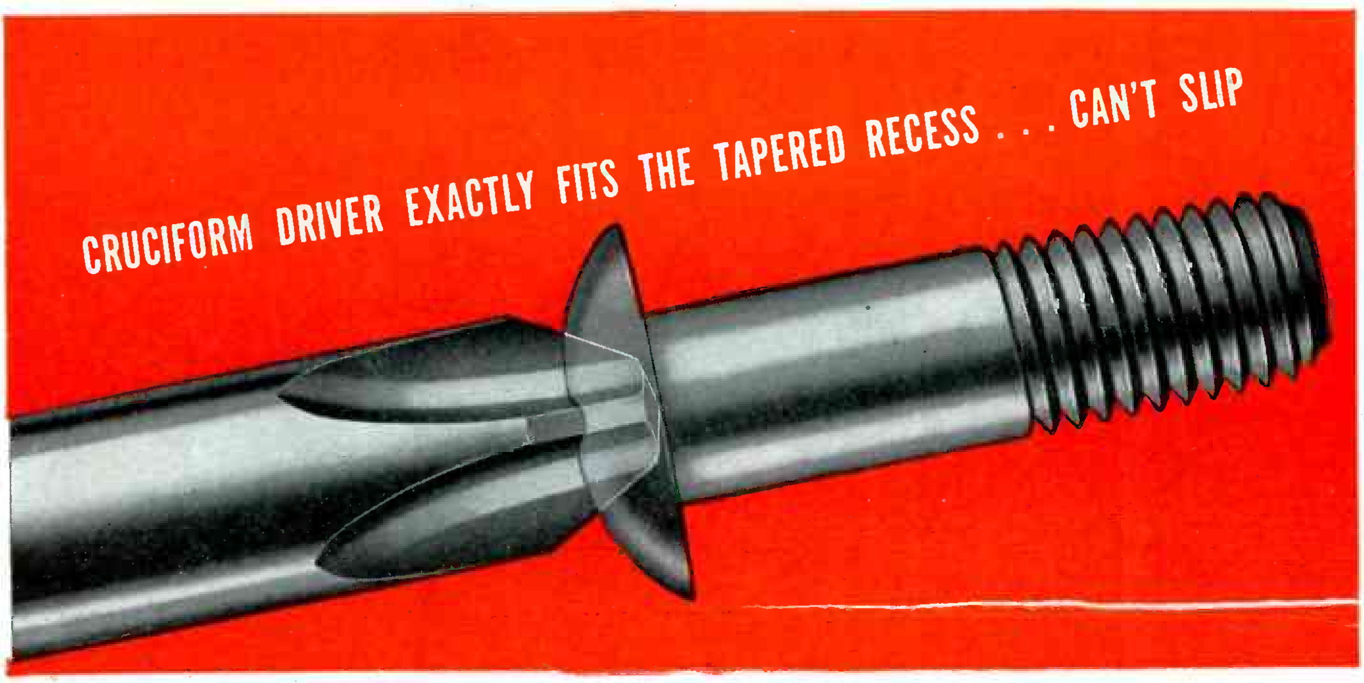

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National
HEADED AND THREADED PRODUCTS

THE NATIONAL SCREW & MFG. CO., CLEVELAND 4, O.

Manufacturers of Quality
Electro-Mechanical Components
Since 1896
Variable Resistors, Plugs, Jacks, Switches, Telephone Generators, Ringers
Representatives
R. W. Farris
2600 Grand Avenue
Kansas City 8, Missouri
Phone: Victory 3070
Frank A. Emmet Co.
2837 West Pico Boulevard
Los Angeles 6, California
Branch Offices
S. J. Hutchinson, Jr.
401 North Broad Street
Philadelphia 8, Pennsylvania
Phone: Walnut 5369
In Canada
C. C. Meredith & Co.
Streetsville, Ontario
CTS
CHICAGO TELEPHONE SUPPLY
Company
ELKHART ★ INDIANA

ART AND SCIENCE...BOTH

Little wonder that tube making is often referred to as an *art.* For much of the work is by hand. To fashion these complex assemblies of filaments, grids, plates and wires; to position the parts within such close space limitations—parts, mind you, that often are so fragile, flimsy and elusive, *tweezers* are required to handle them—calls for a high degree of skill, a steady hand and an eye for accuracy. Art is right!

Yet, today, guiding every move of every N. U. production worker's hands is the "know how" of many scientists and engineers. Here are chemists, physicists, metallurgists, and men high in the sciences of electronics and mechanics—all teamed up in a scientific tube development and production program recognized as a model throughout this industry.

It takes a lot of *both* science and art to make the advanced-design, high performance N. U. tubes now being produced for combat service. It is such superior tubes that will do your electronic jobs better, after the war. *Count on* National Union.

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

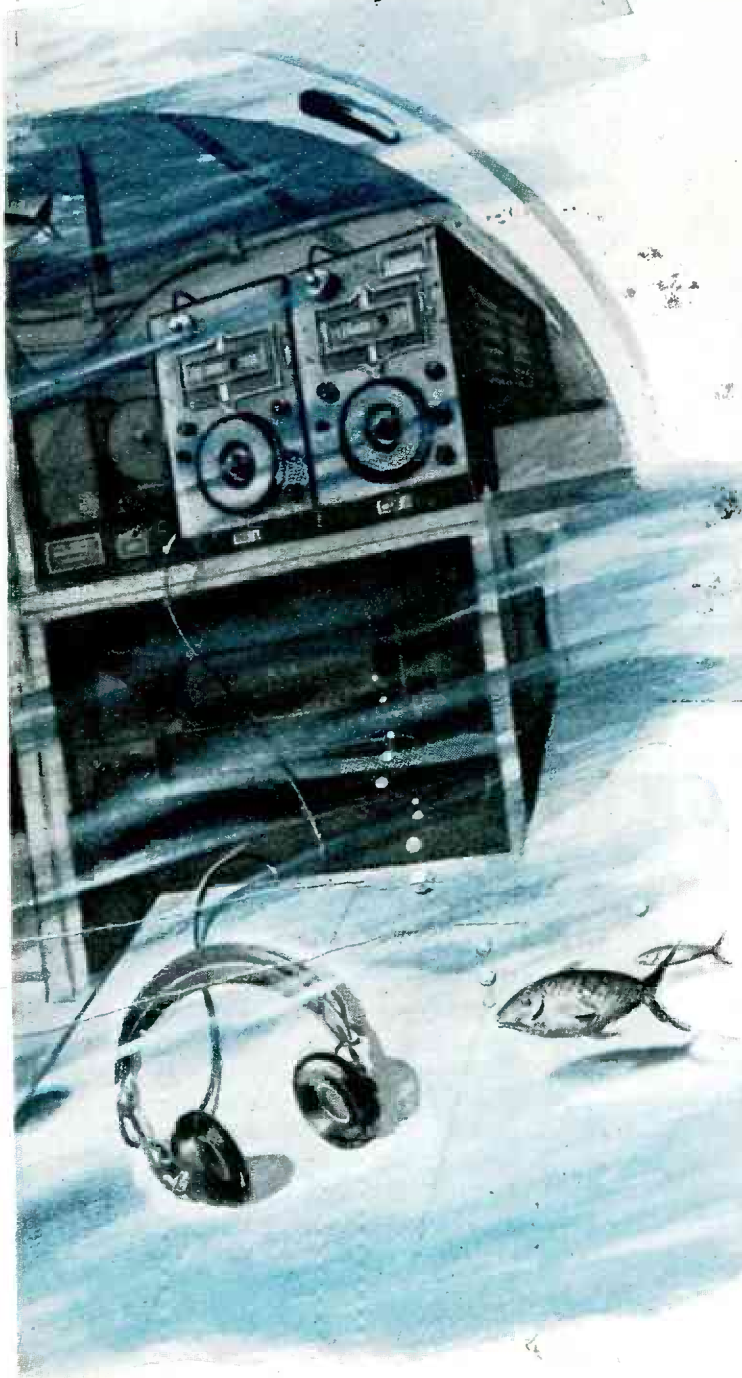
NATIONAL UNION

RADIO AND ELECTRONIC TUBES

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

3 MONTHS IN DAVY JONES' LOCKER

—*And this radio still worked!*



For three months, a radio receiver and transmitter lay at the bottom of the sea. It was part of the equipment of a plane that had accidentally plunged into the ocean during a test.

After three months under water, the radio was brought up and tested. What was found may seem unbelievable, yet it's a matter of record. After the sea water had been drained out, the radio set still worked perfectly.

Unfortunate as the attendant circumstances of this "case history" may be, they afford concrete proof of the invaluable properties and qualities of General Ceramics and Steatite Insulators used in this set.

The fact that Steatite is absolutely impervious to moisture and has no cold flow properties are among the reasons why Steatite is specified by the U. S. Army and Navy.

In the widening use of Steatite Insulators, General Ceramics and Steatite Corporation have been prominent for their increased productive capacity as well as engineering skill in the development of new products and manufacturing methods.

If you have a problem involving insulators whether specialized or standard, our Engineering Department is ready to serve you.

General Ceramics

AND STEATITE CORP.

KEASBEY **NEW JERSEY**

5289

Calibration of a Lavoie Precision Frequency Meter, using a Crystal Calibrator developed in our laboratories

The Newest Thought...

in UHF Calibration and Crystal-Control Methods

In our particular field of specialization we have originated methods of calibrating UHF equipment which require a small fraction of the time formerly necessary for this high precision work. The same principles have been applied to crystal-controlled oscillators and harmonic frequency generators.

As manufacturers we do not limit ourselves to putting into production standardized ideas. We seek new lines of thought, which are followed by original experimentation and development. The results have produced a method for the generation and identification of very high harmonic frequencies. We shall be glad to discuss your specific requirements with you.

UHF PRECISION FREQUENCY METER

Completely Portable
Battery or AC-Operated
Accuracy 0.1%

Models available from 100 to 1500 megacycles with 2 to 1 frequency coverage on each model. Available only on high priority while our nation is at war.

RECOMMENDED FOR:

- Production testing
- Measurement of oscillator drift
- Independent alignment of transmitters and receivers
- Precise measurements of frequencies

Lavoie Laboratories

RADIO ENGINEERS AND MANUFACTURERS
MORGANVILLE, N. J.

Specialists in the Development of UHF Equipment

It was more than 15* years ago that Farnsworth research men synchronized sight with sound electronically and transmitted the two to experimental receiving sets.

By that important operation, they assured modern electronic television a wide public appeal. Its advance has been rapid — and nowhere more productive than at Farnsworth, where 18 years of television research have developed a number of key circuits, tubes and synchronizing devices—including the Farnsworth Dissector Tube and the Photo-Cell Multiplier Tube.

We lay much credit for Farnsworth progress to our research policy, which has always stressed the advantages of parallel work in both tubes and circuits.

Farnsworth research and manufacturing facilities — greatly broadened — are now producing only military communications equipment and highly specialized electronic devices, and our technical knowledge of applied electronics is enriched constantly.

When peace comes, our broadened background and resources will be better than ever able to help you in the fields of sight and sound reproduction.

**Another of a series of advertisements depicting milestones in television's history.*

Look for the Farnsworth Television advertisements in March 6, April 3 *Newsweek;* March 18, April 15 *Collier's.*

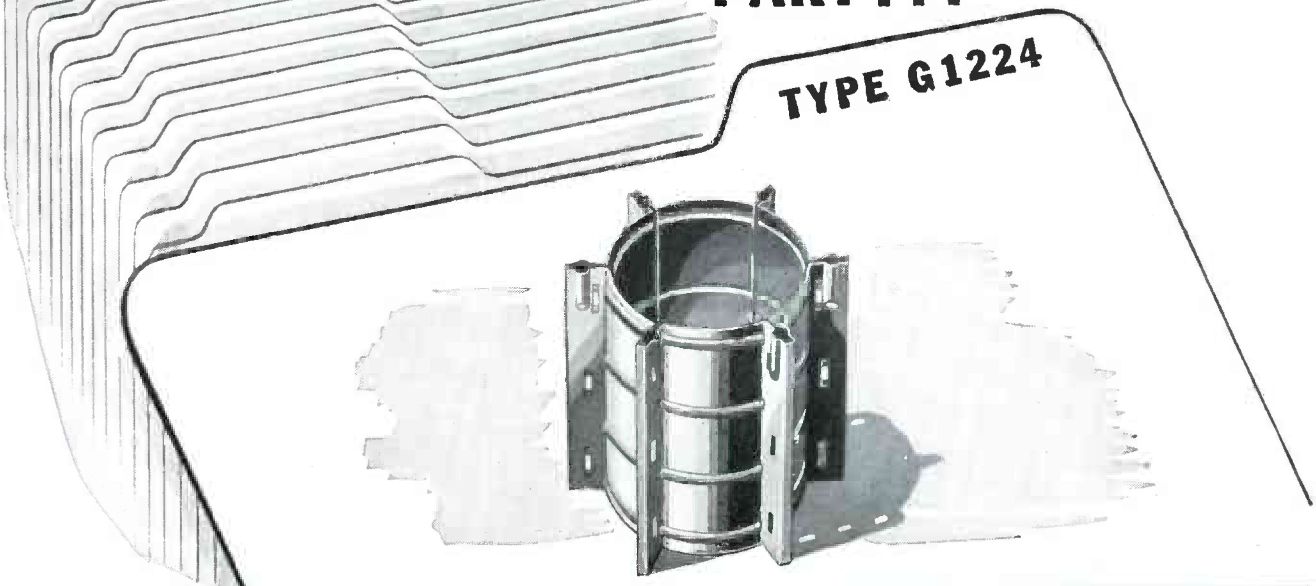
FARNSWORTH TELEVISION

ARMY E NAVY

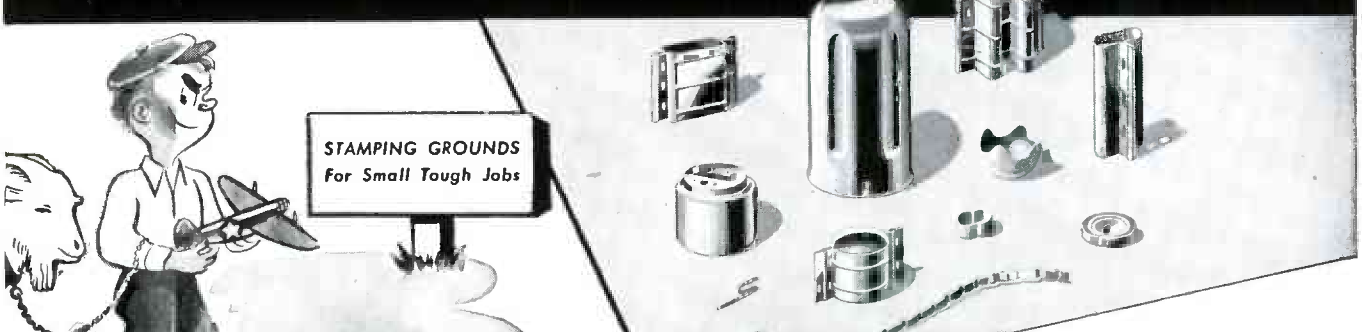
• Farnsworth Television & Radio Corporation, Fort Wayne 1, Indiana. Farnsworth Radio and Television Transmitters and Receivers; Aircraft Radio Equipment; the Farnsworth Dissector Tube; the Capehart, the Capehart-Panamuse; the Farnsworth Phonograph-Radio.

EXPERIENCE?

THIS IS GOAT ELECTRONIC TUBE PART . . .



G1224 is just one of the thousands of parts made by GOAT since the days of radio infancy. GOAT is continually called upon to handle tough jobs requiring skill, precision and efficiency. Because of experience gained throughout the years, GOAT has been able to meet the demands of this industry for greater quality, durability and quantity production. Today, GOAT serves almost every electronic tube manufacturer with a tremendous variety of stock and special parts made of any metal to any required degree of accuracy.



TYPICAL PARTS
Shown here are just a few GOAT electronic tube parts and shields that have been stamped, drawn and formed on GOAT machines, dies and presses.

GOAT METAL STAMPINGS, INC.

A DIVISION OF THE FRED GOAT CO. INC. EST. 1893
314 DEAN STREET • BROOKLYN, N. Y.

PAINTED FOR ELECTRONIC LABORATORIES, INC., BY FENTON CLARK

"Beach 3 Calling Fire Control 3

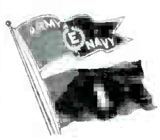
...pinned down by pillbox on right flank!"

★ Landing parties must depend on supporting fire from ships off shore until their own artillery can get into action. By radio communication the Navy's fire is brought instantly to bear on enemy strong points holding up the advance.

When the Marines carry out the tough landing operations for which they are noted, Walkie-Talkies are among the first ashore. *They must get the messages through!* For unfailing power, many depend on ***E·L*** Vibrator Power Supplies.

Wherever reliability is a "must," ***E·L*** Vibrator Power Supplies are also proving their other advantages of light weight, small size and high efficiency. They are products of the most extensive research in vibrator power supplies and circuits ever known.

That research has extended the scope and usefulness of vibrator type power supplies beyond all previous conception. Certainly, in the electronic era of peace to come ***E·L*** Power Supplies will contribute new advances and economies wherever electric current must be changed in voltage, frequency or type.



Electronic
LABORATORIES, INC.
INDIANAPOLIS

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

Power Supply using rechargeable, non-spill storage battery for operation of Walkie-Talkie radio equipment. Input Voltage: 4 Volts D.C.; Output: Numerous Voltages, supplying plate and filament requirements of the equipment. Width, 3½"; Length, 6½"; Height, 4⅜".

Here's How We Find The Angles To Precise Radio Frequency Control

Precision properties of oscillators are determined by the angles at which they are cut. Here are shown the locations of various type crystal oscillators with respect to the axes of a quartz mother.

Crystals developed for the perfection of wartime communications and RADAR will provide startling improvements for many peace-time products. This Company's technical and production facilities are at your service for wartime or post-war crystal engineering and production.

Crystal PRODUCTS COMPANY

1519 McGEE STREET, KANSAS CITY, MO.

Producers of Approved Precision Crystals for Radio Frequency Control

A Third CITATION

FOR THE INSTRUMENT LEADER

. . . FOR MERITORIOUS WAR PRODUCTION

This third citation for meritorious war production . . climaxing a long record of war service . . . is a source of justifiable pride to the men and women of WESTON.

The record began back in the earliest days of our defense period, when a large segment of WESTONS' capacity was assigned to the production of instruments vital to military needs. Thus, when we finally were forced into this world struggle, WESTON was ready for *full-scale war production.*

This new star which adorns our "E" pennant marks the *third* time WESTON has been *first* in this highly specialized field to receive each successive war citation. Weston Electrical Instrument Corporation, Newark 5, New Jersey.

Laboratory Standards . . . Precision DC and AC Portables . . . Instrument Transfomers . . . Sensitive Relays . . . DC, AC, and Thermo Switchboard and Panel Instruments.

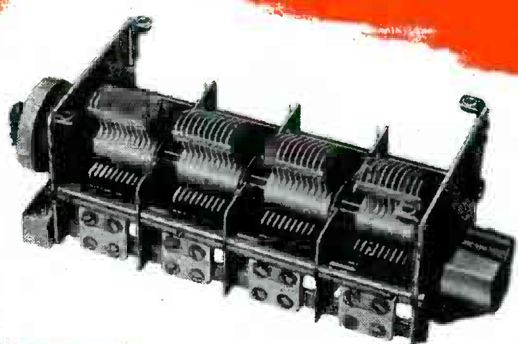
WESTON

Specialized Test Equipment . . . Light Measurement and Control Devices . . . Exposure Meters...Aircraft Instruments... Electric Tachometers...Dial Thermometers.

FOR OVER 55 YEARS LEADERS IN ELECTRICAL MEASURING INSTRUMENTS

IN THIS SHIP . . .

IS THIS AIR CONDENSER . . .



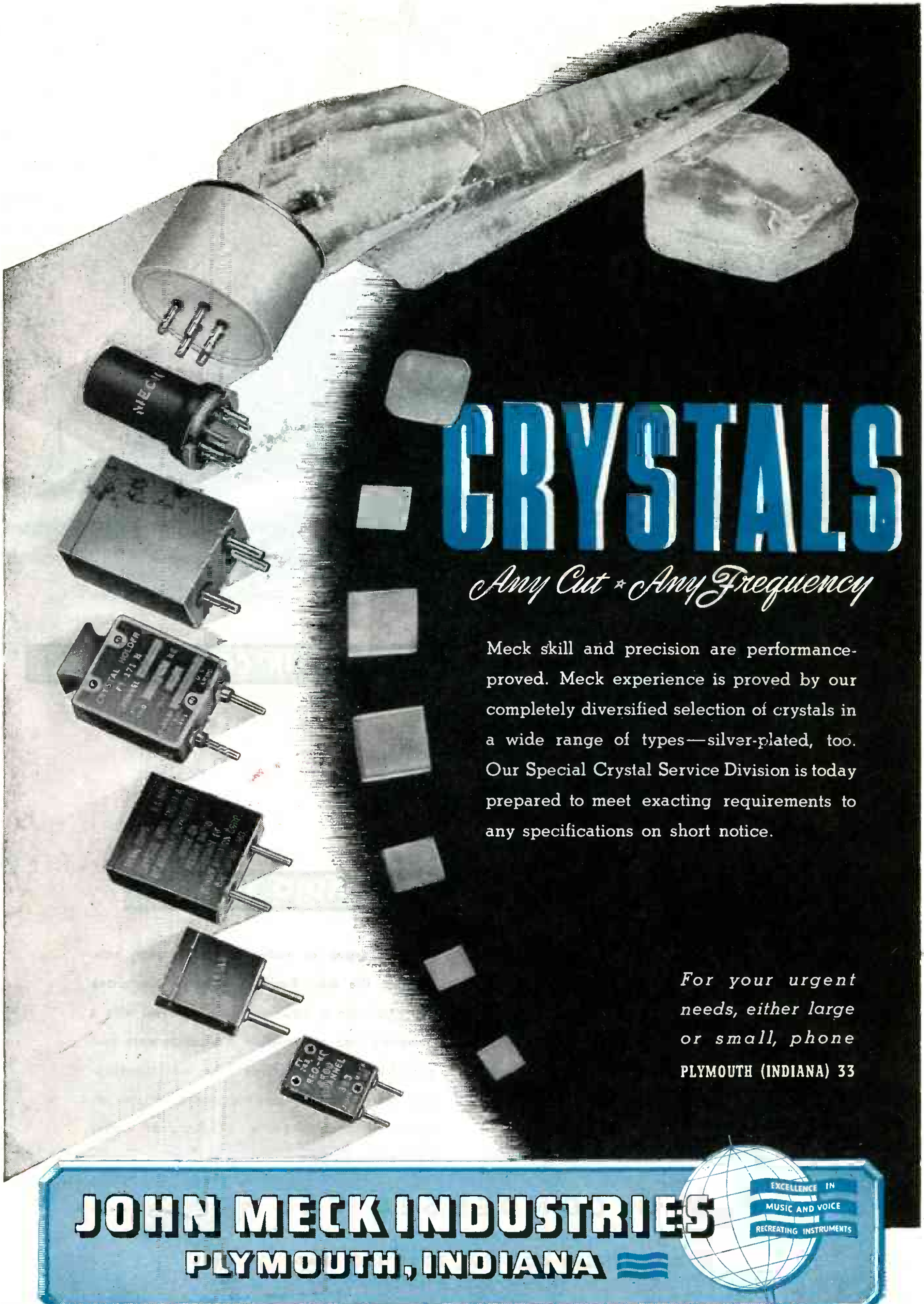
PROVIDING ACCURATE RADIO TUNING

America's ships of war . . . plowing the seas . . . action-bent . . . depend on receiving every radio message — distinctly!

Today, variable air condensers of Radio Condenser Company are being used on many of our ships — assuring accurate radio tuning! Likewise, they are used by our various armed forces on radio apparatus in planes, tanks, and all types of radio communication sets.

After the war, Radio Condenser Company will again be in position to furnish you with a complete line of variable air condensers and push button tuning service. Thus, we urge manufacturers planning postwar radio sets, to include in their schedule: products of Radio Condenser Company.

RADIO CONDENSER CO.
CAMDEN, N. J.
RADIO CONDENSER CO., LTD., TORONTO, CAN.


CRYSTALS
Any Cut ★ Any Frequency
Meck skill and precision are performance-proved. Meck experience is proved by our completely diversified selection of crystals in a wide range of types—silver-plated, too. Our Special Crystal Service Division is today prepared to meet exacting requirements to any specifications on short notice.
For your urgent needs, either large or small, phone PLYMOUTH (INDIANA) 33
JOHN MECK INDUSTRIES
PLYMOUTH, INDIANA
EXCELLENCE IN MUSIC AND VOICE RECREATING INSTRUMENTS

Sound Ideas . . .

Sound ideas! On the drafting board . . . in practical engineering . . . in production "know-how". These form a strong union out of which come many Electro-Voice developments. And the latest of these is the Model T-45 "Lip Mike" . . . a noise-cancelling Differential Microphone.

The soundness of Electro-Voice design refinements will be even more effectively demonstrated in peacetime. We have grown up with the field. We know its needs and its possibilities. You may be sure that products born of Electro-Voice ideas will perform a sound function.

Electro-Voice distributors are giving greater understanding to your requirements than ever before. If your limited quantity needs can be filled by any of our Standard Model Microphones, with or without minor modifications, we suggest that you contact your nearest radio parts distributor.

DON'T WASTE WASTEPAPER . . . TURN IT IN TO FIGHT FOR OUR SIDE

Electro-Voice MICROPHONES

ELECTRO-VOICE MANUFACTURING CO., INC.
1239 South Bend Ave. • South Bend 24, Indiana
EXPORT DIVISION: 13 EAST 40th ST., NEW YORK 16, N. Y. — U. S. A. CABLES: ARLAB

Special purpose
CERAMIC TUBULAR CAPACITORS

In addition to our standard type tubular capacitors Centralab is prepared to furnish SPECIAL PURPOSE Capacitors for radio frequencies (high and ultra-high frequencies) for both transmitter and receiver circuits.

Our extensive laboratory and engineering facilities make possible the production of special types some of which are illustrated here . . . to meet the need of circuits that cannot be serviced through our standard tubular capacitors.

We invite correspondence where special capacitors are indicated.

Send for Bulletin No. 721 for specific details

Centralab

CRL

Division of GLOBE-UNION INC., Milwaukee

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


The ONLY Resistors wound with *CERAMIC INSULATED WIRE!
*IT'S FLEXIBLE
*IT'S MOISTURE-PROOF
*IT'S HEAT-PROOF TO 1000°C
*IT PERMITS USE OF LARGER WIRE SIZES IN LESS SPACE
A MAJOR RESISTOR IMPROVEMENT
The outstanding superiority of Sprague Koolohm Resistors in practically every important characteristic could—and did—result only from an entirely different engineering approach to basic problems—from the wire up. Research proved that the resistor was no better than the insulation on the wire. Koolohm ceramic insulation applied to resistance wire permitted such valuable engineering features that, in less than four years, these resistors have set higher standards of performance on hundreds of the most exacting applications. Standard units include 5- to 150-watt power types, bobbin types and meter multipliers. Write for Catalog—today!
SOLVING PROBLEMS of
UNWIELDY SIZE
REDUCED WATTAGES
CHANGED VALUES
HIGH AMBIENTS
MOUNTINGS
SHORTS
...and many more!
SPRAGUE SPECIALTIES CO.
RESISTOR DIVISION
NORTH ADAMS, MASS.
ARMY E NAVY
SPRAGUE KOOLOHM RESISTORS

. . . New Federal Development Revolutionizes the Metal Rectifier!

By the use of a simple CENTER CONTACT *Federal has achieved another "first" in Selenium Rectifier development.*

The result — remarkable new corrosion resistance and weather stamina added to the important advantages already inherent in Federal Selenium Rectifiers.

Outstanding among these advantages are high efficiency over a wide range of load; small size and light weight; adaptability to wide ranges of temperatures, humidities and atmospheric pressures — plus maintenance-free operation.

CENTER CONTACT *is available only in Federal Selenium Rectifiers, first in the field and standard for industry.*

Federal battery chargers and power supplies, powered by Selenium Rectifiers, have wide application in the fields of radio, telephone, telegraph, aviation, railway signaling and wherever direct current is required from an AC source.

Federal Telephone and Radio Corporation

AN IT&T ASSOCIATE

Newark, N. J.

AAC TRANSMITTERS

TYPE 508 TRANSMITTER

(Illustrated at right). Type 508 Transmitter as designed by AAC for Army Airways Communications Service. Power output 450 watts each channel. Types of emission A1, A2, A3 and FM teletype. Five channels can be operated simultaneously. Single or dual modulator can be supplied.

AAC Products

E-34

AIRCRAFT PRECISION RADIO

Burbank, Calif. Kansas

NEW! Fibron

THE "ALL-PURPOSE" Tape

FOR INSULATING wires, cables and electrical equipment . . . **FOR PROTECTING** electrical wires and cables exposed to caustic or corrosive fumes, oil, grease, acids, alkalies, or moisture...**FOR SPLICING** cables with a continuous, protective covering . . . **FOR COVERING** exposed piping in chemical plants, equipment exposed to moisture or severe atmospheric conditions.

These widely diversified applications of FIBRON TAPE No. 1 are made possible by its combination of outstanding electrical, physical, and chemical properties. (See adjacent panel.) This *flexible, elastic,* "Vinylite"* resin tape is heat sealing, flame resistant, high in dielectric strength, strong mechanically, and highly resistant to oils, acids, alkalies, moisture, and normal variations in temperature and climate.

FIBRON TAPE is a new addition to the already extensive line of Irvington products. It is offered with the usual guarantee that applies to all Irvington Insulation — to protect equipment in accordance with specifications.

Plan now to test the new FIBRON TAPE. A generous sample will be sent on request — without obligation. For further information on FIBRON, or other IRVINGTON INSULATION, write Dept. 106.

*Reg. Trade Mark—CARBIDE & CARBON CHEMICALS CORP.

OUTSTANDING PROPERTIES
FIBRON TAPE No. 1

Tensile strength	1700 lb. per sq. in.
Dielectric strength	1000 VPM (.012")
Low temperature flexibility	–40° C.
Elongation	250% – 400%
Power Factor @ 30° C. (60 cycles)	6.5%
(1 kilocycle)	6.2%
Dielectric Constant @ 30° C. (60 cycles)	7.6%
(1 kilocycle)	6.9%
Bonding temperature	Approximately 150° C.

IRVINGTON for INSULATION

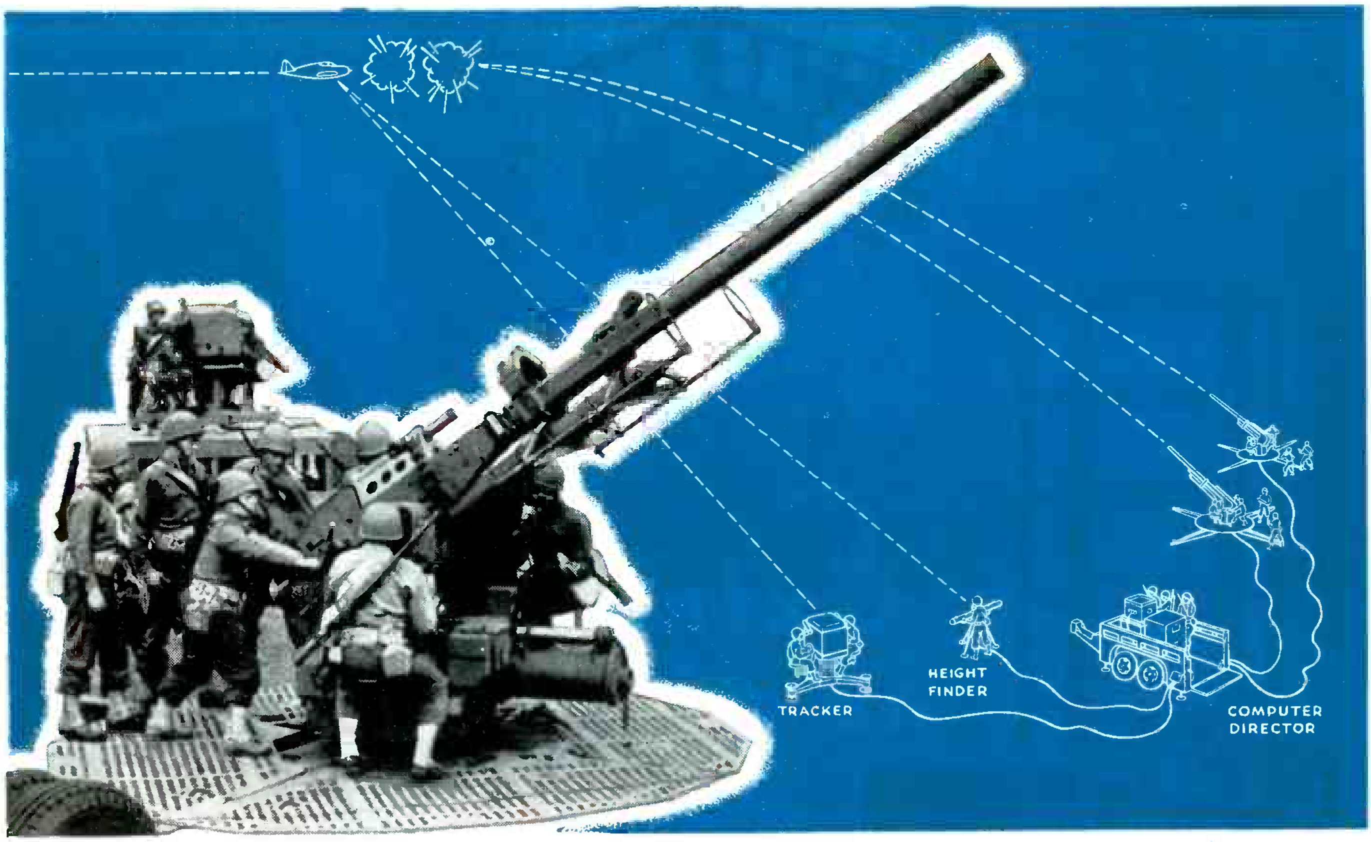
EXTRUDED PLASTIC TUBING
VARNISHED TUBING
INSULATING VARNISHES
VARNISHED RAYON
VARNISHED PAPER
VARNISHED FIBERGLASS
VARNISHED CAMBRIC
VARNISHED SLOT INSULATION
VARNISHED CANVAS AND DUCK
OIL STOPS
VARNISHED AND PLASTIC WIRE MARKERS

STANDARD OF THE WORLD — IRVINGTON INSULATION — TRADE MARK REG. U. S. PAT. OFF.

IRVINGTON VARNISH & INSULATOR COMPANY
6 Argyle Terrace, Irvington 11, New Jersey, U. S. A.
Plants at
Irvington, New Jersey and Hamilton, Ontario, Canada
Representatives in 20 Principal Cities

IRVINGTON *Electrical* **INSULATION**

5582



The M9 GUN POINTER directs ack-ack fire with deadly accuracy, operating on built-in CONSTANT VOLTAGE

With amazing success on our far-flung battle fronts the Army's new M9 gun pointer, operating on electrical voltage controlled to minute limits of fluctuation, directs shells to their targets swiftly and surely, spelling almost certain death to enemy aircraft.

This uncanny accuracy in our implements of war is a tribute to the skill of America's design engineers. Their ingenious application of scientific instruments and devices from every known source has achieved an exactness in modern warfare that has left consternation and fear in the hearts of our enemies.

Without SOLA Constant Voltage Transformers many of these achievements would not have been possible. These automatic, self-protecting transformers have been on the job day and night. On the production line, in research laboratories, even at the battle fronts their important role has been to iron out the peaks and valleys of power fluctuations to the very narrow voltage limits so essential to precision.

On countless drafting boards this war-gained knowledge is already being projected into new things for the future. And here, as in the implements of war, built-in SOLA Constant Voltage Transformers will continue to provide safe, stable operating voltages.

SOLA Constant Voltage Transformers are available in standard units from 10VA to 15KVA for use with any existing equipment where voltage regulation is required. They are fully automatic, with no moving parts to get out of order. They require no manual supervision. Voltage fluctuations as great as 30% are instantaneously reduced to the safe operating voltages specified on the label.

Custom built units of convenient size and capacity can be designed as a built-in part of any electronic device or electrically operated equipment where narrow voltage limitations are required. Sola engineers are available for study of your voltage problems.

SOLA Constant Voltage Transformers

To Manufacturers:
Built-in voltage control guarantees the voltage called for on your label. Consult our engineers on details of design specifications.
Ask for Bulletin DCV-74

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 Clybourn Ave., Chicago 14, Ill.**

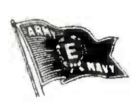

Extra hands
More than just sheet steel specialists, ours is an organization where top emphasis is placed upon the men and women responsible for designing and building our products. Working as a team, over a long stretch of years, we've welded together a fine group of exacting, conscientious artisans, supplemented by skilled replacements and additions due to the war.
We build cabinets, chassis, panels and racks for diversified electronic equipment . . . quickly, precisely, economically. The hundreds of different dies available will reduce the cost of the dies needed on your job and may, in many instances, eliminate die-cost entirely. Because of these unique facilities, we manufacture to required specifications at the lowest possible cost. Moreover, we'll go over your plans with you . . . make recommendations if they can be helpful . . . suggest means of expediting deliveries. Briefly, ours is an extra pair of hands . . . offered willingly as part of a firmly-established policy of unselfish service to our clients.
The services of a Karp engineer are available for a discussion of your problems.
ANY QUANTITIES — ANY METAL — ANY SIZE — ANY FINISH
ARTISANS IN SHEET METAL
KARP METAL PRODUCTS CO., INC.
124 30th STREET • BROOKLYN 31, N. Y.
CABINETS CHASSIS RACKS PANELS
KEEP BACKING THE ATTACK . . . BUY MORE WAR BONDS

WILL YOU NEED DRY BATTERIES IN YOUR POST-WAR PRODUCTS?

Check with Ray-O-Vac before you "freeze" your post-war designs

RAY-O-VAC'S "know how" that has solved the portable power supply in war-important equipment can aid you in engineering the power supply in your post-war products.

If your products require dry batteries, there are many ways in which Ray-O-Vac engineers can help you. One important consideration, for example, is the provision for proper battery space. Be sure your products are designed for the batteries of the future.



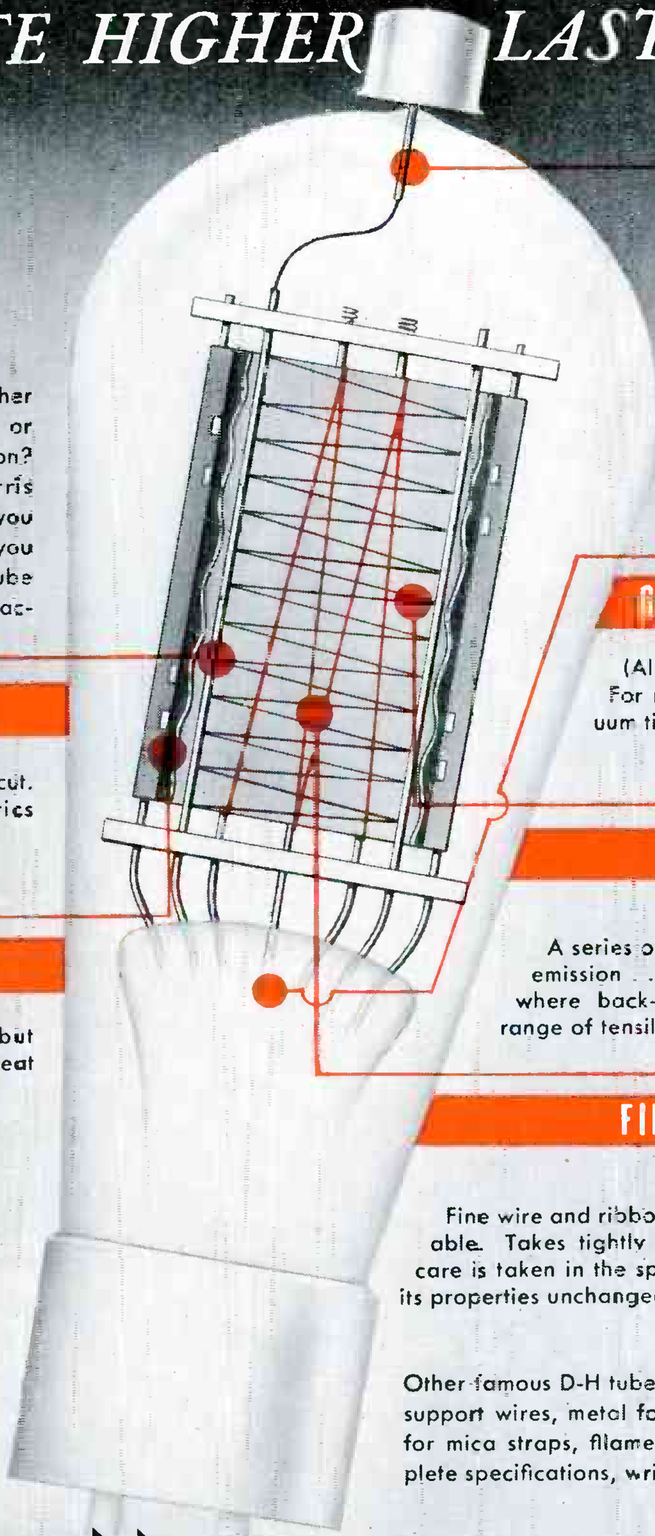
Write Dept. 1—1, Ray-O-Vac Company, Madison 4, Wisconsin. Additional factories in Clinton, Mass., Lancaster, Ohio, Sioux City, Iowa.

BUY WAR BONDS **RAY-O-VAC** BUY WAR STAMPS

Guaranteed **BATTERIES**

FLASHLIGHT • TELEPHONE • LANTERN • HEARING AID • RADIO • IGNITION • MULTIPLE

These Metals can help you build TUBES THAT RATE HIGHER LAST LONGER



MR. TUBE MANUFACTURER:

Are you striving for tubes of higher ratings . . . or longer life . . . or the two qualities in combination? Famous, time-tested Driver-Harris special radio metals will help you achieve exactly the properties you seek. Here are a few D-H tube metals used by leading manufacturers:

GRID SIDE RODS

Easily welded, notched, and cut. Embodies important characteristics necessary in grid side rods.

PLATE STRIP

Nickel and Nichrome.* Thin but rigid. Takes a tightly adhering heat radiation coat.

GLASS SEAL METALS

(Alloy #14, Alloy #42, Alloy #52) For mechanically strong and vacuum tight bonds with glass.

GRID WIRE

GRIDNIC*

A series of alloys with very low electron emission . . . especially suitable in tubes where back-emission is involved. Wide range of tensile strengths available.

FILAMENT WIRE

FILNIC*

Fine wire and ribbon, wide range of alloys available. Takes tightly adhering oxide coat. Extra care is taken in the spooling and packing, to keep its properties unchanged in transit.

•

Other famous D-H tube metals are cathode sleeving, support wires, metal for socket prongs, special strip for mica straps, filament support springs. For complete specifications, write

*Trade Mark Reg. U. S. Pat. Off.

Special Purpose Alloys
Since 1899

Driver-Harris COMPANY

HARRISON, N. J.

BRANCHES • CHICAGO • DETROIT • CLEVELAND • LOS ANGELES • SAN FRANCISCO • SEATTLE

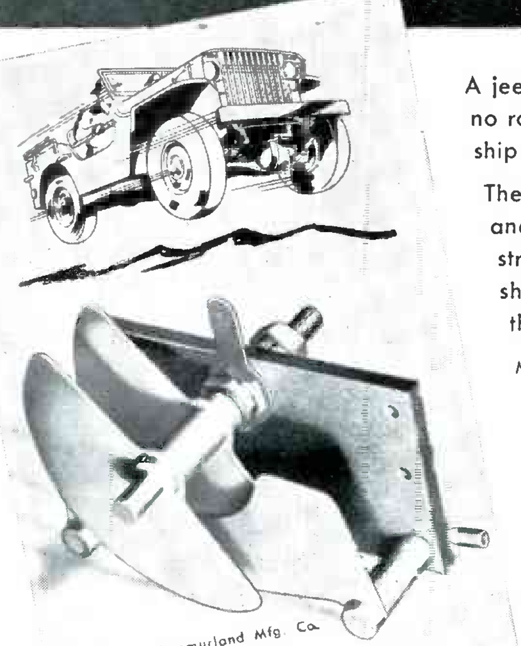


Photo Hammurland Mfg. Co.

In applications where mechanical shock is severe, specify MYKROY No. 38 insulation, especially developed to resist shock. Ample stocks of MYKROY are available in sheets and rods. We manufacture a wide variety of component parts involving MYKROY as insulation.

A jeep that goes bucking and chattering over a rocky, rutted road—or no road at all. A PT Boat smacking the waves at 45 knots . . . A battleship whose broadsides seem to shake the enamel off the gunners' teeth.

These are the places where MYKROY is the "perfect" insulation for radio and other electrical equipment . . . because MYKROY has mechanical strength comparable with that of cast iron. Under severe vibration or shock MYKROY will not warp or crack or otherwise yield to unbalance the precise adjustments of the apparatus.

MYKROY will not pass or dissipate the higher frequencies, owing to its exceptional low-loss characteristics. Its absorption factor is virtually nil. It will stand temperatures as high as 1000° F. It bonds and seals to metal . . . is relatively light in weight and can be machined to close tolerances, as well as molded.

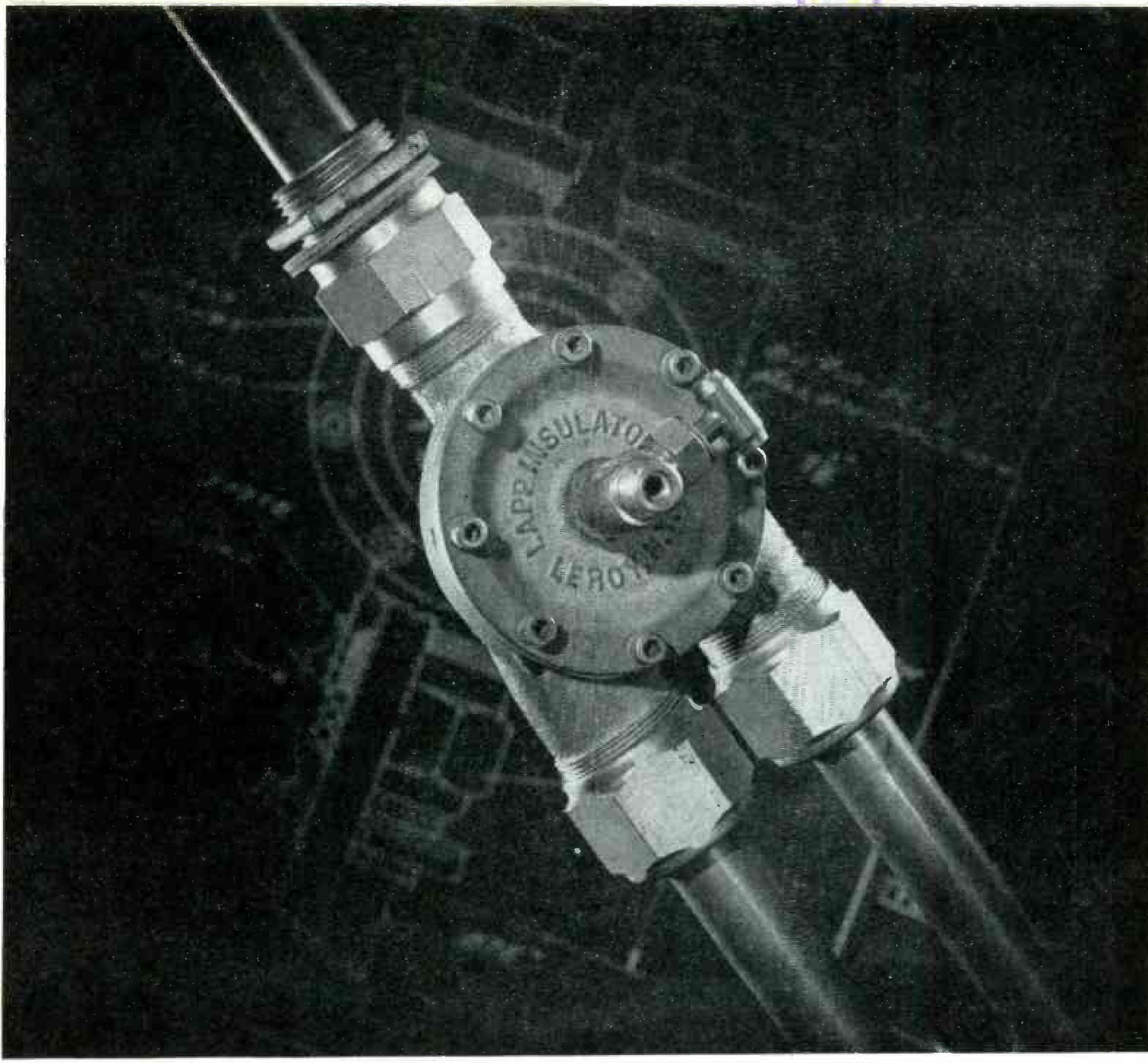
Bring us your insulating problems. Write for new catalog, detailed information and quotations.

Mykroy is manufactured exclusively by

ELECTRONIC MECHANICS INC.

70 CLIFTON BOULEVARD • CLIFTON, NEW JERSEY
Chicago 47: 1917 NO. SPRINGFIELD AVENUE . . TEL. Albany 4310
Export Office: 89 Broad Street, New York 4, N. Y.


A Tribute



Electronic Parts: ENGINEERING AND PRODUCTION

The gadget above is a junction box for a co-axial gas-filled transmission line. It is one of a series of coupling units, end seals and other fittings for high-frequency transmission—designed and built by Lapp.

To this type of construction, Lapp brings several innovations and improvements. For example, such a line from Lapp parts is genuinely leak-proof. Every gasket is under spring loading, so there's no leakage created by vibration or thermal change.

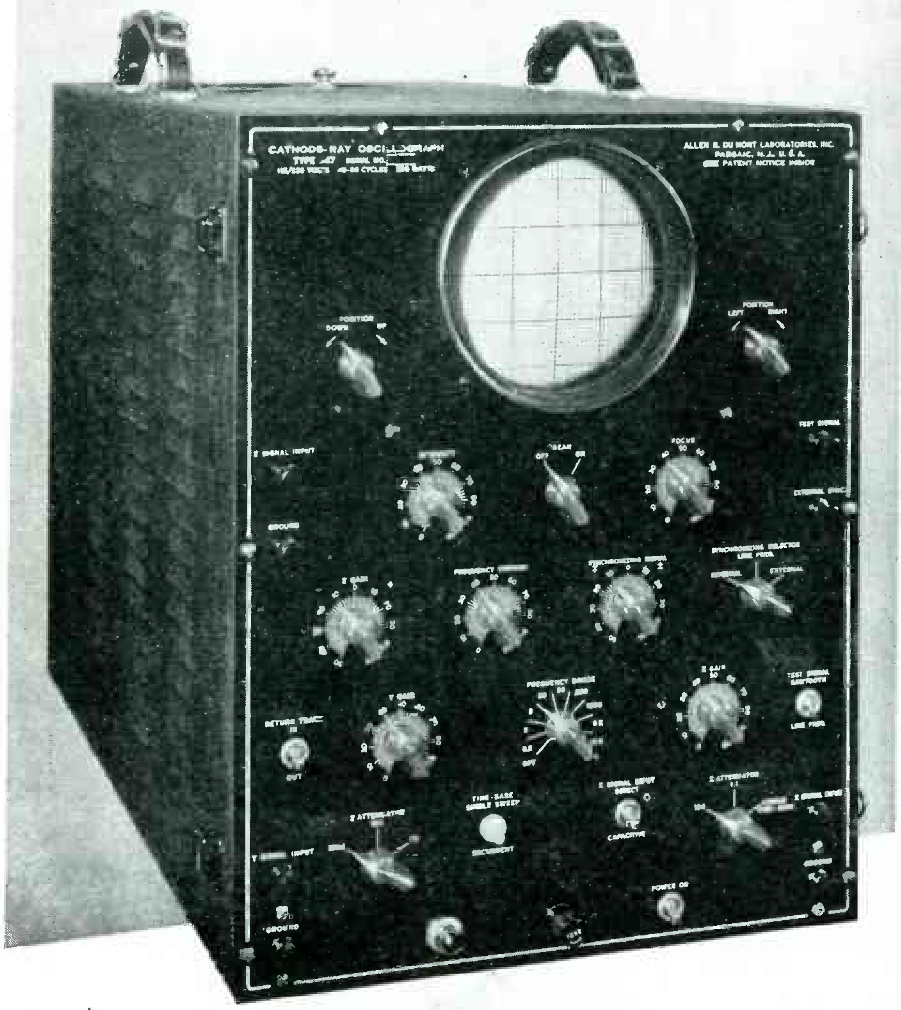
Whether or not you're interested in gas-filled transmission lines, you ought to know about Lapp. Here is an organization of engineers and manufacturers with broad basic knowledge of ceramics and their application. With experience in hundreds upon hundreds of special-purpose electronic parts, we have been able countless times to improve performance, or reduce costs, or cut production time through the application of our specialized skills to design and manufacture of parts involving porcelain or steatite and associated metal parts.

For quick and efficient assistance on a war production subcontract—or for the competitive advantage Lapp-designed and Lapp-built parts will give to you in the postwar battle—an inquiry to Lapp now may pay you dividends. *Lapp Insulator Co., Inc., LeRoy, N. Y.*

Lapp

Another DuMONT *Contribution*...

TYPE 247 CATHODE-RAY OSCILLOGRAPH



Uses new Army-Navy preferred Type 5CP1 cathode-ray tube with intensifier electrode operated at overall accelerating potential of 3000 v. High-intensity patterns. 5" dia. screen.

Medium-persistence green screen, standard. Also available with short-persistence blue screen Type 5CP5 tube for high-speed photographic recording. Or Type 5CP2 long-persistence green screen for visual observation of low-speed phenomena.

Vertical or Y-axis amplifier response does not fall more than 10% below the uniform value from 2 to 200,000 C.P.S. Sufficient gain for maximum deflection factor of 0.05 r.m.s. volt input signal for 1" deflection of beam.

Distortionless, continuously-variable low-impedance attenuator or gain control. Stepped attenuator with ratios of 1:1, 10:1 and 100:1.

X-axis or horizontal amplifier accommodates signal produced by linear time-base generator. Reasonably uniform response from d-c to 100,000 sinusoidal C.P.S. Signal amplitude of 0.5 v. r.m.s. sufficient for deflection of 1" through amplifier.

Recurrent, repetitive and single-sweep operation of linear time-base generator. Continuously variable from 0.5 to 50,000 sawtooth cycles per second. Single sweep of writing rates corresponding to 0.5 to 10,000 cycles per second.

Z amplifier channel for applying external signal to grid or modulating electrode of cathode-ray tube.

Steel case. Black wrinkled finish. Copper-finished steel chassis. Two carrying handles. 14" w.; 19" h.; 26" d. 130 lbs.

This latest oscillograph facilitates the investigation of transient as well as recurrent phenomena over a wide frequency range. And since a permanent record of transient phenomena is usually desirable, this instrument provides for such photographic recording by applying comparatively high accelerating potentials to its cathode-ray tube. Furthermore, a new type of beam-control circuit is incorporated.

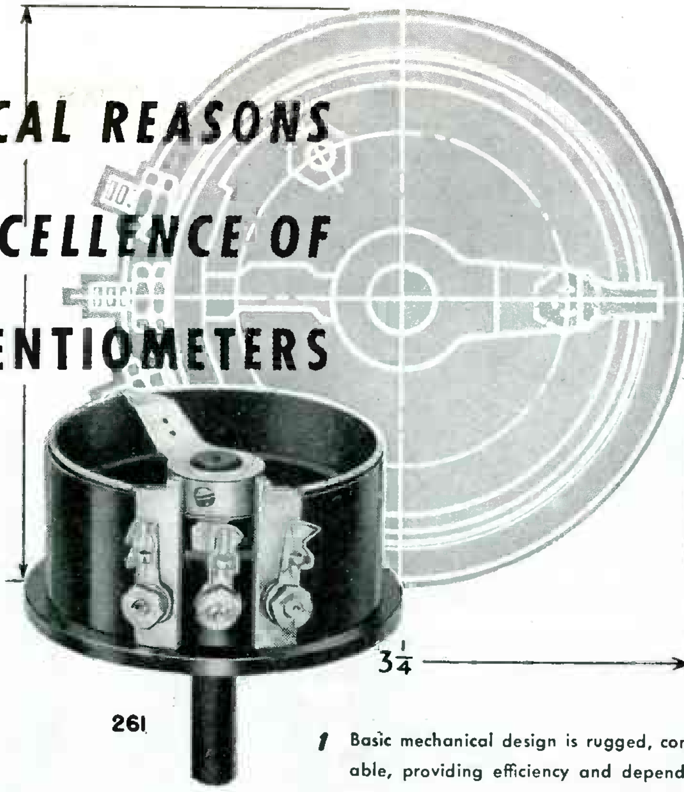
The sweep frequency range has been extended. The instrument may be used for observations on low-speed machinery and for other low-frequency signal functions—even down to ½ cycle per second. At the other extreme, the instrument handles radio-frequency signals as high as 500 kilocycles. The time-base has the necessary range to display such signals properly. Also, the vertical amplifier can satisfactorily accommodate them.

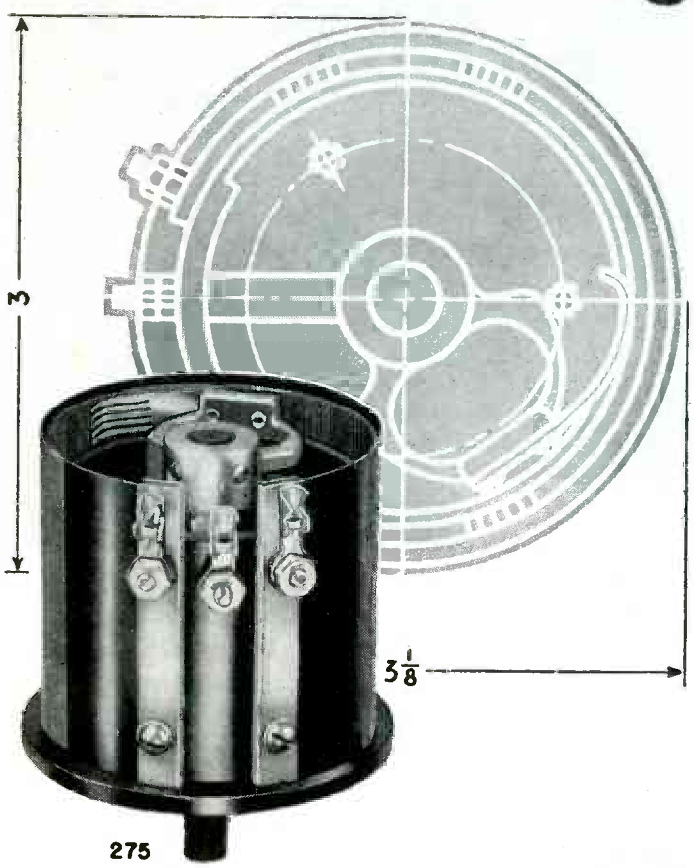
Literature on request . . .

DUMONT *Precision Electronics & Television*

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

9 MORE LOGICAL REASONS FOR THE EXCELLENCE OF DeJUR POTENTIOMETERS





1. Basic mechanical design is rugged, compact and easily adaptable, providing efficiency and dependability.

2. Difficult applications in power and *high frequency* circuits are met with ease. Resistance winding elements are permanently close, smooth, and free from shorted out or irregular turns.

3. Excellent control as variable resistors in filament and plate supply control units, and in tube voltage and circuit elements.

4. Resistance element for *heavy duty* and *heavy watt* designs are specially wound to set up better radiation conditions in the component elements.

5. A close tolerance held on full resistance value for regular production units.

6. Controlled resistance wire quality from ingot to final drawing of wire sizes; resistance element is externally protected against damage.

7. Internal multiple fingers contact arm design, and reduces extraneous noises; assures a smooth operating rotation.

8. Terminal and mounting holes easily re-located for special applications; terminals are heavily tinned for adaptability in subsequent circuit hook-up.

9. Electrical power ratings and the mechanical characteristics are in accordance with National Electrical Manufacturers' Association standards.

ATTACK AGAIN AND AGAIN . . . BUY MORE WAR BONDS . . . NOW

DeJUR U.S.A.

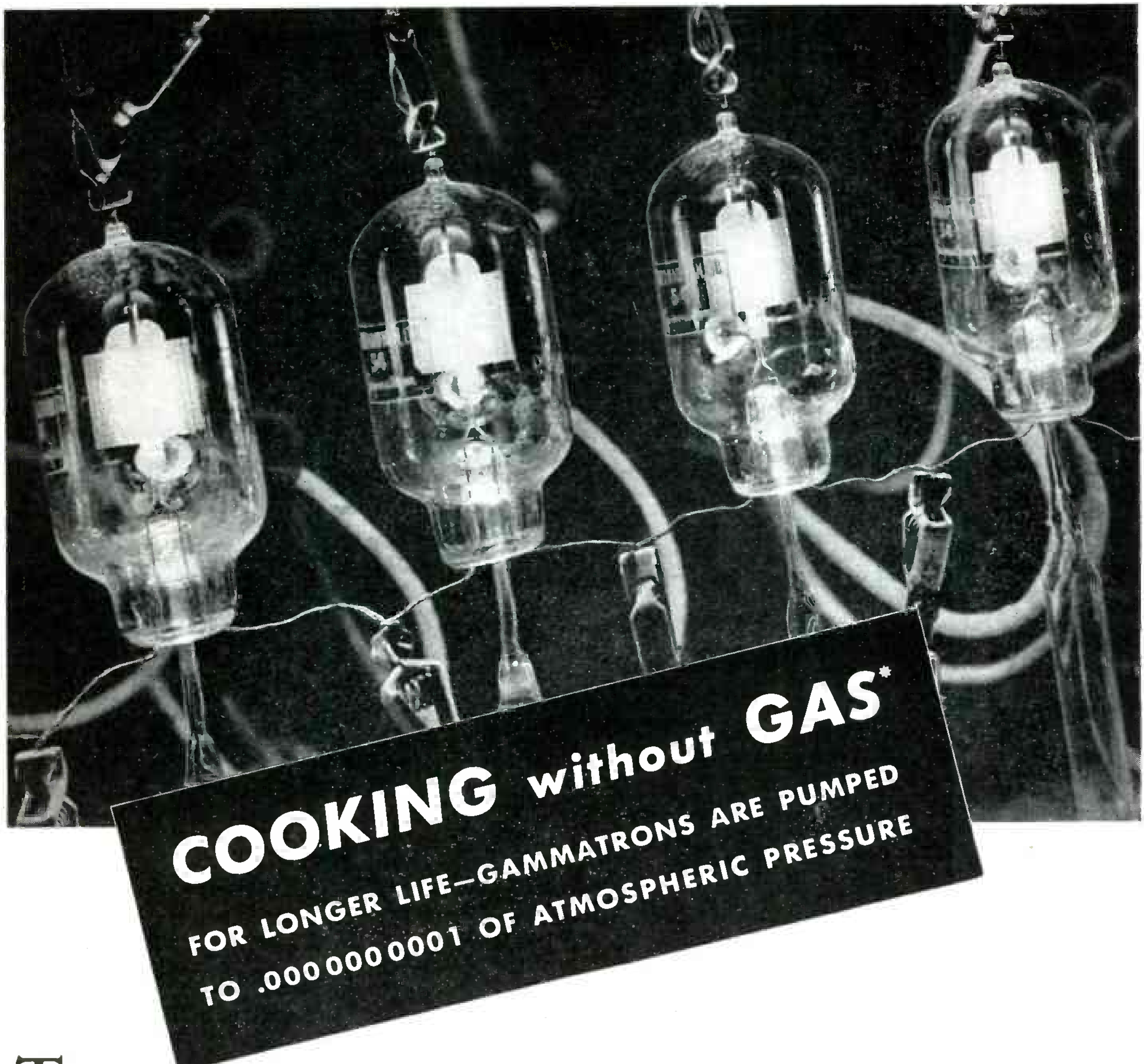
De Jur-Amsco Corporation

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

SHELTON, CONNECTICUT

AWARDED FOR EXCELLENCE IN PRODUCTION AND QUALITY OF MATERIEL — ARMY E NAVY

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



These Gammatron tubes are being submitted to an exhaust process so severe that only tubes made with tantalum elements can withstand it. They are "cooking" at 3,000° F, running at this temperature from 30 to 40 minutes. At the same time they are being pumped to create a vacuum equal to one ten-billionth of atmospheric pressure . . . the best commercial vacuum obtainable.

Heintz and Kaufman Ltd. has perfected such a rigorous pumping process to protect Gammatron tubes from filament bombardment. If many gas molecules remain in an evacuated tube, electrons traveling from the filament to the plate strike these molecules and ionize them. These ions, being positive, dart toward the filament, hitting with such force they strip the filament of its coating. This action, termed filament bombardment, materially shortens the life of a tube.

The severity of the Heintz and Kaufman exhausting process assures superior protection against filament bombardment, and thus adds to the operating life of all Gammatrons.

*(*Practically, but not precisely true. Even at .000 000 000 1 of atmospheric pressure, there are two billion gas molecules to the cubic centimeter of evacuated space.)*

HEINTZ AND KAUFMAN LTD.

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

Gammatron Tubes

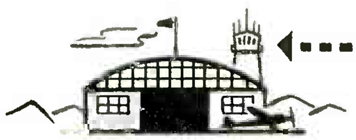
FOR VICTORY AND SECURITY BUY WAR BONDS

Radio Receptor Equipment — *the HEART of the AIRPORT*

At the world's largest and most modern civilian airports — Washington's National Airport, LaGuardia Airport and others —RADIO RECEPTOR airport traffic control radio equipment aids daily in controlling the arrival and departure of countless great airliners on their scheduled trips.

Along the far-flung skyways of the Army Air Forces—110,000 miles in length — RADIO RECEPTOR equipment serves the needs of our armed forces in moving men and materiel to all parts of the globe.

Your Airport



. . . though still in the project stage can also procure RADIO RECEPTOR'S reliable airport radio of the same superior type as supplied to the major civil airports and to the military, adapted to your special requirements. But, *you must plan now*—manufacturing facilities may be overtaxed when Victory comes.

Send for your *Airport Radio Questionnaire*—answer ten simple questions —and we will be in a position to advise you—no obligation. If you are interested in any way in a community airport, we shall be glad to aid you. Address, Desk E-4.

SIGNAL CORPS PHOTO

Airport Traffic Control Tower somewhere along the lines of the Army Air Forces.

RADIO RECEPTOR CO., INC.

251 WEST 19th STREET NEW YORK 11, N. Y.

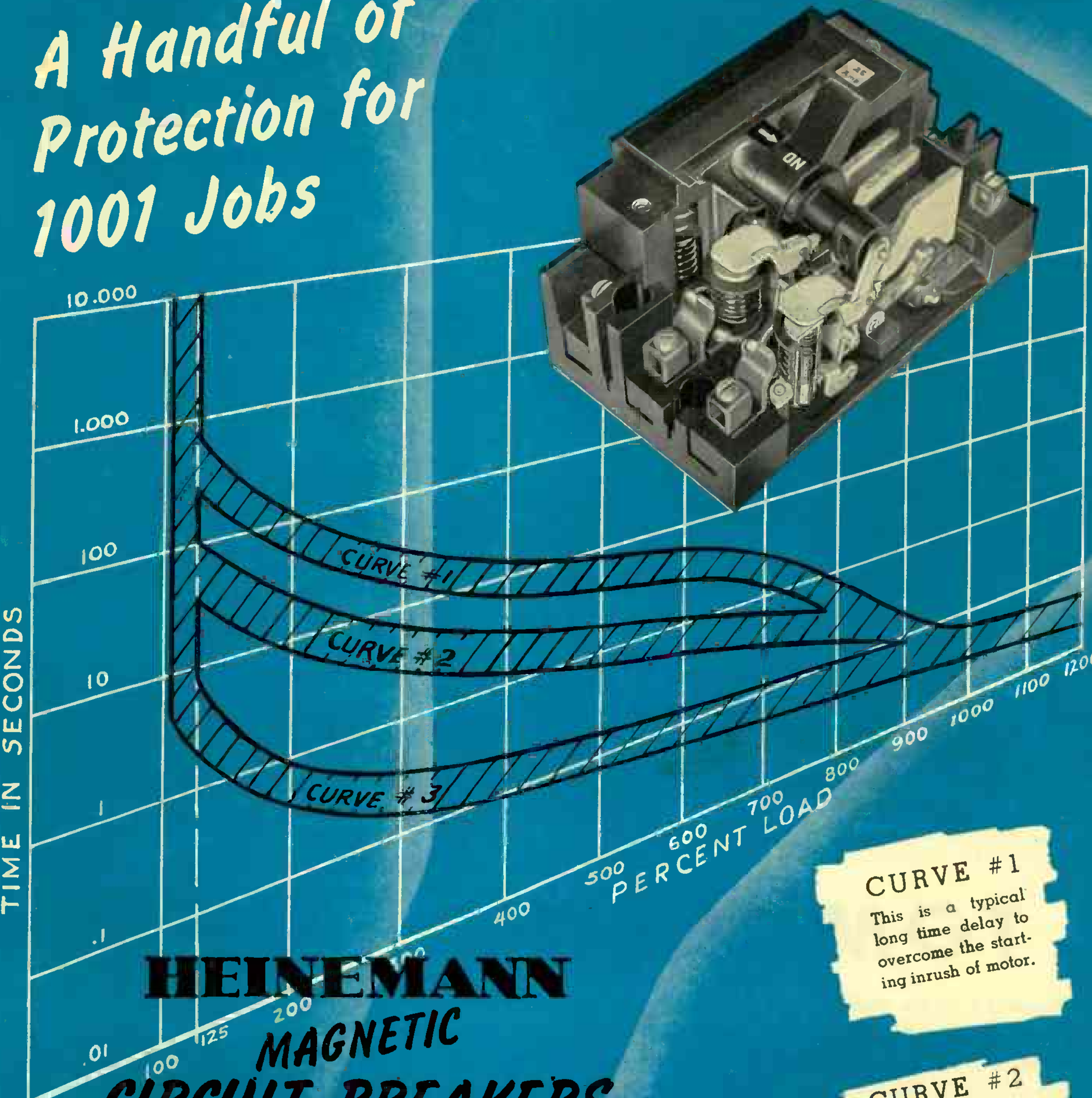
Engineers and Manufacturers of Airway and Airport Radio Equipment

SINCE 1922 IN RADIO AND ELECTRONICS

ARMY E NAVY

Awarded for Meritorious Service on the Production Front

A Handful of Protection for 1001 Jobs



HEINEMANN
MAGNETIC CIRCUIT BREAKERS

Here is a circuit breaker that has the ability to match closely the characteristics of the individual application simply by your selection of 1) the exact ampere rating and 2) the proper time curve. The breaker will hold 100% of rated load; *may* trip between 100% and 125% of rated load; and *will* trip at 125% and above as shown on the curve. Breakers are available in any rating between 10 milliamperes and 50 amperes with time delay in single, two, and three pole as shown. The same breaker can also be had with instantaneous trip for applications where current is applied gradually up to rated load. All instantaneous breakers are set to trip instantly.

CURVE #1
This is a typical long time delay to overcome the starting inrush of motor.

CURVE #2
This may be the ideal protection for small transformers since the breaker takes care of the relatively fast and high inrush of current when first connected to the line.

CURVE #3
This may be the ideal protection for a filament and plate circuit.

HEINEMANN CIRCUIT BREAKER CO.

Subsidiary of Heinemann Electric Co.—Est. 1888

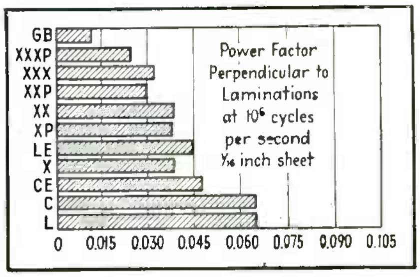
137 PLUM STREET TRENTON, N. J.

Yesterday *wouldn't get much of a reception* TODAY

POWER FACTOR VALUES IN DILECTO Laminated Phenolics*

Power factor may be considered an indication of the stability of the insulating material in question or a check of the uniformity of specimens. In some cases it is desirable to have low power factor, while in others it is not so important. In all cases, however, it is a useful means to indicate purity of composition and useful life under electrical stresses, as well as the efficiency of the insulator.

POWER FACTORS FOR STANDARD DILECTO GRADES



One of the standard test methods for power factor is called the "Resonant Circuit; Resistance Variation Method." Measurements are at 10^6 cycles per second. Equipment consists of a stable high-frequency generator, a vacuum tube voltmeter, decade resistors and a standard precision-type variable air condenser. Below, Mr. Freed is seen operating this equipment.

TOMORROW

Yesterday's radio would fall far short of doing justice to today's broadcasts. Few of us would have the patience to fool around with numerous dials to keep a station tuned in properly. Improved Electrical Insulating Materials have made an important contribution to the performance of today's radios, whether in use by our Armed Forces or by civilians.

The C-D Laboratory has made it unnecessary for Electrical and Design Engineers to "fool around" experimenting with numerous types of electrical insulating materials. C-D has developed grades and types of electrical insulating materials to meet specific and special problems. The "know-how" accumulated through solving thousands of electrical insulating problems is at your disposal to help you solve the question "What Insulating Material?"

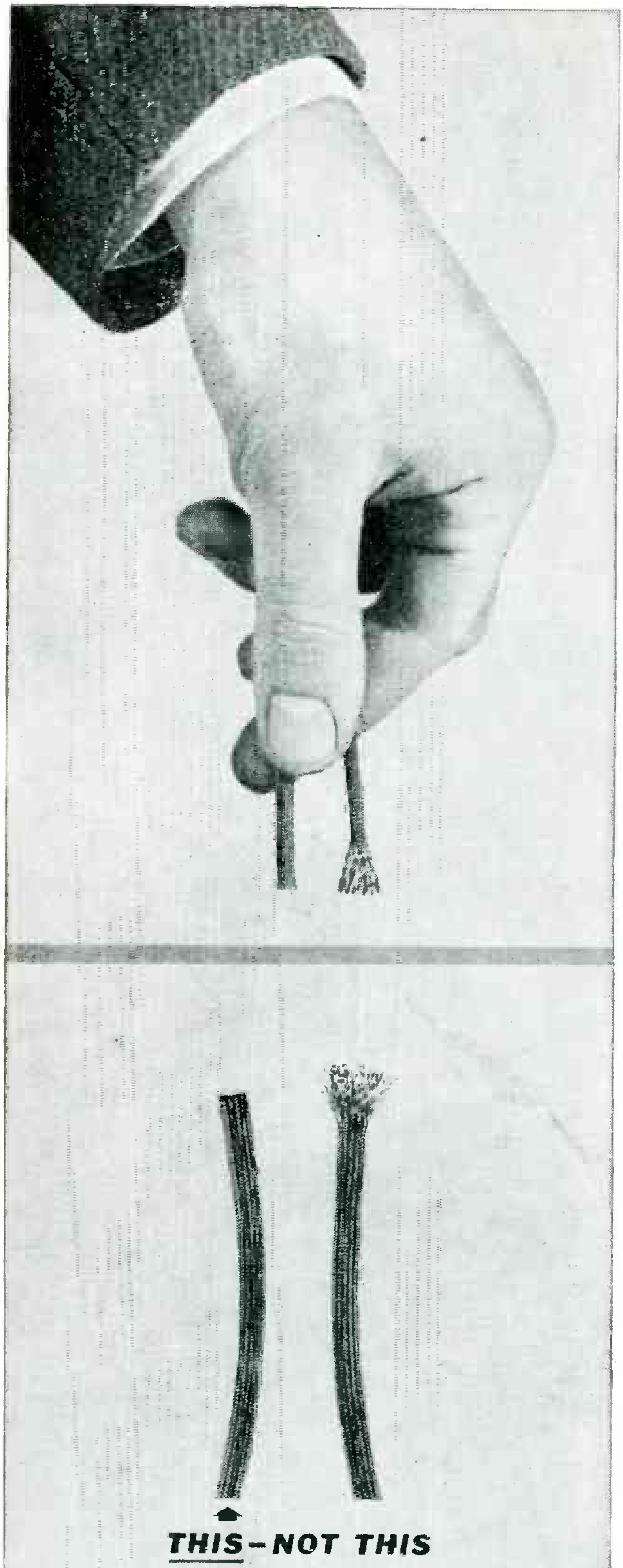
* Excerpts from an article on POWER FACTOR TESTS by J. R. Freed of the Continental-Diamond Laboratory Staff. A copy of the complete article will be sent on request.

CC-43

Continental-Diamond FIBRE COMPANY

Established 1895 . . Manufacturers of Laminated Plastics since 1911 — NEWARK • DELAWARE


SYMBOLS OF QUALITY
THE WALDORF ASTORIA
HAMILTON
The Watch of Railroad Accuracy
COLT
GOOD YEAR
ALCOA
ALCOA
Marshall Field & Company
NEW YORK CENTRAL SYSTEM
STETSON
Jensen
Manufacturers and Designers of Fine Acoustic Equipment



SNUB TEST

Proves non-fray feature of new BH Fiberglas Sleeving

NEW, BH Extra Flexible Fiberglas Sleeving *will not fray,* even under severe conditions. You can prove this *right at your desk*. It's easy as snubbing out a cigarette. Here's how:

Write us for a sample of BH Extra Flexible Fiberglas Sleeving equal in size to the saturated sleeving you use now.

Hold short pieces of both BH Fiberglas Sleeving and the usual saturated sleeving between your thumb and index finger, and snub the ends of both sleevings against your desk, similar to the way you would snub out a cigarette. Do this five to ten times, pressing hard.

BH Flexible Fiberglas Sleeving will spread slightly under this pressure, may fuzz a little, but *will not fray*. The usual saturated sleeving will break down at the edges and separate.

Continued snubbing will not noticeably affect the BH Extra Flexible Fiberglas Sleeving, whereas the saturated sleeving will readily unravel and become progressively worse.

NON-FRAYING • FLEXIBLE • HEAT-RESISTANT
NON-INFLAMMABLE • WATER-RESISTANT
NON-CRYSTALLIZING at LOW TEMPERATURES

The new BH Extra Flexible Fiberglas Sleeving is woven from the choicest continuous-filament Fiberglas yarns. It possesses high dielectric strength, is water-resistant and, like all BH Sleeving and Tubing—is non-inflammable.

All sizes from No. 20 to 5/8″, inclusive, are available. Write for samples of this radically new and different sleeving today—in the sizes you desire. Seeing is believing! Bentley, Harris Manufacturing Co., Dept. E, Conshohocken, Pa.

BH PRODUCTS

NON-BURNING IMPREGNATED MAGNETO TUBING • NON-BURNING FLEXIBLE VARNISHED TUBING • SATURATED AND NON-SATURATED SLEEVING

BENTLEY, HARRIS MANUFACTURING CO.
Conshohocken, Penna.

TO SERVE THE ELECTRONIC DEMANDS *of* AVIATION

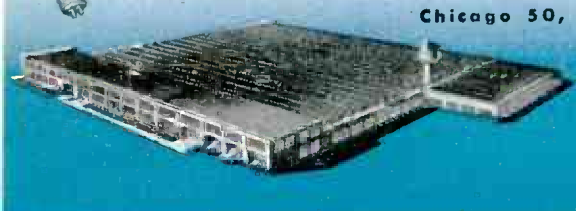
● When American planes concentrate over a target, the total of Amphenol aircraft and communications electrical parts in that area runs into the hundreds of thousands.

Such quantities suggest mass production . . . but two factors in Amphenol production are even more important than volume—(1) the highest precision attainable with modern equipment—(2) complete range of required types in all sizes. Only after these come the speed and savings of mass production.

Primarily, this is Amphenol's war achievement . . . but it is also a peacetime preparation in that it offers extraordinary facilities, for quantity, quality and engineering co-operation when the time comes.

Meanwhile many of these parts are available under proper priorities for current demands.

AMERICAN PHENOLIC CORPORATION
Chicago 50, Illinois



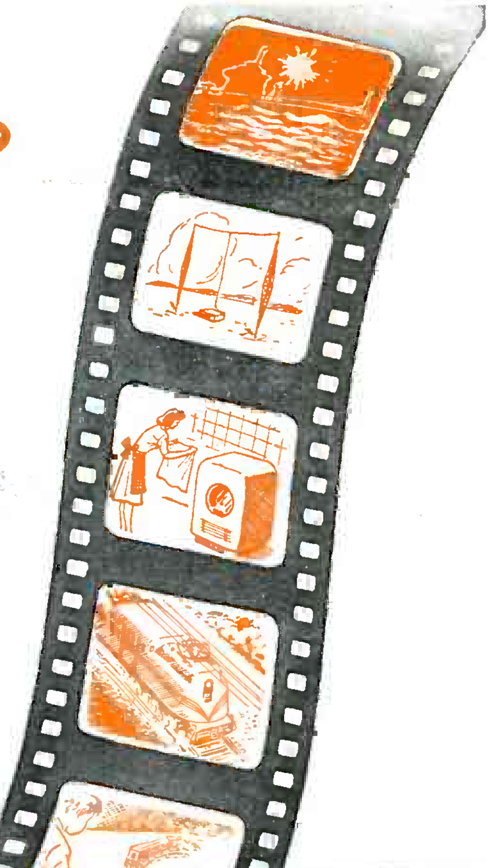
In Canada
Amphenol Limited, Toronto

COMPLETE DATA SHEETS AVAILABLE

Request by Section Letter

AN and 97 Connectors (Section A)
Special Connectors (Section A1)
Conduit Fittings (Section B)
Aircraft Electrical Conduit (Section B1)
Special Tools (Section C)
H.F. Transmission Lines and Equipment (Section D)
British Connectors (Section E)
Radio Parts & Accessories (Section F)
Synthetics for Electronics (Section G)

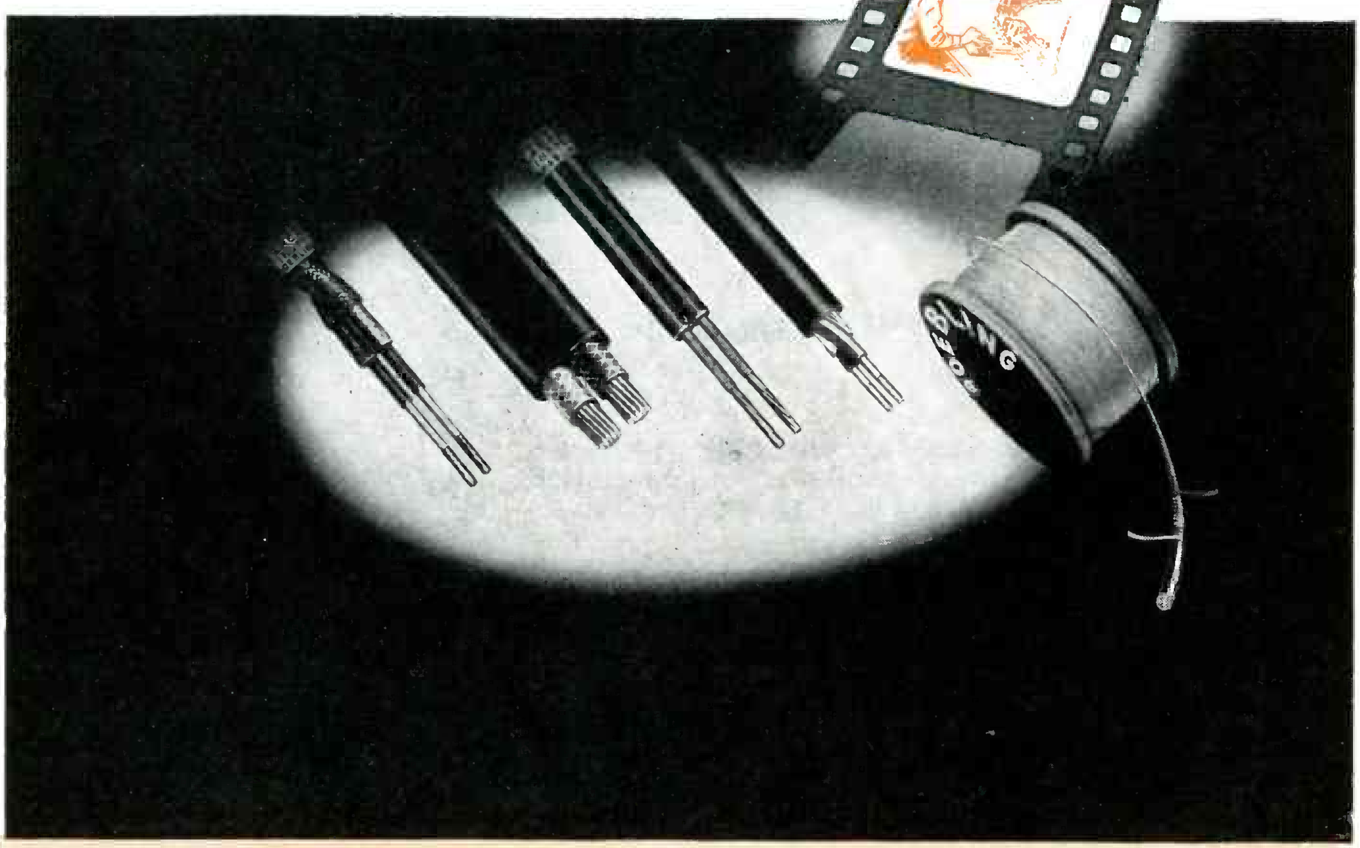
CAN YOU SEE THE *Quality?*



Where do you find *quality* in wire? In the metal itself? ...the insulation?...the sheathing or finish that the eye can see?...or the way they are put together? No, in Roebling Electrical Wires and Cables quality is the sum total of all of these—a result of wire specialization.

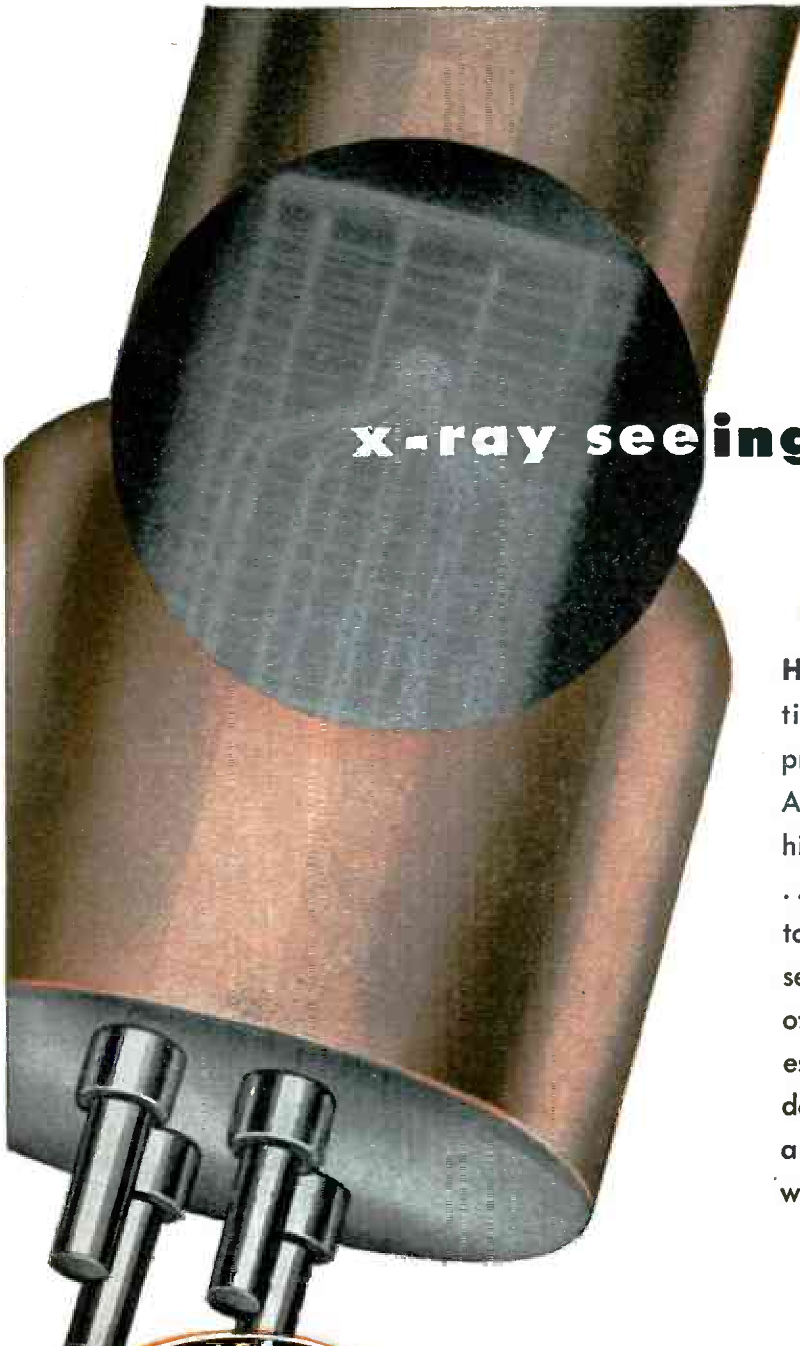
Your products can benefit from this quality. In the war equipment of today, performance takes priority. With return to peaceful times, performance will still be building reputations again. The reliability and integrity that have always characterized Roebling electrical conductors back up the quality of any product you make that uses wire.

JOHN A ROEBLING'S SONS COMPANY
TRENTON 2, NEW JERSEY
Branches and Warehouses in Principal Cities



ROEBLING PACEMAKER IN WIRE PRODUCTS

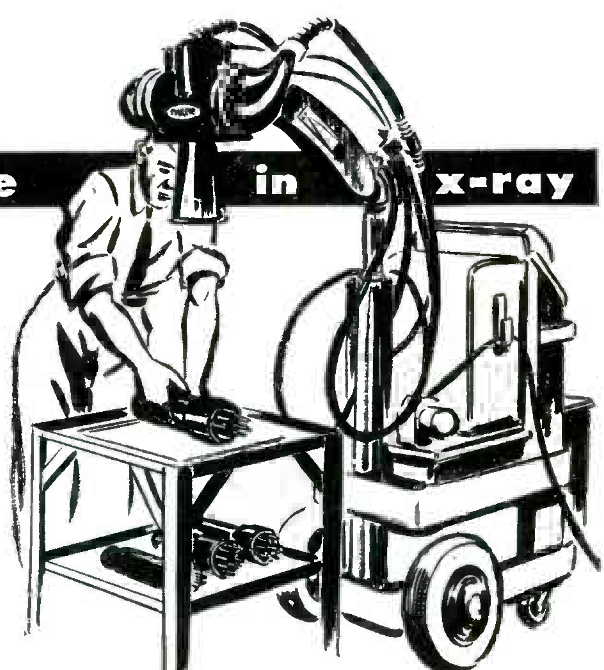
WIRE ROPE AND STRAND • FITTINGS • AERIAL WIRE ROPE SYSTEMS • COLD ROLLED STRIP • ROUND AND SHAPED WIRE
AIRCORD, SWAGED TERMINALS AND ASSEMBLIES • SUSPENSION BRIDGES AND CABLES • ELECTRICAL WIRES AND CABLES
WIRE CLOTH AND NETTING • HIGH AND LOW CARBON ACID AND BASIC OPEN HEARTH STEELS



hidden within $1/2''$ copper walls..yet x-ray seeing is ~~believing~~ knowing

Here is a typical application of non-destructive X-Ray inspection to the kind of tough problem which *it* alone can solve satisfactorily. An extremely complex grid-filament structure hidden deep within heavy copper tube walls ... yet X-Ray demonstrates, with precision, certainty and speed, any error in alignment and sealing of elements, broken connections or any of dozens of other faults which could otherwise escape detection until too late. Moreover, in doing all this, industrial radiography provides a permanent, visible check record at a cost well in line with routine production inspection.

industrial PICKER x-ray sets the pace in x-ray



The radiographic inspection operation described here is one of many being conducted routinely in electronic tube plants, and employing Picker 150 KV X-Ray Units, either stationary or mobile. Picker builds industrial X-Ray equipment in many models and capacities for every phase of industrial x-ray . . . radiography, fluoroscopy, and diffraction.

Branches in principal cities throughout the country. A Picker engineer near at hand will always be glad to discuss with you the application of x-ray to your own inspection problems.

PICKER X-RAY corporation
300 FOURTH AVENUE • NEW YORK 10, N. Y.
WAITE MANUFACTURING DIVISION, CLEVELAND, OHIO

THE KEY to many a new industrial development is frequently the right application of AC to DC Power Conversion. At the heart of many of today's electrical marvels is a BL Metallic Rectifier. Equipment designs once believed impossible or impractical are now in common daily operation rendering efficient, dependable service.

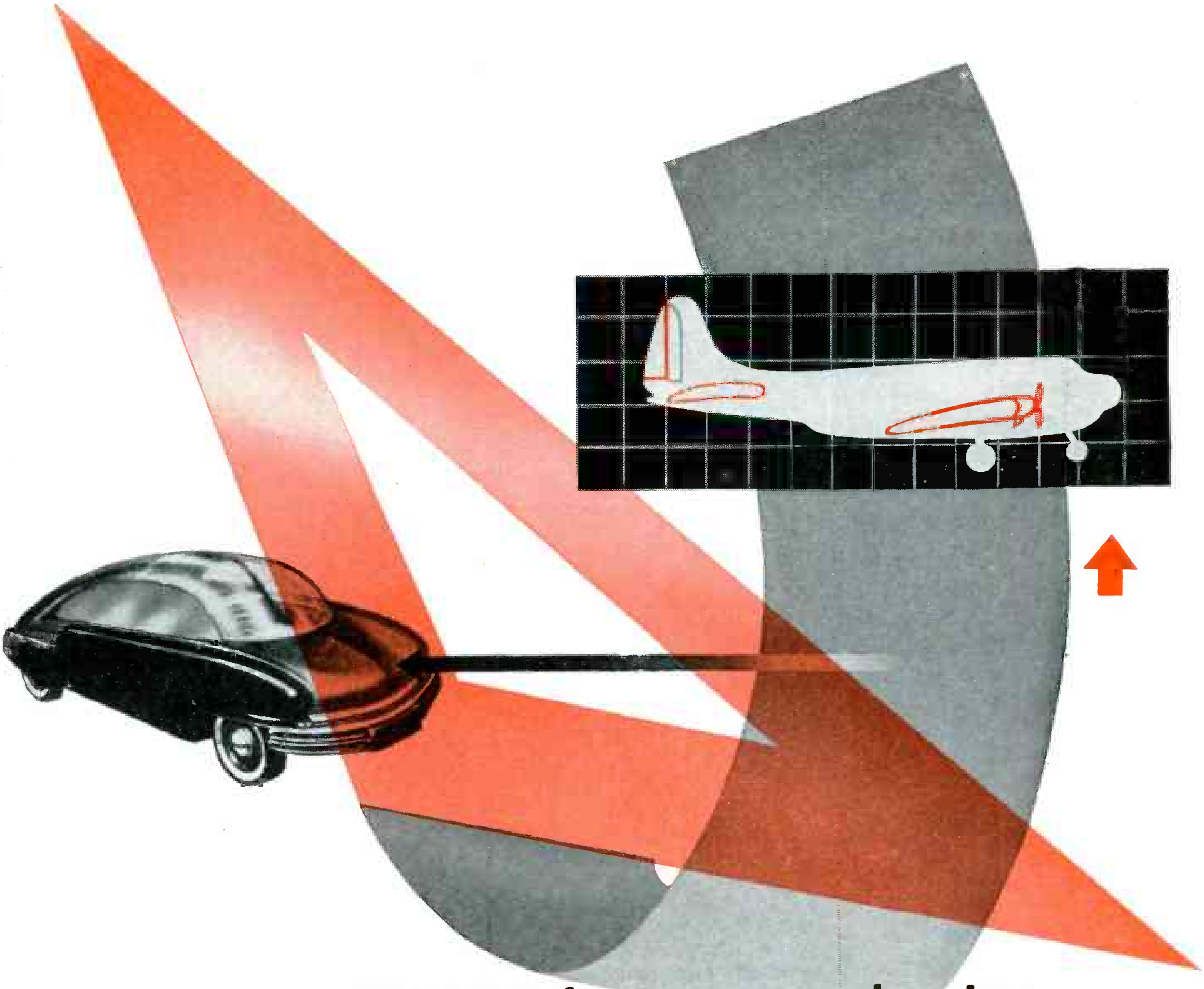
Are you working on any ideas involving DC Power Supplies, Metallic Rectifiers, or Conversion Assemblies? Our Engineers' experience in solving many such problems is at your service. Use it! There is no obligation.

Write for Bulletin No 93 giving details on B-L Metallic Rectifiers.

BL

THE BENWOOD LINZE COMPANY • ST. LOUIS 3, MO.

Designers and manufacturers of Copper Sulphide and Selenium Rectifiers, Battery Chargers, and D.C. Power Supplies for practically every requirement.



PLASTICS for post-war planning

"Cat's head," they call it. The core is Phenol Fibre—to eliminate moisture absorption and to increase dielectric strength. But because an electric arc will not carbonize Vulcanized Fibre, the front and back of the Cat's head are made of Vulcanized Fibre.

While there is still a war to be won, your principal concern, as well as ours, is to produce products that will speed victory. We are all giving our maximum attention and production-capacity to that vitally important objective.

But even the most pessimistic will agree that it is not too soon to *plan* and *think* for the post-war reconstruction period. Peace will dawn with the suddenness of a raised curtain and only those who are prepared for it will be able to swing into profitable, peace-time production with the minimum delay.

Figuring prominently in many a *profitable*, peace-time venture will be the intelligent use of Vulcanized Fibre and Phenol Fibre. In the design, application, and production of such products, Taylor Fibre is unsurpassed, thanks to Taylor's Verifibre Process in which quality is controlled step by step, from raw materials to finished product, in the industry's most modern plant.

Now—before the curtain goes up on a bright, new world, discuss your post-war plans with our engineers. *Now* is the time to Take it to Taylor.

TAYLOR FIBRE COMPANY

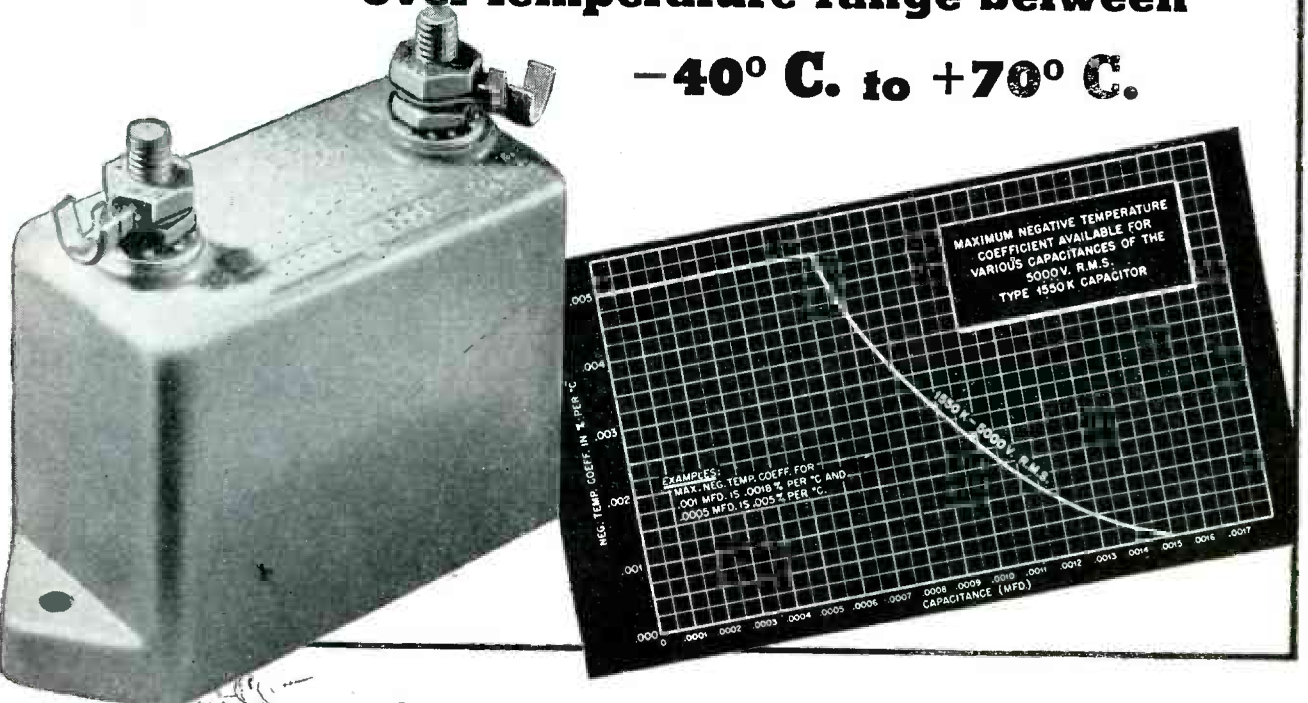
NORRISTOWN, PENNSYLVANIA • OFFICES IN PRINCIPAL CITIES • PACIFIC COAST HEADQUARTERS: 544 S. SAN PEDRO STREET, LOS ANGELES

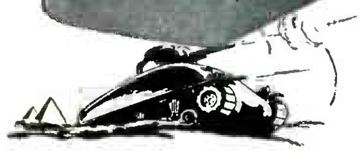
LAMINATED PLASTICS: VULCANIZED FIBRE · PHENOL FIBRE · SHEETS, RODS, TUBES, and FABRICATED PARTS

Accurately MAINTAINED CAPACITANCE

over temperature range between

−40° C. to +70° C.





Type K compensating capacitors are supplied only in low-loss (yellow) XM bakelite cases. Sealed for immersion.

Available in limited range of capacitances and voltage ratings as listed in latest catalog.

Obtainable in any temperature co-efficient from —.005% to +.005% per degree C. over temperature range from —40° C. to +70° C.

Standard tolerance is plus/minus 5%. Closer tolerances obtainable at extra cost. Minimum tolerance available is plus/minus 2% or 2 mmf., whichever is greater.

Can be used to correct normally positive temperature co-efficient of inductances for maintenance of constant L-C products (resonant frequency) of tuned circuits independent of temperature.

● Zero temperature co-efficient capacitors can be used wherever a capacitance *independent of temperature* is required. Furthermore, since Aerovox Type K compensating capacitors are also available in any temperature co-efficient from —.005% to +.005% per degree C., various circuits can be developed or refined to utilize the negative, zero or positive temperature co-efficients of such compensating capacitance. Examples:

One suggested application is as a shunt for the measurement of r.f. currents with a vacuum-tube voltmeter as the indicating instrument.

Compensating capacitors may be used in radio range beacons where it is essential to maintain uniform currents both in magnitude and phase relationship simultaneously in several circuits, regardless of wide temperature changes.

By the use of compensating capacitors it is feasible to obtain oscillator frequency stability comparable with that obtained from quartz crystals, and with marked economies in weight, space, cost.

Therefore, when you face the problem of maintaining constant operational characteristics despite temperature variations, just specify Aerovox Type K compensating capacitors.

● ***WRITE FOR LITERATURE...***

Aerovox Type K compensating capacitor curves, technical details and listings, are included in the new Aerovox Capacitor Manual. Write on your business stationery, for your copy.

AEROVOX *Capacitors*

INDIVIDUALLY TESTED

AEROVOX CORPORATION, NEW BEDFORD, MASS., U. S. A. • SALES OFFICES IN ALL PRINCIPAL CITIES

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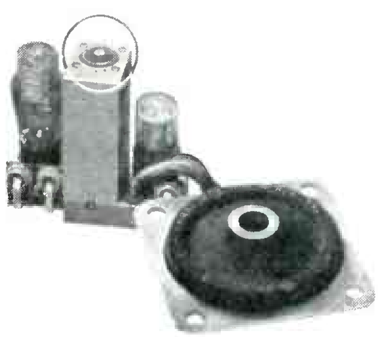
LORD
BONDED RUBBER
Shear Type
MOUNTINGS

FOR *Engineered* PROTECTION

Depend Upon Specialists in Vibration Control



MOUNTING ELECTRONIC CONTROLS
(ASSEMBLY BY SANBORN CO.)

INDIVIDUAL METER MOUNTING

"Engineered Protection" against the disastrous effects of shock and vibration for all types of equipment involves only:

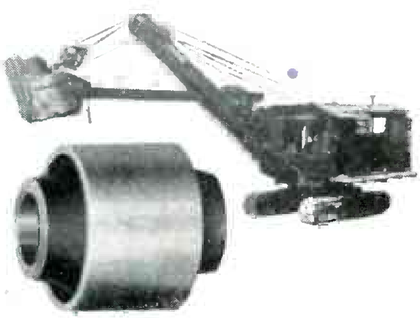
1. Provision in your designs for the use of flexible mountings.
2. Selection of mountings which are of the proper type, size, deflection, and load rating.
3. The correct positioning of the mountings in relation to the direction of the disturbing forces.

Lord Shear-Type Mountings fulfill the requirements of Engineered Protection. They are the result of 20 years' specialization in the design and production of bonded rubber-to-metal products. Lord Mountings are produced in a few basic shapes, but in a multiplicity of sizes, to cover any loading from ½ lb. to thousands of pounds, with deflection ratings from 1/16" to ½". Vibration Isolation efficiencies from 75% to 85% are commonly obtained, and up to 97% in the case of equipment operating at very high frequencies.

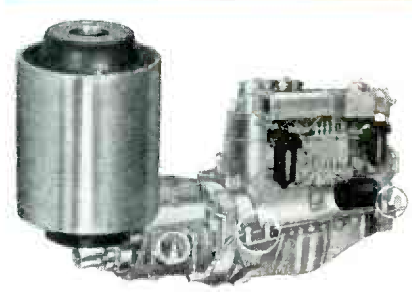
The use of flexible mountings will prolong equipment life, lower maintenance cost, insure accuracy of operation, reduce weights by eliminating necessity for inertia masses, and cut down noise by breaking up metallic paths for sound travel. The illustrations show a few applications of widely varied types, all of which fulfill in detail the requirements of, and have gained the benefits of, engineered protection.

For complete information covering all Lord Mountings, as well as engineering discussion on vibration control, write for Bulletins 103 and 104.

Let's All Back The Attack
BUY WAR BONDS



MOUNTINGS ON INDUSTRIAL EQUIPMENT
(ASSEMBLY BY MARION STEAM SHOVEL CO.)



MOUNTING GASOLINE ENGINES
(ENGINE BY KERMATH)

IT TAKES RUBBER *In Shear* TO ABSORB VIBRATION

LORD MANUFACTURING COMPANY
ERIE, PENNSYLVANIA

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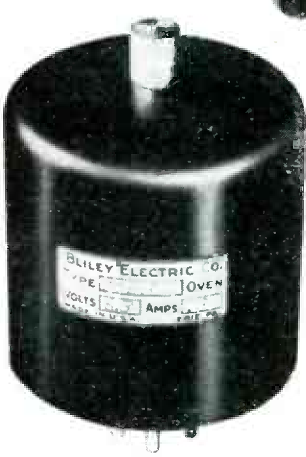
CANADIAN REPRESENTATIVES
RAILWAY & POWER ENGINEERING CORP., LTD.
TORONTO, CANADA

Originators of Shear Type Bonded Rubber Mountings

STANDARD OF EXCELLENCE



TODAY, the entire output of Bliley Crystal Units is directed to vital communications equipment for war purposes. When the United Nations win the last battle, as they most certainly will, the fruits of increased engineering knowledge, expanded facilities and improved production technique, will be available to a peace time world . . . a new world of greater human comfort through applied engineering and science.

In this new world, Bliley Crystals will take their rightful place with their pre-war record of dependability, accuracy and user acceptance. Not counting applications covered by war time secrecy necessities, there will be Bliley Precision-made Crystals for diathermy, ultrasonic generators, pressure gauges, carrier-current communications systems, radio frequency filters, and precision interval timers. And, of course, in greater quantities than ever before, frequency controlling crystal units for all radio communication necessities, F. M. or A. M., fixed, portable, mobile or air borne. As always, Bliley Engineers are ready to extend their assistance to you . . . call on them freely.

Let's All Back The Attack—BUY MORE WAR BONDS

BLILEY ELECTRIC COMPANY - - - ERIE, PA.

Bliley Crystals

IMPROVED radiotelegraph communications from

NEW McELROY

ELECTRONIC CODE TAPE PERFORATOR PFR-443-A

Every ship and every marine station should and probably will, eventually, be equipped with perforator and transmitter.

Marine radiotelegraph communications were given a substantial boost in efficiency when Ted McElroy perfected the McElroy Code Tape Perforator PFR-443. This new model . . . the PFR-443-A . . . represents an even greater advancement in reducing the human margin of error. Entirely mechanical, the PFR-443-A comprises two units: The Keying Unit which is made up of an assembly of two keys, the space bar and punching mechanism; plus the Electronic Unit which relieves the keying contacts of high current and voltage, and provides for utmost ease in operation.

Operation of the PFR-443-A is similar to a semi-automatic ("bug") key excepting that the transmission of dots and dashes is automatic. A light touch actuates the punching mechanism for as long as either the key or space bar is depressed. Experienced operators can maintain, with ease, an accurate speed of more than 40 words per minute . . . in all Morse combinations assigned to the Russian, Turkish, Greek, Arabic and Japanese alphabets and languages, which are not found on the keyboards of standard perforators manufactured in the United States and Great Britain. ***Write for additional information.***

McElroy engineers never imitate . . . never copy
We CREATE . . . DESIGN . . . BUILD

McElroy MANUFACTURING CORPORATION
82 BROOKLINE AVENUE
BOSTON, MASS.

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When Voltage Must Walk The "STRAIGHT AND NARROW"

USE THE "RH" TRANSTAT

FOR ANY COMMERCIAL OR AIRCRAFT FREQUENCY, VOLTAGES UP TO 480

The type "RH" Transtat was developed for electronic applications where voltage must be continuously adjustable in minute fractional-volt increments, or line fluctuations must have instant and accurate compensation. In achieving such results, these regulators sacrifice neither high electrical efficiency nor extreme compactness.

Like other Transtats, this is a highly efficient transformer type regulator that does not distort wave form or interfere with radio reception. The velvety smooth Transtat system that controls without circuit interruption is further refined by Vernier type actuation and innovations in the core, coil and commutator construction.

If you wish improved efficiency and wider latitude in designing your electrical apparatus, consider the advantages of the compact, lightweight "RH" Transtat as a component. Write for Bulletin 51-2E.

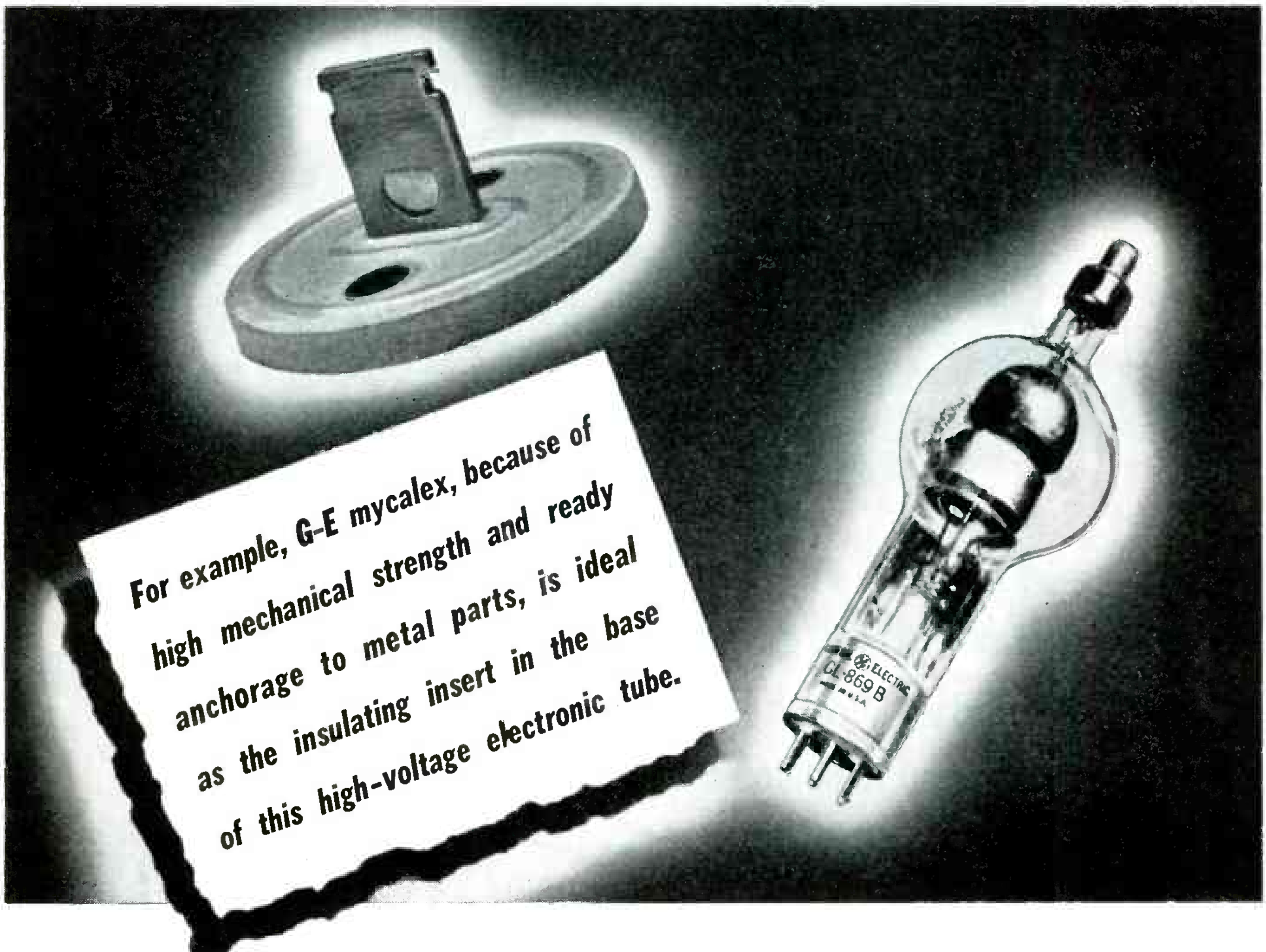
THE AMERICAN TRANSFORMER COMPANY
178 EMMET STREET NEWARK 5, N. J.

Pioneer Manufacturers of Transformers, Reactors and Rectifiers for Electronics and Power Transmission

AMERTRAN

MANUFACTURING SINCE 1901 AT NEWARK, N. J.

G-E MYCALEX—THE HIGH-FREQUENCY INSULATION WITH A THOUSAND AND ONE USES



DON'T be surprised where you find G-E mycalex. This outstanding, high-frequency insulating material has a thousand and one applications. Consider the important properties it has.

High dielectric strength—low power factor — prolonged resistance to electric arcs—ready anchorage of metallic inserts within the body of the material during the molding operation.

These are but a few of the reasons why G-E mycalex has been for more than 21 years helping to solve the toughest insulation problems.

More and more manufacturers today are using G-E mycalex fabricated to their own specifications. There are specialists in fabrication who can serve you right now.

If you want a list of these fabricators — a free sample of G-E mycalex and a copy of the data bulletin, "G-E Compression-Molded Mycalex"— please fill out the coupon.

Remember, when you choose G-E mycalex, you get the full benefit of General Electric's unequaled experience in the application of this amazing material. . . . *General Electric, Schenectady, N. Y.*

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

FREE
G-E MYCALEX BULLETIN

ELECTRONICS DEPARTMENT
GENERAL ELECTRIC CO.
Schenectady, N. Y.

Please send a free sample of G-E mycalex and your descriptive booklet explaining the methods and tools to use for machining G-E mycalex.

(If you wish a list of fabricators of G-E mycalex, check here.........)

Name ________________

Company ________________

Address ________________

____

Over 21 Years of Mycalex Experience — Your Assurance of Quality

GENERAL ELECTRIC

177-M-C2-9915

Here is a Frequency Meter that drives a Recorder without need for Auxiliary Amplifiers

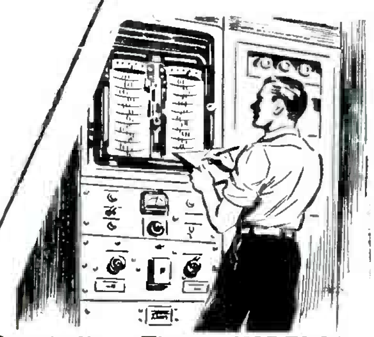
The *Norelco* Direct Reading Frequency Meter

8 Ranges: 0 to 50,000 Cycles

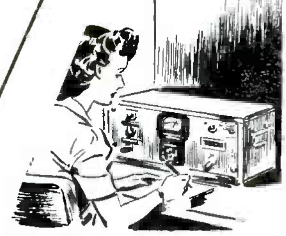
This new NORELCO instrument is an accurate, sensitive and versatile tool for laboratory or factory, adaptable to many regular or special uses and capable of directly driving standard 5 milliampere recorders.

Both the meter and recorder (when one is in use) are protected against overload by a sensitive relay which operates instantly in case a frequency higher than maximum reading of range in use is applied to input.

Write for complete information on this new meter, so that you may be able to decide for yourself its true value in your own plant.



Easy to Use—The new NORELCO meter is supplied in either sturdy oak cabinet (main illustration) or for standard rack mounting and can be used with standard 5MA recorders.



Easy to Read—The direct reading feature throughout the eight ranges, from 0 to 50,000 cycles facilitates measurements, particularly by unskilled operators.

For Army and Navy communications we make Quartz Oscillator Plates; Amplifier, Transmitting, Rectifier and Cathode Ray Tubes. *For war industries* we make Searchray (X-ray) apparatus, X-ray Diffraction Apparatus; Electronic Measuring Instruments; Direct Reading Frequency Meters; High Frequency Heating Equipment; Tungsten and Molybdenum products; Fine Wire in many metals and various finishes; Diamond Dies.

And for Victory we say: Buy More War Bonds!

Norelco ELECTRONIC PRODUCTS by

NORTH AMERICAN PHILIPS COMPANY, INC.

Executive Offices: 100 East 42nd Street, New York 17, New York
Factories in Dobbs Ferry, New York; Mount Vernon, New York (Metalix Division); Lewiston, Maine (Elmet Division)
Represented in Canada by Electrical Trading Co., Ltd., Montreal

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As PERMANENT as the North star, AlSiMag Steatite Insulators are hard, strong, rigid . . . impervious to moisture . . . resistant to heat and cold.

The stability of AlSiMag steatite ceramics lends rigidity and permanence to electronic circuits—affording constancy under climatic or other operating conditions.

Our Engineering and Research Staff is ready at all times to cooperate in developing the most practical design for insulators and to aid in selecting the most suitable of the numerous AlSiMag bodies.

Today for our fighting forces, Tomorrow for the miraculous electronic devices of Peace . . . American Lava is pledged to this Principle: Production to the highest standards . . . Research to find a better product.

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Army-Navy "E"
First Awarded July 27, 1942
Second Award: "Star" February 13, 1943
Third Award: "Star" September 25, 1943

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OUT OF TODAY'S RESEARCH
TOMORROW IS ENGINEERED

STEATITE CERAMIC INSULATORS

CHARACTERISTICS TAILORED TO YOUR REQUIREMENTS

American Phillips Screws are saving an average of 50% of war-production assembly time for two reasons:

1. *Faster Driving Methods.* The snug fit between the Phillips bit point and the tapered Phillips recess prevents the driver from slipping out of the recess, and permits change-over to electric and pneumatic driving, greatly decreasing the driving time over the slower hand-driving method.

2. *No Spoiled Work.* The non-slipping feature eliminates spoiled work and lost-time accidents. Every screw is driven up straight and tight.

These substantial savings in time and materials make American Phillips Screws *the fastest method of war production screwdriving under any conditions.* And when we return to peacetime production, these savings will lower the over-all cost of screw-driving assembly.

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PROVIDENCE 1, RHODE ISLAND

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American Screw Company manufactures a complete line of Phillips Recessed Head Screws, in a full range of sizes, and with all styles of heads.

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B. American Phillips Wood Screws.

C. American Phillips Hardened Self-Tapping Sheet Metal Screws.

D. American Phillips Stove Bolts.

Put the Screws on the Axis... BUY WAR BONDS!

Hepplewhite won fame on design alone. Others could use equally good wood and cut just as good dowels and dovetails. But in today's competition you can and must back better design with superior materials tailored to the function of your products.

Chemicals have been tailored into dozens of plastics and each like Formica laminated plastic into many grades with differing properties which make them exceptional for specialized use.

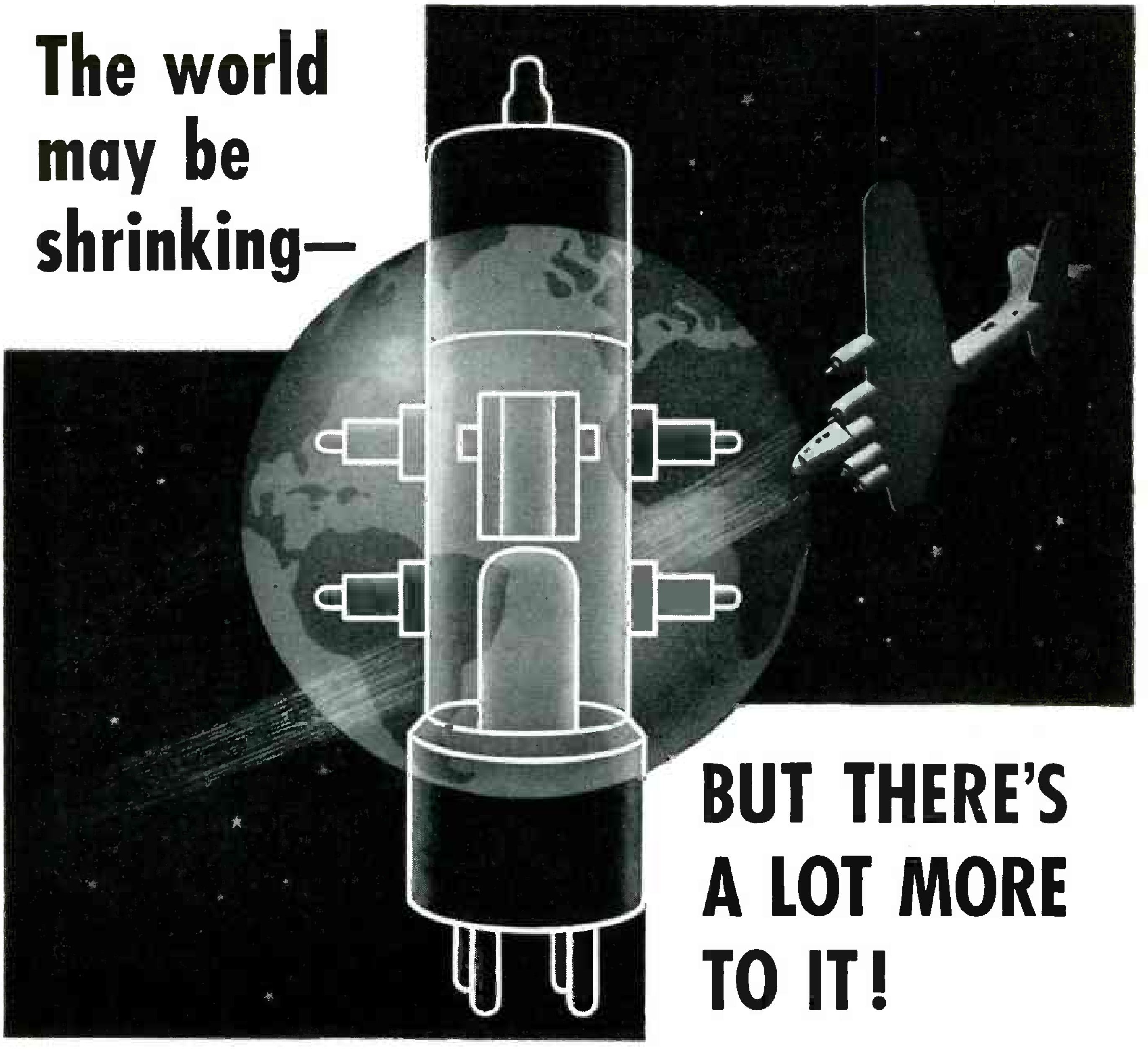
The strength, machineability, dielectric properties, stability of dimensions, moisture and acid resistence of Formica have caused its wide application in communications and other electrical uses. Now is the time to inquire about the interesting properties recent Formica research makes available for your post war products.

ARMY E NAVY

THE FORMICA INSULATION COMPANY
4661 Spring Grove Avenue
CINCINNATI 32, OHIO

FORMICA

The world may be shrinking—



BUT THERE'S A LOT MORE TO IT!

Right now, in action on ships and planes and vehicles, there are radio and electronic applications that were vague dreams a few short years ago. They were built for war, but their principles promise new products and refinements to enrich the peace that follows.

It has been Delco Radio's privilege to work closely with Army and Navy engineers in exploring the possibilities of radio and electronic equipment. Many problems of design have been solved through cooperative research—many problems of production overcome by Delco Radio's experience as a large manufacturer of precision radio instruments. From laboratory to drawing board to production line, Delco Radio has been in on the job of making electronics practical for mobile artillery, tanks, aircraft, ships and field units.

This accumulated experience is a reservoir of technical knowledge that will add a lot to the world of tomorrow.

Put your dollars "in action"

BUY MORE WAR BONDS

Delco Radio

DIVISION OF

GENERAL MOTORS


Sangamo Capacitors Can Take It!
Climatic conditions, under which various communications equipments are operated, vary from the sub-zero temperatures of the northernmost climates to the tropical temperatures encountered at the equator. Conditions of humidity cover the extreme range; from the dry arid regions of the many deserts, to the almost 100% humidity in tropical and sub-tropical atolls.
It has been the problem of Sangamo engineers to design and produce capacitors that perform faithfully under these varying conditions, and so assure vitally needed communications at all times.
The wide variety of capacitors illustrated insures the availability of the proper unit for almost any mica capacitor requirement.
SANGAMO ELECTRIC COMPANY
SPRINGFIELD, ILLINOIS
MICA CAPACITOR
Sangamo Electric Co.
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This little *Smooth Power* motor weighs less than two pounds, but it does some mighty important work. On many fronts, the vital job of maintaining communications between our fighting forces is helped by this little motor.

It comes from a long line of *Smooth Power* motors, that for years have been driving such mechanisms as tape recorders, record changers, turntables, motion displays and such devices. Where smooth starting, quick pick-up and velvety running are prime requirements, you're quite likely to find *Smooth Power* motors on the job.

But, we know that many new peacetime products which are now on the drafting boards or in experimental changes will need small motors. We'd like to know more about these, to see if more work can't be found for our *Smooth Power* motors in homes, commerce and industry.

If you're planning such products . . . or if you are thinking about other postwar developments involving comparatively small electrical or mechanical devices, perhaps we can help you. We've a plant that is completely equipped for such work. While we're busy right now on War demands, we like to think about keeping busy in the future... and we'd like to have you think about us, too.

THE GENERAL INDUSTRIES COMPANY
METAL PRODUCTS

THE GENERAL INDUSTRIES COMPANY
Elyria **Ohio**


COMMUNICATIONS FOR
. . . –VICTORY!
BOUGAINVILLE
GUADALCANAL
NEW GUINEA
AUSTRALIA
New Supreme "Hairline Accuracy" Meter
Allied lives . . . Allied victories . . . depend upon the Communication waves and wires. These channels of contact must be kept open. Our fighting men rely on the accuracy, dependability and ease of operation of Supreme Instruments and Meters, assured by Supreme's 15 years of experience.
Supreme Radio Testing Equipment Keeps Communications Open.
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SUPREME INSTRUMENTS CORP.
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Cathode Ray Oscillographs
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No. 1 of a Series Based on the Role of Insl-x
In War and Peace

PIONEERS IN PROTECTION

Our forces in the Pacific fight more than just Japs. Tropical humidity and fungus "go together" but destructive fungus and vital radio equipment do not.

To help our forces lick fungus, Insl-x engineers have developed the premier moisture proofing, fungus resisting over-all treatment for electrical equipment. The toxicant used in Insl-x No. 25 far exceeds government specifications, yet ***is non-toxic to humans.***

Insl-x engineers are now at work developing new insulating coatings to help speed victory—but always with a mind to improving post-war living.

●

Write for Literature

THE INSL-X CO., Inc.

Dept. EL 857 Meeker Avenue, Brooklyn, N. Y.

APPROVED UNDER SIGNAL CORPS SPEC. 71-2202A

INSL-X #25

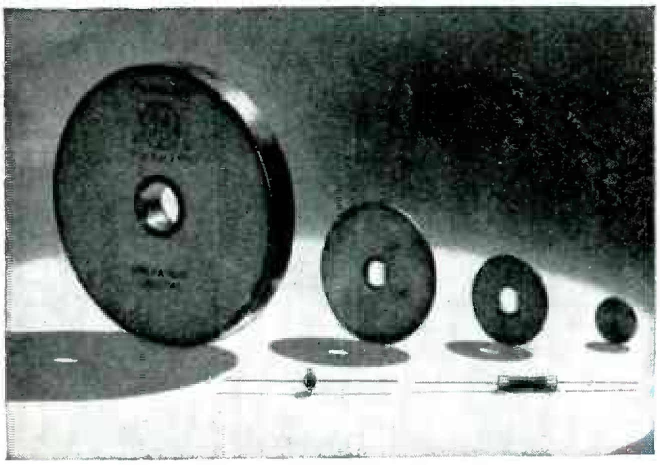
MOISTURE & FUNGUS RESISTANT COATING FOR OVER-ALL TREATMENT OF ASSEMBLED GROUND EQUIPMENT

- Exceeds government specifications for fungus resistance by several hundred per cent. Equally potent in killing higher bacterial forms.
- **Non-Toxic to humans — Official tests show Insl-x will not cause Dermatitis.**
- Moisture proof (wet di-electric strength over 500 v/m).
- Extra fast drying at room temperature. "Tack free" in less than 15 minutes. Hard in less than an hour.
- Adaptable for use on other types of equipment.


TEST POWER
—as you need it!
ONE PHASE
TWO PHASE
THREE PHASE
TAKE ONE CML 1420-A GENERATOR: This gives you 250 watts of power through a frequency range of 50—6,000 cycles at 80-120-135-270 volts. 3% regulation no load to full load; maximum distortion, 6%.
ADD ONE CML 1420 GENERATOR: This gives you 250 watts at *any two* frequencies in the range, or 500 watts of two-phase power with the phase relationship adjustable through 360°.
ADD STILL ANOTHER CML 1420 GENERATOR: This gives you 250 watts at *any three* frequencies in the range, or 750 watts of three-phase power with two phases adjustable through 360° with respect to the third phase. With either Delta or "Wye" output corrections.
WRITE FOR DESCRIPTIVE BULLETINS
COMMUNICATION MEASUREMENTS LABORATORY
Rotobridge · Electronic Generators · Power Supply Units
120 GREENWICH STREET
NEW YORK 6

... can Thyrite GET AROUND IT?

THYRITE—the G-E nonlinear resistance material

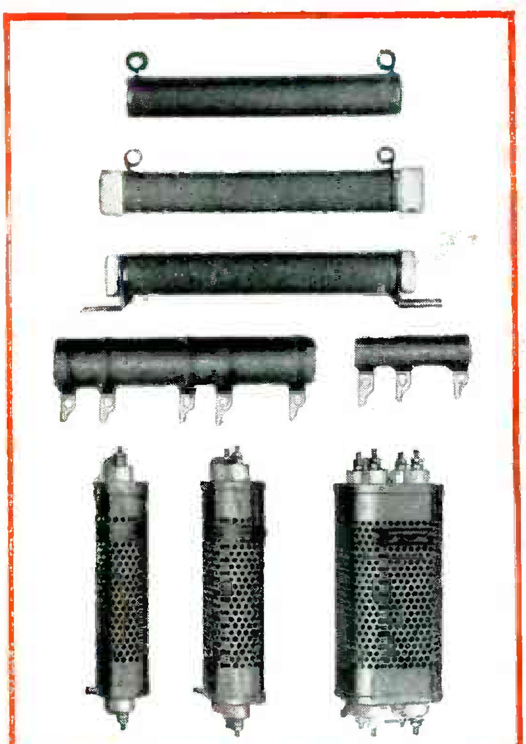


Typical forms of G-E Thyrite resistors

Thyrite is a silicon-carbide ceramic material, dense and mechanically strong. Its nonlinear resistance characteristic is stable, and substantially independent of polarity or frequency. Thyrite has been used for 14 years in many important applications, including electronic. Thyrite can be produced in various shapes and sizes (those which can be successfully molded). Among its countless applications are:

1. Circuit protection (by limiting voltage surges)
2. As a stabilizing influence on circuits supplied by rectifiers
3. As a potentiometer (making division of voltage substantially independent of load current)
4. For controlling voltage-selective circuits

G-E VITREOUS-ENAMEL RESISTORS



Typical construction of G-E enameled resistors

These resistors employ a strong, high-heat-resisting body developed to withstand sudden and extreme changes in temperature. Their resistance remains nearly constant through temperature changes, because of the low temperature coefficient of the resistance wire. The enamel, in which the wire is embedded, is fused at high temperature to a uniform glassy structure. It is moistureproof, durable, and forms a mechanically air-tight casing.

Made in a wide range of resistance and current values, from 10- to 180-watt units, G-E enameled resistors are available in a wide variety of constructions, which include the addition of stranded copper leads, circular-band terminals, copper leads and porcelain bushings, Edison screw bases, etc.

They also are available in virtually every required style—open or enclosed, for any style of mounting.

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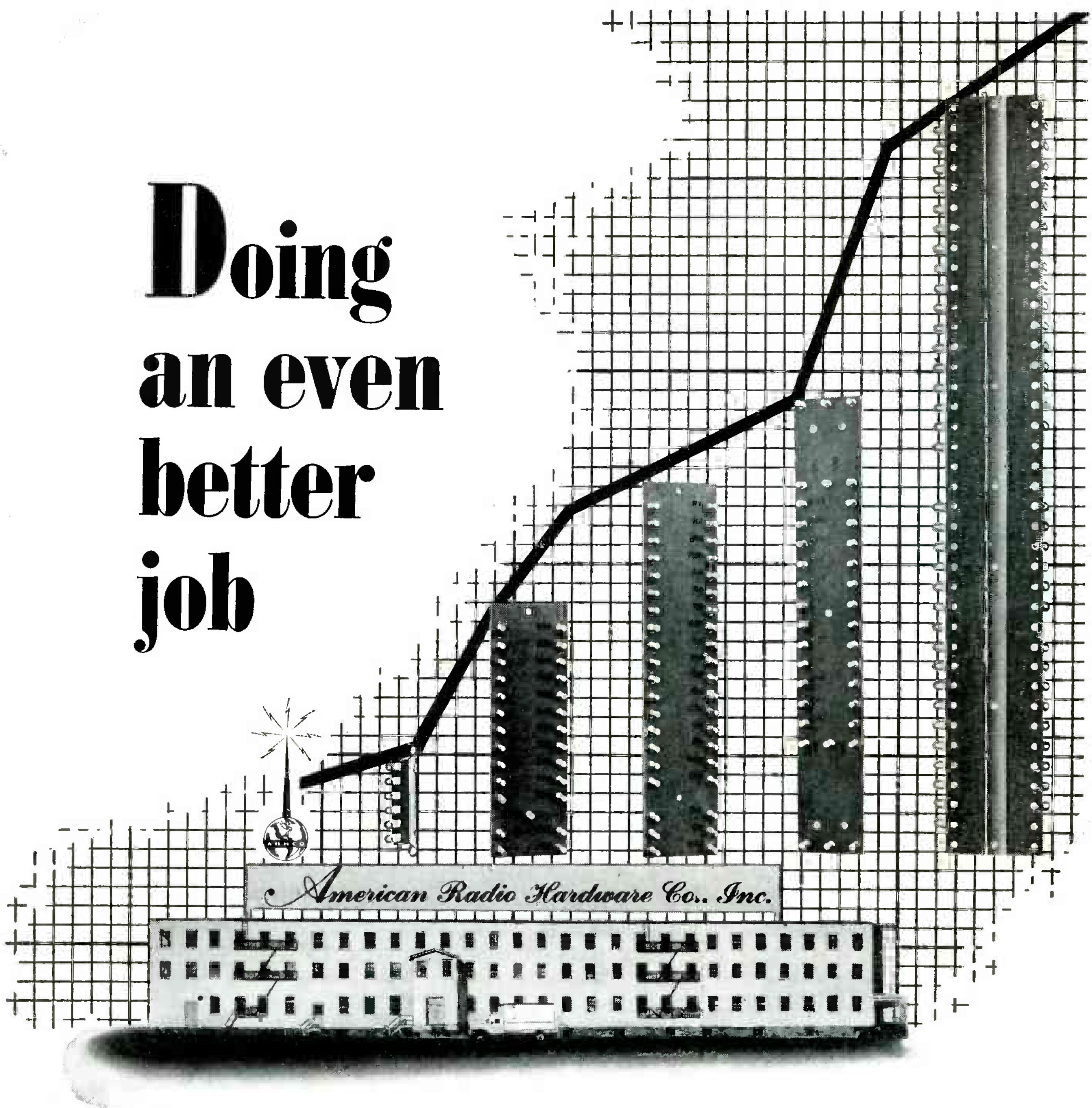
COMPONENTS for ELECTRONIC EQUIPMENT

GENERAL ELECTRIC

Doing an even better job



We were doing a splendid job of war production before the opening of our new plant. Today we're doing an even better job. Increased ARHCO facilities comprise the most modern manufacturing equipment . . . especially designed and developed for us. Every inch of space has been planned to yield the utmost capacity. Each worker utilizes his highest skill.

ARHCO components are dependable "right hands" in countless radar, radionic and electrical applications. They're made right. They work right. We've set our sights high for quality and efficiency . . . the performance of ARHCO components, under current rigid specifications, demonstrates our ability to make good. Your inquiries are invited . . . for present or peacetime techniques.

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Don't burn wastepaper . . . It's a vital war material

FROM EXACT PROPERTIES TO FINISHED PARTS

PANELYTE* CAN BE MADE TO YOUR ORDER

PROPERTIES

PANELYTE properties are listed below—not as descriptive of any one grade of these paper, fabric, wood veneer, fibre glass, and asbestos base thermo-setting plastics—but to show the range of properties of the 32 grades.

HIGH DIELECTRIC STRENGTH

Volts/Mil. Short Time Test, ⅛" Thickness—up to 700 volts.
Dielectric Constant, at Radio Frequency (1 megacycle from 6 to 5 for electrical controlled grades)
Power Factor, at Radio Frequency (1 megacycle from 6.5% to 2.5% for electrical grades)

UNUSUAL STRUCTURAL STRENGTH

Izod Impact Strength (ft. lbs. per inch of notch)—0.5 to 20.
Compressive Strength (psi)—20,000 to 55,000.
Tensile Strength (psi)—7,000 to 35,000.
Modulus of elasticity in tension (psi x 10^5)—7 to 30.
Flexural Strength (psi)—12,000 to 40,000.

EASY MACHINABILITY

May be Sawed, Die Punched, Drilled, Lathe Turned, Milled, Knurled, Grooved, or Shaved.

LIGHT WEIGHT

20 Cubic Inches Per Pound—Half Weight of Aluminum.

LOW WATER ABSORPTION

As low as 0.7% in 24 hrs. immersion.

CORROSION RESISTANT

Not affected by Water, Brine, Oil, Ordinary Solvents, Coolants, Ketones, Esters, Most Acids and Weak Alkalies.

LOW COEFFICIENT OF FRICTION

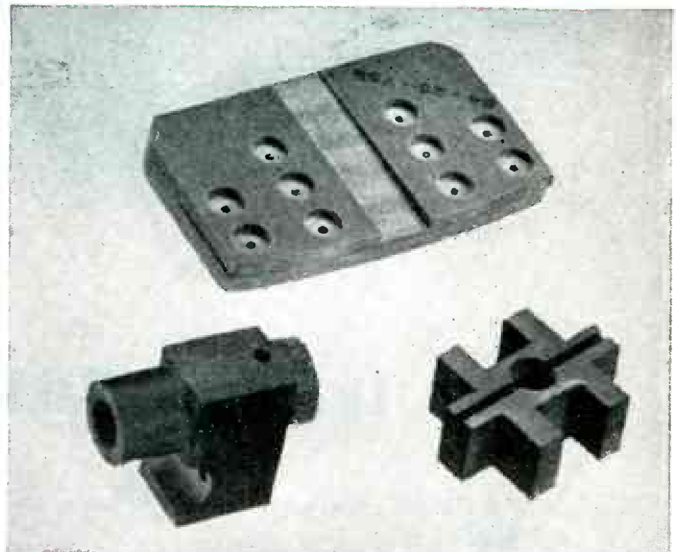
LOW THERMAL CONDUCTIVITY

GOOD DIMENSIONAL STABILITY

Low Cold Flow—Uniform Thermal Expansion—Does Not Warp Under Normal Conditions.

EXCELLENT HEAT RESISTANCE

Heat Resistance—300° F. for cellulosic base; inorganic base materials are flame resistant.—Does Not Soften Under Heat.—Only Effect of Hot Water to Accelerate Absorption.



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

Use Panelyte Service to eliminate time-wasting experiment — to improve your product or simplify its assembly — to save weight — to speed production. Your inquiry is invited on any problem involving the use of structural, laminated, resinous plastics in essential work.

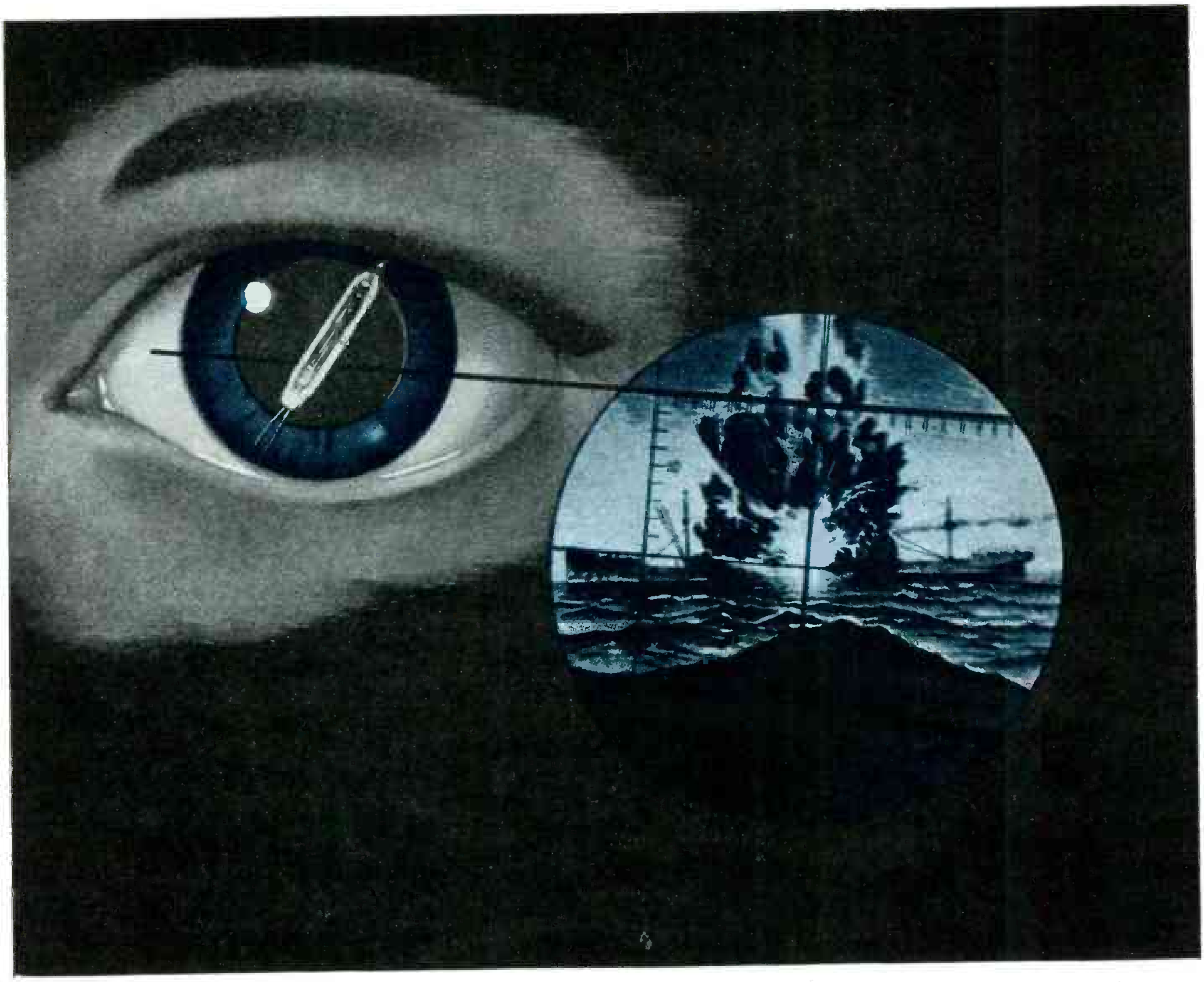
Write for Data Sheets and samples.

PANELYTE *the structural plastic*

PANELYTE DIVISION
ST. REGIS PAPER COMPANY
230 PARK AVENUE
NEW YORK 17, N. Y.

Sales Offices: Atlanta, Boston, Chicago, Cincinnati, Cleveland, Dallas, Denver, Detroit, Kansas City, Los Angeles, Montreal, New Orleans, St. Louis, St. Paul, San Francisco, Seattle, Syracuse, Toronto, Trenton, Vancouver

* MASS PRODUCTION OF SHEETS, RODS, TUBES, MOLDED FORMS, FABRICATED PARTS



teamwork in precision...

Again pre-war research and development has proven its war-time value. An Edison Thermal Switch, originally designed by Thomas A. Edison Inc. engineers, to automatically maintain crystal oven temperature constant to 1/10° C, now serves in numerous critical war applications. Callite Tungsten Contacts, formed parts, welds, and lead-in wires, contribute to the dependability of these sensitive instruments.

Our engineers offer you their experience gained thru years of working with the electrical and electronic industries. We can give you practical help on product development, redesigning, the selection of materials, etc. . . . Consult Callite Tungsten Corporation, 544 Thirty - ninth Street, Union City, New Jersey. Branch Offices in Chicago and Cleveland.

Standard and special shapes in tungsten, molybdenum, silver, platinum, palladium, and alloys of these metals. Send for complete details in Contact Catalog No. 152.

Callite contacts

CALLITE TUNGSTEN CORPORATION

CT

The Edison Thermal Switch is one of a wide variety of sealed-in-glass thermostats and time-delay relays — famed for precision and inherent stamina. That Callite parts are chosen for these products is a tribute to our high standards of quality.

VERSATILE CLARE TYPE "G" RELAY REDUCES OVERALL RELAY COST--SIMPLIFIES INSTALLATION

Features of the Clare Type "G"

1. Standard spring assemblies may embody any combination of the five forms illustrated.

2. It can be provided with twelve different standard—or special—types and sizes of contacts which are welded to the nickel silver springs by a special process. The contacts are made from precious metals and alloys, such as silver, palladium, palladium-iridium, tungsten and elkonium. They can be furnished in sizes from .062" silver, rated at 1 ampere, 50 watts to .1875" tungsten, rated at 4 amperes, 500 watts. Various types may be incorporated in one relay. Also furnished with Micro or other snap-action switches which carry a higher rating.

3. Special anti-vibration springs guard against accidental or vibration-induced operation of the relay.

4. All exposed metal of the Type "G" is cadmium plated to withstand a 200-hour salt spray test.

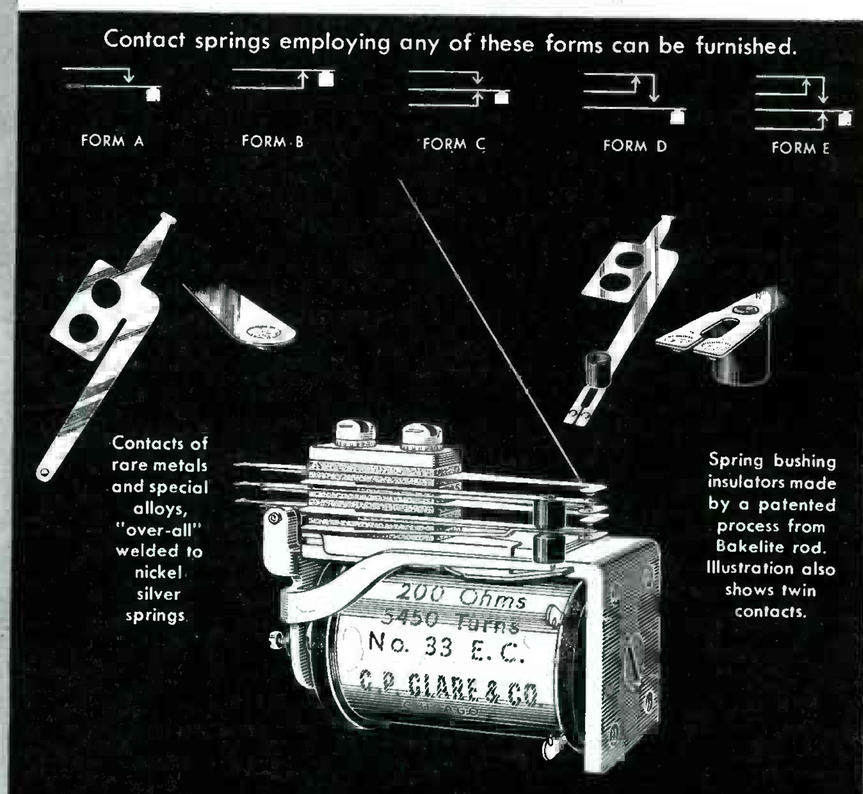
5. Standard insulators are made of special heat treated Bakelite that permits punching without cracks or checks and possesses minimum cold flow and low moisture absorption properties.

6. The patented spring bushing insulators are made of Bakelite rod. These strong, hard, long wearing bushings are essential where heavy contact pressures are employed, where vibration exists or heavy duty service is desired.

7. The heelpiece, coil core, and armature assembly of this relay are of magnetic metal carefully annealed in precision ovens.

8. Coils are carefully wound to exact turns on precision machines. Lead-out wires are securely soldered. Coils impregnated with a special varnish are available. Data regarding resistance, number of turns, type of wire appear on the coil as illustrated. The coil is protected with a transparent acetate covering.

9. The Type "G" is particularly adaptable for plug-in mounting, permitting easy service and replacement.



Clare Type "G" Short Coil Relay

The innumerable contact arrangements supplied by the Clare Type "G" Relay make it readily adaptable to the widest range of applications.

These simple, rugged, "custom-built" relays are especially valuable for use in sequence control of machine tools, electric eye controls, for counting equipment, radio and radar controls and other electronic devices.

Check the features of the Clare Type "G" Relay given here and you will know why they are being increasingly used in spots where hard service, long life and dependability are of prime consideration.

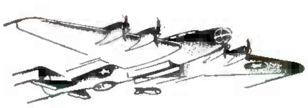
Like all Clare Relays, the Type "G" is carefully designed, precisely manufactured from the finest materials and accurately adjusted. These factors insure that the Clare Type "G" Relay will reduce overall relay cost, simplify installation and insure better and more dependable performance.

Clare engineers are ready at all times to assist in the development of a Clare "Custom-Built" Relay to meet any new and unusual requirement. Send for the Clare catalog and data book. C. P. Clare & Company, 4719 West Sunnyside Avenue, Chicago (30), Illinois. Sales engineers in all principal cities. Cable address: CLARELAY.

CLARE RELAYS

"Custom-Built" Multiple Contact Relays for Electrical, Electronic and Industrial Use

"I understand, Colonel, that you're interested in performance!"



There is a time and place for everything. Oscar's single-minded enthusiasm might have been better timed. On the other hand, his point is well taken.

In manufacturing electronic tubes, performance is the ultimate goal. To assure uniform reliability, Hytron tubes are painstakingly produced to standard factory test specifications tighter than customer tolerances. Then for the final verdict on actual performance, we turn to you who design, build, and operate the intricate electronic tools of war.

Those using Hytron tubes such as the 1616, OC3/VR-105, and OD3/VR-150, will not be surprised to discover that these tubes have earned the reputation of being the best in the industry.

You owe it to yourself to become familiar with these and other popular Hytron tubes, many of which appear on the Army-Navy Preferred List.

OLDEST EXCLUSIVE MANUFACTURER OF RADIO RECEIVING TUBES

HYTRON CORPORATION ELECTRONIC AND RADIO TUBES

SALEM AND NEWBURYPORT, MASS.

HYTRON RADIO TUBES

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SOLAR CAPACITORS ADD "*Quality Above All*" TO WAR EQUIPMENT

160 PAGE CATALOG

FREE

A request on your letterhead will bring you Catalog 12 showing the full line of Solar Capacitors.

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SOLAR MANUFACTURING CORPORATION

285 MADISON AVENUE • NEW YORK 17, N. Y.

CAPACITORS and RADIO NOISE-SUPPRESSION FILTERS

5318

Disposal of Government War Plants and Equipment

In the last four years, the Federal Government has spent over fifteen billion dollars on war plants — two-and-one-half times as much as was spent by private investors.

Of this fifteen-billion-dollar government investment, about one-third has gone into facilities for the manufacture of aircraft and for ship construction and repair; another third has gone into plants for production of combat ordnance; and the remaining third has gone into a variety of facilities for making synthetic rubber, metal products, machinery, and miscellaneous equipment.

Most of these plants are in industries that are expanded far beyond peacetime requirements. Furthermore, their convertibility to other civilian uses will, in many cases, be complicated by their specialized equipment and layout, by their tremendous size, and by their uneconomic location. At the moment, it looks as if roughly one-third of the government-owned plants and equipment can be converted fairly readily to peacetime operation, and will, therefore, be easily disposable to private enterprise.

The discovery of unsuspected uses for war plants and equipment may well raise the disposable proportion to one-half or more. The government, at the end of the war, may own about one-eighth of the commercially-usable industrial capacity of the country. It will be by far the largest owner of machine tools; it will own enormous aluminum capacity, magnesium capacity, many miles of pipe lines, and more ships than the entire private shipping industry.

What the government does with its war plants will have a profound effect on the free enterprise system and on all workers, employers, investors, and consumers who have a part in that system. If this problem is handled badly, we may find ourselves enmeshed in a trend toward monopoly and government operation of industry. If the problem is handled well, we shall have taken a big step toward freedom of action in a competitive society, toward full opportunities for business enterprise, toward well-paid productive jobs for workers, and toward a higher standard of living for us all.

Recently, three important events have signalled encouragement. They are the report of Senator George's Committee, the Baruch report, and the report of Senator Truman's Committee. These reports are noteworthy for their competent sizing up of a complex problem, for their recognition of the major responsibility of government in making a successful transition to peace, for their insistence on wise policy and good administration, and for their genuine concern that our productive powers be given full opportunity in a free private enterprise system. These reports agree on basic principles and many specific lines of action. There are, however, important areas of policy formation, organization, and procedure—especially in regard to plant disposal—which remain to be blue-printed.

In formulating the policies and practices to be followed in dealing with government war plants, our major goal must, of course, be a high level of production and employment in private business after the war.

Government operation in competition with private employers and privately-employed workers will not be desirable because it will make investment unattractive to private capital and will limit opportunities for private employment. On the other hand, sales to private buyers which result in increasing the concentration of industry will also be undesirable. We must use this opportunity to strengthen the competitive enterprise system and to move away from, not toward, the concentration of economic power in either public or private agencies.

To accomplish these objectives, a program of action such as follows will be necessary:

1. An adequate reconversion organization will be needed in the government, but its powers and responsibilities should carefully be defined by Congress. Fortunately, an able Administrator of Surplus War Property already has been appointed. It will be essential for him to work in closest cooperation with Congress and with the Armed Forces and other executive agencies. The Office of War Mobilization, and ultimately the President, must be responsible for seeing that the Surplus War Property Administration is not sidetracked by the operating agencies and is not dominated by their sheer size. Funds must be supplied generously to the Surplus War Property Administrator, so that he can set up an organization adequate to cope with this huge and complex job. Business, too, must be generous in loaning top-flight executives for postwar government service.

2. One of the first acts of the Surplus War Property Administration will have to be to assemble a complete inventory of government war plants and equipment, to make possible the planning and control of the disposal process, and to form the basis of catalogues of property available for sale.

3. Cooperation between the executive and legislative branches of the government will be needed to develop at least tentative plans with respect to matters of public policy which are of special importance to a successful transition to peace. Among these matters are the size of the military establishment to be maintained in time of peace, the stand-by facilities and reserves of matériel necessary for our security in case of future war, and our policy regarding import and production of synthetic rubber and other critical and strategic materials.

4. The Surplus War Property Administrator should

obtain from the Armed Forces, acting under congressional directives, specification of those plants which are needed to supply our peacetime Army and Navy and to provide the essential reserve capacity in case of war.

5. The Surplus War Property Administrator should select certain war plants as depots in which to store the huge surpluses of inventories and equipment which will have to be removed from private and government-owned factories in order to make possible their conversion to civilian use.

6. Those plants which are not desired by the Army or the Navy, which are not needed for storage, and which clearly will be unsuitable for peacetime utilization should be scheduled for dismantling and disposal piecemeal.

7. The two or three billion dollars' worth of government facilities intermingled with private plant should receive attention with a view to early sale, temporary continuance or use under lease, or early removal.

8. The various plants and pieces of equipment available for sale to private business should be classified conveniently, catalogued, and advertised to prospective buyers or lessors. Before the Surplus War Property Administrator offers, for private sale, plants and equipment not desired by the Army or the Navy, he should ascertain whether the plants or equipment are desired by other branches of the government or by public corporations such as the T.V.A.

9. Whenever property can be sold at prices approximating depreciated reproduction cost, that will be by far the best solution. Generous time-payment terms should be offered. In many cases the government may be unable to sell the property for reproduction cost less depreciation, for the simple reason that no one would think of reproducing it. The property may already be partly obsolete or, because of its size, location, or other characteristics, may only be moderately well suited for commercial use. This should not prevent the government from selling it, provided a price which fairly represents the worth of the property can be obtained. The best test of that worth is the price produced by active bidding under favorable market conditions.

10. When property cannot be sold at a fair price, temporary leases with options to buy should be employed to get the facilities into productive use. This should not, however, be done on terms which would cause unfair competition or create clearly excessive capacity in an industry. And the lease must be temporary; it must not be the means to prolong government control or ownership.

11. The government should offer the strongest possible resistance to local groups or industry groups seeking subsidies for continued operation of war properties. Subsidies will burden the Treasury and lead to inefficient use of resources. They will be justified only to maintain facilities needed for national security.

12. The plants and equipment offered for sale and lease should include sufficient quantities in small enough lots to satisfy the demands from small business. The war has tended to concentrate production in larger plants. After the war, we should seek a wider distribution of the government war facilities.

13. Insofar as possible, war buildings and equipment should be offered for sale in units which can be purchased by businesses in peacetime industries. Many of these industries have had to get along during the war without adequate replacement and expansion, and will be ready to buy if they are able to get what they want from the government. This is a particularly desirable market for surplus government property since these industries are, for the most part, not faced with the problems of excess capacity.

14. Property, such as machinery and other movable equipment, which is in excess of our domestic requirements or is more urgently needed by other countries, should be exported. We shall need, and can take, large supplies of raw materials in return.

15. Property which is not needed by the Armed Forces, which cannot be sold or leased on terms which would be fair to competing plants, which cannot be dismantled and distributed piecemeal, and which cannot be sold abroad, should be scrapped as soon as its non-disposability is apparent. The disposal of war plants should be completed within three to five years.

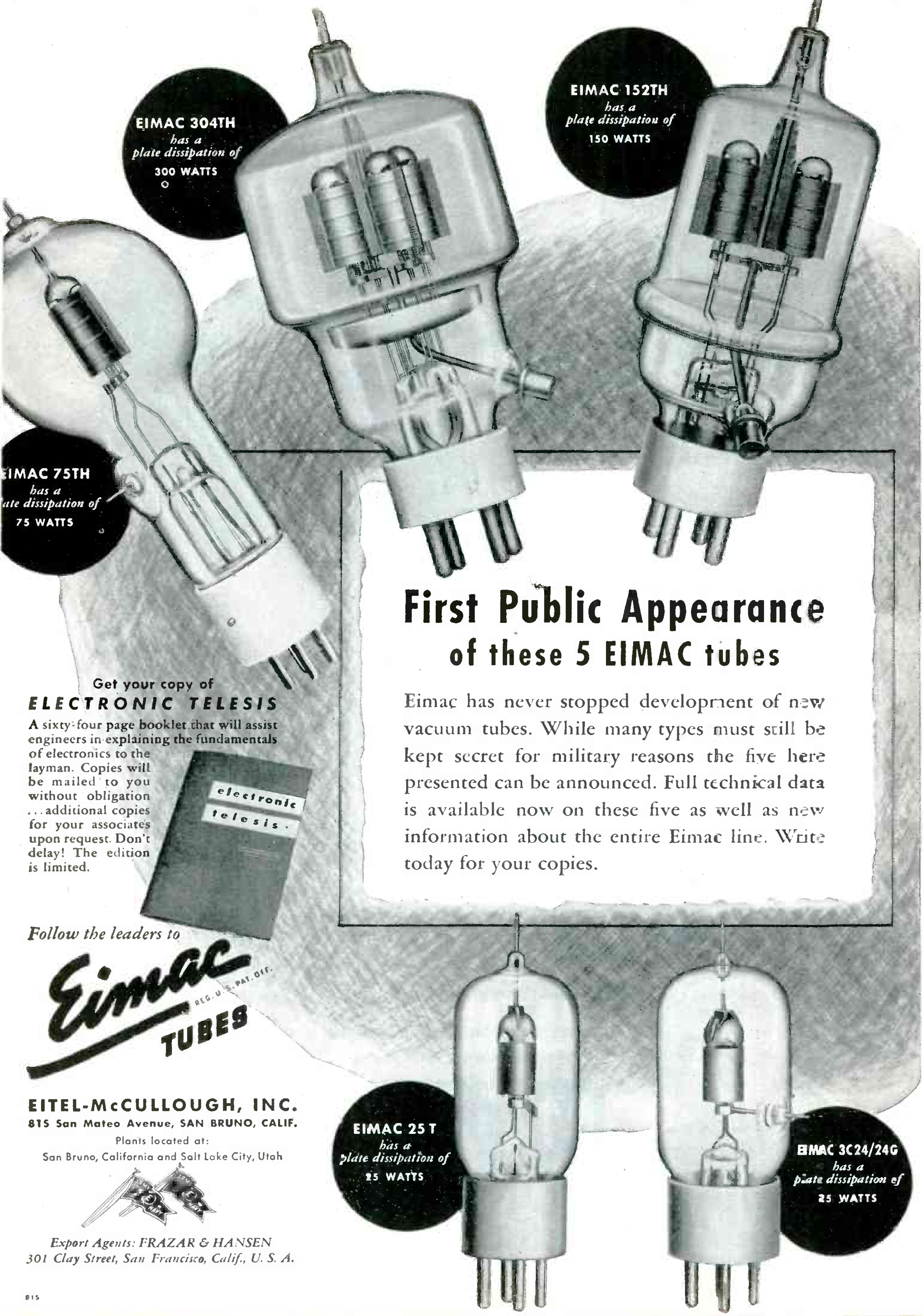
16. All negotiations for sale or disposal should be matters of open public record. As Mr. Baruch has said, the process must be conducted in a goldfish bowl. This is as much for the protection of business as for the protection of the government.

These courses of action do not include everything that must be done, but they do indicate the general lines along which our surplus war plant disposal must proceed if it is to avoid precipitating needless transition unemployment.

The gravest danger of all will be red tape, intergovernmental conflict, and inadequate administration. It would be a great misfortune for the executive and legislative branches to quarrel over details of organization when they agree on the basic principles to be followed in handling the problem. Obviously, the Surplus War Property Administration must cooperate with Congress and look to it for policy guidance. Just as obviously, the disposal problem will involve great difficulties of administration which must not be complicated by congressional interference. We shall need the best we can get in careful policy making, detailed planning, good organization, and courageous action. This is a matter of vital importance to every American. The stakes are too high to tolerate poor administration or petty politics.

James H. McGraw, Jr.

President, McGraw-Hill Publishing Company, Inc.



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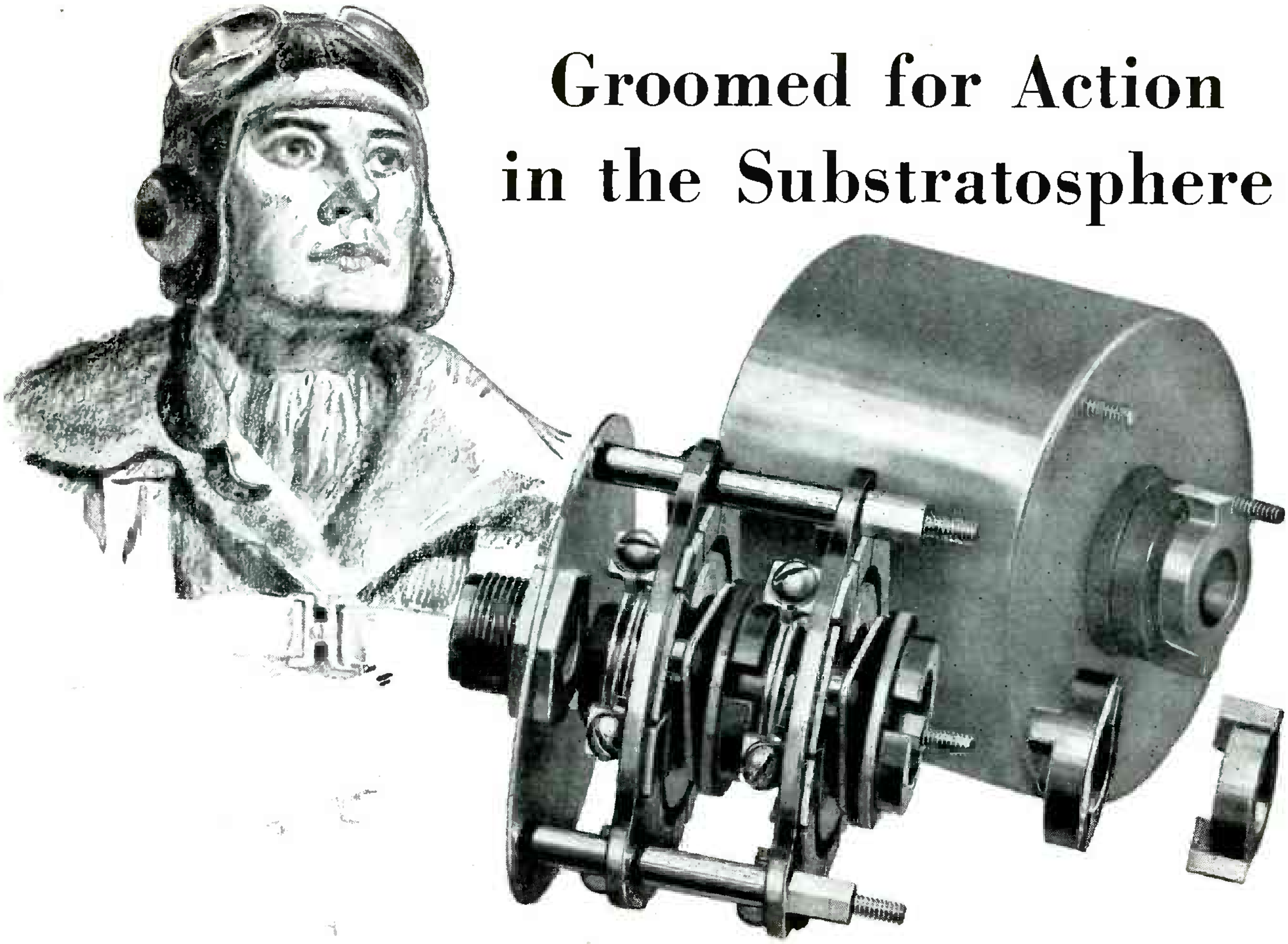

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CROSS TALK

▶ **SYMBOLS** . . . As outlined on this page in the March issue, a compromise set of components symbols was devised at a meeting held in New York on January 22 under the auspices of the American Standards Association. Letter ballots were sent to those who had an interest in the matter with the request that returns be made by February 15. By March 1 the ballots had been returned with a favorable vote by all except a few power people, who again raised objections.

As a result of this disagreement, the whole matter is still up in the air. Another meeting has been scheduled to iron out the troubles.

In the meantime, thousands of men are being trained exclusively in the communications symbols, several industrial electronic books using power symbols have been published and are practically unintelligible to anyone approaching industrial electronics from a communications background, authors request publications like ELECTRONICS to refrain from modifying symbols used in original diagrams to conform with the publication's style, and confusion reigns.

▶ **TELEVISION** . . . There is a great deal of postwar talk about sight-broadcasting these days. There is little likelihood that the industry will wait for the inevitable, ultimate Utopian system to be developed before going on the air. Television will start off very much as it left off, with some changes in standards, some improvement. At the same time experimental work will not stop. Frequency channels will be made available for this forward-looking work. The prospect that some inventions or discoveries will be made and which will improve the present system vastly, perhaps make the present system obsolete, is a chance everybody will simply have to take.

First, however, the conflict between the desires of the FM enthusiasts and the television people for the same space in the spectrum must be resolved. Both services, justifiably, want more space.

Telephone company, in response to request from Niles Trammel, NBC president, indicates large-scale construction of coaxial cable in years 1945–1947 and requests television people to state their requirements so that proper plans for future tie-up system may be evolved.

Anticipating post-war television boom, Local 306, Motion Picture Operators' Union, is sending members to school to learn radio and television. They talk about shooting the television programs on wire lines (telephone) from a central station to a group of theaters so that all can show the same picture but pay for only one rental of the film. MPO wants its members ready for jobs at the local theaters. Telephone linesmen's union and radio broadcast operators' union are keeping their eyes on this business. Quite possible that they will whack it up amongst them, radio men at the transmitters, MPO's at the theaters, telephone men sitting on the wires.

▶ **FM** . . . Decision of broadcast networks to make available to affiliated stations having FM outlets full network programs free of charge is a great decision for those with FM receivers. In New York, for example, full NBC and CBS programs are now available during the hours that the FM outlets are on the air. This puts the New York Philharmonic Society's Sunday afternoon concerts on CBS's FM transmitter.

General opinion now tends toward the idea that FM will grow and grow, that ultimately all of the locals and many of the regional stations will be on FM, thus relieving the congestion in the present AM band. The result will be the freeing of channels for high-power, wide-band, clear-channel transmitters serving communities not near enough to FM transmitters to get good reception.

Thus, as often happens, the advent of something new will not replace something old as was feared, but will actually make it possible to improve the older broadcasting system and enable it to perform a better service.

Idealists who hoped, somehow, that FM would improve soap box operas, cosmetic drivel, sales talk for "keep-regular" pills and other cheap whoopla are doomed to disappointment. This stuff sounds just as nauseating one way as it does the other. FM is no cure for mediocrity and bad taste.

RADIO FOR

War-accelerated technical progress, the need for maximum transportation system efficiency, the improving financial position of railways, and the recent satisfactory experiences of ordnance plants with electronic equipment have fortuitously combined to stimulate growth of the field

By

WILLIAM S. HALSTEAD

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ON DECEMBER 23, 1943, the Association of American Railroads announced that it had requested the Radio Technical Planning Board to examine the public safety possibilities lying in the proposed use of radio-telephony by rail carriers. It is reported that this action was taken, in part, as a result of public comment that radio equipment might have prevented a series of major rail accidents in which heavy loss of life and property was involved.

As it has long been recognized that radio communicating systems have contributed to the safety and efficiency of air and water transportation, it may well be asked why the railroads have moved so slowly in applying radio signaling techniques to their communications problems.

Locomotive radiotelephone installation employed in the Proviso yard of the Chicago and North Western Railway

Reasons for Pre-War Hesitancy

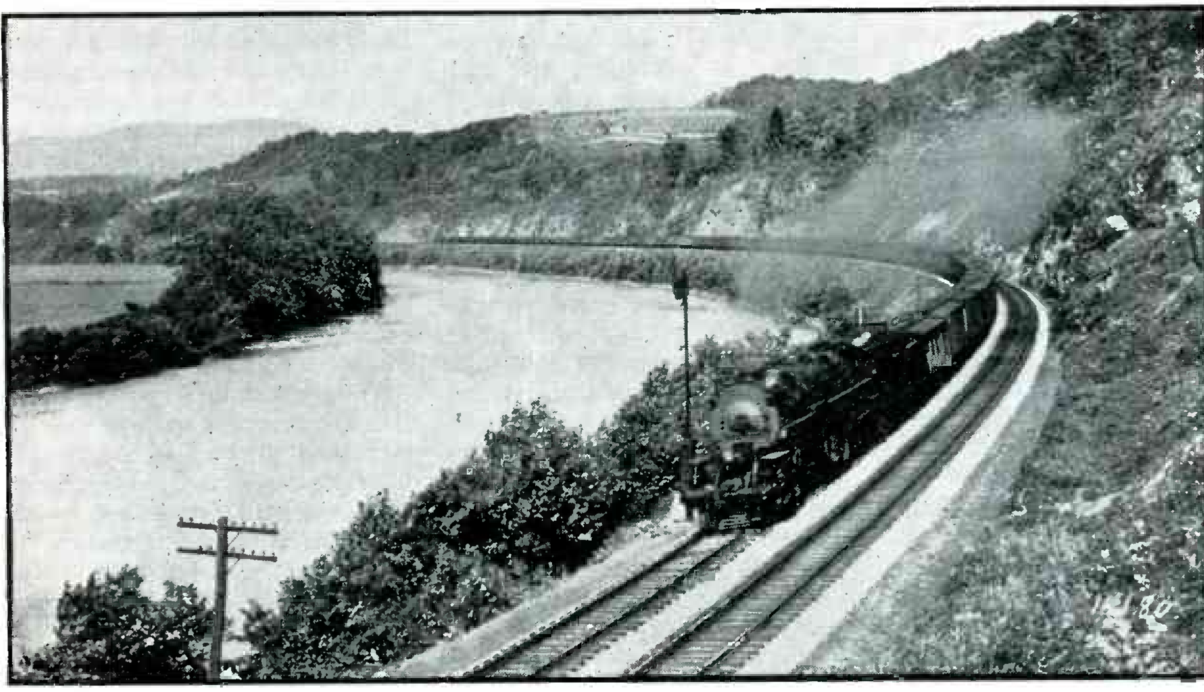
There have been many reasons for hesitancy, including:

(1) The attitude of the railroad industry itself toward radio as a communicating medium. Although some railroads have conducted tests of radiotelephone equipment over a period of many years, and a few far-sighted railroad executives have studied the potential uses of radio apparatus, the industry as a whole has shown only occasional interest in the subject. This attitude has

POTENTIAL RAILWAY RADIO SERVICES

ON MAIN-LINE TRACKAGE	IN YARD AND TERMINAL AREAS
1. Locomotive cab to caboose	1. Yardmaster to locomotive engineers or conductors
2. Train-to-train	2. Towermen to engineers or conductors
3. Train-to-tower	3. Conductors (on trains or on ground) to locomotive engineers
4. Emergency communications	4. Communications between locomotive engineers
5. Control of cab signals	5. Yardmaster to supervisory personnel on foot or in mobile units
6. Passenger communications	6. Communication between ground personnel

RAILROADS



been enforced, to a large extent, by the financial burdens under which the railroads were obliged to operate. Also, the majority of railway executives have been trained in the older telegraph and telephone techniques, and therefore cannot be expected to appreciate the full extent to which modern radio equipment is able to provide many important services of value to rail operators, as well as to the traveling public.

(2) The lack of concerted effort on the part of radio manufacturing groups to develop and market radio communicating systems specifically engineered to meet the special requirements of railway operation. Efforts in this direction have been of a sporadic nature, in most instances, without the existence of a broad plan under which the railroad industry as a whole would derive maximum benefit from the use of radio equipment.

(3) The fear of the railroad brotherhoods that the adoption of radio communicating methods would result in a reduction in the number of men required to perform routine operations, thereby producing unemployment.

(4) Difficulties involved in Federal licensing, particularly with respect to allocation of suitable radio frequencies for railway communications. This problem is complicated by the fact that trains normally operate over long distances, thereby precluding the assignment of frequencies on the basis of limited-area coverage, as is the case in the majority of public utility services.

(5) Technical difficulties peculiar to railway installations of radio equipment, such as the existence of high electrical noise levels in the vicinity of electromotive equipment, wide variation in signal strength along trackage in industrial and mountainous areas, the need for continuous indication in mobile units that radio equipment employed for traffic control purposes is in operable condition, and the need for particularly efficient shock-mounting and housing of transmitters and receivers.

Emergency Gives Idea Impetus

In meeting the unprecedented demands of the war emergency, in which serious shortages of manpower and rolling stock have developed, the over-burdened rail carriers have given consideration to new methods by which the efficiency of existing equipment may be increased. This search for new and improved methods of operation has broadened, to a considerable extent, the viewpoint of railroad executives towards all technological developments. Simultaneously, increased income has put the railroads, for the first time in a number of years, in a financial position where they can give serious consideration to improvements of a basic nature. Finally, recent rail disasters, which emphasized the need for improved communicating methods in emergencies to supplement existing block-signaling equipment and wire facilities, have focused the attention of the more progressive railroad executives on the proposed use of radiotelephony to increase safety and efficiency of rail operations.

In analyzing the reasons for lack of substantial progress in the development and marketing of radio equipment adapted for use on railways, it should be pointed out that prior to the war period neither the railroad industry nor governmental agencies had much practical experience data with which to appraise the value of radio techniques in railroad operations. Most manufacturers, furthermore, were not prepared to underwrite the costly research and development programs required in establishing the practical value of radio in the eyes of hard-headed and tradition-minded rail executives. However, one engineering group had initiated in 1937 a long-range development program directed toward the application of radio traffic-control and communications techniques on highway and railway transportation systems. This development program, utilizing designs of the original engineering group, was extended into the railway classification yard field in 1940 by one of the signal equipment companies, and during that year an experimental radio telephone communications system, engineered for railway use, was installed in the Proviso yard of the Chicago and North Western Railway.

The successful operation of equipment at Proviso, which incorporated automatic means for continuously checking on the operable condition of the system in accordance with railway signaling practice, was brought to the attention of the operators of the Kingsbury Ordnance Plant. The particular problem of this and similar plants was to obtain, on some 200 miles of trackage, maximum safety and speed in handling the rail movement of high explosives. As a result of tests conducted at Kingsbury, this and other government-owned ordnance plants have now adopted radio traffic-control methods. Thus the demands of efficient war production provided the opportunity to demonstrate the practical operating advantages of railway radiotelephony, while the use of radio equipment in ordnance plants over a period of two years has proved the degree to which radio control techniques may increase the safety and efficiency of yard operations.

Unions Becoming More Receptive

In considering the attitude of the unions with respect to the use of radio by the railroad industry, radio engineers anticipate that the sympathetic and constructive cooperation of the railroad brotherhoods will soon be forthcoming.

While it is natural for the leaders of the various brotherhoods to oppose any technological development that might appear to have an adverse effect on the number of employees required for railroad operation, it is thought that these leaders are becoming aware of the fact that unless the railroads employ advanced means to increase efficiency of operation, the railroads will not be in a position to meet most effectively postwar competition from other forms of transportation and thereby maintain full employment at good wages. Further, the degree of safety afforded by radio will, in the opinion of some railroad men, prove to be as important to railway labor as it will be to the traveling public. It is hoped, therefore, that frank and open discussions between the railroad operators and union leaders will make possible the wholehearted support of the brotherhoods in facilitating the successful, widespread use of radio communicating techniques throughout the railroad industry.

FCC Studying Allocation Problem

With regard to questions pertaining to Federal licensing and frequency allocation, it is anticipated that the Federal Communications Commission, other regulatory governmental agencies, and representatives from the railway and radio industries will now actively cooperate in seeking a practical solution to this problem, especially since the public has initiated a demand for use of radio by the railroads in safeguarding life and property. In this connection, it is believed that the case histories of ordnance plants will aid in proving the extent to which safety and efficiency of railway operations are increased by application of radio control techniques.

The problem of frequency allocation for proposed railway services is related directly to the manner in which radio communicating facilities are to be utilized by the railroads. If the use of radio equipment is to be placed on a limited basis to provide emergency communicating facilities only, it is possible that just a few frequencies below 100 megacycles may be utilized initially in railroad services, especially during the war period.

Central-station radiotelephone equipment at the "hump" in Proviso yard, developed by Halstead engineers for the General Railway Signal Company. Units of this general type are adaptable for installation along main-line trackage in radio-repeater or secondary-station services

However, if broad benefits are to be derived from coordinated use of radio communicating systems in routine operations, such as train dispatching, main line and yard traffic control, and other communicating services of value to railroad operators and passengers, it is believed that more frequencies, specifically assigned for routine use in railroad services, will be required.

Microwave and Induction System Possibilities

While it is recognized generally that the number of available radio-frequency channels below 300 megacycles is limited, it is pointed out that accelerated technological progress during the war has extended the useful range of radio communicating equipment to frequencies above 300 megacycles. It appears to be desirable, therefore, that any long-range plan for the application of radio to the railway industry should embody a careful consideration of the use of frequencies in the microwave range where relatively few assignments have so far been made. In this regard, it may be stated that tests conducted on frequencies above 300 megacycles have indicated that use of microwave equipment in railway radio services is technically feasible.

Utilization of the higher frequencies also appears to be desirable for the reason that, at frequencies above 100 megacycles, and in particular above 300 megacycles, directional and restricted-range radio services, limited to line-of-sight distances, become most practicable. Further, the use of directional antenna systems, wide-swing frequency modulation, and automatic relay stations along railway routes could provide railway radio facilities of an extensive nature without involving the assignment of an excessively large number of frequencies for use by the railroad industry for traffic control, emergency, and passenger communicating purposes. In this connection it is estimated that by the use of modern radio-beam communicating techniques, a maximum of 10 to 20 clear channels, on frequencies above 300 megacycles, would be sufficient to provide radio signaling circuits required for traffic control and emergency services on all main-line railway systems.

This central control unit, employed in ordnance plant radiotelephone service, is located at the yardmaster's or dispatcher's office and permits radio-equipped locomotives, motor vehicles and secondary-stations within the service area to be instantly contacted

In addition to the use of directed microwave radio channels in providing new railway communicating services, it is probable that the utilization of induction-radio signaling techniques, in which wayside conductors are employed as wave-guides or transmission lines to keep the effective signaling field within narrow zones extending along the railroad right-of-way, will prove to be of value in solving the frequency allocation problem. These restricted-range signaling methods may be of particular aid in providing supplementary communications channels along main-line trackage, in small railway yards such as those of industrial plants, and in congested terminal areas. Services of this type, however, require the use of wire conductors along railway trackage, and therefore do not have the flexibility afforded by normal space-radiation methods.

Suggested Temporary Channel Expedient

Although railroad radio equipment designed for operation in the microwave field would appear to be the ultimate answer to the problem of frequency allocation, it is understood that during the war period the Federal Communications Commission, upon proper showing that a radio service is in the public interest, will grant licenses on a Class 2 experimental or special emergency station basis to cover operation of equipment on frequencies below 300 megacycles. In this instance, it is possible that it would be necessary, at a later date, to modify the equipment for operation at higher frequencies, should the use of higher frequencies be advisable for technical reasons.

A request of the railroad industry for the allocation of frequencies for rail communications purposes, together with maintenance of a progressive viewpoint on the part of the railroad industry with regard to its future activity, should stimulate a solution to the problem of frequency allocation for general railroad use.

Technical Problems Largely Solved

In meeting the technical problems involved when applying radio techniques to mobile railway units of various types, and in effecting coverage of railway trackage extending throughout industrial or mountainous areas where shielding effects are encountered, it may be stated that solutions to these problems have already been found. These solutions include the development of practical methods of electrical noise reduction as afforded by the frequency-modulation systems developed by Major Armstrong, and the use of automatic

(Continued on page 210)

Medical Electronic

Basic principles of bioelectricity, a survey of present techniques, and predictions of future progress, with emphasis on electro-shock therapy, electrical anesthesia, brain-wave recording, determination of ovulation time and measurements on living tissues

THE PURPOSE of this article is to present a review of the electron arts applied to therapy, medical diagnosis and related research.

In a field indicating so many new directions, with current investigations constantly expanding the available data, it is not possible to "freeze" the information into a static picture. The literature is growing logarithmically with time, and even a bibliography would fill several volumes.

A brief list of special terms, defined according to the meanings intended in this article, appears in Table 1.

The generation of electrical charges by muscular contraction was observed by D'Arsonval in 1870, nearly a hundred years after the reverse effect was demonstrated by Galvani. During the next few decades the presence of electrical waves was discovered in connection with functions of the nerves, heart, brain and other organs in humans. More recent techniques have revealed electro-dynamic fields with distinct patterns corresponding to specific types, species and individual living organisms.

Bioelectric Currents

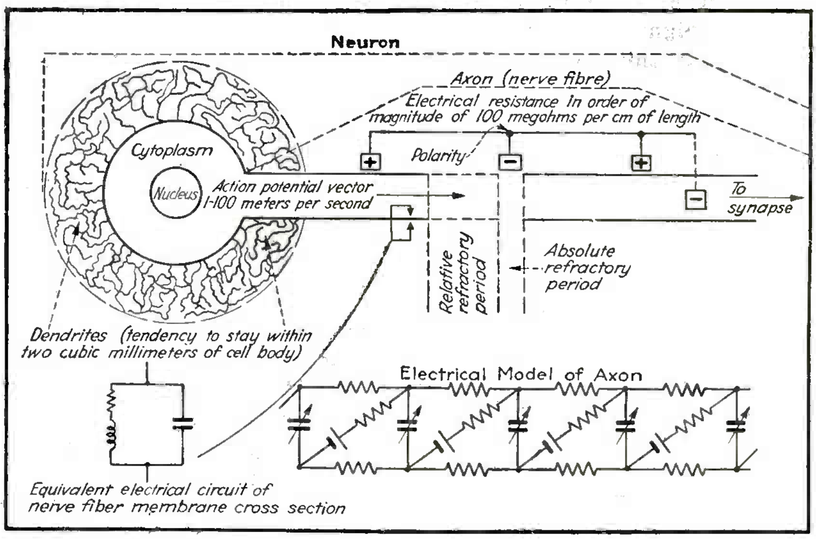
Currents produced in living organisms may be divided into five broad categories:

1. D-C Differences of Potential: These gradients appear in all living tissue, varying directly with the local rate of metabolism. The outer surface of a single cell is normally polarized with respect to its internal structures.

2. Transient Diphasic Spikes: These abrupt voltage changes appear when skeletal muscle or nerve fiber is activated. In nerve fibers such currents are called "action potentials," and often function as a stimulus to activate skeletal muscle, which in sequence produces an electrical response of similar wave form. When a nerve fiber is mechanically, electrically, chemically or otherwise stimulated, the covering membrane becomes selectively (with respect to various ions) more permeable at the point of stimulation. A local bioelectric current then flows from the positive surface to the internal area and stimulates a similar cycle in the adjacent region of the cell. In this manner a wave of increased permeability and consequent depolarization is generated and propagated so as to travel over the entire structure.

Each action potential in a single nerve fiber bears no quantitative relation to the magnitude of the external stimulus; the response is "all or none," and occurs whenever a specific minimum of energy is applied. This quantitative threshold varies in specialized sense organs for different qualitative types of stimuli. Consequently the nerve fibers of each sense organ are normally subject to excitation only by one form of energy. Immediately following local activation, the nerve fiber is incapable of response for the brief period (approximately 0.4 to 0.55 ms) necessary to effect repair. This is called the "absolute refractory period." During recovery, as the original semipermeable state of the membrane is approached, a relative refractory period occurs during which the threshold of stimulation is relatively high, returning to normal as recovery is completed.

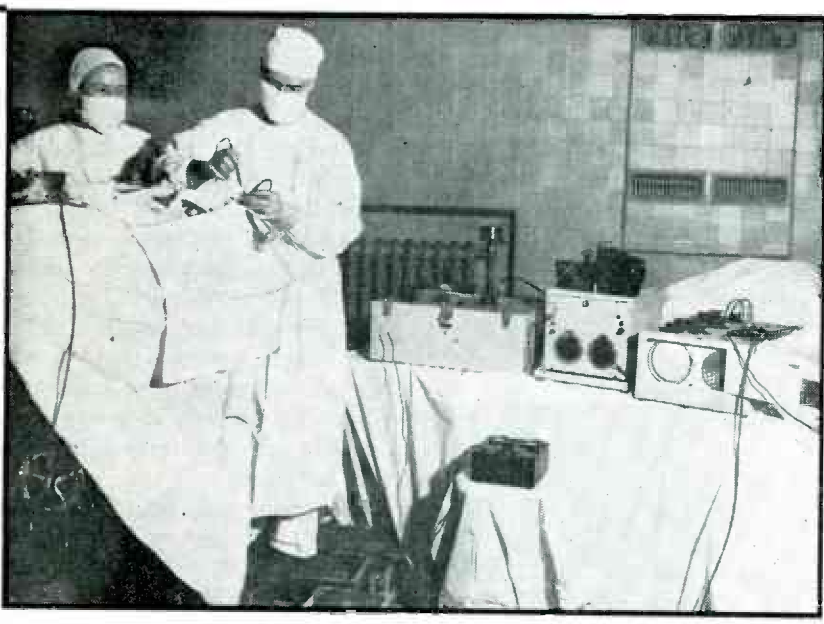
If the stimulus is sufficiently strong and appears periodically so as to re-excite the nerve fiber early in the relative refractory period, the magnitude of the action potentials diminishes to an equilibrium which is a function of the frequency of stimulation. This equilibration may be considered as a form of fatigue, although it levels off at a definite plateau. The maximum pulse repetition rate for action potentials is about 1000 per



Schematic diagram of nerve cell, showing physical and electrical relationships

Practice and Research

By **JOHN D. GOODELL**
Consulting Engineer
Detroit, Michigan



Brain stimulator being used to locate areas of low threshold of irritability in the exposed brain. Currents indicating epileptic seizures, thus induced, are recorded on the electroencephalograph tape and made visible on the screen of the cathode-ray tube for the operating surgeon, while audio-frequency components are reproduced by the loudspeaker. The patient is conscious during the operation, as general anesthesia would disrupt the brain-wave patterns. Equipment shown is from Electro-Medical Laboratory, Inc., Holliston, Mass.

second, and the velocity of conduction ranges from 1 to 100 meters per second, averaging around 30 mps. It should be noted that the considerable length of many axons and the relatively slow travel of action potentials makes it possible for large differences in activity to appear at various points simultaneously in the same cell. An action potential starting at one end may encounter and be terminated by an absolute refractory period further along the fiber which resulted from a second stimulus originating even later in time. This may have some importance in connection with masking effects produced by the series-parallel connection of auditory nerve endings to certain hair cells in the inner ear.

Note: The point of connection between neurons (synapse) presents a number of unsolved mysteries. Some evidence indicates the release of a chemical mediator (sympathin, acetylcholine, etc.) at the nerve endings, which functions to activate muscle tissues and may be the mode of transmission at synapses. The transmission time across synaptic junctions ranges from 0.5 to 3.0 milliseconds.

3. Semi-Rhythmic Wave Forms: Smooth muscle moves with a slow undulation that generates a corresponding electrical wave form. This type of electrical manifestation accompanies the regular contractions and relaxations of the intestinal tracts during digestive processes.

4. Microphonic Currents: The so-called "cochlear response" from the inner ear is an electrical cur-

TABLE I. DEFINITIONS OF MEDICAL TERMS USED IN THIS ARTICLE

CELL: The unit of structure for living organisms. A cell consists of a nucleus, which directs the activity, and cytoplasm, which surrounds the nucleus and carries out the activity. Semi-permeable membranes separate the nucleus from the cytoplasm, and the cytoplasm from its environment.

CYTOPLASM: The viscid, sticky substance which does the work of the cell. It contains many structural variations locally and generally, and is composed of carbohydrates, fats and proteins, as well as many special enzyme systems, minerals, water, salts, etc.

NEURON: A cell specialized by its cytoplasmic form and structures for conducting a nerve impulse.

NERVE IMPULSE: A conducted tendency to excite activity in the next unit of a chain; its energy has electrical, chemical and thermal manifestations and is derived from the local area where it appears at a specific moment of time.

DENDRITE: The branching arms of cytoplasm in the neuron which remain within two cu mm of the cell body in which the nucleus is located; they receive the nerve impulses from other neurons.

AXON: The single structure reaching from the cell body of the neuron which may extend for distances up to four or five feet, terminating upon the dendrites and cell body of another neuron or some other type of specialized cell (effector organ).

MYELIN SHEATH OR MEDULLATION: The fatty coating which covers axons requiring speed of action; the velocity of propagation of the nerve impulses is related to the thickness of the fatty sheath.

INNERVATION: The nerve supply to clusters of cells of the same type and function.

SYNAPSE: Originally a functional concept of the special characteristics of the brain and spinal cord in contrast to axons. These include: (1) one-way conduction; (2) gradation of response to strength of stimulus; (3) easy fatigueability; (4) summation of impulses; (5) inhibition or suppression of excitation. Used in the anatomical sense in this paper to refer to the contact of the specialized endings of axons with the dendrites or cell bodies of other neurons.

OVULATION: The process of discharging an egg cell (ovum) from the ovary into the conducting tubes of the uterus.

STIMULUS: A quantity of energy which when applied will evoke a response.

SENSE ORGAN: A cell or group of cells specialized in responding to a particular form of energy (stimulus) at a lower threshold than other forms of energy.

SKELETAL (VOLUNTARY) MUSCLE: A mass of cells capable of responding to nerve impulses by a rapid, vigorous shortening (or increased tension); this is the type of muscle with which voluntary movements are produced. Under the petrographic microscope the cytoplasm of skeletal muscle shows alternating transverse bands of isotropic and anisotropic substances.

SMOOTH MUSCLE: Layers or sheets of small spindle-shaped cells which enclose all hollow internal organs (stomach, intestine, bladder, genitalia, etc.) and most blood vessels; they are capable of adapting their dimensions within wide limits to changing conditions without increased tension, and are characterized by slow (usually rhythmic) contractions; smooth muscle is not generally subject to voluntary control.

CARDIAC MUSCLE: A special type of cellular construction associated with the action of the heart, with characteristics between those of smooth and skeletal muscle.

rent which follows the frequency and amplitude pattern of the sound energy stimulus with considerable fidelity. This is the only phenomenon where living tissue has been demonstrated to function as a direct ratio transducer of complex energy patterns. The optic mechanism may have some similar characteristics.

5. *Continuous Rhythmic Wave Forms:* In the central nervous system (brain) the electrical component of continuous activity is omnipresent. These brain waves are observed as a steady flow of rhythms subject to many interpretations. The correlations with pathological conditions are based on empiric knowledge.

The vast majority of information about all these currents has been obtained since the advent of vacuum-tube amplifiers. Special equipment of various kinds has been developed for studying specific manifestations. There is a considerable trend today to combine a variety of simultaneous measurements and integrate the resulting data into a coordinated diagnosis. Considerable work along this line was reported by Dr. Lynn in the January, 1944, issue of ELECTRONICS.

Electrodynamic Field Patterns

It is still difficult to state the extent to which the organization and growth of living cells is directed by associated electric fields. The phenomena appear to be inextricably intermingled, each dependent on the other for existence and orientation, and confirmatory evidence for the basic inter-relationship has been clearly established.

Successful predictions regarding the axis along which a central nervous system would develop have been based on measurements of voltage differences existing in the eggs of frogs and salamanders. Studies of cancer in the breasts of mice have shown that a measurable change in field strengths indicates the onset of wild cell growths before they can be observed by touch. Mice susceptible to cancer appear to have characteristic electro-dynamic fields in their breast structures which differ observably from cancer resistant types. Measurements made on unfertilized eggs, on seeds and plants, on wide varieties of living systems, have all seemed to verify conclusively the interdependent existence of electric fields in connection with growth, change and all cellular activity.[1,3] Experiments are indicated to determine whether the growth of living systems can be deliberately influenced by exterior applications of electro-dynamic patterns, but little, if any, evidence of a conclusive nature has been presented from this approach.

Certainly it is an amazing mechanism that controls the growth of living organisms with complex biological designs, in the midst of intricate chemical changes, with so little inconsistency. It may well be that this fundamental organization is accomplished by electrical means.

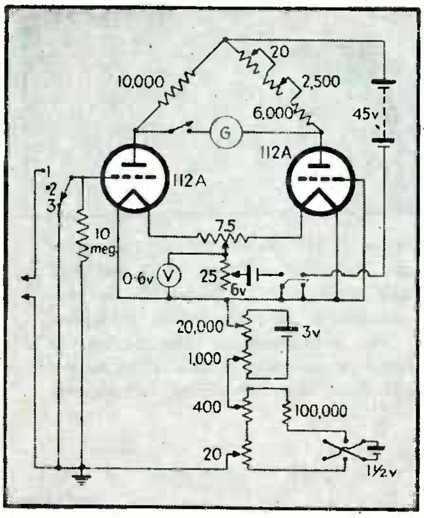


FIG. 1—Circuit diagram of Burr-Lane-Nims vacuum-tube microvoltmeter, used for measuring extremely small potentials in living-tissue structures during medical research and for determining ovulation time in experiments with artificial insemination. Both tubes are used with bases removed. (Yale Journal of Biology and Medicine)

The mapping of direct voltage gradients in living structures presents many special problems, and requires an instrument of sufficiently high input impedance to draw a minimum of current from the area under investigation and be reasonably unaffected by varying resistances. Quadrant electrometers are ruled out by many difficulties involved in their operation, as well as high sensitivity requirements.

The Burr-Lane-Nims vacuum-tube microvoltmeter[4], diagrammed in Fig. 1, solves these problems. This instrument requires little associated shielding, contains standard radio parts and is conveniently portable. The circuit is a bridging arrangement using two type 112-A radio tubes with a special battery bias supply for the grids, which is adjusted to the "floating grid" potential.

Associated equipment consists of an accurate galvanometer and reversible silver, silver-chloride electrodes which may be designed for microscopic manipulation. A number of necessary precautions and calibration procedures are fully outlined in the referenced paper on this instrument.

One of the most dramatic demonstrations of the existence of an electro-dynamic field has been produced by placing on a turntable a vessel containing a salamander immersed in salt water. When rotation takes place between electrodes connected to a galvanometer, a sine-wave output may be recorded, showing that the salamander is functioning as the living armature of a dynamo, proving the presence of an electric field.[5] All of this excites great interest, and the answers to many basic riddles of organization may well be established as a result of such research.

Electro-Shock Therapy

Of more immediate practical importance is the application of electronic devices to therapy and diagnosis. The use of diathermy machines is so common today as to be familiar to nearly everyone. It is of particular importance that acceptance of new techniques is rapid, and the medical practitioner is more eager to take quick advantage of developments than ever before in history.

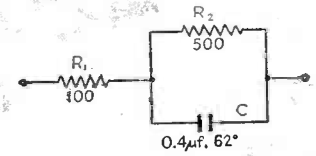
An example is the speed with which the use of electric shock has spread in the treatment of psychotic disorders. Although first demonstrated only five years ago (Rome, Italy, 1938), the literature already contains more than 150 papers on this subject.[6] Commercial apparatus is available, and most major hospitals have trained operators on their staffs. Electric shock offers many advantages of control in convulsive therapy, and has been adopted widely because of the relatively low incidence of post-treatment complications. Among the desirable results from electric shock therapy is the immediate unconsciousness produced upon application of the stimulus, and the freedom from unpleasant sensations such as are associated with recovery from metrazol injections. Of equal interest is the amnesia the patient has for the treatment, which improves his cooperation in successive applications. This is of particular importance because many practitioners regard thirty or more convulsions as necessary for permanent cures of certain disorders.

Manufacturers of this equipment stress the incorporation of safety features, such as protective circuits to prevent application of treatment currents prior to determining the proper amperage and duration of the shock. Automatic timers ranging from 0.1 to 0.5 second are included, and safety switches prevent the possibility of excessive current surges.

When the 60-cycle shock current is applied, it is important that the electrodes be in firm contact with the temples. In most cases 400 to 450 milliamperes applied for from 0.2 to 0.3 second will produce general convulsions, but the exact treatment required varies with the individual patient.

The "why it works" questions about electric shock therapy are completely unanswered. Conjectures, which have little if any basis in definite experimental evidence, range from the belief that organic changes are produced in the brain (possibly destroying higher nerve centers) and the theory that abrupt overloading of the nerve circuits reestablishes proper connections. The brain centers it is desired to affect have not been specifically located. In fact, beyond the bare knowledge that electric shock produces convulsions that are beneficial in certain psychotic disorders and that current magnitude and duration are determining factors, very little is definitely known about this type of therapy. A great deal of experimental work under controlled conditions is needed.

Electric shock is a powerful tool, and as additional experimental work goes forward, an increased understanding may expand the use of this type of therapy. It is interesting to note that early workers based the calculation of treatment currents on d-c resistance measurements and were annoyed and perplexed at the apparent anomalous failure of the treatment current to behave in accordance with Ohm's law. It has been shown that the equivalent circuit approximates

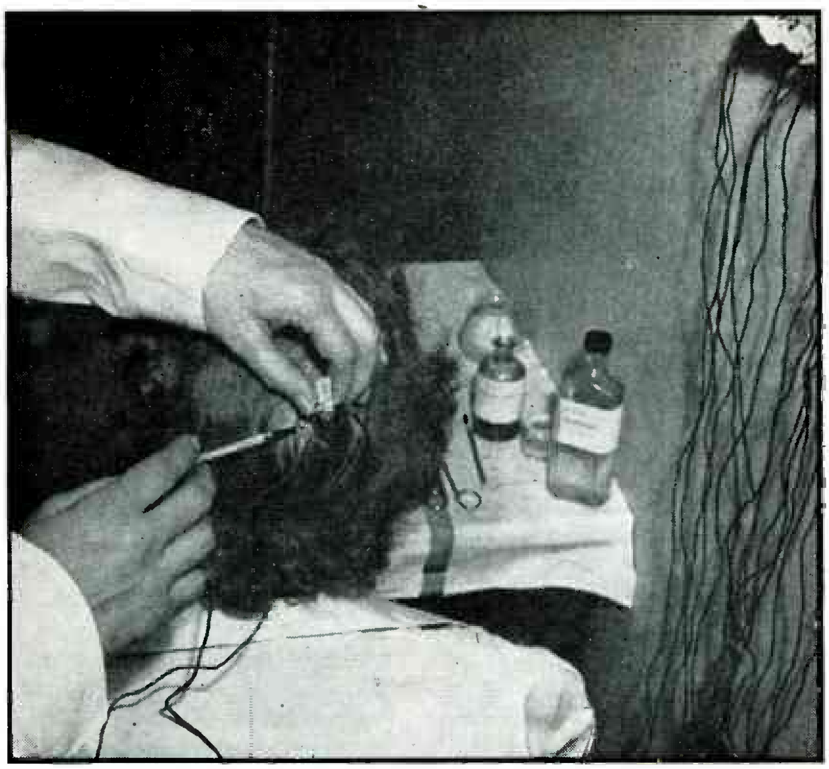


in which C represents the reactance introduced by the polarizability of living tissue. When such tissue is highly stimulated, the polarizability approaches zero and R_2 falls to a relatively low value, essentially short-circuiting C and reducing the effective resistance to a figure far below the measured d-c value. To circumvent this difficulty, some instruments have built-in circuits with which the *effective* resistance is calculated on the basis of a high-frequency (approximately 7000 cps), low-intensity current which is readily passed by C.

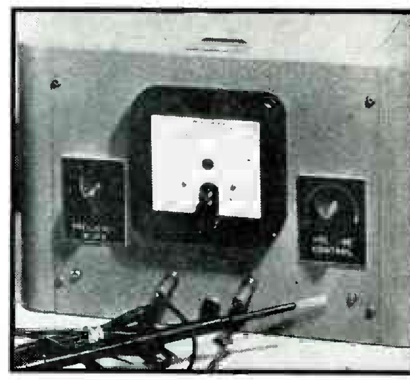
The frequency for the test current must be selected to avoid the pararesonant point of the nerve cells, in order to eliminate any possible sensation by the patient during the test. Actually, d-c resistance measurements change with the manner of electrode application, and voltages vary accordingly. Conversely the electrode

ABOVE—Electro-shock therapy unit made by Rahm Instruments Inc., New York. Balls of steel wool held by locking tongs serve as electrodes

RIGHT—Electro-shock therapy equipment in use. This instrument, made by Offner Electronics Inc., Chicago, uses flat metal electrodes held in position by a soft, flexible band around the head



Application of small lead electrode to the scalp with collodion and a conductive paste, for brain-wave recordings. The scalp is not pierced, nor is it necessary to cut away any hair. This photograph was taken in the Brain-Wave Department of Harper Hospital, Detroit



Cortical stimulator unit made by Rahm Instruments, Inc. When the electrodes are applied to the exposed surface of the brain, the muscles controlled by that section will move and thus identify that cortical area. An RC oscillator using a gaseous triode and followed by an a-f amplifier generates 7.5, 15, 30, 60, 90, 120, 240, 480 and 1000 cps, with the saw-tooth output voltage being variable from 0 to 10 v

technique does not greatly change the effective resistance measured at high frequencies, nor does it appear to alter appreciably the current required for treatment. It is the current, and not the voltage, which produces the convulsions. Hence, variations between techniques and patients may result in widely differing voltages, but data on current values can be correlated without precise reference to other controls.

Electro-Narcosis

Development of electro-shock therapy has led to revived interest in electrical anesthesia. Relatively few papers are available on this subject, but experiments date back over fifty years. Shortly before the turn of the century an operation was reported as successfully performed under local electrical anesthesia. Both direct and alternating currents have been used, but unfortunately the results reported by various investigators differ so greatly that few valid conclusions can yet be assumed..

One set of experimental results from tests on frogs, rats and dogs indicates the production of a reflex block due to central action by application of a current that approximates one milliampere per sq mm of spinal cord cross-section.[8] Complete anesthesia was produced and maintained for eight hours in one dog, and repeated periods of several hours each produced no observable histologic effects in the spinal cords of rats and dogs. In the work with dogs, one electrode was placed in the mouth and the other in the anus. The d-c resistance was measured at a rather surprisingly low value, around 500 ohms. Twenty volts was required to obtain the 45 ma of current necessary for anesthesia. Some experimenters report inability to duplicate these results. Alternating-current tests have produced data with somewhat greater agreement between investigators.

The desirability of producing anesthesia electrically includes a number of obvious advantages of control and convenience. Certain direct-current experiments have shown the effect to be reversible. It is believed, in general, that a-c is less likely to cause serious damage such as is associated with the polarization of delicate cellular structures. As in electroshock therapy, the theories with regard to electrical anesthesia are numerous and varied. No one knows definitely "why," and careful experimental work is needed to exhaust the possibilities. This may have no practical value, or the solution might provide an inestimable contribution to mankind. Certainly it is a field worthy of continued exploration.

Impedance Measurements

In connection with research to determine the effects of centrifugal force in aircraft maneuvers, changes in blood circulation have been correlated with tissue impedance data. A device for automatically recording these effects during flight has been developed at Yale by Drs. L. F. Nims and Jan Nyboer.

Equally interesting is the work in connection with thyroid disorders started in 1933 by Dr. M. A. B. Brazier,[9] now of the Massachusetts General Hospital. As discussed under electro-shock therapy, there are many difficulties of control in making d-c resistance measurements on living tissues. Even slight changes in electrode technique often produce large deviations. Impedance to alternating currents can be determined with greater accuracy, and a definite correlation has been found with thyrotoxicosis. In cases of goiter it is important to distinguish between toxic activity of the thyroid gland and non-toxic conditions. Previously diagnosis has been based on basal metabolism rates. B. M. R. measurements involve hospitalization, fasting and many variables.

In these investigations the human body was considered as an irregularly shaped quantity of dielectric substance. The dielectric loss angle δ, or the correlative power factor angle $\phi, (\delta = \frac{1}{2}\pi - \phi)$, either of which may be considered as the "impedance angle," are quantitative measurements which eliminate the variable factors of size and shape. The angle of the impedance vector may be measured in terms of either reference, i.e., with respect to pure resistance or pure capacitance vectors, because clinical results are concerned only with deviations from a standard.

Using simple, portable devices consisting of an oscillator, a variation of the Wheatstone bridge and a heterodyne unit (in order to make possible the use of frequencies above the audible range), the impedance angle of a human body may be measured in approximately five minutes. No previous conditioning of the patient is required. Extensive statistical programs have determined the validity of this measurement in terms of the B. M. R. in thyrotoxic patients.[10] An additional use for this method is found in the control of thyroid dosage for treatment of mental disorders.[11]

Studies of Ovulation

Conception can occur only during a brief number of hours following ovulation, and for this and other reasons a knowledge of the time at which the ovum is released has importance in gynecology. Characteristic electrical changes were reported in 1935 in connection with ovulation in rabbits.[12] Subsequent investigations in humans appeared to confirm the accuracy of this correlation. Recent studies[13] have involved artificial insemination of previously infertile women at the time indicated by the changing potential associated with ovulation. Although some of these women had

(Continued on page 356)

TABLE II. ELECTRO-BIOLOGICAL MEASUREMENTS

Phenomena	Observing Instruments	Order of Magnitude in Millivolts	Physiologic Source	Application of Knowledge
Voltage generated by heart action.	Electrocardiograph (EKG Recordings.) Special electrode techniques recently developed permit flexible observing viewpoint [21].	1.0–2.0	Cardiac muscle.	Diagnosis; confirmation of diagnosis; Indication of pathologic disturbance to normal functions.
Contraction of skeletal muscle generates abrupt voltage transients.	VT amplifier with associated recording instruments.*	0.05–10.0 (50.0**)	Skeletal muscle.	Treatment for infantile paralysis may be checked to indicate extent of progress. Diagnosis and study of muscular pathology.
Digestive activity raises stomach voltages. The voltage changes appear to vary in relation to normal, ulcerous and cancerous condition.	VT amplifier with associated recording instruments.*	0.1–50.0**	Smooth muscle.	Experimental work indicates the possibility of developing an accurate ulcer and cancer diagnostic method.
If nerves are anesthetized or severed, d-c skin resistance rises. Areas of human skin have been mapped and measurements compared to correlate normalcy between individuals.	String galvanometer.			Determination of damaged nerves in fractures. D-C skin resistance measurements are also studied in connection with diabetes, circulatory conditions, Reynaud's disease, etc.
Skin impedance to alternating currents varies in different areas under changing conditions. Correlative studies indicate relationship of skin impedance to blood circulation.	A-C bridge circuits.			Self-recording instruments have been devised to indicate effects of centrifugal force in aircraft maneuvers on blood circulation.
Voltage measurements on breasts of mice change in advance of cancerous growths. Patterns appear different in mice that are inherently susceptible and those naturally resistant to cancer. Changes and growth in cell structure are accompanied (possibly controlled) by associated changes in electro-dynamic fields.	VT Microvoltmeter.	Few microvolts.	Injury potentials to cell structures or organizing electro-dynamic field mechanism.	Diagnosis of cancer susceptibility; advance warning of wild cell growths. Investigation may assist in development of therapeutic methods.
Ovulation in animals and humans is accompanied by a voltage change.	VT amplifier with associated recording instruments.*	5.0–25.0	Metabolic changes, rupture of tissues, etc.	Determination of ovulation time in humans is of interest for many reasons. It has been used to determine proper moment for artificial insemination of previously infertile women.
Reptile eggs, even previous to fertilization, show variations in voltages for different surface areas.	VT Microvoltmeter.	Few microvolts.	Electro-dynamic fields associated in structural relationships with intracellular organization.	Successful predicitions based on these measurements have been made as to the axis along which nervous centers would develop. Investigations may lead to a better understanding of the forces governing the creation of living organisms.
Normal and abnormal physiology of the brain is accompanied by typical brain wave patterns.	Electroencephalograph (EEG Recordings).*	0.01–1.0**	Continuous functioning of brain cells generates electrical wave forms.	Diagnosis of epilepsy. Diagnosis and location of brain tumors, blood clots, etc. Studies of behavior conditions.

* These devices are used in connection with a wide variety of writing recorders of magnetic, thermal and crystal types, as well as oscilloscopes and oscilloscope motion picture cameras.

** 50.0 millivolts is the theoretical maximum for action potentials, and the lower order of magnitude in practice results from shunting circuits. With amplifiers of special design, spikes (transients) in action potentials of nerve fibres have been observed well above the 100-millivolt range.

Fabricating Wood

R-F heating is extensively used in the production of flat laminated stock. It is also coming into favor for the fabrication of curved spars and other parts of the structural type. This article discusses experimental manufacture of thin coverings such as those that constitute wing and fuselage surfaces

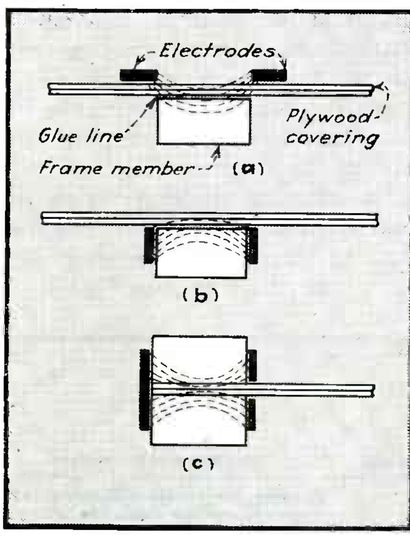


FIG. 1—Several arrangements of electrodes for gluing thin plywood to a frame member by utilizing so-called "stray-field" heating. In (b) and (c) the greater conductivity of the glue line causes a concentration of current

IN THE FIRST PART of a previous article[1], methods of adapting radio-frequency heating to the production of curved laminated wood aircraft parts—particularly *parts of the structural type* such a sthose used in the aircraft frame—were discussed at some length.

Radio-frequency heating may also be used eventually in the production of thin plywood coverings such as those which make up the *wing and fuselage surfaces* of wood aircraft. This use of r-f heating is still in the development stage. A considerable amount of experimental work, however, has been carried out and the results lead to the conclusion that while r-f heating may not be immediately applicable to the manufacture of these relatively thin sections, it does have definite promise for the future.

As in the case of the structural-type parts previously discussed, it is obvious that the greatest advantages will result only when r-f heating is applied to quantity production. Whether wood aircraft production will ever reach the quantities necessary to justify the use of r-f heating on a large scale is a question. However, it is almost certain that plywood parts of a similar nature will find many uses after the war and that some of these uses will require such parts in large quantities. The start which has been made toward developing r-f heating techniques for this type of application is, therefore, of interest beyond the present concern with wood aircraft.

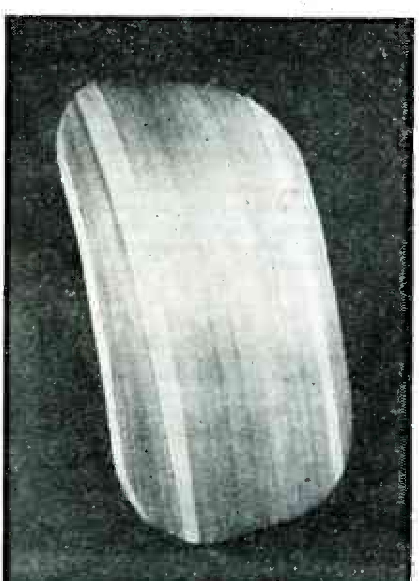


FIG. 2—Experimental plywood door for a two-engined bomber-trainer. Made from five plies of 1/16-in. veneer, this door is typical of "semi-molded" sections

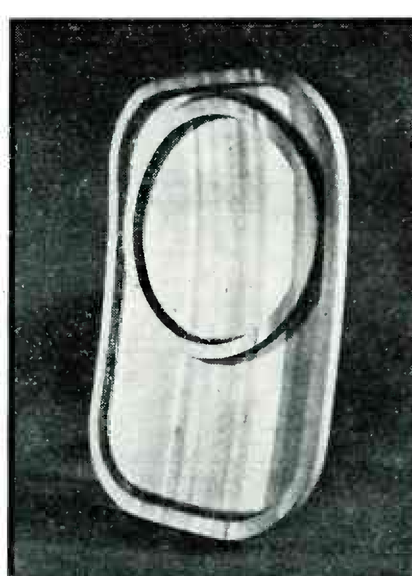


FIG. 3—Rear view of the door shown in Fig. 2. The frame is cut from a piece of 1¼-in. thick plywood formed to the proper curvature at the time of gluing

Making Parts From Flat Sheets

There are three more or less distinct types of construction used in making fuselage or wing sections for wood airplanes. In the first of these a strong wood frame is the essential element. Over this frame thin sheets of flat plywood are bent and tacked or glued in place. This type of construction is similar to that of the so-called "wood-and-fabric" small planes made in prewar days except, of course, that the covering is thin plywood instead of fabric. For lack of a better name it will be referred to as the "frame-and-covering" type of construction.

There are two possible uses of r-f heating in this type of construction. Both are somewhat outside the intended scope of this article and both have been at least partly described before. For the sake of completeness, however, they deserve to be mentioned.

Aircraft "Skins"

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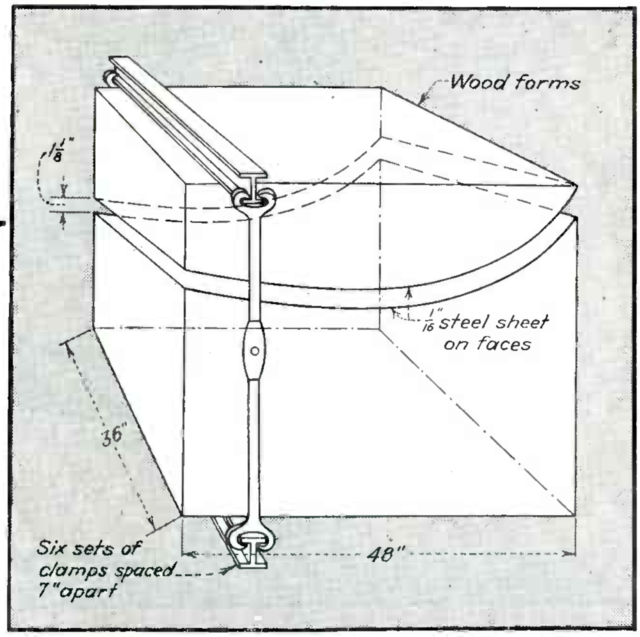

FIG. 4—Arrangement of forms and clamps used to make the thick piece from which the frame of the bomber door shown in Figs. 2 and 3 is cut. The steel faces of these forms were used as electrodes in adapting this operation for the use of r-f heating

The first of these applications is in the production of the large, flat sheets which are used as covering material. Since these sheets are very thin—from 1/20 in. to ¼ in., according to use— they can be made quickly and satisfactorily in hot-plate presses. At the present time, so far as is known, all so-called "aircraft-quality" plywood is made by this method. There is, however, at least one large plywood manufacturing plant in operation today in which r-f heating is being used for the mass production of large, thin sheets of ordinary Douglas-fir plywood.[2] If this operation—in which the cost of the final product is much lower than that of "aircraft-quality" plywood—is economically justified, then it seems at least possible that eventually all plywood will be made this way.

The second possible application of r-f heating to the frame-and-covering type of construction is in "tacking" or gluing the covering sheets to the frame. At the present time this is mostly done by cold-gluing, the sheets being held in place during setting by "nailing strips," which are narrow wood strips tacked along the edges of the sheet.

Conceivably the experimental r-f spot-gluer, which has been previously described[3], could be used for this purpose. By "tacking" the sheets down to the frame with this spot-gluer the necessity of placing and removing "nailing strips" would be overcome and the holes in the skin caused by the nails would be eliminated. No great time saving would be occasioned, of course, since only the "spots" would be immediately glued and the rest of the glue would still be "cold-set," which means a matter of hours. This use of the spot-gluer has not been given a complete trial and there remains a question as to whether spot-gluing will result in sufficient pressure (during the subsequent cold-setting period) to obtain full strength of the bond between sheet and frame.

A more promising method, so far limited to small pieces, is the use of so-called "stray field" heating. This consists of placing two thin strips of copper along the joint to be glued, in one of the ways shown in Fig. 1. These strips are connected to the output terminals of an r-f generator. While the glue-joint does not lie directly between the electrodes, it is usually sufficiently in the field so that the necessary heating results. In some cases the higher conductivity of the glue line provides a current concentration which is of considerable advantage. A production operation of this type was recently described by John Dreyer of Duramold Corporation in a paper before the Radio Club of America[4]. Similar applications have been described by Bilhuber and Godfrey[5]. It is desirable to note, however, that in many instances gluing operations of this kind can be satisfactorily accomplished by the use of simple resistance-heater strips.

Making Semi-Molded Parts

Following the frame-and-covering type of construction, in the natural order of development, comes a second type of wood aircraft construction—usually called "semi-monocoque"—in which a somewhat lighter frame is used and the plywood surfaces themselves are so designed as to give additional strength to the structure. This is accomplished by shaping or molding the plywood coverings to final form at the time the separate veneers are glued together. When these shaped surfaces are placed over the frame and securely glued to it at all points, they tend to hold the whole assembly together rather than to be held by it, as when flat sheets are used as coverings.

In the semi-monocoque type of construction the wing and fuselage surfaces are usually divided into a number of components which are

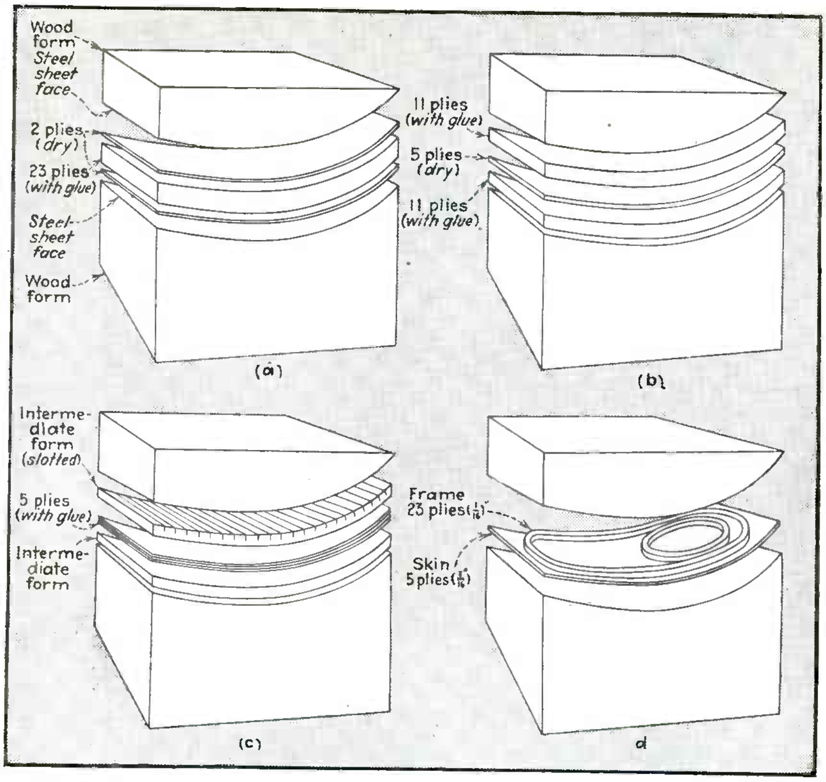

FIG. 5—Four steps in making complete bomber door by r-f heating method: (a) gluing 23 plies of 1/16-in. veneer to make frame piece; (b) gluing two packages of 11 plies each to make intermediate cauls; (c) using intermediate cauls to glue 5 plies for "skin" of door; (d) gluing frame to "skin"

formed separately. The wing, for instance, may consist of a leading-edge section, two slightly curved wing surfaces and a wing tip section. The fuselage will ordinarily be made up of half a dozen or more separate pieces. Some of these individual sections will be of simple curvature or of very slight double curvature. These can be made from flat veneer, providing the individual veneers are quite thin. Such parts are usually referred to as "semi-molded" (to distinguish them from the "full-molded" parts which, as described later, are made up from narrow strips of veneer).

In Fig. 2 and Fig. 3 are shown the front and back of an experimental door for a two-engined bomber-trainer. This door consists of a heavy frame which is about $1\frac{1}{4}$ in. square and is formed to the outline of the door, together with a preformed plywood "skin" made from five sheets of $\frac{1}{16}$-in. veneer. The frame is routed out of a piece of formed plywood $1\frac{1}{4}$ in. thick. The arrangement of forms and clamps shown in Fig. 4 is that which was previously used in making this thick piece by cold-gluing methods. These forms are similar to those previously described[1]; that is, they are made of wood and provided with $\frac{1}{16}$-in. steel facing plates on the inside surfaces. By using these steel plates as electrodes it is relatively easy to apply r-f heating to this gluing operation. Not only is the thick "plywood" piece from which the frame is cut made with r-f in $2\frac{1}{2}$ minutes, as compared to 8 hours by the cold-gluing method, but also the "skin" for the door is made with r-f and, finally, the skin is attached to the door by means of r-f heating.

The method followed in making the completed door by the r-f heating method is illustrated in the several sketches of Fig. 5.

In the first step 23 plies, each $\frac{1}{16}$ in. thick, are glued together (and simultaneously formed to the required shape) as shown in Fig. 5a. (The thick plywood piece shown in Fig. 6 is the result.) From this piece the frame of the door and the inner circle (which forms a frame for a window) are cut by routing.

The second step in the process is to make up two intermediate forms or "cauls" which will act as space fillers and thus allow the same main forms to be used in forming the "skin" for the door. To do this two packages of 11 plies each are glued up as shown in Fig. 5b. (The result of this operation is the two formed caul boards shown in Fig. 7.) The two caul boards so produced are used to fill in the space and thus make the forms fit correctly.

The skin itself is glued up from five plies as shown in Fig. 5c. The operation of gluing up the skin is

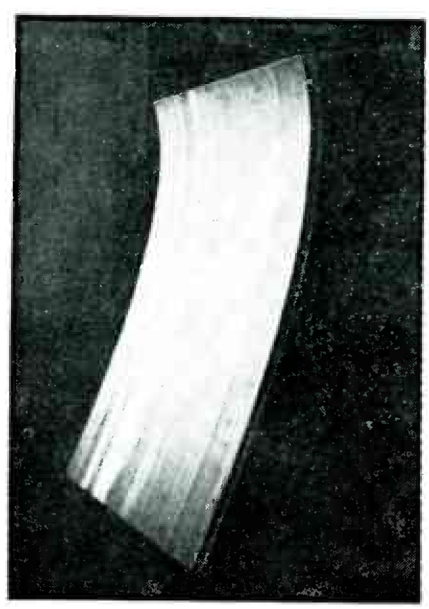

FIG. 6—Thick plywood piece from which door and window frame are routed. Glued as shown in Fig. 5a

FIG. 7—Intermediate cauls used in gluing skin. They are made by means of r-f heating as shown in Fig. 5b

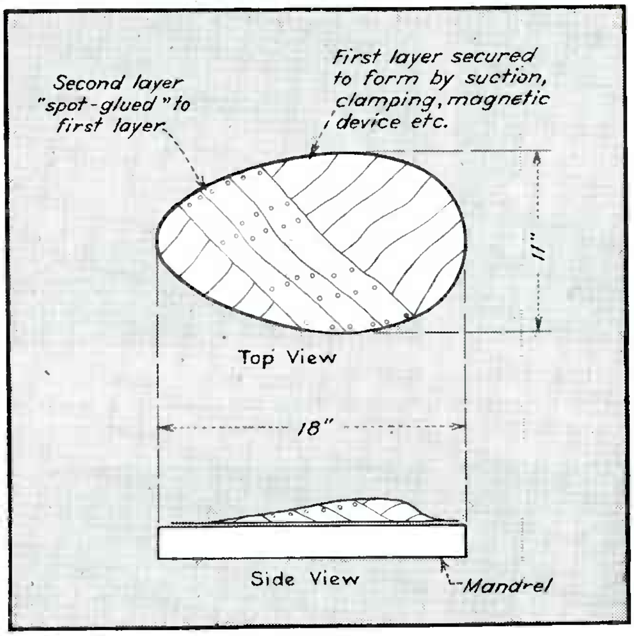

FIG. 9—Top and side views of mandrel during process of "wrapping" veneers used in forming the "blister" piece referred to in the text

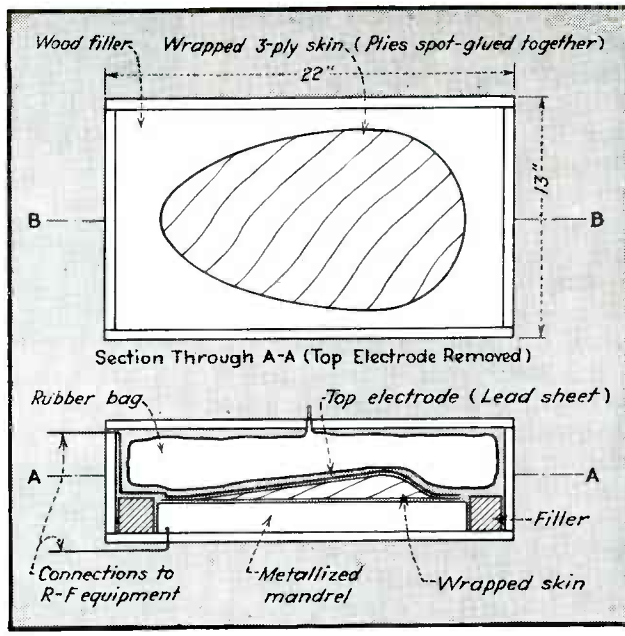

FIG. 10—Arrangement for curing the "blister" piece by means of r-f heating. Pressure is applied by inflating the rubber bag to approximately 50 lb

much more critical than that of gluing the thick piece due to the fact that it is much thinner and hence any small misfit makes for a greater percentage error and a correspondingly greater difference in pressure over the area of the piece. For this reason it was found necessary to position the caul boards very carefully. A further advantage was gained by cutting saw-slots in the top caul board every inch or so along its length.

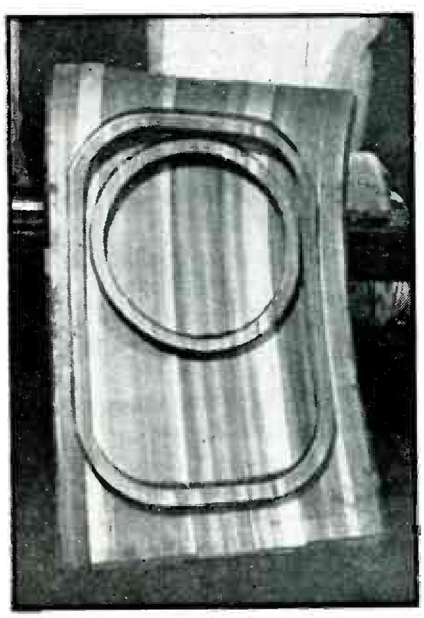

FIG. 8—Frame glued to skin and ready for trimming and sanding

This gave the board considerable flexibility and thereby tended to provide a pressure-equalizing effect.

As the final step in producing the completed door, the skin formed as above and the frame and circle routed from the thick piece made first are placed in the forms again as shown in Fig. 5d and r-f power applied to join them permanently together. After this final gluing operation the assembly needs only to be trimmed and sanded and it is ready for final finish. (The frame and skin, which have been glued but not yet trimmed, are shown in Fig. 8.)

In each of the four gluing operations outlined above the radio-frequency connections are made to the steel face plates of the main forms. Thus all of the material placed between these plates is heated in each instance. This represents a certain waste of power but has the advantage that tuning and power adjustments of the r-f generator are the same in each operation. This is an important consideration where the equipment is to be operated by inexperienced personnel.

R-F Equipment

The r-f feed arrangement used is exactly the same as that used in gluing the laminated fuselage rings previously[1] described. Essentially this consists of a two-wire transmission line from the generator to the two steel face plates which form the electrodes. (In permanent installations a concentric transmission line is used in order to reduce radiation) Tuning is accomplished by an adjustable tuning stub connected in parallel with the load. With a spacing of 1¼ in. between forms, as used in the four operations described above, a frequency of 8 Mc was found most convenient. If only the "skin" were to be heated in the one operation—as by using additional electrodes next to the "skin"—the load capacitance would be so great that a lower frequency, probably 2 or 3 Mc, would have to be used. On the other hand, if an attempt is made to use the lower frequency in making the thick piece, it is found that an impractical amount of tuning inductance is required and, moreover, the voltage gradient across the load is high enough that flashover may occasionally occur. For this reason as well, therefore, the arrangement in which all the material between the forms is heated is much the best.

With this method consistently good results were obtained. Any of the four gluing operations could be completed in an average time of 2½ minutes of actual heating. To insure positive results it was found desirable to apply power for 2½ minutes (during which time the temperature of the wood rose to about 230 deg F) and then to leave the material clamped up for another 2½ minutes with power removed. Thus 5 minutes sufficed to accomplish the same result as 8 hours of setting at room temperature. Not counting time out for routing the frame from the thick piece, a completed door could be turned out every 15 minutes.

The power used in these gluing operations was approximately 8 kw at the generator output terminals. In order to accomplish the above-mentioned heating times it was necessary to readjust the setting of the parallel inductance as the load changed during the heating period. As the reactance may change as much as two-to-one during the cycle, and as the circuit is quite sharply tuned, the current through the load would drop off markedly if this were not done, and a much longer heating time would be required. This is one drawback of the simple and otherwise desirable r-f feed arrangement used here. There are several possible ways to overcome it. One is to use an arrangement in which the load is simply connected across the tank circuit, or a part of it, so that the frequency of the generator, assuming it is a self-excited oscillator, changes with the load and thereby keeps itself in tune. Unfortunately, this arrangement requires the use of low frequencies for other than the smallest loads, and low frequencies invite trouble with flash-over. Moreover, the use of oscillators which drift through a wide range of frequencies during the cycle is questionable engineering. If the practice becomes widespread it will be certain to result eventually in a difficult interference situation.

Another possible solution has been suggested by Hoyler and Bierwirth[6]. This consists in placing in the line a matching section which is so designed as to minimize the effects of load changes.

Making Full-Molded Parts

Wood, unfortunately, cannot be stretched or drawn. Therefore, where the forming of parts for wood aircraft requires pieces having a compound curvature, it is necessary to resort to a third and rather complicated method of construction. This involves molding of these parts by what is commonly called the "rubber bag process." This process has been described in some detail by the author in a previous article in ELECTRONICS[3] and at length in various other journals.[7, 8, 9] Essentially it consists of the following steps.

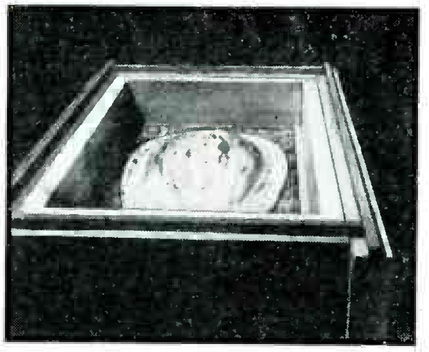

FIG. 11—Metallized mandrel for "blister" piece, mounted in box used for r-f heating. Metallized layer forms bottom electrode

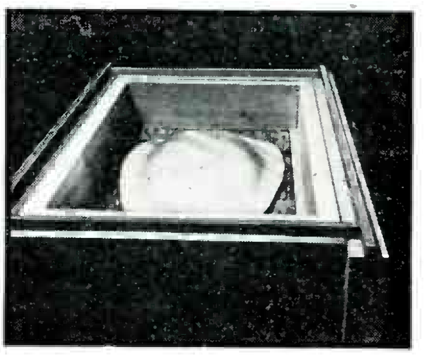

FIG. 12 — The "skin", formed by the veneers "wrapped" as in Fig. 9, is placed on the metallized mandrel for curing

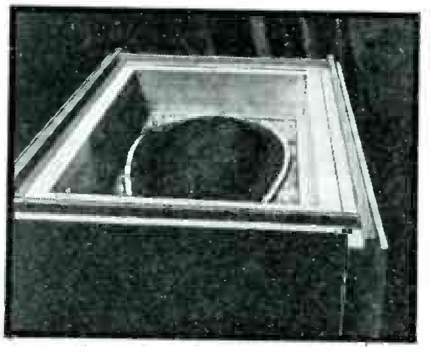

FIG. 13—Upper electrode, consisting of formed lead sheet placed over the "skin" which is to be heated

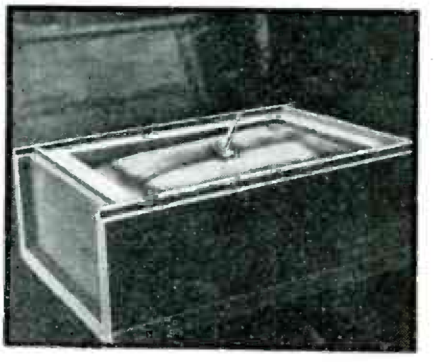

FIG. 14—Rubber bag placed over top of lead sheet. After the box is closed the bag is inflated to provide the required pressure

First, a mandrel is made, usually of wood or plastic. This is a male form carefully shaped to the precise contours of the fuselage or wing surfaces to be made.

Second, narrow strips of thin veneer to which a resin glue has been applied are fitted or "wrapped" on this mandrel as shown in Fig. 9. Each strip is tailored by trimming or slotting so that it fits the form snugly and its edge is tight against the edge of the preceding strip. At the present time these strips are usually secured to the mandrel with staples. From three to as many as nine layers of veneer may make up the "skin" which is "wrapped" on the mandrel in this way.

The third step in the process is to place the mandrel and wrapping in a rubber bag from which the air is then evacuated.

Next the whole package—i.e., mandrel, wrapped-skin and covering rubber bag—is placed in a large pressure chamber called an "autoclave." Steam, hot water or hot air under pressure is then introduced into the autoclave. The resulting combination of pressure and heat serves to set the glue and thereby weld the strips of veneer into a single strong piece of the desired shape.

While this process of making "molded" wood parts is, with a number of variations, in wide use today, it has many acknowledged drawbacks. One of these is the use of staples which leave small holes in the "skin," often puncture the bag and, to some degree, limit the slight shifting of the veneers under pressure which is desirable in obtaining a fully stressed piece. The r-f spot-gluer mentioned above can be used in place of the staples, as has been previously described in ELECTRONICS[3].

An even greater disadvantage in the bag method is the necessity of using an autoclave. Not only is the autoclave method slow, but also it is inefficient and somewhat dangerous. Hence, even though the use of r-f heating for thin pieces, such as these aircraft "skins" represent, is at first glance not too promising—on the theory that external heat can penetrate thin sections quickly and hence "heating the inside" is of no advantage—it turns out on further study that it may yet be found of advantage in this particular case. A few experimental tests of the use of r-f in making full-molded parts have been made. One method which yielded fairly good results will be described.

The piece chosen for this test was a small streamlined "blister" used on a well-known bomber-trainer. While this piece is of small size, it has a sharp double curvature and is otherwise typical of the sections ordinarily "molded" by the bag method. Since r-f heating applications which look good under idealized conditions in the laboratory often come to grief when moved to the factory, an attempt was made to reproduce factory operating conditions. A regular mandrel was used and the layers of veneer were fitted or "wrapped" on this mandrel by one of the regular girl operators.

Three layers of 1/48-in. veneer were "wrapped" on the mandrel using the r-f spot-gluer previously mentioned. Figure 9 shows the position of the spot-glued points on the several layers of veneer.

In Fig. 10 is shown the r-f heating box used to "cure" the skin wrapped as above. This is a heavy wood box in which the mandrel is placed as shown. A rubber bag is arranged so that after the lid of the box has been clamped shut the bag can be inflated, thereby providing the pressure required to press the veneers tightly against the mandrel and assure that they will be adequately bonded.

The necessity of having "flexible" or "fluid" pressure in this kind of gluing has been previously pointed out. The rubber bag arrangement shown in Fig. 10 will provide this if a sufficiently flexible top electrode is used. A number of different electrodes, both top and bottom, were tried. The first requirement of these electrodes is that they be quite smooth and entirely free from irregularities, particularly small protuberances. Since the spacing between electrodes is only $\frac{1}{16}$ in., the slightest roughness will result in flashover.

Attempts to form copper screen or copper sheet over the mandrel as a bottom electrode came to grief. The final and quite satisfactory solution was to "metallize" the mandrel by spraying a layer of aluminum on it with a spray gun. A thick layer—nearly $\frac{1}{8}$ in. deep—was put on carefully, after which it was sanded to a mirror-like finish. This worked admirably and is, no doubt, the best answer for the bottom electrode. The top electrode is a tougher problem, since it must be free to flex. The best of those tried in these tests was a sheet of $\frac{1}{16}$-in. lead which was preformed to the shape of the mandrel by drawing. Because of the preforming there was no tendency for this sheet to crease or crack when pressure was applied. At the same time, it was soft enough to transmit the pressure almost equally and to preserve to some degree the "fluid" pressure provided by the inflated bag. There was some question whether there was quite enough flex in the sharpest part of the curvature and it is felt that thinner lead sheet—probably $\frac{1}{32}$-in. thick—would be better.

Figures 11, 12, 13 and 14 show, respectively, the mandrel in the box, the wrapped skin in position on the mandrel, the upper electrode in place and the rubber bag arranged ready for closing the box. After the box is closed and clamped tightly, the bag is inflated, r-f power applied to the electrodes through connections brought out the sides of the box, and the assembly left to "cook" for about 3 minutes. The "blister", removed from the box after this "cooking" cycle, is shown in Fig. 15.

With the arrangement shown here pressures of 45 to 50 lb were used. This is probably near the minimum. Larger pieces of heavier veneer would undoubtedly require more. To obtain such pressures on fairly large pieces will require retaining structures of great strength comparable, in fact, to the autoclaves now used. However, all the difficulties attendant on the use of steam or hot water, including particularly the deterioration of the rubber bags, will be eliminated. Time cycles can be greatly reduced.

The small "blister" mentioned above required 3 minutes for setting, as against something like 30 minutes in an autoclave. Bigger pieces can be done in the same short time if the necessary power can be justified. At the present time the repair of mandrels spoiled by water soakage is a big item of expense. Bags are also an expensive item, the average life at present being not more than one hundred cycles. Both these expenses would be greatly reduced; in fact, bags and mandrels should last in-

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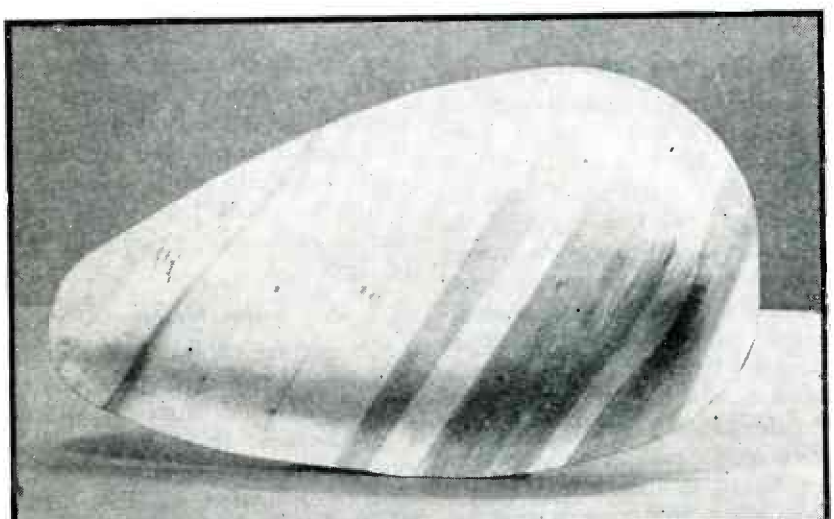

FIG. 15—Molded "blister" piece made as described in the text and "cured" by use of r-f heating in 3 minutes as compared to 30 minutes by "autoclave" method

Electronic Timer for MICROSECOND INTERVALS

A capacitor is charged for the exact duration of the interval, and the capacitor voltage then measured with a vtvm calibrated to read from 0 to 140 microseconds with an accuracy better than ±2 microseconds. Uses include measuring propagation velocities, reaction rates, time lags of relays, and projectile velocities. Calibrating methods are given

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WHENEVER a velocity is to be measured, as in acoustic or ballistic studies—whenever a mechanical, electrical, or chemical reaction time is to be determined, as in studying explosives or measuring the time-lags to be found in a multitude of electronic circuits—an instrument which measures the length of the time interval between two events may be the ideal measuring device.

Like many other devices for the measurement of some specific physical quantity, such instruments have been in existence in the laboratory for some time past. However, it often takes an additional step of consideration and design to make a rugged engineering instrument, constructable of commercially available parts, out of such a laboratory set-up.

Just such a step was required in the case of the time-interval meter to be described. It is designed to measure time intervals in the region of 0 to 140 microseconds, with an accuracy of ±2 microseconds or better. It can be built with a longer time-scale reading up to several milliseconds, if desired, and with some precautions even shorter times can be measured.

Operating Principles

Circuits for the measurement of time intervals have always been based on the effect of a certain amount of electrical charge Q transported over the length of the time interval. Either this charge Q is used to produce a proportional deflection on a ballistic galvanometer, or charge a capacitance C to a potential $V = Q/C$, which then is measured. Such instruments have been described[1,2,3,4] for full-scale ranges of a fraction of a second down to 10 milliseconds. In the present case, the capacitor charging method has been adopted, which eliminates the use of a sensitive galvanometer.

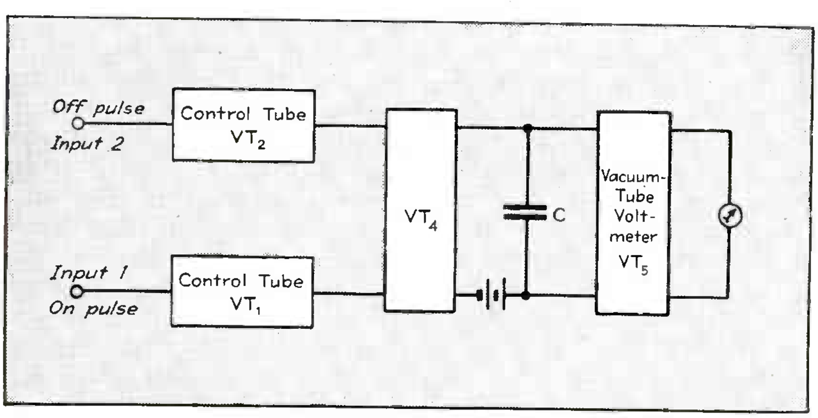


FIG. 1—Block diagram of timing circuit

The block diagram in Fig. 1 illustrates the operating principles. The two electrical impulses representing the beginning and the end of the time interval to be measured are each fed to a control tube. When control tube VT_1 receives the on pulse, it causes tube VT_4 to pass current and begin charging capacitor C. When control tube VT_2 receives the off pulse, it causes VT_4 to block. Thus, capacitor C is charged to a value depending on the time interval over which current passes into it. A vacuum-tube voltmeter reads this voltage, and can be calibrated directly in units of time.

Design Problems

There are three basic design problems which accompany the use of the charging capacitor method:

1. Leakage of charge from or onto the capacitor before, after, or during operation of the current-controlling tube must be eliminated. This imposes requirements on the leakage resistance of the charging capacitor and the general insulation used in construction, on the output impedance of the current-controlling tube, and on the input impedance of the vacuum-tube voltmeter tube.

2. In attempting to design a suitable switching circuit, it is found that most circuit arrangements which suggest themselves have the undesirable feature that various cathodes have different potentials with respect to ground, as in direct-coupled d-c amplifiers.

3. When extending the range of measurements down to time intervals as small as is the case here,

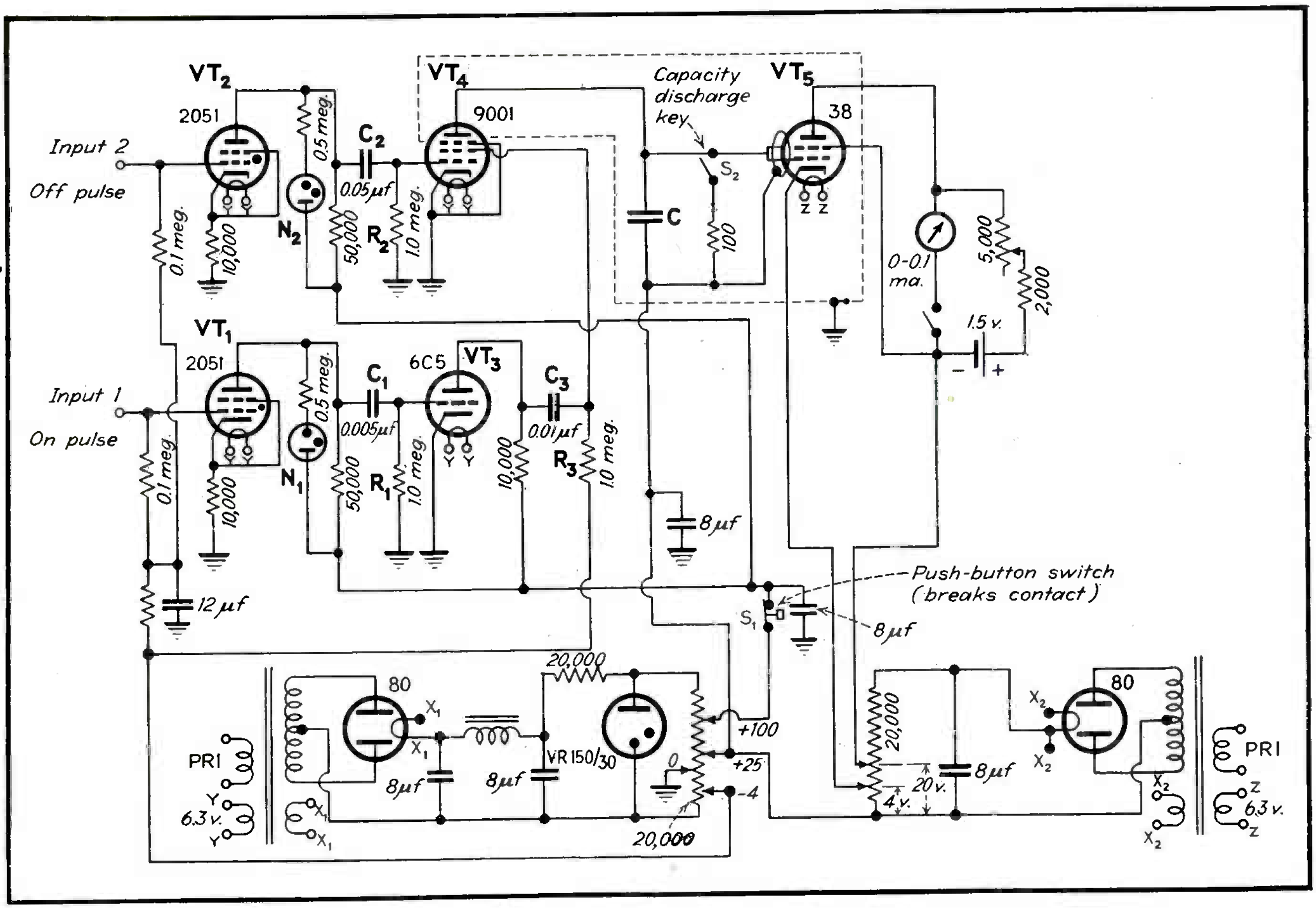


FIG. 2—Complete circuit diagram of high-speed electronic timer

care must be taken that the switching mechanism does not introduce time lags. This eliminates all circuit designs in which the two input circuits have time constants which are large compared to the time intervals to be measured.

Circuit Design

Considering all these points, the circuit design shown in Fig. 2 was finally selected. The control tubes are type 2051 gas tetrodes. There is no appreciable delay in the firing action of such tubes, as the ionization time is less than one microsecond.

In principle, when the type 9001 current-controlling tube (VT_4) is at rest it has zero control-grid voltage and negative screen-grid voltage (with respect to cathode), resulting in zero plate current. The on pulse is responsible for immediate application of a positive voltage pulse to the screen grid of this tube, causing it to pass plate current. This positive pulse is made to last for a time longer than the time interval to be measured.

The off pulse, arriving while the screen grid of VT_4 is still positive, causes immediate application of a negative pulse to the control grid of this tube, thus cutting off its plate current. The negative voltage pulse on the control grid will last a longer time than the positive screen-grid voltage swing, so that the control grid of VT_4 does not return to zero bias until the screen grid has first returned to its at-rest negative potential. Plate current therefore stays at zero after an off pulse.

The entire action, including the resulting plate-current pulse, is shown in Fig. 3, which constitutes oscillograms of the various potential and plate current variations.

The on and off pulses must be of positive polarity at the input with respect to ground. They may be capacitively coupled to the input, or direct coupled if more convenient and not disturbing to the d-c grid voltages on the input tube. Gas tetrodes are preferable to gas triodes, in order to have a minimum of capacitive coupling from grid to plate and to avoid errors due to surges or pulses following the phenomenon to be measured. An input pulse fires its gas tube, which transmits a negative voltage pulse through capacitive coupling to the following tube. The gas tubes remain conducting once they have been fired, until their plate voltage is removed momentarily by operating a push-button switch. Neon bulbs N_1 and N_2 glow to indicate that the associated gas tubes have been fired.

The polarity of the negative pulse from VT_1 (produced by the on pulse) is reversed by VT_3, thus producing a positive pulse that is applied to the screen grid of VT_4. The duration of this positive pulse depends on the time constant of R_1C_1 or R_3C_3 whichever is smaller. Here R_1C_1 governs, and the pulse stays positive for a duration of approximately 0.005 sec. If no other pulse arrived, VT_4 would stay conducting for this interval. However, the negative pulse produced by VT_2 upon arrival of the off pulse is applied to the grid of VT_4 and immediately cuts off its plate current. This pulse on the grid will decay with a time constant deter-

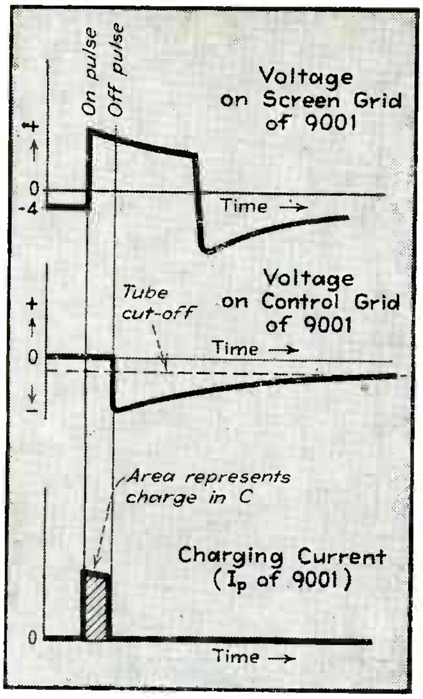


FIG. 3—Capacitor charging-current and electrode voltage curves for the type 9001 tube used in the electronic timer

mined by R_2C_2, which is 0.05 sec (ten times longer than for the screen-grid pulse). In this way VT_4 cannot conduct current at any time after the event to be measured has occurred.

Leakage Resistance Problems

Capacitor C in Fig. 2 is charged by the plate current of VT_4 during the pulse interval. The leakage problem arises here. Conditions can be considered practical and stable if, over a period of $t = 5$ seconds, there is no more than 2 percent change of voltage across capacitor C. The minimum allowable leakage shunt resistance R_e in ohms is determined as follows:

$$\frac{1}{E}\frac{dE}{dt} = t/R_eC$$

$$R_e = \frac{5}{0.02}\frac{1}{C} = 250/C$$

According to this formula, a 1-μf capacitor should have a leakage resistance above 250 megohms; a 0.1-μf capacitor should be above 2500 megohms, and so forth. Such capacitors are now obtainable. For capacitances larger than 0.1-μf, Cornell-Dubilier Dykanol capacitors were used successfully, and below this size their type 86 mica units were likewise satisfactory. The calculated leakage resistance of course combines the leakage in all other parts of the circuit.

The vacuum-tube voltmeter must have an input impedance that is large compared to R_e (larger than 2.5×10^9 ohms for a 0.1-μf charging capacitor). The type 38 tube is known to have good grid impedance characteristics if used properly. Since the input impedance is determined by the grid current, the tube must be operated at a small cathode current. This current is about 0.4 ma in the circuit shown, and is obtained with a plate voltage of about 20 volts and a grid bias of about -4 volts.

To avoid surface leakage over the bulb of the tube (VT_5 in Fig. 2) under conditions of high humidity, the top of the tube can be dipped in a molten nonhygroscopic wax. Another good precaution is painting the rest of the glass envelope with colloidal graphite (Aquadag); when connected electrically to the "cold" end of capacitor C, this serves as an electrostatic shield, as a guard ring for leakage and as a light shield. (Illumination often produces a grid current due to photoelectric liberation of electrons on the grid electrode.)

Leakage from the plate lead of VT_4 is also important. This was formerly a major problem from the point of view of using commercially available material, since ordinary receiving tubes with plate connections through the glass envelope were not available. Some transmitting and power tubes have this feature but do not cut off sufficiently to eliminate internal electron current. In the laboratory it was sufficient to use a tube like the 1B4-P after removing the Bakelite base and filling the glass cavity with wax. Now, special uhf tubes having electrodes passing directly through glass and good cut-off characteristics, such as the type 9001, have solved this leakage problem. Polystyrene sockets for these tubes are also on the market. The sketch in Fig. 4 summarizes construction details of that part of the circuit.

Operation and Calibration

Operation of the instrument is simple. Push-button switch S_1 is pushed to break the discharge current through VT_1 and VT_2 if they were previously fired. Neon bulbs N_1 and N_2 must now be dark. Key S_2 is next closed to discharge capacitor C, and the output meter is adjusted to zero by means of the rheostat. The apparatus is now ready for the measurement. After the on and off pulses arrive, the meter is read.

Before each measurement, capacitor C must be fully discharged. This is accomplished by a key ar-

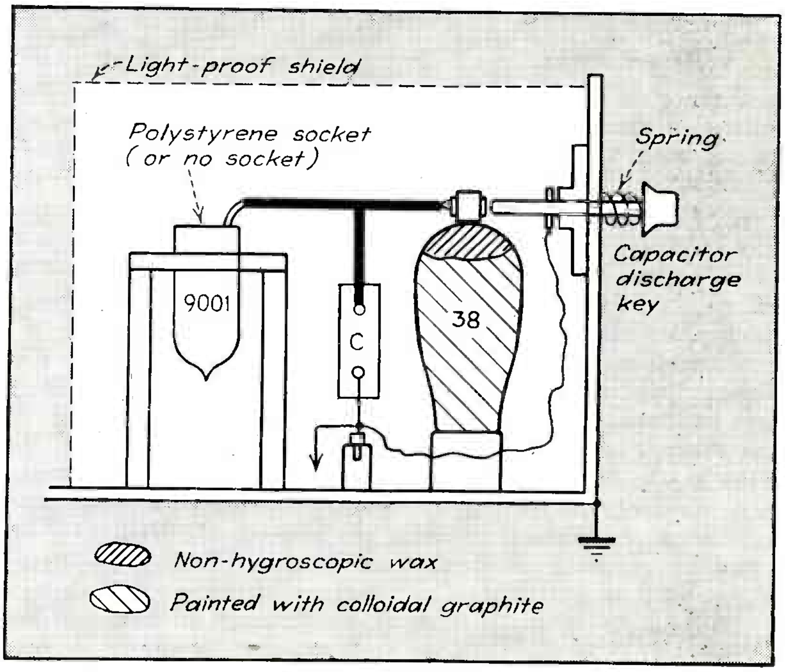
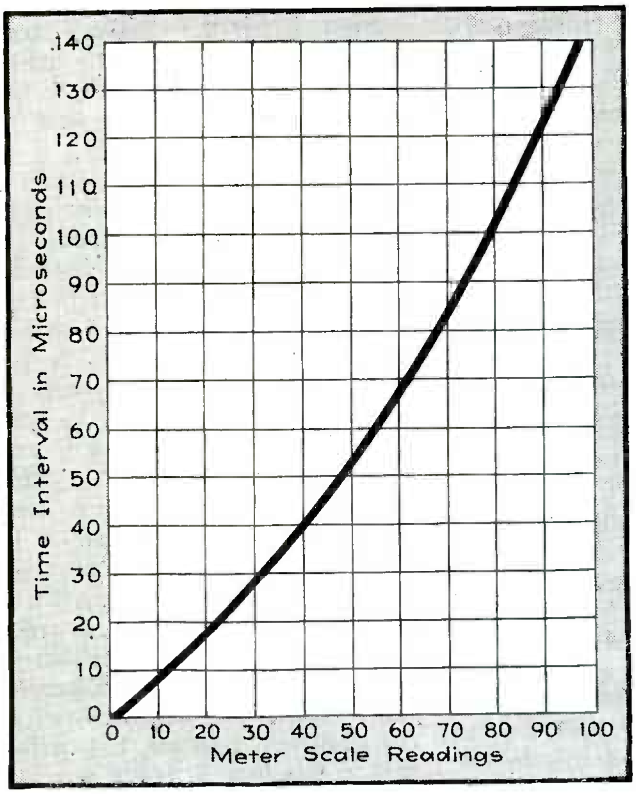


FIG. 4—Mechanical arrangement used in the vacuum-tube voltmeter circuit to eliminate leakage and photoelectric effects



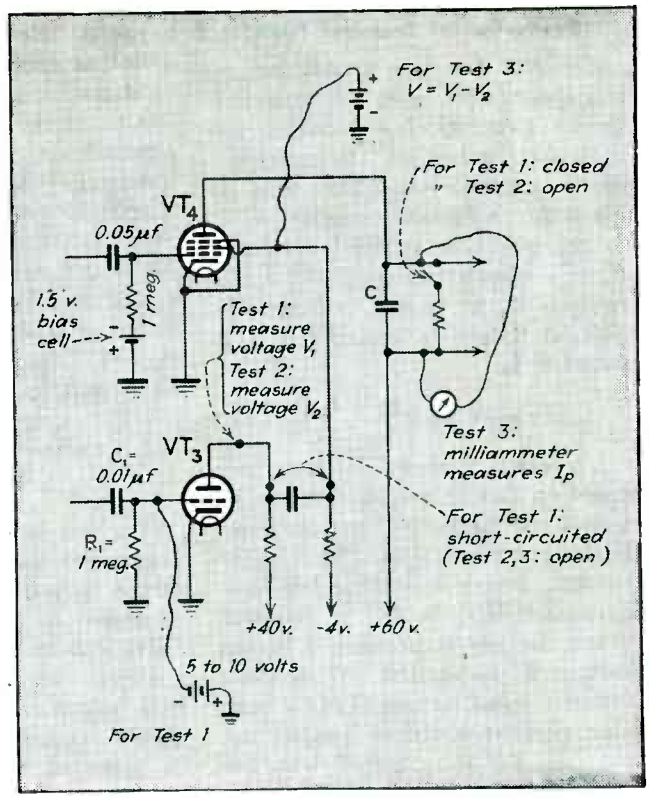


FIG. 5—Calibration curve for the electronic timing circuit

FIG. 6 (at right)—Circuit giving a capacitor charging current that is independent of the plate voltage of the charging tube. The three tests outlined on this diagram constitute a simple method of measuring the capacitor charging current and thereby calibrating the instrument. Tests 1 and 2 determine two voltage values, V_1 and V_2, whose difference constitutes the actual voltage on the screen grid during operation. In test 3 this difference voltage is applied artificially and the resultant charging current is measured. From this value the corresponding time value can be computed

ranged as in Fig. 4, so that no additional dielectric problem is created.

To provide greater sensitivity, the output meter circuit is balanced using a 0.1-ma instrument. It is most convenient to use a dry cell as the source for the balancing potential, since the drain is only a fraction of a milliampere. Voltage drop due to aging over as long as a year or more is immaterial since balancing current can be adjusted with the 5000-ohm rheostat.

For calibration of the instrument, a source for the production of two transients (pulses) with variable and known time spacing is required. If so desired, such a calibrating circuit can be incorporated in the apparatus, to provide a permanent means of re-checking.

If a source of transient pairs is available, but the time spacing unknown, the calibration can still be made with the aid of a cathode-ray oscilloscope having a variable and known sweep frequency. The procedure is obvious if the transient pairs are periodically recurrent. If they are nonperiodic, begin with a low sweep frequency and increase it. During this process, the linear spacing of the pulses on the screen becomes greater, until the sweep frequency is reached at which the two individual pulses occur at exactly the same place on the screen during two successive sweeps; this frequency then determines their time spacing.

A typical calibration curve obtained for the circuit of Fig. 2 is shown in Fig. 5.

Alternative Calibration Procedure

A design variation which shows great promise is shown in Fig. 6. It makes full use of the pentode principle of independence of plate current I_p and plate voltage E_p when the plate voltage is well above the applied screen voltage. If this constant plate current is known for the screen-grid voltage corresponding to the maximum amplitude of the screen-grid pulse when the circuit is operated in the same way as above, the voltage to which capacitor C charges for any time interval of measurement can be found with good accuracy. If this is known, a simple calibration of the plate current meter reading and grid voltage (capacitor voltage) on the vacuum-tube voltmeter tube fixes the calibration of the instrument. Although the screen-grid pulse is a transient, the assumption of a constant screen voltage is justified, since the transient's recovery ($t = R_1C_1 = 10$ milliseconds) is very large compared to the duration of the measurement (0 to 0.15 millisecond).

In Fig. 6 is shown the procedure for finding the effective maximum amplitude of the screen-grid pulse V from two tests, and subsequently finding the constant plate current I_p when voltage V is actually applied to the screen grid in the form of a battery (test 3). With this current found, the voltage to which the capacitor charges as a result of a measured pulse interval t is $E_C = T_pt/C$, where values are in volts, amperes, seconds and farads respectively. By calibrating the output meter reading in terms of a variable applied and known voltage on the grid of the vacuum-tube voltmeter, the calibration giving output meter reading in terms of time t is directly obtained.

Production of Transient Pairs

Circuits for the production of transient pairs, with variable and known time spacing between the individual pulses of the pair, are easily constructed. The time it takes for a known capacitance C_e to charge from an initial voltage E_o to a known voltage E_2 by application of a known voltage E_1 through a known resistance R is found to be

$$t = RC_e \log \left[\frac{E_o - E_1}{E_2 - E_1}\right] \quad (1)$$

The circuits shown in Fig. 7 are based on this principle. Figure 7A uses a gas discharge tube of known flashing potential E_2. The initial voltage, before operating the mercury-pool key, is $E_o = 0$ volts. When the key is pressed, a known voltage E_1 is applied. With three different capacitances C and a variable resistance, three ranges are obtained for the time of delay between pulse 1 and pulse 2, the latter of which will occur as a result of the delayed ignition of the discharge tube.

The voltage regulator tube VR105/30 can be used as a discharge tube. Its flashing potential is accurately reproducible, and was found to be $E_2 = 138$ volts $\pm$ 1 percent for four different tubes tried. Such cold-cathode gas discharge tubes introduce an intrinsic time lag which has to be taken into account. Under normal conditions, this time lag would, in fact, be random and unpredictable, rendering the tubes worthless for this purpose. However, sufficient illumination from a steady source of light produces sufficient photo ionization in the tube to eliminate all randomness, and simply yields a consistent time lag which, for the VR105/30, was found to be approximately $t_e = 2.5 \times 10^{-5}$ sec for 4 different tubes. Thus, the actual time lag between the two pulses of a pair is determined with Eq. (1), taking into account the additional intrinsic lag t_e:

$$t_{real} = t + t_e = RC_e \log \left[\frac{E_o - E_1}{E_2 - E_1}\right] + 2.5 \times 10^{-5} \text{ sec.}$$

The source of light is made a permanent part of the apparatus, in the form of a 25-watt light bulb mounted so as to irradiate the VR105/30 through its top.

Figure 7B shows a more elaborate variation of the same principle. A gas-tetrode (2051) is used in place of the cold-cathode discharge tube. This has two advantages: (1) The intrinsic lag of the gas tetrode (or triode) is negligible; (2) The inter-electrode capacitance (grid to plate) is very small. The arrangement in Fig. 7B is of great advantage for very short time intervals, since there would otherwise be danger of inducing a non-delayed pulse in the output circuit of pulse 2 by way of capacitive coupling. To make full use of this feature, the delayed pulse must be taken from the plate circuit, and since this pulse has negative polarity, must be reversed in phase by a subsequent vacuum tube. If it were not for the relatively large grid-cathode capacitance it could be taken off as a positive pulse on the cathode side without the need of an additional inverter stage.

The principle of operation of the circuit in Fig. 7B is the same as in the case of Fig. 7A, although it may not be immediately obvious. In analogy with the circuit in Fig. 7A, operation of switch S should apply a known voltage E_1 to the delay network between a and b. Actually this does happen, the voltage being between a' and b' and capacitively applied over C_L. This does not introduce an error as long as C_L is much greater than C. In this way, the necessary negative bias can be applied to the grid of the tube through R_G which, in order to introduce no error, must merely be large compared to R. Equation (1) will now apply accurately without additional time lag, but noting that in this case E_o is not zero but equal to the permanent negative bias (—45 volts). The voltage sources were drawn as batteries merely for the sake of simplicity; a-c operation is naturally possible, and can be carried out in the customary ways.

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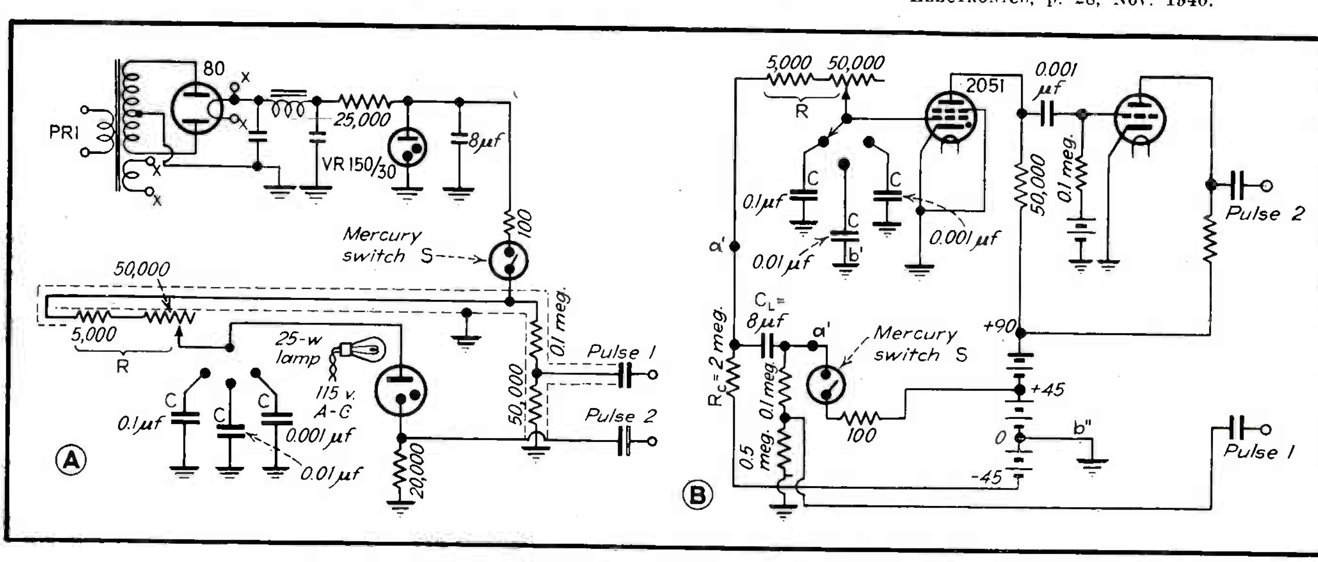
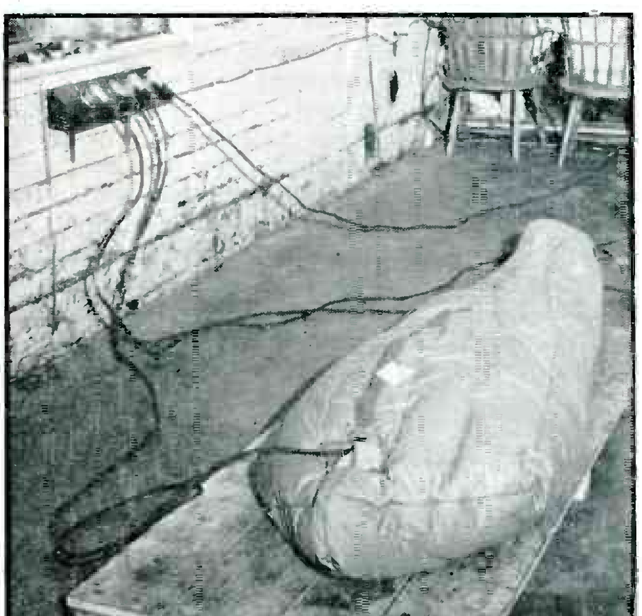


FIG. 7—Two circuits for generating a pair of pulses having a given and known time spacing, for use in calibrating the electronic timer

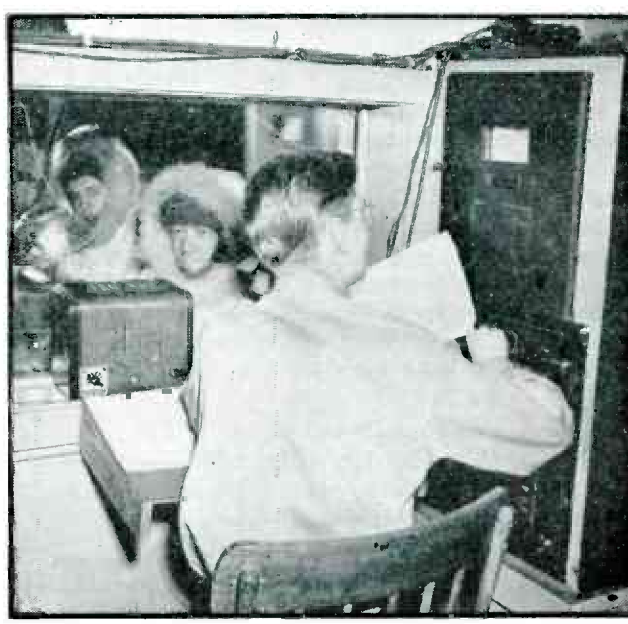
COLD TESTS

Tests of clothing at 60 deg below zero are made by the U. S. Army Quartermaster Corps, using thermocouples placed at the heart, kidney, back, abdomen, thighs and big toes of soldier volunteers

A harness holds thermocouple junctions in contact with the flesh at eight points on the soldier's body. A cable connects the couples to an electronic potentiometer which records body temperatures during various activities in arctic dress



Not a mummy, but a soldier in a sleeping bag undergoing a temperature test at 60 deg below zero to determine the reaction of the body to extreme cold while relaxed. Such tests, conducted by the U. S. Army QMC, should have an effect upon commodity standards after the war



Use of this electronic potentiometer, a product of Brown Instrument Co., has speeded up the recording of the temperature readings over a manually-operated instrument formerly used. A complete record of the eight readings for each man now requires about 30 seconds

Photoelectric INDUSTRIAL

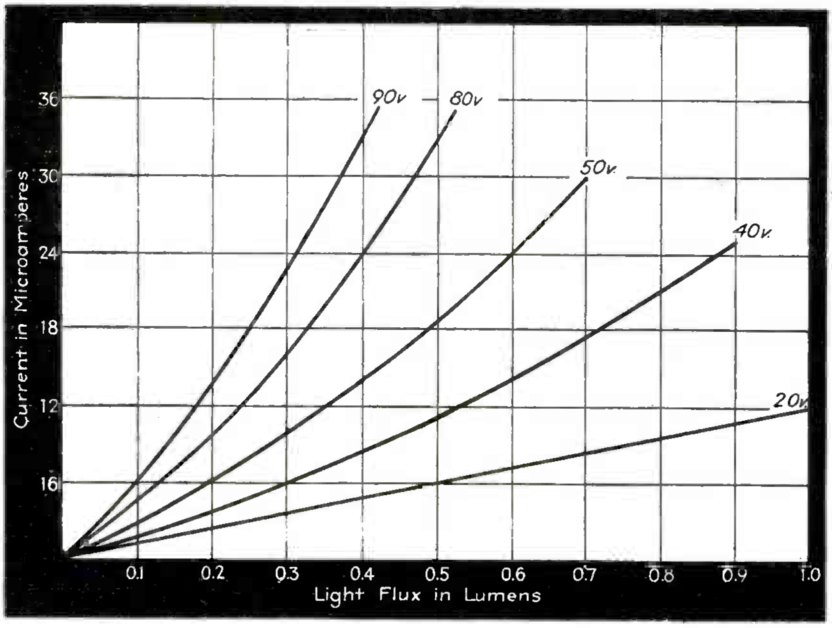


Fig. 1—Current-illumination characteristics of typical phototube

MANY industrial engineers and plant superintendents have been afraid of photoelectric equipment and have regarded it as delicate gear that must be carefully handled. This is, today, an erroneous idea. Photoelectric equipment is now constructed to meet the same rigid requirements as other well-constructed industrial control equipment.

The art of manufacturing electronic tubes has progressed to such a point that they are sturdy and long-lived. Similarly, maintenance of photoelectric equipment presents no greater problem than that of other industrial controls. In many cases, maintenance is less on photoelectric equipment than on other type controls used for the same purpose.

Photoelectric controls can be applied without special knowledge of electronics. Familiarity with amplifiers, control circuits and tube theory is not necessary. One must know only what the equipment will do and how it can be used.

For photoelectric control, light is used as the controlling medium rather than mechanical or electrical contacts. Operations where friction cannot be tolerated (or where mechanical contact cannot be made) are readily and conveniently controlled with simple photoelectric apparatus.

Types of Devices

In general, control by means of light is accomplished by three basic types of photoelectric devices: (1) Photoconductive cells, in which the resistance of a semi-conducting solid substance to electric-current flow is reduced by light radiation. (2) Photovoltaic cells, in which light energy produces a difference in potential across two substances that are in close contact. Sometimes the photovoltaic cell is called a barrier-layer cell. (3) Photoemissive cells, or tubes, whose action is produced by emission of electrons from a light-sensitive cathode surface.

Photoconductive and photovoltaic cells are quite rugged in construction and have relatively high current output. This sometimes makes possible the direct operation of meters, relays or other current operated devices. An amplifier can be used with any one of the three types of light-sensitive devices, however, and the photoemissive type is often selected since its output is so readily amplified.

Phototubes

Photoemissive devices called phototubes are probably the most widely used. They contain two elements, a cathode and an anode, sealed in a glass tube. The cathode is semi-cylindrical in shape and consists of some base metal (such as silver) coated with caesium oxide, which is sensitive to light. The anode generally consists of a straight wire electrode mounted along the axis of the cathode. Light falling upon the cathode results in emission of electrons from the light-sensitive surface. The released electrons are drawn to the anode by virtue of an external voltage applied between the anode and cathode.

Selection of cathode material determines the spectral response of the phototube. Pure sodium, tungsten-on-nickel, thorium-on-nickel or titanium-on-nickel cathodes are particularly sensitive to ultraviolet radiation. A thin layer of caesium deposited on a layer of caesium oxide (formed on a silver surface) is sensitive to visible and infrared

TYPICAL APPLICATIONS

- **Paper mill break indicator**
- **Automatic weighing**
- **Cellophane bag machine controls**
- **Stopping of mechanical devices**
- **Liquid level control**
- **Initiation of flying shears in steel mills**
- **Counting units on production line**
- **Safety Control of machinery, furnaces**
- **Concentration and color control**
- **Weld comparers**
- **Plant protection**
- **Tin reflow regulators**
- **Door opening and closing initiation**

CONTROLS

Rugged construction has taken the electronic equipment out of the experimental stage and made it an important industrial tool. The principles of operation of gas and vacuum-type phototubes and the use of accessories are described

By HAROLD J. HAGUE

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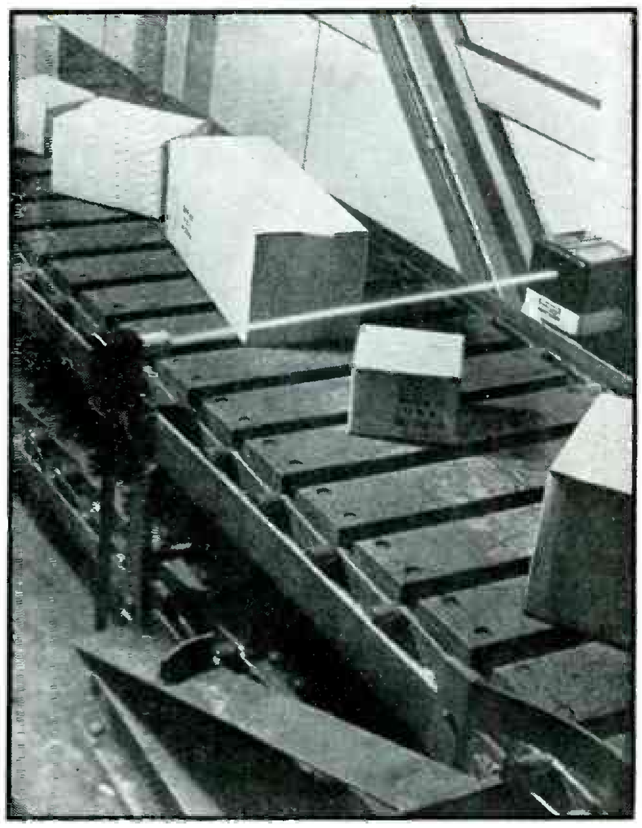
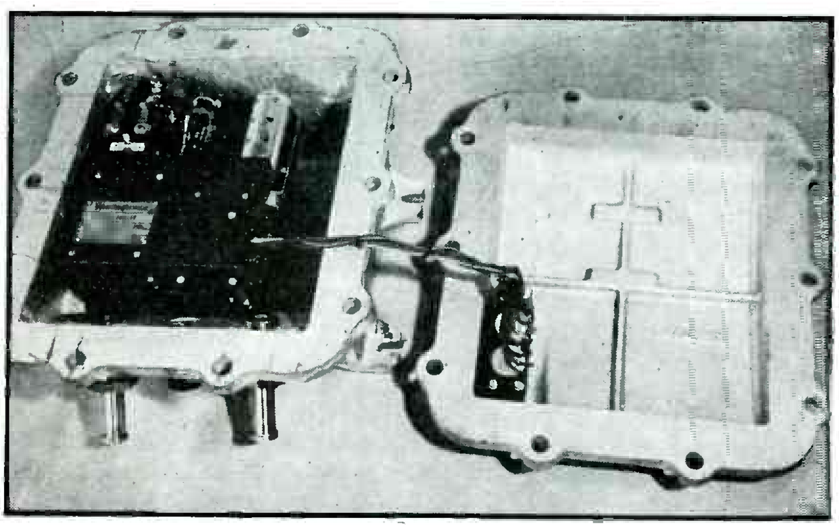


Photoelectric unit of the type commonly employed for counting boxes or packages on a conveyor



An explosion-proof case for special applications encloses this control unit

rays and is a very satisfactory type of cathode. It is particularly useful where Mazda lamps are employed as light sources.

Optical filters and phototubes may be combined to alter the color-sensitivity response of the phototube. If a green filter is used with the Westinghouse type WL-770 phototube, for example, the response is almost identical to that of the human eye.

Phototubes can be divided into two classes, namely, gas and vacuum. The two designs are identical as to structure. A high vacuum is employed in the vacuum type and an inert gas such as argon, neon or helium (at very low pressure) is used in the gas-filled type.

Gas Tubes

Gas-filled phototubes are much more sensitive than vacuum-type tubes. The greater effective response is obtained through gas amplification and secondary emission. Electrons emitted by action of light rays on the cathode are drawn to the positive anode. High velocity of the photo-emitted electrons is sufficient to knock out additional electrons from the gas atoms with which they collide. Gas atoms are thus split into positive ions and free electrons.

The free electrons are drawn to the positive anode and the positive ions migrate toward the negative cathode. The positive ions surround this element of the phototube and exert such force that additional electrons are emitted which combine with the original photoelectric current. These two factors produce additional photoelectric current that may be several times the value of primary electron current.

Phototubes are not particularly sensitive to temperature changes. However, the maximum operating temperature for most commercial phototubes should not exceed 50 deg. C (122 deg F). The temperature referred to is that which comes in contact with the bulb, or the ambient temperature. If the phototube is operated above recommended temperature, sensitivity may decrease. High operating temperature also decreases life of

Fig. 2—Inexpensive light relay for indoor applications where low sensitivity is permissible

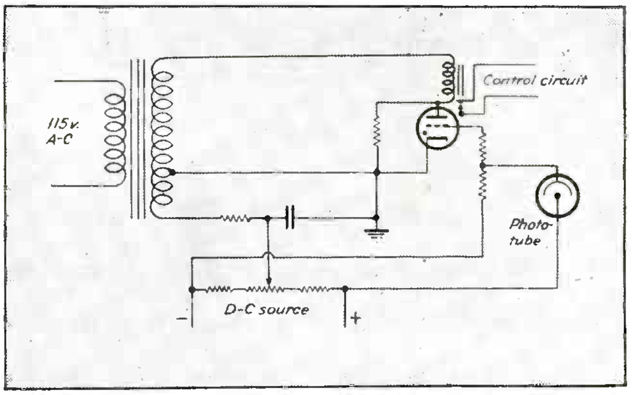


Fig. 3—Schematic circuit of a phototube and thyratron as used to form a simple photoelectric relay

the tube due to evaporation of volatile material on the cathode.

Under ideal operating conditions (normal temperature, proper voltage on the anode and sufficient light on the cathode) the output of ordinary gas or vacuum phototubes does not exceed 100 microamperes per lumen of light. The curves of Fig. 1 show how current flow in phototubes is affected by illumination intensities. It is usually necessary to amplify this small current if phototubes are to be of practical value. The device that amplifies the small currents of a phototube is called a light relay, or photoelectric relay.

Relays

Photoelectric relays are available in a number of different designs. When used to supply initiating action to open and close doors (or for operation where maximum sensitivity is not required and distance from the light source does not exceed, say, 20 feet), a light relay such as shown in Fig. 2 may be used. Such an arrangement consists of a phototube, a thyratron tube, a transformer (to supply proper filament and anode voltages) and miscellaneous small capacitors and resistors.

Thyratron characteristics are such that when the negative grid potential (relative to cathode) exceeds the critical breakdown voltage (for corresponding anode voltage), the tube does not become ionized and no current is conducted through the tube. When the grid potential becomes more positive than the critical grid voltage, the tube breaks down and conducts current. In the photoelectric relay shown in Fig. 2, a negative voltage (relative to cathode) is applied to the grid of the thyratron tube. When the phototube is illuminated, this negative thyratron potential is balanced out as a result of current flow through the phototube and the thyratron conducts current.

As shown in the diagram of Fig. 3, the coil of a relay is connected in series with the anode of the thyratron tube. When the coil is energized, the relay contacts operate a counter or other suitable control.

Many installations require a photoelectric relay that responds to exceedingly small changes in illumination and provides maximum speed of response. In such applications, an amplifier is placed between the phototube and the thyratron tube. The amplifier magnifies the small current impulses that are generated by action of light on the cathode of the phototube. Figure 4 shows a photoelectric relay that utilizes a single stage resistance-coupled amplifier. The phototube is on the left, the amplifier tube is in the center and the thyratron is on the extreme right.

Register Control

Photoelectric relays designed for maximum sensitivity and speed of response are used in installations where the distance between light source and phototube is about forty feet or more. Many are also used for register regulator applications. Register regulators are found in many industries where consumer products (such as cigarettes and candy bars) are wrapped automatically by machine. Such regu-

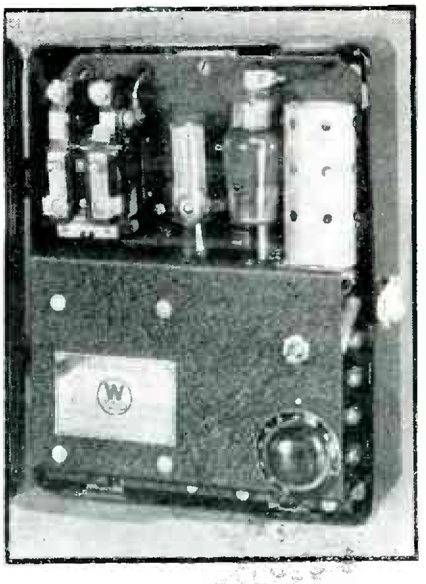


Fig. 4—In this unit the phototube feeds into a single-stage amplifier which, in turn, controls the thyratron under the shield at the right

lators control the cutting of rolls of paper. Aligned to plus or minus $\frac{1}{32}$-in. accuracy, they control the cutting along one edge of the roll. This edge control assures cutting the paper into sheets of the right size to conform to some definite pattern on the wrapper itself. The pattern is often made an integral part of the design of the wrapper. In other cases, the design (frequently a small rectangular spot $\frac{1}{4}$x$\frac{3}{8}$ in.) is placed on one edge of the paperstrip. Register regulators have made paper speeds up to 3,000 ft per minute possible.

When light source and phototube are over 40-feet or so apart it is difficult to obtain sufficient illumination on the phototube to operate the photoelectric relay. In such cases, it is rarely practical to increase the sensitivity of the photoelectric relay since extraneous light (such as that reflected from light-colored objects, windows and people's clothing) is apt to cause false operations. Filters used to provide an invisible light beam sometimes help and sometimes merely accentuate the difficulties. A phototube housing having infrared filters is shown in Fig. 5.

Interrupted Beam

A photoelectric relay, responsive only to a rapidly pulsating light, has been designed for applications where distance between light source and phototube is between 40 and 225 feet. Constant illumination has no effect on the unit, thus, false operation cannot result from light reflections. Pulsating light is obtained by interrupting the light beam with a motor-driven slotted disc that produces five hundred and forty interruptions per second. Figure 6 shows a light source suitable for outdoor pulsating-light installations.

5—This phototube housing contains a large lens and infrared filter

The phototube is not always located near the photoelectric relay. In some applications, space limitations or appearance make it desirable to place the photoelectric relay and the phototube forming part of this unit in different places. The phototube can be mounted in a separate housing and can be connected to the relay by means of a cable. Any convenient position and location (where mechanical vibration is not excessive) can be chosen for the housing so long as it can be rigidly mounted to insure constant alignment with the light beam. Under normal conditions, the cable connecting phototube and relay rarely exceeds ten feet. Increased capacitive reactance in longer cables will influence sensitivity of the relay.

In the majority of photoelectric applications, a special light source is required for successful operation.

Light Sources

Normally, a source includes: (1) A small lamp that usually operates on a potential of six to eight volts. (2) A transformer to supply correct filament voltage to the lamp. The transformer is generally an integral part of the light source. It can also be a separate winding on the main control transformer in the photoelectric relay. (3) A lens assembly to concentrate the light beam. (4) A light-source housing, usually of cast metal and constructed to facilitate lamp inspection and mounting-position adjustment.

In some instances it is desirable to have the light source and phototube housing built as one integral part. Such a combination is called a "scanner." Figure 7 shows a scanner that is often used on register regulator applications. This scanner has a single tube amplifier circuit built in to insure maximum sensitivity and speed of response.

Photoelectric relays, phototube housings and light sources are available with different enclosures for all types of applications. They can be used indoors, in damp outdoor locations, and even in explosive atmospheres where exposed sparking contacts would be hazardous.

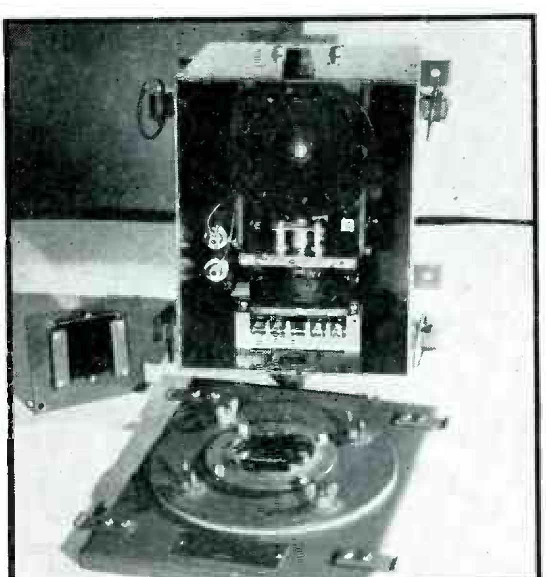


Fig. 6—False operation due to light from other sources is eliminated by the use of this motor-driven slotted disc to interrupt the light beam

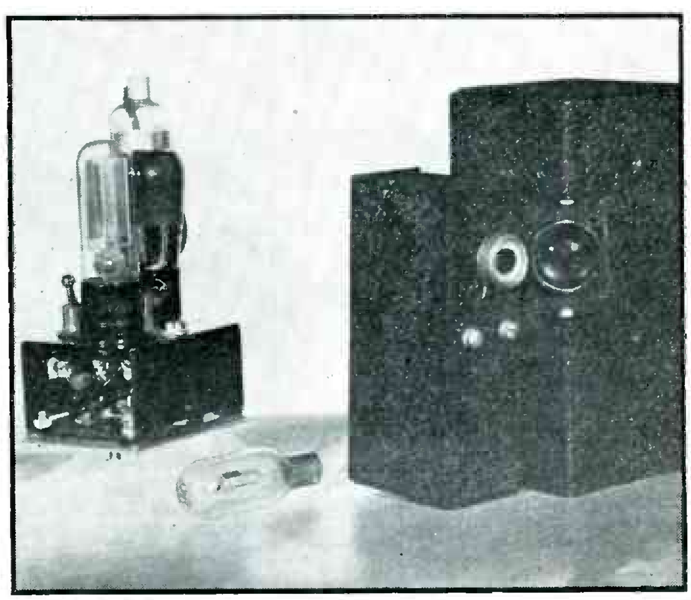


Fig. 7—This combination of phototube and light source in one unit is called a "scanner" and is useful for register-regulator applications where light is reflected from printed moving register marks

EQUALIZER DESIGN

Attenuation and phase functions of frequency-transmission characteristics in circle diagrams, for determining performance and selecting circuit constants of "constant-resistance" and other conventional types

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THE USE of circle diagrams for facilitating the solution of various problems in engineering is well known.[1, 2] A chart which may be used in determining the characteristics of a large number of electrical circuits used in audio and r-f systems is to be described.

The attenuation, phase and impedance functions of various corrective networks may be determined directly from the chart by following the circular loci of constant A and constant X. Here A is the ratio of two resistances, while X is the product of radian frequency and an inherent time constant of the circuit. As soon as particular values of A and X are determined from given specifications, the behavior for all other values of X or A is read directly from the chart. Examples showing both methods of application will be considered.

Suppose it is desired to design a simple low-pass network satisfying the following specifications:

(1) As the frequency increases, the attenuation introduced by the network is to increase gradually from zero to not more than 14 db, while at the pivoting or "cross-over" frequency of 1000 cps, the attenuation should be 7 db.

(2) The network is to work from a signal source having 500 ohms internal resistance.

A circuit having these general characteristics is shown in Fig. 1a, and in the fourth-quadrant group of circuits shown on the chart. The problem is to determine the values of the resistances R and AR, and the capacitance C, which satisfy the specifications. Since the source internal-resistance is to be 500 ohms, it is possible to let R be this internal resistance, 500 ohms. For purposes of analysis, let the signal-source voltage be a sine wave of frequency f, represented by the complex quantity E_o. Let the output voltage be another complex quantity E which differs from E_o in both magnitude and phase.

Certain facts are evident on inspection of Fig. 1a. For d.c., or zero frequency, the ratio $E/E_o = 1$, or E and E_o are equal both in magnitude and phase. As the frequency increases and approaches infinity, the reactance of the capacitance C and the voltage across C approach zero together. Hence, at infinite frequency, E is again in phase with

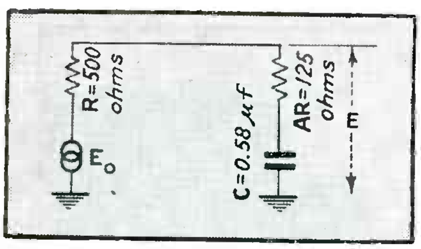


FIG. 1a—Equalizer of Example 1

f (cps)	X	Atten. (db)	Phase Shift
295	0.53	1.5	−27°
520	0.94	3.5	−37°
1,000	1.8	7.0	−42°
1,950	3.5	10.5	=36°
3,900	7.0	12.5	−25°

FIG. 1c—Table of computed values of X for corresponding selected frequencies f, and readings of values for the attenuation and phase-shift functions taken from the chart

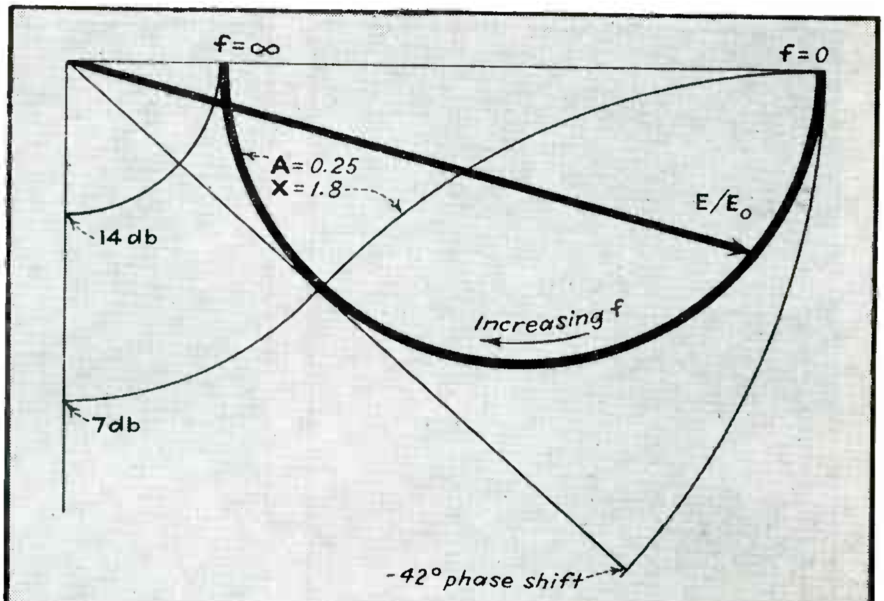
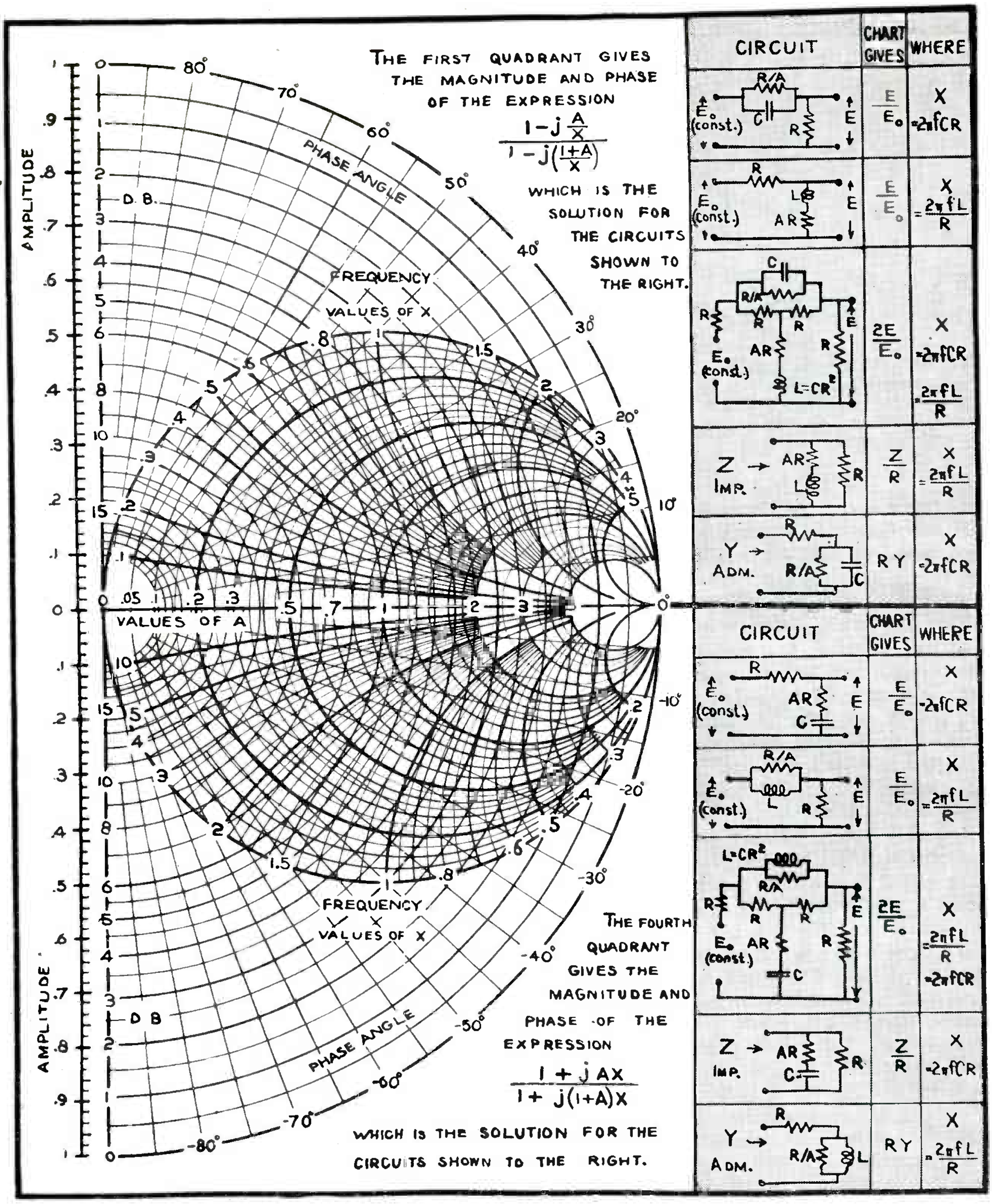


FIG. 1b—Simplified, partial duplication of the design chart, for use in solution of the network of Fig. 1a



E_o and should be 14 db below E_o, or $E/E_o = 0.2$. But $E/E_o = AR/(R + AR) = A/(1 + A) = 0.2$, or $A = 0.25$. This determines AR to be equal to $0.25 \times 500 = 125$ ohms. For intermediate frequencies, a little consideration will show that the voltage E lags E_o and has a magnitude somewhere in the range between $E = E_o$ and $E = 0.2\ E_o$.

Consider now the use of the chart in determining quantitatively the manner in which the ratio E/E_o varies with frequency. Reference is first made to Fig. 1b, since it is a simplified but partial duplication of the portions of the circular loci chart which pertain to the problem.

The end of the heavy arrow indicates the complex quantity E/E_o. The magnitude of this ratio is equal to the length of the arrow, while a clockwise or counter-clockwise arrow rotation indicates a respective phase-angle lag or lead of E relative to E_o. As the frequency increases from zero to infinity, this arrow starts from a horizontal position where $E/E_o = 1$, then rotates clockwise, decreasing in magnitude. The rotation indicates that E lags in phase relative to E_o. After the arrow reaches a point of -42

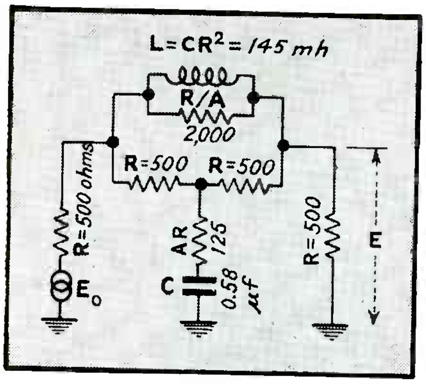


FIG. 1d—Bridged-T network derived for constant-resistance impedance-match at both its input and output terminals, with attenuation characteristics for the circuit of Fig. 1a

deg maximum lag, it continues in reverse rotation, while decreasing further in magnitude. At infinite frequency, the arrow is again horizontal, where E and E_o are again in phase, and the length of the arrow (the magnitude of E/E_o) is 0.2. As the frequency varies, the locus of E/E_o is a circle. This is shown in Fig. 1b by the heavy circular line, which is obtained from the chart in the following manner:

It is recalled that a 14 db maximum attenuation is desired at infinite frequency. Thus, on the vertical-amplitude, linear, db scale, locate the circle of constant 14 db attenuation. Follow this circle in a counter-clockwise direction and note the point where it intersects the horizontal line. The circle of constant value of A which also intersects this point is the circle for which $A = 0.25$. This circle is the desired locus of E/E_o.

The chart and Fig. 1b also show that, orthogonal to the circles of constant A, are those of constant relative frequency X. As indicated in the fourth quadrant of the chart, $X = 2\pi fCR$, i.e., X is proportional to the frequency, and equals unity at the frequency where the magnitude of the reactance of capacitance C is equal to R. It is now recalled that, at 1000 cps, the specifications require an attenuation of 7 db. Figure 1b and the chart show that the circle of constant 7 db attenuation intersects the circle of constant $A = 0.25$ at the value of $X = 1.8$. Hence, C is determined by noting that $X = 1.8 = 2\pi fCR = 2\pi \times 1000 \times C \times 500$, or $C = 0.58$ μf.

Complete Transmission Function

If desired, the amplitude and phase frequency-characteristics of the network, for frequencies other than 1000 cps, are easily determined. Following the procedure outlined above, it is found, for example, that the attenuation is 3.5 db at $X = 0.94$, or $f = X/2\pi CR = 0.94/2\pi \times 0.58 \times 500 = 520$ cps, and the phase angle is -37 deg. Both the attenuation and phase characteristics are tabulated in Fig. 1c. It should be noticed particularly that the chart gives a physical picture of the way in which the ratio E/E_o varies with frequency.

The circuit chosen is the simplest which will fulfill the specifications, but it has the disadvantage of presenting to the 500-ohm source an impedance which is not solely resistive and which varies with frequency. If a constant resistive impedance of 500 ohms is desired, as one looks from the source into the network, then the circuit may be elaborated to the bridged-T type shown on the chart and in Fig. 1d. This is one of a series of "constant resistance" networks[3] whose solution may be obtained using the chart.

Phase-Shifting Network Example

Suppose a simple phase-shifting circuit is to be designed using the circuit shown in Fig. 2. At the frequency of 1000 cps it is desired to control the phase of E relative to that of E_o by the setting of the variable resistance AR. The total phase shift should not be less than 35 deg, and there should occur a minimum change in the magnitude of E as its phase is varied. The problem now is to determine C and AR, R being given equal to 500 ohms.

Studying the chart, it is seen that, inasmuch as the frequency is now constant, the locus of E/E_o is again circular but now follows the circles of constant relative frequency X. It is desired to choose a circle for some value of X such that, as A varies, a maximum phase shift occurs in E/E_o together with a minimum change of magnitude. By choosing the circle for which $X = 2$, a phase shift of from -65 deg to -28 deg, or a difference of 37 deg, is obtainable with only about a 0.6 db change in magnitude. Hence $X = 2 = 2\pi fCR = 2\pi \times 1000 \times 500 \times C$, or $C = 0.64$ μf. The value of A at -65 deg is zero, while at -28 deg the value of A is 0.48. Thus AR should vary from 0 to 0.48, so the resistance AR of Fig. 2 should vary from zero to $0.48 \times 500 = 240$ ohms.

The table in Fig. 2 gives values of phase shift vs. settings of AR. Some attempt should be made to solve this problem without the use of the chart to appreciate its time-saving value in solving problems of this type.

The use of the chart is not limited to examples of the types just described. For example, it is possible to solve also for the magnitude and phase of the input impedance or admittance of the networks shown in the first and fourth quadrants of the charts. Applications to other circuit problems not given here are also possible.

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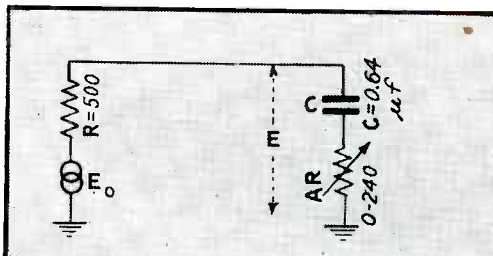
(2) Hazeltine, A., Current Loci in the General Linear A. C. Network, *Electrical Engineering*, p. 325, 56, No. 3, March, 1937.

(3) Terman, F. E., "Radio Engineers' Handbook", p. 245, McGraw-Hill Book Co. (1943).

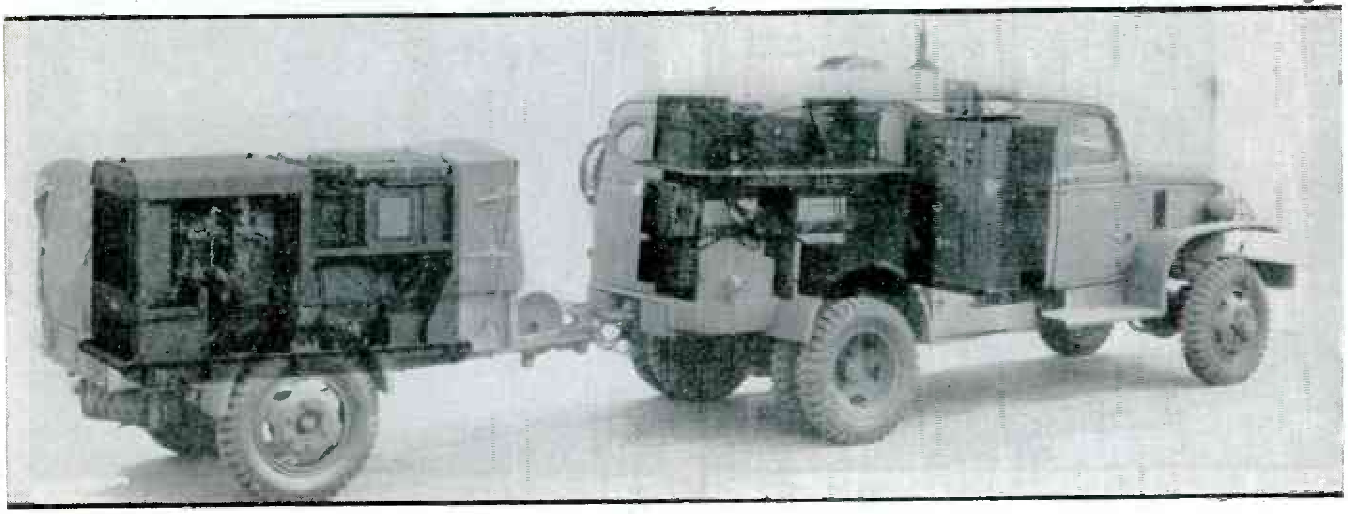


A	AR (Ohms)	Phase Shift
0.48	240	-28°
0.33	165	-37°
0.18	90	-46°
0.09	45	-55°
0	0	-64°

FIG. 2—Phase-shifting network, for constant-amplitude phase-correction, discussed in Example 2. Values of AR, adjusted for the desired condition, are given in the table

Military Transmitter in MASS PRODUCTION

Assembly system similar to those used in the pre-war manufacture of radio receivers is successfully applied to the fabrication of the heavier, much more complicated BC-610-E. Units pass through the steps pictured here in less than six hours



Phantom view of the SCR-299 communications truck and trailer. The transmitter seen in forward part of truck is the BC-610-E

By C. T. READ

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Chicago, Ill.

IN THE home-front battle of war production, an outstanding victory has been won by the adaption of mass-production technique to the manufacture of heavy, yet complicated electronic equipment.

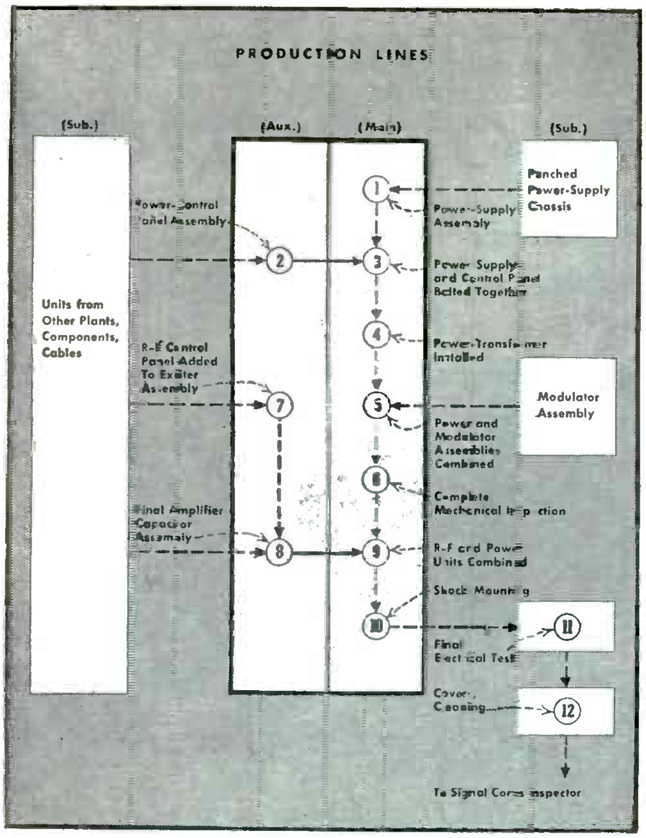
Everyone is familiar with the success that automobile manufacturers have had in applying their methods of fabrication to the airplane engine. Less well known has been the successful use of mass production methods in the construction of radio transmitters.

Apparatus which in pre-war days was virtually custom-built by skilled craftsmen is now being produced on the assembly line. Not only has production been speeded up, but quality has been improved.

The accompanying pictures, taken in the Clearing, Illinois plant of the Hallicrafters Company, where the pre-war model HT-4 transmitter is now being built in large quantities for the armed forces as the BC-610-E, illustrates the major steps in assembly.

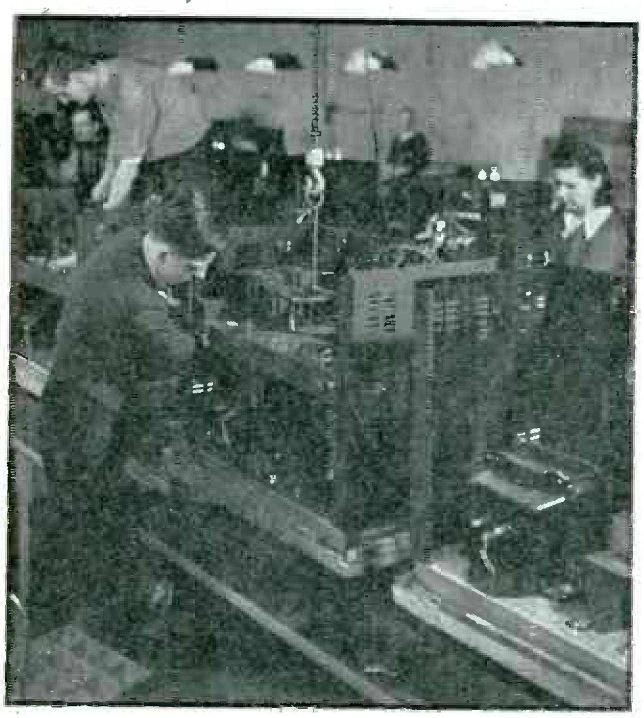
1 Power-supply assembly starts here, on the main production line. This chassis forms a base for the entire BC-610-E transmitter. Rectifier tube sockets, filter chokes and capacitors are the first component parts to be installed. A special wood table holds the chassis upside down for this step

Military Transmitter in



General floor plan showing the production-line scheme employed. Units assembled elsewhere, and components, are delivered to the sub-assembly lines shown at the left and right. Work progresses from the top of the diagram to the bottom, with direct physical transfer from auxiliary to main line facilitated by the adjacent position of these two lines

2 Power-control panel assembly starts here, on an auxiliary production line. Parts are mounted on the panel and wiring is completed



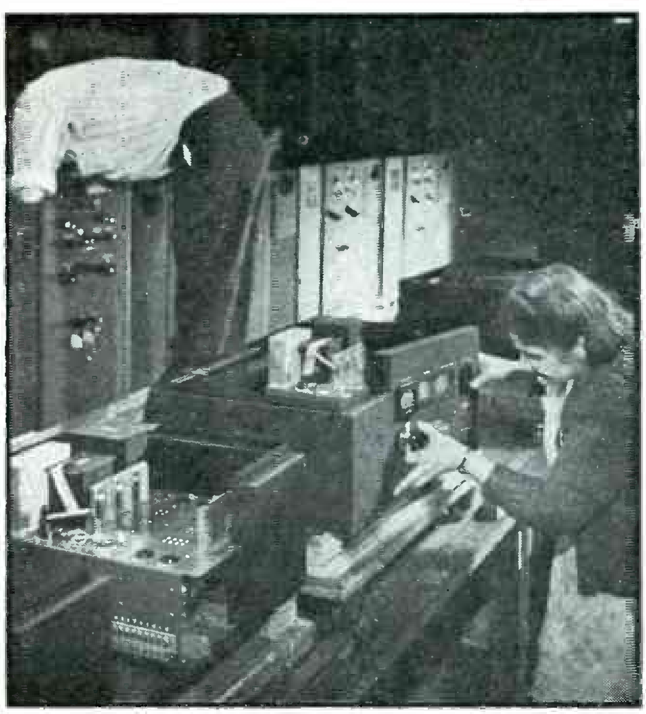
5 The power-supply section of the BC-610-E transmitter is picked up by means of an electric hoist and placed on a dolly which can be moved by hand the rest of the way down the assembly line. This photo shows the modulator chassis, received from a sub-assembly line, being lowered into place. Inter-connection cables are installed here

6 The power-supply and modulator unit receives a complete mechanical inspection. All main support bolts are tested with a special torque-measuring wrench. The bolts holding the main power transformer, for example, must not turn until a torque of 90 inch-pounds is applied

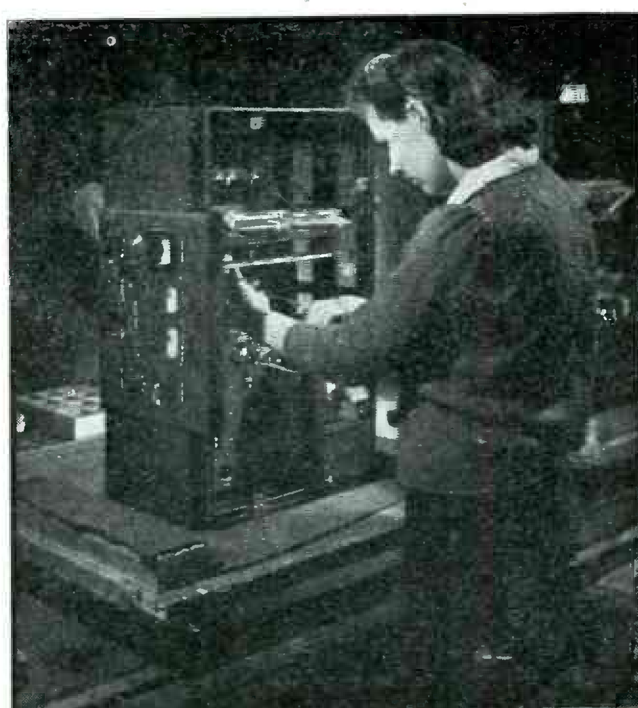
Mass Production (Continued from p. 121)

3 Shifted to the main production line, the assembled and wired power-control panel is bolted to two side members and forms the front of the cabinet. The power-supply chassis is lifted and lowered into place, forming the bottom

4 After the power-supply chassis and power-control panel are fastened together, the unit is turned over and placed in a jig. Then the main power transformer, weighing 113 lb., is lowered into position and bolted down



7 Back on the auxiliary production line, an exciter chassis built as a complete unit at another Hallicrafters' plant is installed in the r-f section of the cabinet and a control panel containing meters, band-switch and final amplifier tuning control is placed in position



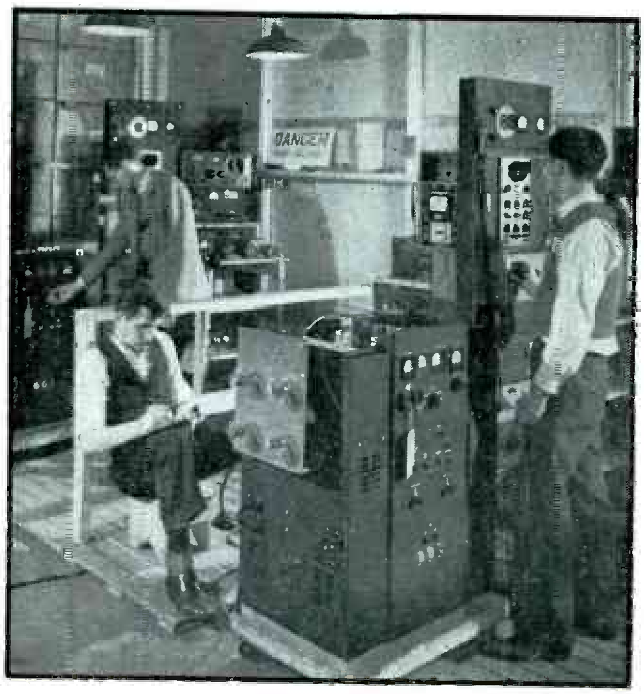
8 The final amplifier tuning capacitor assembly and a socket for the final amplifier tube are installed, and r-f wiring is completed

Military Transmitter in Mass Production

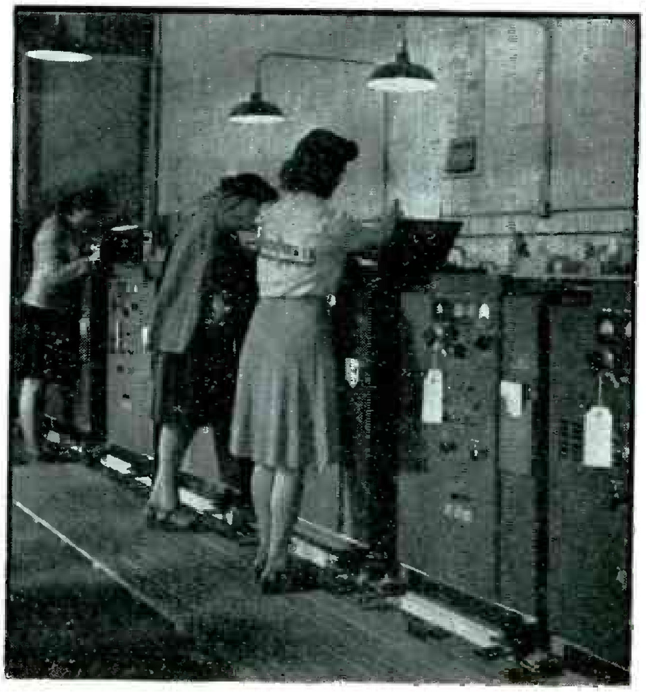
(Continued from page 123)

9 Main and auxiliary production lines now come together. The r-f section of the transmitter is placed on top of the power-supply and modulator section. Cables connecting the units are placed and the two units are bolted together

10 After a final mechanical inspection and the insertion of small tubes and other accessories, the complete transmitter is lifted off the main production line and placed in the shock-mounting plate which is eventually secured to the floor of the SCR-299 mobile communications truck



11 The transmitter is moved into an electrical testing room, where large tubes and plug-in tuning units are inserted. A dummy antenna is connected and the transmitter is keyed and modulated on five successive test frequencies between 1,500 and 18,000 kc



12 Finally, a top cover is installed and the transmitter is given a thorough cleaning by means of compressed air. It is then ready for Signal Corps inspection

TEMPERATURE COMPENSATION

An analysis of an uncompensated temperature error occurring in variable-frequency tank circuits employing ceramic capacitors for compensation

By HERBERT SHERMAN

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MILITARY REQUIREMENTS for the operation of radio equipment over wide temperature ranges have accentuated the problem of temperature compensation of tuned circuits.

One solution has been the development of the variable temperature coefficient ceramic capacitor to the point where well-controlled mass production is possible. This has increased the use of ceramic capacitors for temperature compensation. The extensive use of this type of compensation has introduced an uncompensated error in variable-frequency circuits which appears at all frequencies except the one for which the ceramic capacitor temperature coefficient is chosen.

Fixed vs Variable Frequency

In a fixed-frequency circuit, the temperature coefficient of the ceramic padding capacitor across the tank capacitor may be chosen so as to compensate for the change in capacitance of the tank capacitor or the change in inductance of the tank coil, subject to the present limitations of temperature coefficients of ceramic capacitors and the type of variation of tank capacitance and inductance with temperature.

In a variable-frequency circuit, it is well known that lumped changes in inductance or capacitance have varying effects over the frequency band covered by the circuit. For example, consider a 20 to 40-Mc capacitor-tuned circuit. Assume a padding capacitor is added which causes a frequency change of 100 kc at 20 Mc. It can be shown that this padding capacitor will cause a change of frequency of 800 kc at 40 Mc, a ratio of 8:1, although the band coverage is 2:1.

Let Δf_1 be the change in frequency at frequency f_1 due to the change in the lumped constants, and let Δf_2 be the change in frequency at frequency f_2, due to the same change in the lumped constants. Then, it may be easily shown that, in the following variable-frequency circuits where variable capacitance is used and

(a) Lump capacitance is changed, the change in frequency is

$$\Delta f_2 = \Delta f_1 f_2^3/f_1^3 \qquad (1)$$

(b) Lump inductance is changed, the change in frequency is

$$\Delta f_2 = \Delta f_1 f_2/f_1 \qquad (2)$$

Where variable inductance is used and

(a) Lump inductance is changed, the change in frequency is

$$\Delta f_2 = \Delta f_1 f_2^3/f_1^3 \qquad (3)$$

(b) Lump capacitance is changed, the change in frequency is

$$\Delta f_2 = \Delta f_1 f_2/f_1 \qquad (4)$$

Inductance vs Capacitance Compensation

Let us now consider a capacitor-tuned circuit, operating at frequency f_1, which is temperature compensated by a ceramic capacitor having a specified temperature coefficient. Assume that a temperature change causes a change in the fixed inductance of the circuit and that the ceramic capacitor temperature coefficient has been chosen so as to vary the lumped capacitance to compensate for this inductance change. At any other frequency f_2, the frequency drift due to these changes in the lumped constants is

$$\Delta f_2 = \Delta f_C - \Delta f_L \qquad (5)$$

where Δf_C is the change in frequency at frequency f_2 due to the change in lumped capacitance as defined in Eq. (1), and Δf_L is the change in frequency at frequency f_2 due to the change in lumped inductance as defined in Eq. (2) (which is of opposite sign to Δf_C since Δf_C was arranged to compensate for Δf_L). Substituting Eq. (1) and (2) in (5),

$$\Delta f_2 = \Delta f_1 f_2^3/f_1^3 - \Delta f_1 f_2/f_1 \qquad (6)$$

$$\Delta f_2 = \Delta f_1 \frac{f_2}{f_1}\left(\frac{f_2^2}{f_1^2} - 1\right) \qquad (7)$$

It may be shown that the change in frequency Δf_1 at the frequency f_1, due to a small change in lumped inductance ΔL is given by

$$\Delta f_1 = \frac{1}{2}\frac{\Delta L}{L} f_1 \qquad (8)$$

Substituting Eq. (8) in (7),

$$\Delta f_2 = \frac{f_2}{2}\frac{\Delta L}{L}\left(\frac{f_2^2}{f_1^2} - 1\right) \qquad (9)$$

Equation (9) indicates that only at a single frequency is it possible to compensate for a change in lumped inductance with a lumped capacitance. At all other frequencies complete compensation is not possible, and the resultant error will become more serious as the frequency of the circuit increases, or as the percentage change in lumped inductance increases, or as the frequency changes from the corrected frequency. Thus, a circuit which has been capacitance compensated at 500 kc for a 0.1 percent change in inductance will have a frequency error of 0.15 percent at 1000 kc.

The above discussion does not take into account the error due to the dependence of the temperature coefficient of a variable capacitor on the degree of mesh of plates.

The necessity for compensating inductance changes by equivalent inductance changes rather than by capacitance changes has been indicated in an article by Mr. E. O. Thompson entitled "Temperature Compensated Wavemeter Coil," appearing in ELECTRONICS, Sept. 1943, page 148. This article discussed the temperature compensation of frequency-measuring equipment.

Feedback Amplifier for

Practical application of feedback for impedance compensation in amplifier design gives wide-band performance with small sacrifice of other characteristics. Both electrostatic and electrodynamic deflection applications are covered.

By G. ROBERT MEZGER*

IN COMMON with all vacuum-tube amplifiers, an amplifier which is designed for electrodynamic deflection of a cathode-ray tube must be capable of maintaining a constant output potential with a constant input over a desired frequency range, in the presence of any stray capacitive loading which may be present in the output circuit.

Often this problem is intensified in the case of cathode-ray tube deflection amplifiers, because of the relatively high output potential which is demanded for full-scale deflection of the cathode-ray tube, and the wide frequency range over which they usually are required to operate. In many cases, also, the amplifier must be physically detached from the enclosure which mounts the cathode-ray tube. This type of design introduces additional load-circuit capacitance from the connecting cables and the cable-connection fittings.

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In conventional circuits the interelectrode capacitances between the deflecting electrodes and other electrodes of the cathode-ray tube, and other circuit capacitances, can present a load to the deflecting amplifier which is of the same order of magnitude as the plate-load resistor at frequencies as low as one-half megacycle per second. Variations of plate-circuit impedance of appreciable magnitude, therefore, can readily assume proportions which are of sufficient importance to be the determining factor in establishing amplifier performance.

Methods for controlling the undesirable effects of load-circuit capacitance usually include the reduction of the output impedance of the amplifier by the use of low values of plate-load resistors and the use of small amounts of inductance in the plate-circuit network to compensate for the shunting effects of stray capacitances at high frequencies.

Limitations Due to Plate Loading

Reduction of the plate-load resistor is a powerful method for attacking this problem, but it has the disadvantages of simultaneously increasing the plate dissipation of the output tubes of the amplifier, increasing the load on the power-supply equipment, and reducing the gain of the stage. The addition of inductance to the plate-circuit network of the amplifier makes it difficult to predict the performance of the amplifier under the effect of transients which may have high-frequency components. A knowledge of the transient performance of an oscilloscope amplifier is especially important, for the signals which are supplied to the input circuit of such an amplifier are usually of an unknown nature. At least in the case of the simpler plate-circuit networks which employ inductive compensation, reduction of the inductance to the value where overshoot of a square-wave

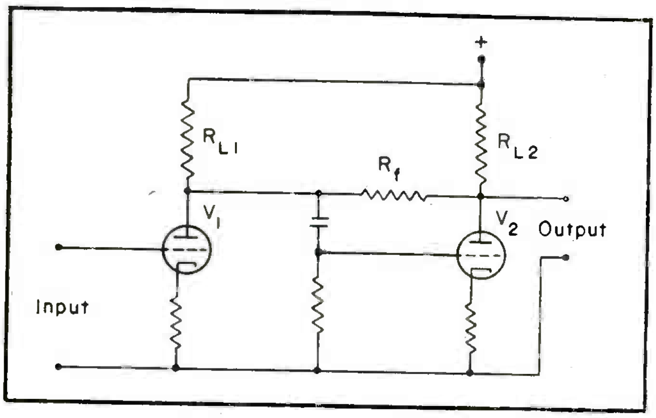

FIG. 1—General feedback amplifier circuit

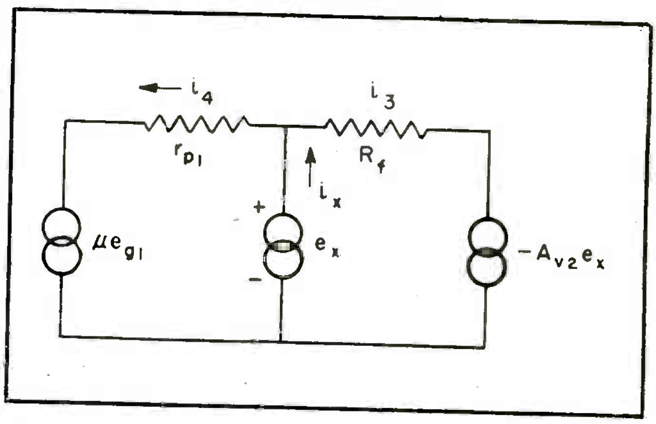

FIG. 2—Equivalent circuit for the determination of the effect of feedback upon r'_{p1}

C-R Oscilloscopes

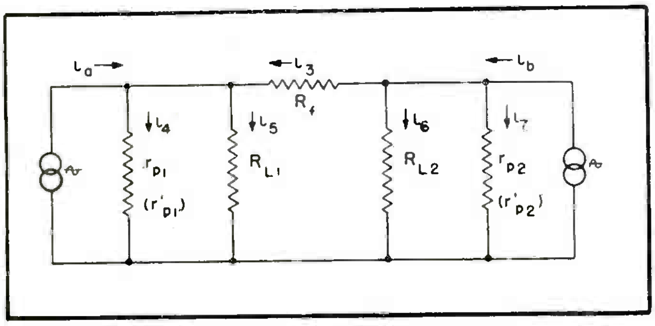

FIG. 3—Equivalent circuit for the amplifier of Fig. 1

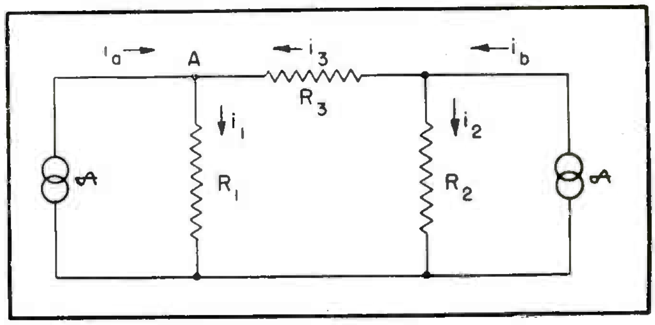

FIG. 4—Simplified form of the circuit of Fig. 3

test signal is not present requires such a small value of inductance as to make its effect questionable.

It would appear, therefore, that some method for reduction of the output impedance, which would not sacrifice load-circuit impedance and thereby transfer the power dissipation of the circuit to the plate of the vacuum tube, would prove of value. In special cases, where wide frequency-range is of prime importance, cathode-followers have been employed for the deflection of cathode-ray tubes. The low limit on the output potential available from the cathode-follower, however, has precluded its general adoption for such purposes.

Negative Feedback Method

Another method for reduction of the impedance level of the output circuit of a vacuum-tube amplifier is available in the effective reduction of internal plate resistance of a vacuum tube which is obtained through the use of negative voltage feedback. Because the internal plate resistance of a vacuum-tube amplifier is connected in shunt with the external load, reduction of this resistance will effect a reduction of the overall impedance level of the output circuit.

It has been shown[1,2] that the internal plate resistance r_p of a vacuum-tube amplifier changes under the influence of negative voltage feedback to a new value r'_p, which new value is lower than the internal plate resistance without feedback, and which is related to that value by the expression

$$r'_p = r_p/(1-\mu\beta) \quad (1)$$

where μ is the voltage-amplification factor of the vacuum tube and β is the transmission factor of the feedback network. This new value of internal plate resistance changes the output impedance level Z'_0 of an amplifier with negative feedback from its value without feedback to a lower value which is given by

$$Z'_0 = \frac{r_p R_L}{r_p + (1 - \mu\beta) R_L} \quad (2)$$

where R_L is the resistance of the entire plate-circuit load network.

The reduction of impedance level of the output circuit of a vacuum-tube amplifier by the use of negative voltage feedback can be greater than 90 percent of the value without feedback. This fact is further developed in the Appendix. Such a method, therefore, is of particular interest in the case of cathode-ray tube deflection-amplifiers, where the high deflection potentials required often demand the use of expensive transmitting tubes and large power dissipations to obtain full-scale deflection.

General Feedback Amplifier Circuit

A general circuit[1] useful in deflection-amplifiers, and which conveniently includes negative voltage feedback, is shown in Fig. 1. Interconnection of the plates of V_1 and V_2 provides a simple feedback network which is reliable over the widest possible range of frequencies the amplifier may be required to pass.

In the amplifier of Fig. 1, the effects of negative voltage feedback in reducing plate-circuit impedance level are found not only in the output stage, whose grid and plate circuits are enclosed by the feedback network, but also in the plate circuit of the first stage. This permits both the first and second stages to operate with a high value plate-load resistor, while the impedance level, and therefore the effects of stray shunt capacitances, are kept at a practical minimum.

The reduction of the plate-circuit impedance level of the first stage may be shown by application of the principles of Thevenin's theorem to this circuit. This theorem states that, with respect to any single external circuit connected to any given pair of terminals of a network, the network can be replaced by a single branch having an impedance which is equal to the actual driving-point impedance of the network at these terminals and contains a single electromotive force which is equal to the open-circuit potential of the network across the given pair of terminals.

Equivalent Circuits for Plate-Circuit Impedance Level

If a generator is connected across the output terminals of a vacuum-tube amplifier, with the input signal to the amplifier zero, the current delivered by the generator will be determined by the output-impedance level of the amplifier. Thus, if a generator whose output potential is e_x is connected to the plate of V_1, if the load resistor for V_1 is removed (since it does not enter into this discussion), and if the input to this stage is short-cir-

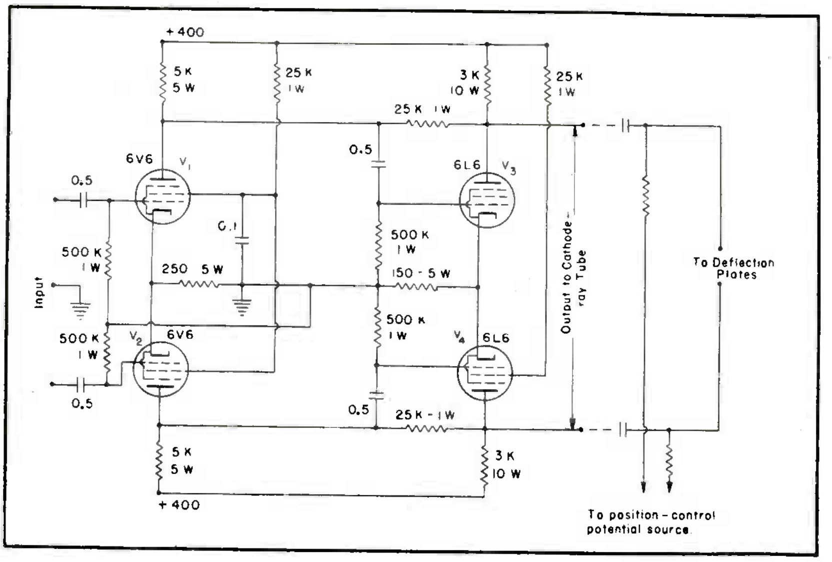

FIG. 5—Resistance-capacity coupled deflection amplifier

cuited, the equivalent circuit for the first stage of the amplifier may be represented as shown in Fig. 2. The generator whose output potential is $-A'_{v2}e_x$ represents the potential which is generated in the plate circuit of the second stage by the application of the voltage e_x to the input circuit of the second stage. Then, by the application of Kirchhoff's laws,

$$i_x = i_3 + i_4 \tag{3}$$

$$e_x - i_4 r_{p1} = 0 \tag{4}$$

$$e_x - i_3 R_f - A'_{v2} e_x = 0 \tag{5}$$

Solving simultaneously:

$$i_x = \frac{e_x}{r_{p1}} + \frac{e_x\,(1 + A'_{v2})}{R_f} \tag{6}$$

Equation (6) is an expression for the current which would be delivered into an impedance r'_{p1} by a generator which delivers a potential e_x. Then,

$$r'_{p1} = \frac{e_x}{i_x} = \frac{1}{\dfrac{1}{r_{p1}} + \dfrac{(1 + A'_{v2})}{R_f}} \tag{7}$$

$$r'_{p1} = \frac{r_{p1} R_f}{R_f + r_{p1}\,(1 + A'_{v2})} \tag{8}$$

The quantity r'_{p1} may be termed the effective internal plate resistance of the first stage under the influence of negative voltage feedback.

In a manner similar to the foregoing, it can be shown that the internal plate resistance r'_{p2} of the second stage with negative voltage feedback is

$$r'_{p2} = \frac{r_{p2}}{1 - \mu_2 \beta} \tag{9}$$

where r_{p2} is the internal plate resistance of the tube as determined from its plate characteristic, μ_2 is the voltage amplification factor of the tube and β is the transmission factor of the feedback network.

Equations (8) and (9), while accurate, are merely convenient forms for assigning the effects of feedback to the internal plate resistances of the vacuum tubes under consideration. This procedure is useful, for it is more difficult to establish mentally a physical concept of change in the value of a fixed, wirewound plate-load resistor than it is to imagine a variation in r_p of a vacuum tube. Equations (8) and (9), then, represent merely a simple means for visualizing the change which has been effected by the use of negative voltage feedback.

Equivalent Circuits for Output Impedance Level

The end point of the work is the reduction of overall plate-circuit terminal impedance. This may be determined by evaluating the shunt combination of r'_p and R_L, where R_L has the same significance as it has in Eq. (2). It also may be determined by a process exactly similar to that which was used to develop Eq. (8) and (9) but including R_L also in the plate-circuit network. Such a process will yield the following equations for Z'_{01} and Z'_{02}, the terminal impedances of the first and second stages respectively.

$$Z'_{01} = \frac{R_1 R_f}{R_f + (1 + A_{v2}')\,R_1} \tag{8a}$$

$$Z'_{02} = \frac{r_{p2} R_{02}}{r_{p2} + (1 - \mu_2 \beta)\,R_{02}} \tag{9a}$$

R_{02} is the complete load-circuit network resistance for the second stage. R_1 is the parallel resistance of r_{p1} and R_{L1}.

Allowable Simplifications

In Fig. 3 is shown a simplified equivalent circuit for the complete amplifier of Fig. 1. This equivalent circuit neglects entirely the loading effect of the grid circuit of the second stage and the degeneration which may occur in the cathode resistor of each stage. As will be shown later, grid-circuit loading is negligible at the impedance level at which the plate circuits of the two stages operate. In the practical amplifier for deflection of the electron beam of a cathode-ray tube, symmetric deflection always is used, and the common cathode load of push-pull amplifiers eliminates degeneration in the cathode circuit.

Figure 3 may be further simplified by combining the internal plate resistances and the plate-load resistors as shown in Fig. 4 so that

$$R_1 = \frac{r_{p1} R_{L1}}{r_{p1} + R_{L1}} \tag{10}$$

$$R_2 = \frac{r_{p2} R_{L2}}{r_{p2} + R_{L2}} \tag{11}$$

By the use of Fig. 4, the voltage gain, feedback-network transmission, and impedance level of the amplifier plate circuits may be calculated in the following manner:

Applying Kirchhoff's laws to Fig. 4

$$R_1 i_1 - R_2 i_2 + R_f i_3 = 0 \tag{12}$$

$$i_1 = i_3 + i_a \tag{13}$$

$$i_b = i_2 + i_3 \tag{14}$$

Solving these simultaneously,

$$i_1 = \frac{i_a\,(R_2 + R_f) + i_b R_2}{R_1 + R_2 + R_f} \tag{15}$$

$$i_2 = \frac{i_b\,(R_1 + R_f) + i_a R_1}{R_1 + R_2 + R_f} \tag{16}$$

$$i_3 = \frac{i_b R_2 - i_a R_1}{R_1 + R_2 + R_f} \tag{17}$$

and, from elementary vacuum-tube theory,

$$i_a = -g_{m1} e_{g1}, \tag{18}$$

$$\text{and } i_b = -g_{m2} e_1, \tag{19}$$

where g_{m1} and g_{m2} are the grid-plate transconductances of the first and second stages respectively, e_{g1} is the grid-signal potential for the first stage, and e_1 is the grid-signal potential for the second stage, or the potential from point A to ground in Fig. 4.

Gain Equations

From Eq. (15), (18) and (19)

$$e_1 = i_1 R_1$$

$$= \frac{-g_{m1} e_{g1} R_1 (R_2 + R_f) - g_{m2} e_1 R_1 R_2}{R_1 + R_2 + R_f} \quad (20)$$

or

$$A'_{v1} = \frac{e_1}{e_{g1}}$$

$$= \frac{-g_{m1} R_1 (R_2 + R_f) - g_{m2} A_{v1}' R_1 R_2}{R_1 + R_2 + R_f} \quad (21)$$

and

$$A'_{v1} = -\frac{g_{m1} R_1 (R_2 + R_f)}{(R_1 + R_2 + R_f) + g_{m2} R_1 R_2} \quad (22)$$

where A'_{v1} is the voltage gain of the first stage with feedback. That is, the reduction in voltage across R_1 which is caused by feedback voltage arriving from the second stage is arbitrarily assigned to the first stage in this analysis. This arbitrary concept is a useful approach to practical expressions for the characteristics of this amplifier.

Similarly, the output potential of the second stage, from Eq. (16), is

$$e_2 = i_2 R_2$$

$$= \frac{-g_{m2} e_1 R_2 (R_1 + R_f) - g_{m1} e_{g1} R_1 R_2}{R_1 + R_2 + R_f} \quad (23)$$

and th evoltage gain A'_{v0} of the entire amplifier with feedback then becomes

$$A'_{v0} = \frac{e_2}{e_{g1}}$$

$$= \frac{-g_{m2} A'_{v1} R_2 (R_1 + R_f) - g_{m1} R_1 R_2}{R_1 + R_2 + R_f} \quad (24)$$

The voltage gain A'_{v2} of the second stage then is

$$A'_{v2} = \frac{A'_{v0}}{A'_{v1}} \quad (25)$$

This equation expresses the gain of the circuit between point A of Fig. 4 and the output terminals, and is a true expression for the gain of the second stage either with or without feedback, since all gain reduction due to feedback has been arbitrarily assigned to the first stage.

Equivalent Load Impedances

The load R_{01} into which the plate of the first stage feeds may be determined by reference to Fig. 3, from which it is apparent that

$$R_{01} = \frac{R_1 (R_2 + R_f)}{R_1 + R_2 + R_f} \quad (26)$$

The load into which the second stage feeds:

$$R_{02} = \frac{R_2 (R_2 + R_f)}{R_1 + R_2 + R_f} \quad (27)$$

The values of R_{01} and R_{02} given by Eq. (26) and (27) represent the load impedances seen by the plates of the first and second stages, respectively. They are the resistances which would determine the load line superposed on the plate characteristic family of the tube to define the operating conditions of the tube. They may be considered to represent, also, the plate load of a fictitious amplifier, similar to the amplifier of Fig. 1 in every respect, but without negative feedback.

Output Impedance Level

For any vacuum-tube amplifier, the load-circuit impedance level Z_0 may be shown to be

$$Z_0 = \frac{r_p Z_L}{r_p + Z_L} \quad (28)$$

where Z_L is the impedance of the load circuit and r_p is the internal plate resistance of the vacuum tube. In the case of the amplifier of Fig. 1, therefore, if there were no feedback present in the circuit, the load-circuit impedance level of the first stage would be

$$Z_{01} = \frac{r_{p1} R_{01}}{r_{p1} + R_{01}} \quad (29)$$

and the load-circuit impedance level for the second stage would be

$$Z_{02} = \frac{r_{p2} R_{02}}{r_{p2} + R_{02}} \quad (30)$$

When negative voltage feedback is added to these stages, the load-circuit impedance levels become, from Eq. (8), (9) and (28),

$$Z'_{01} = \frac{r'_{1p} R_{01}}{r_{p1}' + R_{01}} \quad (31)$$

and,

$$Z'_{02} = \frac{r'_{p2} R_{02}}{r_{p2}' + R_{02}} \quad (32)$$

If preferred, Eq. (8a) and (9a) may be used to determine the values of Z'_{01} and Z'_{02}. This would eliminate the need for evaluating Eq. (8), (9) and (26).

Design Considerations

Equations (29) and (30) have little practical value, except for purposes of comparison, because the value of R_{01} is based upon the resistive coupling between the plate circuits of the first and second stages; and the value of R_{02} bears the same relation to the plate circuit of the first stage. Equations (29) and (30) do, however, indicate the output impedance level of fictitious amplifiers with loads of R_{01} and R_{02} respectively, and they are therefore useful for comparison with the values of Z'_{01} *and* Z'_{02} to show the reduction in dynamic impedance level which has been obtained through the use of negative voltage feedback. Z'_{01} and Z'_{02} do, therefore, through their dependence upon R_{01} and R_{02}, reflect a less favorable and more accurate representation of the reduction in terminal impedance which is effected by negative voltage feedback than if only the internal plate resistance and the individual load resistance of each separate stage were considered. In other words, the circuit of Fig. 1 does impose slight additional plate-circuit loading on each stage, over and above the normal loading which is present in the absence of a feedback circuit of this type.

Evaluation of Eq. (31) and (32), as is performed for two practical

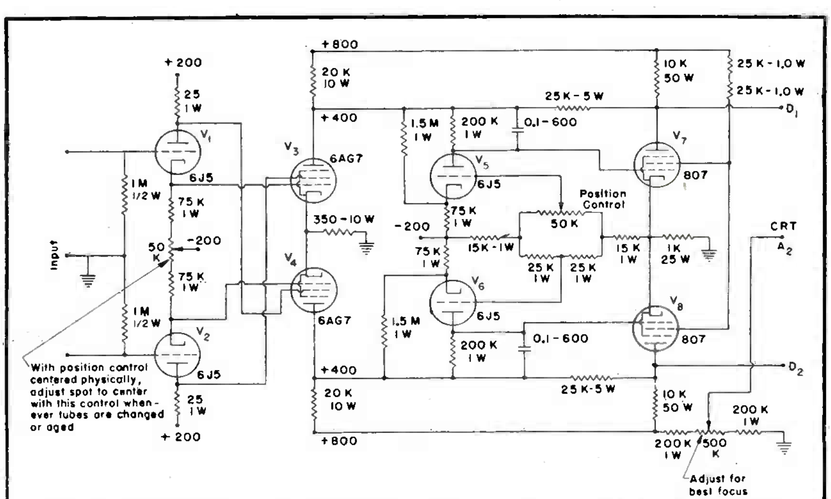

FIG. 6—Direct-coupled deflection amplifier

amplifiers later in this paper, will yield values which justify neglecting interelectrode capacitances in this analysis of the circuit. And these low values of output-impedance level show the usefulness of negative voltage feedback in reducing the deleterious effects of stray circuit capacitance on the response - vs. - frequency characteristic of an amplifier.

In order to evaluate the foregoing expressions, the transmission factor β of the feedback network must be evaluated. From Fig. 4

$$e_1 = R_1 g_{m1} e_{g1} - \frac{A'_{v2} e_1 R_1}{R_f + R_1} \qquad (33)$$

Also, from the general feedback equations

$$e_1 = \frac{R_1 g_{m1} e_{g1}}{1 - A'_{v2} \beta} \qquad (34)$$

Solving (33) for e_1

$$e_1 \left(1 + \frac{A'_{v2} R_1}{R_f + R_1}\right) = R_1 g_{m1} e_{g1}$$

$$e_1 = \frac{R_1 g_{m1} e_{g1}}{1 + \dfrac{A'_{v2} R_1}{R_f + R_1}} \qquad (35($$

and, by comparison[3] of (35) with (34)

$$\beta = -\frac{R_1}{R_f + R_1} \qquad (36)$$

The product $A_v\beta$, which is termed the feedback factor, is assumed to be positive if the sum of the applied potential and the feedback potential is larger than the applied potential. In the case of negative feedback, therefore, this product is negative, and the negative sign is assigned arbitrarily to the transmission factor β of the feedback network.

The foregoing theoretical development of the operation of the circuit of Fig. 1 arranges in undesirable order those expressions which are of interest in the design of such an amplifier, for many of them are interdependent. They could, however, readily be arranged in a more convenient order for calculation. It should be borne in mind in applying such expressions that they are given for an unbalanced amplifier. In their application to push-pull amplifiers it should be noted that this difference should be considered. For example, the plate-to-plate output impedance for a push-pull amplifier of this type will be twice the value obtained from equations (30) and (32). The value of the transmission factor of the feedback network will, of course, remain unchanged.

Practical Circuits

In Fig. 5 and 6 are shown two schematic circuits of practical deflection amplifiers for cathode-ray tubes which utilize the principles discussed herein.

Figure 5 shows a capacity-coupled amplifier designed to deflect a Type 5LP5 cathode-ray tube. The tube was operated at a second-anode potential of 1100 v and a third-anode potential of 2000 v. The amplifier will produce symmetrical deflection of the cathode-ray with either balanced or unbalanced input signals. For this amplifier, the significant design quantities have the following values:

$\mu_1 = 200$ $g_{m1} = 4x(10)^{-3}$ mho $r_{p1} = 50{,}000$
$\mu_2 = 120$ $g_{m2} = 6x(10)^{-3}$ mho $r_{p2} = 20{,}000$
$R_{L1} = 5000$ $R_{L2} = 3000$ $R_f = 25{,}000$

The calculated characteristics of this amplifier are:

R_1	= 4,540	r'_{p2}	= 1040
R_2	= 2,610	R_{01}	= 3910
A'_{v1}	= −4.85	R_{02}	= 2400
A'_{v0}	= +68.4	Z'_{01}	= 1145
A'_{v2}	= −14.1	Z'_{02}	= 725
r'_{p1}	= 1602 ohms	Z_{01}	= 3630
β	= −0.1527	Z_{02}	= 2140

All of the foregoing quantities are calculated for one phase of the amplifier, and voltage gains are referred to unbalanced input and unbalanced output.

No attempt has been made to evaluate R_{02} with load-circuit capacitance considered. Inasmuch as the design was approached as an attempt to render the stray capacitance as ineffective as possible, the impedance level of the output circuit has been reduced by approximately 80 percent.

Application

In Fig. 6 is shown a direct-coupled amplifier which was designed for deflection of a Type 5JP5 cathode-ray tube operating at a second-anode potential of 2000 v and a third-anode potential of 3000 v. The amplifier has deflection-voltage capacity considerably greater than that required for deflection of this tube by normal standards. An attempt was made, however, to limit operation to the use of only a small part of the essentially linear portion of the plate characteristic of the amplifier, in an effort to reduce amplitude distortion to a minimum.

Tubes V_1 and V_2 are cathode-follower stages, provided to increase the input impedance of the amplifier. Tubes V_3 and V_4 comprise the first amplifier stage of the assembly. Tubes V_5 and V_6 are the main elements of a constant-current direct-coupling network employed to reduce the average level of the signal potential appearing on the plates of V_3 and V_4 to a level suitable for the grids of V_7 and V_8, while maintaining uniform response to signals of zero frequency.[5] Tubes V_7 and V_8 constitute the feedback-controlled output stage of the amplifier unit. The differentially connected feedback circuit between the screens of V_3 and V_4 and the plate circuits of V_1 and V_2 is provided to stabilize the amplifier against long-time drifts and differences which occur in the input tubes. The resistance of the plate loads in these two tubes is too small to affect seriously their operation as cathode followers. The feedback circuit, which is effective in reducing the impedance level of the output circuit, is provided by the connection between the plates of V_3 and V_7 and between V_4 and V_8.

For the amplifier of Fig. 6 the significant design quantities are:

$\mu_1 = 360$ $g_{m1} = 9x(10)^{-3}$ mho $r_{p1} = 40{,}000$
$\mu_2 = 63$ $g_{m2} = 5x(10)^{-3}$ mho $r_{p2} = 12{,}600$
$R_{L1} = 20{,}000$ $R_{L2} = 10{,}000$ $R_f = 25{,}000$

The calculated quantities are:

R_1	= 13,300	r_{p2}'	= 550
R_2	= 5,570	R_{01}	= 11,200
A'_{v1}	= −9.05	R_{02}	= 7,220
A'_{v0}	= +205	Z'_{01}	= 916
A'_{v2}	= −22.6	Z'_{02}	= 510
β	= −0.348	Z_{01}	= 8750
r'_{p1}	= 1030	Z_{02}	= 4580

All of the foregoing quantities are calculated for only one phase of the amplifier, and voltage gains are referred to unbalanced input and unbalanced output.

No attempt was made to evaluate R_{02} with load circuit capacitance considered. The design was approached as an attempt to render the stray capacitance as ineffective as possible, and the impedance level of the output circuit has been reduced by approximately 90 percent.

Application

Measurements of Z'_{01} and Z'_{02} on the circuit of Fig. 6 indicate close correspondence to the values given here. Although a considerable sacrifice of voltage gain has been made in the second stage, it is believed that this is amply justified by a reduction in output impedance from approximately 4500 to 500 ohms. Used with a Type 5JP5 cathode-ray tube, this circuit has produced uniform spot deflection, as a function of frequency, from zero to 1.5 Mc. While this high-frequency limit of response seems rather low, it was adequate for the purpose at hand and was not investigated further. The characteristics of the circuit seem to indicate, however, that a considerably better figure for the high-frequency response limit should be obtained, on the basis of experience; and it is believed that the mechanical arrangement of the amplifier used for the tests of the circuit could be redesigned considerably to achieve improved high-frequency response with no change in electrical characteristics.

The particular value of β which was employed for the amplifier of Fig. 6 results merely from the choice of a convenient value for the resistor R_f. Experiments indicated, however, that attempts to increase the feedback materially beyond this value, in an effort to obtain even greater decrease of Z'_{o2}, caused A'_{vo} to decrease so rapidly as to question the value of any further decrease in output impedance.

Examination of the average plate characteristics of the Type 807 tube indicates that, in an amplifier circuit without feedback, it is impossible to achieve the output impedance level of the circuit of Fig. 6 without sacrificing output-potential swing, exceeding the plate-dissipation rating of the tube, or else sacrificing voltage gain even more by a reduction of screen potential.

Further Reduction of Impedance Level

It has been shown by Mayer[2] that the output impedance level of an amplifier can be reduced to zero, and the loss of gain through feedback considerably reduced by the proper combination of positive current feedback and negative voltage feedback. This should present some interesting possibilities for modes of attack upon the general problem of high-fidelity amplification.

While it is not necessarily true that the adjustment of a circuit for minimum output impedance level coincides exactly with the optimum feedback compromise for stabilization of the gain of an amplifier, nevertheless the problem of gain stability is very real with the circuit of Fig. 6, as it is in all direct-coupled amplifiers. Although a good measure of gain stabilization is inherent in this amplifier, through its direct-coupling circuit, this form of the circuit does not entirely exploit that possibility, and the additional stabilization of gain obtained with negative feedback was valuable in making the circuit absolutely reliable.

The advice of Mr. W. F. Curtis of the Structural Mechanics Section of the David Taylor Model Basin, particularly on the analysis of the circuit, is greatly appreciated. Various members of the staff of the Taylor Model Basin have examined the report and have made valuable suggestions. The circuit of Fig. 5 is an adaptation of a circuit first used by Mr. Geo. W. Cook, of the Electronics Section of the Taylor Model Basin, in the development of a general-purpose amplifier.

Appendix

The Effect of Negative Voltage Feedback Upon the Output-Impedance Level of an Amplifier. Consider the case of a negative feedback amplifier in which a certain fraction of its output potential is fed back to its input circuit. Such an amplifier is shown in Fig. 7. If, across the output of this amplifier, the load circuit is replaced by a generator of output potential E, as shown in Fig. 8, and if the input circuit is short-circuited, the current I delivered by the generator will be

$$I = \frac{E - \mu\beta E}{r_p} \tag{37}$$

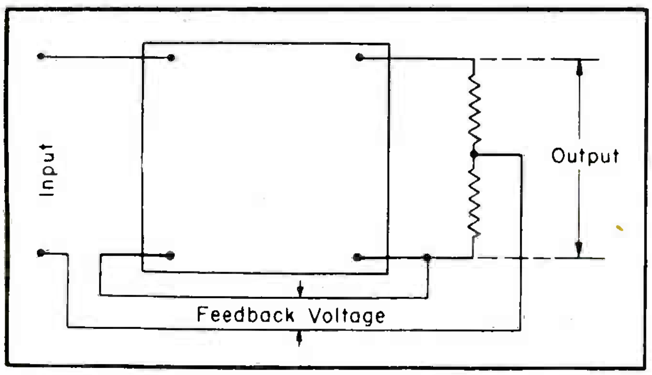

FIG. 7—Generic voltage-feedback amplifier

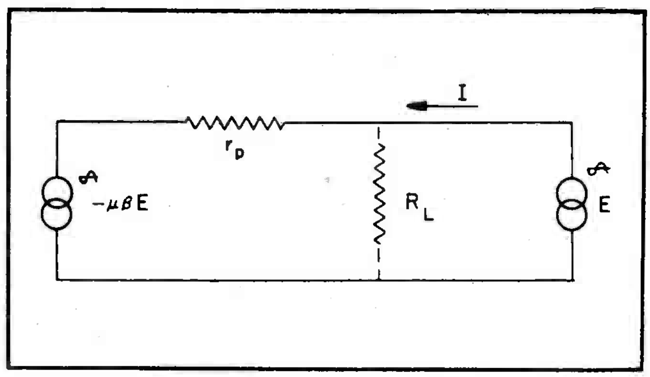

FIG. 8—Equivalent circuit of the amplifier of Fig. 7

where $-\mu\beta E$ is the potential resulting in the plate circuit from the potential fed to the input from the output, β is the transmission factor of the feedback network (negative in the case of negative feedback), and μ is the voltage-amplification factor of the vacuum tube. Then the impedance Z' seen by the generator will be

$$Z' = \frac{E}{I} = \frac{E\, r_p}{E - \mu\beta E} = \frac{r_p}{1 - \mu\beta} \tag{38}$$

This is the dynamic value, with feedback, of the internal plate resistance of the vacuum tube. It is interesting to note from Equation (37) that the internal plate resistance of an amplifier, under the influence of negative voltage feedback, is reduced by the factor $1/(1 - \mu\beta)$, while the voltage amplification A_v of the same amplifier (without feedback) is reduced by

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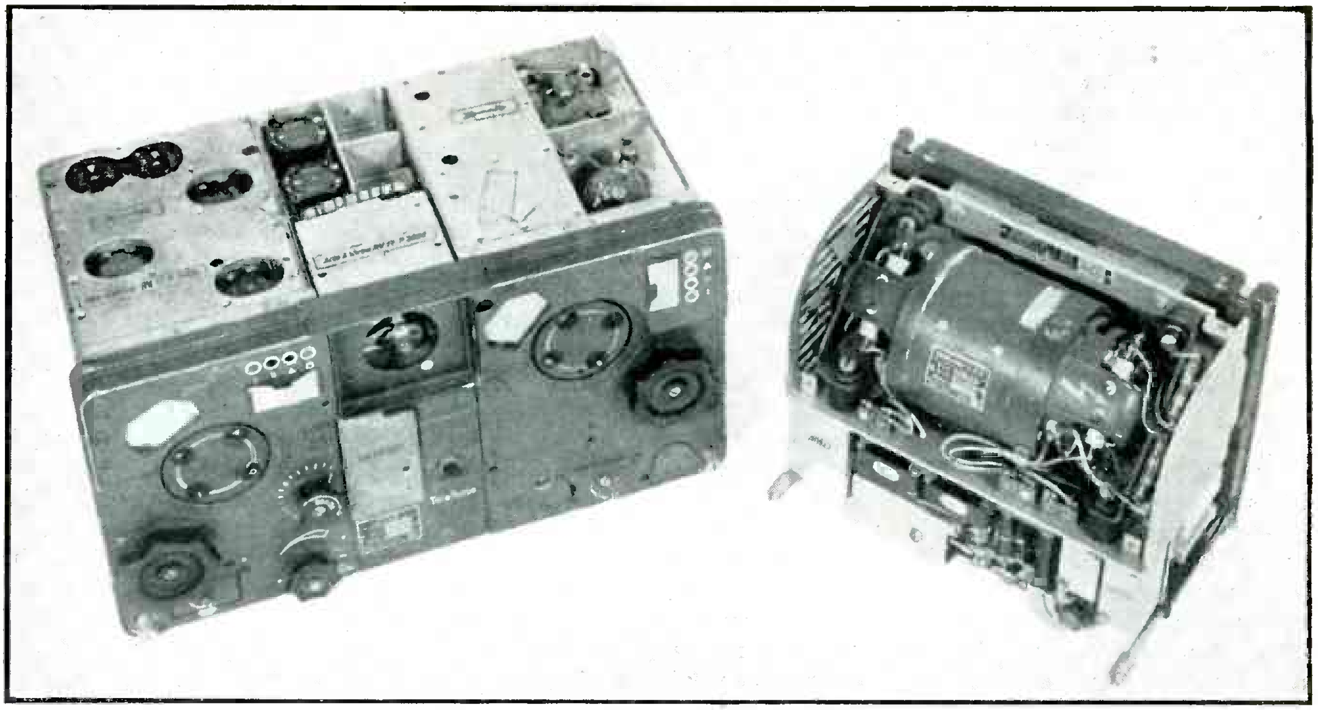

FIG. 1.—Model FUG-16 vhf transmitter-receiver, with companion dynamotor

German VHF

A detailed description of the FUG-16, a transmitter-receiver unit operating in the 38-42 Mc band. Believed to be of 1935 design, the equipment lends itself to use on shipboard, in tanks and other motorized vehicles, as well as in aircraft

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THE GERMAN VHF COMMAND SET, model FUG-16, operates in the 38-42-Mc band. Figures 1 and 2 illustrate general construction.

This equipment is voice-operated and consists of a transmitter and receiver, fastened together by means of bolts. The whole unit is placed in a shock-proof mounting and is approximately 15 in. long, 9 in. high and 10 in. in depth, not counting a control box which can be located at a remote position. The assembly weighs 60 lb.

The complete unit is mounted in the operating position on hooks and is locked in place by means of two special screws located at the front of the panel. Plugs and jacks automatically make all necessary connections at the rear. They consist of brass pins which engage beryllium copper contacts tightly.

The unit has a power drain of 400 watts and gives an r-f output of approximately 10 to 13 watts with input voltage variations from 24 to 28 volts d.c. Filaments are normally kept running during stand-by periods.

Transmitter Performance

Power output of the transmitter is normally 12.9 watts, which represents an overall efficiency of 3.25 percent. This is considered very low. Considering size and weight, the overall efficiency should be greater, say 10 to 12 percent. Power output varies from 8 to 13 watts with an antenna having resistance of 20 to 100 ohms and 25 to 20 $\mu\mu$f capacitance. The optimum resistance and capacitance for maximum output appears to be 56 ohms and 23 $\mu\mu$f. Values of power output given here are for 100 percent modulation at 400 cycles.

The transmitter r-f tube lineup includes two type RL-12P-35 tubes in an ordinary self-excited oscillator and power-amplifier circuit. The tubes are pentodes capable of handling approximately 35 watts plate dissipation. The master oscillator and power amplifier tuning is ganged to one control.

Power is obtained from a dynamotor.

Two throat microphones are included as an integral part of a helmet which also contains earphones. Connections for earphones

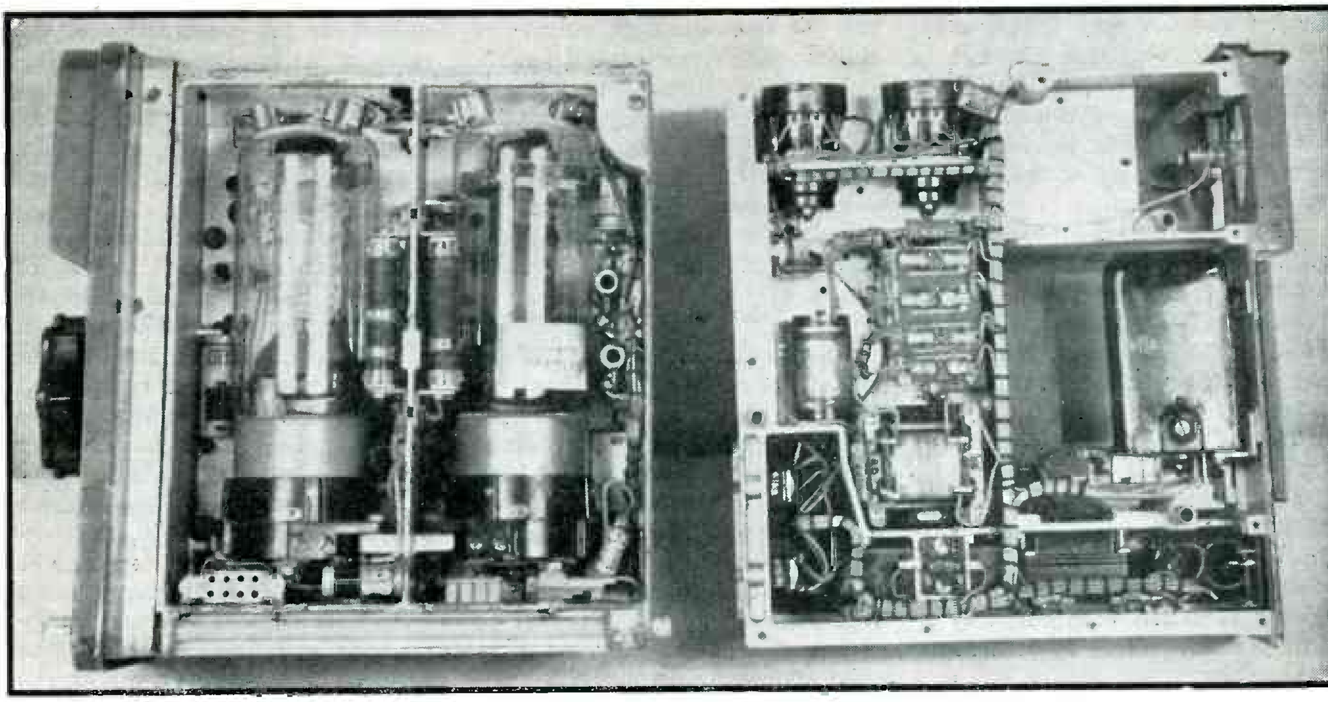

FIG. 2—Open views of the equipment, showing internal construction

COMMAND SET

and mikes is through a small pull-apart cord plug. The transmitter can be grid-modulated up to 100 percent. A two-stage speech amplifier-modulator is used and the two tubes in this amplifier-modulator are the same type as those used throughout the receiver.

The audio fidelity to the transmitter varies about 6 db over a range of 200 to 6000 cps, which is satisfactory for voice transmission. Under test, the transmitter was modulated 65 percent by a 2400-cps audio signal.

Frequency stability of the transmitter, with changes in supply-battery voltage, is 0.0045 percent per volt. Power output changes 0.8 percent per volt between 23 and 28 volts.

The frequency variation of the transmitter over a temperature range of +50 deg to −30 deg is 0.04 percent. At temperatures above 40 deg C., the power output falls off considerably. The equipment was not designed, obviously, to meet conditions of high temperature and high humidity.

At different parts of the frequency band, the percentage frequency change with temperature change varies up to 0.075 percent, which clearly indicates that no provision was made for temperature compensation.

The frequency change with humidity is different in different parts of the band, but the average over the band is approximate 0.035 percent.

Receiver Characteristics

The receiver incorporates a conventional superheterodyne circuit, consisting of one r-f amplifier, first detector, beat oscillator, three stages of i-f amplification, second detector with avc and one stage of audio. The audio output is approximately 115 ma, which is sufficient to operate two head-sets.

The tubes used are identical in all stages. The RV-12P-2000 miniature, externally-shielded type, is employed throughout. The Germans apparently use this tube in many units operating from 300 kc to 42,000 kc.

Receiver sensitivity, with a 30 percent-modulated input signal and 10 milliwatts output, is approximately 4 μv. The signal-to-noise ratio is 5.

The bandwidth is 80 kc, 10,000 times down for standard output of 10 mw. The receiver will block at an output of 27 mw.

The i-f selectivity is 47 kc at 20 db, 73 kc at 40 db, and 103 kc at 60 db.

The overall fidelity varies ± 6 db from 120 to 4,000 cps.

Overall distortion, with a 30 percent-modulated signal, is 5 percent at 6000 cps and up to 23 percent at 400 cps, with standard output of 10 milliwatts. The receiver distortion varies with variation of percentage modulation from 4 percent to 40 percent and audio output varies from 2 to 54 mw.

Image rejection is relatively poor, as only 800 microvolts at the image frequency will give standard output (measurements taken at 8 μv input); this gives a ratio of about 100:1. This condition has been studied and the conclusion drawn is that trouble is caused by the method of coupling the oscillator to the first detector. The plate of the r-f stage is very loosely coupled to the oscillator through a pickup coil, and is capacitively coupled to the detector. This method of coupling is simple and provides sensitivity at the expense of image rejection.

The fact that the receiver has relatively poor image rejection does not materially detract from its usefulness as the image is 2 times 3174, or 6349 kc, below the incoming signal. This is out of the frequency range used.

The i-f rejection ratio is well over 50,000.

Frequency variation with change of temperature per degree Centigrade averages 0.001 percent, which is considered excellent. Frequency variation with humidity is 0.09 percent, which is considered very poor.

At temperatures above 55 deg C and below 20 deg C, the antenna relay failed completely to operate during tests.

The equipment contains the same feature of four operational spot frequencies as the FUG-10 equipment, described in ELECTRONICS last month. The spot frequencies are set up separately on the receiver and on the transmitter.

Excessive distortion was observed due to frequency modulation. The transmitter was subjected to microphonics. Further examination disclosed that the design of the tubes was such as to produce microphonic tendencies.

Mechanical Design

The mechanical design and layout of the complete equipment was very well executed. Wherever possible, everything has been standardized, such as one type of knob, one type of tuning control, the use of standard die castings (which are practically identical with those of the FUG-10 equipment), one type receiver tube, 6 types of resistors, 4 types of capacitors, and only one transmitting tube type.

The equipment lends itself to extreme ease of operation, servicing and removal of parts. It also lends itself to mass production and interchangeability of parts or units. The use of diecast frames throughout (except for shields) presents a very favorable appearance as little or no machine operations are required for the construction of the chassis. It is noticed that no lacquer or paint is used on soldered joints. Not a single lock washer is used on the entire equipment. No corrosion was noticed on any of the joints.

Component standardization, which minimizes the number of values of resistors and capacitors needed, in many cases has produced loss of efficiency. However, the Germans have grouped resistors in series and parallel so that nearly correct values are obtained for critical circuits. Tests show that, by using a correct value resistor or a different type tube, the performance of this equipment can be increased by over 300 percent.

A single meter is used and merely reads antenna current, which is an adequate indication of the overall operation of the transmitter.

Servicing this equipment is a fairly simple and routine job, with very little training required. In the field, replacements can be made with only a few tools. Checking and testing can be accomplished while the gear is in place in an

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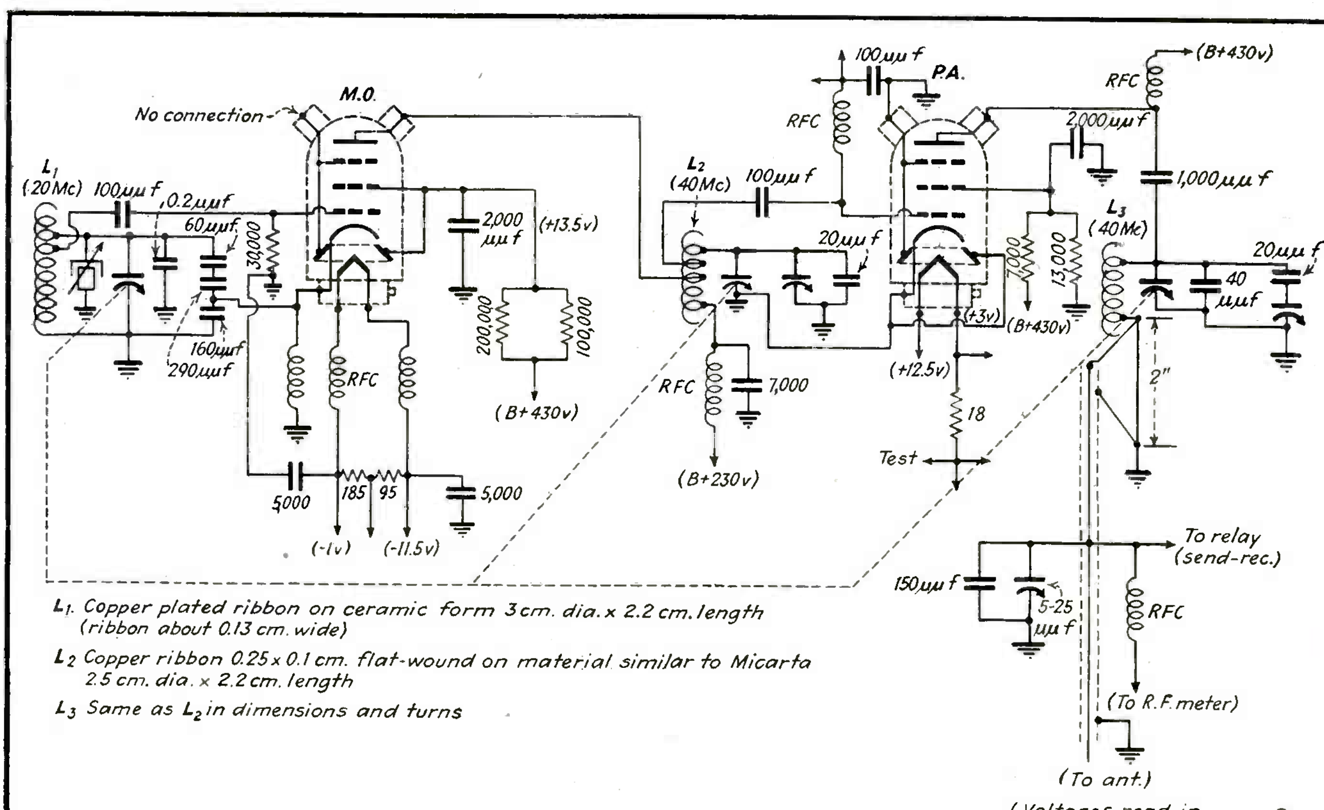

FIG. 3—Circuit diagram of the FUG-16 transmitter

Permanent Magnet Measurements

The concluding article of a series on permanent magnets, giving procedures for using the ballistic galvanometer, fluxmeter, magnetometer and permeameter to determine if sample magnets confirm the accuracy of design calculations and produce the required results

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PREVIOUS ARTICLES of this series discussed the fundamental principles of permanent magnet design and developed the fundamental design equations. Following this, minor hysteresis loops and magnet stabilization were considered, along with the principles involved in designing a magnet subject to a demagnetizing influence other than that exerted by the working gap. Finally, rules of good mechanical design of permanent magnets were taken up insofar as they apply to the various grades of Alnico.

From the information contained in these articles, an engineer—even one who has had no previous experience with the subject—should be able to design a permanent magnet to do a given job. He should be able to start from the basic requirements of a certain field strength in a certain gap, proceed through the calculations for magnet size, and emerge with a blueprint (complete with all tolerances) of the correct magnet for the job.

From here the magnet manufacturer is well able to carry on, and the designer finds himself with nothing further to worry about until the time he receives his first sample magnets. At this time he is confronted with the problem of determining by actual test whether or not his design calculations were correct and whether or not the magnets he has in his possession are really the magnets for the job. He is thus introduced to the very important and very fascinating subject of magnetic measurements.

The purpose of the present article is to present this subject as completely as space will permit. As in the previous articles of this series, the assumption throughout will be that the reader is a competent engineer but that he is entirely unfamiliar with the tools of magnetics. Consequently, the discussion of magnetic instruments and methods of measurement will be confined to those which an engineer working with permanent magnets will find most useful. These will be presented in their order of *basic* importance.

Eliminated entirely from the discussion will be instruments of primary importance to the magnet manufacturer rather than the magnet user, such as permeameters, and methods of measurement of primary importance to the research engineer or physicist rather than the design engineer, such as methods of establishing the NA value of a primary search coil. (A method of establishing the NA value of a secondary search coil will be presented, however, as this is of great practical importance to an engineer engaged in magnetic measurements work.)

Almost all magnetic measure-

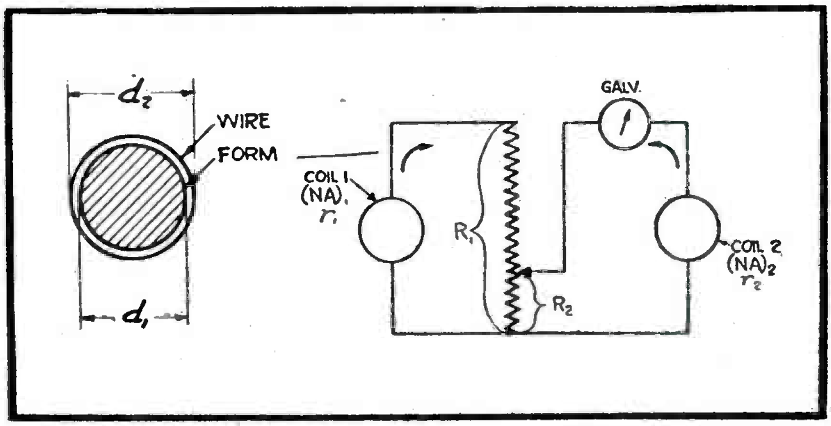


FIG. 1 (left)—Cross-section of single-layer search coil

FIG. 2 (right)—Circuit for measuring the NA product of a multi-layer search coil

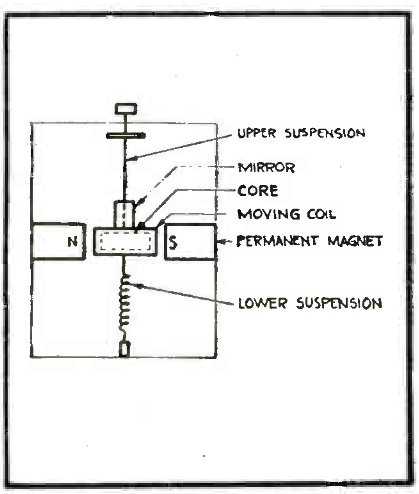


FIG. 3—Essential features of ballistic galvanometer used for magnetic measurements

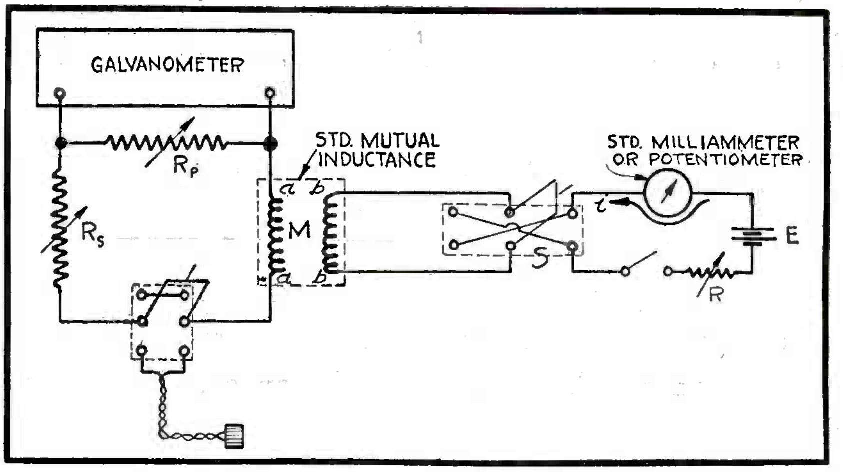


FIG. 4—Standard ballistic galvanometer circuit

ments are performed with the aid of a search coil.

Use of Search Coil

This most useful flux-responsive device consists merely of a number of turns of wire (usually wound in a single layer) about a form, the size and shape of which is proportioned to coincide with the space in which the measurements are to be made. After the coil has been correctly located in the magnetic field it is to measure, it is connected to the indicating device to be used (usually a ballistic galvanometer or a fluxmeter) and a measurement taken by withdrawing the coil completely from the field and noting the deflection of the instrument. (Caution: Always take care that the leads from the search coil are carefully and closely twisted together for their entire length from search coil to measuring instrument. This, of course, is to avoid measuring the field in any space other than that in which the search coil is resting).

As will be shown later, the deflection of the indicating device is proportional to the interlinkages which existed between the search coil and the magnetic field. (The interlinkages existing between a coil and a magnetic field are the product of the number of turns of the coil by the number of flux lines threading these turns.) Consequently, total interlinkages $= KD$, where K is the calibration constant of the instrument, and D is the deflection of the instrument.

It follows, then, that the total number of flux lines threading the search coil is $\phi = KD/N$, where N is the number of turns on the search coil.

Sometimes ϕ is all that is desired. Frequently, however, the average flux density B through the search coil is required. If A is the effective area of the search coil in sq cm, this may be written as

$$B = KD/NA \qquad (1)$$

Determination of Coil Area

Perhaps the most difficult quantity in Eq. (1) to determine accurately is A. For single-layer coils wound on forms 0.3 inch or greater in diameter, the effective diameter is usually taken as

$$D = (d_1 + d_2)/2 \qquad (2)$$

where d_1 and d_2 are as shown in Fig. 1. The effective area then is

$$A = \pi D^2/4 \qquad (3)$$

The effective area computed in this manner may be shown theoretically to be incorrect, but the error is small and completely dwarfed by substantially greater inaccuracies in the measuring instrument systems themselves. For this reason and the fact that the exact formulas are more complicated, Eq. (2) and (3) are universally used for the determination of the effective area of a single-layer search coil.

Multi-Layer Search Coils

The determination of the effective area of a multiple-layer search coil is quite a different problem. The difficulties encountered find their source not in the mathematical problems that arise in connection with the formulation of correct equations, but rather in the mechanical troubles involved in making the requisite measurements accurately. Values for d_1 and d_2 of Eq. (2) may be measured quite easily and accurately by means of a micrometer, but it is altogether a different matter to measure the outside diameters of additional layers of wire when these additional layers may or may not fit into the grooves of preceding layers and may or may not sink to a uniform depth when they do fit. All in all, the problem of obtaining accurate measurements on a multi-layer search coil is a fairly hopeless one even with the observation of the most stringent precautions. For this reason the effective area of a multi-layer coil is measured rather than computed.

Measuring *NA* of a Coil

In Eq. (1) the product of N and A appears in the denominator. This product is a constant of the coil and is probably more frequently used in computations than either of its components by themselves. If the NA of a coil is known, its effective area is easily determinable, it being assumed that the turns of the coil were counted when they were wound.

Fortunately it is a fairly simple matter to measure (not compute) the NA of a multi-layer coil. This is accomplished by comparison in a uniform field with a standard coil, the NA of which is known accurately. The simple circuit employed for this purpose is shown in Fig. 2. Coils 1 and 2 represent respectively a standard coil of known NA value and the coil to be tested. The coil of higher NA value must be in the position of coil 1. The two coils are placed in a uniform field with their axes parallel. They are then withdrawn simultaneously (or the field reduced rapidly to zero), and the potentiometer sliding contact is adjusted so that upon withdrawal from the field the net gal-

PREVIOUS ARTICLES

Permanent Magnet Design, p. 126, Dec. 1943

Designing Stabilized Permanent Magnets, p. 118, Jan. 1944

Mechanical Problems of Permanent Magnet Design, p. 126, Feb. 1944

vanometer pointer displacement is zero. (During the withdrawal the pointer may swing off zero but if it swings back to zero upon completion of the withdrawal, the potentiometer may be assumed to be in balance.) At balance,

$$\frac{(NA)_1}{(NA)_2} = \frac{R_1 + r_1}{R_2} \quad (4$$

From this the NA value of the unknown coil is obtained.

The potentiometer in Fig. 2 may be of the slide wire type, and R_1 and R_2 measured by means of a Wheatstone bridge after balance is obtained. It is more convenient, however, to use a pair of decade boxes for this purpose, and read the values of R_1 and R_2 directly off the dials of the boxes. The values of r_1 and r_2 are the simple d-c resistances of coils 1 and 2.

The standard coil of known NA value may be a single-layer coil the NA of which had been computed by means of Eq. (2) and (3), or it may be a single-layer or multi-layer coil the NA value of which has been certified by the National Bureau of Standards or some other competent laboratory. To obtain balance, coils 1 and 2 must be connected so their instantaneous voltages have the relation shown by the arrows of Fig. 2.

Ballistic Galvanometer

Perhaps the most universally used instrument for primary magnetic measurements is the ballistic galvanometer. This is an extremely accurate instrument (under proper conditions, accuracies of the order of 0.1 percent may be realized) identical in construction to an ordinary galvanometer except that it has a very high natural period, usually 25 to 30 seconds or more.

The essential parts of a ballistic galvanometer are shown in Fig. 3. Current is conducted in and out of the moving coil by means of the upper and lower suspensions. As ordinarily used, a search coil, connected to the suspensions, is withdrawn from the field under test. A beam of light, focused on the galvanometer mirror, indicates the deflection of the moving coil on a scale located at a distance from the galvanometer. By calibration, the *maximum* deflection is then interpreted in turn into interlinkages, flux lines, and flux density.

The ballistic galvanometer reads total current, Q, or interlinkages, $N\phi$. (Proof of this is given in the Appendix).

Now, let us investigate the actual operation of the ballistic galvanometer. It is most common, when making a test, to include the calibrating equipment in the circuit. Thus, in addition to the search coil and the galvanometer, the circuit would incorporate a standard mutual inductance, a standard milliammeter or potentiometer for precise current readings, a reversing or current-breaking switch, a low-voltage source of very steady direct current such as a storage battery, and a variable resistance (a decade box, for instance) for adjusting this current. Additional variable resistances are generally placed in series and in parallel with the galvanometer itself, in order to vary the sensitivity and damping of the instrument.

The most commonly used ballistic galvanometer circuit is shown in Fig. 4. In actual use, the search coil is removed from the field under test and the maximum deflection of the galvanometer noted. With the search coil still in the circuit (but free of all fields), the current i is adjusted in the calibrating circuit to a value such that when the switch S is opened the galvanometer deflection is approximately the same as previously. (Before all readings, of course, the galvanometer light spot must be brought back and carefully set on zero). The current at this point is carefully noted. The flux density (or total flux or interlinkages) of the field under test may now be computed on the basis that the galvanometer deflection will be proportional to the total change of interlinkages in the circuit:

$$(N\phi)_T = KD_T \quad (5)$$

where $(N\phi)_T$ represents the interlinkages between search coil turns and the flux threading them, K is the proportionality constant, and D_T is the galvanometer deflection as the search coil is removed from the field under test.

To evaluate K in Eq. (5), let us study the voltage induced in coil a-a of the standard mutual inductance in Fig. 4 as the calibrating current i is suddenly reduced to zero (this is the current which when suddenly broken gives a galvanometer deflection D_c approximately equal to D_T).

$$e = N_c \frac{d\,\phi_c}{d\,t} \times 10^{-8} = M\frac{d\,i}{d\,t}, \text{ and therefore}$$

$$(N\phi)_c = Mi \times 10^8 \quad (6)$$

where $(N\phi)_c$ represents interlinkages between turns of coil a-a and the flux threading them. This flux arises from current i in the turns of coil b-b. M is the value of mutual inductance in henrys between coils a-a and b-b, and i is the calibrating current in amperes. The deflection D_c is proportional to $(N\phi)_c$, and since D_c is approximately the same as D_T, the constant of proportionality, K, is the same as that in Eq. (5). Therefore,

$$(N\phi)_c = KD_c, \text{ or}$$

$$K = \frac{(N\phi)_c}{D_c} = \frac{Mi \times 10^8}{D_c} \quad (7)$$

Substituting Eq. (7) into Eq. (5),

$$(N\phi)_T = Mi \times 10^8 \times \frac{D_T}{D_c}$$

Expressing M in millihenrys and i

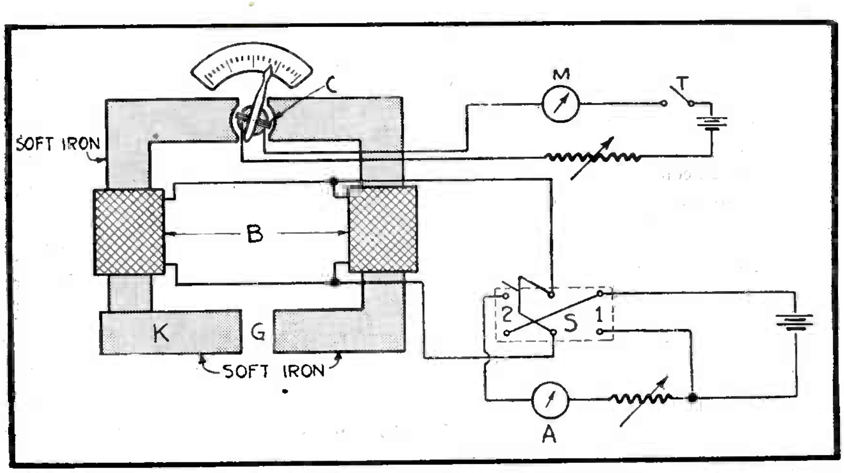


FIG. 5—Essential features of a magnetometer as used to secure readings that are reliable indications of residual induction and coercive force

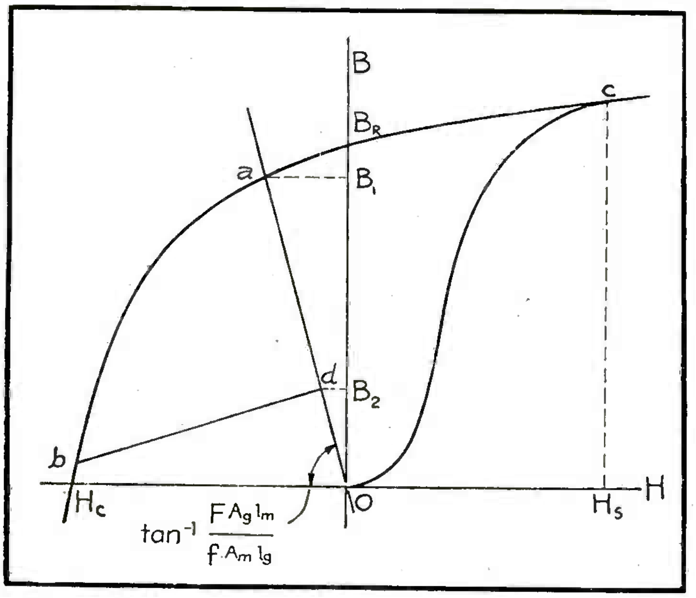


FIG. 6—Curves of actions taking place during a magnetometer test

in milliamperes, this becomes

$$(N\phi)_T = 100\ Mi \times \frac{D_T}{D_c} \quad (8)$$

The total flux threading the search coil is obtained by dividing Eq. (8) by the number of turns, N, on the search coil:

$$\phi = \frac{100\ Mi}{N} \times \frac{D_T}{D_c} \quad (9)$$

The average flux density through the search coil is obtained by dividing Eq. (9) by the area of the search coil in square centimeters:

$$B = \frac{100\ M\ i}{NA} \times \frac{D_T}{D_c} \quad (10)$$

The meanings of the symbols in Eq. (8), (9) and (10) are repeated here for convenience:

$(N\phi)_T$ = interlinkages between search coil and magnetic field under test.
ϕ = total number of flux lines threading search coil, in maxwells.
N = number of turns on search coil.
B = average flux density through the search coil, in gausses.
A = area of search coil in square centimeters.
M = value of standard mutual inductance, in millihenrys.
i = value of calibrating current in milliamperes.
D_T = search coil deflection.
D_c = calibration deflection (approximately equal to D_T).

Equipment Needed

The correct values to use for the circuit parameters of Fig. 4 depend a great deal, of course, on the magnetic and physical magnitudes of the fields to be measured, on the number of turns on the search coil, etc. However, a good general laboratory set-up for Fig. 4 might consist of the following items:

1. Storage batteries of from 6 to 12 volts for E.
2. A standard milliammeter of double range, 0-30 and 0-150 milliamperes. A potentiometer is a preferable alternative.
3. A standard mutual inductance of 50 millihenrys for M.
4. A four-dial decade box, 0-9999 ohms in steps of one ohm, for R.
5. A four-dial decade box, 0-9999 ohms in steps of one ohm, for R_s.
6. A four-dial decade box, 0-9999 ohms in steps of one ohm, for R_p. When R_s is adjusted to give a convenient galvanometer deflection in connection with the particular search coil being used and the particular field being tested, R_p will be adjusted to such a value that the resistance of the external network seen by the galvanometer is equal to the critical damping resistance of the galvanometer. This may not always be possible to do.
7. A ballistic galvanometer the sensitivity of which with zero external resistance is 700 interlinkages per millimeter or higher. (Note—a sensitivity of 600 interlinkages per millimeter is a higher sensitivity than 700, *not* lower.) This sensitivity figure is to be interpreted as applying to a galvanometer set-up having a scale located approximately perpendicular to the light beam and one meter distant from the galvanometer.
8. Suitable search coils and switches.

Next in basic importance to the ballistic galvanometer in making magnetic measurements is probably the flux meter.

Fluxmeter

A meter for measuring flux consists essentially of an ordinary d'Arsonval movement and a scale calibrated in terms of interlinkages. The restoring torque is made as near zero as possible. The deflection of the pointer of such an instrument is proportional not to the rate of flow of charge through the moving coil (as in an ammeter) but rather to the total quantity of charge moved through the moving coil. Thus the fluxmeter is an instrument which reads total current or interlinkage change.

Actually, in commercial models of this instrument, the restoring torque is close to, but very seldom equal to, zero over the entire scale range. This is due to the fact that current must be lead to and from the moving coil by some means or other and the ordinary means used are insufficiently pliant to forbid the self-exertion of some influence on the coil.

The common accuracy for commercial fluxmeters is 2 percent. This may be improved somewhat if the fluxmeter is used in connection with a calibrating circuit similar to that of Fig. 4.

Magnetometer

The ballistic galvanometer and the fluxmeter are the two commonly used instruments in the laboratory. The fluxmeter is also used frequently and satisfactorily as a production testing instrument, but in this respect it is probably less satisfactory than either the magnetometer or the production permeameter. These are the commonly used instruments in the production inspection department and have proved their worth over and over again.

Figure 5 shows schematically the basic layout of the magnetometer. Operation of this instrument is as follows: The piece to be tested is placed in gap G and movable member K is closed down upon it so that good magnetic contact is made at both ends of the specimen. Incidentally, the contact-making ends of the specimen are usually ground smooth and parallel before test. The test specimen is now in a soft iron circuit completely closed except for the gap provided for moving coil *C*. Next, switch *T* is closed and current supplied to coil *C*. This current, as read by milliammeter *M*, is adjusted to some predetermined value. Next, switch *S* is closed in position 1 and a heavy magnetizing current put through coils *B*. (In most instruments it is essential to provide a mechanism to interrupt the current through coil *C* while switch *S* is closed in either position 1 or 2. This is to prevent the pointer from breaking or bending itself against the pointer stops). Switch *S* is held in position 1 for a matter of 3 or 4 seconds, or long enough for the current to completely build up in coils *B*, and is then opened.

The test specimen is now magnetized and provides the field for the operation of the d'Arsonval movement of which coil *C* is a part. The pointer deflects across the scale and a reading is taken when it comes to rest. After this reading is taken, switch *S* is closed in position 2 and a much smaller current put through coils *B* in the *opposite* direction to that previously. This current, as measured by ammeter *A*, is adjusted to a previously determined value and must always be adjusted in such a way that the current is *increased* to this value, never decreased to it. If the mark is overshot, the test is valueless and the cycle must be repeated from the start.

Switch *S* is held in position 2 for three or four seconds and then reopened. The test specimen has now been partially demagnetized and will supply a much weaker field to coil *C*. A second reading of the pointer deflection, which of course is proportional to this field, is taken at this point. The specimen is removed from the gap *G*, the next piece inserted, and the cycle repeated.

The two readings taken during the test form an excellent production index of the quality of the magnet tested. Of course, the various current values used in the test will in general differ for pieces of different size and shape (will *not* differ, however, between pieces of the same size and shape). The specification of the value of the demagnetizing test current and the specification of the low limits of acceptability for the two magnetometer readings must be decided upon as a result of an interpretation of the usage requirements of the particular magnets in question.

Magnetometer Principles

Reference to Fig. 6 and the second article of this series will make clear the action taking place during a magnetometer test. Assuming that the magnet is initially demagnetized when placed in the magnetometer (this is *not* a necessary condition to the proper functioning of the magnetometer) the flux density in the magnet will rise along the curve *oc* when the switch *S* is closed in position 1. Sufficient current must be put through coils *B* to assure that the magnet operating point carries beyond point *c*, i.e,, to assure that the magnet is saturated. When switch *S* is opened, the magnet operating point runs down the curve cB_Ra to point *a*, and the first reading will be proportional to the flux density value, B_1. (Note that the operating point goes to *a*, not B_R. This, of course, is due to the small gap introduced into the soft iron circuit of the magnetometer to allow operation of coil *C*). When switch *S* is closed to position 2, the operating point will continue down the demagnetization curve to a point (depending on the value of demagnetizing current used) shown as *b*. Then, as the switch is opened, the operating point travels up minor hysteresis loop *bd* to point *d*, and the second reading will be proportional to the flux density value, B_2.

While the magnetometer gives no answers in terms of absolute quantities and doesn't even give answers in terms of points on the demagnetization curve, it nevertheless gives two readings on each test piece, the first of which is a good indication of the residual induction of the piece and the second of which is a good indication of the coercive force. (This latter statement is predicated on the proper adjustment of the demagnetizing current during the test.) Thus, by means of this simple test, it is possible to determine rapidly whether or not the demagnetization curve of the magnet under test conforms, at least near its end points, with minimum established requirements for that magnet. The method is extremely rapid (one machine can test 200 magnets per hour if properly set up) and is used by magnet purchaser and magnet manufacturer alike.

Use of Production Permeameter

The production permeameter is shown schematically in Fig. 7. Its operation is as follows:

The piece to be tested is very carefully demagnetized (this is important) and inserted in the gap of the production permeameter. A search coil, *C* of a size to permit it to just slip over the test specimen, is placed into position and the mag-

(*Continued on page* 385)

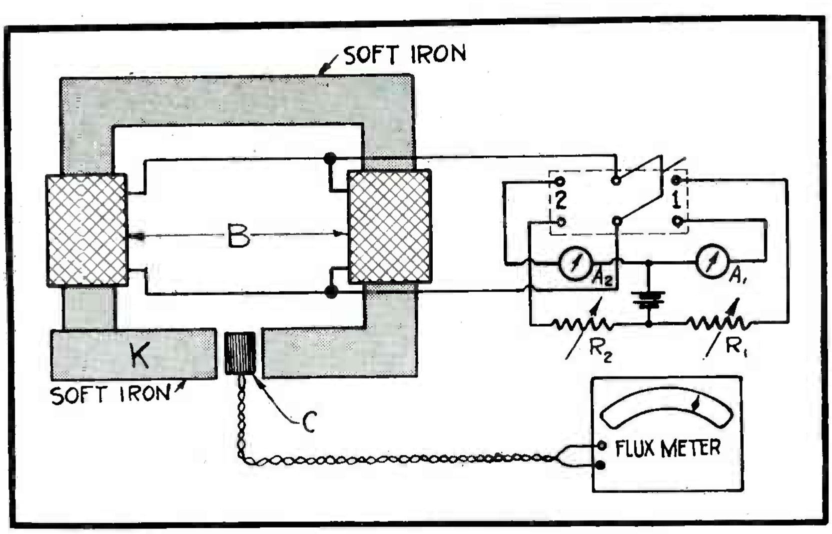
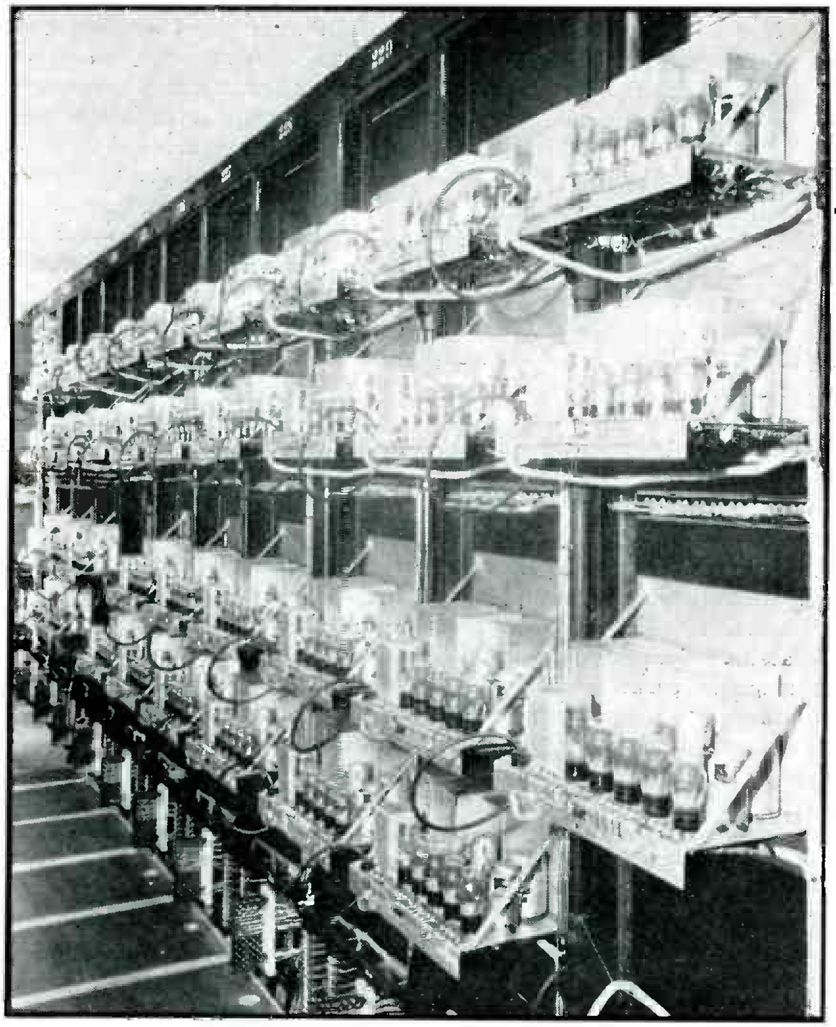


FIG. 7—Essential features of a permeameter designed for production-line use

CONSERVING Small Tubes



Rear view of a bay at Radio City, showing the many amplifiers employing small tubes used in audio service

By C. A. RACKEY

Audio-Video Facilities Engineer
National Broadcasting Company
New York, N. Y.

UNDER WAR CONDITIONS small vacuum-tubes are more difficult to procure. The number of tube types produced is arbitrarily reduced and the availability of remaining types varies. Furthermore, general performance standards may be somewhat lower and manufacturing variations tend to increase.

The audio operating engineer is faced with a distinct small-tube problem and he must make every effort to solve it in order to maintain his plant in good working condition. The problem divides broadly into two parts: (a) Means of dealing with initial variations in performance characteristics and (b) methods of insuring normal life and even increasing it.

Seven methods by which troubles in small vacuum tubes may be minimized immediately come to mind:

(1) Reduce the number of different tube types used in the plant by modifying equipment and so, in effect, increase the available stock from which selection can be made.

(2) Make certain that all tubes, particularly rectifiers and output tubes, are operating well within rating. Reduce requirements, if possible.

(3) Analyze equipment faults carefully to make certain that circuit elements other than tubes are not the cause.

(4) Use external mechanical or electrical devices designed to protect tubes.

(5) Adapt equipment to use substitute types of tubes which are more readily procurable.

(6) Use all tubes to the very end of their useful life.

(7) Shut off equipment when it is not in use.

Tube "Selection"

Small tubes are not absolutely uniform in their characteristics, because of inevitable variations under conditions of economical quantity production. There is also some variation between similar types of different manufacture and between different lots or "runs" of the same type by any one manufacturer. For this reason some suppliers offer "selected" tubes, which are available at increased cost for critical applications.

The user may himself employ selection, provided a sufficient number of tubes of the required type are available. This suggests a study of equipment with a view toward possible changes in tube line-up. It may prove desirable to use a single type in more sockets. Tubes in a sizeable stock can be tested and marked as "first" or "seconds", depending upon whether they are found suitable for use in critical positions, such as in the initial stage of an amplifier, or in later stages and secondary applications.

Aside from the present necessity, reduction in the number of tube types employed will be a permanent step in the right direction. In most audio systems it would be entirely practical to use the same type of tube for all stages of amplification except the final or output stage, to which a line or resistance-termination load is connected.

Among the variations to which an average lot of small tubes is subject are hiss, microphonics, thumps, clicking and popping

in AUDIO SERVICE

In wartime, the broadcast station operating engineer must devise means for dealing with initial variations in characteristics and methods of insuring maximum life. Practical suggestions for achieving small-tube economies are given

noises, and frying or sputtering noises.

In the case of hiss, triodes are inherently quieter than tubes with more elements, substitution being desirable if the application is a stringent one with respect to noise and if some gain reduction can be tolerated. Selection is rarely practical where hiss is encountered since this usually accompanies reduced emission. A tube found in such condition initially will generally have a short period of life expectancy and should be discarded.

Selection is of definite advantage in the case of tubes with thumps, clicks or pops, since tubes having such characteristics can often be used in second or later stages where the faults are not too pronounced. Sometimes these noises occur only during the warm-up period (as much as an hour for some types) and allowance should be made for this.

Frying noises, sometimes occurring at infrequent intervals and therefore hard to locate, may indicate reduced insulation between elements. Such tubes can frequently be used effectively in circuit positions requiring less plate voltage.

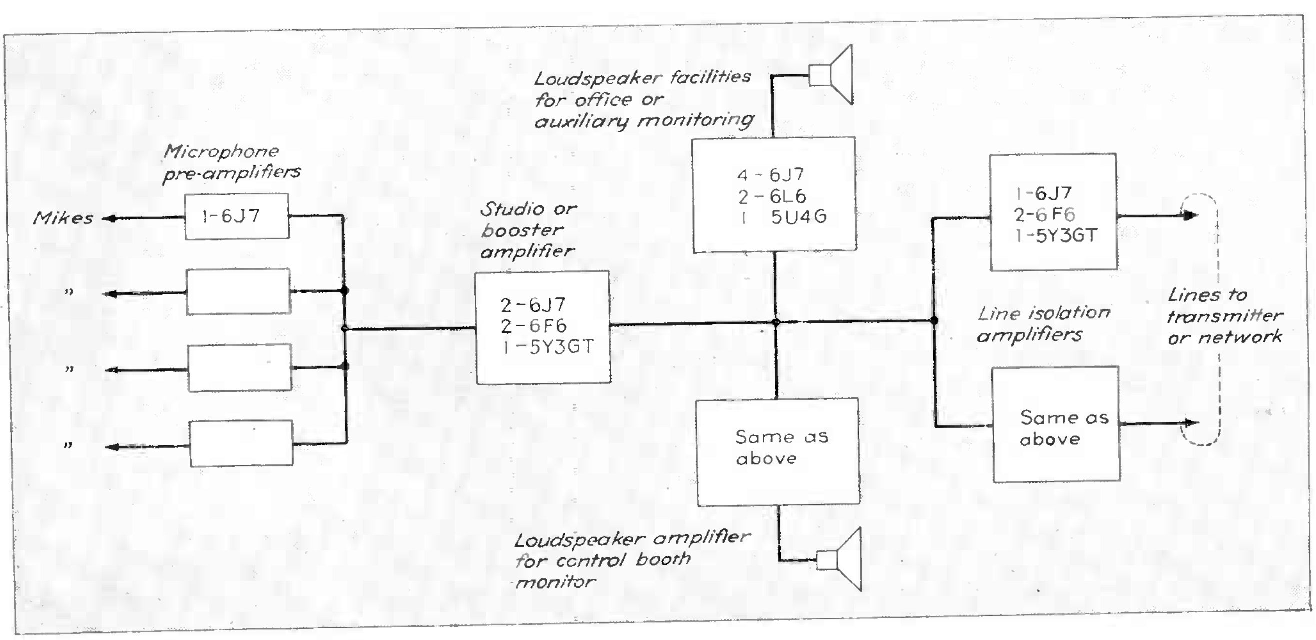
Selection is of very definite advantage in the case of microphonics as variations among tubes of similar types are usually great in this respect.

Reducing Loads

Tubes, in common with all physical devices, have limits of work capacity which, if exceeded, reduce life expectancy and may cause permanent damage. In the audio plant the output tubes of power amplifiers are frequently overloaded. Rectifier tubes are even more often abused.

Rectifiers are, in a sense, power-originating devices. They constitute a fundamental limit in a-c equipment, so that both designers and users tend to demand full and often excessive output. As new rectifier types become available the tendency is to "design up to them," so to speak, the practical result being that in much present equipment the power-supply circuits are overloaded or very nearly so.

Mercury-vapor rectifiers, having a low internal impedance, are particularly subject to excessive currents and care must be employed in choosing suitable loads. Filters having a capacitor as the first circuit element are not suitable, as competent engineers know, but there are cases where this fact has been ignored. In such cases a small inductance should be installed between the capacitor and the rectifier tube output. The value of this choke will depend upon the reduction of filtered output voltage



Typical modern broadcast station audio line-up. There are 31 tubes in this equipment but only five different tube types. Sixteen tubes of one type are used as voltage amplifiers which can be tolerated, but even a comparatively small choke is of value in limiting maximum current peaks. Lacking a choke, a resistor of equivalent d-c value can be used, without of course the additional filtering benefits of the former. In the case of a half-wave rectifier, a choke eases the load on the tube but is of little advantage in filtering.

It should be remembered that substantial changes in power-supply output voltage will require corresponding readjustments of grid bias on the amplifier tubes involved to avoid distortion. The amplifier output will also be reduced, but there is little disadvantage in this as present-day equipment delivers power in excess of most requirements, especially to monitoring loudspeakers used in small spaces. In the case of said loudspeaker amplifiers, where they are used in secondary locations, and for other secondary amplifier equipment, a simple "brute-force" method of obtaining substantial increases in tube life consists of inserting a series resistance in the a-c line, reducing the input voltage from 10 to 15 percent. This will introduce some distortion, of course, but it is surprising how far the line voltage can be reduced while still retaining acceptable quality. Try it and see for yourself! Check quality by listening to a program, or to harmonics from an audio oscillator if distortion-measuring equipment is not available.

High-vacuum-type rectifiers, because of their much greater internal impedance, are not as susceptible to damage as mercury-vapor tubes, but they do tend to run hotter. In some types heating has been known to reduce life seriously. Tube ratings and actual operating conditions should be carefully compared and either a choke or a resistor used to reduce the load where necessary. Here also a choke-input filter will be beneficial but it is not imperative as in the case of the mercury type.

A reasonable operating ambient temperature of from 110 to 115 deg F should be provided, either by inducing natural circulation or by resorting to a blower. Cooling also reduces the danger of flashback in mercury-vapor rectifiers. (Incidentally, while on the subject of temperature, it is well to point out that the life of electrolytic filter capacitors decreases rapidly above approximately 120 deg F and, since these are usually mounted adjacent to rectifier tubes, a double advantage is obtained by cooling. There is no practical point in operating below about 100 deg F unless transformers and other parts are potted so badly that they drip!)

Equipment Faults

Equipment faults should be carefully analyzed to determine whether tubes, or other seemingly-innocent circuit elements, are causing trouble. Many engineers refer humorously to the alleged practice of the radio servicemen who completely re-tube a receiver at the slightest provocation. Yet this very stunt was at one time, and perhaps still is, common audio maintenance practice.

Faulty operation blamed on tubes may be due to poorly-soldered or fastened wiring, high-resistance or corroded connections in coupling transformers or inductances, corrosion at tube terminals and socket contacts, and sometimes poorly-designed input circuits or inferior circuit elements which give rise to excessive thermal agitation easily mistaken for tube hiss.

Protective Devices

Various external mechanical and electrical means may be used to improve performance of tubes in critical positions. Since the general adoption of heater-type tubes having inherently low microphonic response, the use of sockets with elastic mountings has been all but forgotten. To one who has not tried it before, the beneficial results of suspending a tube and socket from the chassis by means of several stout rubber bands will seem remarkable. Sponge-rubber and even steel or phosphor-bronze springs can be used when the requirements are not too severe. All electrical connections to the floating socket should be flexible.

The foregoing applies chiefly to cases of mechanical vibration, transmitted into the tube from the chassis. If the microphonics are air-borne, i.e., purely acoustical, try damping the tube by fastening an ounce or so of lead to the envelope with spring clips. The experiment may first be tried by securing the lead mass with a rubber band. If rubber bands are unobtainable, cut strips from an old rubber glove or inner tube. In extreme conditions of air-borne noise the tube or socket can be surrounded with a lead shield (a piece of pipe with a cap over it—painted dull black inside and out to facilitate heat radiation). Extreme cases of mechanical vibration, usually of low frequency and due to building rumble, etc., can be reduced by insertion of a simple high-pass filter with a low cut-off at 60 to 80 cps. A microphonic tube can sometimes be cured by giving it a sharp snap of the finger while in operation. Presumably, this shakes into place elements which were in a loose or unstable condition.

Substitute Types

The availability of various tubes has changed since the beginning of the war and tends to vary from time to time, with certain types continuing in greater demand and thus scarcer. A check of local suppliers will indicate the immediate condition.

Tube catalogs and handbooks show a diversity of similar types, the variations being in respect to socket terminals, filament voltage, glass or metal envelope, etc. Types 6C6-6J7-57 and 6L6-807 are examples of this. Tetrodes and pentodes can replace some of the older triodes with a change of sockets and paralleling of screens and plates. Substitution of glass for metal and vice versa is usually a matter of socket change and sometimes space, requiring shifting of other components. It is possible to use lower-voltage types in 6v parallel-operating filament or heater circuits; in series circuits, suitable series-parallel combinations of tubes and resistors can almost always be worked out.

Extending Life

In the old days burn-outs of tungsten filaments were anticipated where continuity of service was a factor. Tubes were replaced after a certain period of use, regardless of whether or not they were in

(*Continued on page* 393)

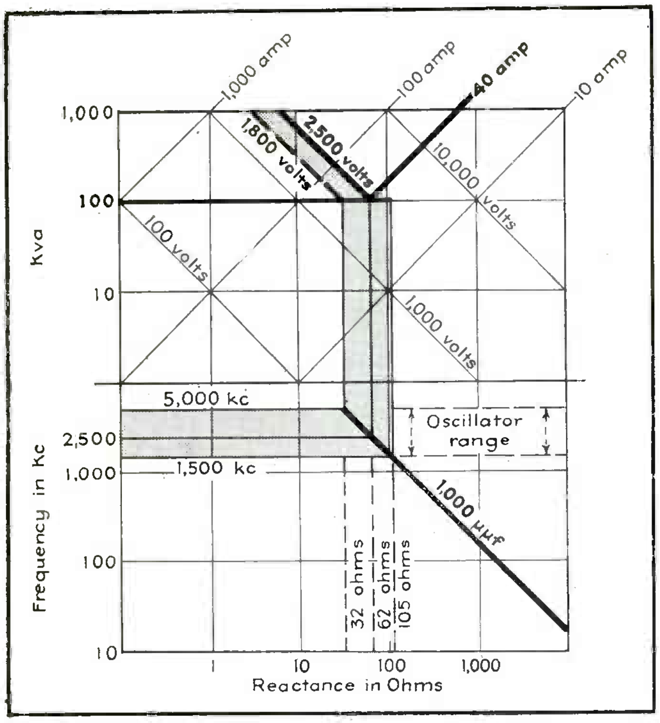


FIG. 1—Skeleton form of the chart, illustrating procedure for shifting decimal point for inductance and capacitance values, as required for the case of dielectric heating

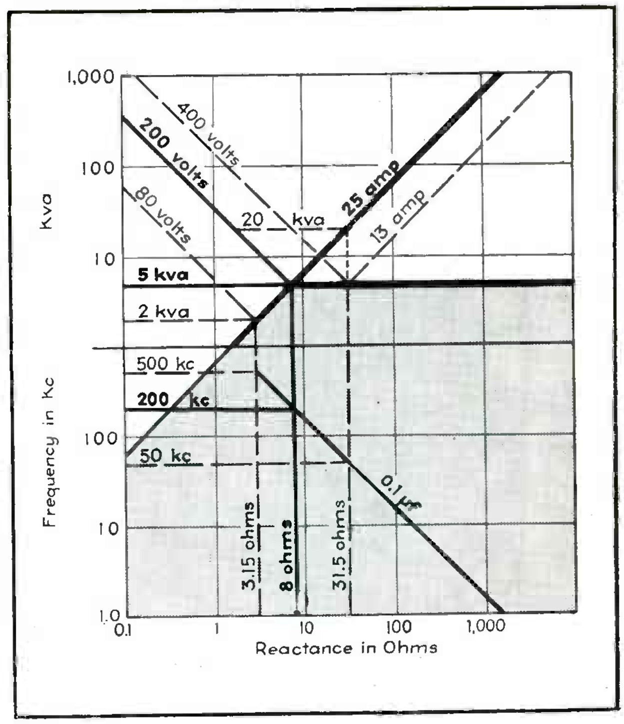


FIG. 2—Skeleton form of the chart, indicating operating boundaries of current and kva, determined by original rated conditions when an adjustment in frequency is desired

ELECTRONIC HEATING Design Chart

Choice of overall circuit constants for induction and dielectric heating applications can be made directly from the chart. Their limitations and dependencies are visualized

By C. V. FIELDS

Switchgear Engineer, Westinghouse Elec. & Mfg. Co. E. Pittsburgh, Penna.

DESIGNERS of induction heating, dielectric heating, and other apparatus of relatively high audio and radio-frequency power can choose appropriate circuit constants, in accordance with operating requirements, by the relations conveniently arranged in the accompanying chart. By this method such relations can be easily held within physical, electrical, and economic limitations.

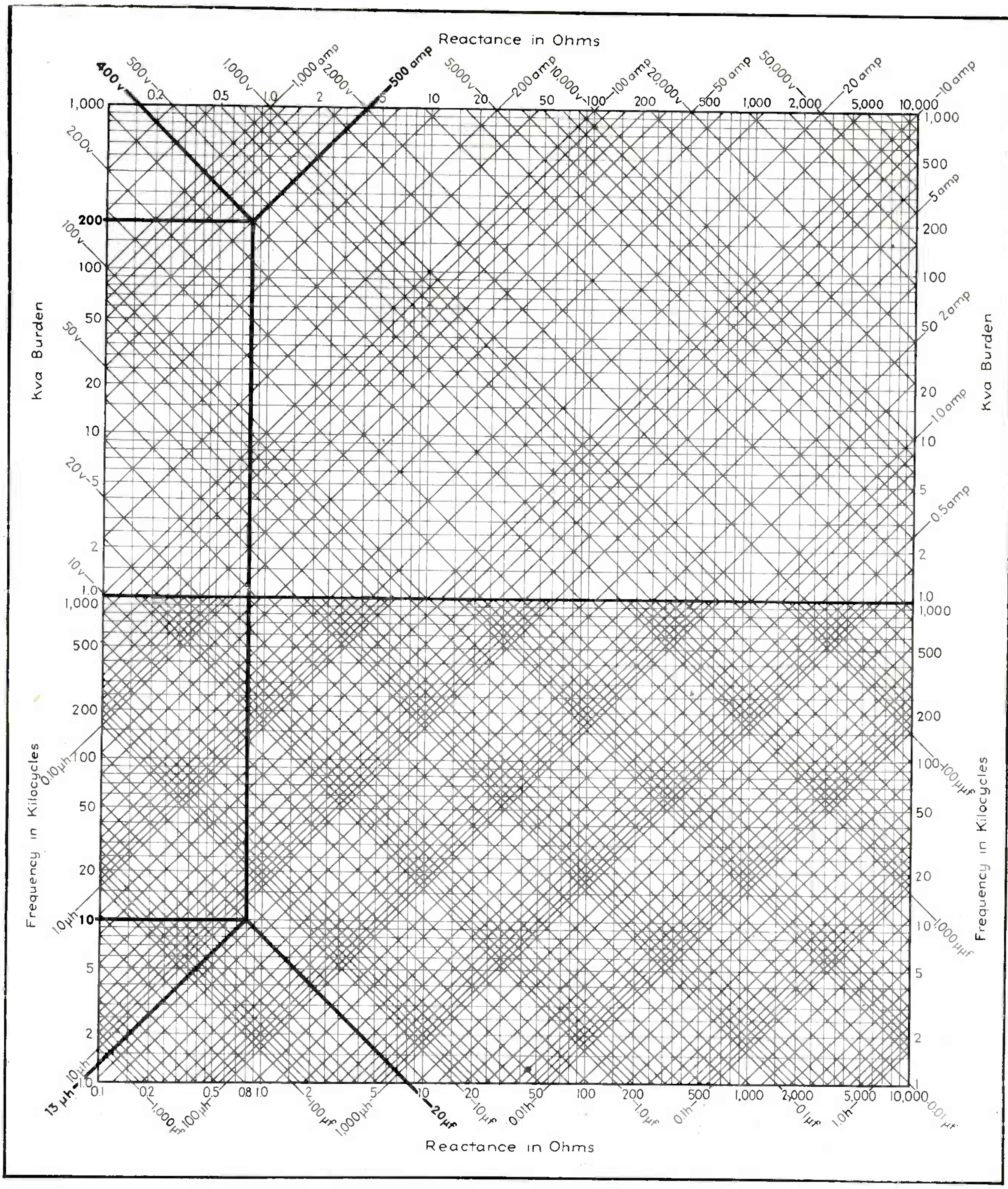
The seven parameters covered by the chart are (1) current, (2) voltage, and (3) kva, correlated by the upper section; and (4) inductance, (5) capacitance, and (6) frequency, in the lower section; with (7) reactance having its scale as a common coordinate between the two sections in the construction of the chart as a whole.

The horizontal lines are ordinates of kva, in the upper section—and of frequency, in the lower section. The 45 degree diagonals are cross-coordinates of voltage and current in the upper section—and inductance and capacitance, in the lower. The vertical lines are of constant reactance, common to both sections; their values are shown along the abscissa.

There is no set order of operations in arriving at a desired solution, since any point represents a set of values for each of the four parameters, and naturally satisfies any equations involving them. It is necessary only to familiarize oneself with the directions of increase and decrease, and with the calibration of the scales so that correct interpolation may be made, to obtain a commensurate set of values.

Induction Heating

In the usual case of induction heating equipment design, three factors have been established and it is necessary only to ascertain the remaining values on the chart. The voltage and frequency are set by the power supply characteristics in the example shown on the chart;



namely, 400 v and 10 kc. The current required was calculated to be 500 amperes. The intersection of the known voltage and current gives the corresponding kva (200) at the left, and the 0.8-ohms inductive or capacitive reactance is read on the abscissa directly above or below the intersection. Interpolating between the two sets of diagonal lines, where the 0.8-ohm vertical line crosses the 10-kc horizontal line, in the lower half of the chart, we find the inductance to be 13 μh and the capacitance 20 μf.

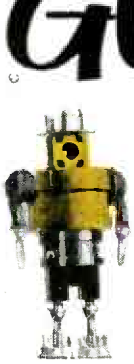
Dielectric Heating

Physical and electrical properties of specimens to be heated by the dielectric loss method establish the capacitance, power factor, and permissible voltage. From the desired temperature and rate of heating, one computes the required kilowatts, which is divided by the power factor to get the kva burden of the load. In the example shown in Fig. 1 the 1000 μf specimen requires 100 kva at a maximum of 2500 v, and the oscillator covers the 1500 to 5000 kc range.

Before proceeding to use the

(*Continued on page* 395)

★GUNG HO!

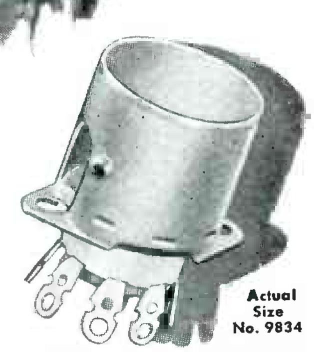


Each man, each machine acts as a unit . . . And every part—small and large—in every piece of equipment, performs as *one* . . . That's vital; that's what all the effort's about . . .

The very command: "cast off!" "contact!". . . must get through instantaneously, perfectly. And they do—because in every line of communication each CINCH part "works *GUNG* in perfect harmony *HO*."

★ From the Universal Picture, "Gung Ho"—GUNG: Work; HO: Harmony.

CINCH MANUFACTURING CORPORATION
2335 West Van Buren Street, Chicago, Illinois
SUBSIDIARY: UNITED-CARR FASTENER CORPORATION, CAMBRIDGE, MASS.



Actual Size No. 9834

CINCH Miniature Socket with "integral" or one piece shield and saddle. The high base virtually acts as a shoe horn . . . as tubes must travel a straight path when inserted or removed, thus preventing tube breakage. Full floating contacts . . . a shield base that acts as a support neutralizing vibration shock and distortion.

TUBES AT WORK

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Electronic Control for Burning Machine 164
Electronic Radio Range Monitor 172
Safety Grounding-Switch System 180
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Lightning Counter 198
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Carrier Current for Railroad Communication

A CARRIER CURRENT system of communication, using the rails and wires on poles parallel to the track, has been put into operation by the Pennsylvania Railroad on the 67-mile Belvidere-Delaware branch running northward from Trenton, N. J. The system has been applied to freight service on a branch where considerable traffic is handled.

So far, equipment has been installed on 10 locomotives, 10 cabin cars and one block station. An installation at another block station is under way at Trenton, where the branch leaves the New York-Washington main line. The system permits the crews of freight trains and block operators in wayside towers to talk to one another at any time for the transmission of orders, reports, and information on matters affecting train operation. The conductor in the cabin car and the engineer in the locomotive cab may also communicate with one another and the crew of one train may talk with the crew of another train several miles distant.

The equipment operates on a push-talk system with a button provided that causes a constant audio tone to be transmitted when calling. This tone is received by

A handset with a press-to-talk switch and an overhead speaker (not shown) is used by the engineer in the locomotive cab. The carrier-current equipment, mounted above the driving wheels, utilizes the tracks and adjacent wire lines for reception and transmission from train to train or to the block operator

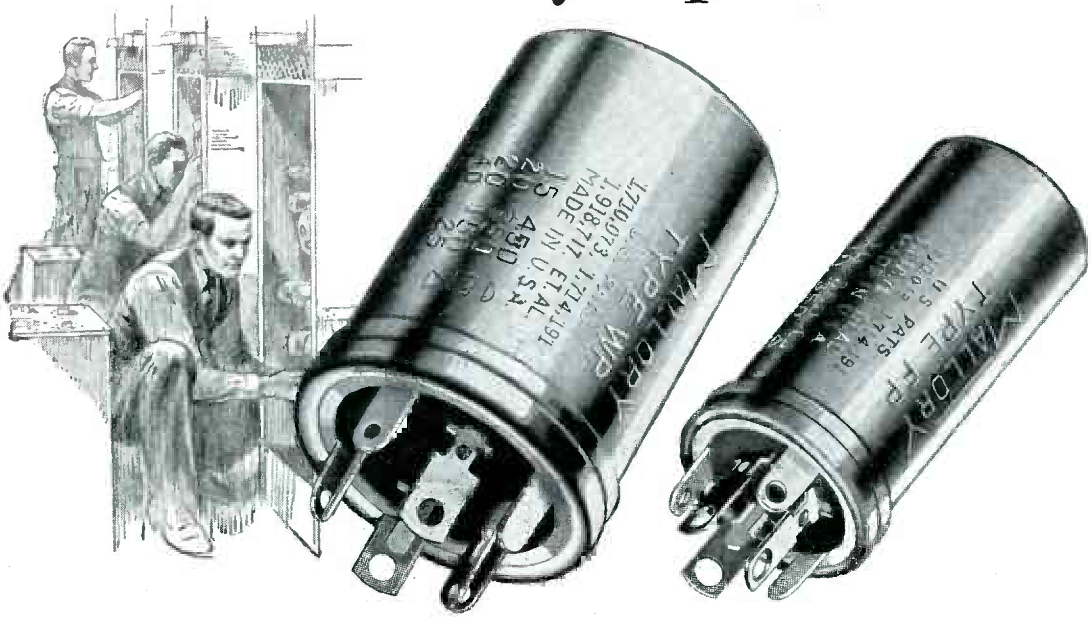
The projection behind the wheel of the locomotive contains a coil for picking up the signal from the track in the carrier-current system used by the Pennsylvania Railroad

Electronic equipment for transmitting and receiving carrier-current signals at the block station, made by Union Switch and Signal Co.

the block operator and other crews on the branch, as is also the ensuing conversation. Thus, orders to one train crew are noted by other crews and a constant check may be provided on overlapping orders.

Reception of the signal from the rails is made by a pickup coil that is mounted a few inches above the track. Power for the engineer's unit comes from the headlight generator on the locomotive, while storage batteries supply the conductor's set in the cabin car. Loudspeakers are used in all positions and permit the men to hear whistle signals

Save Assembly Space and Time



LONG considered standard for metal encased units, Mallory FP and WP Capacitors are widely specified for radio and electrical assemblies. Light in weight, compact, complete with mounting features, they save assembly space and time. Mounting brackets or other accessories are not required where the chassis has been punched with the characteristic FP slotted design.

Mallory FP and WP Capacitors insure these savings:

1—Less engineering expense in capacitor applications
2—Lower costs per unit
3—Eliminate the need of special capacitors
4—Less labor in assembling to chassis
5—Eliminate the need of hardware for mounting
6—Uniformity eliminates the need for other parts to stabilize circuit performance
7—Encased in metal—hermetically-sealed against extrêmes of temperature and humidity
8—Smaller sizes simplify design and conserve chassis space

We invite you to send for complete test data and specifications.

Pioneers in capacitor research and manufacture, Mallory engineers welcome consultations on your problems. An exceptionally broad background in designing, testing and producing specialized types of capacitors and noise filters is at your disposal. Please feel free to use it. Write Mallory direct or see your nearest distributor.

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Lend a Hand—Buy War Bonds

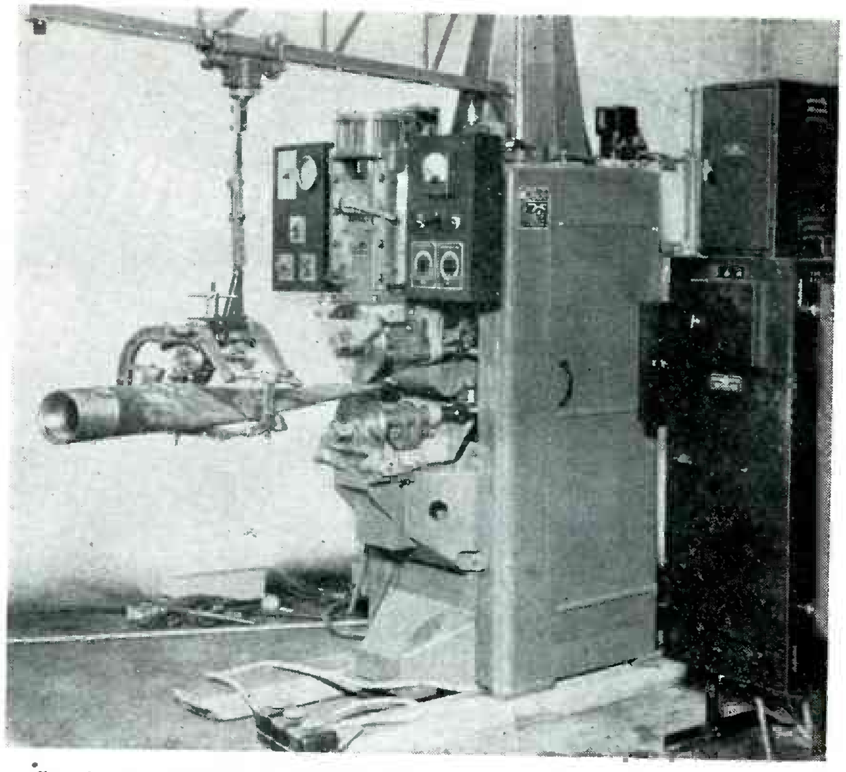
P.R. MALLORY & CO. Inc
MALLORY
ELECTROLYTIC, FILM AND PAPER CAPACITORS

foot apart, extend into the room at right angles to the walls, ceiling, and floor. These alternate from seven to four feet in depth and are used to trap extraneous and reflected sounds.

The photograph shows the use of a robot head to test the sound reflection effects of a speaker's face and head when close to the microphone. An electronic audio oscillator is used to produce tones at various frequencies which are made to issue from a diaphragm in the robot's mouth. Tests are made on a grilled platform located 11 feet above the floor and supported by vibration-isolated feet.

Welding Current Regulator

By B. Cooper
*Electronics Section
Industrial Control Engineering Division
General Electric Co.*

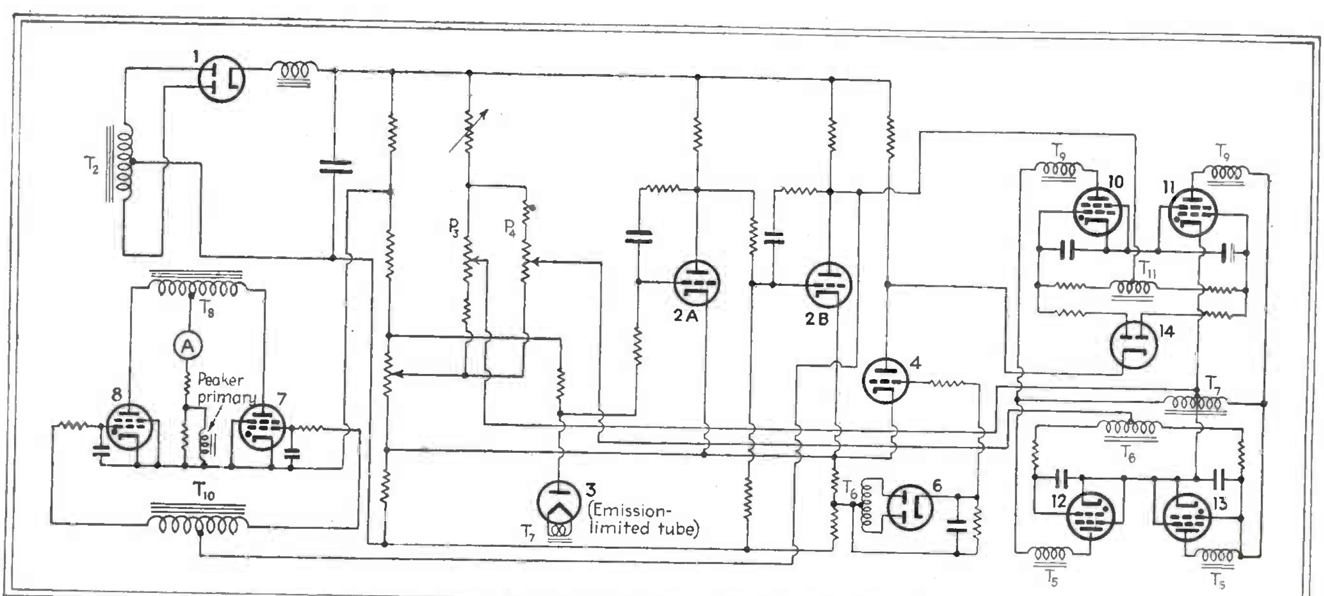


Complete setup for seam welding of aircraft propellors. The current regulating compensator is the top unit at the right. The larger cabinet contains an electronic timing control

One of the most frequent causes of variation in resistance welding current is a variation in the power supply voltage during the making of the weld. Since the welding current is directly proportional to the supply voltage, any change in the supply produces a proportional change in the welding current unless compensations are made. The current regulator to be described is not designed to maintain the supply voltage at its normal level but nullifies the undesirable effects of variations in the supply voltage and permits consistent quality welding comparable with that produced on a power line having only a few percent regulation.*

* Condensation of a paper presented before the annual meeting of the American Welding Society in October 1943, at Chicago. For purposes of consistency, the symbols employed in this article are those commonly used in communication circuits.

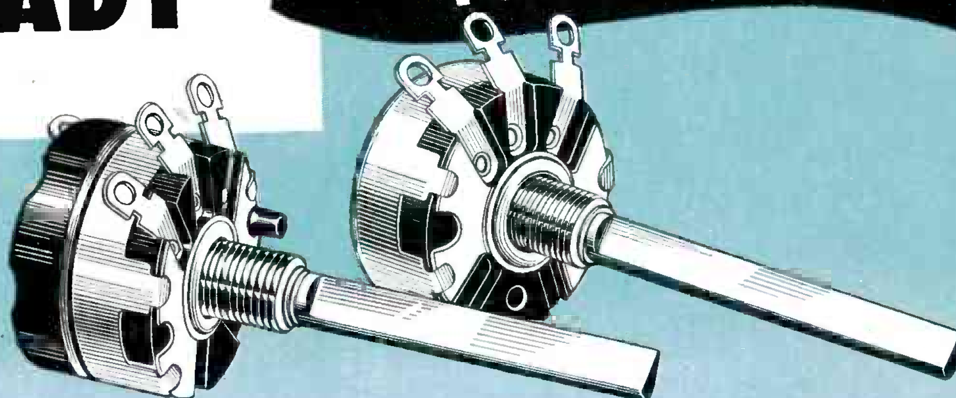
Other causes of changes in the welding current are either a change in the power factor of the welding transformer and load, or a change in the impedance of the transformer and load, or a combination of these two effects. These changes may be caused by moving the electrodes of the welding machine to alter the size or shape of the sec-



Simplified diagram of the current regulator for resistance welding. The unit corrects for variations of welding current resulting from impedance or power factor changes caused by the welding operation as well as supply voltage changes

IRC WILL BE READY

with WIRE WOUND POTENTIOMETERS



At war's end, IRC will be prepared to furnish ample quantities of resistors of *all types* to meet Industry's post-war needs.

That these IRC units will be available on a mass production basis is due to the fact that, in meeting war requirements, we have developed the Nation's largest resistor plant using the most improved and efficient types of specialized equipment.

ENGINEERING HELP FOR YOU

At your service on any resistance problems involved in your peacetime product design plans is our Engineering-Research staff. You may be assured that all projects discussed with this department will be held in strictest confidence.

FEATURES OF IRC WIRE WOUND POTENTIOMETERS (TYPE W)

1. *Tight uniform winding on specially processed bakelite.*
2. *Uniform contact pressure which can be adjusted to meet application requirements.*
3. *Welded resistance wire terminations.*
4. *Only one wiping contact-clock spring between center terminal and contact arm.*
5. *Designed for maximum stability under conditions of vibration and shock.*
6. *Available as duals and triples in combination with composition controls.*

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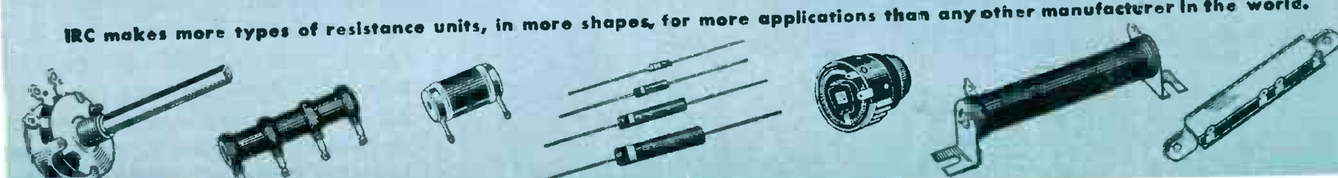
INTERNATIONAL RESISTANCE CO.

401 N. Broad St. Philadelphia 8, Pa.

IRC makes more types of resistance units, in more shapes, for more applications than any other manufacturer in the world.



ondary throat to fit a specific welding job or the introduction of magnetic material into the throat of the welder. The latter instance changes the secondary inductance and tends to make the welding load more reactive, while at the same time eddy current and hysteresis losses in the magnetic material projecting into the throat increase the effective resistance of the secondary.

A third condition exists where the welding machine is used to make welds which may alternately require a welding gun connected in parallel with the secondary of the welder. This requires a certain amount of cut-and-try juggling to get identical results. On a setup of this type the current regulator can maintain constant electrical welding conditions irrespective of the projection of material into the throat of the welder and irrespective of whether the weld is made between the main electrodes or with the welding gun.

Applications

One application of the control involved the welding of propeller blades where different amounts of steel projected into the throat of the welder at various times and caused changes in the welding current which could not be tolerated. Another application was in the making of oil and gas drums where, at one time during welding, the entire drum projected into the throat of the welder. The variation in welding current at different positions of the drum was about 40 percent before the current regulator was installed and constant manual readjustment was required. Without readjustment the drum was burned severely at one point and not even tacked together at another. The welding regulator held the welding current within 1 percent of normal throughout the range and permitted uniform welds to be obtained.

Operation

The circuit of the current regulator is shown in simplified form. The regulator consists of: first, a special tungsten filament rectifier tube which measures the rms welding current; second, a comparison and amplifying circuit for comparing this value of welding current

NOW A Miniature Thyratron With a Man-Size Rating

RCA-2D21—For Control Jobs Where Lightness and Small Size Count

STURDY construction—stable operation—high control ratio—yet this new RCA thyratron, the 2D21—is a true miniature. It weighs but ½ ounce; stands just 2⅛ inches high. And it will handle 100 milliamperes average; 500 milliamperes peak. The 2D21 is a gas-type tetrode electrically similar to the well-known RCA-2050.

In addition to its small size, RCA-2D21 has many application advantages—for example:

Low Internal Drop: Only 8 volts!

Any-position Mounting: The 2D21 is xenon-filled; no mercury to limit mounting position, or to restrict motion while in operation.

Wide Temperature Range: The 2D21 has wide temperature limits: –55 to +90°C, with little change in operating characteristics over the entire range.

Quick Heating: Anode voltage may be applied not less than 10 seconds after application of heater voltage.

Stable Operation: The inherent stability of this type of gas-filled thyratron makes greater control-circuit sensitivity possible. Low grid-anode capacitance makes the 2D21 insensitive to line-voltage surges.

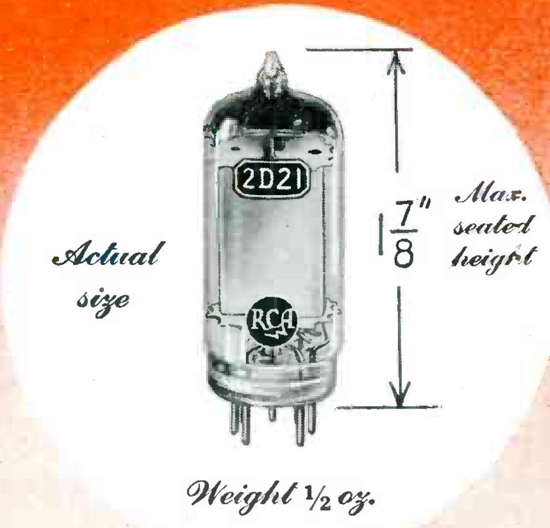
Versatility of Control: You can control the operation of the 2D21 by means of both the shield grid and the control grid. This makes for flexibility of control where needed.

Low Preconduction Current: Electrode structure provides low preconduction current right up to the start of conduction.

High Sensitivity: Grid current of this tube is very low; hence, a high resistance can be used in the grid circuit, providing high sensitivity. A high-vacuum phototube can be coupled to a 2D21 without intervening amplifier.

High Current Ratings: For periods up to 6 seconds out of 30, the 2D21 will safely carry 0.5 ampere plate current. It will carry 0.1 ampere continuously.

Need further information? RCA application engineers will be glad to help you in applying the RCA-2D21 and other RCA tubes to your design problems. Write to Commercial Engineering Section, Radio Corporation of America, Harrison, N. J.



TECHNICAL DATA

RCA - 2D21 **$3.75**

		MAXIMUM RATINGS	
Heater volts (A.C. or D.C.)	6.3	Peak Forward Anode Volts	650
Heater ampere	0.6	Peak Inverse Anode Volts	1300
Tube drop (Approx.)	8 volts	Shield-grid Volts	-100
Max. overall length	2⅛ in.	Control-grid Volts	-100
Max. seated height	1⅞ in.	Peak Cathode Milliamperes	500
Bulb	T-5½	Average Cathode Milliamperes	100
Base	Miniature Button 7-pin	Max. Control-grid Circuit Resistance	10 Megohms
Ambient Temp. Range	-55° to +90°C.		

Typical A-C operation: RMS Anode Volts, 400; Shield-grid Volts, 4; RMS Control grid Bias Volts, 5; Control-grid Signal Volts (Peak), 5; Control-grid Circuit Resistance, 1 megohm; Anode Circuit Resistance, 2000 ohms.

SEND THIS FOR DATA SHEET

RCA, 710 So. Fifth Street, Harrison, N. J.
Please rush data sheet containing curves, drawings, and other application data on RCA-2D21 miniature thyratron to:

Name ....

Company ....

Address ....

City.............................. State..............................

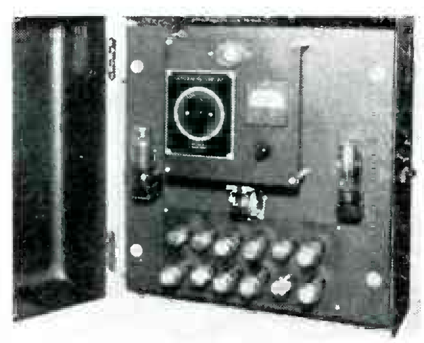
RCA

RADIO CORPORATION OF AMERICA

★ The Magic Brain of all electronic equipment is a Tube . . . and the fountain-head of modern Tube development is RCA with a normal value and giving a signal proportional to any deviation from normal; and finally, a phase-shifting circuit for controlling the power ignitrons in the main welding control.

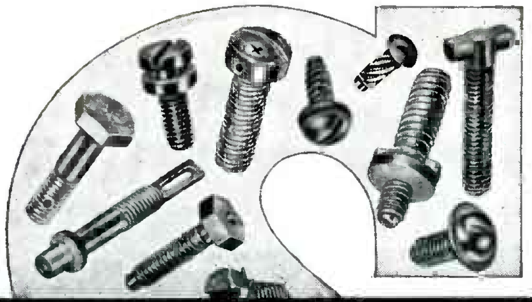
In order to hold the welding heat at a constant value, it is necessary to keep the rms value of the welding current constant. This is done by placing a current transformer in the line supplying the welding transformer and using the secondary current output to control the welding current regulator.

The heart of the regulating system is the tungsten filament rectifier, Tube 3, whose filament is heated by the current from the current transformer and whose output is proportional to this current. Since an identical facsimile of the actual welding current from the current transformer heats the filament of this rectifier tube, any variation in the heat at the weld caused by current changes will produce a like variation in the temperature of the rectifier filament. The output of this rectifier tube, which is operating in an emission-limited state, will be directly proportional to the filament temperature and to the heating value of the welding current, and will therefore, be a true measure of the rms welding current.



Control panel of the current regulator for correcting variation of resistance welding current

The output of the emission-limited tube is compared with a reference voltage appearing across part of the voltage divider on the d-c control supply. This reference or comparison voltage is held essentially constant by virtue of the voltage stabilizing action of transformer T_2, so that it will not be affected by variations in the control voltage. The difference be-



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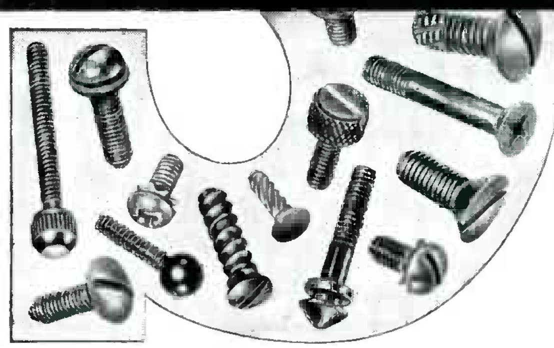

"Cold-forging" — proof #18 . . . more each month

COLD-FORGING skill mastered that job illustrated above—it was cold-forged by Scovill specialists. Many buyers of special designed fastenings believed their job could not be cold-forged until they were shown just what cold-forging ingenuity could accomplish.

That is where Scovill comes in. It is our job at Scovill, not only to serve you effectively by helping select the exact cold-forged fastenings that will best fill your specific requirements, but also to advise you just what fastenings can and should be cold-forged.

To serve you effectively—we must understand your particular problems thoroughly—help you to choose between "standard" and "special" fastenings—advise you candidly whether cold-forging can and should be employed to obtain the best results—design, or help you design, the fastening device most advantageous to your assembled product—deliver your job for minimum money—materials—motions.

Save time, trouble, money—as many Scovill customers have done—by calling in one of our Fastenings Experts from our nearest office to plan your fastenings when the product is still in the design stage.

SCOVILL MANUFACTURING COMPANY

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IN SHORT-WAVE BROADCASTING...

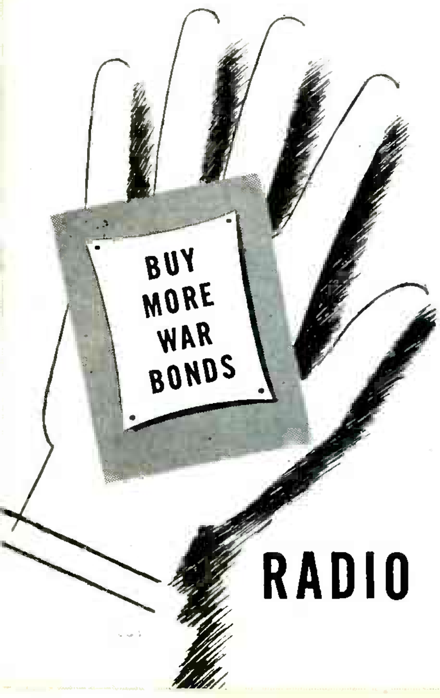
RCA has installed standard broadcast transmitters all over the world.

RCA also has led in development of short-wave transmitters specifically designed for international broadcasting.

The 50 KW Short-Wave Transmitter shown at the right is one of more than twenty-five of this type built by RCA in the last two years.

This is the first high-power short-wave transmitter to be built to broadcast standards and to include such features as high-level modulation, front access doors, vertical chassis construction, and streamline styling.

RCA's broad experience in every field of broadcasting—AM, FM, Television and Short-Wave—is a powerful and effective force in aiding all phases of the industry. RCA quality is the standard of the industry.



RCA

RCA BROADCAST EQUIPMENT

RADIO CORPORATION OF AMERICA

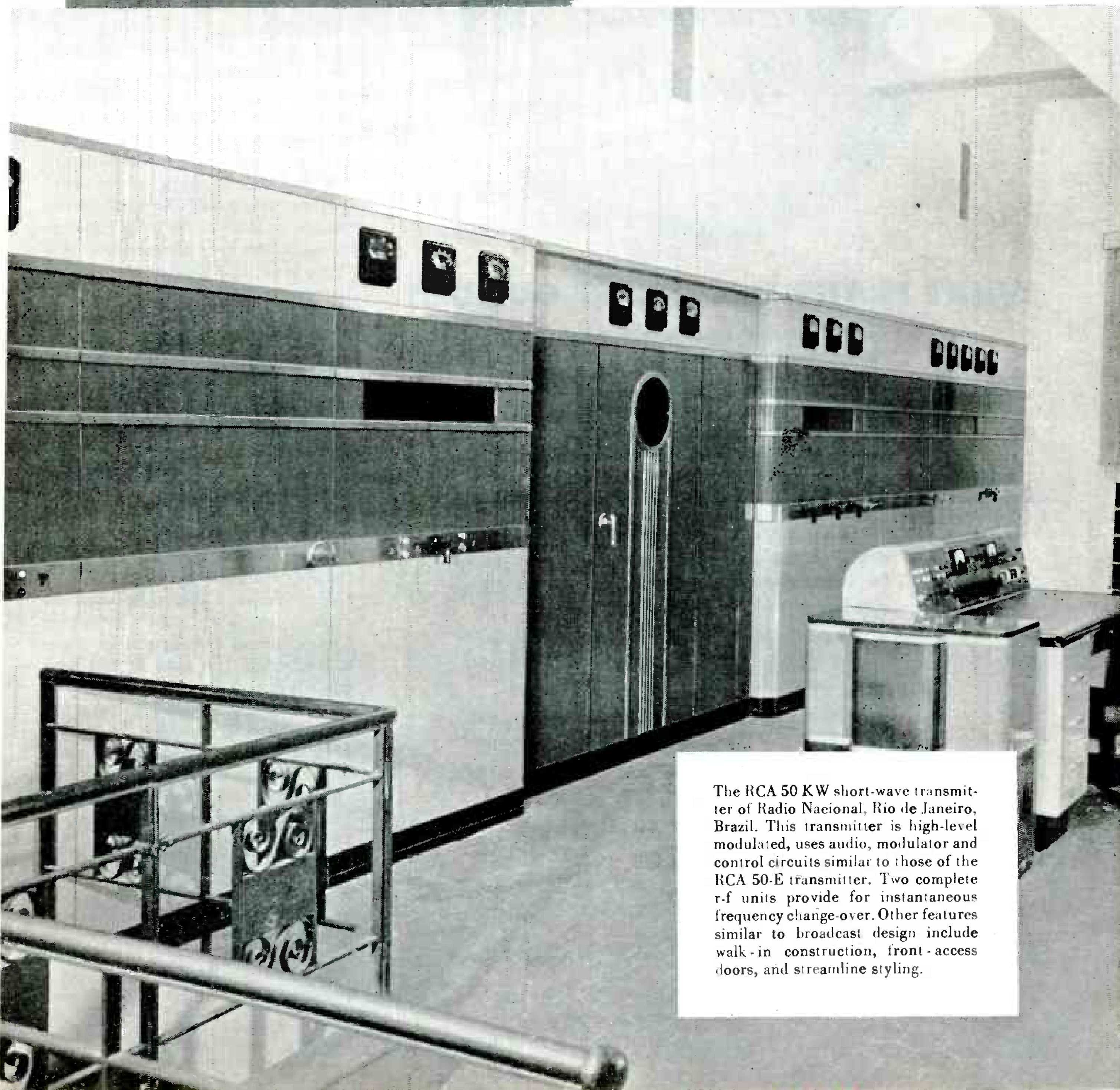
The first high-power short-wave broadcast transmitter to be produced in quantity

The 50 KW Transmitter of Radio Nacional, Rio de Janeiro, Brazil, shown below, is one of more than twenty-five of these 50 KW transmitters built and installed by RCA in the last two years.

Most of these units are already taking an active part on the broadcasting front of this global war.

Never before were so many high-power broadcast transmitters of a single design built and installed in so short a time.

RCA experience in AM, FM and Television—plus world-wide organization—paved the way!



The RCA 50 KW short-wave transmitter of Radio Nacional, Rio de Janeiro, Brazil. This transmitter is high-level modulated, uses audio, modulator and control circuits similar to those of the RCA 50-E transmitter. Two complete r-f units provide for instantaneous frequency change-over. Other features similar to broadcast design include walk-in construction, front-access doors, and streamline styling.

tween the output voltage of the emission-limited tube and the reference standard is applied to the grid of the first stage of a two-stage amplifier. The direct voltage of the two-stage amplifier is used as the d-c component in an a-c, d-c phase-shift system employing thyratron tubes 7 and 8 and transformer T_8 as a source of excitation for the peaking transformer on the main welding panel. This peaking transformer produces a peaked output voltage whose phase corresponds to the point of firing of Tubes 7 and 8. The peaked output voltage controls the firing tubes and hence controls the ignitrons.

Moving Firing Point

Regulation of the welding current is accomplished by changing the point of firing of the ignitrons. If the welding current tends to decrease, the firing point is automatically moved to a point earlier in the cycle, thereby permitting the ignitrons to carry current over a larger portion of the cycle. If on the other hand, something attempts to make the current increase, this firing point is retarded, thereby reducing the time of current conduction per cycle and decreasing the current to normal. The new firing point is chosen by the regulator so as to make the rms value of welding current constant.

Following through one regulating operation, assume that the welding current is higher than the nominal setting. Under this condition, the filament of the emission-limited rectifier, Tube 3, will be hotter than normal, and will cause the output of this tube to be greater than normal. The difference in voltage between the reference standard, and the output of Tube 3, will make the grid of the first amplifying tube more negative. The resulting action of the two-stage amplifier is that the plate of the second stage moves more negative, causing the peaker exciting tubes to be phase retarded. This in turn, retards the point at which the power ignitrons are made conducting and thereby returns the current to normal.

Regulation

Control of current by changing the point of firing is obviously limited to operation below 100 per-

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C.C. #50.352-1
British Ref. #10H-395
Signal-Corps #SO-147
Connector Corporation
401 NORTH BROAD ST., PHILADELPHIA, PA.

cent or less than full sine-wave current conduction. Once full sine-wave conduction is reached, no further regulation of the weld current can be expected. At points below the full sine-wave condition, the regulator will hold the welding current to within ±2 percent of the nominal setting, for changes that would otherwise have produced a ±20 percent variation in welding current. And ±20 percent change in circuit impedance is by no means the outside limit of regulating possibilities. This regulator will hold the current essentially constant over a possible 5 to 1 change in current, having a regulating error over this range in the order of 5 percent.

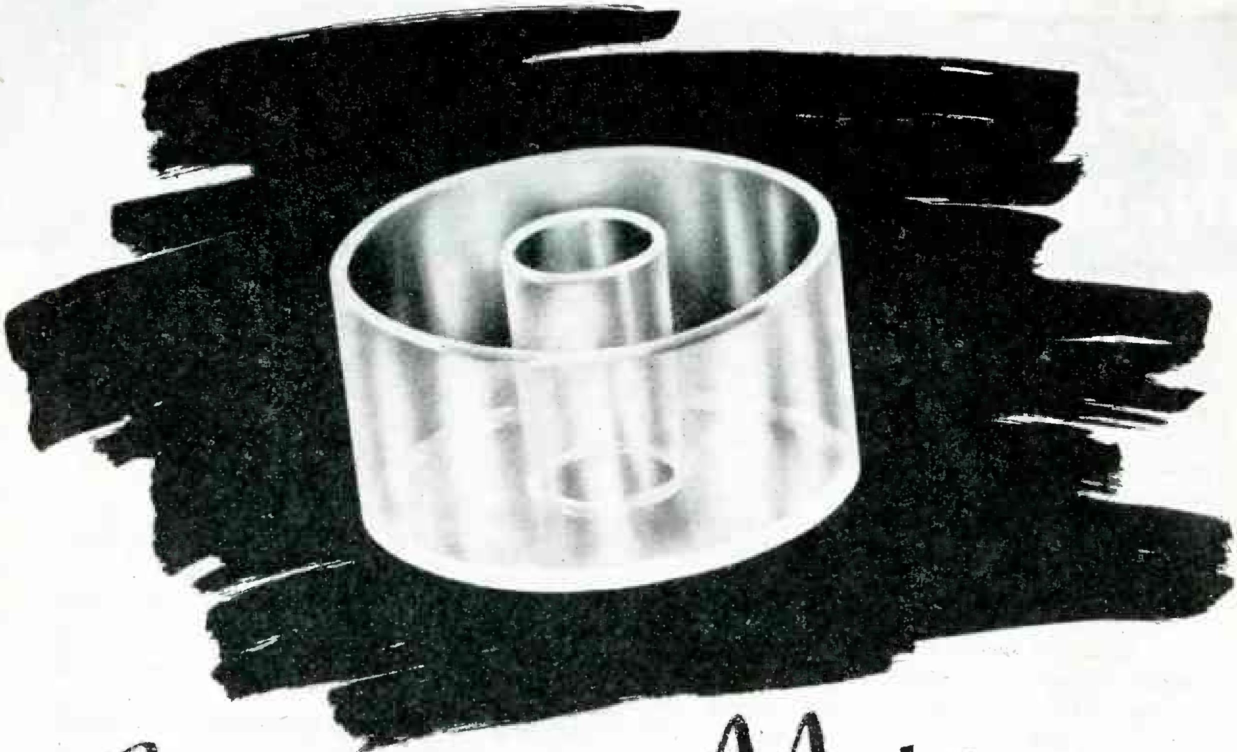
Filament Switching

Since welding current does not flow continuously in the welding line, the filament of the emission-limited tube would be heated only intermittently if some other means were not provided. It is necessary to have the filament of the emission-limited tube already near its normal operating temperature in order to eliminate any appreciable thermal lag which would hinder fast and accurate control at the start of each weld.

The control provides a stand-by source of voltage to excite the filament of Tube 3 when no line current is flowing. This allows the emission-limited tube filament to be preconditioned according to the magnitude of the stand-by source of voltage. At the instant welding current does flow, the filament of Tube 3 is switched from the stand-by source to the voltage supplied by the line-current transformer.

The initial cycle of weld current will have a magnitude determined by the temperature of Tube 3 at the instant prior to the starting of the weld. By controlling and regulating the filament current prior to the start of the weld, the initial cycle of weld current may be made any value desired. By use of the tandem potentiometers P_3 and P_4 and the milliampere meter, the starting current may be easily set. Usually, it is desirable to set the first cycle to be as near as possible to the other cycle that will follow. This can be done to an accuracy of approximately 5 percent.

Since the starting cycle is set



"Water Buffalos" are tough on Tojo!

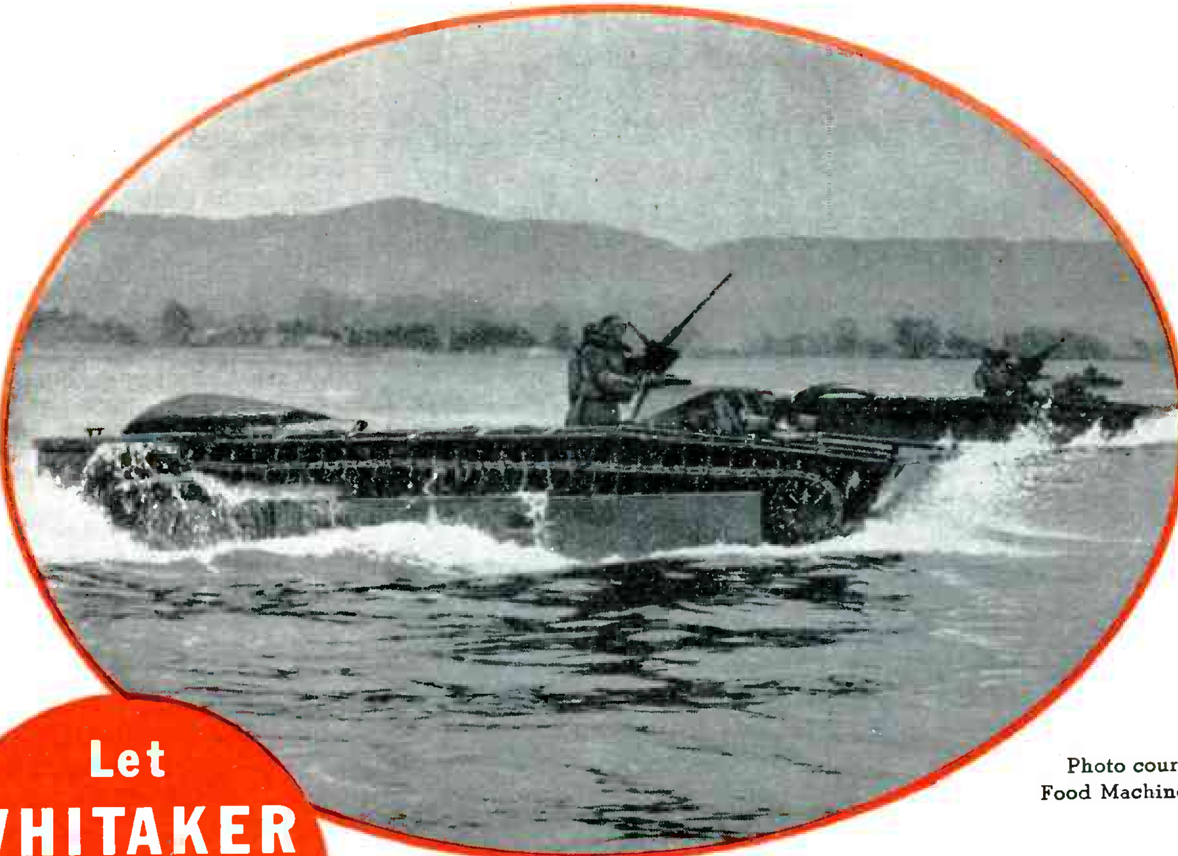


Photo courtesy of
Food Machinery Corp.

Let WHITAKER help you with your wiring problem

Whitaker Can Wire It

Through heavy seas and swirling surf, across scorching sands and through dangerous, dense jungles, Uncle Sam's "Water Buffalos" are carrying our fighting men to Victory.

Now that it can be told, we are proud to report that Whitaker supplies the cable assemblies and wiring harnesses for the LVT "Water Buffalos" built for our government by the Food Machinery Corp.

The above is but one of many ways in which Whitaker works with other manufacturers in the production of war needs. Possessing a background of 24 years' experience in the automotive, electrical and radio fields, Whitaker has the "know-how", skilled manpower, and ample plant facilities for a big volume of wartime and post-war production.

We solicit your inquiries. Please mail a wiring diagram or blueprint of the assembly required...Whitaker Battery Supply Company, Kansas City, Mo., St. Joseph, Mo., Philadelphia, Pa., and Oakland, Cal.

★ WIRING HARNESSES

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WHITAKER

at an arbitrary value to be approximately the same as the following cycles of welding current, it is apparent that should the duration of the welding cycle be made too short, any error in the manual presetting of the starting weld current will become an appreciable part of the total welding heat. For this reason, minimum "on" or weld time of not less than six cycles is recommended. Also, in the switching of the emission-limited tube filament from the current-transformer voltage back to the stand-by source, a small transient is introduced in the control circuit. In order to be sure this transient has completely died away, the minimum "off" or cool time during seam or pulsation welding should be not less than four cycles.

If variations in the welding current occur as a function of line voltage fluctuations, then a more simplified control than the one described here may be used. This type of control, known as a welding voltage-regulating compensator, will maintain the welding current to closer than 3 percent of the nominal current setting for a plus 5 percent to minus 25 percent voltage change. However, if variations in the welding currents occur as a result of impedance or power factor changes, in addition to possible voltage variations, then the current-regulator control described is recommended.

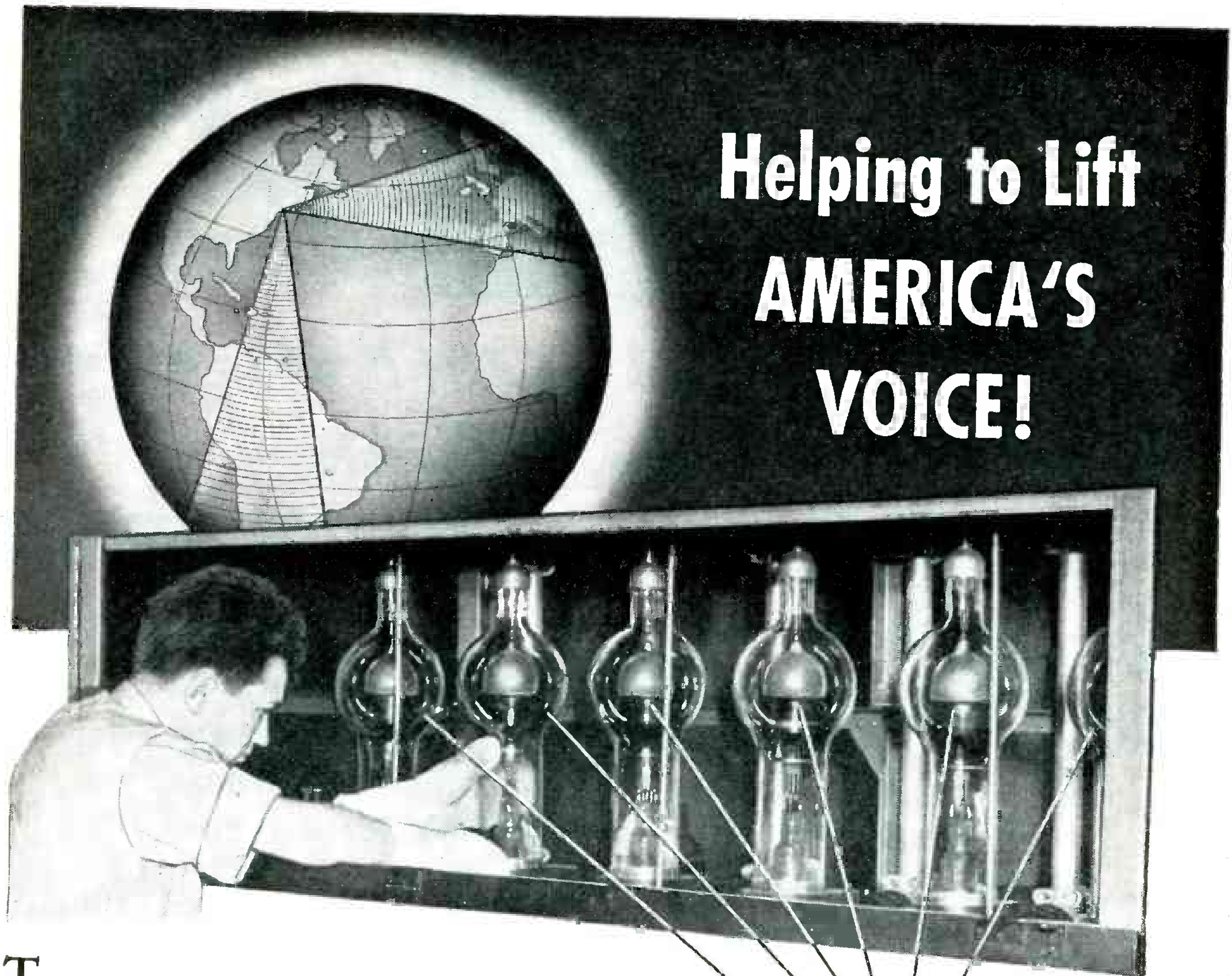
• • •

Electronic Control for Burning Machine

By Dallas A. Miller

The circuit of an electronic control for a burning machine, used in cutting large metal plates for ships, is shown in the diagram. The unit provides an even motor speed both forward and reverse. Where a mechanical governor is used for this purpose there is a variation due to the lag of the governor, and the resultant uneven speed of the motor, although comparatively slight, slows down the burning operation.

The electronic control was applied to a burning machine that runs on tracks and burns off and trims large steel plates, some as thick as $1\frac{1}{2}$ in. and as long as 30 feet. The plate is placed in proper alignment with the machine, the acetylene



TWENTY HOURS A DAY, for some 22,000 hours in three years, one of the six RCA-857B mercury vapor tubes in this main rectifier unit has operated without replacement. The rest of the tubes are nearing that mark. All are equipped with graphite anodes manufactured by National Carbon Company, Inc.

At WRCA-WNBI...N.B.C.'s international short-wave transmitter at Bound Brook, N. J. . . . the rectifier unit supplies 10,000 volts to the modulator and to a 50,000 watt r.-f. power amplifier. The station beams OWI and CIAA programs to Europe and South America on a day and night schedule, helping to lift America's voice where it is important to be heard.

The graphite anodes show no signs of deterioration. That is because the properties of "National" graphite make it ideal for electronic tube elements, adding dependability, power, and life to tubes of both communications and industrial types.

Made to highest standards of purity, "National" graphite elements do not fuse, soften, or warp. With nearly perfect heat radiation properties, they give extremely low operating temperatures per unit area per watt plate dissipation, and reflect minimum heat to the filament. The overall lowering of heat reduces warpage of other tube parts. And graphite itself helps keep the interiors of both vacuum and gas-filled tubes uncontaminated.

National Carbon Company, Inc., for years has furnished graphite for many kinds of electronic apparatus. We welcome the opportunity to discuss with you the advantages of graphite anodes, grids, and other elements for electronic tubes of any type.

The word "National" is a registered trade-mark of National Carbon Company, Inc.

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FLEXIBILITY OF CIRCUITS

one of seven special features described

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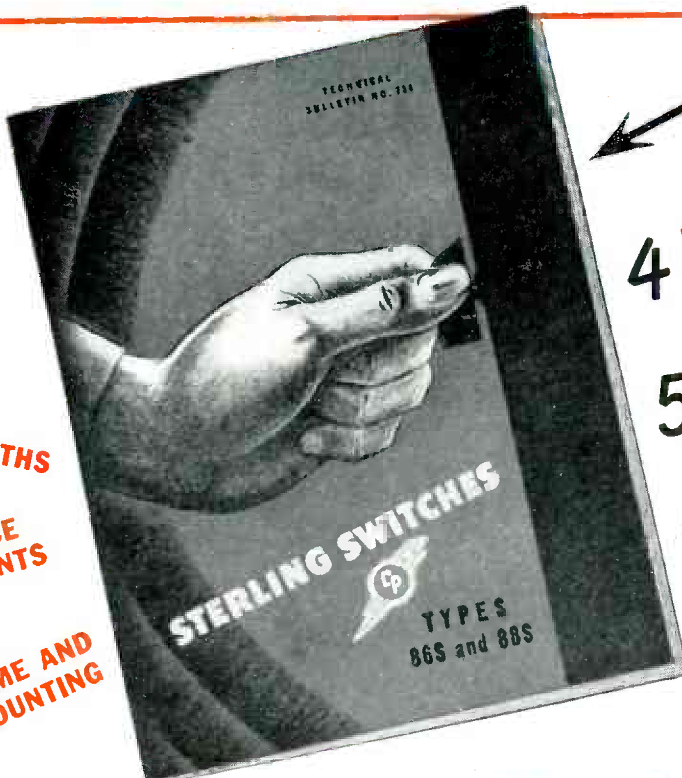

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highlights of New Sterling Switches

Communication Products Company describes in this new booklet the many features of these exceptional switches—developed after careful research and a thorough testing of their performance in the laboratory.

The use of pure silver in the construction of STERLING SWITCHES makes unnecessary the high spring pressures ordinarily required to cut the insulating oxides formed on the base metal contacts commonly used on this type of switch. The reduction in friction thus effected provides great ease of operation in multiple-section assemblies. Careful planning of contact arrangement assures maximum voltage flash-over between all parts of the switch and frame.

Described and illustrated in detail is the design which gives to STERLING SWITCHES a maximum of strength and rigidity with a minimum of weight. Illustrated also is the unusual flexibility in circuit design which is possible with STERLING SWITCHES.

Send for your copy of this informative booklet today.

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Coaxial Transmission Line and Fittings • Sterling Switches • Auto-Dryaire • Antenna and Radiating Systems • Q-Max A-27 Radio Frequency Lacquer

Components of the electronic device added to the burning machine for speed control. The thyratrons supply current to the motor armature while the field is energized by the small receiving-type tube

torches are lit, and the machine moves across the plate, burning as it travels. The torches can be adjusted to any angle to give the proper bevel to the cut. Thus, one side may be cut straight and the other side at a 45-deg angle.

Both sides are cut at the same time, with the torches secured a certain distance apart, to insure a uniform piece of metal. If one side were cut at a time, there would be the chance of bulge of a fraction of an inch in various places due to heat warping the plate. The even cut of the plate is important since the plate must fit the allotted portion of the ship's hull.

With the electronic unit, the variation is eliminated and the speed is so uniform that it is possible to burn 10 in. per minute where before only 5 in. could be burned. In other places where it was usual to burn 13 in. per minute it is now possible to burn 17 in. because the preheat travels at a uniform speed instead of spasmodically. The control can be adjusted to burn from ¼ to 10 in. per minute, and, although designed for the Link Belt burning machine, can be used on any motor-driven equipment such as drill presses, small lathes and the like.

The same electronic system can be used to control the motor speed of a coil winder. A foot pedal is used which is in turn connected to the variable auto transformer to control the speed of winding the coil. This permits the operator to lead the wire evenly onto the various layers; if trouble occurs, he can

If you believe in the future of America as we do, then we're asking for an appointment immediately after the victory has been won . . . when a bright new era awaits us all.

Perhaps we can talk about a coil problem . . . how thoroughly we're organized to help you on such a problem only military censorship forbids telling now. Or it may be that you manufacture your own coils and will be interested in discussing magnet wire—any shape —any insulation that your operations require.

As a matter of fact, perhaps we can get together now, but if it happens we can't, remember we have a date in and for the future. When we both can keep it, you can again take advantage of Anaconda's service and the benefits derived from the single product control "from mine to consumer" backed by years of continuous metallurgical experience.

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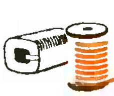
ANACONDA
from mine to consumer

This familiar trade-mark symbolizes the best efforts of modern research and production.



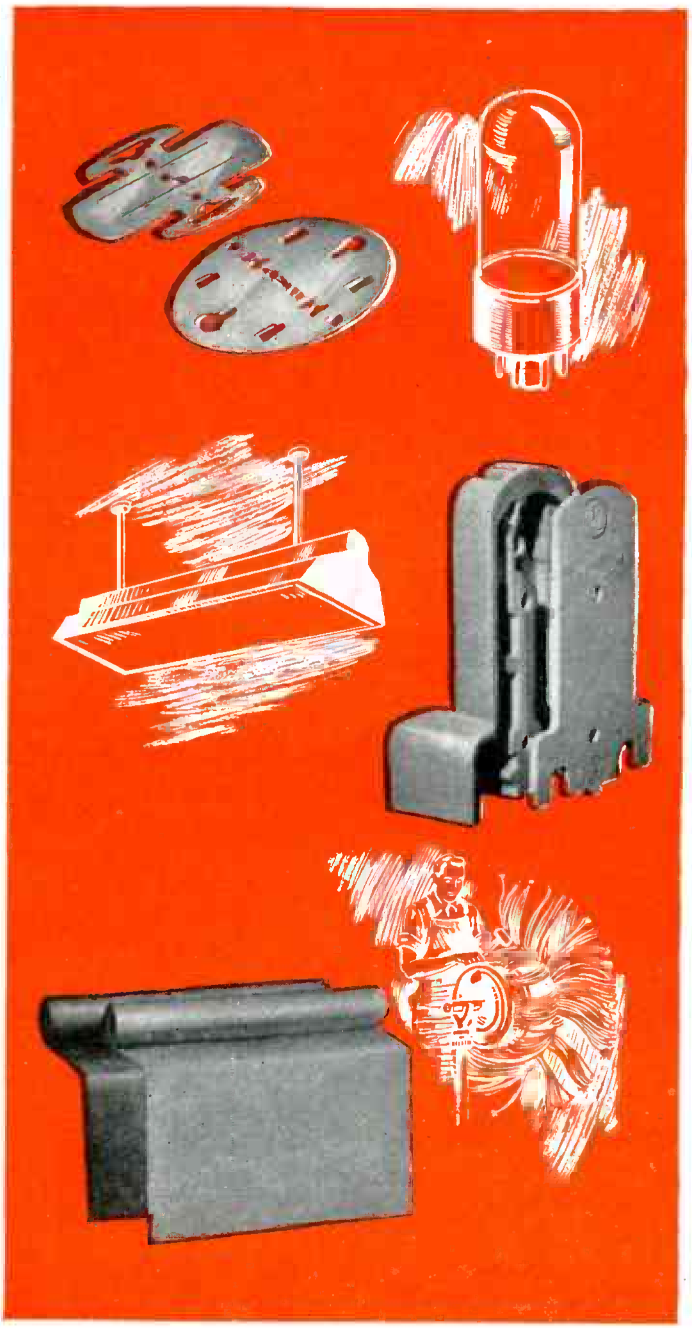
magnet wire and coils

ANACONDA WIRE & CABLE COMPANY

INSULATION FOR THE ENTIRE INDUSTRY

From Generator

Under the aegis of four time-tested trade names, EMPIRE, MICANITE, LAMICOID, and MUNSELL—insulating products made by Mica Insulator Company have proved their dependability and importance as adjuncts to the development of electricity's spreading horizons. Their performance



OTHER APPLICATIONS: Sound and oxygen diaphragms, aircraft magneto and transmitting condenser films, gauge-glass shields, heating appliance elements.

SHEET MICA—

of which our Munsell Division is one of the largest single importers, is extensively used in the field of electronics, where high frequencies often combine with high operating temperatures. As element supports and thermal guards, their use ranges from small receiver to heavy duty transmitting tubes. Supports shown at left are punched to specification by Mica Insulator Company from high-grade Muscovite mica sheets.

OTHER APPLICATIONS: Coil forms, circuit breakers, bus bar insulation, condensers, panels, terminal strips and blocks, controllers, switch gear insulation, etc.

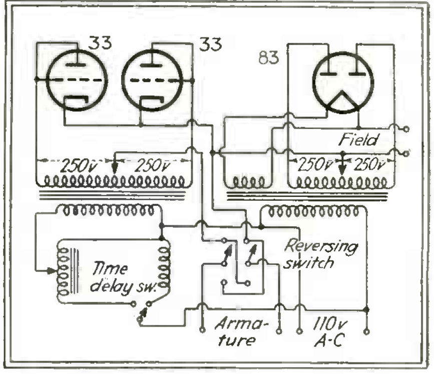
LAMICOID—

A thermo-setting plastic laminate in sheet, rod or tube form, fabricated with a variety of cloth and paper bases. It has uncounted applications for mechanical, electrical, graphic and decorative uses and is readily machined into intricate shapes. Illustrated is a Lamicoid insulating closure for a fluorescent light bracket, one of many new Lamicoid applications where electrical and mechanical strength requirements combine in the manufacturing field.

OTHER APPLICATIONS: Phase separation, slot and end winding, magneto, ignition and instrument coils, padding and banding cushions, armature ends, etc.

EMPIRE—

The most widely accepted name in varnished cloths and tapes marks the products of Mica Insulator Company exclusively. Cambric, canvas, duck, silk, rayon and Fiberglas, impregnated with carefully selected varnishes and varying in thickness from 2 to 40 mils, offer the manufacturer or designer the widest selection of insulating fabrics for coil wrapping and other similar uses.



Circuit of the electronic speed control for a burning machine used in cutting steel plates. A Variac is used to change the voltage applied to the thyratron tubes

immediately stop and make the necessary corrections.

The unit may also be used for controlling the rotation of welding turntables and for testing the coils of a stator to determine the polarity of the poles. This is done by disconnecting the motor leads and connecting the two armature leads to the coils of a 3-phase motor in the customary testing sequence.

• • •

Electronic Radio Range Monitor

A NEW AUTOMATIC radio range monitor for use at airports provides instant warning if any radio course shifts as little as 3 deg from its normal setting, or fades below its normal strength. The monitor may be adjusted to operate all warning devices with a range course shift of less than 1 deg.

The course monitor receiver is located 1200 feet from the radio range station, directly on the radio course, and is connected through a telephone line to an indicator panel in the airport control room. Four receivers are required for all the four radio courses of the standard CAA four-course radio range.

So long as the radio course does not shift, the monitor receiver continuously picks up the interlocking A and N signals transmitted by the range station. If the course shifts, either the A or the N signal begins to predominate, the amount of the course shift being indicated by the comparative difference in strength between the A and the N signals. When this happens, the monitor receiver automatically transmits an electrical impulse to the moni-

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TUBE TEST
EQUIPMENT

RECOGNIZING *HIGHER* MANUFACTURING STANDARDS

In many of America's most vital electron tube plants, where the ideal is the standard—Sherron Tube Test units are standard equipment. Hit-or-miss has no place in these plants. Halfway measures aren't tolerated. Precision means—*precision!* That is why Sherron-engineered test equipment has been selected to provide the highest degree of automatic vigilance necessary to assure and maintain precision production standards.

SHERRON TUBE TEST UNITS MEASURE:

Inter Electrode, Capacitance—Gas Current. Power Output. Trans-conductance. Amplification Factor. Oscillation and Frequency Cut-off. Power Rectifier. Peak Emission. Pulse Tests. Mechanical Impact or Sound Impact. Vibration.

MANUFACTURING PROCESSES:

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CATHODE RAY:

Life Racks—Persistency—Intensity.

Sherron Electronics

SHERRON METALLIC CORPORATION
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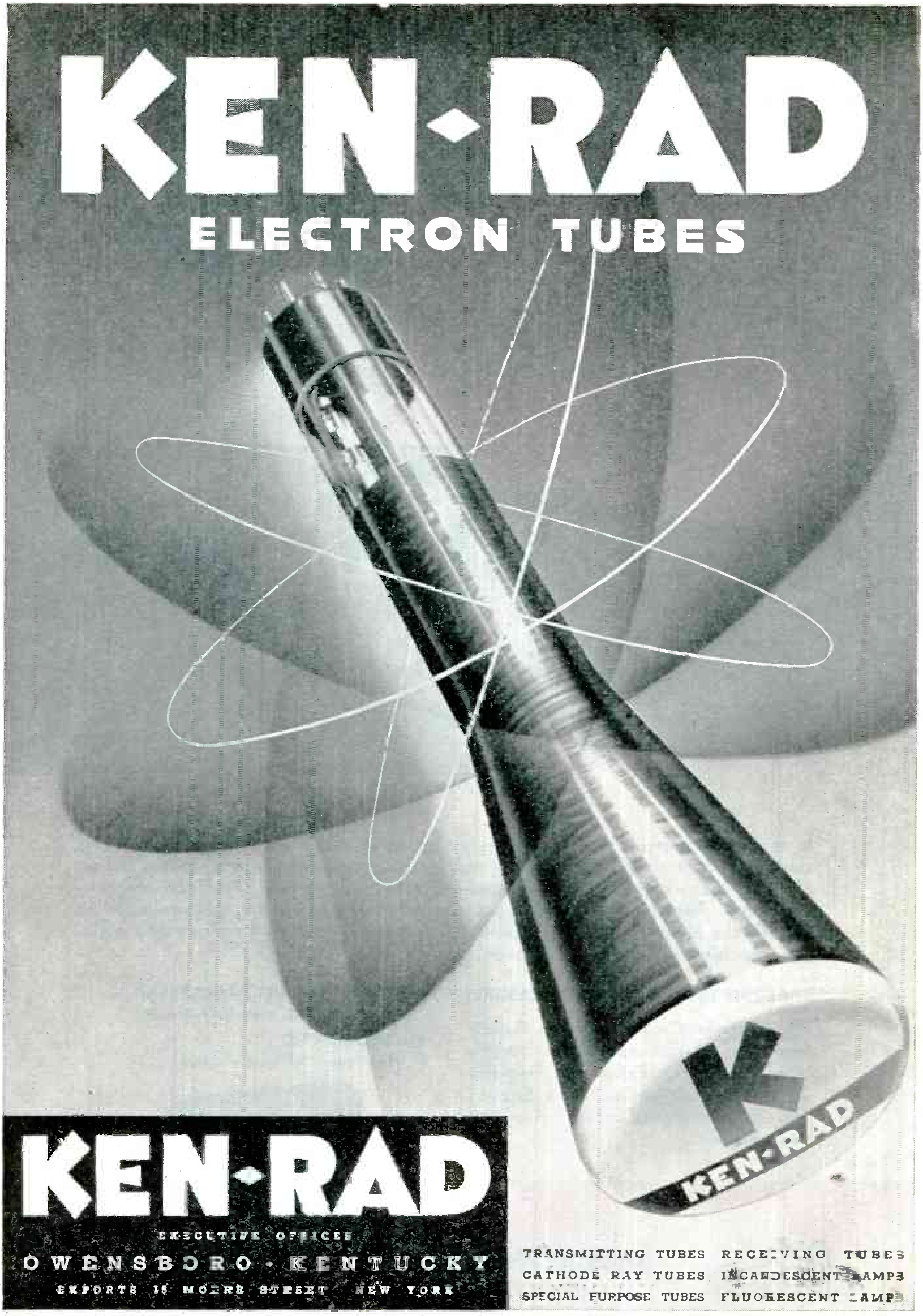
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TURBO

...FOR HIGH FLASH POINT!

SATURATED SLEEVING

VARNISHED TUBING

This TURBO insulation sleeving copes with the wide divergency in operating conditions in present day applications. It embodies all the major essential factors responsible for above-par functional efficiency.

The ability of TURBO Saturated Sleeving and Varnished Oil Tubing, to protect circuits at all times, is corroborated by its great dielectric strength. Extreme resistance to heat is emphasized by its high flash characteristic.

The imperviousness of TURBO insulation tubing to moisture, alkalis, rot, corrosion, oils and acid fumes, assures dependability under all conditions. Inside impregnation and non-projecting properties add to its long, efficient service life, while smooth bore and uniform diameter assure rapid snaking and fishing when installing. Write for free specimen board and list of standard sizes today.

WIRE IDENTIFICATION MARKERS:
● The facilitating of production and assembling operation, with corresponding increases in functional efficiency, are effected with this TURBO insulation product. Available in any size, length or color, these TURBO markers are strictly in accord with Army, Navy and Air Corps

SAMPLE SPECIMEN BOARD: with list of standard sizes
● A request on your company letterhead will promptly bring the special TURBO Specimen Board, with necessary data pertaining to size and color. Our engineers will gladly urnish additional information regarding any of the wide range of TURBO products. You incur no obligation.

FLEXIBLE VARNISHED OIL TUBING:
● This TURBO insulation meets the diversity of requirements necessary to stand up against general break-downs, impairment through moisture absorption, and the general deteriorating influences caused by acids, alkalis, etc.

EXTRUDED TUBING: resistant to sub zero temperatures
● Where the effects of extreme low temperatures are apt to induce insulation embrittlement, TURBO Extruded Tubing is especially suited. Sudden climatic changes, wide fluctuations in temperature, or refrigerant operating conditions will not affect the dependability.

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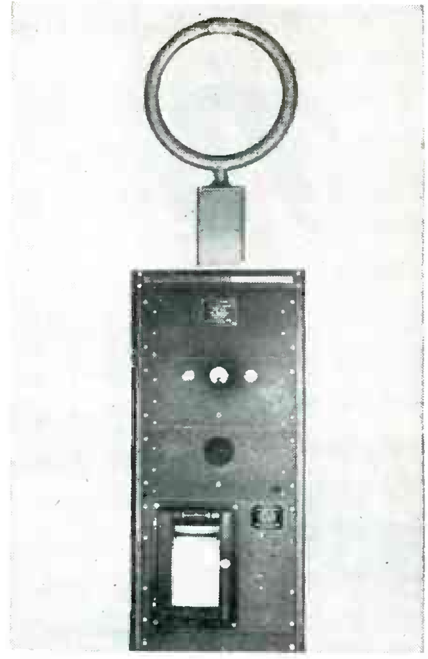

This radio range monitor constantly receives radio range signals and flashes the ground crew if changes occur in the signal. A warning signal is also sent out over the defective beacon to warn pilots

tor board at the airport, which flashes a red light and sounds a siren to warn the ground crew; at the same time, the monitor automatically dials the range transmitter which begins to send out to all pilots a warning signal at the end of each A-N cycle.

The same warning is given by the automatic monitor if the link circuit relay fails to interlock the A and N signals correctly or becomes locked; or if the output of the radio range station drops below a predetermined level; or if more than one-half of the range station identification call is not being transmitted.

Balance Circuit

To measure the comparative strength of the A and N signals, the receiver automatically divides them and feeds them into separate channels. After the two signals have been equally amplified and rectified, the resultant direct currents from the two channels are fed, in opposite phase, to a balanced bridge circuit. Should the course shift, the output of one channel becomes greater, causing the pointer of the indicating instrument on the control board to move, showing how much the course had shifted, and to which side; at the

Always

CENTER  SEALED!

Wire or cable protected by Lexel insulating tape *cannot get out of center*. That's because this unique tape forms a continuous helical tube in which the conductor is automatically and permanently centered and heat-sealed.

This positive centering provides the further advantage of light weight and low bulk because no extra insulation is needed for a margin of safety. Of course, Lexel meets every requirement of high dielectric strength, high insulation resistance, flame retardant qualities and extremely low moisture absorption.

For compact, lightweight installations in low-tension service, such as controls, instruments, lead-in and hookup wires and electronic circuits, Lexel (cellulose acetate butyrate) is an accepted military specification.

Write us for additional information and names of manufacturers who supply Lexel insulated wire and cable.

CUSTOM-MADE INSULATION

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

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

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INDUSTRIAL PRODUCTS DIVISION • CLEVELAND 13, OHIO
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How we make Cathode Ray Tubes

OF UNIFORM QUALITY

AT WARTIME SPEED

This non-stop rotating oven enables North American Philips to produce cathode ray tubes in assembly line quantities despite the complex heat treatment required for uniformly high quality.

In baking out and rendering inert the binders in the "Aquadag" and fluorescent coating on the inner surfaces of the bulb, heat must be gradually raised and as gradually lowered to prevent damaging residual strains in the glass. The oven illustrated, product of North American Philips ingenuity, accomplishes this by rotating slowly racks of bulbs through zones of increasing and decreasing temperatures within the oven from room temperature to 450*C*, then down to 200*C*.

This is but one of the many innovations in engineering and production techniques which assure for NORELCO Cathode Ray Tubes a uniformly high level of performance.

Painstaking concern for perfection and constant striving for improvement characterize *all* the activities of North American Philips in the development and manufacture of NORELCO electronic products.

Various types of cathode ray, transmitting and amplifying tubes are now being produced for our armed forces, together with quartz crystals for land, sea and air-borne communication equipment.

For our war industries we make Searchray (X-Ray) Apparatus for industrial and research applications; X-Ray Diffraction Apparatus; Direct Reading Frequency Meters; Electronic Measuring Instruments; High Frequency Heating Equipment; Tungsten and Molybdenum in many forms; Fine Wire in many metals and various finishes; Diamond Dies.

And For Victory We Say: Buy More War Bonds

Norelco ELECTRONIC PRODUCTS by NORTH AMERICAN PHILIPS COMPANY, INC.

Executive Offices: 100 East 42nd Street, New York 17, New York
Factories in Dobbs Ferry, New York; Mount Vernon, New York (Metalix Division); Lewiston, Maine (Elmet Division)

same time, the warning light and the siren begin to operate.

The course monitor board is located at the airport, and contains a visual indicator to show the radiation strength of the range station; a green light which remains lit so long as the station is transmitting its courses correctly; a red warning light which flashes on if anything goes wrong; a siren with a resetting switch which allows the ground crew to silence it while repairs are being made whereupon it automatically resets itself to sound a new warning; and an Angus-Esterline recorder which automatically traces a complete record of the performance of the radio range station.

Fan Marker Monitor

A similar device is used to safeguard the functioning of airway fan markers that give a pilot a definite position check along the radio range course. Both this and the course monitor are made by Islip Mfg. Corp.

The fan marker monitor receiver is located near the marker, and is connected through a telephone line with a monitor board in the airport control room. If the marker radiation strength, or its percentage of modulation, drops below a certain level, or if the marker identification signal keying becomes faulty, the red light flashes on the monitor board and the sirens are sounded. The fan marker monitor board has all the automatic features of the course monitor board. In addition, a neon light is provided which flashes with the keyed signal to provide visual check on the functioning of the fan marker.

• • •

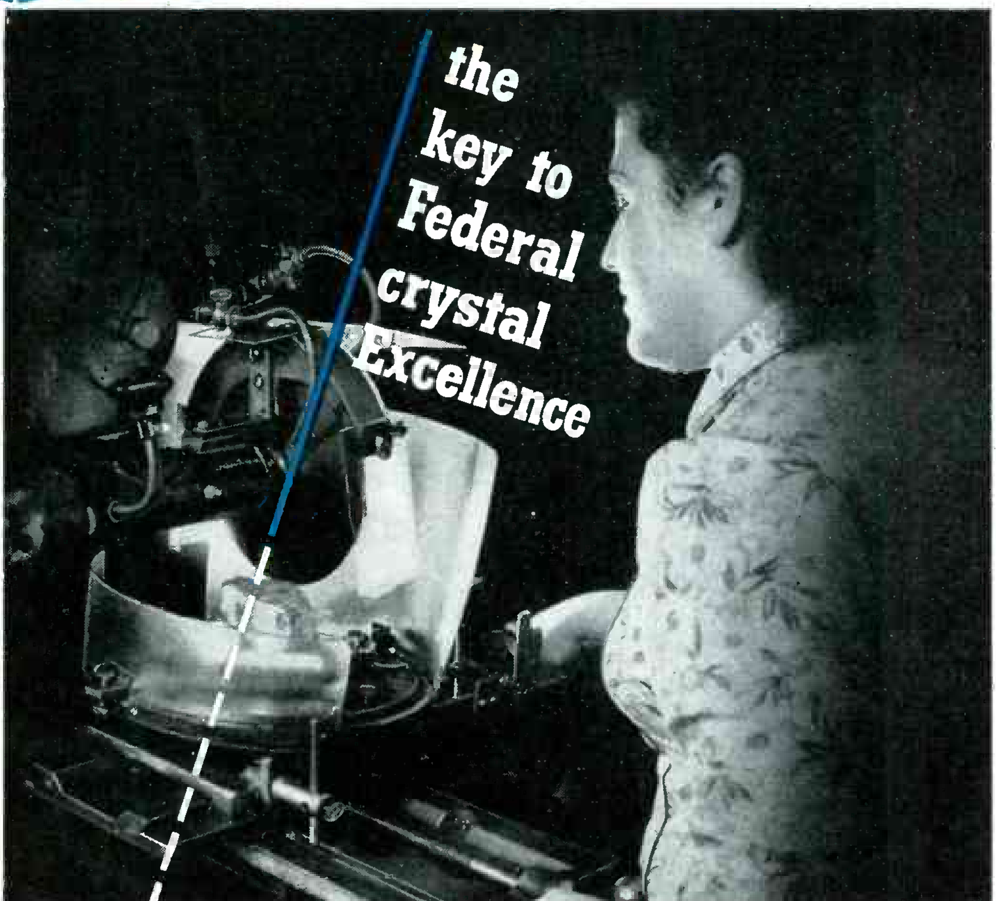
Safety Grounding-Switch System

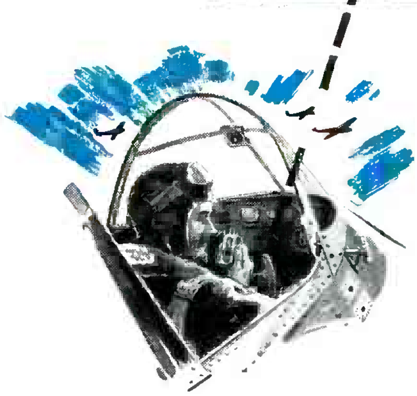
By Joseph Zelle

Transmitter Technician, WABC Columbia Broadcasting System

ACCIDENTAL ELECTROCUTION by a radio transmitter can be avoided by using the circuit shown at *A* in the illustration. In addition to the regular interlock system, interlock switches that close when the door is opened are connected in parallel and made to operate a relay when any door is opened. The relay, operated by the line voltage, shorts the high voltage bus to ground

INSPECTION





★ ★ ★

Federal is a leading manufacturer of aerial navigation, broadcast and general communications equipment. Its outstanding contributions through the years have made the name Federal synonymous with radio development and progress.

Key to the excellence of Federal Crystals is intensive, step-by-step inspection, geared to strict production tolerances.

And behind this painstaking process are world famous engineers, skilled technicians, highly developed precision machinery.

As a result, Federal has earned a reputation for crystals of the highest standard — crystals which are today filling a vital role in wartime radio.

Remember, Federal's comprehensive facilities can fill any crystal need . . . from the lowest frequency bar to the highest oscillator plate.

And with every crystal goes the Federal stamp of approval, an assurance of uniform performance under the most difficult operational conditions.

When it's crystals you want—call Federal.

Federal Telephone and Radio Corporation

AN IT&T ASSOCIATE

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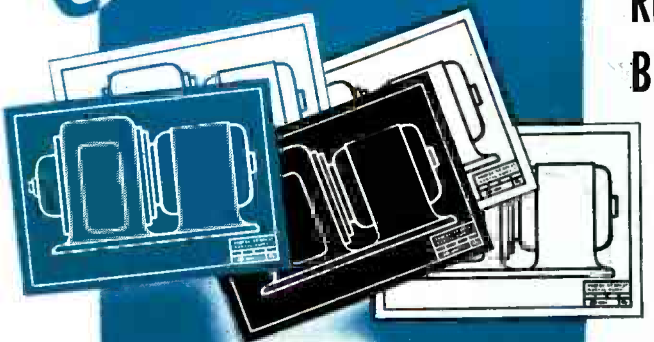
Versatility

. . . MAKE ALL KINDS OF TRACING REPRODUCTIONS WITH PEASE CONTINUOUS BLUEPRINTING-PROCESSING MACHINES



BLUEPRINTS with sharp white lines and dark blue backgrounds . . . also Blueline prints with clear cut dark blue lines on clean white backgrounds are made better and faster, 30 feet per minute with Pease "22" (not shown). What is more, they are made at lower cost . . . as low as one cent (and even less) per square foot of finished prints on Pease Continuous Blueprinting and Processing Machines.

BROWNPRINTS (Negatives) and Brownline prints instead of Blueprints are made on Pease Continuous Blueprinting-Processing Machines by simply using Negative Paper and utilizing the quick change Chemical Applicator System to change from Potash to Hypo. Pease Machines are the only ones, to our knowledge, wherein Hypo is applied to both sides of the paper thus producing superior color. The prints are then dried in the continuous drier.

Pease "K" Continuous Wet Direct Process Developing Attachment for complete Continuous Blueprinting and Processing Machines.

WHITEPRINTS (Dry Direct Process) are efficiently made by exposing Pease Multazo Whiteprint paper, or any other Dry Direct Process paper, in any Pease Printer, after which exposure the prints are developed in a separate, table style, Pease "700" Continuous Multazo Whiteprint (Dry Direct Process) Developing Machine (illustrated at left).

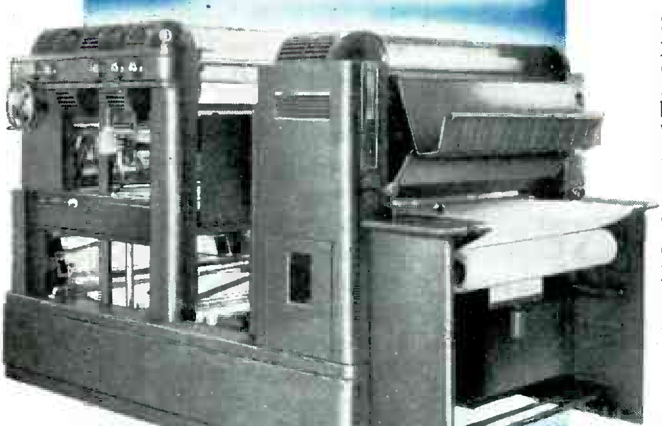
Pease "700" Continuous Whiteprint (Dry Direct Process) Developing Machine only.

WET DIRECT PROCESS PRINTS are made by threading the Wet Direct Process paper through the Printer and the Pease "K" Continuous Wet Direct Process Developing Attachment (illustrated at left), which is firmly bolted to the printer and which consists of a developer tank, tray and rolls. The prints are then carried over the drier, through the wind up device which delivers them at the back of the machine.

PEASE FEATURES . . . Sliding "Vacuum-like" Contact smooths tracings, prevents errors in printing • **Three Speed Lamp Control** provides operation at 10, 15, or 20 amperes, minimizes running speed and drier heat changes • **Actinic "No-Break" Arc Lamps** burn 45 minutes without breaking arc, resume instantaneously • **Horizontal "Floating" Water Wash** floats prints free from tension, prevents wrinkles, stains, bleeding • **Quick Change Chemical Applicator System** economically allows change from Blueprints to Negatives in 30 seconds • **Eight-inch Diameter Drying Drums,** thermostatically controlled, heated by gas or electricity, dry prints "flat as hung wallpaper."

PEASE SENSITIZED PAPERS are completely dependable for superior Blueprints, Blueline Prints, Brownprints (Negatives), Brownline Prints and Multazo Whiteprints (Dry Direct Process). Of course, Papers produced by other manufacturers may also be used satisfactorily.

Write for Literature and Prices . . . No obligation, of course.



Pease "22-46" Continuous Blueprinting and Processing Machine has an actual production speed of 20 feet per minute. Pease "22" (not illustrated) has a speed of 30 feet per minute.

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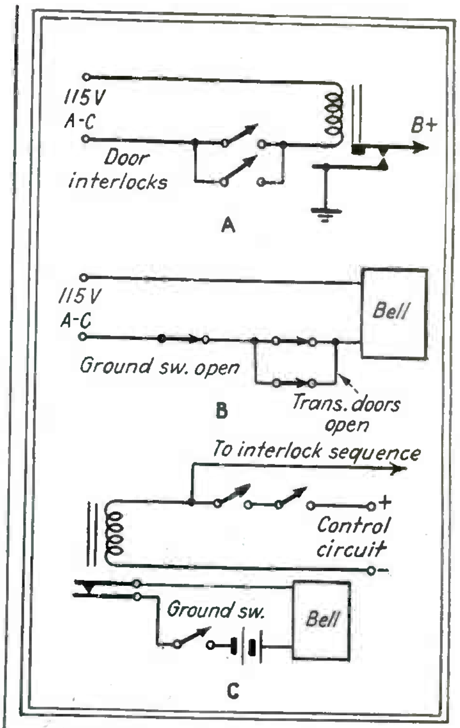
Pease Blueprinting Machines for all kinds of Tracing Reproductions

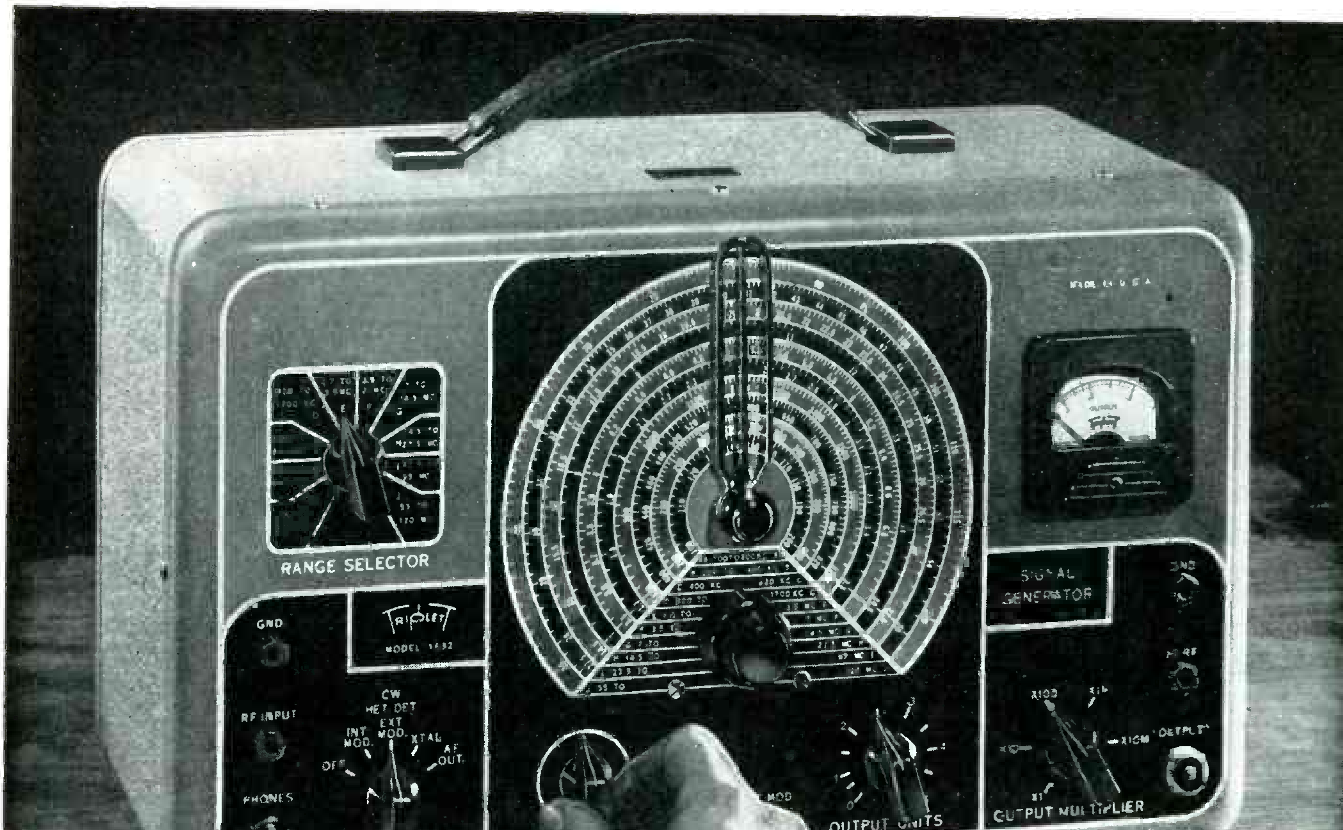


Switching circuits for maximum safety of operating personnel in broadcast stations

whenever any door carrying high voltage is opened. The relay should be one capable of handling the high voltage and care should be taken to mount it where no flashover or breakdown will occur between the relay and the high voltage bus, framework, etc.

A warning system can be rigged up as shown at *B*. Here a second interlock switch is mounted on every door and the parallel switches connected in series with a switch operated by a cam on the grounding switch bar. The secondary door interlock switch closes when the door is opened, while the grounding switch interlock is closed when the ground switch is open. Thus either the transmitter door must be closed or the grounding switch in the ground position, otherwise a circuit is completed which operates a bell, buzzer, repeating chimes, flashing lights, etc. which will "wake up" the operator. Furthermore, the line supply might be replaced by several dry cells, thus assuring operation even with all power cutoff. The dry cells can be stored in a cool place, need no attention and last for months.

A third system is shown at *C* of the figure. This system uses the original door interlocks and the control circuit voltage to operate the relay. It will be noted that the



MODEL NO. 1632

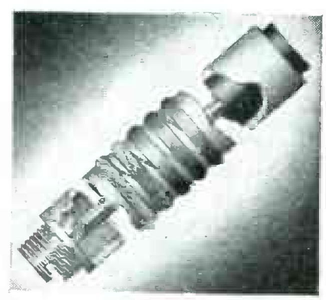
Signal Generator

CONTINUOUS COVERAGE—100 KC. TO 120 MC. • ALL FREQUENCIES FUNDAMENTALS

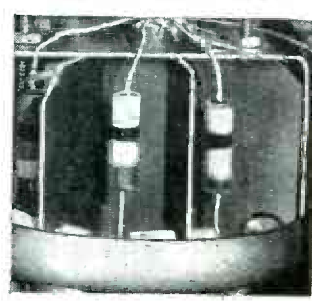
A complete wide-range Signal Generator in keeping with the broader requirements of today's testing. Model 1632 offers accuracy and stability, beyond anything heretofore demanded in the test field, plus the new high frequencies for frequency modulated and television receivers, required for post-war servicing. Top-quality engineering and construction throughout in keeping with the pledge of satisfaction represented by the familiar Triplett trademark.

Of course today's production of this and other models go for war needs, but you will find the complete Triplett line the answer to your problems when you add to your post-war equipment.

• Triple shielding throughout, Steel outer case, steel inner case, plus copper plating.



• All coils permeability tuned. Litz wire wound impregnated against humidity with "high-Q" cement.



• Note sections individually shielded with pure copper. Entire unit encased in aluminum shield.

Triplett

ELECTRICAL STANDARDS ARE SET BY TRIPLETT **INSTRUMENT CO.**

BLUFFTON OHIO ★ ★ ★

NO INSULATING SLEEVING TO BUY—STOCK—or APPLY

AMP

PRE-INSULATED

DIAMOND-GRIP SOLDERLESS TERMINALS

(Fully Protected by Patents Pending)

THE INSULATION IS BONDED TO THE TERMINAL

RED

INSULATION FOR

22-18

BLUE

INSULATION FOR

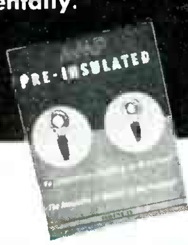
16-14

Perfect solderless connections — designed for mass production — with pre-insulation that saves time, labor, money!

Production cost of applying separate tubing to the terminal approximately the same as the cost of applying the terminal itself to the wire.

Only one operation — just crimp terminal on wire. Nothing else.

The insulation is bonded to the terminal and cannot be removed accidentally.



All the facts! Write today for Bulletin 29 which includes test data.

All of the features of the famous AMP Diamond Grip Insulation Support Terminal. The insulation takes the exact contour of the crimp.

Easy identification: Red insulation on terminals for wire sizes 22 to 18; Blue insulation on terminals for wire sizes 16 to 14. Press dies marked with matching color.

AMP precision power-operated dies make one complete crimping cycle in 28/100 of a second — every crimp is perfect.

"PRECISION ENGINEERING APPLIED TO THE END OF A WIRE"

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AIRCRAFT-MARINE PRODUCTS INC.
AMP
SOLDERLESS WIRING DEVICES

A & M ACCESSORIES, LTD.," TORONTO, ONTARIO, CANADA interlock switches must come directly off the "hot" side of the control circuit so that only the transmitter doors will operate the alarm. The other side of the interlock switches continues normally to complete the control sequence.

Now if the ground switch is up and a door is opened, the relay will be de-energized, the arm will fall back completing a circuit with the back contacts of the relay operating the warning bell, and/or grounding the high voltage. One disadvantage of this circuit is that with control voltage shut off and the high voltage ungrounded (as when closing down) the device will operate. This circuit is better suited to "round the clock" transmitters that are closed down only for maintenance work.

These precautions are simple to install and inexpensive but pay large dividends in saving a human life. At the WABC transmitter on Columbia Island, for instance, the grounding system prevents an operator from opening any high voltage door unless the grounding switch is in the ground position. We have likewise found it important to inspect and check periodically the continuity of the ground switch contacts. A bad contact, a warped relay arm, or bent blade is as bad as no grounding switch at all.

• • •

Electronic Heating and Radio Sondes Discussed by Chicago Engineers

RECENT DEVELOPMENTS in meteorology and weather forecasting by means of air mass analysis make it desirable to know the atmospheric temperature to 1 degree, the relative humidity to 10 percent and the atmospheric pressure to 1 millibar for altitudes up to the stratospheres. In addition, meteorologists would like to know the thickness of cloud formations, the turbulence of the atmosphere, and icing conditions as an aid to aviation. At the present time it is impossible to obtain all of this information although the first three can be obtained to a satisfactory degree of precision by means of radio sondes or balloon-borne radio transmitters. The transmitters are so constructed that the character of the signal

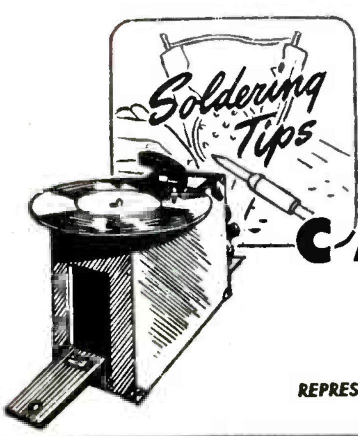
YOUR MAN IN OUR EMPLOY

Cannon Quality Control requires that one man out of every fifteen employees at the Cannon plant be a full time inspector. He's on our pay roll but he's working for you. For it is up to him to see that anything you might reject never leaves our plant.

He's a top bracket man—keen and alert. His kind watches everything that goes on from receiving room, through parts manufacture and assembly up to shipping—farther even, snooping out possible weakness in the field.

He saves you money—not only in inspection but in lower assembly costs, less trouble shooting, repairs and servicing.

NEW TRAINING FILM ON SOLDERING



An important training aid "Soldering Tips," a 25 minute slide film with sound, giving step-by-step procedure in soldering contacts . . . a companion film for "The Quick Disconnect," available on request. Contact your Cannon Representative or write direct to the Factory, Dept. A-120. Cannon Electric Development Company, 3209 Humboldt Street, Los Angeles 31, California.

CANNON ELECTRIC

CANNON ELECTRIC

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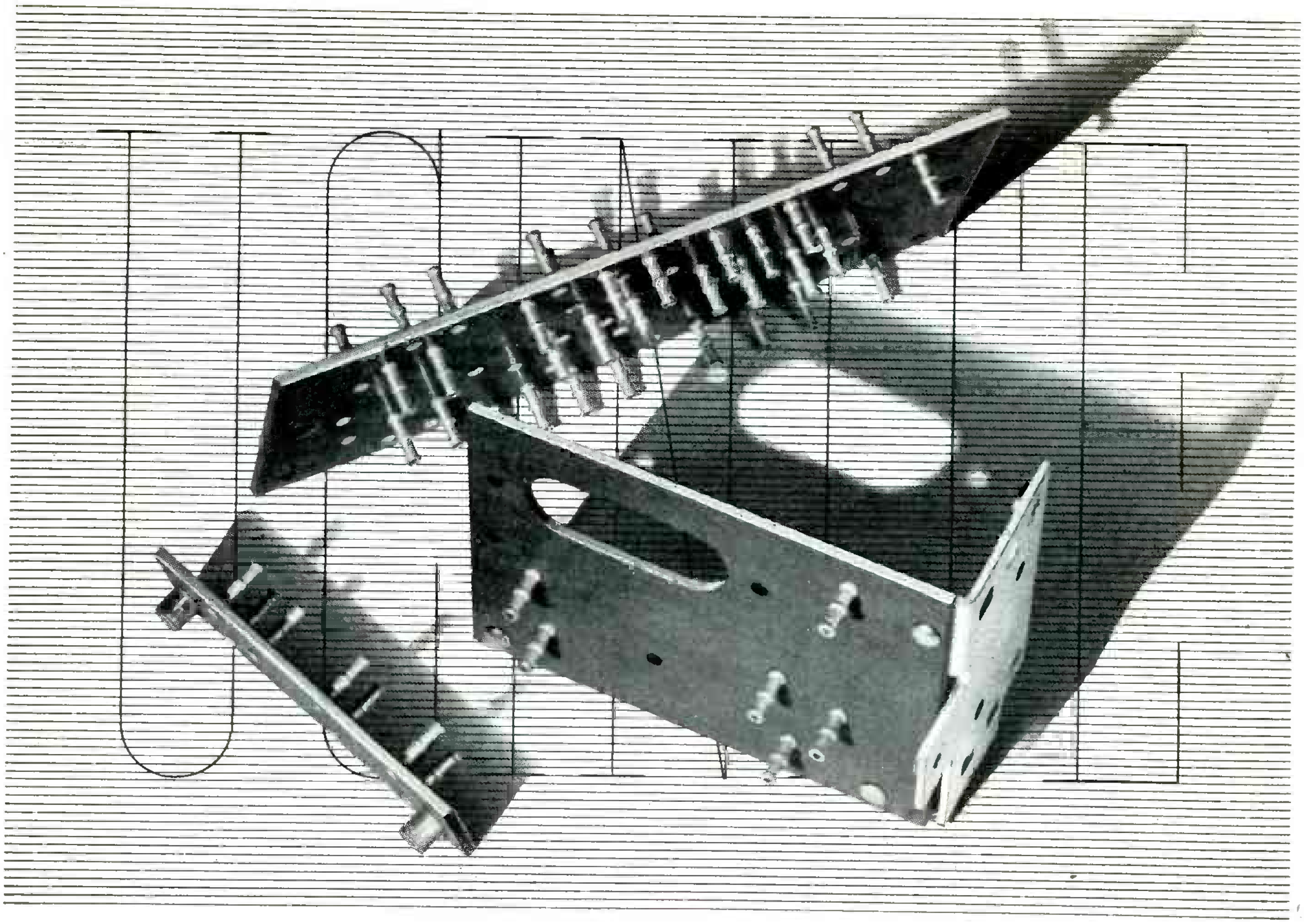
Canadian Factory and Engineering Office: Cannon Electric Co., Ltd., Toronto

REPRESENTATIVES IN PRINCIPAL CITIES — CONSULT YOUR LOCAL TELEPHONE DIRECTORY



Three out of thousands

We are specialists, at Ucinite. But we specialize in variety on certain lines. Laminated bakelite assemblies are an example. We make them in all types, all kinds and all sizes . . . manufacturing the metal pins and brackets, fabricating the bakelite and putting them together as a complete one-shop operation that saves time and cuts corners on every job.

In the course of producing thousands of different assemblies like the above we have developed a designing staff and a manufacturing setup that serve our customers well . . . both new and old.

The UCINITE CO.

Newtonville 60, Mass.

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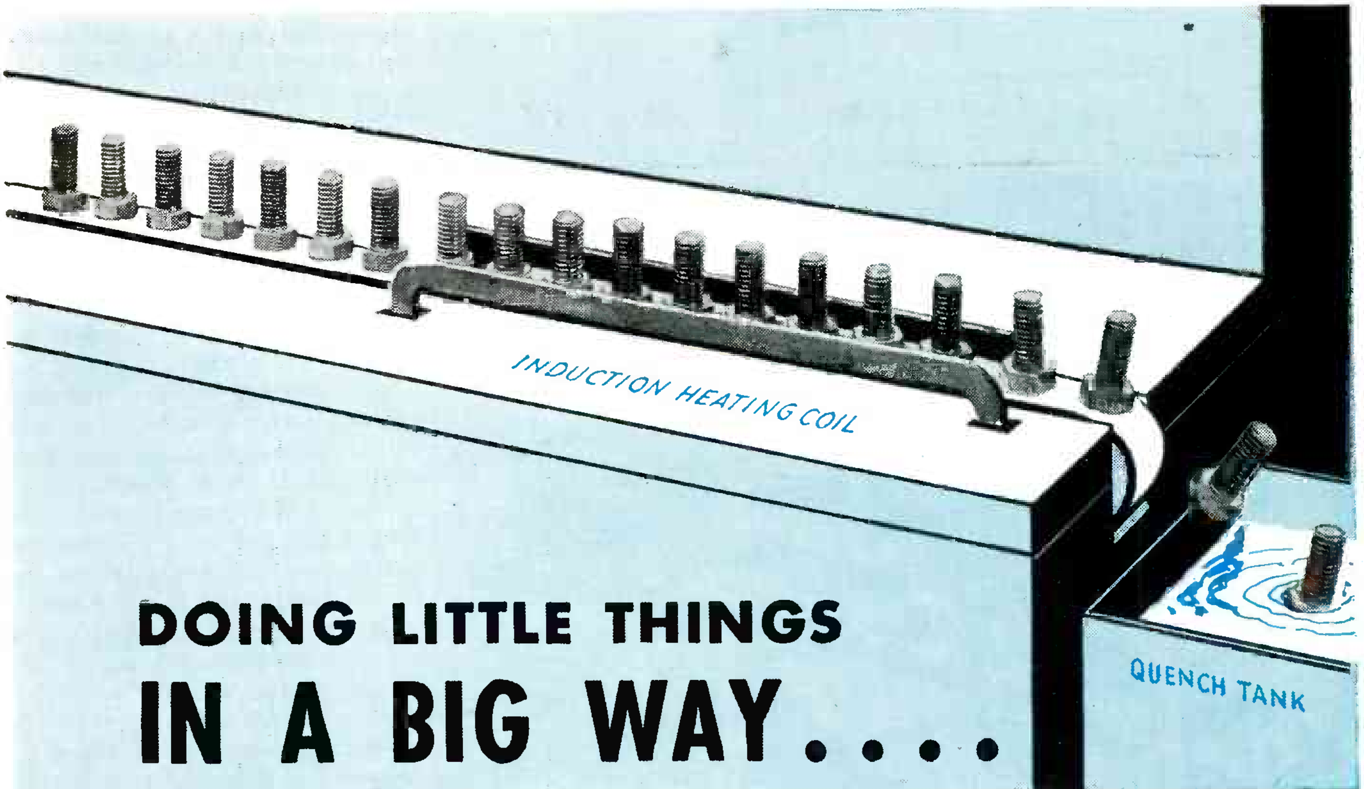
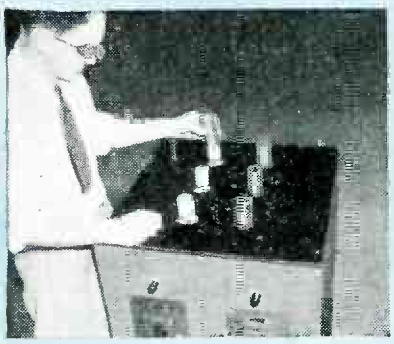
Specialists in **RADIO & ELECTRONICS**
LAMINATED BAKELITE ASSEMBLIES
CERAMIC SOCKETS · BANANA PINS & JACKS · PLUGS · CONNECTORS · ETC.



DOING LITTLE THINGS
IN A BIG WAY....



Six clean, perfect, brazed joints per minute with this unit.

Carbide tool tips are brazed to shanks with better bond by high frequency heating.

WITH ELECTRONIC HEAT

Hardening the heads of screws as they pass on a conveyor through a heating coil is only one way Ajax-Northrup electronic heating can do the little things in a big way on your production lines.

For instance, Ajax-Northrup induction heating has hardened razor blades on the fly, brazed tin cans, and dried welding rod coatings. Big jobs too, such as heating bars for forging 20,000 shells per day.

Or if you work with small-production quantities, you'll need Ajax-Northrup's flexibility. By a simple change of jigs and coils, you can braze 1,000 parts one day, and harden 500 of another part the next day — with the same equipment. Conversion to post-war will be easy.

Call on us for suggestions. Our 25 years of experience and complete lines of carefully engineered high frequency equipment are available from no other source.

63

AJAX-NORTHRUP HIGH-FREQUENCY HEATING MELTING

AJAX ELECTROTHERMIC CORPORATION • Ajax Park TRENTON 5, N. J.

AJAX

ASSOCIATE COMPANIES . . . THE AJAX METAL COMPANY. Non-Ferrous Ingot Metals.
AJAX ELECTRIC FURNACE CORPORATION. Ajax-Wyatt Induction Furnaces.
AJAX ELECTRIC COMPANY, INC. Ajax-Hultgren Salt Bath Furnaces.
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transmitted to the ground receiving station can be interpreted in terms of temperature, atmospheric pressure and humidity.

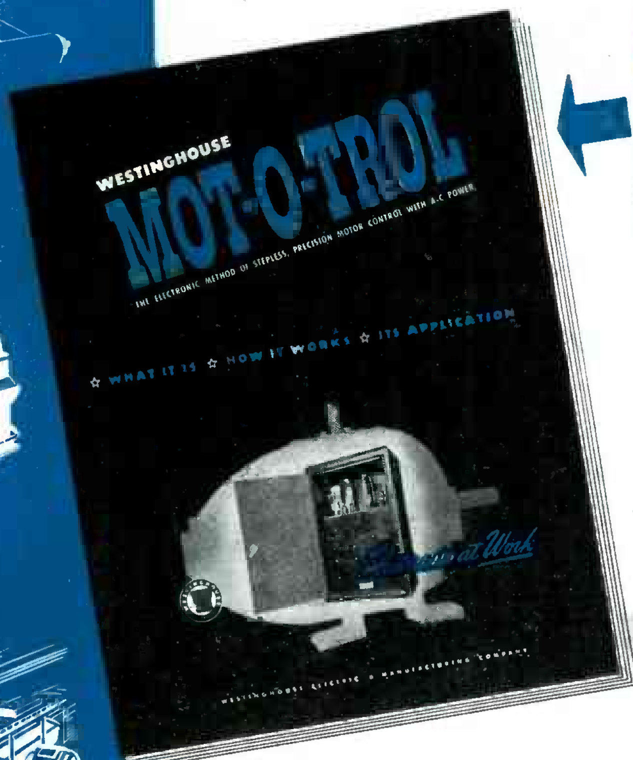
Four types of radio sondes were discussed by V. E. Suomi of the University of Chicago at the February meeting of the Chicago Section of IRE. In the first, mechanical motion, resulting from variations in temperature pressure or humidity, produces a variable-frequency carrier. Another type uses a coded type of transmitter with humidity, temperature, and pressure signals in a prescribed sequence. A third type, similar to the first, makes use of a variable-frequency carrier but employs an improved method of indicating the atmospheric condition. The fourth, most commonly employed in the United States, employs a blocked or modulated oscillator in which the audio-frequency variations are interpreted in terms of meteorological characteristics.

A number of difficulties which are encountered in practice were outlined by Mr. Suomi. While temperature and pressure records can be made quite accurately, considerable difficulty is encountered in recording relative humidity. Especially at lower temperatures, even the concept of relative humidity is somewhat uncertain. Any means for producing or providing a device whose indications in relative humidity are precise and reliable would be a most useful contribution to this technique. It was also shown that the range of radio sondes could be considerably increased by employing frequency modulation in the transmitter rather than amplitude modulation.

Induction Heating

A symposium on electronic heating led by Dr. Eugene Mittelman was the second event on the program. He spoke on the desirability of matching the output of the electronic generator to the load impedance. This problem is particularly important in the electronic heating of ferromagnetic material whose magnetic characteristics change quite rapidly at the Curie temperature (in the neighborhood of about 1400 degrees). At this temperature the permeability of the magnetic material is decreased so that the impedance match which was satisfactory at low tempera-

the answer is in this book



ELECTRONIC

MOTOR CONTROL

How to get Stepless d-c Motor Speeds from an a-c Current Supply

Mot-o-Trol, developed by Westinghouse, employs the precision of electronics to provide a new, wide, *stepless* range of speed control for d-c motors from an a-c current source. It starts motors, brings them up to preset speed smoothly and rapidly. It permits wide change of speed at any time, regulates speed under varying loads, applies dynamic braking for timed stopping—and reverses the motor. Many other functions are also possible. There are no separate linestarters—no field rheostats. To get all the facts about this new packaged motor drive, write today for your copy of booklet B-3301. Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., Dept. 7-N.

J-21306

MOT-O-TROL

Electronics at Work

ture is no longer effective at the higher temperatures. As a result, the load is unable to absorb power at the same rate at elevated temperatures as at lower temperatures.

To overcome this defect, it is necessary to change the impedance-matching conditions when the metal under treatment reaches the Curie temperature. This is accomplished in practice by making use of the change in plate current which occurs in the oscillator tubes as this temperature is reached. This change in plate current operates a pair of relays, one of which temporarily removes plate voltage from the oscillator tubes. The other relay is used to effect the necessary coil switching for the two conditions of impedance matching. After this switch has been made, the first relay can then be used to apply power again. The entire change of switching takes place in about three milliseconds.

Dielectric Heating

Harold R. Weinmuller gave an interesting outline of some of the applications of electronic heating to dielectrics which have been made by the Commonwealth Edison Company.

Infestation in grain is frequently troublesome. By the applications of electronic heating, wheat can be raised to a temperature of 135 deg to effectively destroy bacteria without harming the wheat. Insects can also be killed by this method, even though the products may already be packaged. The use of electronic heating for the killing of bacteria shows considerable promise in the application of fruit and vegetables canned in glass jars as well as for the application in package units.

Electronic heating has been used for a number of years in the gluing of wood products, particularly when thermo-setting plastics are used as the adhesive. A 600-kw electronic heating unit operating at 1.5 megacycles has been used for a number of years in Oregon where it is employed in drying wood. It is capable of heating a stack of wood laminations 14 inches thick, 4 ft wide and 8 ft long.

Electronic methods are also applied to the processing of wood impregnated with plastic. Such wood has high strength, is impervious to moisture, is tough and has high re-

Special Tubes for Special Purposes...

...manufactured with Special Care

DR 300

Especially adapted for High Frequency Bombarders. A rugged tube for rugged service. Used by leading manufacturers for electronic heating of vacuum tubes. 300 Watt capacity.

DR 872A

Medium power Rectifier. 10,000 volt inverse peak. Extensively used for power supplies from 1,000 to 5,000 volt output. Current output . . . 2 tubes . . . 2½ amperes.

DR 17

Grid controlled Rectifier. Combining in its use a high voltage rectifier with a means for varying the rectified DC output continuously from 0 to 5000 volts DC without changing the applied input voltage.

Experienced heads, which among other things, pioneered the graphite anode and carburizing thoriated filament, have joined in this young and virile company to develop and manufacture the finest in vacuum products for electronic applications . . . with no prejudices, no preconceptions, no antiquated equipment or methods to hinder their creative and productive abilities. The tubes shown are modern in design and construction and represent use of the latest knowledge in the electronic field.

GENERAL ELECTRONICS INC.

CHICAGO 47, 1917 NO. SPRINGFIELD AVE. • **101 HAZEL STREET, PATERSON, N. J.** • EXPORT DEPT., 85 BROAD ST. NEW YORK 4, N. Y.

DO YOU NEED D. C. AMPERES?

THIS single unit has an output of 4000 amps. at 6 volts D. C. We also build small laboratory units or large group installations. We will custom build units of any capacity to meet your requirements.

WE engineer and custom build complete RECTIFIER UNITS to meet the needs of any industrial or laboratory application.

Your problem may call for high current, low or medium voltage, or you may need high voltage and low current.

Selenium disc rectifiers will take care of one—Electronic tubes the other. *We have both.*

Each type of rectifier excels for certain work and it is our job to engineer and build equipments to meet *your* particular needs.

May we apply our engineering skill and construction experience to your D.C. needs.

Write L. W. Reinken, Chief Engineer

W. GREEN ELECTRIC COMPANY, INC.

GREEN EXCHANGE BLDG., 130 CEDAR ST., NEW YORK 6, N. Y.

RECTIFIER ENGINEERS

EST. 1892

Motors and generators in all types and sizes from ⅙ H.P. to 3 H.P. single phase, 5 H.P. polyphase. Engineering service on special designs.

THE LELAND ELECTRIC CO.
DAYTON, OHIO

Leland
ELECTRIC MOTORS

sistance to moisture absorption. The curing of rubber and the cooking and dehydration of dry goods are other applications which appear to be promising for electronic heating. Coffee has been roasted by this process but there are indications that the inside of the bean is heated more than the surface, with a resulting change in flavor. The heating of feed corn as well as the heating and drying of table salt (if not too moist) are other applications of electronic heating. Paper cartons, rayon fiber and shredded vegetables have also been dried satisfactorily by electronic means. In foundries, sand cores for molding have also been dried by dielectric heating.

• • •

Lightning Counter

POWER COMPANY ENGINEERS can now record the lightning strokes that hit their lines to compile more accurate statistics on the frequency of the strokes and show the locations where protective devices are needed.

The new lightning counter consists of two strips of metal foil enclosed between two pieces of transparent plastic. A number of teeth are cut in the edge of one strip and the point of each tooth is a few thousandths of an inch from the straight edge of the second strip. When lightning strikes a power line, a small part of the current is sidetracked into the counter and sent into the saw-toothed foil strip. The current must jump from the saw-toothed strip to the straight-

Two strips of metal foil between sheets of plastic form a counter for recording lightning strokes on power lines. Each stroke burns away a toothed section on one foil

For those hard-to-get tubes and parts

He's Your Man!

HE'S only human, so he may not click *every* time —but your local round-the-corner RCA Tube & Equipment Distributor is the nearest thing we know of in the Miracle Man line.

So if you're a manufacturer who uses electron tubes and components, you're missing a real bet if you don't make use of the 4 wartime services he's equipped to offer you today:

1—Local supplies
2—Technical "know how"
3—Quick delivery
4—Intelligent emergency expediting

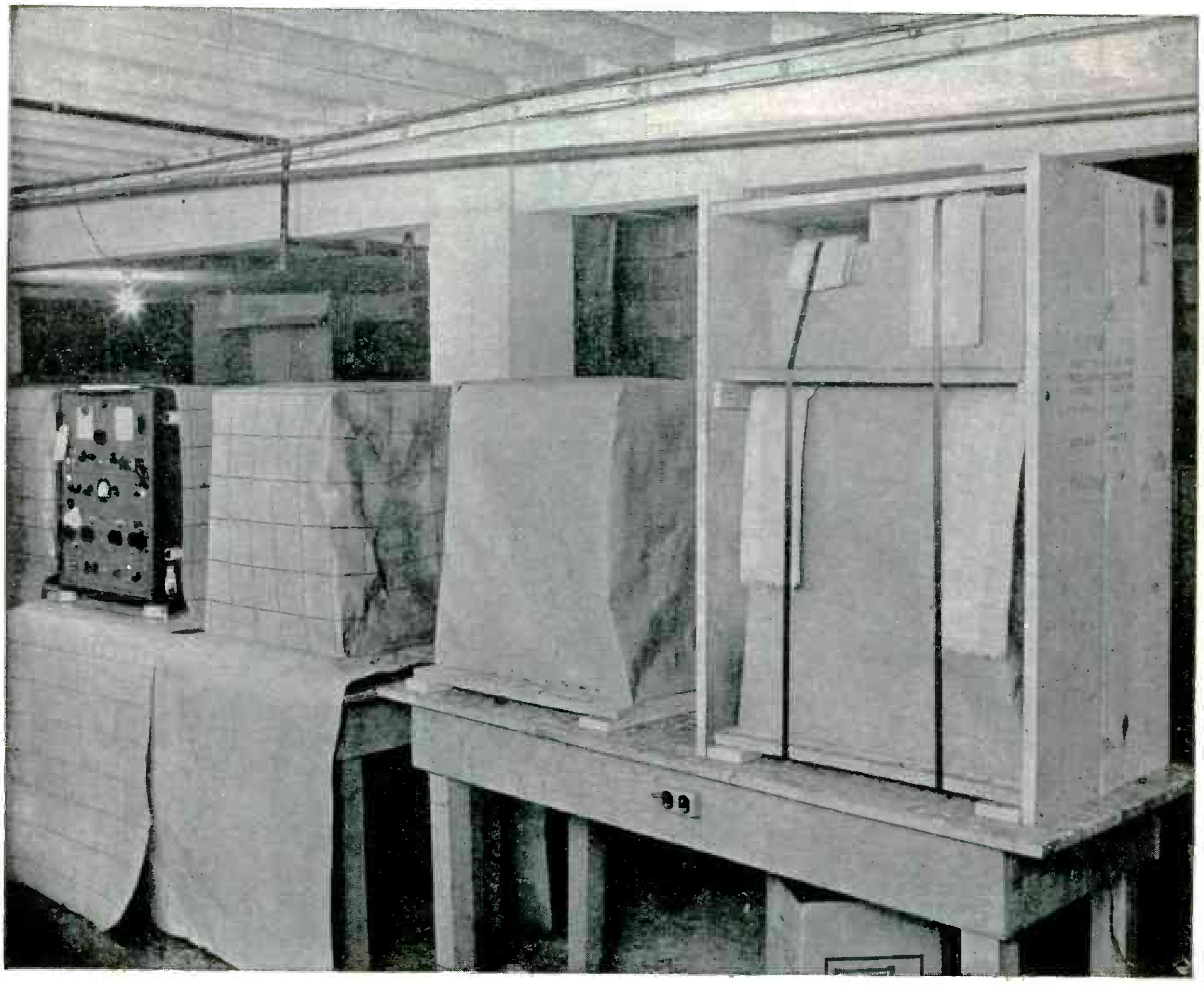
And if he doesn't have right in his own stock the part you need to fill a rush priority order, he'll do his triple-X doggonedest to locate it for you.

He's your man! If you don't know his name, write or wire us and we'll let you know.

RCA

RADIO CORPORATION OF AMERICA

CAMDEN, N. J.



Even the packing is engineered at Techrad

In the production of high quality technical equipment the importance of good engineering cannot be overemphasized. The extent to which Techrad carry engineering activities is not only exemplified by the superior performance of the equipment itself but can be noted even to the method of packing the equipment for shipment to the ultimate user.

You can look to Techrad for many such achievements both large and small for everything they do is important enough to merit the attention of the top engineers. Years of experience, building radio equipment and operating it, experimenting and developing new devices, has taught Techrad the sound value of careful, thorough engineering. For this reason you can depend upon Techrad products and have confidence in the ability of Techrad engineers to help solve your special radio or electronic problem.

TECHRAD

Remember: Master Engineering takes nothing for granted... not even the method for shipping the product.

Technical Radio Company

Over ten years of continuous experience

275 Ninth Street • San Francisco, California

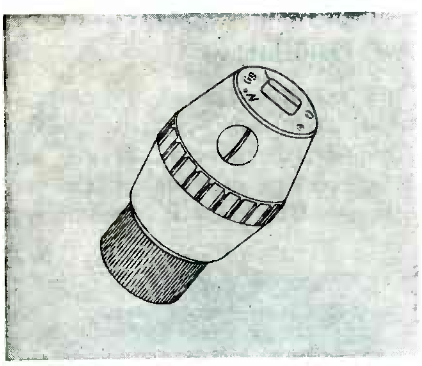
630

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

DESIGN DATA ON PLASTICS

An Interesting Case History FROM THE DUREZ LABORATORIES

The major reason for the popularity of Durez phenolics in the electrical industry is their electrical properties, naturally. Still a second answer may be found in their rather amazing adaptability to the hundred and one problems which confront any designer. For a case in point let's go outside the electrical field.



The designers' prayers for a versatile material were answered

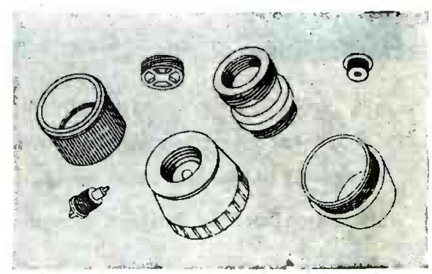
This seven-molded-part grenade and fuse called for some real designing ingenuity. And surely the designers' prayers for a versatile material were answered with the two Durez phenolics used.

The designers had to provide for fast production. Grenades are needed in enormous numbers. The moldability of Durez is a "spark plug" to speedy production. Two methods of molding were used . . . a reminder of the many advances which have been made in the faster molding of phenolics.

The designers had a worry (with a capital W) on their hands when it came to tolerances. There had to be molded-in threads, internal and external, and some very exact fits were obviously needed. Durez was the answer, with its moldability to extremely close measurements.

The designers were also up against severe service requirements. Grenades must work under all conceivable climatic conditions. Specifications were set up for a material with dimensional stability between—40° F and + 170° F (there are Durez materials with heat resistance up to 450° F) and impervious to all kinds of weather. Furthermore, the material must not affect the explosive with which it is in contact. You know why!

These properties were all imparted to the same Durez phenolics which provided the desired moldability.



The designers were up against severe service requirements

All in all, this piece of "bad news for the super-race" gives you an idea of what can be accomplished when designer, material manufacturer and custom molder pool their talents. We welcome your inquiry on all plastic material problems and offer the facilities of one of the Plastics Industry's most experienced technical staffs in helping you work them out. Durez Plastics & Chemicals Inc., 84 Walck Road, North Tonawanda, N. Y.

PLASTICS THAT FIT THE JOB

DUREZ
PHENOLIC MOLDING COMPOUNDS AND RESINS

edged piece of foil to get to the ground and always picks the easiest path—the tooth whose tip is closest to the straight-edged strip. As the current leaps across this gap, it makes a tiny spark which scorches a black spot on the clear plastic and burns away the tip of the tooth, so that the next discharge will choose another tooth.

The counter never makes the error of jotting down two hits for a single thunderbolt because no two of the gaps between the two strips are ever exactly the same. Though the difference in size between two gaps may be smaller than a ten-thousandth of an inch, there is always one path which is the easiest. As soon as the spark occurs, the voltage in the strip drops and another spark will not occur until lightning strikes again.

The device is fastened near the bottom of a power line tower so the black dots burned on it can be counted in a few seconds by a lineman or an engineer. This will enable power companies to keep a record of the number of times each lightning arrester along their lines has operated. The counter was invented by Dr. Leo Finzi, a Westinghouse research engineer.

• • •

Temperature-Compensated A-F Oscillators

THE DIFFICULTIES of obtaining a wide frequency range, freedom from drift, constant output and independence of atmospheric conditions, often make it impossible to

Heater and ventilator controls are recessed in the side of the cabinet on the a-f standard oscillator. The thermometer shows the operating temperature

COIL FORMS OF

Steatite BODY (302)

and *Centradite BODY (400)

An almost endless variety of coil forms (up to 5 inches in diameter) are available processed to your specifications within reasonable tolerances. We are also able to furnish pressed pieces to approximately 6 inches square. • The facilities of Centralab's engineering and laboratory experience are at your disposal.

Write for Bulletin 720

Centralab

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Division of GLOBE-UNION INC., Milwaukee

★ Centradite is especially indicated where Low Thermal Expansion, High Resistance to Heat Shock, Low Porosity and Low Loss Factor are requisites.

PRODUCERS OF VARIABLE RESISTORS • SELECTOR SWITCHES • CERAMIC CAPACITORS, FIXED AND VARIABLE • STEATITE INSULATORS

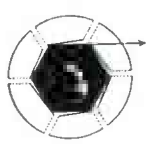
Take a Good Look at THE SCREW

THAT'S "GEARED TO THE KEY"

Bristol Multiple-Spline Socket Set Screws set tighter . . . even in hard-to-reach places . . . without rounding out or breaking.

Where a small screw is called for . . . where vibration will be a problem . . . where the fastening point is at an awkward place — think immediately of the *screw that's built like a gear.*

The Bristo Multiple-Spline Socket Set Screw is specified for aircraft parts, photographic equipment, electrical assemblies, because the multiple-spline design (the teeth in socket are geared to the key) provides much greater strength, permitting more tightening force even on screws as small as No. 4 wire size! The diagram shows why.



Hex: Key exerts *outward* pressure against socket wall; screw will round out or break.

Bristo: Key exerts *inward* pressure; no danger of rounding out or breaking socket wall.

So Bristo Multiple-Spline Screws can be set tight to hold against vibration, yet they can be loosened with a flick of the key! See THOMAS' REGISTER for more facts, list of product applications.

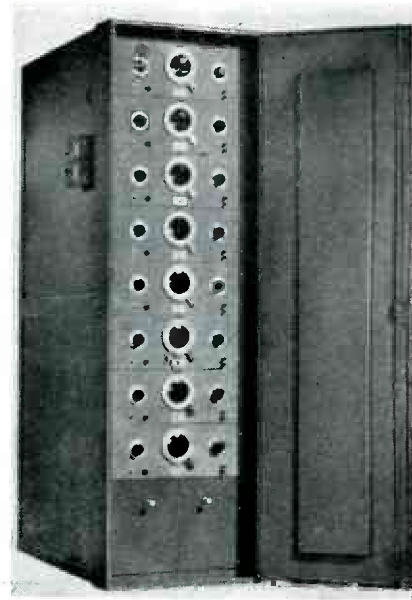
Here's What You Get from the Screw that is Geared to the Key

1. Easier transmission of rotary wrenching power; hence faster assembly.
2. Tight "meshing" with the spline-shaped key; hence no key slippage.
3. No rounding out or breaking socket wall; turning key does not spread the screw.
4. Quick removal — the gear principle acting to release the screw's strong hold.

BRISTO "MULTIPLE-SPLINE" SOCKET SET SCREWS

Geared to the Key — for faster, easier, tighter setting

The BRISTOL Company
MILL SUPPLY DIVISION
154 Bristol Road
Waterbury 91, Conn.



Eight temperature-compensated a-f oscillators in one cabinet provide a convenient source of separate frequencies for production testing of low-frequency units

adapt wide-range audio frequency oscillators to precision measurements. A solution to this problem has been achieved by the Electro Products Labs. of Chicago by providing constant temperature control for an R-C negative feedback type of oscillator.

This type of oscillator can be designed to provide a frequency ratio range of at least 10 to 1 by varying the capacitance of the frequency-determining circuit. Use of an amplifier stage with a considerable amount of feedback provides considerable stability but the oscillator is still subject to frequency variation as a result of changes in temperature.

As a means of overcoming this difficulty, the oscillator has been enclosed in a temperature controlled chamber so designed that operating temperature is always somewhat greater than room temperature.

Eight temperature controlled oscillators have been built up into a single unit for the Thordarson Electric Mfg. Co. of Chicago where it is used to provide eight separate frequencies simultaneously for laboratory and production testing. It is reported that the audio oscillators maintain their frequency precision within one cycle over long periods of time, as determined against a check with a primary frequency standard.

SR-4 STRAIN GAGES

New Types AND New Low Prices

Type	Effective Gage Length Inches	Trim Width Inches	Resistance Ohms Approx.	Gages Per Set	Selling Price Per Gage
A-1	13/16	11/32	120	12 & 50	$0.50
A-3	13/16	11/32	120	10	0.75
A-6	½	9/32	120	10	0.85
A-7	¼	3/16	120	10	~~1.45~~ $1.15
A-8	⅛	¼	120	10	~~1.90~~ 1.50
A-9	6	5/16	300	5	0.95
A-11	1-1/16	¼	120	50	0.50
A-12	1	⅛	120	10	1.20
A-13	⅜	5/16	350	10	~~2.30~~ 1.70
A-14	⅜	5/16	500	10	~~2.45~~ 1.80
AB-1	15/16	⅜	350	5	~~2.60~~ 1.85
AB-5	½	3/16	75	5	~~2.50~~ 1.75
AB-7	¼	3/16	120	5	~~3.00~~ 2.20
AB-11	⅛	¼	120	5	~~3.50~~ 2.80
C-1	1-1/16	9/32	500	10	0.70
C-5	½	5/16	350	10	1.05
C-7	¼	3/16	500	10	~~2.10~~ 1.65
C-8	⅛	⅜	500	10	~~2.50~~ 2.00
C-10	⅜	5/16	1000	10	~~2.20~~ 1.85
C-11	⅛	0.3	500	10	~~2.60~~ 2.10
C-14	⅜	½	2000	10	~~2.95~~ 2.35
CB-1	15/16	⅜	1000	5	~~2.90~~ 2.30
CB-5	½	3/16	200	5	~~2.90~~ 2.15
CB-7	¼	3/16	500	5	~~3.25~~ 2.4[illegible]
CB-8	⅛	⅜	500	5	~~3.50~~ 2.60
CB-10	5/16	⅜	1000	5	~~3.70~~ 2.75
CB-11	⅛	¼	350	5	~~3.85~~ 3.05
AR-1	13/16	Y Rosette	120	5	1.50
CR-1	1-1/16	Y Rosette	500	5	2.40
AR-3	13/16	T Δ Rosette	120	5	2.45
AR-4	13/16	▲ Rosette	120	5	1.70
CR-4	1-1/16	▲ Rosette	500	5	2.50

MINIMUM ORDER—$10.00 F.O.B. POINT—EDDYSTONE, PA.

Other gages in special types and sizes are available. Data on request. Dimensions are stable but subject to change without notice. Prices subject to change without notice. Write for Bulletin 175.

The Baldwin Locomotive Works, Baldwin Southwark Division, Philadelphia, Penna., U. S. A. Offices: Philadelphia, New York, Chicago, Washington, Boston, Cleveland, St. Louis, San Francisco, Houston.

THE BALDWIN GROUP

BALDWIN SOUTHWARK TESTING EQUIPMENT

SECO OFFERS

ALL THESE FEATURES . . .

HIGH EFFICIENCY

LOW COST PER KVA

LOW EXCITING CURRENT

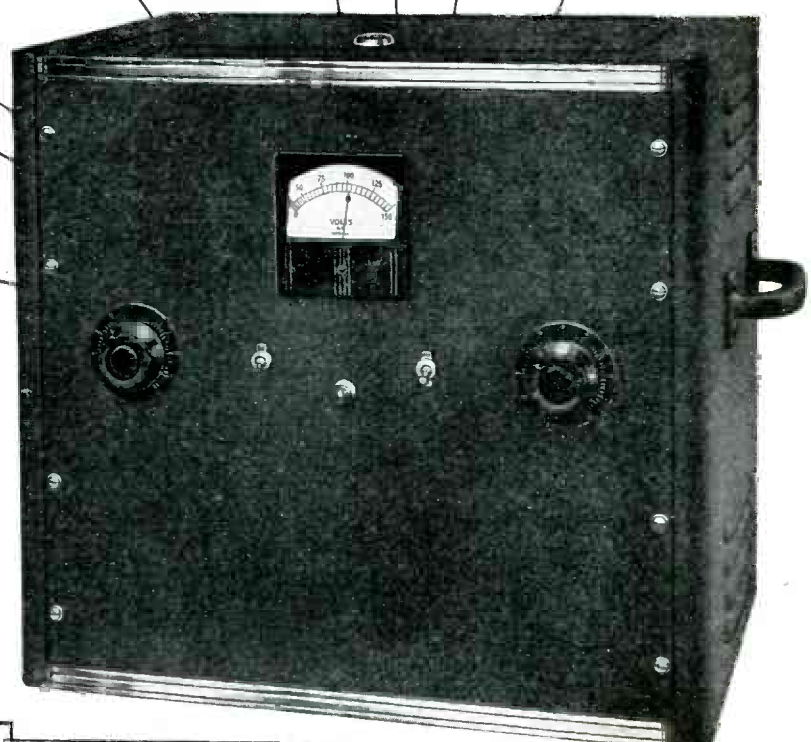
ZERO WAVE FORM DISTORTION

OUTPUT VOLTAGE AND SENSITIVITY ADJUSTABLE OVER WIDE RANGE

NO INTERNAL MECHANICAL ADJUSTMENTS

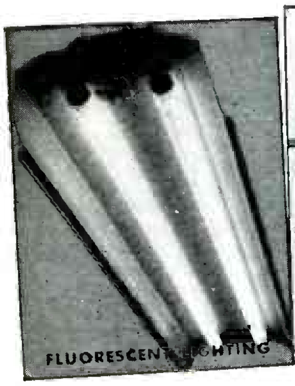
NOT AFFECTED BY LOAD OR POWER FACTOR

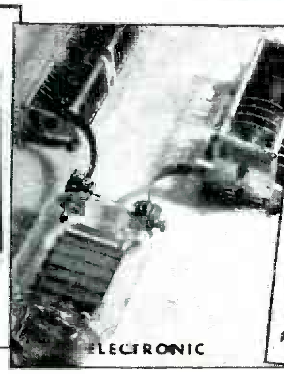
CORRECTS A WIDE RANGE OF INPUT VOLTAGES



WITH . . . SECO AUTOMATIC VOLTAGE REGULATOR — the electronic controller of A-C power lines — maintaining a constant output voltage with variations in input voltage and output load current.

FOR THESE APPLICATIONS





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149 LE
and
163 LE

SUPERIOR ELECTRIC CO., 203 LAUREL ST., BRISTOL, CONN.

SUPERIOR *Electric Company*

IT WILL SOON BE ANOTHER DAY

The lush days of "Cost Plus" that have placed so little emphasis on production economy will disappear when "C-Day" arrives. Conversion to civilian goods will again place a premium on efficiency that springs from a cost "know-how." But cost-sensitive production comes only of long experience. It is not born of wartime . . . it is a stranger to war production.

Peace-time manufacture survives only as it demonstrates the principles of profit-and-loss accounting. There is no room for carelessness, or laxity, or indifference to costs.

Lewyt is *not* a war baby. Lewyt is a "manufacturer's manufacturer" with 56 years of cost-conscious "know-how". It returns to peace-time contract manufacturing with long experience in meeting the needs of production engineers who will have only costs and efficiency in mind.

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USE A MANUFACTURER'S MANUFACTURER . . . . .

● *One Contract—One Responsibility—One Cost*

Lewyt's business is Contract Manufacturing. We specialize in electric and electronic instruments, chassis and housings; mechanical and electrical assemblies; highest precision machine work; sheet metal fabrications; all types of welding, product finishing, etc.

We also provide advanced engineering facilities as service assistance to our clients in connection with the design and re-design of their products under development.

Write on your business stationery for 48-page book, "Let Lewyt Do It" . . . the story of the Lewyt Organization told in pictures.

LET LEWYT DO IT

BUY MORE WAR BONDS

Railroad Radio

(*Continued from page* 95)

radio repeater equipment with associated antennas which provide considerable directivity and reinforcement of signals at various points along extended railway routes.

In this regard, it should be stressed that the problems involved in the design of radio equipment for use by the railroad industry differ considerably from those associated with the development of radio apparatus employed in other forms of transport communications. Not only must such equipment meet the specific technical and operational requirements of railroad service, but the installation of equipment on locomotives must comply with the safety requirements of the Interstate Commerce Commission.

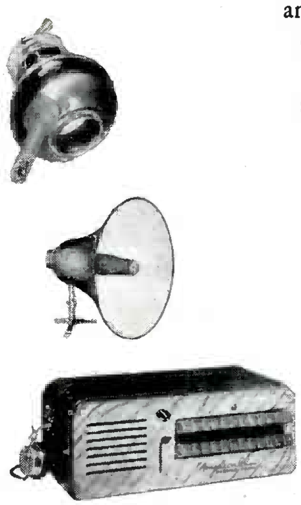
Special Equipment Needed

It is believed by radio engineers intimately acquainted with railroad problems that no simple adaptation of present-day, two-way automobile or military radio equipment will meet satisfactorily the various requirements of the railways. Equipment must stand the violent shock and multi-directional vibration peculiar to locomotive operation. Apparatus must be housed and constructed in such manner as to withstand the effects of smoke and corrosive gases emanating from steam locomotives. The equipment must also be mounted and housed in such manner as to be replaceable with maximum speed in order to avoid delaying the scheduled operations of locomotives in the event of failure of radio components. Further, the electrical design of the equipment must be such that it will operate on existing power-supply sources employed on various types of locomotives. Inasmuch as primary power supply voltages on different locomotives normally range from 32 to 110 volts d.c., radio equipment must be adaptable for use over a wide range of operating voltages.

In considering the problems related to shock-mounting and design of transmitters and receivers for

Birthplace of Electroneering*

In this ever-widening field of Electronics, *specialization* is the modern keynote. Early recognition of that fact is the reason behind the RAULAND growth and reputation for advanced electronic ideas and high quality products. For RAULAND is an organization of experienced, electronic engineering specialists . . . men, devoted to custom-engineered tasks, who have produced such notable examples as *High Powered Cathode Ray Tubes, Frequency Standards, Transmitting Type Tuning Condensers, Two-Way Radio* and *Intercommunicating* and *Sound Control Units* for Industry. All of these precision, electronic instruments are busily at work now in our war and industrial effort, as they will one day serve industry and the home.



* *Electroneering*—the RAULAND term for engineering vision, design and precision manufacture.

RADIO... SOUND... **Rauland** ...COMMUNICATIONS

Electroneering is our business

THE RAULAND CORPORATION . . . CHICAGO, ILLINOIS

Buy War Bonds and Stamps! Rauland employees are still investing 10% of their salaries in War Bonds

PERMANENT MAGNETS MAY DO IT BETTER

U. S. Signal Corps Photo

Engineered Savings!

Shortly after Pearl Harbor, our engineers recommended changes in the permanent magnets used in the GN-38 generator of the Signal Corps' field telephone, because the material then employed contained a high percentage of cobalt, the supply of which was limited.

Our engineers designed a new permanent magnet which exceeded specifications, yet has resulted in savings of more than:

- **150,000 pounds of cobalt**
- **140,000 pounds of other critical materials**
- **½-pound in weight per generator**
- **25,000 man-hours**
- **$1,000,000 in cost**

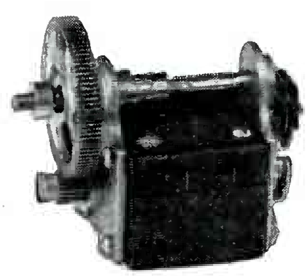


Photo Courtesy Kellogg Switchboard & Supply Co.

These savings are typical of the many benefits which have been realized through modern permanent magnet engineering. Because of our 34 years of specialized experience in this one particular field, our organization has played a leading role in designing and manufacturing permanent magnets for ever-increasing numbers of electrical and electronic devices for land, sea and air warfare.

This unusual experience should prove valuable to you in solving your engineering problems . . . and our engineers will be pleased to consult with you. Write us, on your letterhead, for the address of our office nearest you and a copy of our "Permanent Magnet Manual".

Help Win the War in '44—Buy War Bonds!

The

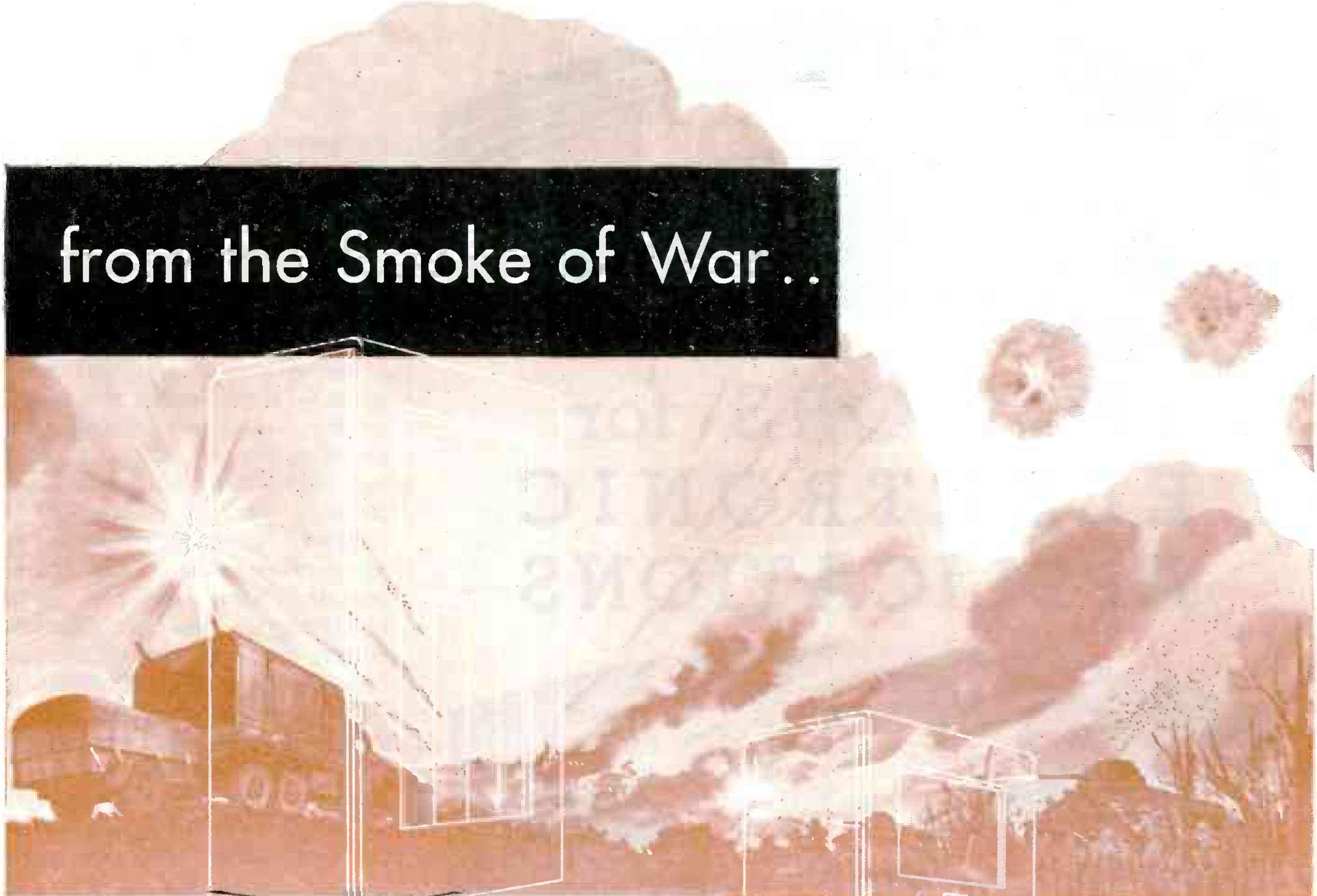
INDIANA STEEL PRODUCTS

Company

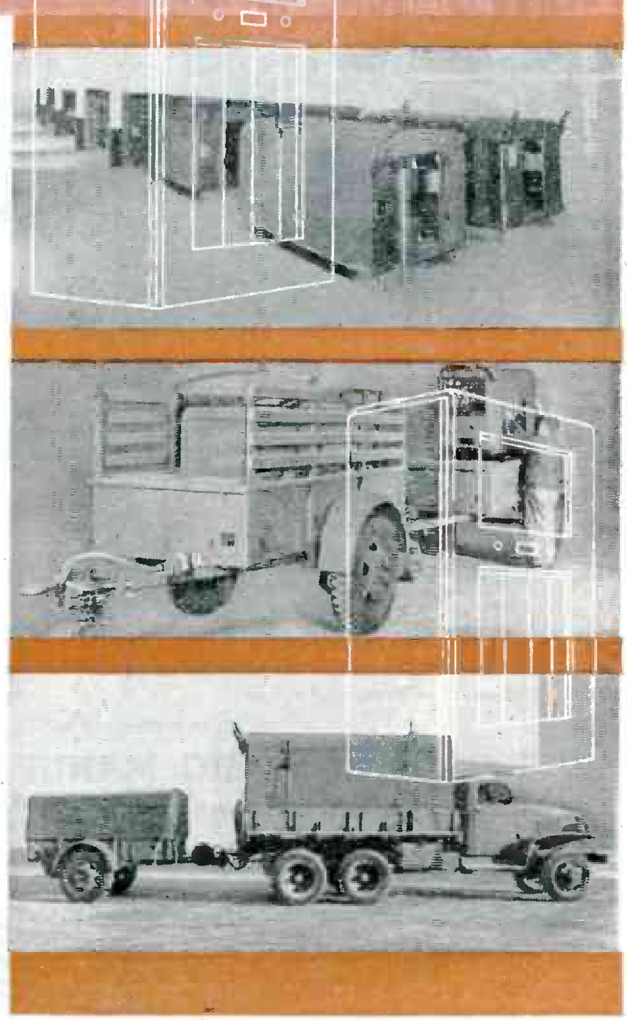
★ SPECIALISTS IN PERMANENT MAGNETS SINCE 1910 ★

6 NORTH MICHIGAN AVENUE • CHICAGO 2, ILLINOIS

from the Smoke of War..



finer Radios for Peace



War's demands for better weapons have added mightily to the progress of radio. Here at Detrola we are in the forefront of it. Detrola engineers are giving their knowledge and experience to the perfection of new and finer electronic equipment. Detrola production workers are learning and employing new short cuts in the mass manufacture of quality products. Our work today is providing us with ideas for a great variety of postwar radio-electronic devices . . . and new ability to translate them into products of finest quality. *Every War Bond You Buy Helps Bring Victory Closer. Buy Another Today.*

DETROLA RADIO

DIVISION OF INTERNATIONAL DETROLA CORPORATION • BEARD AT CHATFIELD, DETROIT 9, MICH.

C. RUSSELL FELDMANN dr PRESIDENT

railway use, it may be pointed out that the war has educated many radio manufacturers in the matter of building rugged and shockproof equipment, while many improved types of tubes, power-supply units and other component parts, possessing the necessary durability for sustained railroad use, have been developed.

In summarizing the state of the new railway communications art, it is encouraging to note that the accelerated technological progress resulting from war research, the practical benefits afforded by the use of railway radio communications in ordnance plants, and the improved financial condition and progressive spirit of the railroad industry have combined fortuitously at this time and should facilitate rapid growth of this new field. On the continued cooperation of the railroads, unions, governmental agencies and groups in the radio field is required in order to create an important postwar industry which will provide new services and employment opportunities for many men and women.

• • •

ELECTRONICS AT KISKA

An electronic megaphone in use by American-Canadian forces while advancing inland during the occupation of Kiska. The equipment consists of a University IB-8 reflex speaker, fed by a Bogen amplifier and American microphone. Official U.S. Navy photograph

NOW

For

HIGH TEMPERATURE APPLICATIONS

"HI-STRESS"* *Speed Nuts*

[PATENTED]

A6103H-1032
CONFORMS TO
AAF SPECIFICATION
25531

in all Structures

● The new "Hi-Stress" SPEED NUT conforms to AAF specification No. 25531 and has been granted engineering approval by the Army Air Forces. It is interchangeable with nut plate AN362, for high temperature applications in all structures.

This new SPEED NUT is a lighter weight, one-piece integral unit. Because of its unusually low installation torque, it allows more rapid insertion of bolts or screws. Even after many removals under service conditions, this new SPEED NUT still retains its self-locking torque, Identify by SPEED NUT No. A6103H-1032.

TINNERMAN PRODUCTS, INC.

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* TRADE MARK REG.
U. S. Patent Office

SPEED NUTS - THE FASTEST THING IN FASTENINGS!

THE ELECTRON ART

Polarized Light Servo-System for Integration 216
Photo Tube for Biological Recording 230
Simple C-R Tube Voltmeter 234
Converting Coordinates with a Mannheim Rule 244
Electron Gun for X-Ray Tube 248

Polarized Light Servo-System for Integration

AN ELECTRONIC MACHINE that contains a polarized light servo-system has been successfully applied to the accurate solution of problems involving integration. One of these applications is that of testing samples of turbine nozzles through which steam is normally supplied at a rate of 1200 miles per hour.

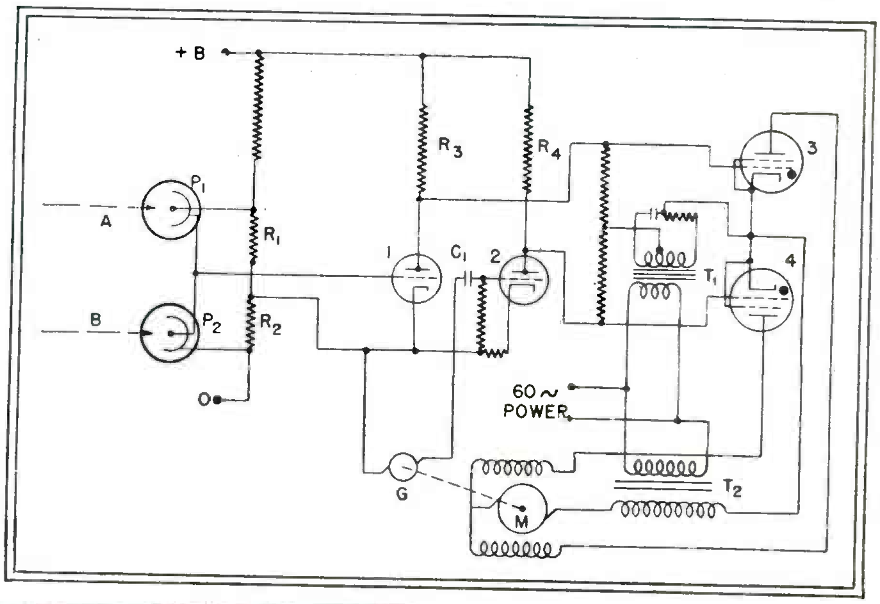
In the test, compressed air is substituted for steam and is passed through the nozzle at various pressures while the instrument measures, records and adds up energies at various points on the nozzle. The integrated values of the flow phenomena check each other within 0.01 percent on repeated integration of the same function. The small error appears to be due to mechanical tolerances.

The photograph shows the polarized light servo-system as used in the General Electric integrating pressure-traverse recorder, which employs two follow-up systems as integrators. This is used by the Research Section of the G-E Electric Turbine Engineering Division in its air test laboratory for studying flow phenomena through turbine passages.

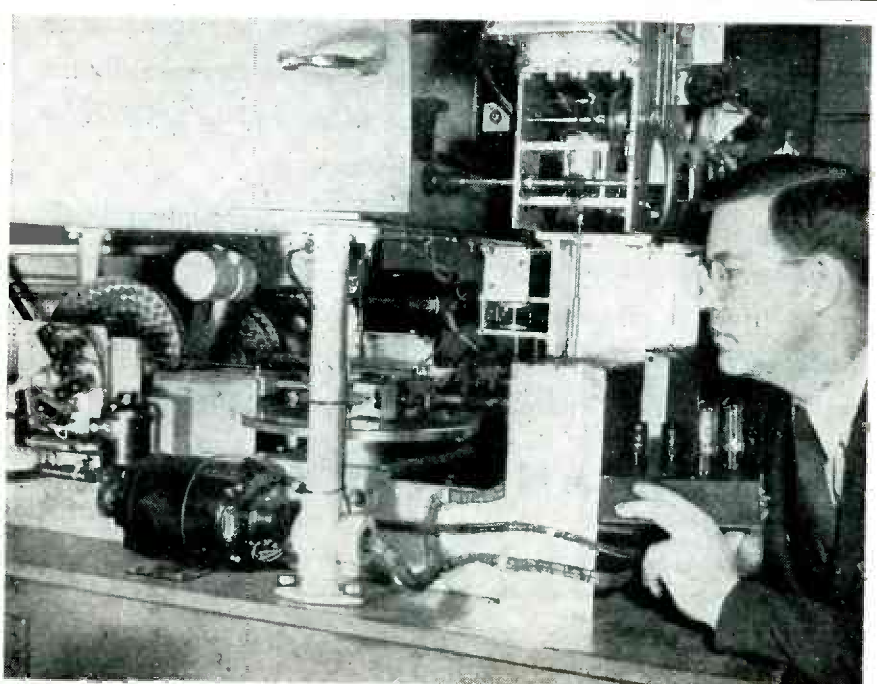
Fourteen of the integrating units, each with its own polarized light servo-system, are contained in the G-E differential analyzer which is used in solving problems involving the use of differential equations. The principles of operation of the polarized light servo-system were described by T. M. Berry of the G-E General Engineering Laboratory in a paper delivered at the AIEE winter technical meeting in January.

The mechanical arrangement of the units of the system is shown in the drawing. A small integrating wheel rolls on the surface of a turntable at an adjustable radius r. On the shaft attached to the wheel is mounted a light-polarizing disc or primary polarizer. Two beams of light, A and B, passing through the primary polarizer are polarized similarly and the plane of polarization rotates as the primary shaft rotates.

A secondary shaft is, in effect, coupled to the primary shaft by means of these two rotating beams of polarized light in the following manner. The two beams of light fall on two phototubes after each has passed through a separate sec-



Simplified circuit of the electronic control unit used in the polarized light servo-system



T. M. Berry of G-E installs the phototube unit in the calculating machine used for integration and differentiation. Fourteen of these machines are contained in the G-E differential analyzer

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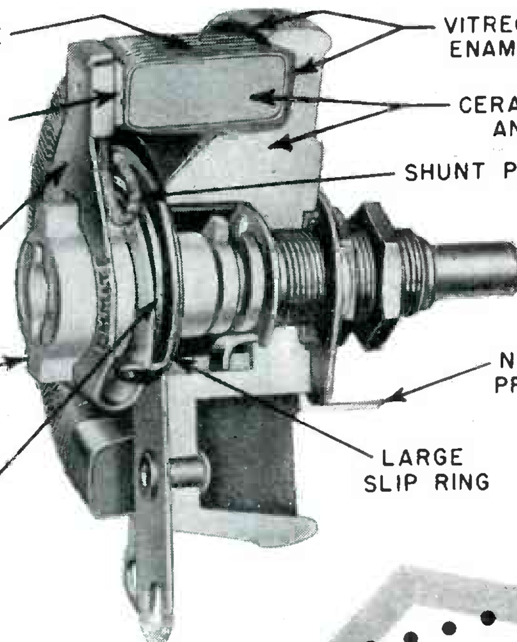

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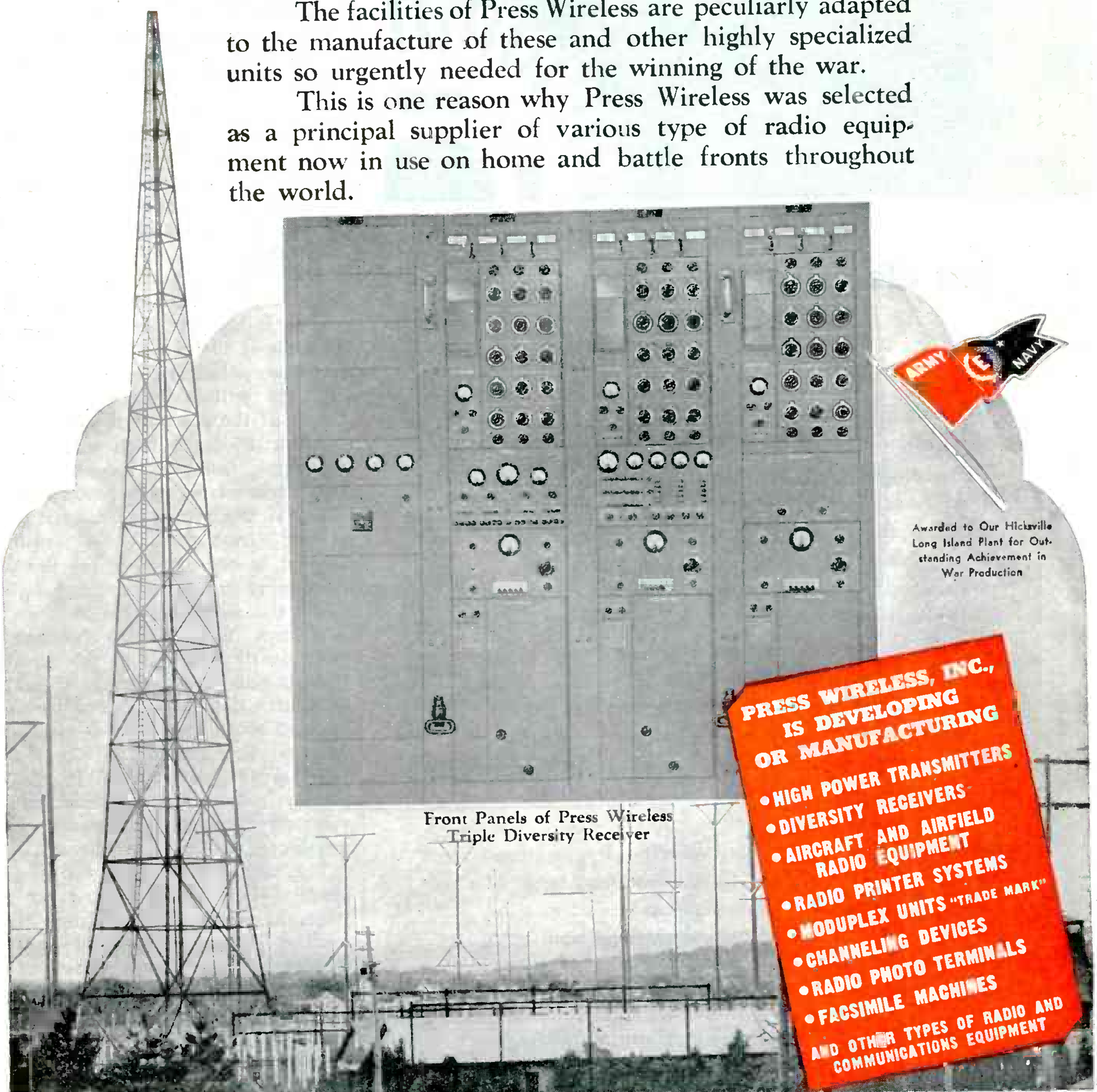

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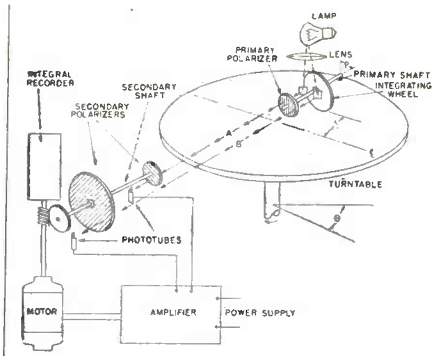

Mechanical arrangement of units forming the polarized light servo-system as contained in an automatic integrating pressure traverse recorder used for studying flow phenomena through turbine passages

ondary or control polarizer. These two secondary polarizers are attached to the secondary shaft in such a manner that their planes of polarization are at right angles to each other.

When the primary polarizer is oriented so that its plane of polarization is half way between, or at an angle of 45 deg with both of the secondary polarizers, equal amounts of light will strike both phototubes. If the plane of polarization is not at 45 deg to both secondary polarizers, unequal amounts of light will strike the phototubes. Thus, if the primary polarizer is rotated from balance a small amount in one direction, the light on one phototube is reduced because the angle between the two polarizers in that beam becomes more nearly 90 deg.; at the same time, the angle between the planes of polarization in the second beam becomes more nearly zero, with a corresponding increase in light on the second phototube. If the primary polarizer is rotated in the other direction the light beams are unbalanced in the other direction.

The unbalanced ouput of the phototubes is amplified and controls the speed and direction of rotation of the servo-motor, and thereby the secondary shaft and polarizers, to keep the light on the phototubes always at or near balance.

There are four positions of the primary shaft with respect to the secondary shaft where the light beams may be balanced. Only two of these positions, however, will give a condition of stable balance. Once the condition of stable bal-

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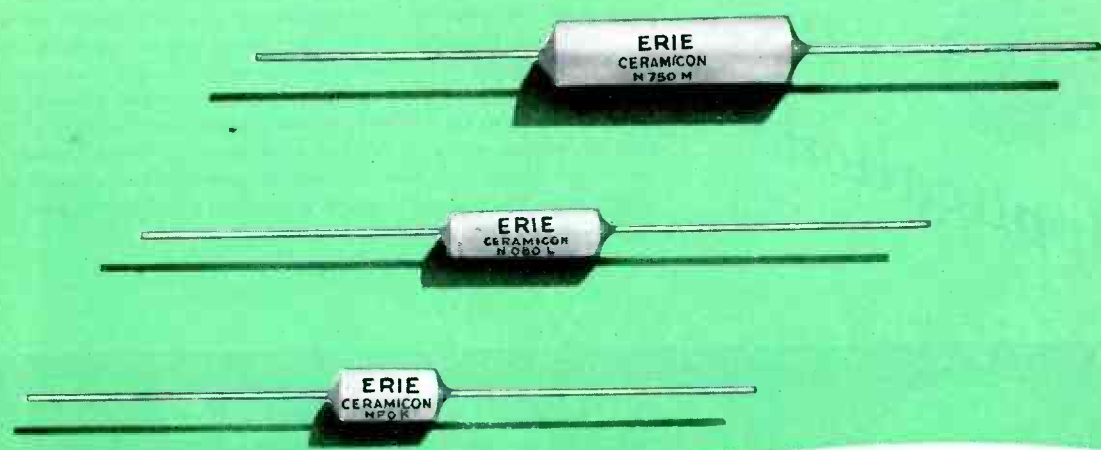

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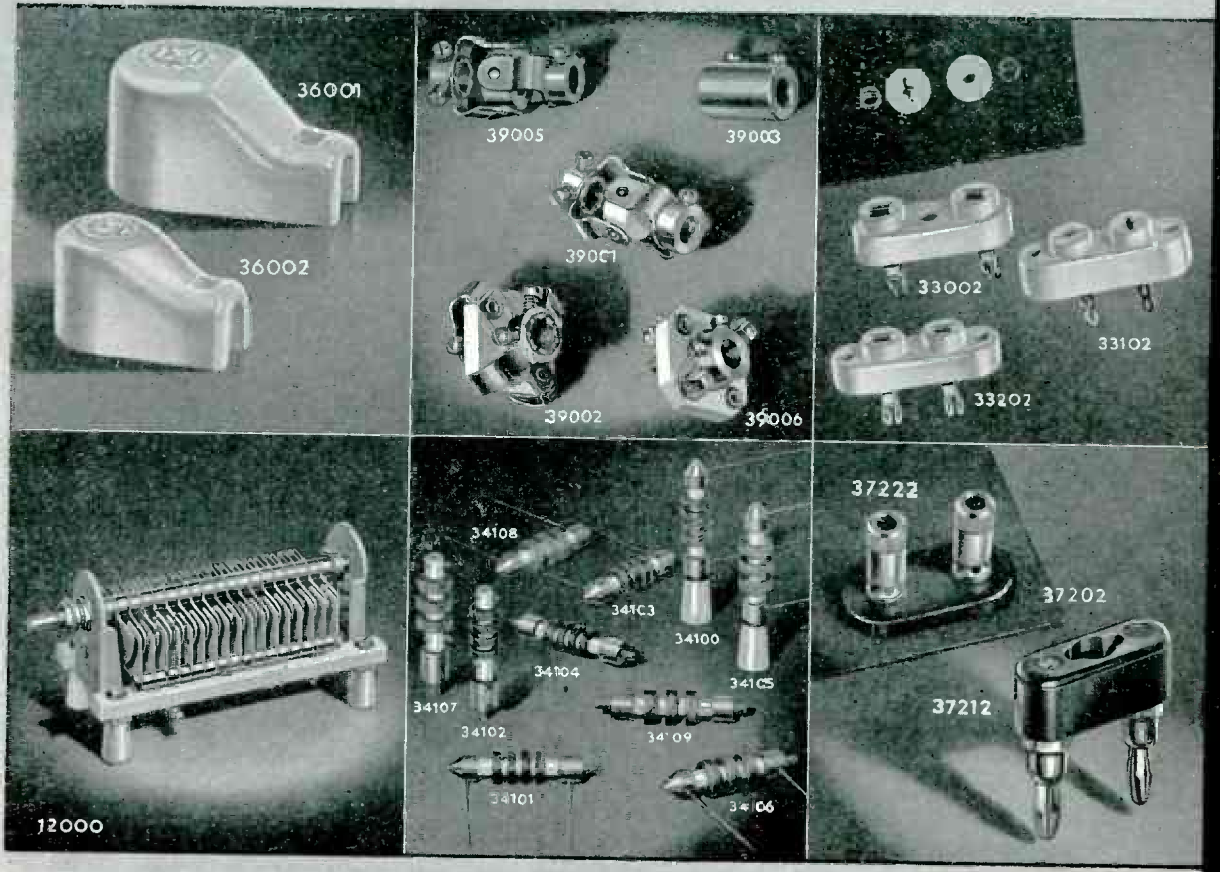

Illustrated above, left to right; Top row: No. 36001 and 36002 insulated plate caps; No. 39000 series of coupling units; No. 33000 series of steatite crystal holder sockets; Bottom Row: No. 12000 series transmitting condensers; No. 34100 series RF chokes and No. 37212 plug for use with our captive head No. 37222 posts and No. 37202 mounting plates. Plates and plugs available in black or red regular Bakelite as well as brown mica filled low loss Bakelite for RF applications.

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SALES OFFICES IN ALL OTHER PRINCIPAL CITIES ance has been established it is maintained and the secondary shaft will rotate with the primary shaft in either direction within the allowable limits of speed, acceleration, and load as determined by the motor and amplifier characteristics.

The axis of the primary shaft is held by bearings parallel to the plane of the turntable surface. For changes in radius of contact of the integrating wheel, the primary shaft and polarizer can be moved axially along the two light beams without materially affecting their balance.

Electronic Circuit

A simplified schematic diagram of the control circuit is shown. The two light beams fall on phototubes P_1 and P_2 which form two legs of a bridge circuit comprised of R_1, R_2, and the resistances of the two phototubes. The voltage unbalance of this bridge is applied between grid and cathode of VT_1. This tube together with VT_2 and resistances R_3 and R_4 form a second bridge circuit whose output is applied to the grids of two thyratron tubes, VT_3 and VT_4.

The anode currents of the thyratrons, supplied from the 60-cycle power source through transformer T_2, flow through a split field series motor to control its speed and direction in response to unbalance of the light beams A and B.

A small d-c generator is attached to the shaft of the motor and its output voltage is applied through a capacitor (C_1) between the grid and cathode of tube VT_2. The voltage (e) generated by this generator is proportion to the speed $\bar{\omega}$ of the secondary shaft. For the frequencies encountered the current through C_1, and therefore the voltage across the grid resistor of tube VT_2, is proportional to de/dt, and is therefore proportional to $d\bar{\omega}/dt$, the acceleration of the output shaft. Thus, the condition of balance of the two light beams is anticipated, and the system is stabilized and remarkably free from the hunting or oscillation commonly experienced in servo-systems.

A single lamp is used as a light source for both beams of light so that any changes in the light output due to aging, darkening of the bulb, and input voltage affect equally the light falling on both phototubes, causing no unbalance of the system. The bridge circuits employed also make the electronic circuits relatively free of unbalance due to supply voltage fluctuations.

The torque, angle characteristics of the polarized light servosystem are dependent on the characteristics of the amplifier and motor. Within operating limits the torque is approximately proportional to the relative angular displacement of the light polarizers at any given speed. Series motor characteristics make possible very high torques for rapid acceleration and deceleration. It is estimated that the primary shaft can accelerate or decelerate at 2,000 rpm per second or more before the secondary shaft will drop out of synchronism. Speeds as high as 1,500 rpm have been used but this is not necessarily the upper speed limit.

The secondary shaft will follow the primary shaft in angular position with an accuracy of plus or minus one or two degrees. This accuracy will be affected by nonuniformity of polarization in the polarizers and non-uniformity of light transmission through them. Since the primary and secondary polarizers normally operate at 45 deg to each other, the rate of change of light transmission with respect to angular displacement is a maximum. Therefore, the angular errors due to variations in the polarizers are at a minimum.

Integration

For accurately solving problems involving integration, the radius r at which the integrating wheel rolls on the turntable is variable by means of a cam or screw and represents the integrand.

If θ is the angular displacement of the turntable, the angular displacement of the integrating wheel and primary shaft ρ is proportional to $r\,d\theta$, or $\rho = k . \int r\,d\theta$.

The angular displacement of the secondary shaft is the same as that of the primary shaft and integrating wheel, and, since considerable power is available to drive this shaft, it can be loaded to drive other calculating and recording mechanisms. The primary shaft is


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held in alignment by jewel bearings and is balanced so that radial and thrust loads are substantially zero. Since there can be no restraining torque on the primary shaft due to loading of the secondary shaft, the integrating wheel rolls on the turntable with negligible slippage and correspondingly high accuracy.

The secondary shaft is at right angles to the primary shaft and the light beams are changed in direction by means of mirrors.

The photograph of the machine shows the cams for moving the integrating wheels on the turntables. The driving motors and thyratron controls are on the shelf above the turntables and cams.

Speed Measurement

In another application a variation of this servo-system has been used to accurately measure over a wide range the speed of a large rotating machine. The turntable is driven at a constant and accurately-known speed by a synchronous motor from a regulated frequency source. The secondary polarizers are driven by the machinery whose speed is to be measured and the wheel is positioned on the turntable so that it follows the secondary polarizers, thus the radius of the wheel on the turntable is an accurate measure of the unknown speed. Speed measurements have been made to 0.025 percent accuracy for primary shaft speeds up to 1300 rpm.

Differentiation

In the measurement of speed as described above, the servo-system is actually used as a differentiator in which the angular displacement of the secondary polarizers ρ' may be expressed by the equation: $\rho' = \int \omega_1 dt$ where ω_1 is the angular velocity of the control polarizers.

The angular displacement of the primary polarizer ρ is expressed by $\rho = k \int r\, d\theta$, $\theta = \omega_2 t$, *where* ω_2 is the angular velocity of the turntable, $d\theta = \omega_2 dt$.

If $\rho = \rho'$, then $d\rho = d\rho' = \omega_1 dt = k\omega_2 r dt$ and $\omega_1 = d\rho'/dt = d\rho/dt = k\omega_2 r$. Since ω_2 is constant, $d\rho'/dt = Kr$.

When used as a differentiator, the servo-system is inherently oscillatory, but by taking the proper


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steps the oscillations can be highly damped.

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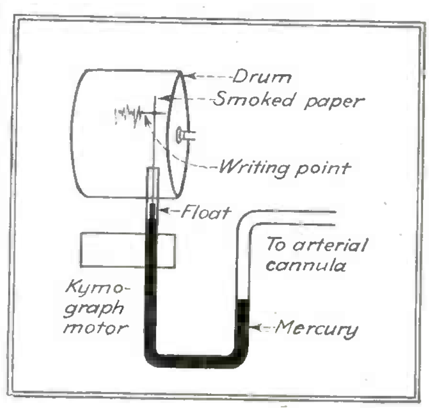
• • •

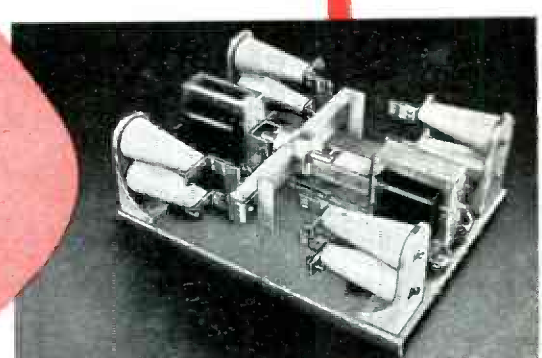
Photo Tube for Biological Recording

A DEVICE FOR transforming motion of a column of mercury or other opaque fluid into a corresponding motion of a power-driven pen is described by Sergei Feitelberg, of Mount Sinai Hospital in New York, in the *Proceedings of the Society for Experimental Biology and Medicine* for February, 1942. This is an application to a physiological problem of a method used in several recording meters for controlling a pen.

The method ordinarily used in physiological recording of pressures requires a vertical kymograph with smoked paper. A wide manometer tube with a light float connected to a writing point lightly touching the paper produces the record. Very little pressure on the writing point can be used, as the float is easily submerged. A wide manometer tube is necessary in order to provide better support for the float, but has the disadvantage of drawing several cc of blood from



The conventional method used in recording blood pressure consists of transmitting the pressure variations to the writing point on the smoked paper by means of a float in a manometer tube



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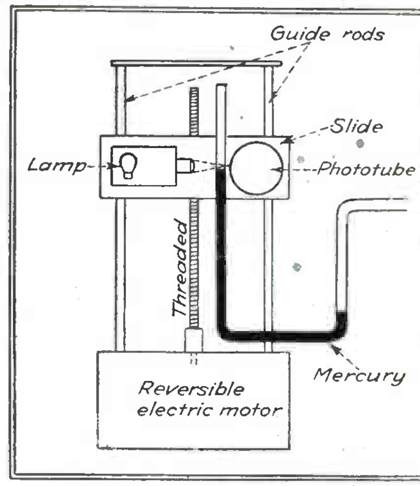


In the electronic system of recording blood pressure, the light beam and phototube cause the motor to correct the position of the slide constantly at a rate of two oscillations per second over a distance of 1 to 2 mm. When the mercury column moves due to variation of pressure, the motor moves the slide at a rate of 20 mm per second

the vessels of an animal when a rise in blood pressure occurs.

In the apparatus described, a light beam is used instead of the float. A slide carries a lamp and phototube. It has a female thread, engaging a threaded brass rod, which controls the position of the slide with respect to the mercury column. The rod is rotated by a reversible electric motor, and the slide raised and lowered, depending on the direction of rotation of the motor. This factor is controlled by a phototube-amplifier-relay combination.

The light from the lamp is directed to the manometer tube. If it is prevented from striking the phototube by the mercury column, the motor rapidly raises the slide until the light beam is above the mercury. The light hitting the phototube causes the relay to reverse the motor, and the slide is lowered until the light beam is again interrupted. This oscillation continues over a distance of 1 to 2 mm, at a rate of 2 per second. If the mercury column is moving, the slide follows at a rate of 20 mm per second.

The advantages of this method over an ordinary float with a pen recording on a smoked drum are given as follows:

1. Any system of recording can be used, as the power is supplied by the motor.

2. A very thin mercury column

can be used, reducing the change in volume in the system in which the pressure is being measured. This is rather important for recording arterial pressures in small animals.

3. The deflection of the manometer can be amplified by mechanical means, by connections between the moving photocell assembly and the pen. Amplification can also be obtained by inclining the manometer tube; the amplificaton factor is $1/\cos a$, where a is the angle between the tube and the vertical.
—W.E.G.

• • •

Simple C-R Tube Voltmeter

A NEW TYPE of cathode-ray tube that uses the shadow of an obstacle placed in the path of the electron beam as an indicating pointer for the measurement of high voltages is described in by W. Ehrenberg and H. Hirsch in the October, 1943 issue of *Journal of Scientific Instruments* (The University, Reading, Berkshire, England). Voltages up to 50,000 are measured directly by the tube without deflecting plates or special focusing.

In the tube, a fine crossover is formed a little in front of a circular aperture placed in front of an emitting cathode, so that the electrons that emerge from the aperture may be considered to originate from this crossover point as from a point source. An obstacle placed in the path of the beam beyond this point throws a sharp shadow on the fluorescent screen, which remains sharp for all values of the anode voltage. A suitable obstacle consists, for example, of an oblong aperture along which is stretched a fine wire. The beam then passes through the field of a small permanent magnet by which it is deflected as a whole. Some distortion due to the non-homogeneity of the field and to the variation of the angle at which the beam hits the screen results but there is no loss of definition.

A good idea of the scale can be obtained by assuming the field to be short and uniform. Then for a screen normal to the undeflected beam (as in the ordinary cathode-ray tube) situated at a distance L beyond the end of the field the position of the shadow is given by $x = ML/\sqrt{V} - a$ where M is a con-

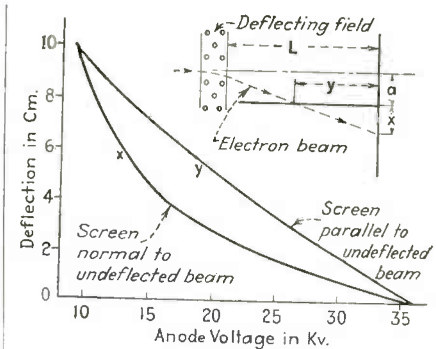


Fig. 1—Placing the screen parallel to the axis of the undeflected beam provides the nearly linear calibration curve shown above

stant depending on the field and $(x + a)$ is the distance of the pointer from the axis; $x = 0$ for $V = V_{max}$. If, however, as in the new tube, the screen is placed parallel to the axis of the undeflected beam, the position of the pointer is given by $y = L - \sqrt{V} \cdot a/M$. Here again $y = 0$ for $V = V_{max}$.

The variations of x and y with voltage are shown in the two curves of Fig. 1; the constants are different for the two curves, being so chosen that the range from 9 kv to 36 kv shall extend over 10 cm of the scale in each case. It will be seen that the new scale is nearly linear.

Tube Assembly

The construction of the new tube is shown in Fig. 2. The cathode consists of a fine tungsten wire in the form of a hairpin, supported on a ceramic base. In front of the bend of the hairpin is a cathode screen with a 0.03 in. circular aperture. This is electrically connected with the negative high voltage, and also, through a half-megohm resistor, to the filament, so that the cathode is maintained with a positive bias to the cathode screen. The total current passing through the tube amounts to about 10 μa, and is almost independent of the voltage. The drain imposed on the source is therefore very small and the heat produced by the electron beam at any part of the tube is negligible.

The whole upper part of the tube forms the anode; it is metallized on the inside except for a strip down the side covered by the fluorescent screen. A nozzle extends downwards from the upper portion to

within about 1 cm of the aperture. This part of the construction follows closely that given by Pearce.[7] The obstacle consists of a straight wire 0.004-in. diameter stretched over an oblong aperture. This is placed about 1.5 in. up the nozzle. At a farther distance of about 2 in. is the small magnet giving the deflecting field, which is clamped on the outside of the tube.

For a steady response the inside of the tube must be free from stray electric fields such as would be produced by any areas not in electric contact with the metallized surface. For this reason the fluorescent screen is deposited on a thin undercoating of zinc oxide.[8] The zinc oxide is remarkably photo-conductive, and, so formed, the whole screen becomes conducting, and will therefore be at the same potential

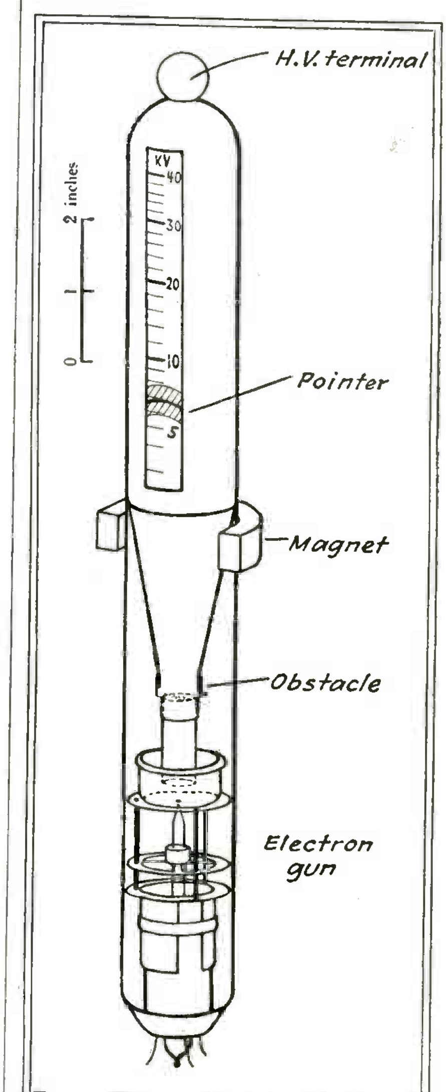


Fig. 2—Mechanical arrangement of the elements forming the electronic voltmeter for measuring high voltages

as the rest of the inner surface. All metal parts are well degassed before they are inserted in the tube and the tube is highly evacuated with the usual precautions and sealed off.

The only accessory required is a filament transformer, of small dimensions if the negative high voltage is grounded. A circuit diagram is given in Fig. 3. The luminous pointer appears on the scale when the filament is heated and the high voltage connected. The inhomogeneity of the field and the curvature of the screen cause a slight curving of the pointer which increases towards the high-voltage end of the scale. A sufficient definition is maintained over a 10 cm

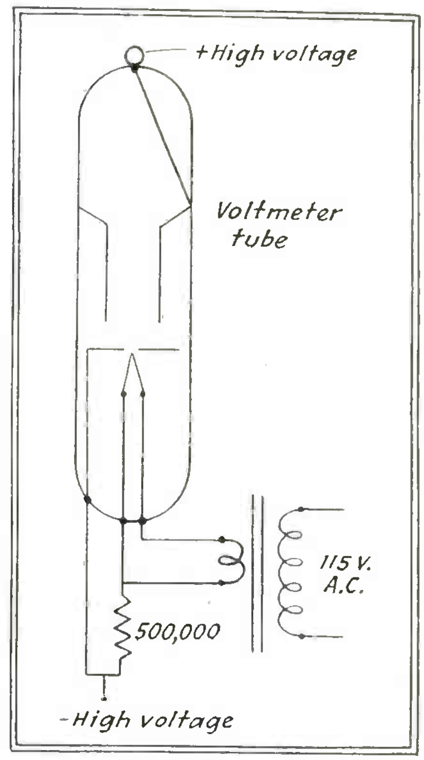


Fig. 3—The high voltage to be measured connects between the cathode screen and the anode formed by the upper part of the tube

scale, so that the voltage can be read to within 3 percent over the whole scale. It would seem possible to eliminate the pointer curvature though the effect was not found disturbing enough to warrant a sacrifice of simplicity.

The range of the meter depends on the strength of the magnet; a magnet giving the instrument any voltage range desired is easily obtained. A number of different magnets were tried, but no very

great superiority was found for any particular shape. A steel ring magnetized across a diameter appeared to give a slightly more homogeneous field than the U-shaped magnet shown. The magnet is clamped in position by a simple non-magnetic clip (not shown) that may be sealed in position with some sealing wax. The constancy of the scale depends critically on that of the magnet. A limit is set to the voltage applicable by the electric strength of the tube; the particular tube described was tried up to 40 kv.

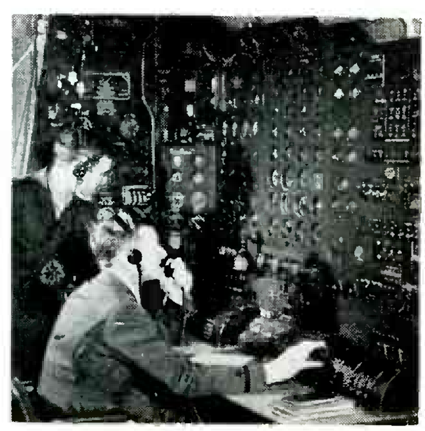
Calibration

As the diameter of the tube is only about 4 cm, the glass may be quite thin and no grave parallactic error is incurred by having the scale on the outside. The earth's magnetic field causes an additional deflection of the pointer of a few millimeters that is noticed if the tube is turned. The earth's field can be allowed for either by keeping the tube always vertical and facing the same direction or, approximately, by setting the magnet according to the direction of the tube. With these precautions no magnetic shielding was found necessary.

For poorly smoothed d.c. a narrow slit is preferable to the obstacle described as the shadow of the thin wire becomes obliterated when the pointer moves rapidly. The tube can then be calibrated to read peak voltage on the upper edge of the patch. The same applies

• • •

MARS CONTROL PANEL



Some of the indicating instruments and operating controls of the flight engineer's panel aboard the mammoth Navy flying boat MARS

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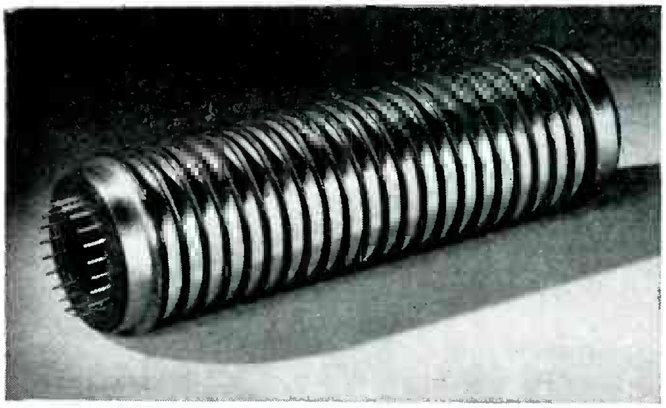
Collaborating closely with the engineering staffs of manufacturers engaged in producing for America's military requirements, this organization has specialized in the redesign of products and parts to assure maximum benefits through the use of plastic materials and plastic molding. Our engineering experience and molding facilities will be available to serve post-war industry in similar degree; assisting in product betterment, in reducing assembly time, in lowering cost of manufacture . . . in the most practical application of plastics to products old or new. The molded plastic assemblies described below illustrate some of our precision molding and assembly services.



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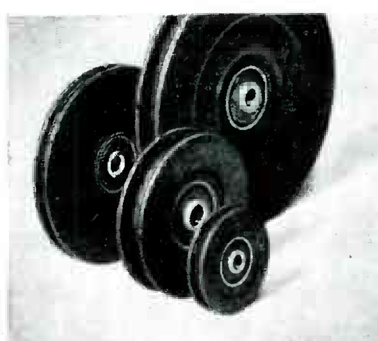
MOLDED PLASTIC ROTORS above are made in one-piece with 22 rings and 3 rings respectively. Bi-metal rings are precisely spaced and transfer-molded in a material selected by our research engineers to provide balanced physical and electrical properties. Permanent alignment is assured through one-piece construction, with consequent elimination of assembly and service problems. Our molded finish is more moisture-resistant than a machined surface with consequent reduction in power loss.

CONTROL PULLEYS . . . molded complete with ball-bearings to eliminate the need for metal bushings. This avoids variations that may occur when bearings must be fitted to bushings and saves assembly time. Mold finish of groove is smoother and harder than machined surfaces, which serves to prolong cable life. Pulleys are molded from a phenolic compound, reinforced by macerated fabric for greater durability.



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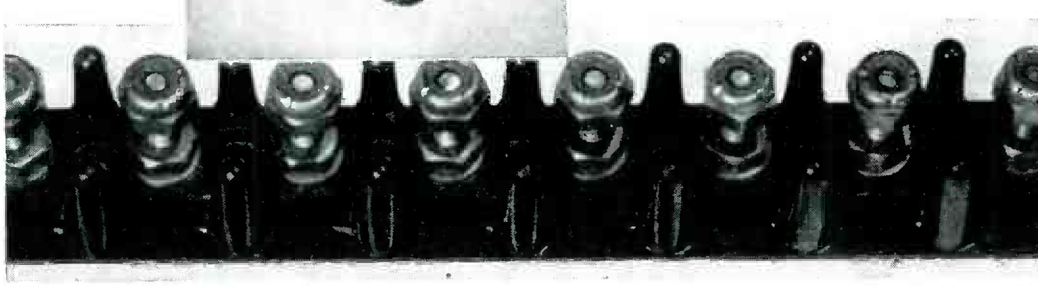
As suppliers of molded plastic parts to the aircraft industry, one of our services is the manufacture of connector panels, molded and assembled complete with hardware. These are delivered cut to desired lengths and ready for use. Assembly time is saved. Loss from scrap is avoided. The assemblies are available in 2 types: NAS 17 and NAS 18.



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to pure a.c. though the breakdown voltage of the tube might be lower for the inverse phase.

Although it is not possible to calibrate a tube with a permanent magnet without reference to an independent meter, a tube as described may also be used for establishing a voltage scale with reference to a known voltage of a few kilovolts, if the steel magnet is replaced by a coil without an iron core. An unknown voltage V_2 is determined by $V_2 = V_1 L_2 / I_1$, where V^1 is a known voltage and I_1 and I_2 are the currents passing through the coil for the same position of the pointer. Here again the earth's field must be taken into account and compensated.

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(7) Pearce, A. F., British Patent 527,980 (1940).
(8) British Patent 479,306.

• • •

Converting Coordinates With A Mannheim Rule

By RICHARD W. CRANE

THE CONVERSION of rectangular to polar coordinates, and from polar back to rectangular a number of times, is often a tedious process. The use of a loglog vector slide rule greatly eases this task. However, it is not generally known that these conversions can also be rapidly and fairly accurately accomplished with the use of a few short cuts and a maximum of two settings on a Mannheim slide rule.

The methods for converting $R - jX$ to $Z\angle\theta$ are as follows:

Procedure 1. Where one component is 10 or more times the other: assume Z = larger component (maximum error 5 parts per 1,000).

To find the phase angle, place the right-hand index of the "S" scale under the value of the larger component on the right side of the "A" scale and place the glass indicator over the value of the smaller component on the left side of "A" scale. Read the phase angle on the "S" scale. If the reactance value is greater than that of the resistance,

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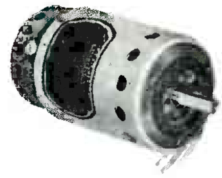

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Voltage Generator, Weight 20 oz. Length 3". Diameter $2\frac{1}{4}$". Output voltage is linear with speed to within ±1% and voltages are equal with ±1% of rotation.

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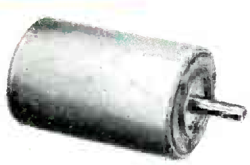
J36A—under 200 R.P.M.

MODEL J31B
400 to 1200 Cycles variable frequency 115 Volts. 15 oz. Diameter $1\frac{15}{16}$". Length $2\frac{29}{32}$".

MODELS J49 AND J49A
115 Volts, 1/250 H.P. Weight 16 oz. Diameter $1\frac{3}{4}$". Length $2\frac{11}{16}$".

J49—60 Cycles
J49A—400 Cycles



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MODEL J53 —28 VOLTS D.C. Delivers 22 C.F.M.
MODEL J54 (Midget)—60 CYCLES, 115 VOLTS Delivers 6 C.F.M.
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the phase angle will be $\pm(90° -$ reading). This operation is based on the fact that, for very small angles, the sine is almost equal to the tangent, approaching it in value as the angle approaches zero.

Procedure 2. Where one component is less than 10 times the other.

Place right hand index of the "T" scale over the value of the larger component on the "D" scale. Place the glass indicator over the value of the smaller component on the "D" scale and read the phase angle on the "T" scale.

Set this angle on the "S" scale under the value of the smaller component on either end of the "A" scale. The right hand index of the "S" scale will give the value of the impedance.

As in Procedure 1, if the reactive component is the larger the actual phase angle will be $\pm(90° -$ reading).

This method is an exact operation and the precision of the results will depend solely on the slide rule used.

Example—Convert $130 + j2500$ to polar coordinates.

Solution. Procedure 1 applies here, therefore $Z = 2500$ ohms. By placing the right hand index of the "S" scale under 2500 on the right end of the "A" scale and the glass indicator over 130 on the left side of the "A" scale, we read 2° 59′. By inspection it is seen that the impedance is predominantly inductive, therefore the phase angle equals $90° - 2° 59'$ or 87° 1′.

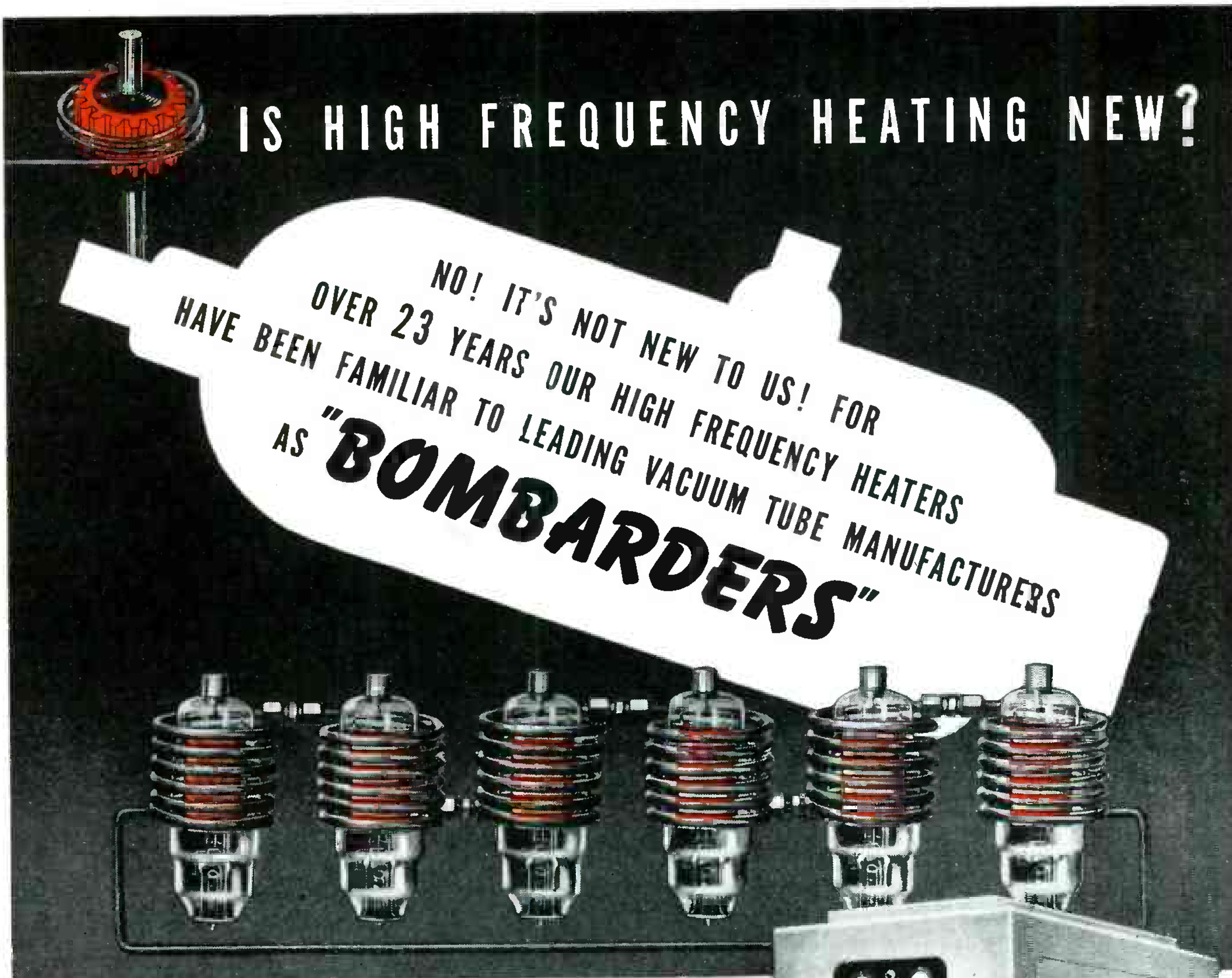
Answer. $2500 \angle 87° 1'$. (Actual value $2503.8 \angle 87° 2'$).

Example—Convert $400 - j300$ to polar coordinates.

Solution. Using Procedure 2, place the right hand index of the "T" scale over 400 on the "D" scale, put glass plate over 300 on the "D" scale and the angle is seen to be 36° 50′. Set 36° 50′ on "S" scale under 300 on "A" scale, read 500 above the right hand "S" index. The resistive component is larger than the capacitive, therefore the above angle is correct, except for sign.

Answer. $500 \angle -36° 50'$.

To change from polar coordinates to rectangular, the operations are simply reversed, unless the problem comes under procedure 1, in which case we assume only one component is present.



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Electron Gun for X-Ray Tube

THE USE OF an electron gun as a source of cathode-rays to minimize contamination of the target by material evaporated from the filament, along with the effect of the space charge in limiting the target current at low voltages, are described by J. J. G. McCue in the Nov. 1943 issue of *Review of Scientific Instruments*. The arrangement also offers the additional advantage of adjustable focal-spot size.

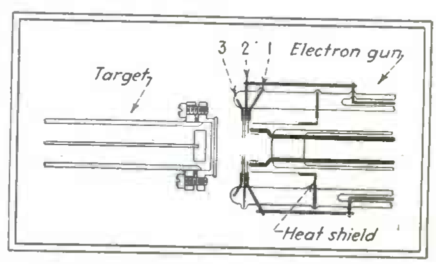
A successful tube has been constructed, using a cylindrical stainless steel shell 5 in. long, 4 in. in outside diameter, and ¼ in. thick. The target insulator is an 8-inch length of standard Pyrex flanged pipe, 1½ in. inside diameter, mounted on one end of, and coaxial with the stainless steel body. The other end of the tube bears a sylphon bellows with a flange soldered on each end. One flange serves to connect the bellows to the tube body, through a fuse wire gasket. The electron gun is mounted on a stainless steel plate screwed to the other flange, the seal being made with a rubber gasket.

Three threaded rods, parallel to the axis of the bellows and 120 deg apart around the circle, carry knurled nuts which bear on either side of the flange holding the gun. By adjusting the nuts, the bellows moves the electron gun toward or away from the target, or moves the focal spot about on the target.

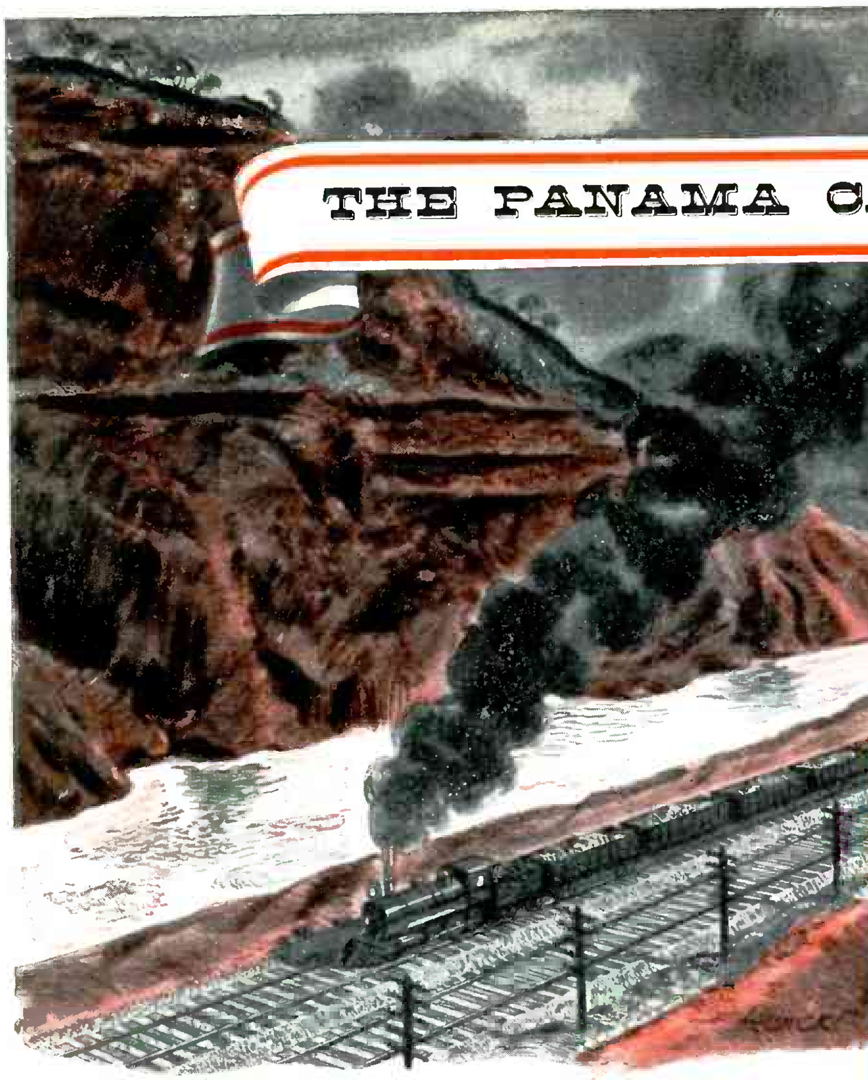
A brass water-jacket is shrunk onto the tube body to cool it. A port on top of the tube permits visual observation of its interior.

Construction of Gun

The electron gun assembly is shown in the illustration and consists of a filament, a cylindrical heat shield, and three focusing



Arrangement of the electrodes forming the electron gun. The filament, not completed for clarity in the illustration, consists of a single circular loop of oxide-coated nickel strip



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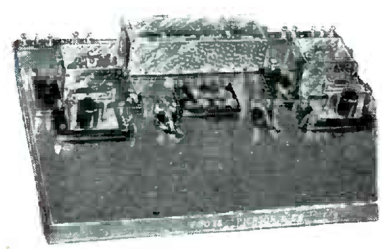

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plates. Each rod is sealed to a glass tube passing through a hole in the steel plate which supports the gun, the seal being made with a gasket cut from small rubber tubing. Each of three of the tubes contains a 0.02 in. tungsten wire, one end of which emerges through the wall of the tube, near the butt joint to the glass rod; this wire acts as a lead for one of the focusing plates. The heat shield is grounded to the steel supporting plate by a nickel lead.

The first guns were unsatisfactory because the glass around the tungsten wires holding the focusing plates decomposed and became conducting under the influence of heat from the filament and the potentials applied to the focusing plates. This difficulty almost vanished when the tungsten wires sealed into the glass rods were cut off as close as possible to the rods and their ends covered with small blobs of glass spotted onto the rods.

One wire from each plate was left long and connected to one of the tungsten leads sealed into the supporting tubes. After prolonged use the gun would exhibit some leakage between the electrodes; it could be repaired by simply heating the glass rods in the neighborhood of the plates.

Plates

The heat shield, a cylinder of 0.01 in. stainless steel, is 1 in. long and 0.75 in. in diameter. The focusing plates are 1 in. in diameter, cut from 0.01 in. stainless steel sheet and made flat by pressing them between two steel blocks in a hydraulic press. For reference purposes the plate nearest the filament is called No. 1, the next No. 2, and the one nearest the target No. 3. There is a 0.375 in. hole at the center of No. 1, while No. 2 and No. 3 have 0.25 in. holes at their centers. A centrally located 0.6 in. glass tube holds a pair of 50-mil tungsten wires in a press seal; these support the filament and serve as leads to it.

This arrangement prevents the focal spot from "seeing" the filament, which is a single circular loop of oxide-coated perforated nickel strip 4 mm wide and 11 mm in diameter. It is mounted inside the heat shield, 1 mm from and coaxial with plate No. 1.

The gun operates satisfactorily

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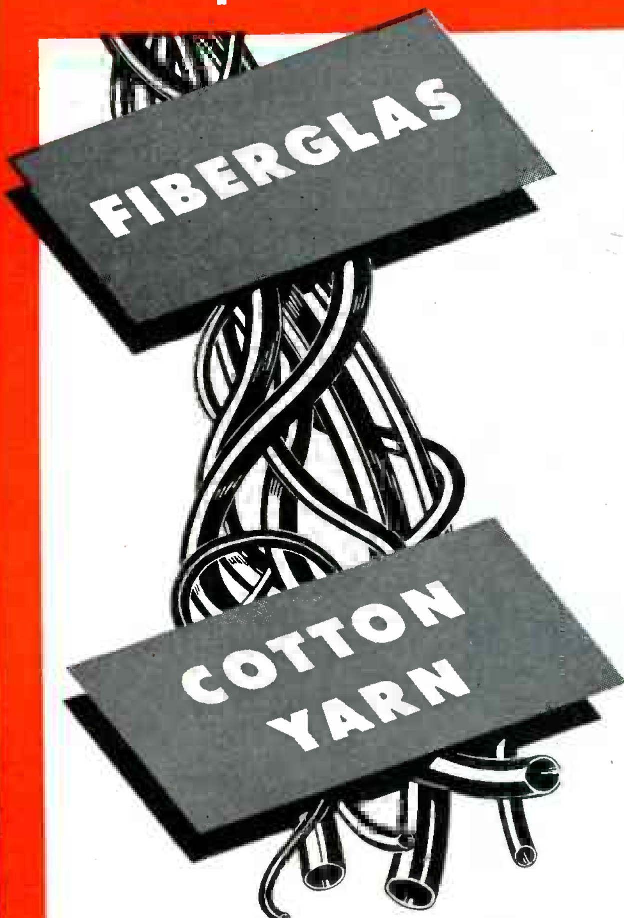

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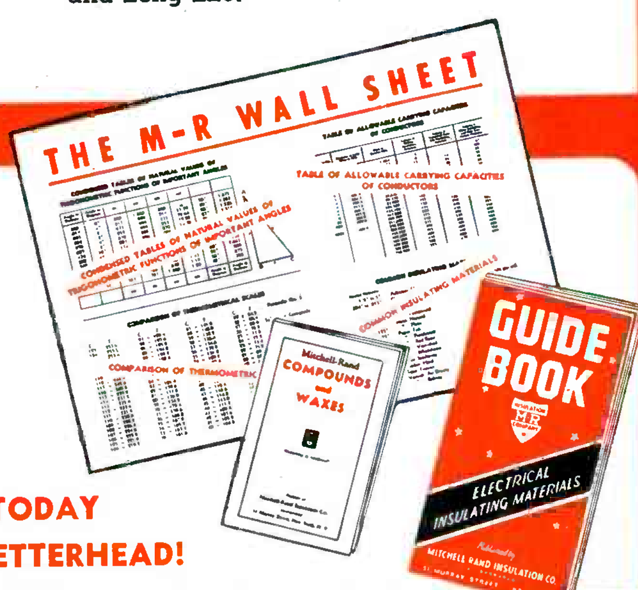

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with Plate No. 1 at 500 volts and No. 2 at 1100 volts positive with respect to the grounded filament. With No. 3 connected to No. 2 the cathode-rays form on the target a rather well-defined image of the filament, so that the focal "spot" is an annulus 1 mm wide and from 3 to 5 mm in outside diameter. Decreasing the potential of No. 3 reduces the size of the focal ring; with No. 3 grounded the diameter of the ring is 2 or 3 mm. These diameters depend to some extent on the target potential. The cathode-rays cross over near plate No. 1; therefore, the aperture in No. 2 could probably be made smaller if further screening of the target is necessary.

The tube operates satisfactorily with currents as high as 100 ma to the target. The current to plate No. 1 varies from 10 percent to 100 percent of the current to the target, depending on the age of the filament and the magnitude of the target current. The percentage of the emitted electrons collected by plate No. 1 decreases with increasing filament emission and increases with age of the filament. It also increases slightly with decreasing target voltage, especially below 10 kilovolts. This effect could be considerably reduced, if it were objectionable, by simply increasing the distance from the gun to the target. The current to plates No. 2 and No. 3 is of the order of 1 ma to both plates.

Operation

Since it was necessary to reduce to a minimum the contamination of the target, mercury diffusion pumps and a liquid-air trap were used and there were no wax joints in the tube other than a single wax seal in the lead between the tube and the pumps. The pressure as measured by an ionization gauge was about 1.2×10^{-5} mm of mercury when the tube was operating.

At first the tube contained enough foreign matter (presumably grease or oil) to contaminate a copper or silver target very badly in an hour or two. The target became discolored while simply sitting in the vacuum, even when the filament was cold. This difficulty was overcome by passing a rather violent discharge between the target and the tube body with the

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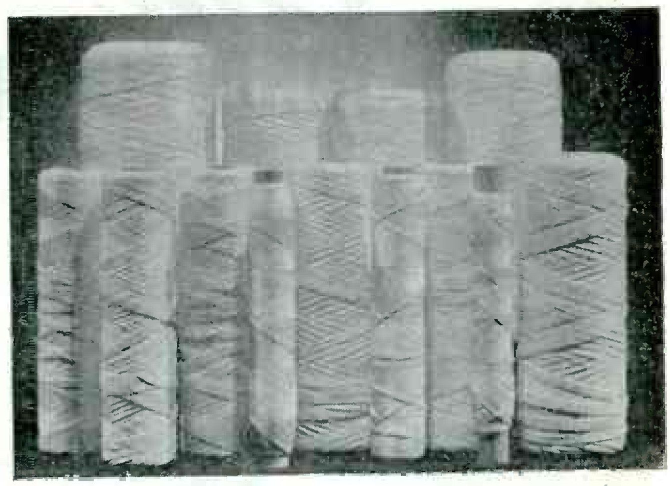

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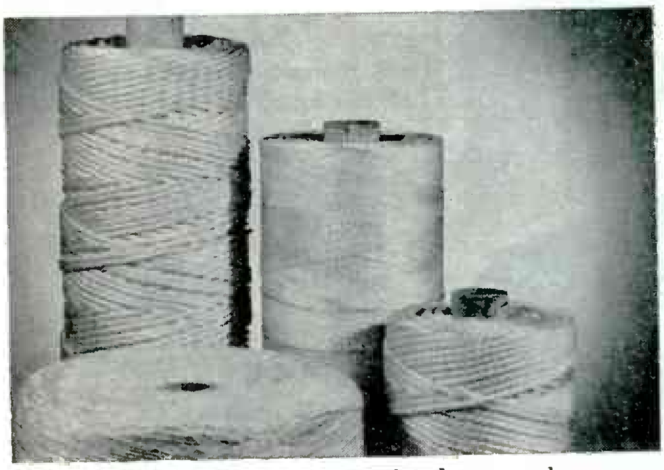
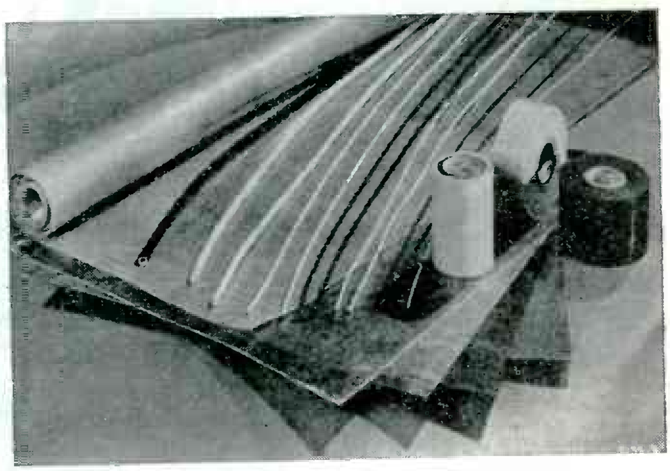


Fiberglas Tying Cords both treated and untreated.



A few of the many types of Fiberglas fabricated materials, including Fiberglas cloths, tapes, and tubings; Fiberglas-mica combination material and Fiberglas laminated sheets.

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tube full of oxygen at a pressure of a few hundredths of a millimeter, and then using hydrogen in place of oxygen. The gas was flushed out and renewed every five minutes; about six changes of oxygen and three of hydrogen proved effective.

• • •

Feedback Amplifier

(*Continued from page* 131)

the factor $1/(1-A_v\beta)$ when negative feedback is applied. A_v is always less than μ in the practical case.

If the load resistance is connected to the vacuum tube, as indicated by the dotted lines of Fig. 8, the current I then becomes

$$I = \frac{E}{R_L} + \frac{E - \mu\beta E}{r_p}, \qquad (39)$$

and the output-impedance level Z'_0 of the amplifier and load circuit with feedback is

$$Z'_0 = \frac{E}{I} = \frac{E}{\dfrac{E}{R_L} + \dfrac{E - \mu\beta E}{r_p}}$$

$$= \frac{1}{\dfrac{r_p + (1-\mu\beta)R_L}{R_L r_p}} \qquad (40)$$

or

$$Z'_0 = \frac{r_p R_L}{r_p + (1 - \mu\beta) R_L} \qquad (41)$$

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DOW

CHEMICALS PLASTICS MAGNESIUM

INDISPENSABLE TO INDUSTRY AND VICTORY

NEWS OF THE INDUSTRY

New FCC setup; television network in 1946; standards for electronic heating; Panel 13 activity; British television plan, Navy technical training; RMA standardization machinery

New Army-Navy Preferred List of Electronic Tubes

A NEW LIST of unclassified preferred general-purpose tubes, selected jointly by the Signal Corps and the Bureau of Ships, has been issued as of February 15, 1944, and supersedes the similar list dated March 1, 1943. All unclassified tubes to be used in all future designs of new equipments under the jurisdiction of the Signal Corps Laboratories or the Radio Division of the Bureau of Ships must be chosen from this list.

If tubes other than those included in the list are to be used in the design of new equipment, specific approval of the Service concerned must be obtained. Publication of the list is in no way intended to hamper or restrict development work in the industry.

The list now contains 70 types of receiving tubes, 51 transmitting types and 16 miscellaneous types. In the latter group are now included clipper, gas switching and crystal types.

New FCC Setup

EWELL K. JETT, chief engineer of FCC since January, 1938, and assistant chief engineer since 1929, took his oath of office as FCC Commissioner on February 15 and attended his first Commission meeting in that capacity the following day. With his assumption of duties, the FCC has, for the first time in nearly eight months, its full complement of seven members.

Commissioner Jett will continue in his capacity as chairman of the Coordinating Committee of the Board of War Communications and will also work closely with the interdepartmental communications post-war planning committee of the State Department. His post as chief engineer has been filled by the appointment of George P. Adair, former assistant chief engineer in charge of broadcasting, who will also replace Commissioner Jett as observer on the Radio Technical Planning Board.

Philip F. Siling, chief of the International Division of FCC, has been promoted to assistant chief engineer in charge of the Broadcast Division, and Marion H. Woodward, assistant chief of the International Division, has become chief of that Division.

ARMY-NAVY PREFERRED LIST OF RADIO ELECTRON TUBES

RECEIVING TYPES

Filament Voltage	Diodes	Diode Triodes	Triodes	Twin Triodes	Pentodes Remote	Pentodes Sharp	Converters	Power Output	Indicators	Rectifiers
1.4	*1A3*	1LH4	1LE3	*3A5* 3B7/1291	*1T4*	*1L4* 1LN5 *1S5*	1LC6 *1R5*	*3A4* 3D6/1299 *3S4*		
5.0										5U4G 5Y3GT
6.3	*6AL5* 6H6* 559 *9006*	6AQ6 6SQ7* 6SR7*	2C22 2C26 *6C4* *6J4* 6J5* 7E5/1201 *9002*	*6J6* 6SL7GT 6SN7GT	6SG7* 6SK7* *9003*	6AC7* *6AG5* 6AG7* *6AK5* 6SH7* 6SJ7* 7W7 *9001*	6SA7*	6G6G 6L6GA 6N7GT/G 6V6GT/G 6Y6G	6E5	6X5GT/G 1005
12.6	12H6*	12SQ7* 12SR7*	12J5GT	12SL7GT 12SN7GT	12SG7* 12SK7*	12SH7* 12SJ7*	12SA7*	12A6*	1629	
25 and above								25L6GT/G 28D7	991	25Z6GT/G

Miscellaneous	
Crystals	IN21B IN23 IN27
Phototubes	918 927
Voltage Regulators	OB3/VR-90 OC3/VR-105 OD3/VR-150

TRANSMITTING TYPES

Triodes		Tetrodes	Twin Tetrodes	Pentodes	Rectifiers Vacuum	Rectifiers Gas	Rectifiers Grid Control
2C26	801A	5D21	3E29	2E22	2X2	4B25	3C23
2C44	809	715B	815	803	3B24	83	3C31/C1B
6C21	811	807	829B	837	5R4GY	866A/866	C5B
15E	826	813	832A		371B	872A/872	884
VT127A	833A	814			705A		2050
327B	838	1625			836		
434A	1626				1616		
446A	8005				8016		
527	8014A				8020		
530	8025						

MISCELLANEOUS TYPES

Clipper Tubes	Gas Switching	Cathode Ray
73	1B32/532A	2AP1
719A	471A	3BP1
	532	3DP1
		3FP7
		5CP1
		5CP7
		5FP7
		5JP1
		7BP7
		12DP7
		12GP7

* Where direct interchangeability is assured "GT" and "L" counterparts of the preferred metal tubes may be used. Miniature tubes (shown in Italics) shall be used only when essential to Service requirements.

Veteran in Search of a Peacetime Future

THIS veteran knows of no job to come back to after the war.

It was born of war necessity—built to perform a strategic purpose new in the history of aircraft.

The requirements were an engineering challenge. It had to be strong to do its heavy work. Yet it had to be light and fit in the small space available.

That is why even optimists doubted such a device could be built.

But here it is: The Lear Actuator.

Its job is operating flaps, landing gears, shutters and other equipment on the power of an airplane storage battery.

Now, of course, our plants are working round the clock to make enough of these for the fighting ships of Uncle Sam.

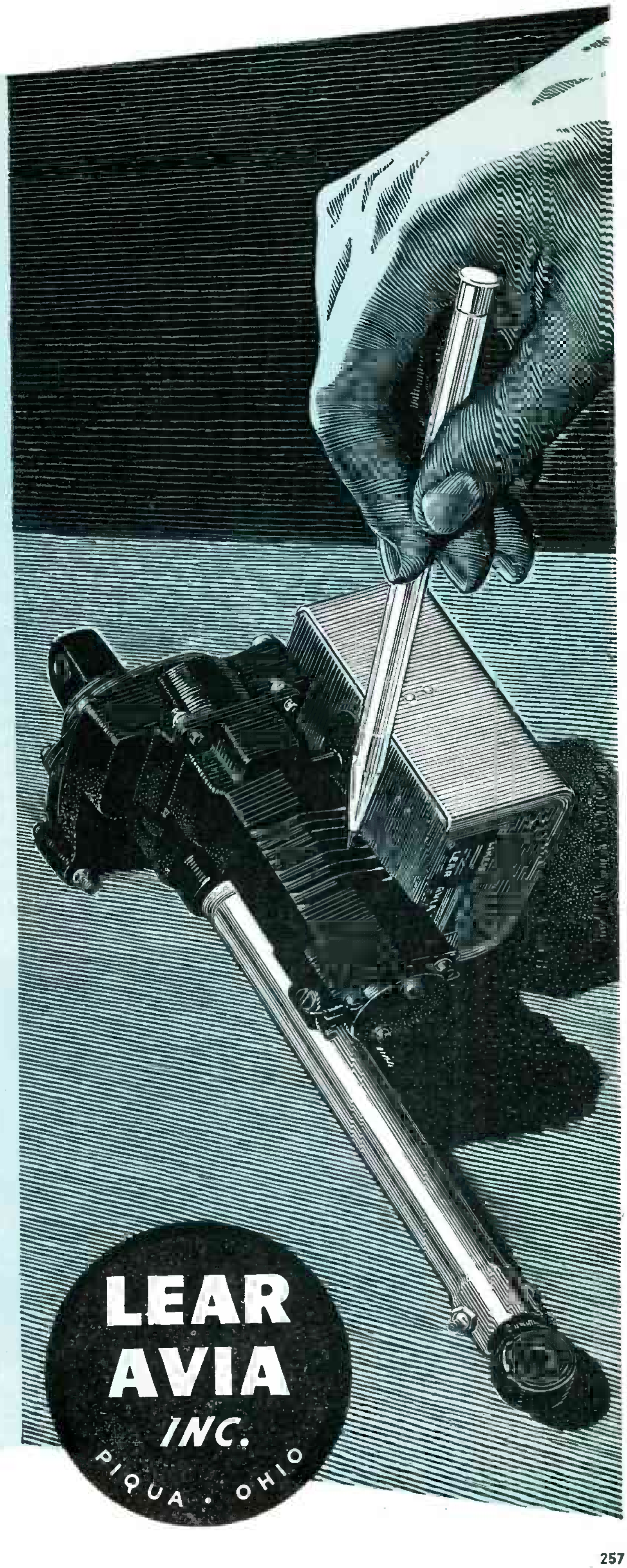
But we know that such unique devices, the midget motors that drive them and all the 250 Lear products, must have an important future in some peacetime products.

They may park your car with the push of a button—or do any of thousands of jobs we haven't thought of.

That is why we are telling you about them. We want to find jobs for these able veterans.

And we want you to know that the kind of engineering thinking and production technique that made them possible is available.

PLANTS: Piqua, O., and Grand Rapids, Mich. BRANCHES AT: New York, Los Angeles, Chicago, Detroit, Cleveland, Providence.



Checking Electronic Autopilot

The turn control of the autopilot is checked against servo motors on the table before the instrument is shipped to plane plants for installation

CAPABLE of making over 300 flight corrections per minute, the Minneapolis-Honeywell autopilot holds Army bombers on the correct course during high-altitude bombing runs. At the height flown, an error of one mil would cause the bomb to miss the target by 360 feet or more.

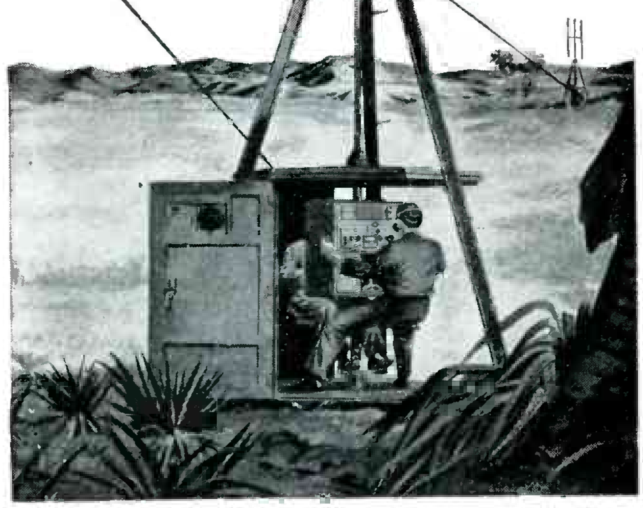
Heart of the system is the gyroscope that maintains an upright position at all times during the course of a plane's flight. Movement of the plane changes the relative position of the case of the gyroscope to the spinning gyro and produces voltages that are amplified by electronic tubes and fed to servo motors that adjust flying controls to maintain a fixed flying attitude.

The photos show steps in the manufacture of the gyroscope for the electronic system. The degree of mechanical tolerance necessary in construction is indicated by the fact that the rotor must be oiled with only one drop of oil from a hypodermic needle.

The plant is located at 45° N. Lat., so the test-table is tilted to the same degree.

A special "tilt-table" is used to hold the spinning gyroscope so that the instrument is exactly parallel to the earth's axis

POSTWAR RADIO INDUSTRY WILL FIND MAGNAVOX ON THE BEAM

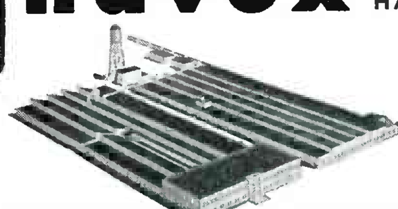


MAGNAVOX was well prepared for its important wartime role, having made many technical contributions to the radio industry during thirty-three years of pioneering.

This wartime experience, in turn . . . designing, developing, manufacturing . . . prepares Magnavox to contribute even more in the peacetime developments to come, in all phases of electronics. Our skills and the excellent facilities of the new, modern six-acre plant will be ready, at the very peak of their efficiency. The Magnavox Company, Fort Wayne 4, Indiana.

RADIO DIRECTION FINDERS help bring our fliers home safely, and locate enemy transmitters in the air, at sea or on land. These are among the many scientific instruments of war made by The Magnavox Company . . . equipment ranging from gun firing solenoids to the most intricate radio communication systems.

FOR 33 YEARS **Magnavox** HAS SERVED THE RADIO INDUSTRY



LOUD SPEAKERS • CAPACITORS • SOLENOIDS   COMMUNICATION & ELECTRONIC EQUIPMENT

Standards for Induction and Dielectric Heating

THE ELECTRONICS SECTION of National Electrical Manufacturers Association has adopted standards for electronic equipment for dielectric and induction heating.

The complete text of the new standards follows:

EL 5-5 Output Ratings

The following output ratings for Electronic Induction or Dielectric Heating Units shall be considered as preferred:

0.5 kw	20.0 kw
1.0 kw	50.0 kw
2.0 kw	100.0 kw
5.0 kw	200.0 kw
10.0 kw	

These ratings are recommended until there is need for intermediate sizes. *Suggested Standard for Future Design 1-18-44.*

EL 5-10 Ratings Of Tubes And Parts

Electronic tubes and other component parts of electronic induction or dielectric heating units shall be used within the manufacturer's ratings. *Recommended Standard 1-18-44.*

EL 5-15 Radio Interference

Electronic induction or dielectric heating apparatus shall be so designed and installed as to minimize radio interference. *Recommended Standard 1-18-44.*

EL 5-20 Protection Of Personnel

Electronic induction or dielectric heating apparatus shall include provisions for protecting the operating personnel against dangerous voltages. *Recommended Standard 1-18-44.*

EL 5-25 Protective Equipment.

Installations of electronic induction or dielectric heating apparatus should include protective equipment such as fuses, relays and/or circuit breakers, acting to disconnect the apparatus from the supply line in case of failure or flashover of internal components. *Recommended Standard 1-18-44.*

EL 50-5 Induction Heating—Definition

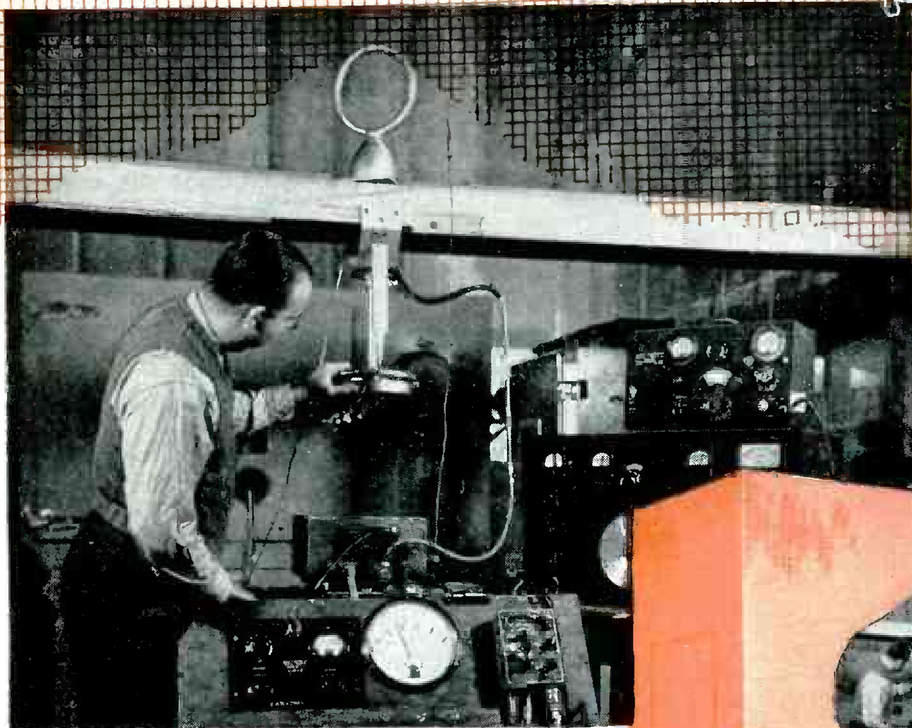
Induction heating is the heating of a nominally conducting material due to its own I^2R losses when the material is placed in a varying electromagnetic field. *Adopted Standard 1-18-44.*

El 50-10 Dielectric Heating—Definition

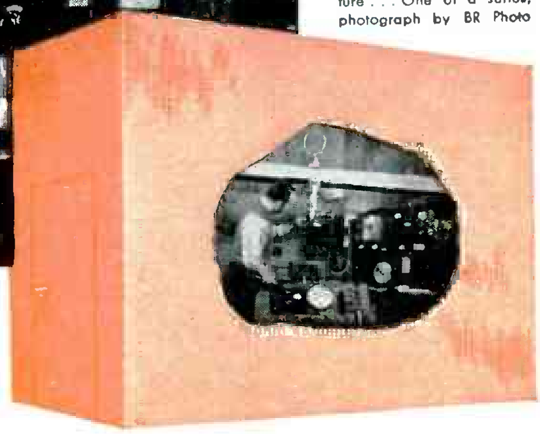
Dielectric heating is the heating of a nominally insulating material due to its own dielectric losses when the material is placed in a varying electric field. *Adopted Standard 1-18-44.*

The NEMA has also issued a

Keeping out the "Bugs"



Behind the scenes in Precision Aircraft Radio Manufacture . . . One of a series, photograph by BR Photo



IN a Zone of Electronic Silence known as the Screen Room, this radio engineer measures the directional characteristics of a Bendix* Aircraft Radio Compass—completely surrounded by double walls of bronze mesh, soldered and grounded to keep out all electronic interference. No electronic "bugs" can creep in to disturb the test readings during these meticulous and intricate adjustments . . . for on their accuracy a pilot's life may one day depend.

The ideal conditions of the Screen Room represent but one of several thousand tests and inspections established at Bendix Radio. Bendix Engineers also create extremes of substratospheric cold and low pressure, tropical heat and humidity, atmospheric interference and static . . . as well as combat strain and landing shock . . . so that radio equipment engineered and manufactured under the Bendix name will more than meet the rigors of war service.

Every step in production is guarded by these tests . . . from individual components and sub-assemblies to the compact, finished, aircraft radio you see being tested in the Zone of Electronic Silence. It is this insistence upon quality and precision that builds dependable performance into the equipment Bendix Radio has pioneered for the airlines and our nation's armed forces.

THE INVISIBLE CREW
Precision Equipment by
Bendix
Aviation Corporation

*TRADE MARK OF BENDIX AVIATION CORPORATION.

BENDIX RADIO

BENDIX RADIO DIVISION OF THE BENDIX AVIATION CORPORATION

BALTIMORE, MARYLAND — NORTH HOLLYWOOD, CALIFORNIA manual for the guidance of members in dealing with contract terminations. This contains a check list of the steps which all prime and sub-contractors should take in the preparation and conduct of contract terminations. The check list is divided into the following six major divisions: preparation of claims; reviewing of contractual relationships; establishment of proper internal organization for handling terminations; checking of company status and financial policies; planning production control problems; and reviewing of contractual relationships.

Renegotiation Refunds

According to a ruling by the Joint Price Adjustment Board, reserves for renegotiation refunds which war contractors may set up and show in their statements and annual reports are not to be regarded by Government renegotiation officials as binding on contractors.

"The increasing practice of providing such a reserve is to be encouraged as a matter of sound accounting," Joseph M. Dodge, chairman of the Joint Price Adjustment Board, stated.

"The amount established in individual cases will vary widely, depending upon the policy of the particular contractor. It may be more or less than is actually needed when the renegotiation of the fiscal year for which the reserve has been set up is concluded. It would be manifestly unjust for the contractor to be bound by the amount of any reserve he may have created or for the existence of the reserve or the amount of it to affect the renegotiation procedings. The renegotiation officials are instructed that such reserves are not to be considered directly or indirectly in connection with the determination of any price adjustment to be refunded to the Government under the terms of the renegotiation statute."

The six Federal renegotiation agencies represented by the Board are: War, Navy and Treasury Departments, the U. S. Maritime Commission, the War Shipping Administration, and the Reconstruction Finance Corporation.

Coast-to-Coast Television by 1946

PLANS FOR THE COMPLETION of a coast-to-coast television network within five or six years have been announced by Niles Trammell, president of NBC, in releasing a schedule received from Keith S. McHugh, vice-president of AT & T, outlining the proposed installation of coaxial cable for transmission of television signals over long distances.

The schedule, contingent on the war and other considerations, shows the following dates for installation of the portions of the proposed cable links:

1945—New York-Washington

1946—New York-Boston; Washington-Charlotte; Chicago-Terre Haute-St. Louis; Los Angeles-Phoenix

1947—Chicago - Toledo - Cleveland-Buffalo; part of the southern transcontinental route including Charlotte. Columbia - Atlanta - Birmingham - Jackson-Dallas-El Paso-Tucson-Phoenix

1948-'50—Completion of southern transcontinental route; Washington-Pittsburgh-Cleveland; St. Louis-Memphis-New Orleans; Kansas City-Omaha; Des Moines-Minneapolis; Atlanta-Jacksonville-Miami; Los Angeles-San Francisco

Two coaxial cables are now in operation. One links New York and Philadelphia, and another connects Minneapolis and Stevens Point, Wisc. The former was first used for television broadcasts from the Republican National Convention in 1940, and the latter is used for experimental programs.

NBC also plans to construct a television station in Washington to be used to transmit programs to WNBT, the NBC outlet in New York City. This will be built when materials become available and when the AT & T coaxial transmission line between the two cities is completed.

RTPB Panel 13 Meeting

SEVENTY-FIVE RADIO ENGINEERS and delegates representing police and five departments, forestry and conservation, power utilities, transit utilities and railroads, gathered in a two-day meeting in Chicago in January to discuss full organizational plans. The meeting was held in response to a nationwide invita-

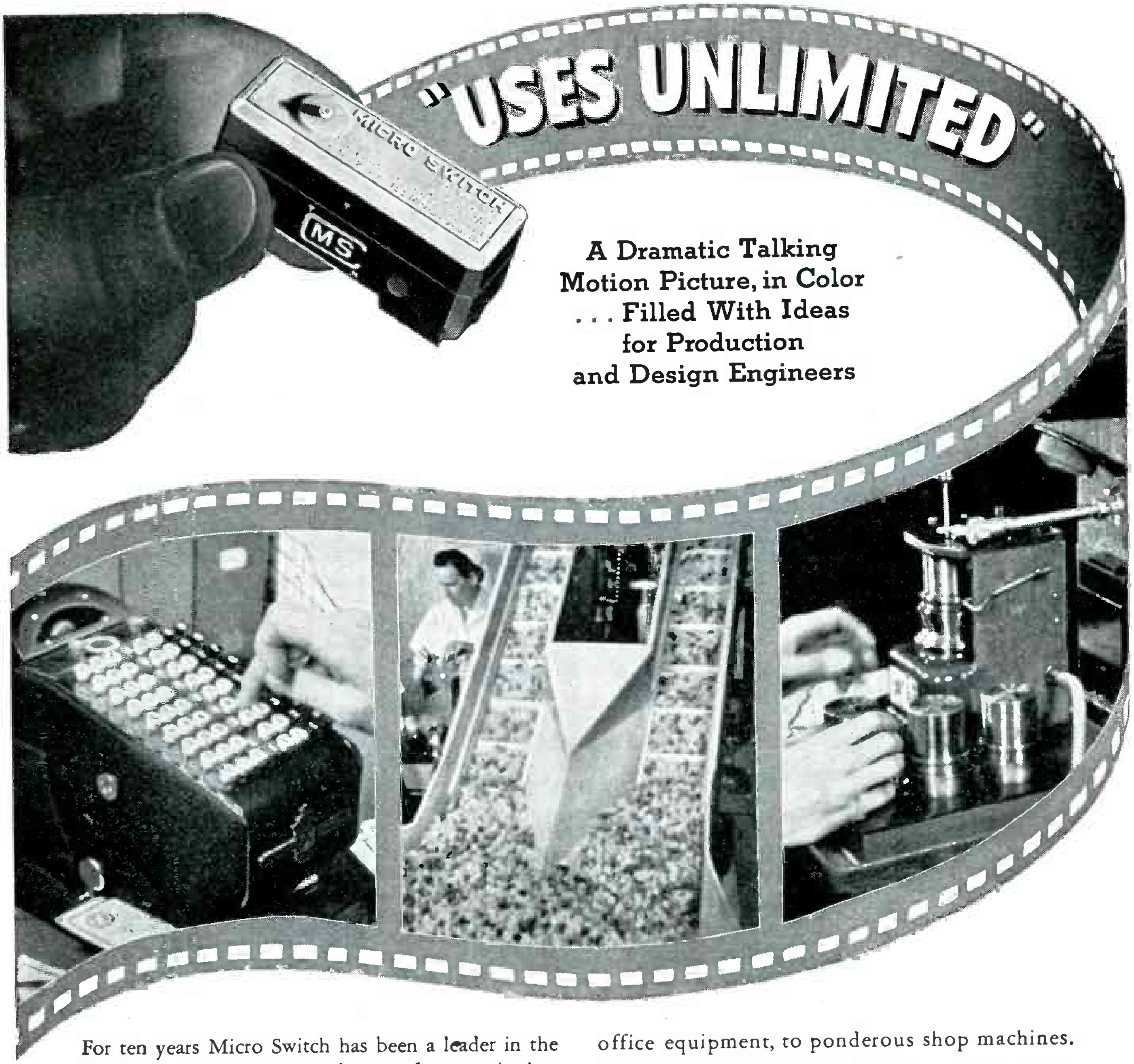
tion to convene that was issued jointly by D. E. Noble, chairman of the Radio Technical Planning Board's Panel 13 on Portable, Mobile and Emergency Service Communication, and Frank W. Walker, vice-chairman of the Panel and alternate representative of International Association of Chiefs of Police.

Chairman Noble set the keynote of the Panel's work by explaining the need for viewing the frequency assignment, allocations and engineering problems on the basis of service requirements with a distinct realization of the practicability of application as compared to an idealistic engineering approach. William N. Krebs, chief of Safety and Special Services Division of FCC, spoke on the importance of postwar planning.

The Panel adopted a workable plan involving a Steering Committee, composed of the Chairmen of eight committees assigned to special tasks, who would meet with the administrative group; chairman, vice-chairman and secretary. To complete the executive officer appointments, the meeting selected Ero Erickson of APCO, member of the Illinois State Police, Chicago, as permanent Panel 13 secretary.

Agreement was reached on the operation of the Steering Committee which would allow each committee chairman to become an ex-officio member of the Engineering Committee in order to assure closest practicable inter-locking of all of the related engineering problems. The Engineering Committee would be called upon to supply appropriate consultant engineers to assist other committees not completely staffed with technical representatives.

Robert L. Batts, Chairman of Committee #1, announced that due to the great size of the police radio problem, his group would be further divided into sub-committees working on municipal, county, state and radiotelegraph communication reports. He also revealed arrangements would be completed with IACP to distribute a comprehensive radio survey questionnaire addressed to all Police Chiefs, Sheriffs and State Police Superintendents, to obtain information required by the Police Radio Communication Systems Committee. As a contributing sponsor of the RTPB which

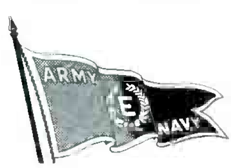


For ten years Micro Switch has been a leader in the development, throughout industry, of automatic electrical control. The war program drafted Micro Switches for use in almost every type of fighting and radiation equipment on land, on sea, and, most of all, in the air. It put them into production lines where the implements of war are being built.

Fast-moving action, interesting color, and the concise description of "Uses Unlimited" convey the grippingly romantic story of how Micro Switches are made. It shows the myriad ways this tiny switch serves to control everything from sensitive, precise instruments and office equipment, to ponderous shop machines.

This film is packed with examples of tried and proven applications of Micro Switches which will stimulate every engineer to new conceptions of uses for compact, lightweight, precise, long-lived, trouble-free, electrical controls.

"Uses Unlimited" is available to industrial groups, training classes, schools and colleges. Size: 16 mm. Length: thirty minutes. Write us for details.



Micro Switch Corporation, Freeport, Illinois • Branches: 43 East Ohio Street, Chicago (11) • 4900 Euclid Avenue, Cleveland (3) • 11 Park Place, New York City (7) • 1709 W. 8th St., Los Angeles (14) • Sales & Engineering Offices: Boston • Hartford

LET'S ALL BACK THE ATTACK BUY EXTRA WAR BONDS

The trademark MICRO SWITCH is our property and identifies switches made by Micro Switch Corporation

MICRO (MS) SWITCH

TRADE MARK

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

involves a supporting expenditure of $1,000, IACP is keenly interested in bringing home to all of the nation's police departments the vital importance of immediate postwar planning of radio communication requirements.

Magnetic Wire Recorder On Bougainville

SERGEANT Roy Maypole, combat radio reporter, recorded interviews with Marines as they returned from forward assault positions on Cape Torokina, Bougainville. He used a portable magnetic wire recorder of a type being manufactured by General Electric for the armed forces, under license from Armour Research Foundation at the Illinois Institute of Technology. The men interviewed were in the initial landing at Empress Augusta Bay.

Official U. S. Marine Corps Photo

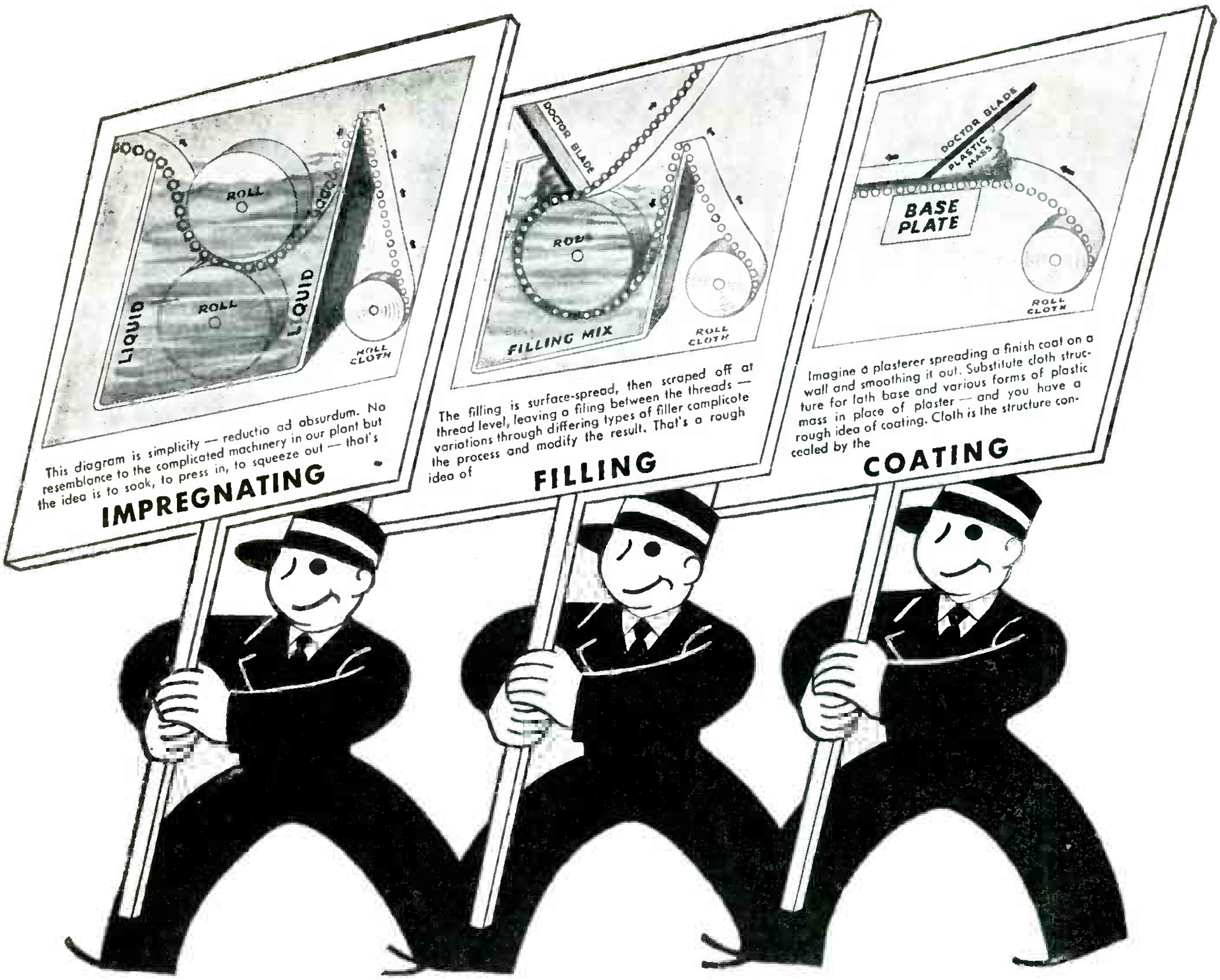
The recording was flown to Washington and made available to the radio networks. Mutual and Columbia carried portions of the recording recently.

Plan for British Television Network

A TELEVISION NETWORK, covering 85 percent of Britain's homes and which could operate nine months after the war, has been suggested and put before the Government Committee on Television.

The scheme suggests setting up 13 television diffusion stations, each relaying programs from a BBC main station, to which they would be linked either by radio or land line.

According to the London *News*



3 STEPS TO BROADER FIELDS OF USEFULNESS

Cloth is not finished, it has not passed its last frontier. Coupled with the science of chemistry and the magic of plastics, cloth is definitely in the material picture of postwar planning. Only woven cloth affords structural and tensile strength with extreme durability and flexibility. Cloth drapes, folds, creases, bonds, reinforces, protects, decorates.

FILLING

In the three major steps of specialized cloth treatment, *Impregnating, Filling,* and *Coating* — filling means closing the interstices between the woven strands sealing the cloth and making it a barrier to the passage of light, air, gases, moisture, etc. Filling may or may not change the appearance of the fabric or affect its natural qualities. Its variations are endless.

We start with cloth and, through knowledge of processing, plus adequate research facilities, add special properties for special needs.

CURRENT HOLLISTON PRODUCTION includes COATED AND IMPREGNATED FABRICS . . . INSULATING CLOTH BASE . . . SEPARATOR CLOTHS rubber, starch-filled, glazed. TRACING AND BLUE PRINT CLOTHS white and blue, ink or pencil. MAP CLOTH, PHOTO CLOTH, self-adhesive. REINFORCING FABRICS. SIGN, LABEL AND TAG CLOTHS, waterproof to take any ink, meet any inking problem. BOOK-BINDING CLOTHS. SHADE CLOTH, impregnated waterproof, opaque, translucent or light proof.

We urge you to consider CLOTH; and invite you to consult with us concerning possibilities and developments for your specific requirements.

The Holliston Mills, Inc.
PROCESSORS OF CLOTHS FOR SPECIAL PURPOSES
NORWOOD, MASSACHUSETTS
Sales Agents in Principal Cities

Chronicle, a member of the Television Commercial and Development Committee said, "We aim to give employment to all those in the industry and in the Services who have been working on radio and television devices during the war.

"Developments due to war designs have shown the way to great improvements in technique. American designs are not ahead of ours.

"An improvement in circuit design is enabling us to give a much livelier picture than was possible previously. It won't be a bigger picture. It is now possible to get in a small room practically the same impression as in the circle at a first-class cinema. There is no question of flicker now.

"The range will be the same, about 35 miles, but with rediffusion stations it will be possible to get first-class reception practically anywhere in the country."

A member of the trade said: "The price we aim at is approximately £25 plus a further £8 if ordinary radio reception is desired as well."

Army Patent Agencies

ESTABLISHMENT of an Aircraft Signal Patent Agency at Wright Field, Dayton, Ohio, and a Ground Signal Patent Agency at Camp Evans, Belmar, N. J., has been announced by the Office of the Chief Signal Officer.

The Dayton organization will be responsible for preparation of patent applications covering inventions made at the Signal Corps Aircraft Signal Agency laboratories, while the organization at Belmar will have similar responsibility for inventions at the Signal Corps Ground Signal Agency laboratories.

Navy Electronic Training For Volunteers

FORMERLY, only youths of 17 and men in Navy "pools" between 18 and 30 were eligible to take the "Eddy Test," an examination designed to gauge an applicant's fitness for technical training. Now, men in Navy "pools" up to 38 years of age, as well as those 38 to 50½ can qualify.

Men who make the grade in this program are sworn into the Navy

as seamen, first class, at $66 per month and transferred to service schools in Chicago for 10 month's training in electronics.

After graduation they are rated radio technicians, second class, and then assigned to sea or shore billets to maintain, install and operate various devices. The average graduate is able to qualify for a first class rating shortly after taking up his new duties.

The "Eddy Test" covers basic mathematics, physics, fundamental electricity, shop practice and radio.

American Programs for Chinese

CHINA'S MOST POWERFUL long-wave station, XGOA in Chungking, is now regularly rebroadcasting short-wave programs by the overseas Branch of OWI originating in San Francisco. Chungking reports that these rebroadcasts of American programs are as clear as local programs originating in Chungking.

Speaking of this evidence of China's technological development, FCC chairman James L. Fly said, "Here is clear evidence of the Chinese Government's desire to stimulate an awareness of global developments among the Chinese people, not just among the most wealthy people with short-wave receiving equipment, but among the middle-class people with less expensive long-wave radio sets. In fact, China has even made a start at bringing foreign radio programs to the lowest income groups, to the man in the street who could not dream of owning a 'receive-listen machine'.

For example, San Francisco is now broadcasting a daily half-hour program especially for Kweilin, one of the great cities of southeast China. This program is rebroadcast by means of a public-address system whose amplifiers are placed at strategic locations throughout the city's streets and parks.

"These developments presage a growing two-way exchange of ideas between the people of America and the people of China—a direct popular intercourse that will lay the foundation for a deep-rooted understanding and friendship in years to come."

Revised Standards for Instruments and Shunts

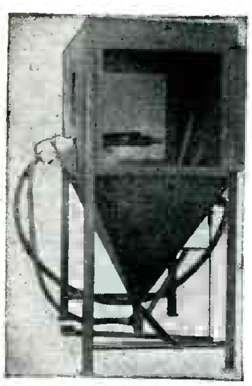
REVISIONS OF American War Standards for electrical panel-type instruments and shunts have been announced by the American Standards Association. These revisions have been made as a result of field experience. They cover performance requirements, test methods, standard dimensions and ranges for a standard series of the instruments mentioned which will meet the quality demanded by the armed forces. The standards provide for complete interchangeability, both electrically and mechanically, but leave the manufacturer free to use his ingenuity in internal design and improvements.

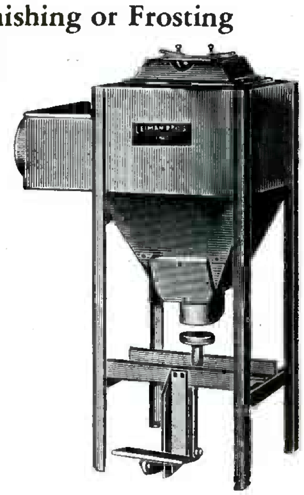
Both standards include applicable specifications and drawings, classification, materials, workmanship, general and detail requirements, methods of sampling, inspection and tests, packaging, packing and marking for shipment, and requirements applicable to individual government departments. Copious notes and drawings further clarify the text.

The American War Standard, Electrical Indicating Instruments (2½-inch, Round, Flush-Mounting, Panel-Type) (C39.2–1944) may be obtained for 50 cents a copy and the standard for External Ammeter Shunts (C39.5–1943) for 25 cents a copy. Both may be ordered from the American Standards Association, 29 West 39th Street, New York 18, N. Y. They are available from the government agency concerned, without charge, for procurement purposes only.

Future Radio Models

PREDICTIONS ABOUT the future of radio were made by Paul V. Galvin, president of the Radio Manufacturers' Association, while addressing the National Retail Furniture Association in Chicago. He reviewed the wide use of radio and special electronic apparatus in the war and pointed out that the radio industry is in a rather unique position in that it is able to make a quick conversion to civilian production. Unlike other industries, the conversion from war radio models to civilian radio models will involve





the same type of manufacturing facility and the same "know-how".

"I predict that there will be no civilian radios built and delivered to the trade during the year 1944. I predict it will be over six months after Germany is defeated, before the industry gets squared around for any production of civilian sets.

Authorization

"You will hear from some manufacturers that they will get back into civilian production in ninety to one hundred and twenty days. Unfortunately, that statement is inferentially interpreted as ninety to one hundred and twenty days after Germany is licked. In reality, it will be some time after the Limitation Order under which we are now operating is altered by WPB, and we get authorization to use materials for civilian radio sets.

I don't think the operational services of the Army, Navy and Air Corps will leave the radio industry off the hook the day after Germany is defeated. They will appraise their further needs from our industry for the Pacific job. After this appraisal, we will get some relaxation of the Limitation Order from WPB, and there will be an allocation of "X" amount of material in order to make "X" quantity of radio sets by "X" number of radio manufacturers. From this release, there will not be enough radios to fill the market needs from the start.

As the Pacific phase of the war draws to a completion, and the military services are sufficiently supplied, greater relaxation will continue from time to time and increased quantities of sets will be made from period to period as time goes on, until finally the restriction will be removed entirely. But the full restriction will not be lifted until after Japan is defeated.

"Upon resumption of civilian radio manufacture, we will get broadcast receivers, both the AM and FM type. There will be no Victory models. Each manufacturer will have his own designs. We may possibly get phonograph combinations on the first release. Phonograph combinations will depend upon how soon we will resume production and upon the material situation at that time. Retail prices of radio sets on resumption of civilian

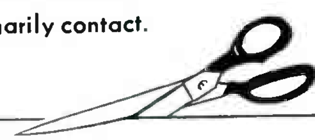
An Important New Publication

[ENGINEERING HANDBOOK]

"MECHANICAL SPRINGS, *Their Engineering and Design*"

Whether you buy, use or design mechanical springs, this new engineering handbook will prove interesting and practical. Its purpose is to collect and present charts, tables and formulas upon which the engineering and design of mechanical springs are currently based. The material offered represents the research and knowledge of the combined engineering forces of the several Divisions of the Associated Spring Corporation. Helpful pointers on the selection of materials, types of springs, methods of calculation — all appear in easy-to-read, simple language.

A copy will be sent to any executive, engineer, designer, or purchasing agent who is interested in Springs. Use the coupon, or request it on your letterhead, and address to the nearest Division, or the Division you customarily contact.



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The WILLIAM D. GIBSON COMPANY
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PLEASE SEND THE NEW ENGINEERING HANDBOOK
"Mechanical Springs, their Engineering and Design"

NAME ______________________________

POSITION ______________________________

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DIVISIONS OF ASSOCIATED SPRING CORPORATION

production will be from 25 to 40 percent higher than pre-war sets.

Television

"I believe that there will be no television sets built until after Japan is defeated. Technically, television is here today, but the system standards and frequency allocation problems, as well as the station transmitting problems, relay station problems, and programing problems for commercial television will hold it back. However, when commercial television does come it will move very fast. Technical advances during the war have brought forth improvements that make possible moderately priced television sets which will reach the mass market.

Television after the war will not be confined to a little peep-hole view somewhere in front or on top of the television cabinet. Projection of a good-sized picture on the wall will make it much more acceptable from a viewing standpoint. The post-war opportunities in manufacturing, merchandising, advertising, programing, and broadcasting of television open such a tremendously interesting field for American ingenuity and enterprise that we will have a new industry—television—superimposed onto a now already large industry—the radio industry.

Combinations

"After the war, the automatic radio-phonograph combination is going to be the source of tremendous business. I don't thing the wax platter record is going to pass out, the record manufacturers are not sound asleep. The automatic radio-phonograph combination will be within reach of the mass American buying public, and it will be an instrument of very high quality.

Radio discounts, in my estimation, were not out of line before the war considering the service and trade-in problems, and I believe about the same discount structure will prevail upon resumption of sales.

This is a thumb-nail picture of post-war radio as I see it. The term "post-war" is somewhat ambiguous because we are not actually going to wait until our entire war effort is completed before we resume the production of civilian

CETRON
RECTIFIER CE 872-A *

● Continental, one of the pioneers in the electronic tube industry, produces a wide range of Power Rectifiers, grid control tubes (Thyratrons), Phototubes and other special electronic tubes.

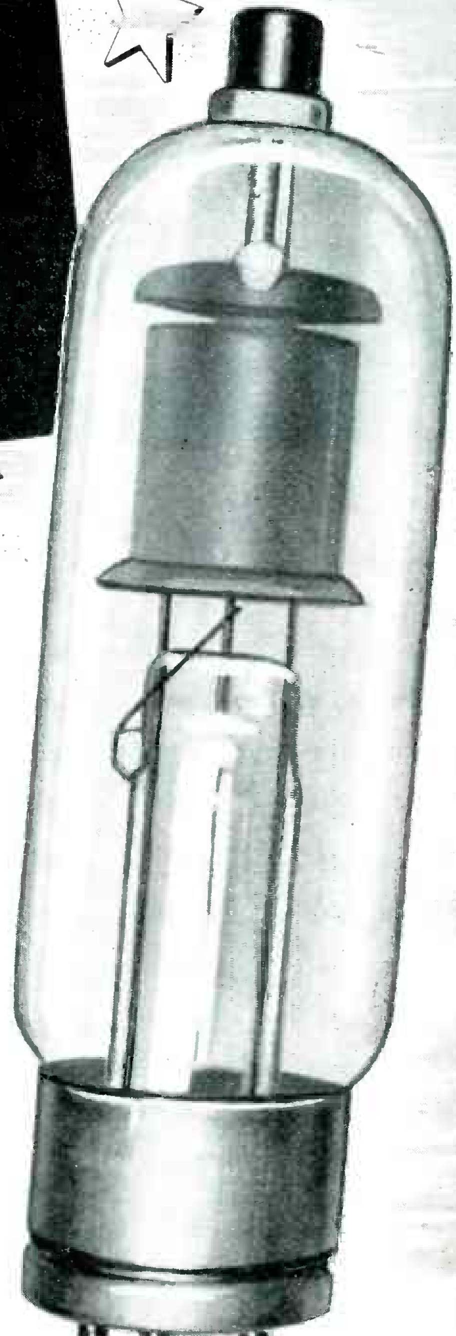
● Long before the war, their high quality and thorough dependability had earned for them national recognition and acceptance by many of the country's leading companies. From raw materials to the finished tube, we tolerate only the best of materials, rigidly controlled processes, close inspections and exacting final tests.

● Have you a tube problem? If so, perhaps we can help you as we have helped many others. Your inquiry is invited—No obligation incurred.

COMPLETE!

We produce a wide line of RECTIFIERS, PHOTOTUBES AND ELECTRONIC TUBES

Write for catalog giving complete details.



* An outstanding tube in the famous CETRON line

● Continental's CE 872A is designed to meet rigid Army and Navy specifications. It incorporates numerous improvements in design and processes which insure EFFICIENCY . . . RUGGEDNESS . . . LONG LIFE.

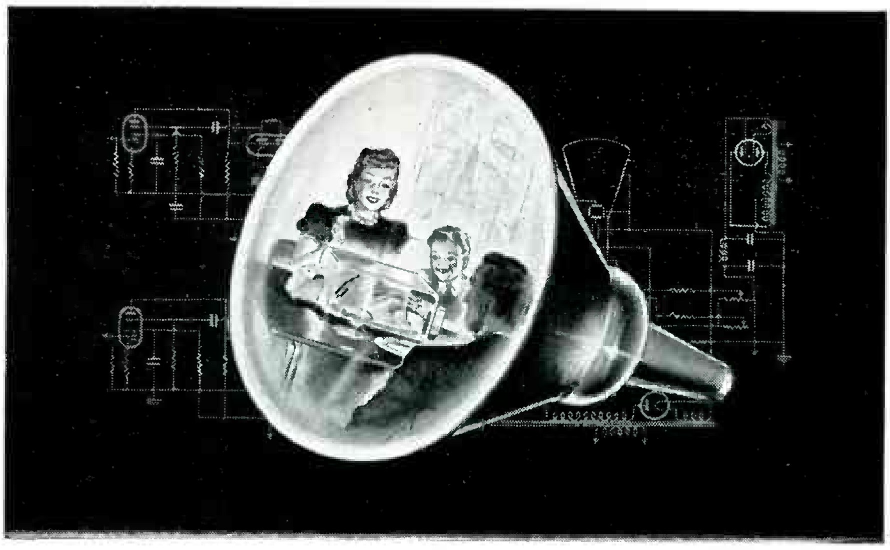
● Detailed specifications are given in Bulletin 117-A which will be sent on request. We are able to make prompt delivery on satisfactorily rated orders.

CONTINENTAL ELECTRIC COMPANY

CHICAGO OFFICE
903 MERCHANDISE MART

GENEVA, ILL.

NEW YORK OFFICE
265 W. 14th ST.



sets. We are going to resume production some time after the European phase has been concluded. This period will cover the filling of the pipe lines with very greatly improved models. From there on out, the industry will continue to incorporate its war-time improvements into models which will meet the current radio wants of consumers."

Dry Cells for Civilians

ALTHOUGH THE MATERIALS situation has improved, and facilities of the industry have been greatly expanded, the possibility of increasing the supply of dry batteries for civilian use in 1944 appears remote. In fact, production of some kinds of batteries used by civilians may be even lower than in 1943, according to the Consumers Durable Goods Division of WPB.

Last year the dry battery industry produced the equivalent of 3,750,000 radio battery packs, compared with 3,500,000 produced in 1940. Less than two percent of this quantity was used in industrial and technical equipment. All the rest went to the farm market.

Shipments of No. 6 type batteries, including multiple types, were almost exactly the same in 1943 as in 1940. These batteries are used to a large extent in rural areas for telephones, gas engine ignition, and electric fences. Large quantities are used also by railroad, telephone and telegraph companies, by the fishing industry, and for protective alarm systems.

More than 55,000,000 individual cells were produced for assembly into hearing aid batteries. Final figures show that production of assembled hearing aid B batteries reached a total of approximately 1,600,000.

Lantern battery shipments were 85 percent higher than in 1940. Almost the entire amount produced went to railroads for use by trainmen.

Approximately half as many flashlight batteries were shipped in 1943 as in 1940, and many of these did not reach the retail market. War plants, public utilities, and other users, whose requirements had increased as a result of the war, received a much greater share than in 1940.

All military operations, on land

and sea and in the air, require enormous quantities of dry batteries. If batteries are not immediately available, it is because batteries are needed for walkie-talkies, bazookas, signal lights, or other war equipment.

RMA Standardization Setup

THERE HAS RECENTLY been some misunderstanding of the functioning of the standardization machinery of the RMA Engineering Department and the following expanation of the origin and theory of operation is timely, as plans are being formulated now for the post-war operation of the Engineering Department and constructive comments would be welcomed by Virgil M. Graham, associate director of the Department. His address changed recently and communications should be addressed to him at Radio Manufacturers Association, P. O. Box 750, Williamsport, Pa.

Reorganization for peacetime activities may require minor changes in the details of operations.

In the early days of the RMA engineering activities, standards or recommended practices were proposed by any of the several engineering committees, considered by a "General Standards Committee" and, if approved, submitted to the membership by "letter ballot". If 90 percent of the votes were favorable (ballots not returned were considered affirmative) the proposal became an RMA Standard or Recommended Practice. The obvious difficulty with this system was that there usually were so few ballots returned that the proposal had to be considered approved "by default". This procedure was bad because when valid objections were raised with one or two negative ballots, they had to be disregarded according to the rules unless the chairman of the Standards Committee exercised a power not delegated to him and threw the subject back to the committees.

SAE System

About 1934, a survey was made of the standardization procedure of several similar organizations. This survey indicated that the procedure evolved and used with satisfaction by the Society of Automotive Engineers suited our needs

THIS GUARD'S BACK IS *Never* TURNED

The Browning Signal System for plant protection effectively covers every inch of a given "beat" by means of a balanced-capacitance, electronic circuit. Proved in service before Pearl Harbor, it obviates human failure, releases guards for needed man-power.

Browning Frequency Meters pre-check radio transmitters, help assure communications clarity and dependability. Long have been standard equipment for police, fire, public utility and similar emergency radio systems. Meet FCC requirements.

Illustrated Literature Upon Request

BROWNING

LABORATORIES, INCORPORATED
WINCHESTER, MASSACHUSETTS

quite well. This system eliminated the bad features of the one outlined above and provided needed flexibility for our industry.

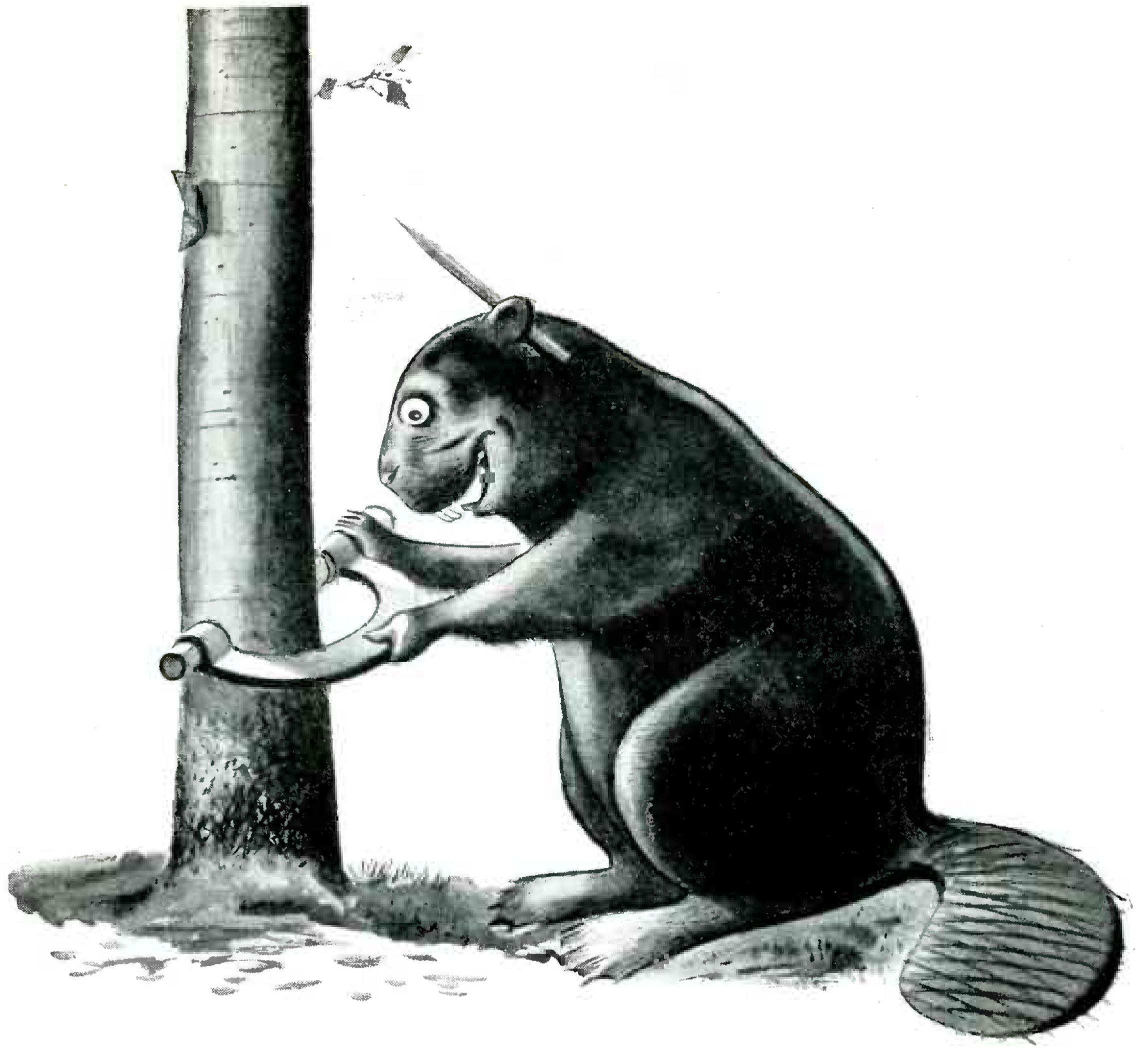
This SAE System, as adapted to RMA provides for the formulation and proposal of material for standardization by the several committees or sections of the Engineering Department, on their own initiative or on request of the various RMA Divisions on occasion. The material is then circulated in the form of "Standards Proposals" requesting comment and criticism. These Standards Proposals are sent to all members of all engineering committees, the executive of each member company, and now to the members of all divisions and sections of RMA. When comment and criticism is received it is filed with the particular Standards Proposal and prior to the ensuing meeting of the General Standards Committee these files are incorporated into an agenda for this meeting.

Recommendations

This General Standards Committee has no power to make changes in a proposal other than minor ones of an obvious or editorial nature as result of comments received. Its actions are therefore confined almost entirely to acceptance, rejection, or reference back to the formulating committee with recommendations. These actions must be based on the answers to the Standards Proposals or discussions in the meeting, where new objections are sometimes raised as a result of occurrences subsequent to the Standards Proposal procedure. In other words the General Standards Committee functions as a quasi-judicial group deciding on the validity of any objections to the material proposed for standardization. It is obvious that this type of procedure eliminates the major objection to the older procedure, as now one valid objection can at least cause the proposal to be reconsidered, whereas if the industry has raised no objections and if the members see none, the proposal becomes an RMA Standard or RMA Recommended Practice. The General Standards Committee can act only *in meeting*.

Typical Procedure

If several unfavorable comments



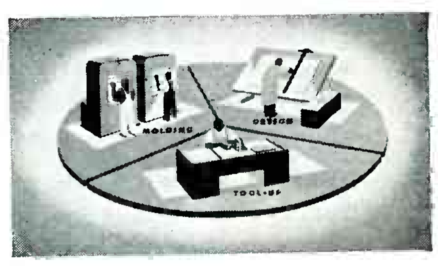
Make Sure of **ENGINEERING** when you choose your Plastic Molder

Engineering is only one of the functions a Plastic Molder must perform . . . but it's a vital one. And we'll whistle *that* again!

Because without a thorough knowledge of toolmaking, molding compounds and molding techniques, ideas never become blueprints, and blueprints never become products. That's why we forever feature engineering functions at Kurz-Kasch.

From the blueprint to the finished parts, of course, more specialized skills are called for. Here at Kurz-Kasch, they all find a common meeting place with your engineers at the Plastics Round Table . . . where a generation of experience in plastics is pooled to work out the best Engineering and Production treatment of your application.

Behind all this lies the production capacity of a large and modernly equipped plant which we confidently expect to keep quite busy after the war. We know, because right now we're talking Engineering on many products for customers both old and new. If you're interested in Plastics —now's the time! No obligation.



THE EARLIER Engineering gets on the job, the better! When you look at a top-notch plastic application, it's ten to one that the Custom Molder sat in on the job from the ground floor up. Let us help with blueprints *and* molding material specifications.

WAR BONDS BUY VICTORY—HAVE YOU BOUGHT YOURS TODAY?

KURZ-KASCH

For over 25 years Planners and Molders in Plastics

Kurz-Kasch, Inc., 1421 South Broadway, Dayton 1, Ohio
Branch Sales Offices: New York • Chicago • Detroit • Indianapolis • Los Angeles • Dallas
St. Louis • Toronto, Canada. *Export Offices:* 89 Broad Street, New York City

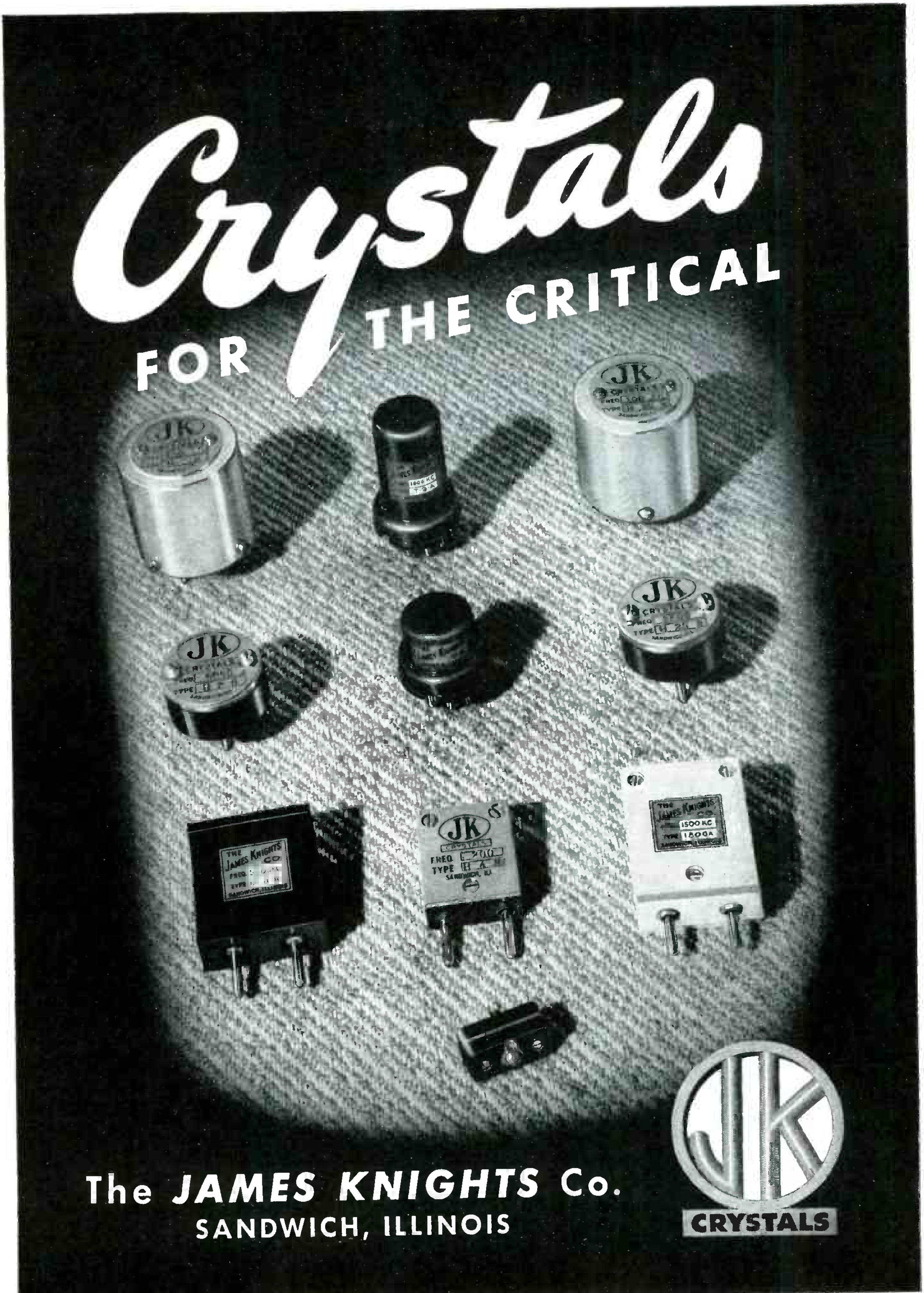
are received on a Standards Proposal they are forwarded to the formulating committee to give it a chance to revise the Proposal to reconcile it with valid criticism before it goes to the General Standards Committee. After such revision the material is again sent out in Standards Proposal form. A limited amount of flexibility of action in this respect is allowed as many times as a formulating committee may fix up objectionable points in a proposal just prior to the meeting of the General Standards Committee. In such a case, the Chairman of the particular committee presents the revision to the General Standards Committee and it decides whether to accept the revised proposal or whether it should again go out as a Standards Proposal.

Both RMA Standards and RMA Recommended Practices should have the same use, validity, and importance to be adopted. In general, standards are made for concrete matters such as shaft dimensions, etc. Recommended Practices are formulated for actions or procedures such as furnishing instruction sheets, etc. Thus a Recommended Practice on furnishing instruction sheets might lead to a Standard on the form of the sheet.

Provisional Standards

While the above standardization procedure has not been functioning during the war period for obvious reasons, any "standards" which may be printed during that time through actions of the several wartime committees are only "Provisional Standards" and will not be adopted as RMA Standards (or Recommended Practices) until after the reconstitution of the General Standards Committee at such time as our industry is reconverted to peace time activity. No material will bear the term "RMA Standard" unless it has passed through all the processes prescribed by the "Organization and Working Rules" of the RMA Engineering Department.

A NEW PATENT suggests flooding movie theaters with ultraviolet radiation at low intensity. Fluorescent material on the seats and carpeting would help patrons find seats.


Crystals
FOR THE CRITICAL
The JAMES KNIGHTS Co.
SANDWICH, ILLINOIS
JK
CRYSTALS

BWC on International Communications

THE BOARD OF War Communications has ordered that

(1) Non-governmental business radiotelephone calls between the United States and Great Britain shall be permitted subject to the prior approval thereof from the Office of Censorship. No personal radiotelephone calls shall be permitted between the United States and Great Britain.

(2) No non-governmental business or personal radiotelephone call shall be made to or from any foreign point outside of the Western Hemisphere other than Great Britain unless such call is made in the interest of the United States or the United Nations and unless an agency of the United States Government sponsors such call and obtains prior approval therefor from the Office of Censorship. This provision shall not apply to American press calls or radio broadcast programs, or to such other press calls and radio programs as may be specifically approved by the Office of Censorship.

(3) No calls of any nature, over the radiotelephone circuits under the jurisdiction of the United States, no matter where such calls may originate, unless sponsored and approved as provided in paragraph (2), shall be permitted to, from, or on behalf of, the following thirteen countries: Egypt, Finland, France, Iceland, Iran, Ireland, Latvias, Lithuania, Portugal, Spain, Sweden, Switzerland, and Turkey.

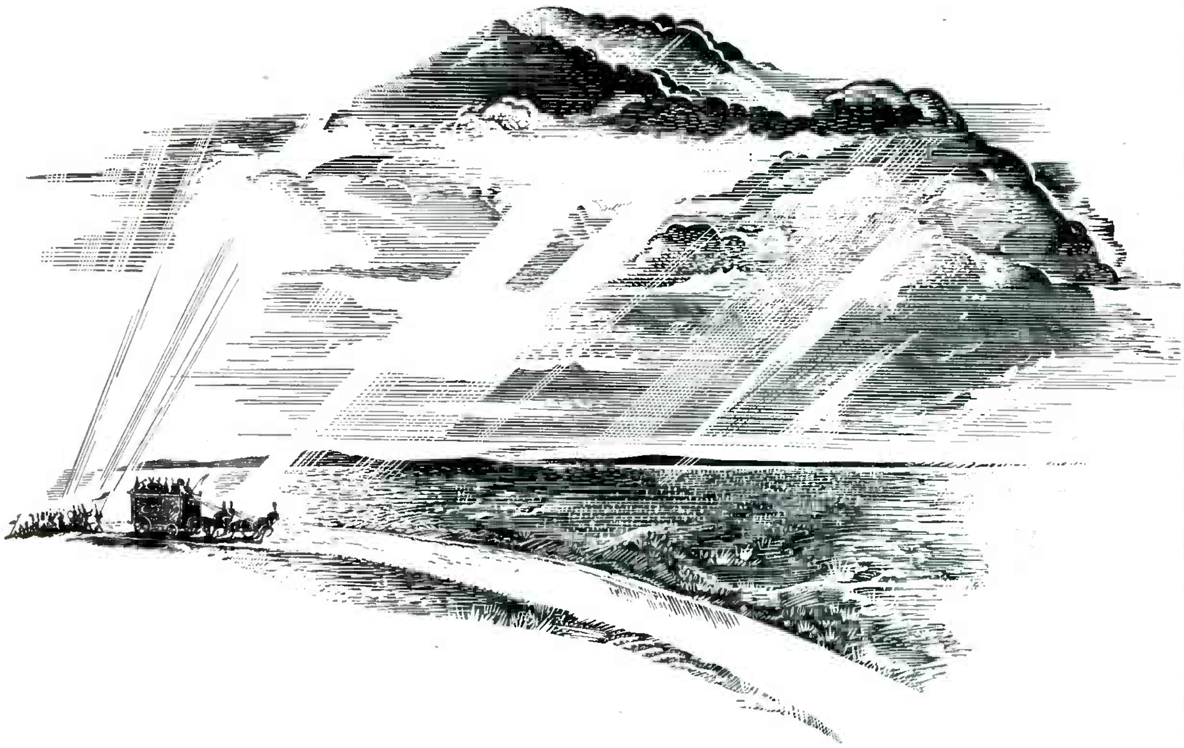
Science Talent Search Finalists

FORTY FINALISTS in the third annual nationwide Science Talent Search attended a five-day, all-expense Science Talent Institute in Washington during March when they met leaders in many fields of science and high government officials.

During the Institute, interviews and final examinations determine the award of two four-year Westinghouse Science Grand Scholarships worth $2,400 each, and at the discretion of the judges, up to $3,000 in additional scholarships.

Citations of honorable mentions

HERE'S THAT BANDWAGON AGAIN



Once in a blue moon it comes along . . . that symbol of great opportunity dear to the heart of every progressive American—the Bandwagon! It's here again!

This time the Bandwagon is Television. You've been waiting for it. Do you recognize it now that it's time for the first seats to be taken? Better look again.

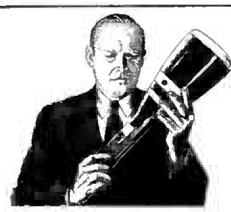
Television stands today where radio stood a few years ago . . . where movies stood a few years earlier. Those Americans who were *the first to climb* aboard are continually congratulating themselves!

Men who can judge the future by the past are already climbing aboard this 1944 Bandwagon. They know that television, which combines the best in radio and movies (plus a few things of its own), promises to confound the skeptical and reward the enterprising by soaring to the greatest heights of all . . . *soon.*

Plan *now* for your telecasting studio. Reserve that equipment *now*. . . equipment that insures low cost operation. These things can be done. DuMont will do them for you.

Allen B. DuMont has specialized in television since it was a laboratory curiosity. By developing the DuMont Cathode Ray Tube, he earned the title, "The Man Who Made Commercial Television Practical"; he put wheels on Television's Bandwagon. Climb aboard!

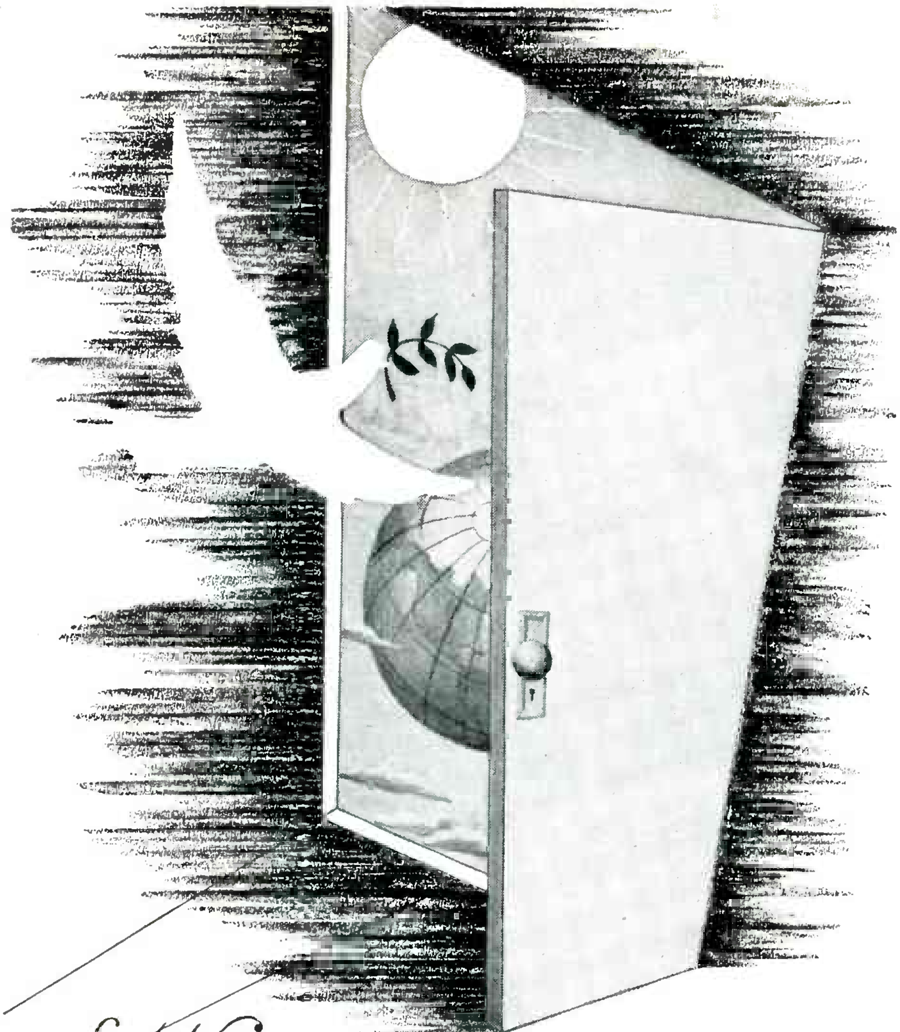
The man who made commercial television practical can make it profitable for you.



Allen B. DuMont, creator of the DuMont Cathode Ray Tube. DuMont is now providing complete plans for complete telecasting equipment . . . will custom-build your transmitting set-up, provide training for personnel at cost, equip your station, reserve your material. The very cornerstone of this service is low cost of operation. We invite your inquiries.

DUMONT *Precision Electronics and Television*

ALLEN B. DuMONT LABORATORIES, INC., GENERAL OFFICES AND PLANT, 2 MAIN AVENUE, PASSAIC, N. J.
TELEVISION STUDIOS AND STATION W2XWV, 515 MADISON AVENUE, NEW YORK 22, N. Y.



were also awarded to 260 entrants who ranked high in the preliminary phases of the Search, but not high enough to qualify as delegates to the Institute. Honorable mentions are brought to the attention of all colleges and universities, which in past years have offered substantial scholarships on the basis of this attainment.

The Science Talent Search is conducted by Science Clubs of America, and the scholarship awards are provided in the interest of developing new scientific talent in America by the Westinghouse Electric and Manufacturing Company.

Radio Club of America New Officers

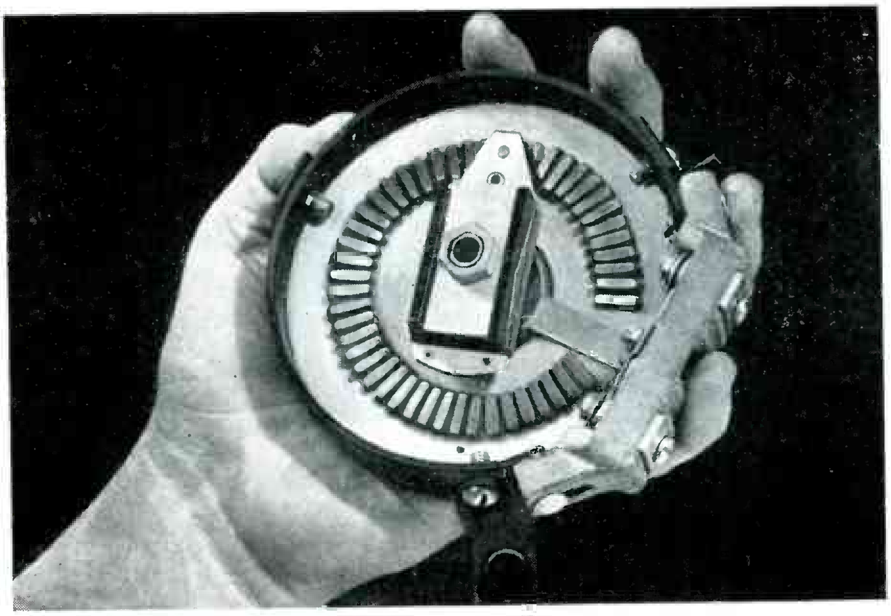
NEWLY-ELECTED OFFICERS of the Radio Club of America, Inc., for 1944, are as follows: president, F. L. Klingenschmitt, Amy, Aceves & King, Inc.; vice-president, O. James Morelock, Weston Elec. Inst. Corp.; treasurer, J. J. Stantley, Continental Sales Co.; corresponding secretary, M. B. Sleeper, *FM Radio-Electronics;* and recording secretary, J. H. Bose, engineer connected with Major E. H. Armstrong at Columbia University.

Personnel

Dr. Vannevar Bush, director of the office of Scientific Research Development of the Office of Emergency Management and president of the Carnegie Institution of Washington, received the 1943 Edison Medal of AIEE at the winter meeting in January. He is chairman of the joint committee on new weapons and equipment of the joint United States Chiefs of Staff since 1942, and is a member and former chairman of the National Advisory Committee for Aeronautics.

W. R. David, G-E engineer since 1919, has been named sales manager of broadcast equipment for the Transmitter Division of the General Electric Co. Electronics Department.

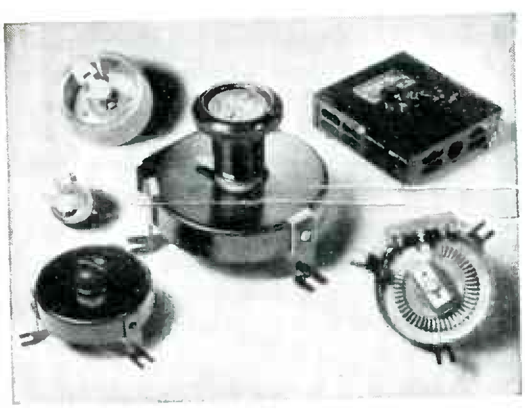
Les Willyard has been appointed chief engineer of Universal Microphone Co.



A SMALL RHEOSTAT with *BIG* FEATURES

The fact that a Rheostat is small, in no way diminishes the importance of its functioning.

Ward Leonard recognizes this and has produced their 4" Plate Type Rheostat with all the desirable features of their largest equipment. It dissipates heat from both sides. The contacts are solid metal blocks for durability. Action is smoothness itself. There are forty-three steps of control.



WL RHEOSTAT BULLETINS

Bulletins are available describing the various Ward Leonard Rheostats. The line is complete including from the small ring types up to the heaviest duty, multiple mounted, power driven units. Write for data bulletins describing the type of Rheostats of interest to you.

ARMY E NAVY

WARD LEONARD

RELAYS • RESISTORS • RHEOSTATS

Electric control WL *devices since 1892.*

WARD LEONARD ELECTRIC COMPANY, 32 SOUTH STREET, MOUNT VERNON, NEW YORK

A. W. Hill, design engineer, has been named manager of Power Circuit Breaker Engineering at the Westinghouse East Pittsburgh Works.

George C. Connor, radio field engineer with Sylvania Electric Products, Inc., has been appointed manager of the California division of the company's equipment tube sales.

Lloyd Long, radio engineer and instructor at the Oakland Airport for United Airlines, is now technical engineer in the production control laboratory of Universal Microphone Co.

R. Morris Pierce, chief engineer of WGAR for thirteen years, has been elected vice-president in charge of engineering of WJR, Detroit, WGAR, Cleveland, and KMPC, Los Angeles. He is chief engineer of Psychological Warfare for OWI and made possible the broadcast of surrender terms to the Italian navy. Lloyd Wingard will serve as acting chief engineer of WGAR until Pierce returns from overseas and a successor is named.

Charles Hubbard Hill, for forty years design engineer with General Electric Co., died at his home in Drexel Hill, Pa. at the age of seventy-four.

Henry J. Hoffman, engineer and chairman of the Electronics Division of NEMA, has been appointed sales manager of the Power Tube Division of Machlett Laboratories, Inc. as well as administrative assistant to Miles Pennybacker, vice-president of the company.

Herbert L. Rawlins has become manager of the Protective Devices Engineering Department at the Westinghouse East Pittsburgh Works.

Robert G. Hoof has become liaison engineer in the Contract Administration Department of Pacific Division of Bendix Aviation Corp.

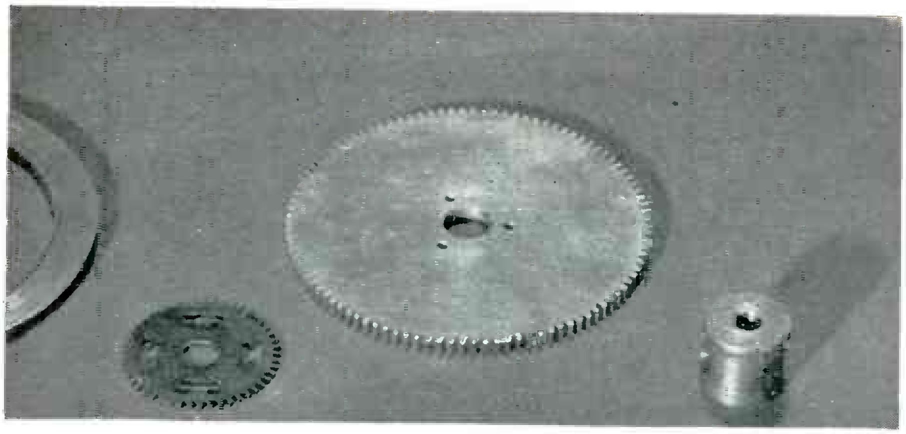
Harry K. Werst, partner and former staff engineer of Booz, Allen and Hamilton, has been appointed vice-president in charge of manufacturing of Elastic Stop Nut Corp.

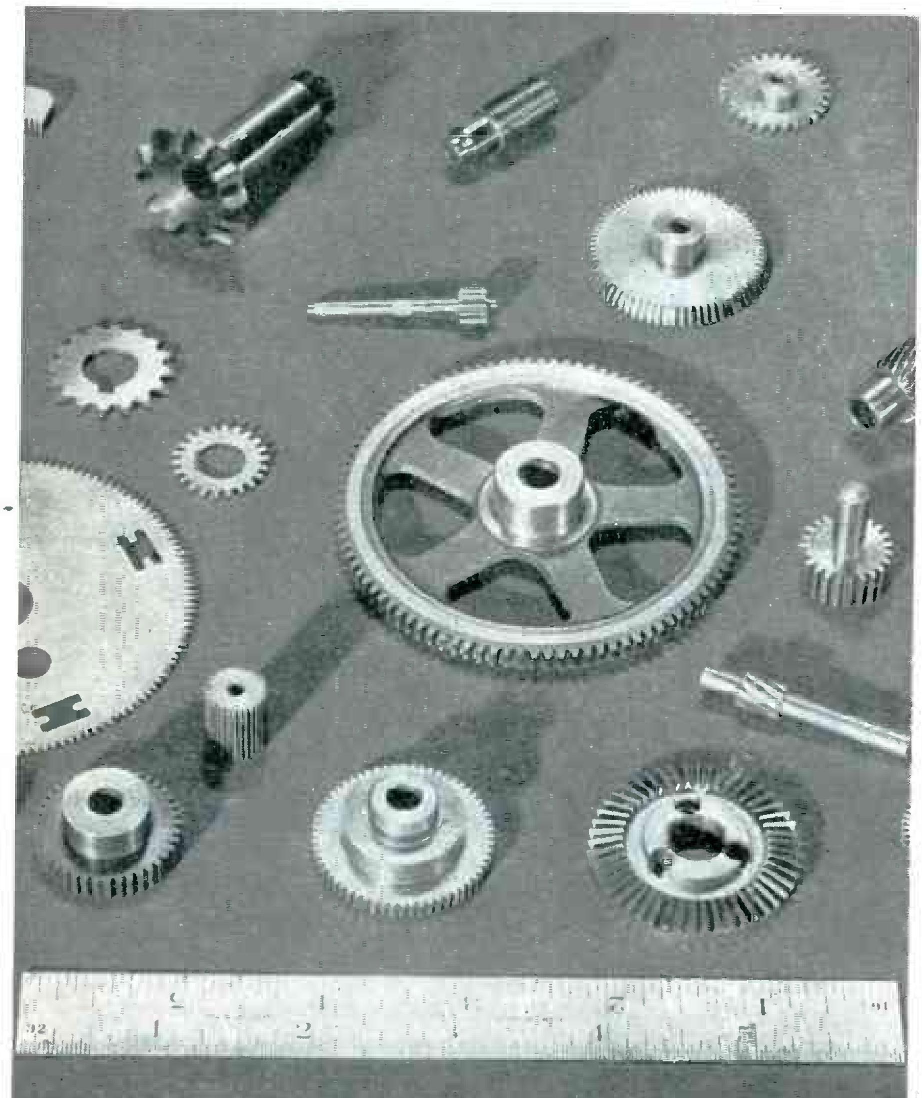
Connecticut Telephone and Electric Division,

MERIDEN — GREAT AMERICAN INDUSTRIES INC. — CONNECTICUT

Today: Field telephones, military switchboards, electronic devices, aircraft ignition systems—produced to Army-Navy "E" standards by a group of men and women putting an average of 15% of their incomes into war bonds and proud of one of the lowest percentages of absenteeism in the nation.

Tomorrow: Civilian communications equipment, industrial control instruments, hospital communicating and signalling equipment, and precision electrical products — produced by men and women who are demonstrating their ability to get things done and done right—earning the right to be remembered.





Dr. Walter H. Kohl has been appointed chief engineer and vice-president of Rogers Radio Tubes Ltd. of Toronto, Canada.

John Harold Ryan, assistant director of Censorship in charge of radio, has been elected president of NAB to succeed Neville Miller when his term of office expires on June 30, 1944.

Fred D. Williams, past president of RMA, has succeeded Ross D. Siragusa as chairman of the RMA Committee on Industry Statistics. G. W. Henyan, chairman of the RMA Transmitter Division, is a new member of the statistics committee.

W. P. Hilliard, director of Sales and Engineering of the Radio Division of Bendix Aviation Corp. since 1936, has been appointed general manager of the Radio Division, succeeding Hugh Benet who has assumed a special assignment.

J. Kelly Johnson has joined the engineering staff of Hammarlund Manufacturing Co. as executive engineer in charge of all engineering activities.

R. L. Anderson has been appointed chief engineer of Franklin Transformer Co. of Minneapolis.

Robert C. Gold, field engineer in Photophone theater equipment installation, has returned to RCA Service Co. headquarters in Camden after spending eight months servicing radio and electronic equipment of the armed forces in North Africa.

Allan B. Chapman, RCA Photophone engineer in Texas, is in Europe on assignment by RCA for installation of ship-borne electronic equipment, in cooperation with the U. S. Navy.

E. D. Van Dyne, field engineer for RCA Service Co., has been appointed a group leader on electronic equipment installation at a U. S. Navy Yard on the Atlantic Coast.

Major W. P. Saunders is on duty in the Office of the Chief Signal Officer, where he was recently promoted to the grade of Major from Captain.

The part you can't see...

Of course you can't even see post war products yet . . . but when they get here we know they are going to be pretty fine. One reason is that the parts in them will be better due to the precision techniques learned in war.

Rubber parts today are precision made, too. Some of them we make must be accurate to a thousandth of an inch . . . and stay resilient at terrific extremes of temperature and pressure.

Thousands of such small parts make the efficient, unbeatable operation of America's war machines possible . . . all Johnson Rubber production today is for Uncle Sam.

There will come a day, though, when we all have to think about transferring the boys' names from the honor roll to the pay roll, and getting back to our regular job of supplying a peacetime market. To meet that great day with a minimum of time waste is important to the boys coming back . . . and important to you.

Lay your plans now. Let us help you. Johnson engineers and designers can help you solve problems in your post war products . . . and come up with the right answers in the right kind of rubber in the specific part you need . . . and this precision in rubber perfected in wartime will serve you well in peacetime.

We will be ready to supply you when the time comes . . . but the time to think about it and plan ahead is now . . . not then.

Make Rubber Stocks
STRETCH
They are a wartime weapon!

JR

The JOHNSON RUBBER CO. • Middlefield, Ohio

MOLDED & EXTRUDED RUBBER PARTS FOR INDUSTRY'S VITAL ASSEMBLIES

Indispensable in War—Essential in Peace

Since 1895

Radio Business News

BROWN INSTRUMENT CO. is conducting an instrument maintenance and repair course designed to meet the requirements of customers who send students to the school to receive continuous-balance instrument instruction.

AMPEREX ELECTRONIC PRODUCTS has placed a second plant in operation near the parent plant in Brooklyn, N. Y.

MACHLETT LABORATORIES, INC. has opened a Power Tube Division in Norwalk, Conn.

GENERAL ELECTRIC CO. Electronics Department is conducting a thirty-day course in electronics for Navy personnel and civilians.

WESTERN ELECTRIC CO. has leased 200,000 sq ft of floor space in two industrial buildings in Lincoln, Neb.

PRECISION PAPER TUBE CO., maker of dielectric coil bases, has quadrupled its factory space.

KEN-RAD TUBE & LAMP CORP. made cash awards to 28 employees for suggestions that improved production and efficiency.

BENDIX AVIATION CORP. has opened an office in the Lincoln Building, 60 East 42nd St., New York 17, N. Y.

ELECTRO PLASTIC PROCESSES of 2035 West Charleston St., Chicago 54, Ill. has taken over the new process of metal plating on plastics, glass, etc. developed by Precision Paper Tube Co.

NORTH AMERICAN PHILIPS CO., INC. has purchased Philips Metalix Corp., maker of x-ray tubes and equipment, and will continue operation as the Metalix Division of the company.

ALLIED CONTROL CO., maker of electrical control devices and fiber lock-nuts, will open a new factory in Chicago.

AMERICAN RADIO HARDWARE CO., INC. has opened a new plant at Mount Vernon, N. Y.

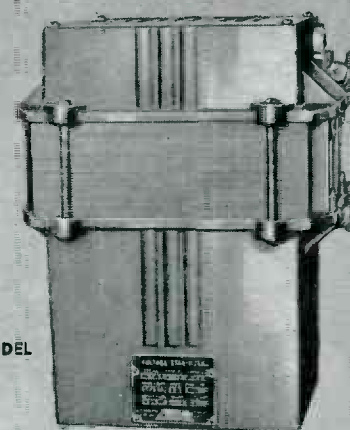
INTERNATIONAL TEL. & TEL. CORP. has appointed four new vice-presidents and four second vice-presidents. The new vice-presidents are: H. C. Roemer, vice-president and

RAYTHEON VOLTAGE STABILIZERS

control fluctuating voltage to ±½%

- Stabilize at any load within their ratings.
- Hold constant varying A. C. input voltage to ± ½%.
- Quick action . . . fluctuating input voltage is stabilized within 2 cycles. Variations cannot be observed on an ordinary volt meter.
- Wide A.C. input voltage limits . . . 95 to 130 volts.
- Entirely automatic . . . no moving parts . . . requires no maintenance . . . connect it and forget it.

Bulletin DL48-537 is new — write for your copy.



ENDBELL MODEL

DIMENSIONS IN INCHES

Index Ref. No.	L 50~	L 60~	W	H
G-5	13 1/8	12 1/2	9 5/8	8 1/2
G-6	14 5/8	14	14 3/4	11 7/8
G-7	17 1/2	16 3/4	14 3/4	11 7/8

INPUT 95-130 V 60 CYCLES 1-PHASE OUTPUT 115 V PLUS OR MINUS ½%

WATTS	CASED Cat. No.	CASED Net Wt.	Index Ref. No.	UNCASED Cat. No.	UNCASED Net Wt.
30	VR-1	8 lbs.	G-1	VR-107	6 lbs.
30	VR-1-A†	8 "	G-1	VR-107-A†	6 "
60	VR-2	18 "	G-2	VR-207	16 "
120	VR-3	26 "	G-3	VR-307	22 "
250	VR-4	46 "	G-4	VR-407	36 "
500	VR-5	70 "	G-5		
1000	VR-6	140 "	G-6		
2000	VR-7	200 "	G-7		

†OUTPUT 6.0 or 7.5 VOLTS PLUS OR MINUS ½%.

INPUT 190-260 V 60 CYCLES 1-PHASE OUTPUT 220/230 V ± ½%

WATTS	CASED Cat. No.	CASED Net. Wt.	Index Ref. No.
2000	VR-7-A	200 lbs.	G-7

INPUT 95-130 V 50 CYCLES 1-PHASE OUTPUT 115 V PLUS OR MINUS ½%

WATTS	CASED Cat. No.	CASED Net Wt.	Index Ref. No.	UNCASED Cat. No.	UNCASED Net Wt.
25	VR-155	8 lbs.	G-1	VR-158	6 lbs.
60	VR-255	21 "	G-2	VR-258	19 "
120	VR-355	26 "	G-3	VR-358	23 "
250	VR-455	50 "	G-4	VR-458	42 "
500	VR-555	80 "	G-5		
1000	VR-655	150 "	G-6		
2000	VR-755	220 "	G-7		

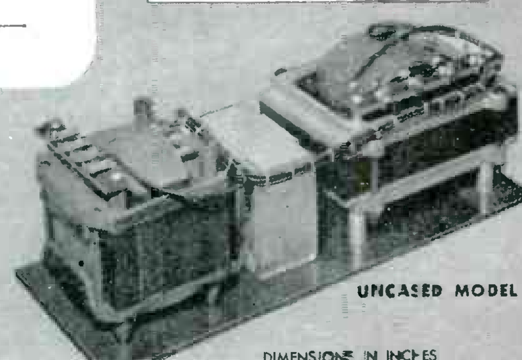
INPUT 190-260 V 50 CYCLES 1-PHASE OUTPUT 220/230 V ± ½%

WATTS	CASED Cat. No.	CASED Net Wt.	Index Ref. No.	UNCASED Cat. No.	UNCASED Net Wt.
25	VR-521	8 lbs.	G-1	VR-510	6 lbs.
60	VR-522	21 "	G-2	VR-520	19 "
120	VR-523	26 "	G-3	VR-530	23 "
250	VR-524	50 "	G-4	VR-540	42 "
500	VR-525	80 "	G-5		
1000	VR-526	150 "	G-6		
2000	VR-527	220 "	G-7		

CASED MODEL

DIMENSIONS IN INCHES

Index Ref. No.	L	W	H
G-1	8 7/8	3 7/16	4 1/2
G-2	11 3/8	4 7/8	5 5/8
G-3	15	6	6 1/8
G-4	18 5/8	7	8 7/8



UNCASED MODEL

DIMENSIONS IN INCHES

Index Ref. No.	L	W	H Max.
G-1	7 9/16	3	3 5/8
G-2	7 7/8	5 1/16	5 3/16
G-3	12 7/32	5 1/16	5 3/8
G-4	15 9/16	6 3/4	7

Raytheon RectiChargeRs (battery chargers) . . . complete range of units from 1 to 12 amps . . . many models for 50 cycles input.

Raytheon RectiFilteRs (battery eliminators) . . . wide range of models available for varied operations . . . 50 or 60 cycles.

RAYTHEON MANUFACTURING Company

190 WILLOW ST WALTHAM, MASS

The coveted Army-Navy "E", for Excellence in the manufacture of war equipment and tubes, flies over all four Raytheon Plants where over 12,000 men and women are producing for VICTORY.

comptroller of Federal Tel. & Radio Corp., affiliate of IT&T; W. H. Freng, assistant general attorney, also appointed solicitor; Charles D. Hilles, secretary of the corporation; and Francis White, vice-president of International Standard Electric Corp., another IT&T affiliate.

The second vice-presidents appointed are F. F. Davis, H. H. Buttner, vice-president of Federal Tel. and Radio Corp., G. A. Ogilvie, Leonard Jacob II.

WHEELCO INSTRUMENTS COMPANY will continue at the same location since purchase by Fred A. Hansen and Cary H. Stevenson, vice-presidents of Lindberg Engineering Co. and several associates. The company will expand in industrial applications of electronics and supersonics.

NORTH AMERICAN PHILIPS CO., INC. has established a new electronics research laboratory at Irvington, N. Y. and appointed Dr. Ora Stanley Duffendack, professor of physics at University of Michigan since 1922, as research director. He has been a director of research with NDRC and serves as chief of one of its sections.

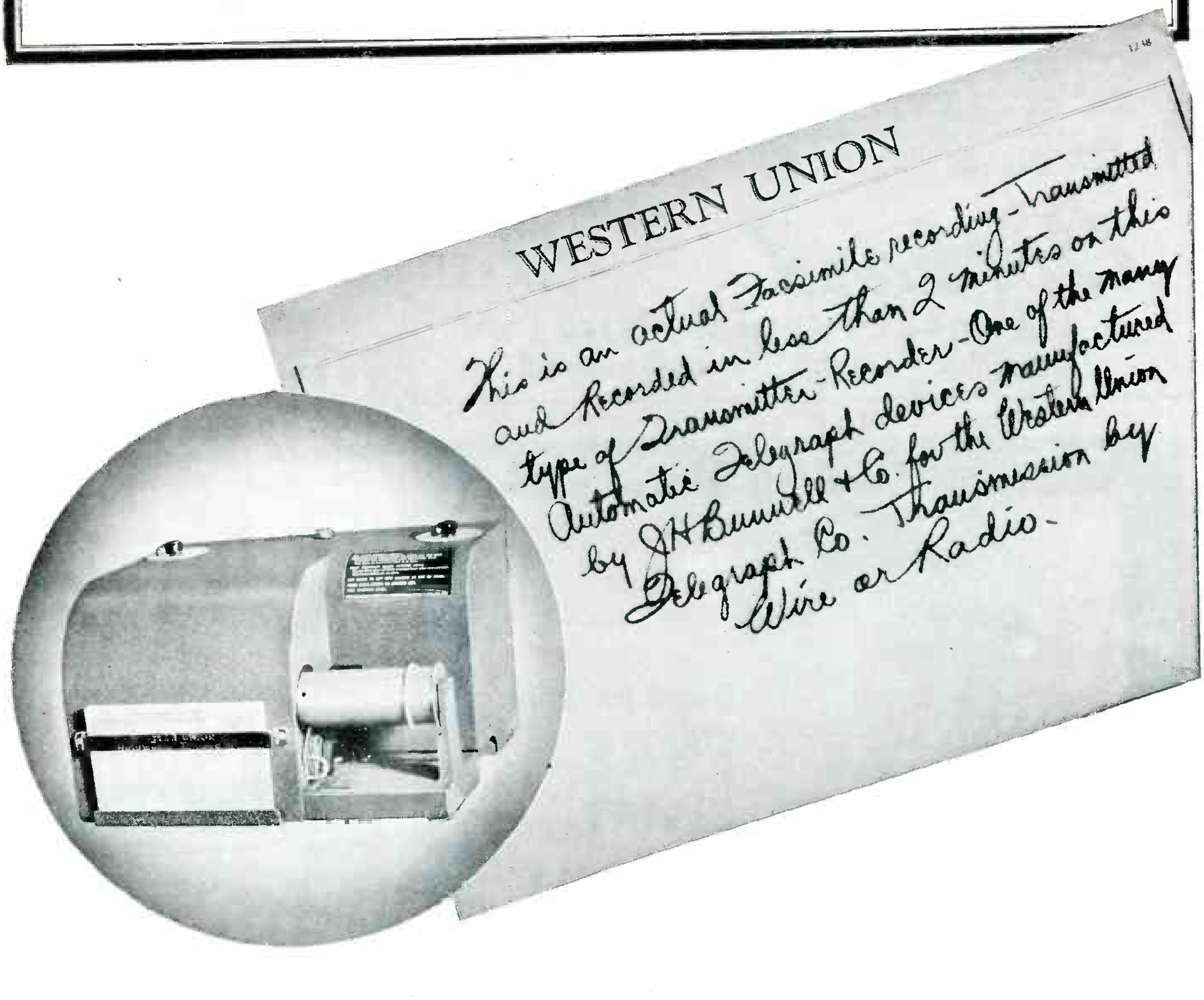
UNIVERSAL MICROPHONE CO., LTD. has become Universal Microphone Company.

E. I. DU PONT DE NEMOURS & CO. is building a plant at Towanda, N. Y. for the Patterson Screen Division to manufacture phosphors of the type previously imported from England.

ZENITH RADIONICS CORPORATION OF NEW YORK has been formed as a subsidiary of Zenith Radio Corp, with offices in the Empire State Building. Zenith president E. F. McDonald, Jr., will also head this new distributing corporation, and H. J. Wines has been appointed general manager. Announcing the new set-up at a press conference in New York in March, Zenith vice-president J. J. Nance stated that a great deal of post-war planning today consists of figuring out how to get into the other fellow's business. He also pointed out that obsolescence is speeded up during wartime, so that there will be a post-war replacement market of 30 to 40 percent of the 60,000,000 radio receivers in homes today.

Facsimile

Tells its own story!



J. H. BUNNELL & Co.

DESIGNING ENGINEERS AND MANUFACTURERS OF
ELECTRONIC INDUSTRIAL & COMMUNICATIONS EQUIPMENT

GENERAL OFFICES: 215 Fulton St., New York City • FACTORIES at Brooklyn, N. Y.

German Radios

(*Continued from page* 134)

airplane, by inserting a test plug in a jack panel provided on the front of both receiver and transmitter. A complete diagnosis of any unit can be made by this means.

Summary of Features

German design for this particular equipment, which is thought to be of 1935 construction, features:

Ease of operation.
Simplicity of control.
Serviceability.
Ease and speed of repair or replacement.
Mass production, and
General utility. (By general utility, we mean that this particular set, due to its construction, could readily be used on shipboard, in tanks and other motorized units.)

Getting down to the fine points of design, the FUG-16 features:

Extensive use of die castings.
Small wire sizes.
Use of band seals in place of lock-washers.
Fewer values of resistors and capacitors.
Fewer tube types, both for transmitter and receiver.
Provision for obtaining spot frequencies.
Provision for checking the transmitter frequency against the receiver.
Color-coded screws to show which screws are to be loosened in removing unit.
Frequency-calibrated dial scales.

• • •

MOBILE MEGAPHONE

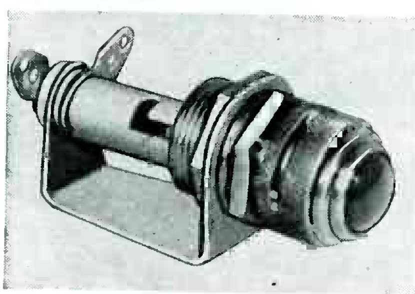
To decrease road fatalities in London, pedestrians are directed by an officer with a portable electronic megaphone. This unit can be used while walking with the batteries and amplifier in the carrying case

NEW PRODUCTS

Month after month, manufacturers develop new materials, new components, new measuring equipment; issue new technical bulletins, new catalogs

Dim-Out and Black-Out Pilot Lights

PILOT LIGHTS are available either as dim-out lights or as complete black-out lights. The lights employ two discs, each of which has 3 holes. When the discs are aligned so that the 3 holes in each disc is opposite each other, the pilot light produces a bright light. As the discs are rotated 90 deg, the grad-



ual misalignmnt of the holes slowly reduces the brilliance of the light until it finally reaches a total black-out. If a dim glow is desired instead of a total black-out, a fourth hole is provided in the center of each disc. This fourth hole always allows a small amount of light to seep through.

Gothard variable intensity lights are also available with polarized lenses.

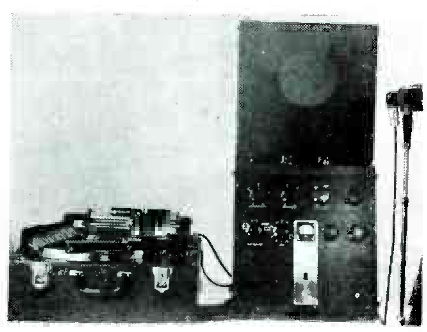
Gothard Pilot Light Co., 1300 North 9th St., Springfield, Ill.

Portable Sound Recording Devices

A RECORDER AND PLAYBACK unit and an amplifier-equalizer are two devices which have been improved over pre-war models and which will be available from the manufacturer in the very near future. The first of these devices is a recorder which uses a new magnetic cutter head and has an improved low-pressure pickup with a choice of crystal or dynamic type. The weight of the equipment has been reduced by approximately 70 pounds. The general vibration level has been reduced by 5 to 8 db.

The equipment may be used either indoors or outdoors though it is designed for portable field service.

It will take direct lateral recordings and will reproduce sound at speeds of 78 rpm or 33.3 rpm and will play back discs up to 16 inches. Cables and plugs provide instantaneous hookup to an amplifier to enable recording or playback. The recording mechanism can select



four cutting pitches (either from the inside of the record to the outside or from the outside in) without the necessity of changing feed screws. A push rod on the center pivot of the turntable is used to change the speed of the turntable from 78 rpm or 33.3 rpm. The recorder is equipped with 110–120 volt, 60 cps, synchronous motor which is dynamically balanced. The equipment itself is supplied for operation on 115 volts, 60 cps.

Lower hum and noise level are the main improvements made in the amplifier-equalizer unit. This unit is designed for use in studio recording, playing back records, and PA uses. It is compact and comes in a light guage metal trunk which measures 17 inches wide, 18¼ inches high, 11 inches deep. A boost of from zero to 20 db is available at any frequency from 20 to 100 cps, and from 4,000 to 10,000 cps. It is not necessary to alter the volume or gain of an amplifier in the midst of a recording merely because the equalization is changed. Input plugs are available for a microphone of 50 or 250 ohms impedance, for two crystal pickups of 10,000 ohms impedance, and for a T unbalanced and an H balanced 500 ohm impedance for radio tuner or line from an external mixer. Outputs are provided for two recorders as well as for a T unbalanced and an H balanced 500 ohm output line.

Maximum undistorted output is 12.51 watts from the 500 ohm winding of the T or H position on the output. The noise level below zero level of 0.006 watts at full gain of amplifier with bass and high controls off is —22 db. and the hum level is —40 db. The microphone input positions have a gain of 107 db. Both pickup positions have a gain of 61 db, and both line input positions a gain of 67 db. If the dynamic pickups are used the pickup inputs will be wired for 50 ohm impedance at 170 db. gain.

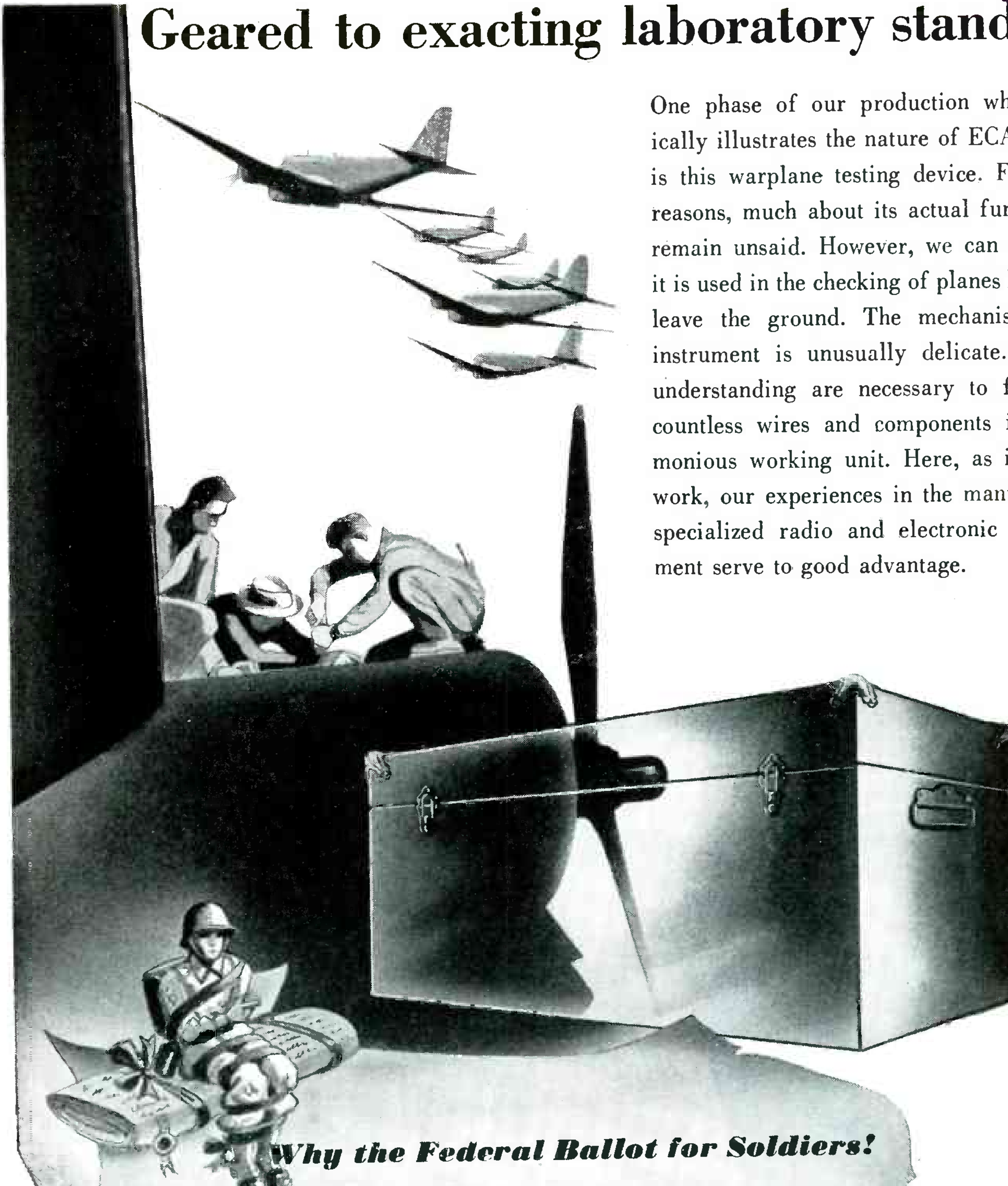
Fairchild Camera and Instrument Corp., 475 Tenth Ave., New York 18, N. Y.

Electron Microscope Capacitor

THIS 0.01 MFD, 40,000 volt d-c capacitor was built for a special application of the electron microscope. It is capable of continuous operation at 80 deg C and of withstanding total submersion and heavy surges. The case is welded steel measuring 4$\frac{11}{16}$ x 5¾ x 7 inches. The case has a stand-off insulator (Westinghouse Solder Seal type) which is soldered directly to the case, eliminating the possibility of oil leakage or the entrance of moisture.

Industrial Specialty Co., 1725 W. North Ave., Chicago 22, Ill.

Geared to exacting laboratory standards



One phase of our production which graphically illustrates the nature of ECA standards is this warplane testing device. For obvious reasons, much about its actual function must remain unsaid. However, we can reveal that it is used in the checking of planes before they leave the ground. The mechanism of this instrument is unusually delicate. Skill and understanding are necessary to fashion the countless wires and components into a harmonious working unit. Here, as in all ECA work, our experiences in the manufacture of specialized radio and electronic test equipment serve to good advantage.

Why the Federal Ballot for Soldiers!

At ECA, we earnestly cooperate with every phase of the war program. We are also conscious of another responsibility to our soldiers, that is, the preservation of their rights. As this is being written, legislation permitting soldiers to vote is under consideration. The Federal Ballot is unconstitutional, it violates states' rights—so some men say. To us, the argument for the Federal Ballot is quite clear. If the government has the power to go into any state and select a man for service, then it should have the equal power to make certain that he can take advantage of his *constitutional* right to vote—in the easiest possible manner. Back the President, the War Department and all others who support the Federal Ballot. There is no red tape wrapped around a bullet. It should not be wrapped around a ballot.

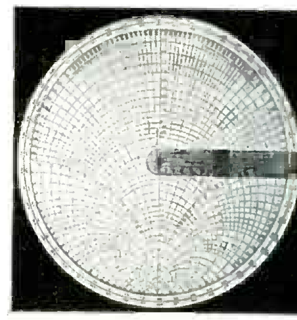
ECA

ELECTRONIC CORP. OF AMERICA

45 WEST 18th STREET • NEW YORK 11, N.Y. WATKINS 9-1870

Transmission Line Calculator

IN THE JANUARY 1944 issue of ELECTRONICS there appeared an article and a cut-out form of an improved transmission line calculator which was an extension of the



"calculator" originally published in the January 1939 issue of ELECTRONICS and for which many requests have been received. Now this new and improved calculator from February issue is available separately as a chart. It is available for $5,00 from The Emeloid Co., Inc., Arlington, N. J.

Hermetically Sealed Transformer

TYPE S IS AN ADDITION to the manufacturer's line of transformers which utilize the "Vac-sealing" im-

pregnation process to insure impregnation. It has a case of cold drawn copper cadmium plated steel to insure ruggedness. The terminal of the unit is molded into a plastic block which has a metal flange molded into its periphery. This flange is then soldered into the case. The manufacturer states

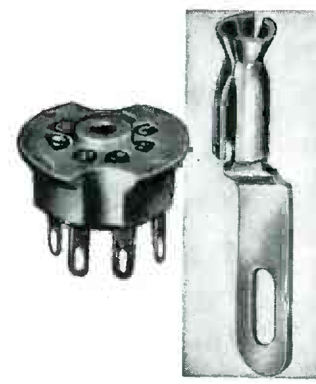

rods
tubes
shapes
tapes
RIGID...to FLEXIBLE...
Compounders and Extruders of Specific Materials for Specific Uses
Synflex Compounds as developed in our own laboratories are produced only in the form of rods, tubes, shapes, tapes and elastics. These distinguished materials meet and surpass the most exacting requirements of the electrical and aviation industries. Many formulations are available, each for a specific job.
Synflex FT 10 is used for the lowest temperature applications, retaining its flexibility to −85°F. * * Synflex FT 11, a transparent material, is effective in a wide range of working temperatures from −60°F. to 188°F. * * Synflex FT 22 has a high dielectric strength and for many applications supplants varnished tubing and sleeving.
Synflex rubber-like Tubings are in continuous lengths from B. & S. #24 (.021 I.D.) to 2.000" I.D. Special sizes and shapes upon request.
Inquiries invited. We will gladly submit complete test methods, data and samples.
SYNFLEX
INDUSTRIAL SYNTHETICS CORPORATION
60 WOOLSEY STREET, IRVINGTON, NEW JERSEY

this new construction offers great flexibility in number and arrangements of terminals.

Peerless Electrical Products Co., 6920 McKinley Ave., Los Angeles 1, Cal.

Miniature Tube Sockets

TWO TYPES OF MINIATURE tube sockets (designed and developed at the Signal Corps Laboratories) incorporate "Micro-Processed" beryllium copper contacts which assure constant, even pressure on all parts of the socket pin without fatigue in the contacts after continuous use. The two types include (1) a low-loss type with Navy Grade G Steatite Casting having loss factor of 0.016 or less when tested in accord-

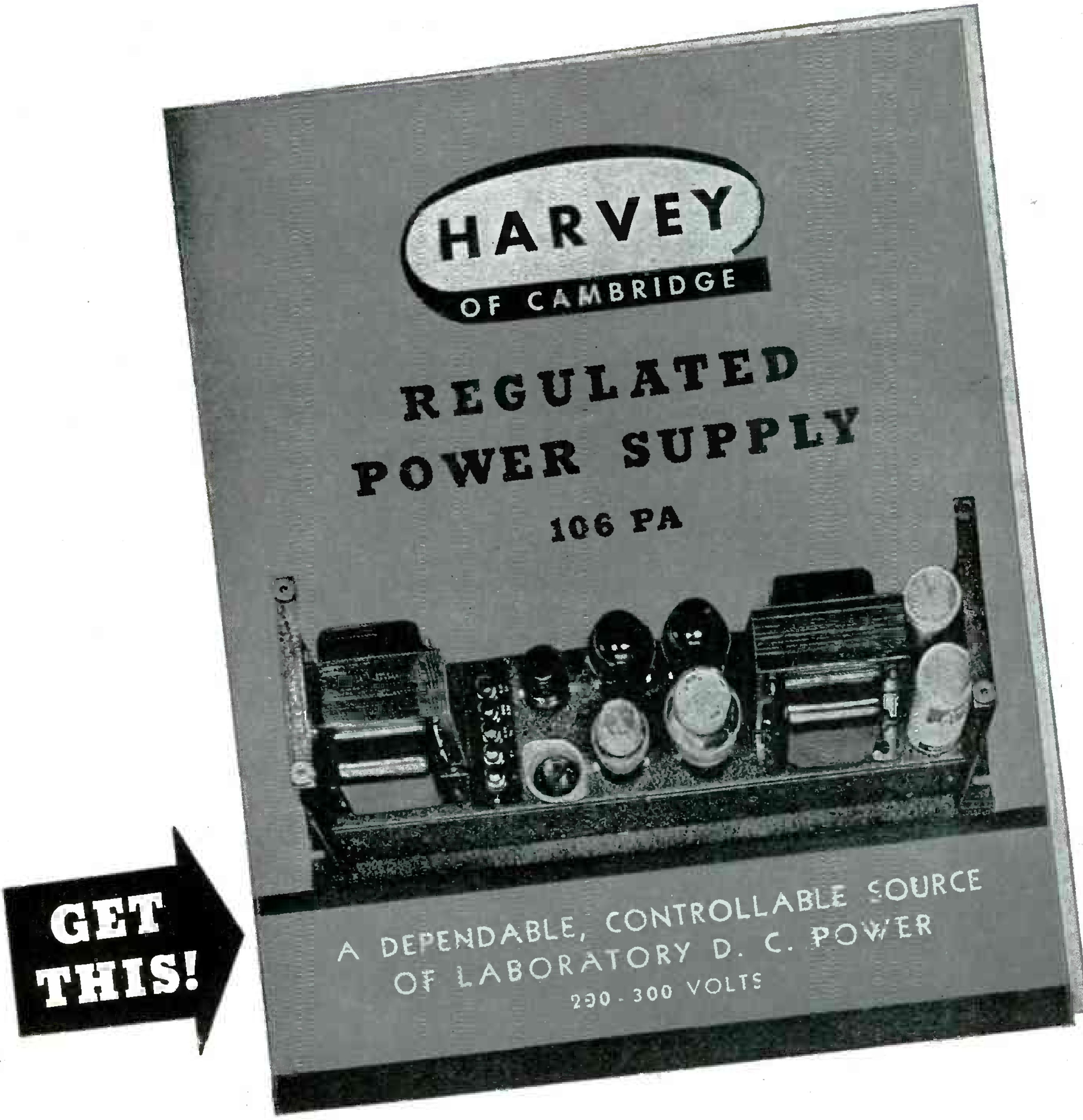


ance with ASTM D 150-42T. Its capacity is 1.5 mmf or less at 10 Mc. The second type is a general purpose type with mica filled plastic casting having a loss factor of 0.05 or less when tested in accordance with the ASTM standard mentioned previously. Its capacity is 5 mmf or less at 10 Mc. The sockets will withstand humidity cycle; immersion; shock; vibration; and thermal shock.

Hugh H. Eby, Inc., 18 W. Chelten Ave., Philadelphia 44, Pa.

Flow Rate Alarm

A NEW FLOW RATE METER may be used by broadcast stations for protecting transmitter tubes against cooling water failure, or the meter may be used in other applications as a means of visible and audible protection against dangerously low or high flows of liquids and gases. This alarm is known as Rota-Sight Flow Rate Alarm. It operates through a float which moves up and down a pyrex tube into which tri-



Reading time only two minutes, yet this boiled-down bulletin on the HARVEY Regulated Power Supply gives you all the answers on a dependable source of D. C. power. You'll want it for reference whether or not you have immediate use for a controlled power supply.

It's yours for the asking. Just jot down your name, position and company address and say, "Send me the bulletin on the HARVEY Regulated Power Supply."

Write to

HARVEY
OF CAMBRIDGE

HARVEY RADIO LABORATORIES, INC.

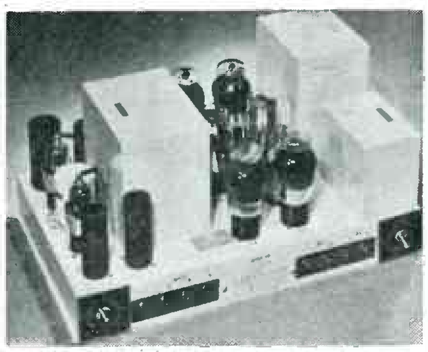
439 CONCORD AVENUE · CAMBRIDGE 38, MASSACHUSETTS

angular flutes have been fashioned. As the float rises, the area within the flutes increases, causing the float to assume a position in the tube in direct proportion to the flow rate. A magnetic extension on the float trips an external switch to operate the alarm circuit. The alarm flow point is adjustable over the entire flow range and operates accurately at the set position. It is built in sizes up to 2½ inches and may be obtained in any corrosion-resistant metal that can be cast.

Bulletin 92-B with full description is available from the manufacturer, Fischer & Porter Co., 9111 County Line Road, Hatboro, Pa.

Amplifier

TYPE 101-A AMPLIFIER has as its outstanding virtue good low-frequency wave form at high output levels. The volume range (inherent noise level) is rated 68 db unweighted below full output of +47 vu at 2 percent rms harmonic distortion. With the input impedance

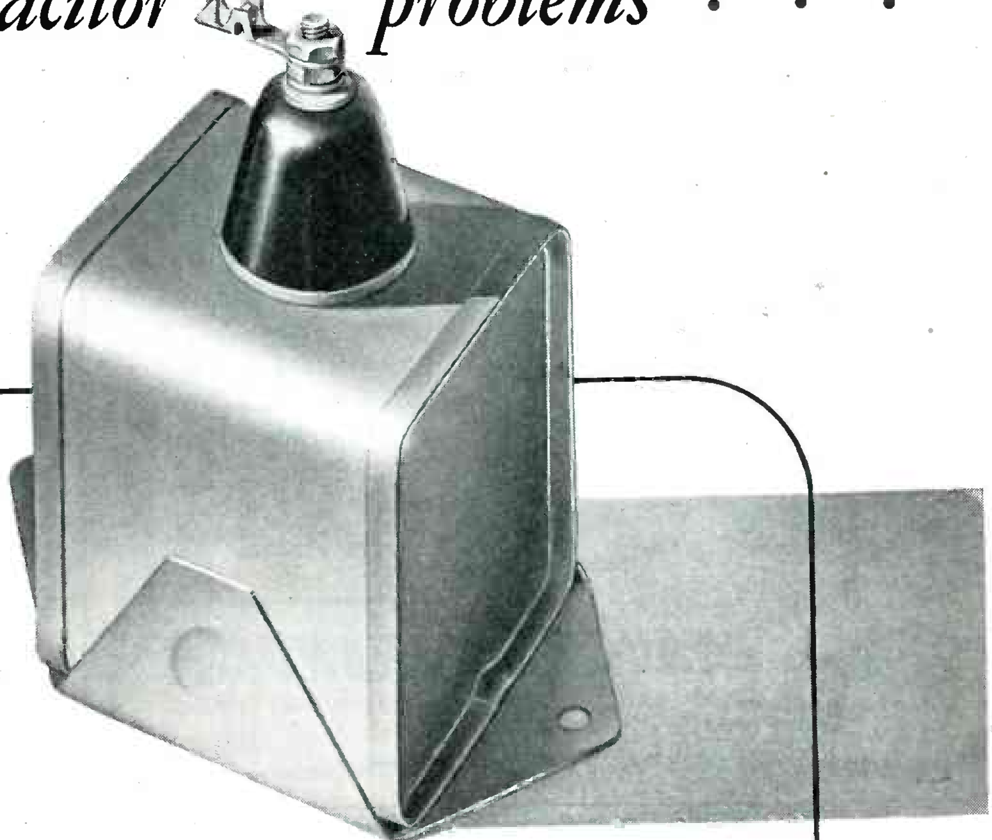


of 600 ohms, the gain is 60 db. Using bridging input, the gain is 46 db. Output impedance is adjustable 1 to 1000 ohms. Gain versus frequency and power output versus frequency characteristics are available upon request from the manufacturer. The Langevin Co., Inc., 37 West 65th St., New York 23, N. Y.

Winding-Insulation Tester

A NEW ELECTRONIC winding-insulation tester for production-line testing of faulty insulation and winding dissymmetries in motors, generators, coils, and transformers employs the principle of balance and comparison. The instrument simultaneously tests turn-to-turn,

Here's How Micamold Helps Project-Engineers *with capacitor problems . . .*



Several thousand transmitting mica capacitors were needed for an imperative wartime function

***Micamold* engineers analyzed the specifications of the mica condenser. They found that a similar type could be built—*without using strategic and costly mica.* This *Micamold* Paper Capacitor is the result.**

The Micamold-created Paper Transmitting Capacitor is mechanically interchangeable with its mica counterpart . . . and serves its purpose in the particular application for which it was designed. Thousands of pounds of precious mica were saved and production costs were greatly lowered.

IF YOU HAVE A CONDENSER DESIGN PROBLEM, CALL ON MICAMOLD

Micamold is equipped to help you with your capacitor problems and to manufacture a wide variety of standard or special types to suit your requirements. Collaboration between project engineers and our own staff has broken many a "bottleneck" We would like to work with you on present or postwar projects.

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

NO LET UP and NO LET DOWN • *KEEP BUYING MORE WAR BONDS*

coil-to-coil, and coil-to-ground insulation. It simulates qualitatively such procedures as resistance, impedance-balance, turn-balance, and complete high-potential tests with one voltage application. It also tests the completed windings of three-phase, low-voltage rotating machines, and is capable of testing the windings of single-phase, two-phase, and d-c motors and transformers whose insulation is not designed to withstand more than 10 kv.

The tester consists of a repeating-type, surge-voltage generator, a cathode-ray oscilloscope, and a synchronously driven switching equipment—all enclosed in one steel cabinet especially designed for bench mounting. The oscilloscope is mounted at eye-level height, where it can be seen easily by the operator, and all the controls are conveniently arranged. Adequate safety portection has been built into the equipment.

General Electric Co., Special Products Div., Schenectady, N. Y.

Multi-Circuit Switch

This new multi-circuit switch weighs three ounces and comes in a sturdy frame which is molded of high-impact phenolic which conforms to Navy specifications. Knurled inserts with full ¼-inch depth of thread are provided (on ⅝ x 1¼ inches centers) and are locked in place so they cannot twist or pull out. Coin silver contacts carry 10 amps a.c., or 2 amps d.c. current, at 115 volts. The contacts may be ganged in any desired number and combination or they may be used for locking or spring-return in either lever position.

Bulletin A-422 gives complete information and is available from Metallic Arts Co., 243 Broadway, Cambridge, Mass.

Induction-Heating Machine

THIS COMPACT INDUCTION motor generator unit is designated as "Tocco Junior" and is a 15 kw output, 9600 cps high-frequency unit useful for a wide-range of heat treating applications such as brazing, annealing, heat-treating and surface hardening of small and medium-sized parts. The generator is driven by a 25 hp, 3 phase, 229–440 volt motor. Capacitors for power factor correction are an integral part of the unit. Controls and four high-frequency instruments (voltmeter, ammeter, wattmeter and var-meter) are mounted on the front of the machine. Timers are provided for establishing the heating or hardening cycles. Field control is obtained through use of a variable voltage transformer operating in connection with selenium rectifiers for obtaining field excitation. Inductors for brazing are designed to treat more than one size of tip. These coils are sturdy, shock resistant and water cooled. The unit measures 43 x 32 x 51 inches and can be easily fitted into a production line.

Other 9600 cps Tocco Junior models available come in ratings of from 7½ to 125 kw ratings, and 200 kw at 3000 cps.

The Ohio Crankshaft Co., 3300 Harvard Ave., Cleveland 1, Ohio.

Tubular Steel Telescopic Radio Mast

A TELESCOPIC 90-FOOT radio mast, designated as "Harco" Speed King, is designed to withstand a wind

MOTHER'S ON THE PLASTIC FRONT

Remler worker removing threaded ear pieces for telephone hand set from plastic molding press.

A VARIETY OF TASKS in all departments of the Remler Company are performed by women. Their dexterity and painstaking attention to detail contribute to the precision accuracy of Remler components and communication equipment. • Like their sister workers in factories all over the country, many of these Remler women also have the responsibility of managing a household. To this double task they bring a devotion worthy of their menfolks in the fighting fronts. Hats off to the women of America!

REMLER COMPANY, LTD. • 2101 Bryant St. • San Francisco, 10, Calif.

REMLER

SINCE 1918

Announcing & Communication Equipment

PLUGS & CONNECTORS

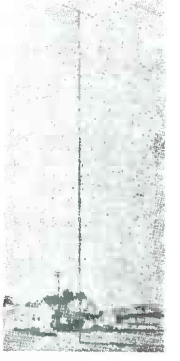
Signal Corps · Navy Specifications

Types:		PL			NAF
50-A	61	74	114	150	
54	62	76	119	159	
55	63	77	120	160	1136-1
56	64	104	124	291-A	
58	65	108	125	354	No.
59	67	109	127		212938-1
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			

OTHER DESIGNS TO ORDER

pressure of 125 miles an hour. It can be erected from ground anchors to top cross-arm in approximately one hour without the aid of trained riggers. The mast is also available in heights from 25 feet up to 200 feet. Is is completely self-contained, portable, and light weight and is suitable for erection on buildings, as well as on the ground.



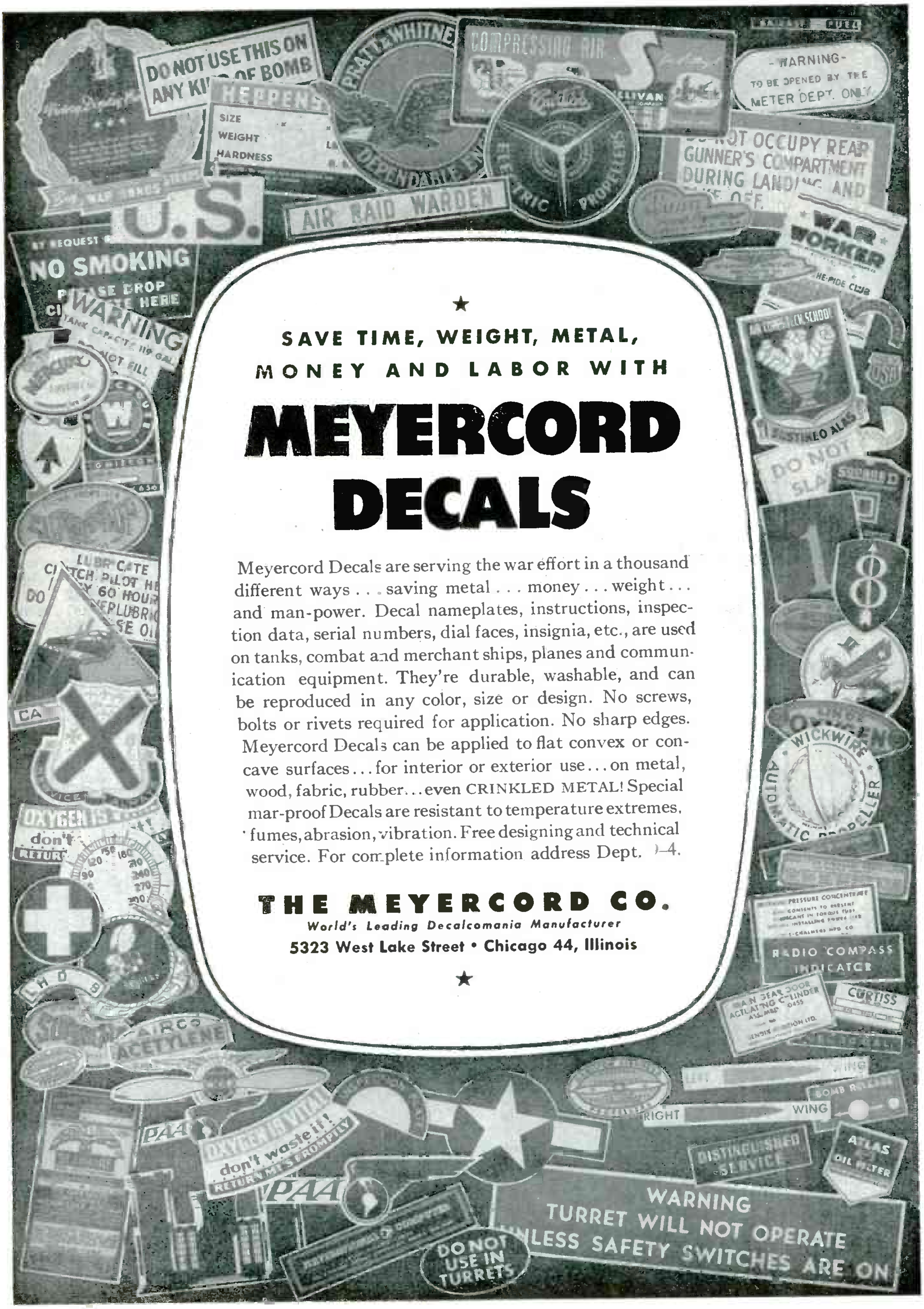
It may be used as a single unit or two or more masts may be set up as a multiple unit for various types of antennas. Insulators may be placed at any connection joint or at the base. The addition of small auxiliary connectors make the mast suitable for use as a vertical radiator.

Basic in the design is the use of light-weight steel tubing. Connecting the section is accomplished by the use of tapered bars and wedges. The smallest section of the 90-foot mast measures 3¼ inch in diameter, and the sections increase to 4½ inches in the center. The unit (complete with cross-arm of approximately 8 feet) weighs 750 pounds.

Harco Steel Construction Co., 1180 E. Broad St., Elizabeth, N. J.

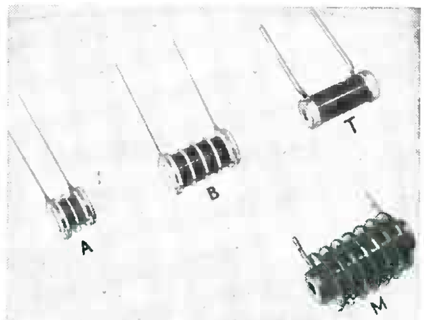
Transmitting Triode Tubes

THESE TWO NEW HIGH-POWER triodes may be used at maximum ratings at frequencies as high as 5 Mc and with reduced ratings up to 25 Mc. Type 9C21 is a water-cooled type and Type 9C22 is a forced-air-cooled-type. Both are for use in the class B modulator stage and in the plate-modulated class C final amplifier stage of high-power transmitters. They may also be used in large units for industrial r-f heating applications. Two separate bulletins describing these tubes are available from RCA Victor Division, Harrison, N. J.


DO NOT USE THIS ON ANY KIND OF BOMB
SIZE
WEIGHT
HARDNESS
U.S.
AIR RAID WARDEN
ELECTRIC PROPELLERS
- WARNING -
TO BE OPENED BY THE METER DEPT. ONLY
GUNNER'S COMPARTMENT DURING LANDING AND
WAR WORKER
NO SMOKING
WARNING
WICKWIRE
AUTOMATIC PROPELLER
RADIO COMPASS INDICATOR
CURTISS
ACETYLENE
PAA
OXYGEN IS VITAL don't waste it! RETURN MTS PROMPTLY
RIGHT
WING
DISTINGUISHED SERVICE
ATLAS OIL METER
DO NOT USE IN TURRETS
WARNING
TURRET WILL NOT OPERATE UNLESS SAFETY SWITCHES ARE ON

Wire Wound Resistors

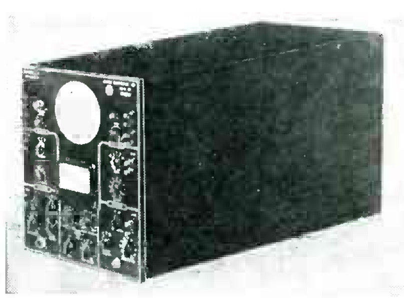
FOUR DIFFERENT TYPES of wire-wound resistors (A, B, M and T) have been recently announced. Types A and B are non-inductive pie-wound and are rated at ½ percent accuracy. Type M is non-inductive wound and Type T is inductive wound. Types T and M are rated at 1 percent accuracy. Ratings are: A ½ watt; B 1 watt; M 1½ watt; and T 2 watts. All of these types are rated at 100 deg maximum operating temperatures and all of them have baked varnished finishes. Resistance varies for the individual units.



Elco Resistors Co., 114 West 18th St., New York 1, N. Y.

Wide Range Oscilloscope

MODEL 556 IS A 5-INCH oscilloscope, equipped with a direct-reading voltmeter for measuring the input signal, and is designed to make measurements at higher frequencies. The sweep generator has a frequency range of 20 cps to 1 Mc. The horizontal amplifier, as well as the vertical amplifier, is practically flat to 2 Mc. The Z-axis amplifier, which is rated up to 6 Mc, permits blanking and marking. A comparison voltmeter is incorporated to increase the usefulness of the instrument and requires no additional equipment to determine the value of the signal.



Reiner Electronics Co., 152 West 25th St., New York 1, N. Y.

CHECK THESE SPECIFICATIONS WITH YOUR REQUIREMENTS

1. General—Designed to conform to "American War Standards C 39.2—1944" for Electrical Indicating Instruments.
2. Size—2½", Round, Flush Mounting, Panel Type.
3. Case—Standard case is of moulded bakelite. Available also in metal (brass) case.
4. Solid alloy-steel magnet (not laminated).
5. Range—Available from 0-200 micro-amperes to 0-10 amperes, or 0-1.0 volt to 0-200 volts.

Expanding production now enables G-M to accept a few volume contracts for meters conforming to the specifications outlined above.

Early in the war G-M converted its civilian production of instruments to volume production of war meters. For one aircraft application alone G-M has supplied over 100,000 meters.

Write or wire today for complete details concerning early deliveries on volume orders.

G-M

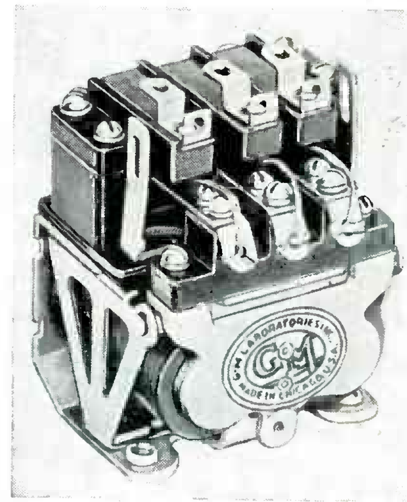
G-M LABORATORIES INC.

4313 NORTH KNOX AVENUE, CHICAGO 41, ILLINOIS

Buy WAR BONDS & STAMPS

Power Relays for Electronic Circuits

TYPE 27 SENSITIVE POWER relays are designed for use in electronic circuits which require small multipole relays, and on aircraft and mobile equipment where vibration is encountered. Contact blades are shimmed to the correct adjustment to do away with bending of any of the metal parts and to retain the original metal structure. General



specifications of the Type 27 relays are: Sizes of 1, 2 and 3 pole relays measuring approximately $1\frac{1}{3}$x$1\frac{11}{16}$x2 inches. Five pole relays measuring approximately 2x$2\frac{1}{2}$x$2\frac{1}{8}$ inches. Weigh $4\frac{1}{2}$ to $6\frac{1}{2}$ ounces; vibration and acceleration, 10 g; contact capacity up to 10 amps depending on available power and on coil and circuit characteristics; contact pressure 30 to 50 grams.

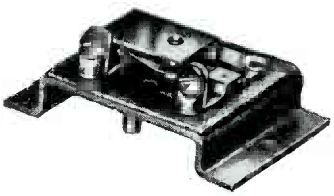
G-M Laboratories Inc., Chicago, Ill.

Recording Paper

ELECTRIX is an electrically marking recording paper requiring no processing either before or after use, and providing a highly legible black permanent mark wherever electric current passes through it between the stylus and the backing contact plate. It comes in rolls, sheets, and discs, with widths ranging from $\frac{1}{2}$ inch to 26 inches. Little or no stylus pressure is required. Current and voltage values needed are dependent upon paper speed, stylus motion and stylus pressure, with normal current ranges being 5 to 40 ma and normal voltage ranges being 60 to 150 volts. The speed of recording is exceeded only by photosensitive papers. Finished

WHEN YOU WANT *Accurate Control*

USE KLIXON SNAP-ACTING CONTROLS



Type C-4351 Series
Used for Tube Warming, Tube Cooling, and High-Low Limit Controls, etc.

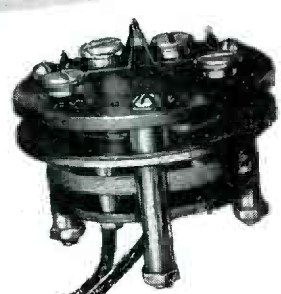
Type C-2851 Series
Used as Roughing Controls on Outer Crystal Ovens

Type B-3120
Crystal Dew Point Control

Type PM
(NAF-1131)
Circuit Breaker

Type RT
Adjustable Crystal Temp. Oven Control

Type C-6363
Switch Circuit Breaker



Type ER Series
Ambient Compensated Time Delay Relays

There are no two ways about it . . . controls for motor and transformer overheat protection, electric circuit overload protection, or temperature controls for radio equipment *must* operate accurately every time for efficient protection.

Klixon Snap-Acting Controls provide sure, accurate operation under all conditions. The secret of Klixon dependability lies in the Spencer snap-acting thermostatic disc. This foolproof actuating element snaps "on" and "off", always making a quick, clean break or a solid make. Its accurate performance is unaffected by shock, vibration, motion, altitude or the mounting position. And because it contains no fussy parts, such as relays, toggles, magnets, there is nothing to get out of order.

Small, compact and light weight, Klixon Snap-Acting Controls are available in many standard models, such as those illustrated, for most control requirements. Write for complete information.

KLIXON

SPENCER THERMOSTAT COMPANY, ATTLEBORO, MASS.

recordings are easily handled, and cost is only 3 to 10 cents per 100 square inches depending upon the form of paper used and the quantity ordered.

Other papers also available include hard white-surfaced paper for sooted or smoked recordings, waxed surface paper in which compression of wax by the stylus permits the contrasting blue, black or red background to show through, ammonia papers that can be developed dry merely in the presence of ammonia vapors, regular blueprint papers, and regular photographic papers requiring wet developing.

Gorrell & Gorrell, 40 Littlefield Road, Newton Centre, Mass.

Multi-Frequency Generator

MODEL ATF-1336-2 PORTABLE multi-frequency generator ("Watch Master") produces eleven different frequencies between 10 and 190 cps. All of the frequencies are derived from a single temperature-compensated and pressure-controlled tuning fork and therefore have the same accuracy as the tuning fork.

Output voltage of the instrument is rated 30 volts minimum for any frequency. The output impedance is rated 500,000 ohms, maximum. Power supply is 100–125 volts, 50–60 cps. Power consumption is rated 40 watts, maximum.

American Time Products, Inc., 580 Fifth Ave., New York, N. Y.

Improved Test Chamber

IMPROVEMENTS OF MODEL RTC-1 test chamber for high and low temperatures include four individually operated plugs in the panel of the door to permit ready access to the interior of the testing chamber to either adjust the position of the part being tested or to change the reading of a regulated instrument without removing it from the

Over the whining bullets and the bursting shells . . . and in the dark silence of the night . . . he wants to hear the beat of your heart.

High up in his jungle roost, or down in the mud on his belly . . . waiting, watching, listening . . . he wants to know whether you're doing the things that will make his job easier, and the war shorter.

And if he were right here beside you, he might want to ask a few personal questions . . . like these:

Did you put some of this week's pay in war bonds?

Are you saving the scrap and fats and paper and other things we need to fight this war?

Have you given blood to the Red Cross to save the boys who are fighting to save you?

And . . . did you do your job today as if the outcome of the war depended on you alone?

These are the ways to show you're backing him up. These are the ways to let him hear the beat of your heart.

★ ★ ★

Here, at Kenyon, we're mighty proud to be playing a small part in winning a big war. That is why every Kenyon transformer used by the U.S. Signal Corps and other military branches reflects the same high craftsmanship and precision that went into our peacetime production. To bring victory closer, Kenyon workers are determined to do their share by turning out good transformers as fast as they know how.

THE MARK OF EXCELLENCE

KENYON TRANSFORMER CO., Inc. 840 BARRY STREET NEW YORK, U. S. A.

chamber. This eliminates the necessity for opening the whole door and endangering the accuracy of the test on other parts in the chamber. The machine can produce and maintain whatever temperature is desired between −70 to 158.8 deg. C.

American Coils, Inc., 25 Lexington St., Newark, N. J.

Series Power Supplies

MODELS 1100 AND 1110 are identical in performance but differ in construction. Model 1100 is a table model for use in the laboratory, and Model 1110 is designed for rack mounting. Both instruments utilize a high gain two stage circuit to insure low noise level and good regulation. A potientiometer controls the high voltage output which can be shifted through a range of 225 to

300 volts. The change in voltage output from no load to full load is less than 1 volt. The primary of the power transformer is tapped for use at 105, 115 and 125 volts on 50–60 cps. Furnished with the instrument is an unregulated heater supply winding of 6.3 volts at 5 amps.

Communication Measurements Laboratory, 116 Greenwich St., New York, N. Y.

50 Amp Aircraft Relay

SOLENOID TYPE, 50 amp, aircraft relay will withstand a surge load of 400 amps without injury to the contacts (leads are fully protected). Vibration resistance is rated 5 to 55 cps with a total excursion of $\frac{1}{16}$ inch in any direction. The unit weighs 0.6 lbs approximately and may be used in applications other than aircraft.

The Hart Mfg. Co., Hamilton St., Hartford, Conn.

Mister! These Could Be Your Hands . .

Right at your own desk, alone and in your own way, you can appraise the value of this modern CLUTCH HEAD Screw in terms of speed, safety, and low cost on the assembly lines.

With the assortment of CLUTCH HEAD Screws and sample Center Pivot Type "A" Bit . . . *mailed to you* on request . . . you can check the fact that CLUTCH HEAD has everything offered by any other screw, *plus* definite features found in no other screw on the market today. In a word, we are content to let you discover that CLUTCH HEAD is a screw that sells itself, on sight, and by any basis of comparison.

On the score of dependable production, you may place reliance on the resources of this organization and on those of responsible Licensees.

For field maintenance and repair, it is important to note that this is the only modern screw operative with the ordinary type screwdriver . . . even with a piece of flattened steel rod in emergency. This feature has proved its value in many phases of the war effort.

CLUTCH HEAD SCREWS

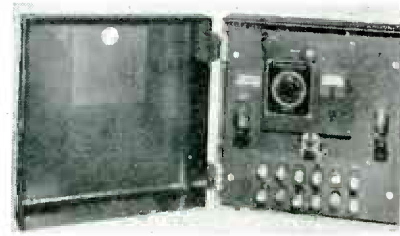
Consider the economy of time and money in this Center Pivot Type "A" Bit. It serves through a longer continuous "spell." Full reconditioning is merely a matter of a brief application of the end surface to a grinding wheel.

UNITED SCREW AND BOLT CORPORATION

CHICAGO CLEVELAND NEW YORK

Current-Regulated Compensator

A NEW CURRENT-REGULATED compensator for resistance welding machines is specifically designed to facilitate consistent welds by holding the rms, or true heating value, of the weld current constant for any heat-control setting, without requiring continual manual adjustment. The compensator consists of



an electronic control circuit which automatically retards or advances the firing point of the ignitron tubes used to control the welding current. The compensator can be readily mounted on or near the welding machine. It can be applied to resistance welding controls which incorporate the phase-shift method of heat control.

Electronic Control Section, General Electric Company, Schenectady, N. Y.

Vibration Fatigue Tester

THIS TESTER IS AN addition to the manufacturer's line of testing machines. It is designated as Model 10V and features automatic cycling. It has a table area of 8 x 8 inches and has drilled and tapped holes for attaching work which is to undergo the test. It tests small electronic, electrical and mechanical parts and can handle parts or assemblies up

to 10 lbs in weight. Vibration, in simple harmonic motion, is produced vertically. Acceleration is controlled automatically by a device which changes the frequency from 10 cps to 55 cps (600 to 3,000 vibrations per minute) and back to 10 cps continuously and uniformly, the complete cycle re-

quiring one minute. Acceleration can also be adjusted manually from 10 cps to 60 cps. Frequencies are accurately recorded on a sensitive electric tachometer. Maximum capacity is approximately 37 g. The unit is powered by ½ hp, 110 volt, 60 cps a-c split-phase motor.

The tester is described completely in Bulletin 210 available from All American Tool & Mfg. Co., 1014 Fullerton Ave., Chicago 14, Ill.

Electromagnetic Chuck and Power Unit

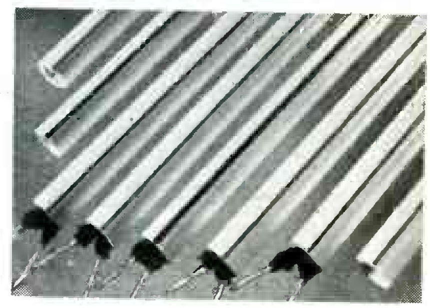
THESE "DO ALL" MAGNETIC CHUCKS are designed expressly for precision work. They provide high holding power. They are made of steel and are waterproof. The coils are wound with a type of plastic covered magnet wire and are sealed to prevent damage from moisture or breakdown from electrical or mechanical sources. The input wire is located on the right end of the chuck to eliminate interference in grinding and cleaning operations and wear on the cord. No auxiliary clamps are necessary since the chucks can be mounted directly to the table.

The varying power unit is an electronic device and is known as "Do All" Selectron. It gives the operator control over the magnetic pull from the chuck and also demagnetizes the chuck. The variable magnetic pull makes possible the grinding of difficult jobs such as flat warped pieces. The unit eliminates the need of a generator or rectifier since it produces the d-c current with which to operate the chuck. Work may be removed from the chuck without scratching either the work or the chuck and an operator can take the warp out of thin parts in very little time. It is rated at 175 watts maximum with an input rating of 220 or 440 volts 60 cps a.c. Output rating is 220 volts d.c. Angle brackets are provided for mounting on any make surface grinder.

Chuck Models 618 and 824 and the Selectron are illustrated and described in a bulletin available from Continental Machines, Inc., 1301 Washington Ave., S., Minneapolis 4, Minn.

Tubing with Colored Identification Stripes

TO PROVIDE INSULATION for electrical wiring, and to facilitate identification, Lumarith plastic tubing is extruded with contrasting color identification lines right in the body of the tubing. This tubing is designated as "Striatube" and is available in opaque or transparent tubing, in either flexible or rigid form in a variety of sizes, lengths and thicknesses, as well as various degrees of flexibility. In all instances the color stripes are an integral part of the extrusion and are as permanent as the body of the tubing itself. Striatube has high dielectric strength and non-oxydizing properties and is highly resistant to acids, alkalis, oils and greases, nor will it deteriorate due to aging or constant exposure to light.

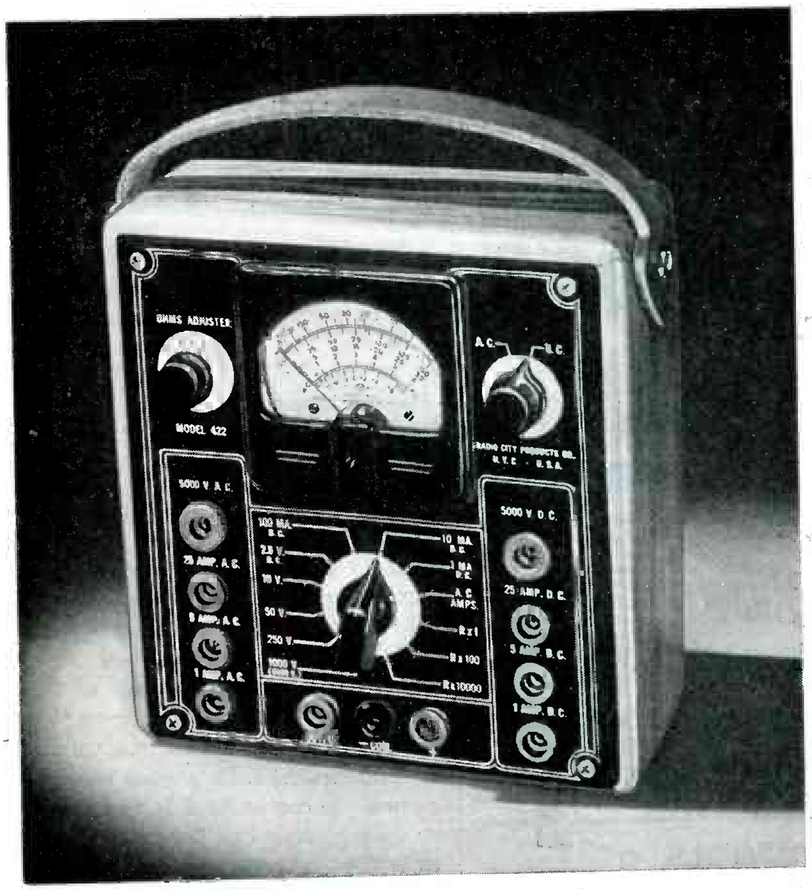


Lumarith is a product of the Celanese Celluloid Corp., 180 Madison Ave., New York, N. Y., and Striatube is a product of Carter Products Corp., 6921 Carnegie Ave., Cleveland, Ohio.

Insulating Varnishes

AIR-DRYING, insulating varnishes, designed for use in the manufacture and repair of electrical equipment are called "Speedairbonds." The varnishes dry fast to a smooth, glossy finish. They are oil-proof and water, acid and alkali resistant and possess high dielectric qualities. They are designed to give complete protection and insulation under adverse circumstances and atmospheric conditions. The varnishes may be applied by brushing, dipping or spraying. The several types of varnishes are described in Bulletin 243.

The Sterling Varnish Co., 181 Ohio River Blvd., Haysville, Pa.



RCP SUPERTESTER

MODEL 422

This test instrument is equivalent to 27 individual instruments in one compact unit — with very low and very high ranges. Excellent for general circuit testing — speeds up trouble shooting — and combines many important measurements in one small case. Features are: Current measurements in both A.C. and D.C. up to 25 amperes. Voltage measurements in both A.C. and D.C. up to 5,000 volts. D.C. sensitivity 5,000 ohms per volt. Resistance measurements up to 10 megohms.

Code — MERAY . . .
Complete with batteries............ **$29.50**

POCKET MULTITESTER

MODEL 420

"Pocket" size yet rugged with good accuracy comparable to larger RCP models — Model 420 — only 6⅜" x 3½" x 3" — open face — weighs only 25 ounces — meter movement accurate within 2%. Voltage and multipliers accurate to 1%. A.C. and D.C. voltmeter up to 5,000 volts at 1,000 ohms per volt sensitivity. D.B. meter, output meter, milliammeter and ohmmeter. Total 23 ranges.

Code — LIYOR . . .
Complete with batteries, ready to operate.................... **$19.95**

Complete details of these two testers and other RCP radio, electrical and electronic testing instruments are contained in the *NEW* RCP Catalog No. 128 of standard commercial models. Write today for your copy. Our engineers will welcome the opportunity to cooperate with you on production testing problems.

REASONABLE DELIVERIES ARE NOW BEING SCHEDULED

RADIO CITY PRODUCTS COMPANY, INC.

127 WEST 26th STREET — NEW YORK CITY 1, N. Y.

MANUFACTURERS OF PRECISION ELECTRONIC LIMIT BRIDGES — VACUUM TUBE VOLTMETERS — VOLT-OHM-MILLIAMMETERS — SIGNAL GENERATORS — ANALYZER UNITS — TUBE TESTERS — MULTI-TESTERS — OSCILLOSCOPES — AND SPECIAL INSTRUMENTS BUILT TO SPECIFICATIONS

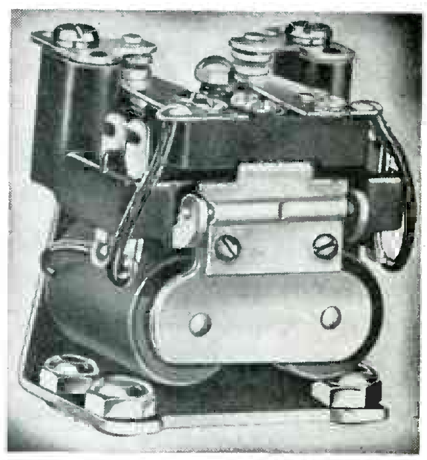
Bakelite Plug

DESIGNED PRIMARILY FOR use with the manufacturer's No. 37222 captive head posts and No. 37202 plates is a compact plug (No. 37212) which is available in black or red regular bakelite, as well as low-loss brown mica-filled bakelite, for r-f uses. There is a small circular depression on top of the plug for use in color coding or polarity indication.

James Millen Mfg. Co., Inc., Malden, Mass.

Dual Coil Relay

MODEL BOY IS A small dual coil power relay suitable for use in plate circuit applications where the limited amount of current is insufficient to operate a single coil power relay directly. The two coils of this new model may be connected in series for operation at one voltage and in parallel for a second voltage; or one coil can be used for operation



while the other is used for holding. The relay features semi-balanced armature construction and is ruggedly built to withstand 10 G. The coils are cellulose acetate sealed; will withstand salt-spray and high humidity. The relay meets Army, Navy and CAA Specifications. Dimensions are $1\frac{3}{8} \times 1\frac{7}{8} \times 1\frac{1}{2}$ inches, and the weight is 5 ounces.

Allied Control Co., Inc., 2 East End Ave., New York 21, N. Y.

Capacitor Unit

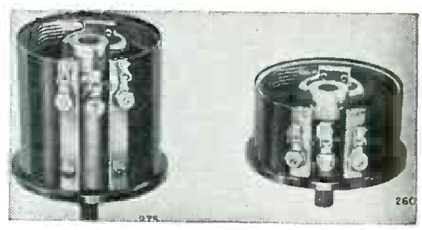
OIL TYPE CAPACITORS, designated as "EC" Capacitrons, are designed as standard components to replace similar types of special capacitors

used in the production of war equipment. They are being manufactured in several ranges with d-c working voltage ratings from 600 to 1,500 to meet U. S. Signal Corps and Navy Specifications. The units are locked on the chassis by means of a solid nut and lockwasher through a single hole to clear the $\frac{3}{4}$ x 16 inch threaded Bakelite neck. The neck is lock-spun into the extruded, insulated metal container, making possible a 100 percent hermetic seal. Grounding of either insulated terminal is readily accomplished with a special ground-lug. Dimensions of the 3 and 4 μf size units are $1\frac{1}{2}$ inches in diameter by $4\frac{1}{2}$ inches in height.

Capacitrons Inc., 318 W. Schiller St., Chicago 10, Ill.

Precision Potentiometers

Precision potentiometers (defined by ASA as low operating temperature types) which can operate for 2,500,000 revolutions at 360 degrees continuous rotation in both directions, for 24 hours a day are available in Types 260, 260T, 261, 275, 276, 281, 291, 292, and 296. Extremely close tolerances are used in the making of these units. Special machines spacewind the resistance wire on a strip of fabric base bakelite. The strips are then

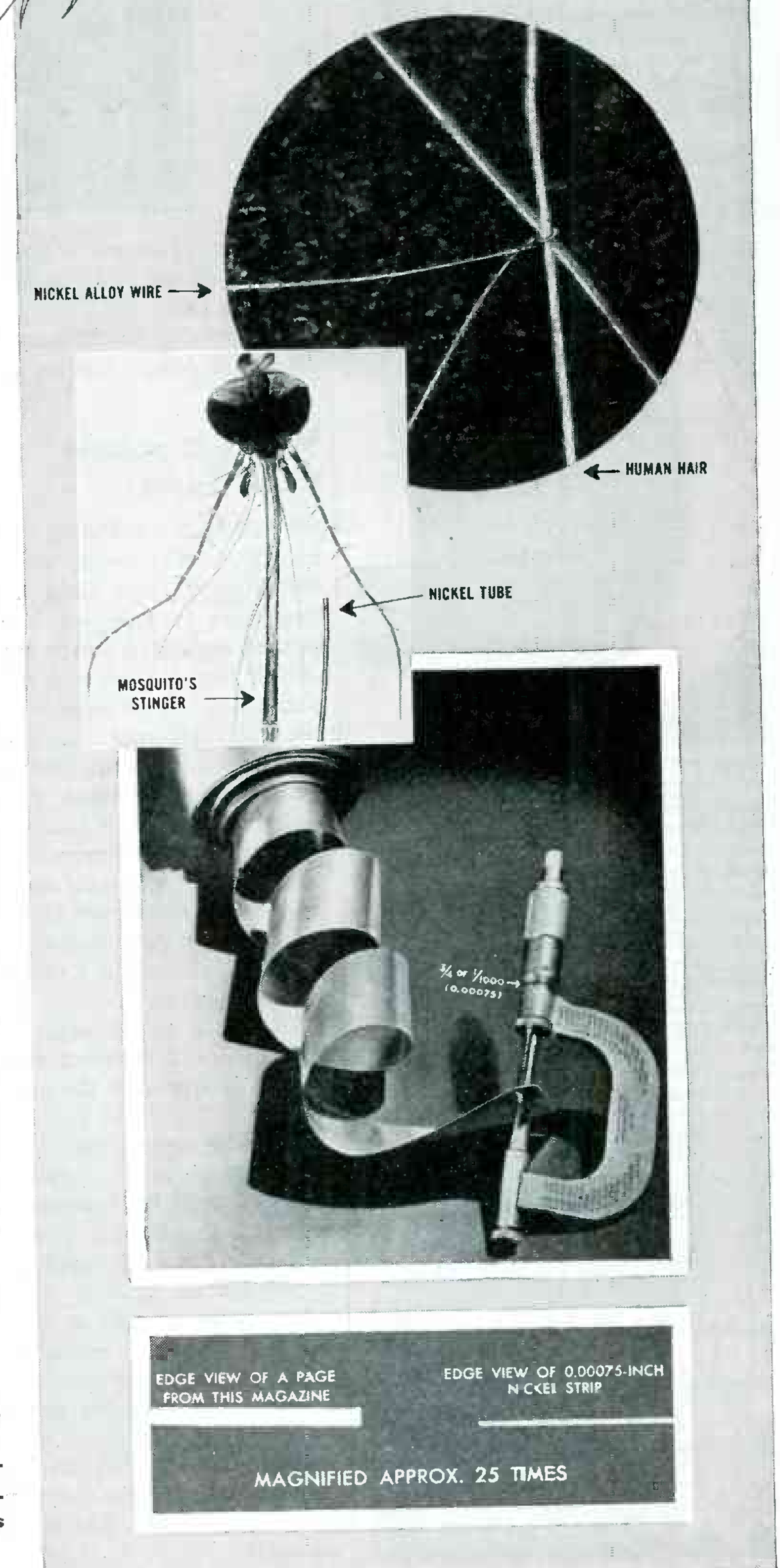


coated with a bonding agent which bonds the wire to the strip. A protective bakelite band is placed externally over the wire strip, securing the wire against mechanical damage or derangement. It is then bent around and fastened to the bakelite supporting form. Constant contact resistance and low noise level are maintained for any position of the knob through the use of separate wiping fingers. Types 261, 276, 281, 291, 292 and 296 have top wipers which are provided for the highest accuracy and for the closet tolerances.

De Jur-Amsco Corp., Shelton, Conn.

They wanted wire, tube and sheet in *Split-Hair Sizes*

...and found the strong, corrosion-resistant metals they sought among the INCO Nickel Alloys



Are you looking for metals in ultra-fine sizes for essential applications today... or for your new products after the war?

Do you want... in addition to the split-hair size ... metals with strength, toughness and high resistance to corrosion?

Then take a look at these examples of how INCO Nickel Alloys can be produced in practically any form or size you may want for applications that need a rustless corrosion-resisting material with high mechanical properties...

THE WIRE shown in the magnified photo above knotted around two strands of human hair is 0.0009" thick. A pound would stretch 80 miles. It is a regular commercial product of the Driver-Harris Co.

THE TUBING, smallest ever drawn, is compared with a mosquito's stinger. Outside diameter of this nickel tube is 0.0019"; inside diameter, 0.0004". Superior Tube Company produces commercial tubing in INCO Nickel Alloys as small as 0.010", outside diameter.

THE STRIP is .00075" thick . . . one-third the thickness of this page. It would take more than 1300 strips to equal an inch. This nickel strip is made by Somers Brass Company for regular commercial use.

In addition to their group properties of high strength, toughness and corrosion resistance, individual INCO Nickel Alloys have *specialized* properties for applications requiring high-temperature strength, special hardness, resilience, etc.

"Tremendous Trifles" a booklet which discusses the properties, sizes and forms of 8 INCO Nickel Alloys will be sent to you on request. Please give Company, Name and Title. Address:

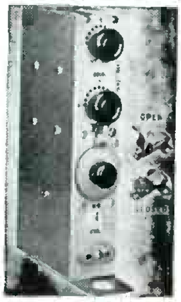
THE INTERNATIONAL NICKEL COMPANY INC.
67 Wall Street, New York 5, N. Y.

INCO NICKEL ALLOYS

MONEL • "K" MONEL • "S" MONEL • "R" MONEL
"KR" MONEL • INCONEL • "Z" NICKEL • NICKEL
Sheet... Strip... Rod... Tubing... Wire... Castings

Dial Lock and Tuning Indicator

A TUNING-DIAL LOCK, designated as Type TU-52, performs a dual function of a dial lock that will accommodate a wide range of dial thicknesses and also a precision tuning



indicator that maintains a fixed position on the dial simply by snapping the lock.

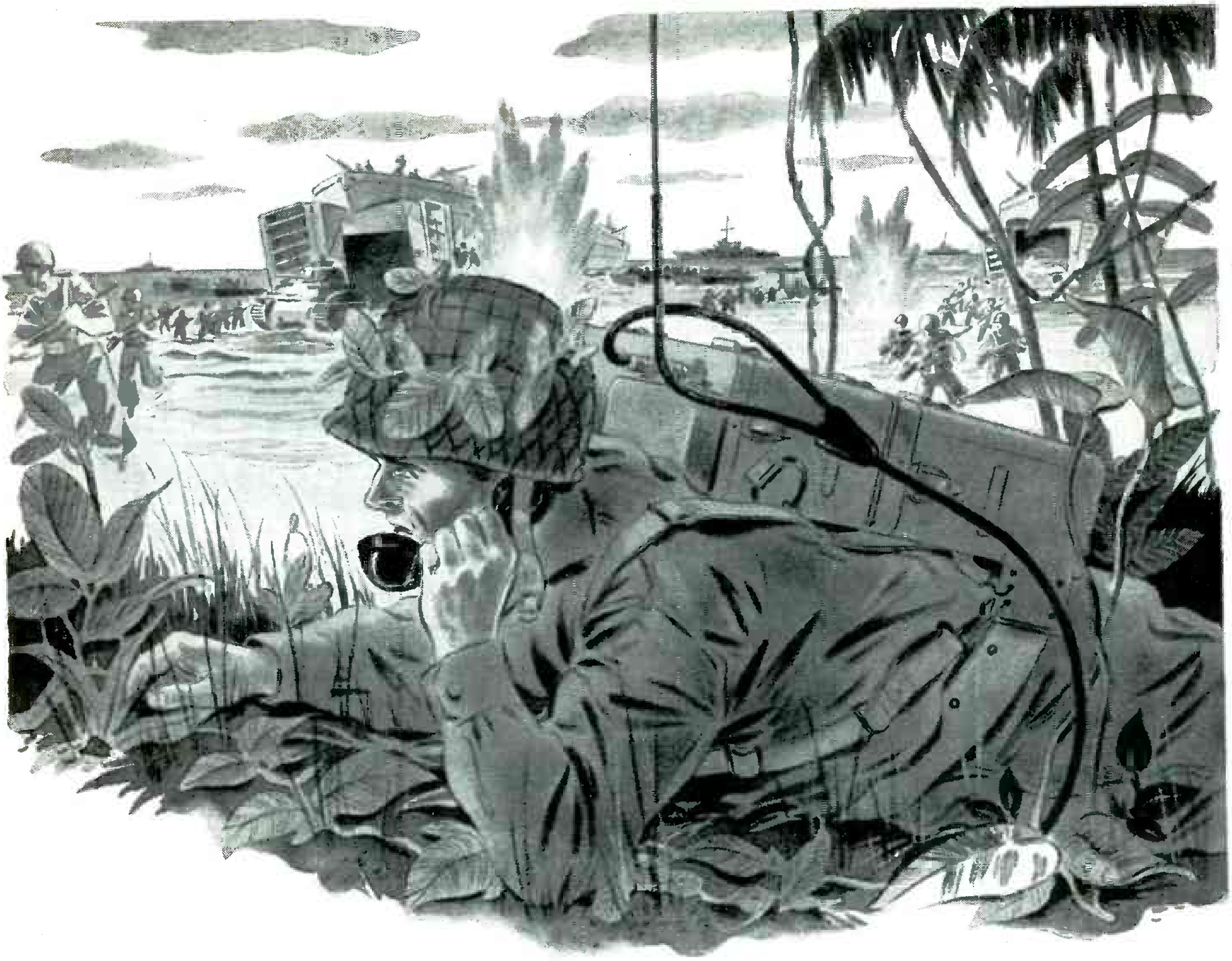
The Radio Craftsman, 1341 S. Michigan Ave., Chicago 5, Ill.

Voltage Regulated Power Supply

SUPPLYING D-C LOADS up to 40 watts at 200 to 400 volts, with voltage variation of less than 1 percent from zero to full load, Model 1218 voltage regulated power supply is a useful tool for general use in experimental development laboratories. A single operating control allows the d-c output voltage to be set at the desired value, where it remains regardless of load variation; current may be drawn up to 100 milliamps at 400 volts and increasing to 200 milliamps at 200 volts, with voltage regulation electronically maintained in a circuit using standard tubes.

The built-in voltmeter and milliameter permit direct reading of output delivered at the safety jack located on the front panel. Another feature of convenience is the provision of a second output jack at which is available 4 amps a.c. at 6.3 volts (unregulated). Both the d-c output and the a-c input are fused for protection against overload.

The power supply is housed in a ventilated steel cabinet, which measures 13 x 9 x 9 inches and has a convenient carrying handle. Bulletin J-1218 describes this equipment and may be obtained from the Technical Apparatus Company, 1171 Tremont Street, Boston, Massachusetts.



"Landing According to Plan"

IN the planning . . . and the execution . . . of landing operations Communications are playing a vital part. That's why in the forefront of every landing party there usually is to be seen the man with the Pack Set strapped to his back. Light and compact, yet powerful and sturdy, this adaptation of the walkie-talkie provides the *instant communication* by which our intricate military operations are planned . . . and carried out.

In the Pack Set, as in many other audio communication instruments, Transformers by Rola are living up to a reputation gained through 25 years of leadership in Sound Reproduction. That, no doubt, is the reason why so many of the largest producers of communication equipment are looking to Rola for Transformers, Headsets, Coils and other Electronic Parts . . . why others are saying, "Let's discuss our problem with Rola".

THE ROLA COMPANY, INC., 2530 SUPERIOR AVENUE, CLEVELAND 14, OHIO

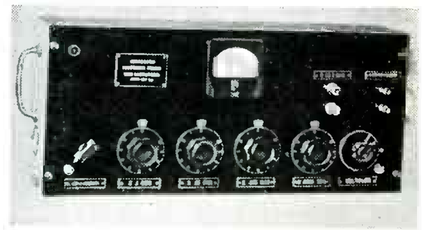
ROLA

Let's do more ARMY E NAVY *in forty-four!*

MAKERS OF THE FINEST IN SOUND REPRODUCING AND ELECTRONIC EQUIPMENT

Microhmmeter

TYPE G-710 MICROHMMETER is an improved a-c bridge for use in recording or controlling apparatus such as temperature, moisture and pressure control. It will measure from 0.001 ohm to 1 megohm. The readings are taken from a decade. A meter is used as a null indicator. On all ranges the instrument re-



quires a few tenths of a milliwatt through the resistance being measured. Measuring voltage is 60 cps a.c. Pure resistance may be read directly in ohms. Impedances are measured by comparison and changes as low as 0.01 percent are indicated.

A bulletin (No. 432) is available from Tech Laboratories, 7 Lincoln St., Jersey City 7, N. J.

Lightweight Power Transmission Unit

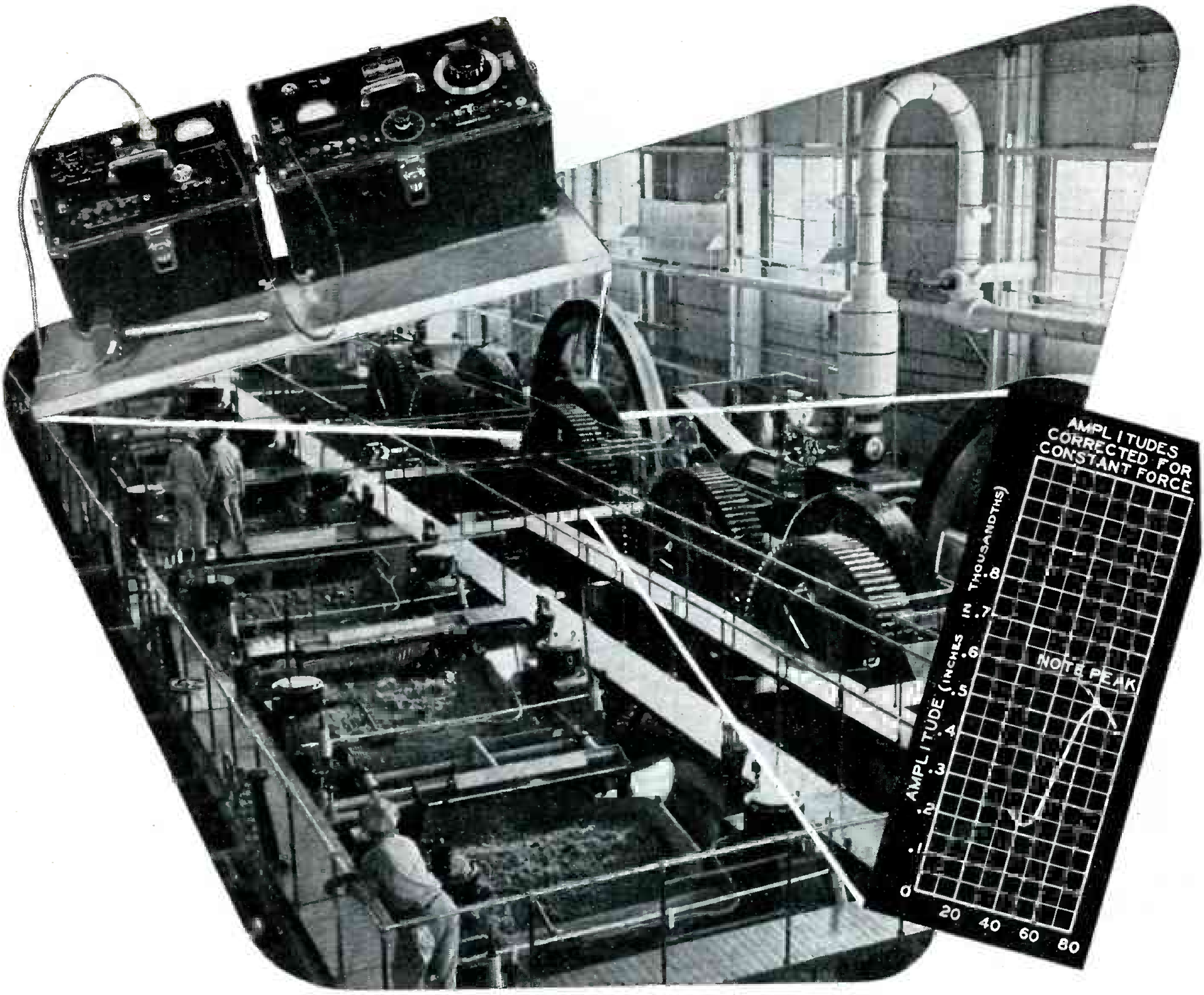
A REMOTE CONTROL right angle adapter is designed to provide a connection for flexible shaft control where the space limitations do not permit a direct conjunction without bending the shaft in too small a radius. The unit is sturdy and light in weight (0.141 lbs) and may be used in applications where the power transmission must of necessity be at a small radius. The size of the adapter is $2 \times 1\frac{7}{8} \times \frac{3}{4}$ inches. The gear ratio is 1 to 1. The maximum torque load is 25 inch pounds. The connections are $\frac{5}{8} \times$ 24NF3 threads.

F. W. Stewart Mfg. Corp., 4311 Ravenswood Ave., Chicago, Ill.

Beryllium Copper Wire

SILVER COATED BERYLLIUM copper wire is available in sizes 0.064 to 0.007 inches. It is trade-marked "Silvercote" and has a guaranteed minimum tensile strength of 185,000 pounds after hardening.

Little Falls Alloys, Inc., 189 Caldwell Ave., Paterson, N. J.



VIBRATION in this Heavy Engine Foundation

Located and Analyzed with General Radio Vibration Meters

VIBRATION in this sugar-cane grinding tandem in the Florida Everglades was sufficiently serious to cause uneven settling of the heavy concrete foundation. The magnitude of the vibration depended upon the speed of one of the three Corliss engines driving the tandem, increasing as the speed increased.

MEASUREMENTS with the General Radio Vibration Meter and Analyzer showed that the frequency of the main component of the vibration corresponded to the single-mesh frequency of the main pinion on the engine. A speed-vibration characteristic, taken over the complete range of operating speeds, showed a pronounced resonance peak at 68 rpm. near top speed. Calculations confirmed the fact that the concrete foundation was in resonance at the gear mesh frequency corresponding to this speed.

ELIMINATION of the vibration was simple, once its nature and source were completely known. The cause was found to be poor gear alignment, resulting in worn gear teeth.

Most vibration problems encountered in industry are simple — when you know the answer. General Radio noise and vibration-measuring instruments are designed to get that answer for you quickly and accurately. Their theory and operation are completely described in "THE NOISE PRIMER." Write for your copy today. **Ask for Bulletin No. 869.**

Because all of our facilities are devoted to war projects, this equipment is at present available only for war work.

GENERAL RADIO COMPANY Cambridge 39, Massachusetts
NEW YORK CHICAGO LOS ANGELES

Regulated Power Supply

MODEL 44 REGULATED power supply is intended to be used as a laboratory instrument, or wherever a source of voltage of a variable nature is desired. It has good regulation with change in load current or line voltage. It can be used for either bias, filament or plate supply voltage. Output voltages of from 300 volts down to 0 in three ranges may be obtained. Rated d-c output current is rated 100 milliamps on all ranges. Maximum power consumption is 200 watts; voltage controls are of single knob adjustment and range-changing switch; hum content is 12 millivolts, rms, maximum. The unit uses 11 tubes.

Radio-Television Institute, Inc., 480 Lexington Ave., New York 17, N. Y.

Aircraft Receiver

THIS COMPACT AIRCRAFT receiver, designated as Model AR-10-A, weighs 24 lbs and is designed to replace five or six receivers which are used in a plane as it is an all-purpose, all-frequency receiver. It has a beacon band coverage from 195 to 425 kc with spot tuning on 278 and 271 or any other two specific frequencies. Communications band coverage is from 2500 to 4500 kc and from 4500 to 8000 kc with pre-tuned circuits for twelve crys-

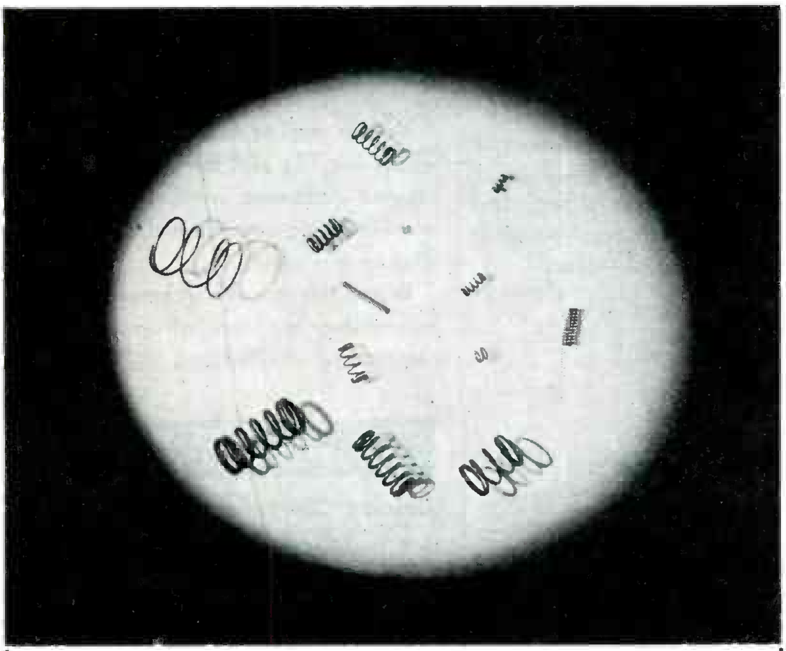
tal controlled frequencies anywhere in the 2500 to 10,000 kc band. There are two r-f channels, one for frequencies from 4.5 to 10 Mc for the day channel and one for 2.5 to 4.5 Mc for night channel. Image attenuation is greater than 65 db. An input of two microvolts modulated 30 percent at 400 cycles produces an output of 50 milliwatts at a signal to noise ratio of 6 db.

Harvey-Wells Communications, Inc., Southbridge, Mass.

SPRING GRADE WIRE is Now the First Step in Micro-Processing

Better Coil Springs at No Added Cost

Micro-processing essentially is a specialized production technique by which the inherent electrical and mechanical properties of beryllium copper are controlled to produce maximum performance in coil springs.



Meets higher specifications than established ASTM Standards
"Silvercote" Spring-Grade Wire used in Micro-processed Springs has these guaranteed properties: Guaranteed minimum tensile strength, 190,000 lbs. per sq. in. after hardening. High uniformity in temper. Accurately controlled conductivity.

Years of laboratory research and design experience by Instrument Specialties Company has indicated that the ultimate in spring performance could not be reached until a beryllium copper wire of guaranteed "spring grade" were available. Now, an adequate supply of this premium quality beryllium copper wire is an accomplished fact as the data to the left signifies. Silvercote Spring-Grade beryllium copper wire is being used 100% by Instrument Specialties for coil springs of all types. As a result, Micro-processing can do even a better job than ever before — at no added cost to you.

By using this special wire with guaranteed premium spring qualities, it naturally follows that peak spring performance is achieved in the micro-processing.

Every Micro-Processed Coil Spring Benefits

Plain or "fancy" springs benefit by the addition of Spring-Grade Beryllium Copper wire to the other values of Micro-processing — higher safe working stresses, less loss of tension, higher proportional limit, maximum conductivity, higher safe operating temperature, lower electrical loss, freedom from set or drift, and closer tolerances.

It would pay you to evaluate Micro-processed beryllium copper springs for your own use. Instrument Specialties Company produces coil springs which out-perform in service because every step in their production is controlled — beginning with Spring-Grade wire.

I-S Brush Spring Data Sheet
The quicker easier way to put Micro-processing to work — fill out the I-S Data Sheet and we'll do the rest. Write for data sheets today, or send your specifications and inquiries. Remember Micro-processed brush springs are easier to assemble, add life to brushes and give maximum performance in service.

INSTRUMENT SPECIALTIES CO., INC.
258 BERGEN BOULEVARD, LITTLE FALLS, NEW JERSEY

MICRO PROCESSED I-S BERYLLIUM COPPER SPRINGS

FIELD ENGINEERING OFFICES: BOSTON · CHICAGO · CLEVELAND · PHILADELPHIA · NEW YORK

Industrial X-ray Film Illuminator

ACCORDING TO THE manufacturer, this new illuminator (for viewing industrial x-ray films) provides four times more illumination than previously available. It has a finger-tip adjustment which attains brightness for films of different density, or for different parts of the same film. The photoflood lamps of the machine are designed with a fan-type cooling system to avoid cracking, curling or damaging the film from heat. A foot-switch controls the lamps. Another feature is a spotlight which measures 3 inches in diameter. The glass front of the spot is water-cooled with the light from the lamp passing through four inches of water.

Kelley-Koett Mfg. Co., Covington, Ky.

Tube Voltmeter

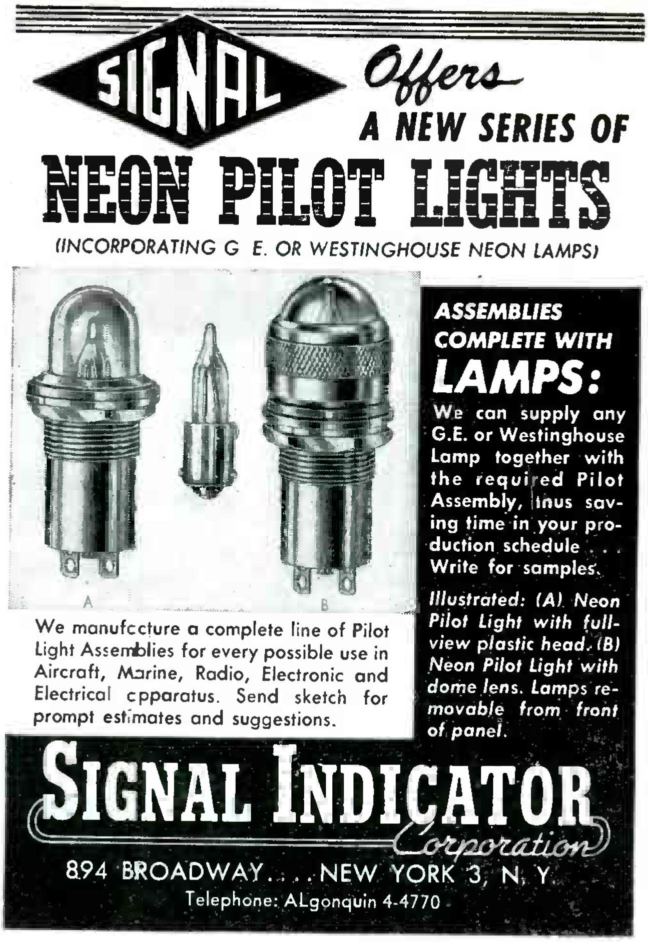
VACCUM-TUBE VOLTMETER, Model VM-27E, features a high frequency probe which permits close connection to be made to the circuit under test at high frequencies. It is

simple to operate. Voltages which can be measured range from 0.1 to 100 volts at d.c., and a-c and r-f frequencies to over 100 Mc.

Alfred W. Barber Labs., 34–02 Francis Lewis Blvd., Flushing, N. Y.

Portable Transformer

AN EMERGENCY, portable, 110-volt current source, 1 kva air-cooled unit (supplied for either 440-volt primary and arranged with dual fused secondaries of 110 volts each) is availabe from The Acme Electric & Mfg. Co., Cuba, N. Y.



Fixed Interval and Repeat Cycle Timers

SERIES 5800 CONTINUOUS running repeat cycle timers are available for either a-c or d-c operation, and with from 1 to 8 switches. Motor speeds depend upon the timing cycle desired. The manufacturer can adjust these timers to 1 revolution per six months if such timing is desired. ST or DT precision snap switches are used, and are rated ten amps, 110 volt, a.c.

Haydon Mfg. Co., Box 52, Forestville, Conn.

Cable Clamp

MODEL O-T CABLE CLAMP is for the use of radio, aircraft and electrical manufacturers. It is a compression type tool with all parts mounted or ringed on the cable axis to facilitate assembly time. All parts are locked by a simple

push-together and turning motion which results in a finished unit that is twist-proof, rupture-proof and water-proof. It is available in any size and shape and can be adapted to various types of jobs.

Oxford-Tartak Radio Corp., 3911 S. Michigan Ave., Chicago 15, Ill.

Magnet Wire Insulation Tester

THIS REPEATED-SCRAPE abrasion tester is a device for comparing the toughness of insulation on film-coated magnet wires. The equipment is particularly useful on wires which range in size from No. 10 to No. 30 (0.010 to 0.102 inch). It is portable and is easily operated, and consists essentially of an anvil, a clamp for holding the sample of wire, and a scraper head which is drawn back and forth over the film

Adlake *Plunger-type* Mercury Relays

STAMINA
SIMPLICITY
DEPENDABILITY

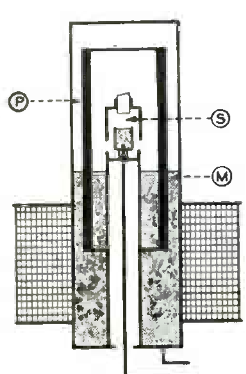
Adlake Relay No. 1040—(for A.C.)
5½" high, 2½" wide, 2¾" projection. For panel mounting. Contact normally open or closed. Quick or time delay action. Contact protected by metal armor.

Automatic power control can be no more dependable than its relays. That is why the plunger-type mercury relay is replacing other types. It is the most dependable relay thus far developed for many types of service, because dirt, dust, moisture, temperature changes, humidity etc. can not affect its hermetically sealed contacts.

ADLAKE Plunger-type Mercury Relays are available for either quick or time delay action . . . for A. C. up to 440 volts . . . for D. C. up to 115 volts (and higher, with outside resistors) . . . and contact capacity from a fraction of an ampere to 100 amperes. All operate on the same basic principle. All are armored against outside impact. All have *hermetically sealed mercury to mercury contacts* which are *positive, chatterless, noiseless* and *arcless.* For complete data, request bulletin.

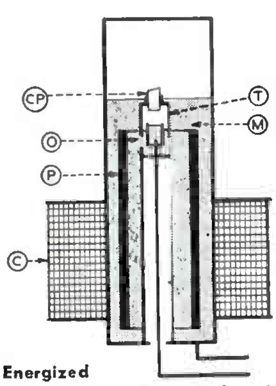
"Back the Attack—Buy Bonds"

S I M P L E , U N F A I L I N G , P O S I T I V E A C T I O N

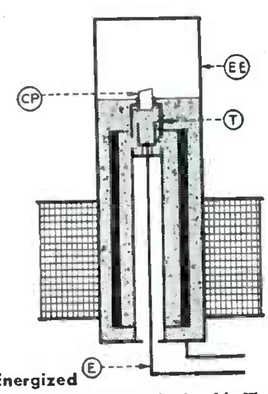


De-energized
Plunger P is floating in mercury M. Space indicated by S is filled with inert gas.

The above and accompanying sketches are not mechanical drawings. They show how Adlake Relays work, not construction detail.



Energized
Coil C pulls plunger P down into mercury M. Mercury thus displaced enters thimble T through orifice O. Inert gas in thimble has not yet escaped through ceramic plug CP, thus effecting time delay.



Energized
Mercury now fills thimble T, is completely leveled off and mercury to mercury contact established between electrodes E and EE. Degree of porosity of plug CP determines length of time delay—and accurately.

Proved
IN THESE AND OTHER APPLICATIONS

- Radio transmission
- Electric time controls
- Photo-electric apparatus
- Heating and ventilating controls
- Production line time controls
- Remote and automatic controls
- Air conditioning controls
- Signals and indicators
- Refrigeration controls
- Voltage regulators
- Burglar alarms
- Electric call systems
- Across the line motor start switches
- Motor reversing switches
- Sign flashers
- Animated displays
- Telephone circuits
- Mill and factory service
- Navigation buoy flasher light controls
- Dry cleaning equipment
- Surgical lighting controls
- Electrolysis prevention
- X-ray control

Adlake TRADE MARK

THE ADAMS & WESTLAKE COMPANY

ESTABLISHED IN 1857 — **ELKHART, INDIANA** — *NEW YORK · CHICAGO*

MANUFACTURERS OF ADLAKE HERMETICALLY SEALED MERCURY RELAYS FOR TIMING, LOAD, AND CONTROL CIRCUITS

surface by a motor-driven eccentric mechanism. Each revolution (considered one scrape) requires one second. A steel sewing needle is used as the abrading device. A set of weights provide the necessary pressure for conducting the tests.

The tester is illustrated and described in Bulletin GEA-4166 and is available from General Electric Co., Schenectady, N. Y.

Rayon Coil Winding-Tape

KAPPA CELLULOSE ACETATE rayon coil winding tape is designed to provide approximately 52 percent increased tensile strength. The tapes are available in standard widths from ¼ to 1½ inches and in consistent 3, 5, 7 and 10 mil thicknesses. The manufacturer states the average breaking load of 10-mil samples (1 inch wide) recently tested by an independent laboratory was 71.2 lbs. The strength will increase or decrease proportionately for other widths. Other advantages of the tapes are uniform impregnation with smooth, completely sealed surface free from pinholes; less varnish is needed; longer insulation life; higher dielectric breakdown; and non-corrosive characteristics.

William E. Wright & Sons Co., Industrial Div., West Warren, Mass.

Hot Wax Dip Tanks

TWO NEW ELECTRICALLY heated, portable, hot wax dip tanks which meet Army-Navy specifications for packaging for overseas shipments are available. The first of these is called Twin Waxmaster which is used for wax dipping or for heating wax for spray lines. It has two hot wax dip compartments (insulated) in one tank. Thermostats provide positive temperature control from 100 to 550 degrees F. The second tank is called Waxmaster Senior because it is a larger adaptation of the model just described. It measures 25 x 25 x 9¾ inches and will heat and melt up to 24 lbs. of solid wax in 50 minutes without discoloration or scorching.

Aeroil Burner Co., Inc., West New York, N. J.

General Plate COLLECTOR RINGS

In Solid or Laminated Silver

The extremely delicate, supersensitive equipment used in modern warfare requires raw material that can contribute its share of high quality. Collector Rings, such as used in Radar, signal communication, auto-syn motor, searchlight and other equipment, fall in this category. Today, manufacturers rely on the improved performance and longer life obtained from General Plate collector rings made from solid or laminated silver in whose manufacture, electroplating has no part. General Plate rings are true to dimension and produced in a wide range of diameters, thicknesses and widths. Joints in the larger diameter rings are silver soldered and hardly visible.

If your manufacturing of equipment calls for collector rings, it will pay you to consult General Plate. Our engineers will work with you on your requirements.

General Plate Division

of Metals & Controls Corporation

Metals and Controls Corporation Divisions manufacture the following products: Laminated & solid precious metals, electrical contacts—Solid and rolled plated precious metals in all forms—Truflex Thermostat Metals.

ATTLEBORO, MASSACHUSETTS

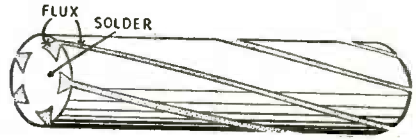
Interelectrode Capacity Meter

THIS DIRECT-READING instrument (Model 27) provides accurate measurement of vacuum tube interelectrode capacitances. It has a range of from 0.001 to 100.0 mmfd, with an accuracy of 5 percent or better on all five steps. On the lowest range, increments as low as 0.00001 mmfd may be used. Measurement is made at radio frequency in a crystal-controlled circuit having all voltages automatically regulated for maximum operating stability.

Bulletin A-344 describing the construction and use of this meter is available from Technical Apparatus Co., 1171 Tremont St., Boston 20, Mass.

Fluxed Wire Solder

A NEW TYPE OF FLUXED wire solder (called Fluxrite) contains flux in longitudinal grooves on the surface rather than in the core. The flux liquefies and flows onto the work before the solder melts. It is always visible to the user and can be quickly checked to detect gaps or voids. The solder is available in



the same diameters as regular cored solder and comes in two compositions designated as Red Stripe and Green Stripe. These color designations are for easy identification.

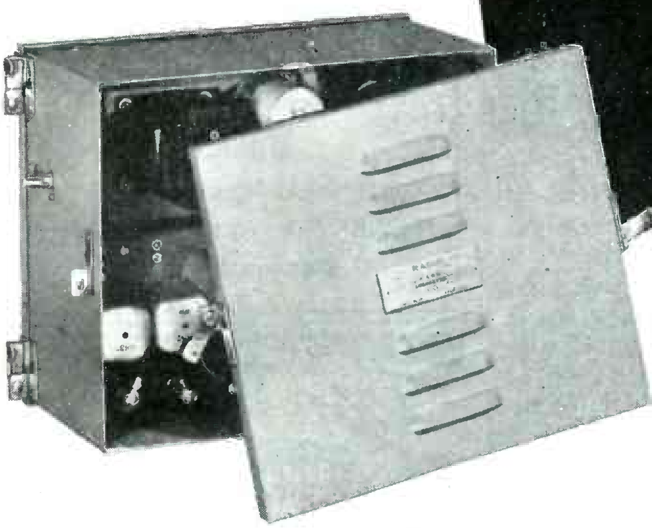
National Lead Co., 111 Broadway, New York, N. Y.

Literature

Controls. Bulletin 697 contains 8 pages of data on standard, midget, sub-midget and elf radiohms, as well as switch covers, shafts and bushings that apply to this manufacturer's controls. Parts, detailed engineering drawings, specifications and resistance curves are included. Centralab Div., of Globe-Union Inc., 900 E. Keefe Ave., Milwaukee, Wis.

Look how easy it is to service KAAR *Mobile* RECEIVERS

1 The Kaar 11-X receiver is installed beneath the dash, and held securely by bolts through firewall.



2 For simple servicing, such as the replacement of tubes, the dust cover is removed by releasing two convenient snap catches. Takes but a moment.

3 For complete servicing, the entire chassis can be removed from the vehicle by releasing four snap catches. All wiring is instantly accessible.

FOUR CATCHES EXPOSE ENTIRE UNDERCHASSIS FOR SWIFT SERVICING

There is no "get out and get under" when it comes to servicing or checking Kaar receivers...they can be lifted out of a vehicle in a matter of seconds. In fact, the speed with which they can be serviced is one of their most popular features.

Another is the no-signal squelch circuit which automatically silences the receiver except when a call is actually being received. This is a blessing in military, civil, or private radiotelephone communication, where a wavelength must be guarded and continual background noise jangles the nerves.

The 11-X is operated by a control unit which can be mounted on the underlip of the dash. This unit contains a jewel light to indicate when receiver is on, a squelch circuit switch, and a combination volume control and power switch.

The Kaar 11-X receiver is crystal controlled, and may be tuned for any frequency from 1600 to 2900 KC.* (For frequencies between 30-40 MC. specify the Kaar PRS-9X.)

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

KAAR
ENGINEERING CO.
PALO ALTO • CALIFORNIA

KAAR ENGINEERING CO

Manufacturers of high grade mobile and central station

RADIOTELEPHONE EQUIPMENT AND ACCESSORIES

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

Indent Type Electrical Connectors. "Hydent" connectors are for use in a wide variety of applications in marine, aircraft, electronic and electrical manufacturing industries and Technical Bulletin No. 6050 gives detailed information about them. Burndy Engineering Co., Inc., 107 Eastern Blvd., New York 54, N. Y.

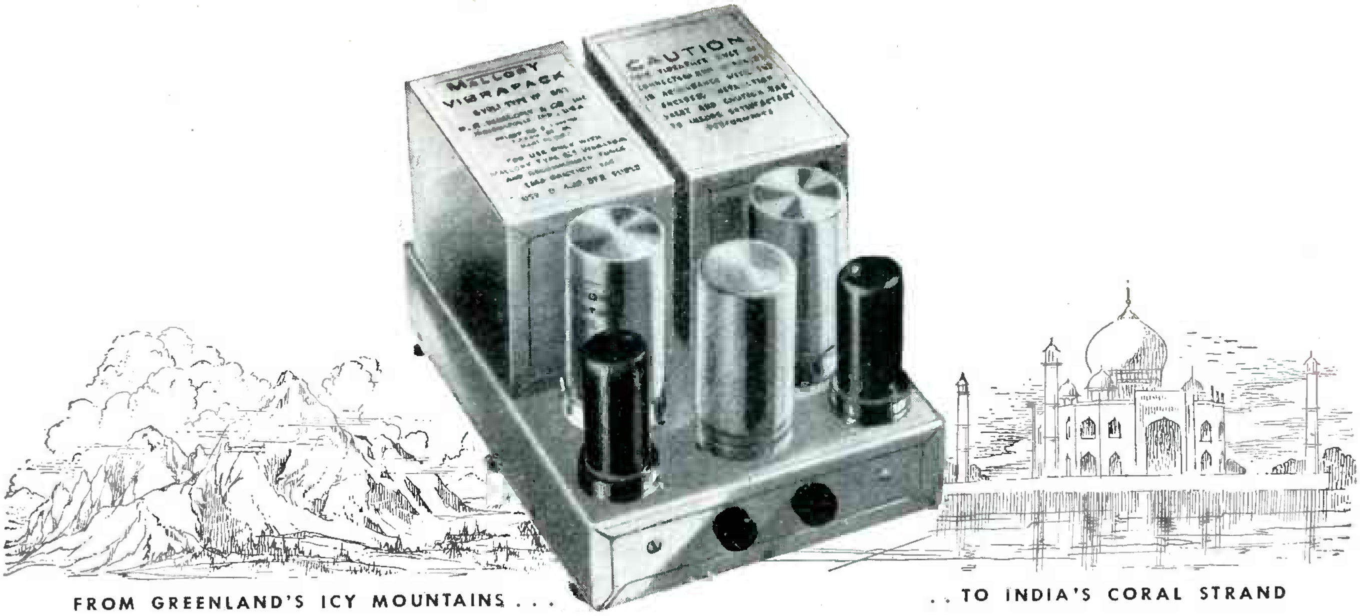
Glass-Bonded Mica Insulation. An attractive brochure called "Mykroy" (the name of glass-bonded mica insulation) gives all the pertinent data and contains many illustrations of this electrical insulation, which is available in ample quantities and can be supplied in various forms. A free sample of insulation is contained in an envelope in the back of the brochure. This envelope is provided as a handy file in which material may be kept for reference. Electronic Mechanics, Inc., Clifton, N. J.

New House Organ. "Allied News" is the name of a new house organ which is published as a service to engineers, technicians and users of radio and electronic equipment. The idea behind this publication is to keep its readers posted on new products, provide data on development in the electronic field, and to survey topics of general interest. Allied Radio Corp., 833 W. Jackson Blvd., Chicago 7, Ill.

Industrial X-Ray Units. Picker 250-kv industrial x-ray units are available in jib crane, mobile and dolly types and are completely illustrated and described in Bulletin 1144. Picker X-Ray Corp., 300 Fourth Ave., New York, N. Y.

Capacitors. Various Army-Navy type bathtub capacitors; oil-filled oil-impregnated can type capacitors; and various mica capacitors are available for immediate deliveries and are listed in a 4-page folder (Form XI) available from Sprague Products Co., North Adams, Mass.

Electronic Tubes. Catalog No. RS gives complete information and technical data on phototubes, rectifier tubes, and grid control tubes (Thyratrons) available from The Continental Electric Co., Geneva, Ill.



FROM GREENLAND'S ICY MOUNTAINS . . . . . TO INDIA'S CORAL STRAND

P.R. MALLORY & CO. Inc MALLORY Vibrapack*

Is Setting New Records of Dependability and Efficiency

Modern war, with its rigorous demands on communications equipment, requires vibrator power supplies that can operate under great extremes of heat, cold and humidity, and are able to withstand terrific jolts and jars.

The Vibrapack meets these conditions unfailingly in its use with our armed forces. Military restrictions prevent our showing the latest Vibrapack units, but here are some of their features:

Hermetically-sealed vibrators and other components . . . rigid anchorage of parts to withstand abnormal vibration . . . special mechanical designs and mountings, including duplicate mountings for replacement of other equipment . . . wide band and special band RF "hash" filtering . . . multiple input and/or output voltages, including independent bias supplies and AC or DC filament power in addition to plate and screen potential.

With these and other Mallory improvements, the Vibrapack carries tremendous implications for new-born products of today and tomorrow. If you are looking for a method of obtaining high voltage DC current from a low voltage source, we shall be glad to send you further information.

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

Hermetically-Sealed MALLORY Vibrators

Fully protected against corrosive fumes, extremes of atmospheric pressure and moisture-laden air, Mallory hermetically-sealed vibrators operate under ideal conditions for economy and long life.

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

Your Best Buy Today and Every Pay Day: Government War Bonds

P.R. MALLORY & CO. Inc. MALLORY VIBRATORS AND VIBRATOR POWER SUPPLIES

Radio Components. A new and comprehensive 46-page catalog contains detailed information, dimensions, specifications, blue prints and photographs of a complete line of sockets, plugs, terminal strips, switches, assemblies, and plastic fabricated parts. A. W. Franklin Mfg. Corp., 175 Varick St., New York 14, N. Y.

Induction Heating for Steel Parts. A 32-page book entitled "The Tocco Process" describes the application of this process in induction heating of carbon steel. Chapters in the book cover The Underlying Principle; Metallurgy of the Induction Principle; Carbide Solution; a table of Hardness Tests; Superhardness; Equipment (a 15-kw induction heating machine is described in this issue of ELECTRONICS in the "New Products" column); Surface Hardening; Heat Treating; Normalizing and Annealing; Brazing and Soldering; and Heating for Forging and Forming. The author of the book is the research and development engineer (Dr. H. B. Osborn, Jr.) of Tocco Division, The Ohio Crankshaft Co., Cleveland 1, Ohio.

Radio Frequency Lacquer. The name of this lacquer is Q-max, A-27, and its electrical and physical properties are given in a 24-page booklet called "Q-max." Also illustrated graphically, for a wide frequency range, are the dielectric constant, power factor and loss factor. Data are included for dielectric strength, density, drying time, adhesion and other characteristics. Communication Products Co., 744 Broad St., Newark, N. J.

Structure Manual of Prefabricated Steel. To aid engineers now engaged in post-war planning, there is available a 40-page book "Lindsay Structure Manual" which describes this strong, light-steel, prefabricated construction that can be assembled with simple wrenches and which may be used for cabinets and enclosures on various types of electronic equipment, as well as in other industrial and marine applications. Lindsay and Lindsay, 222 W. Adams St., Chicago, Ill., or 60 East 42nd St., New York 17, N. Y.

TEAM BEHIND THE BOMBER TEAM

• Just as seven men fight as a team in a bomber, seven girls work as a team at a Sylvania Radio Tube assembly bench.

Thousands of fine precision radio tube parts are assembled into a finished product that must pass rigorous tests for ruggedness and sensitivity.

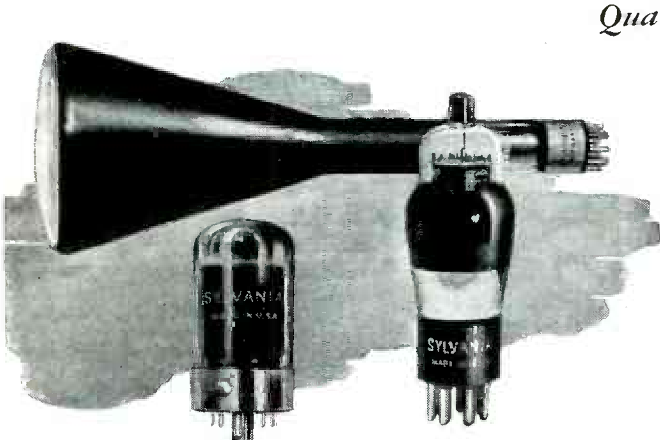
This is work that calls for the feminine touch, patience and sense of detail. Each girl "plays the position" on the team best suited to her ability.

Sylvania assembly teams compete with each other. But the champion in accuracy always takes precedence over the champion in speed.

This teamwork is just another example of how Sylvania maintains radio tube production at the highest standard of quality anywhere known.

You can sell Sylvania Radio Tubes with complete confidence.

Quality That Serves the War Shall Serve the Peace



RADIO DIVISION EMPORIUM, PENNSYLVANIA

SYLVANIA

ELECTRIC PRODUCTS INC.

RADIO TUBES, CATHODE RAY TUBES, ELECTRONIC DEVICES, INCANDESCENT LAMPS, FLUORESCENT LAMPS, FIXTURES AND ACCESSORIES

TECHNICAL NOTES

Excerpts from New Home Study Lessons Being Prepared under the Direction of the CREI Director of Engineering Texts

FILE IN YOUR NOTEBOOK

The Use of Thévenin's Theorem In Circuit Analysis

Many engineers have a reasonable knowledge of Ohm's Law, a bowing acquaintance with complex algebra (j operators), and a faint recollection of transient analysis and circuit theorems. In keeping with the purpose of the series of little articles appearing in the Institute's monthly magazine, the CREI NEWS, we are publishing a short article on the use of Thévenin's theorem in circuit analysis. We think it will interest the engineer because it enables him to analyze complicated circuits in terms of simpler, more fundamental ones, and obtain answers with a minimum of mathematical analysis. The increased use of Thévenin's theorem is evident from a comparison of radio text books of a few years ago, and those being currently published.

We hope to continue the discussion of the use of circuit theorems in future issues of the CREI NEWS, and also to take up topics, such as active perameters, that are seldom more than mentioned in radio texts.

Your comments and suggestions will be very welcome. This implies that you are reading the articles as they appear in the CREI NEWS. If not, all you have to do is to write to us in order to be placed on our mailing list. *We shall be glad to send you the article on "Thévenin's Theorem" in the March issue of the CREI NEWS without cost, and without your incurring any obligation whatsoever.*

★ ★ ★

PUNCH IN HOLES INDICATED

The subject of "Thévenin's Theorem" is but one of many that are being constantly revised and added to CREI lessons by A. Preisman, Director of Engineering Texts, under the personal supervision of CREI President, E. H. Rietzke. CREI home study courses are of college calibre for the professional engineer and technician who recognizes CREI training as a proven program for personal advancement in the field of Radio-Electronics. Complete details of the home study courses sent on request. . . . *ask for 36-page booklet.*

CAPITOL RADIO ENGINEERING INSTITUTE

E. H. RIETZKE, President

Home Study Courses in Practical Radio-Electronics Engineering for Professional Self-Improvement

**Dept. E-4, 3224—16th Street, N. W.
WASHINGTON 10, D. C.**

Contractors to the U.S. Navy—U.S. Coast Guard — Canadian Broadcasting Corp. — Producers of Well-trained Technical Radiomen for Industry.

Photoelectric Colorimeters. A folder on Lumetron photoelectric colorimeters (Model 400-A and Model 400-G) describes and illustrates these instruments which are designed for speed and accuracy in colorimetric and turbidimetric analysis. Photovolt Corp., 95 Madison Ave., New York 16, N. Y.

Signal Systems. "Cannon Signal Systems" for the modern hospital is the title of the new 16-page catalog which describes and illustrates nurses call and doctor's paging systems, registers, time recorder, special switches and light. According to the manufacturer the leading feature of these systems is a new single dial-control. The systems may also be used in factories or large offices where paging must be done silently. Signal System Dept., Cannon Electric Development Co., 3209 Humboldt St., Los Angeles 31, Cal.

Inter-Communication Systems. Catalog 1944 describes and illustrates many types of models of complete inter-communication systems available in 10, 20, 30, 40, 50, 60, 80 and 100 stations. Talk-A-Phone Mfg. Co., 1219 W. Van Buren St., Chicago, Ill.

Guide for Settling Cancelled War Contracts. This Guide tells how to organize a claims division; how the claims division can function efficiently; what forms to use; and how to expedite the payment of claims. It was written by J. J. Carroll out of his experience in supervising the settlement of claims resulting from eighteen million dollars worth of cancelled contracts. The book is published by Cope Inc., 3800 Chester Ave., Cleveland 14, Ohio, and is available for $2.50.

Vacuum Tube Data. "Gammatron Electronic Products" is the title of bound data sheets which describe Gammatron tubes. Heintz & Kaufman Ltd., South San Francisco, Cal.

Radio and Electronic Equipment. This new, 1944 catalog, No. 94, is a catch-all of the latest supplies available for radio and electronic equipment. It contains 104 illustrated pages and gives information on nearly 50,000 individual items. Lafayette Radio Corp., 901 W. Jackson Blvd., Chicago 7, Ill.

Variable Capacitors. These capacitors are for radio and electronic heating uses. A 4-page folder (designated as Condenser Catalog 75-C) gives complete information on this line of heavy-duty capacitors. Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.

Radio, Electronic and Electrical Parts. "Approved Precision Products" is the title given to the 1944 catalog which includes radio, electrical and electronic parts. Sizes, dimensions and rated capacities, together with list price are given. P. R. Mallory & Co., Inc., 3029 E. Washington St., Indianapolis 6, Ind.

Cowl Fasteners. Engineering and procurement data are contained in Catalog AD-2 which is a new reprint of the manufacturers' catalog published in July 1942. It is a 30-page booklet, printed on white coated paper, and contains all the pertinent data one needs to know about these fasteners. Aviation Division, Shakeproof Inc., 2501 N. Keeler Ave., Chicago, Ill.

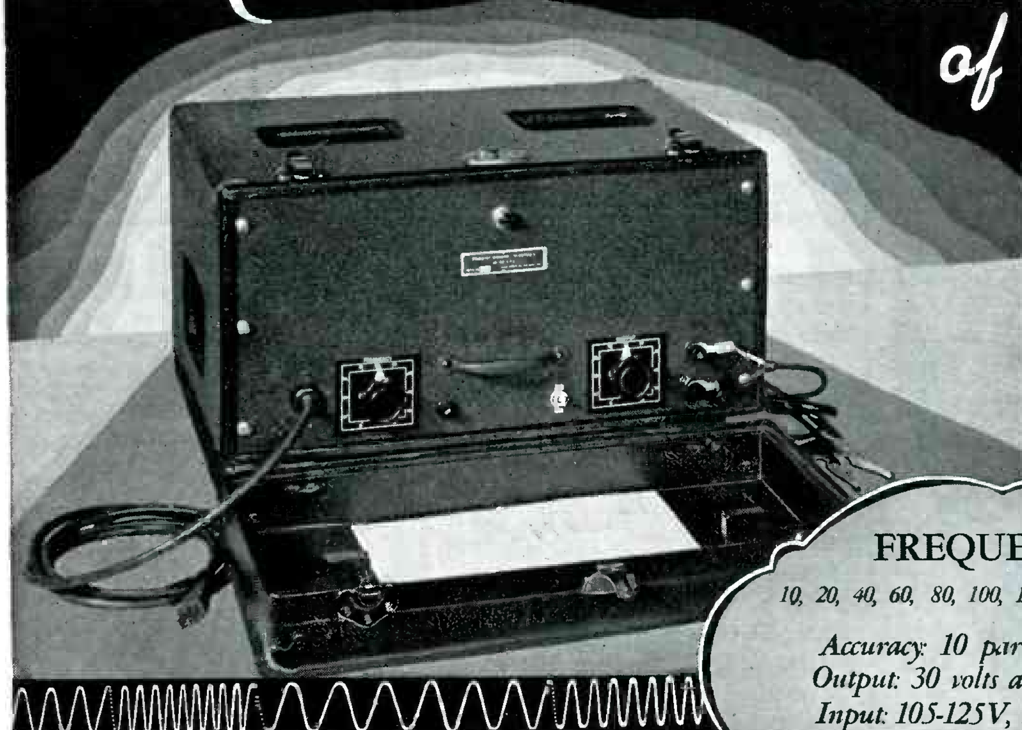
Gage and Gage Instruments. "Quality Control" is the name of a new handbook on scientific inspection with DoAll gages and gage instruments. It contains 64 pages of descriptive literature and illustrations.

The purpose of the handbook is to give the reader a working knowledge of this phase of production. Continental Machines Inc., 1301 Washington Avenue South, Minneapolis 4, Minn.

Die-Less Duplicating Catalog. This catalog No. 44–6 is a newly revised and enlarged catalog containing descriptive data of Di-Acro Products. It contains data on two new machines recently added to the manufacturer's line of products—namely, the radius brake and Bender No. 3. O'Neil-Irwin Mfg. Co., Minneapolis 15, Minn.

STERILAMPS, used to irradiate newly hatched chicks, have reduced mortality to less than one-third durnig the first 16 days of life. Chicks given the treatment reached in five weeks a weight previously attained in eight.

STANDARD FREQUENCIES—*Octaves of them*



FREQUENCIES

10, 20, 40, 60, 80, 100, 120, 140, 160, 180, 190

Accuracy: 10 parts in 1,000,000
Output: 30 volts at 500,000 ohms
Input: 105-125V, 50-60c, 40 watts
Weight: 50 pounds

Impossible? Well, here it is—

This Multi-frequency generator furnishes the frequencies shown above at the turn of a switch. All frequencies are obtained from a temperature-compensated tuning fork and voltage-stabilized circuit.

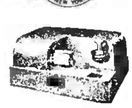
With this unit it is possible to calibrate oscillators at many selected points without encountering complex oscilloscope patterns. One of the uncertainties involved in development work on tuned circuits, filters, reeds—and in time measurement can be minimized with the aid of this instrument.

Developed primarily to check frequency meters for precision war work, this Multi-frequency generator possesses a rugged durability and dependability in service that will prove an extra value to many laboratories.

Additional information available on request.

Manufacturer of the

Watch Master



and distributor of ***Western Electric*** *Watch-rate Recorders*

American Time Products, INC.

580 Fifth Avenue New York 19, N. Y.

Medical Electronics

(*Continued from page* 101)

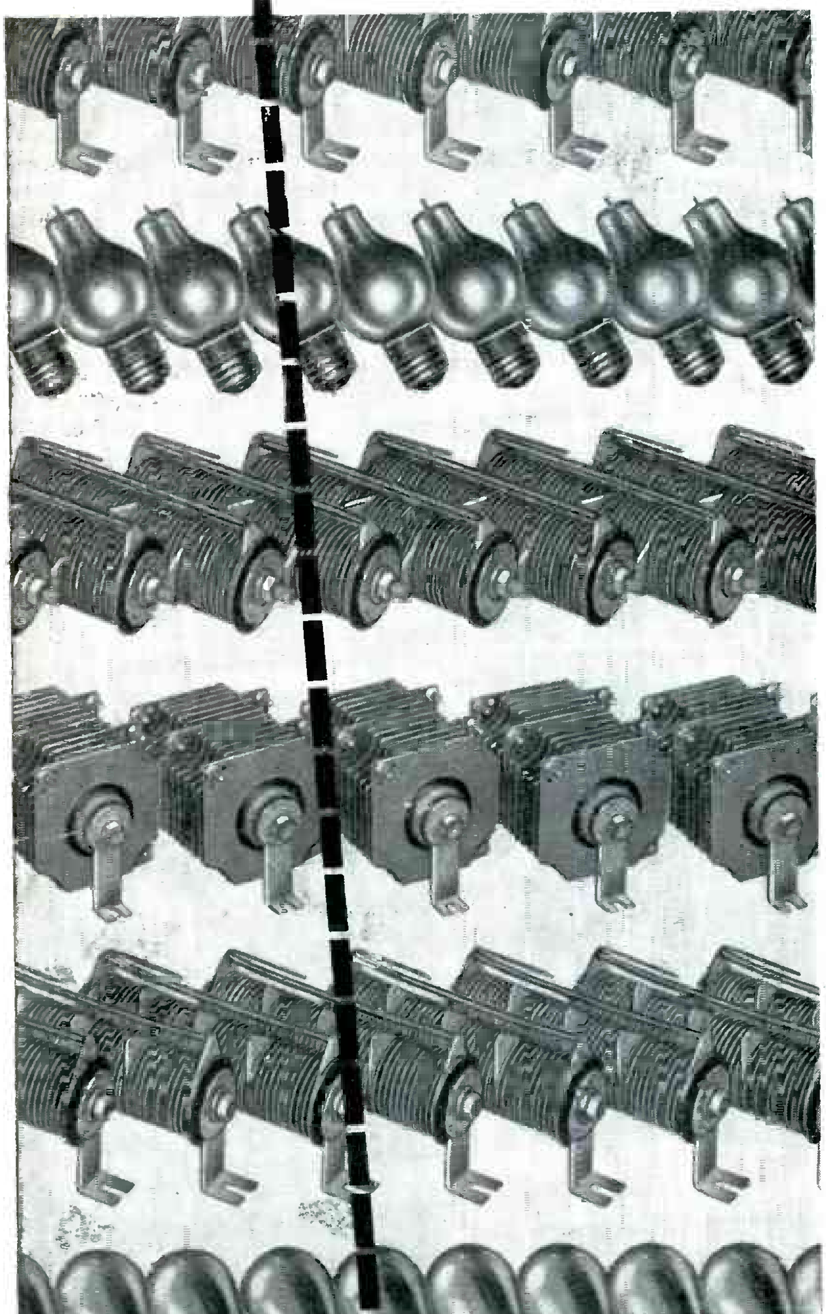
been married for years without becoming pregnant, this procedure was successful and they now have healthy children.

The equipment used includes a microvoltmeter such as is diagrammed in Fig. 1, associated with a photoelectric recording galvanometer. Non-polarizable, reversible silver, silver-chloride electrodes were used, immersed in a physiologic salt solution from which rubber tubes were connected to the patient. The positive electrode, terminating in a rubber diaphragm packed with cotton saturated in normal salt solution, was placed over the cervix uteri (lower cylindrical portion of the uterus). The ground electrode was led to a sponge rubber disc strapped on the ankle. The electrode technique is of particular importance, and although the method is simple, it is necessary to exercise care to avoid air bubbles in the leads, and other conditions which might introduce artefacts into the record. The shift is not rapid, and devices with relatively slow time constants are quite satisfactory.

The voltage difference between the cervix and the ankle normally appears from 5 to 25 millivolts, with the cervix positive during the menstrual period. A pronounced negative shift of the cervix, which may appear at any time during the cycle, is believed to indicate the time of ovulation. The data accumulated recently indicate that ovulation occurs at irregular intervals throughout the cycle in the majority of women, and occasionally during the menstrual period. It is important to obtain a statistically valid quantity of evidence through the use of this procedure in the office practice of a large number of physicians. It would be desirable if apparatus were made commercially available, and undoubtedly the market for such equipment will grow as the techniques are increasingly simplified and the validity of the method is more widely established.

(An article by Snodgrass, Rock and Menkin appearing in the De-

SELENIUM, COPPER-OXIDE, TUNGAR RECTIFIERS built to Specifications



Where other manufacturers offer one or two of the three standard types of low-voltage rectifiers, General Electric is alone in supplying all three—an important fact to remember when next you need a rectifying unit. The reason: The *most* efficient type in one application may be *least* efficient on the very next application. It is in determining which type to use in each instance that G.E. can help you most—having all three types it can give impartial engineering advice on which one you should use. Full details from Section A445-119, Tungar & Metallic Rectifier Division, General Electric Co., Bridgeport, Conn.

GENERAL ELECTRIC

The only manufacturer of all three types of Low-Voltage Rectifiers

cemper 1943 issue of the *American Journal of Physiology*, volume 140, page 394, describes recently completed experiments indicating data which refute previous evidence of potential changes associated with ovulation. The summary of these investigations expresses a belief that the previously observed changes in potential believed to be associated with ovulation may merely indicate a period which is favorable for successful fertilization. A further outcome of this data shows a thermal correlation with bioelectric currents where the warmer region is positive with respect to a cooler region, and this in turn appears to be intimately related to changes in pH (the negative logarithm of the concentration of the hydrogen ion in gram atoms per liter—a measure of acidity and alkalinity). Other measurements made during this investigation offered an interesting indication that right and left handedness may be correlated with the potential difference between the hands, the positive side indicating the handedness of the person. The addition of this paper to the literature is indicative of the experimental status of most electro-physiological investigations and the need for an increasing in-

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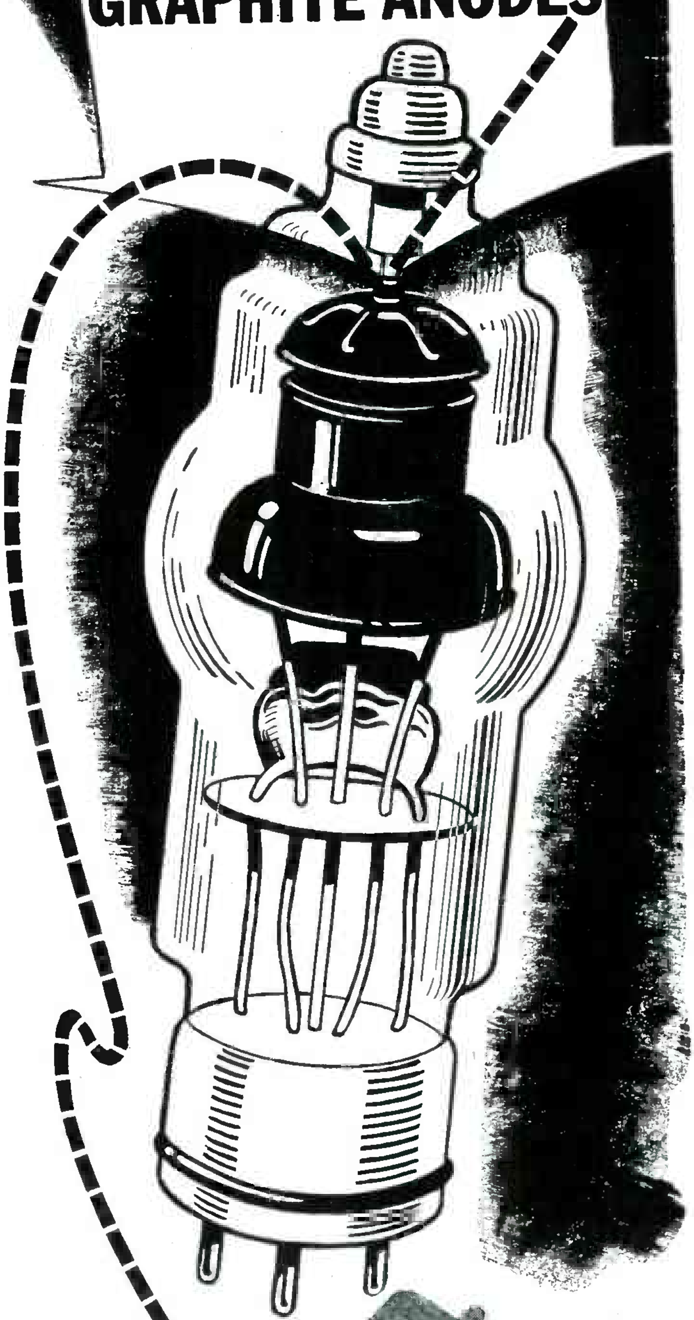
WELDING CONTROL

The circuit of an energy storage welding control, used for welding aluminum aircraft sub-assemblies, is examined by Edward Clayton Hartwig, U. of Missouri '43, and member of the Westinghouse graduate student course. Originated 50 years ago, the course helps graduates bridge the gap between academic preparation and actual production work

SAVE STRATEGIC MATERIALS

BY USING SPEER GRAPHITE ANODES

Put SPEER graphite anodes in transmitting and rectifying tubes you make. *They save strategic materials.* You also simplify production by eliminating the need for expensive dies, and tube shrinkage is less of a problem because anode dimensions are constant and rigid. Then too, it's important to bear in mind that:



SPEER GRAPHITE ANODES

Increase allowable plate power dissipation.

Lower temperatures of associated tube parts.

Withstand severe overloads.

Defy warping.

Prevent hot spots or fused holes.

Minimize bulb darkening and insulator leakage.

Improve degassing qualities.

Decrease gas troubles.

Enhance tube appearance.

Provide precise anode dimensions.

Produce uniform tube characteristics.

Retain original dimensions in service.

Maintain normal tube characteristics.

Leading manufacturers now produce tubes with SPEER graphite anodes for all transmitting and rectifying requirements. Write for descriptive literature on SPEER graphite anodes.

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terest in this field by competent research workers.)

Electroencephalography

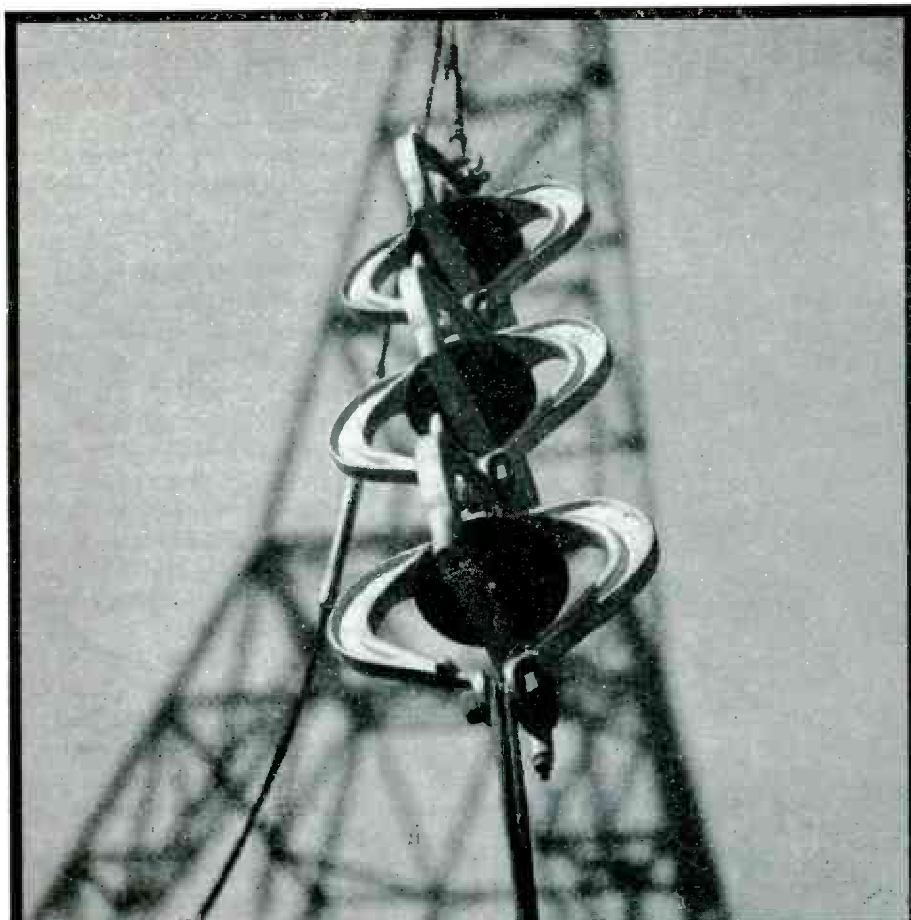
The electrical activity associated with grey matter, commonly called brain waves, is recorded on paper or film according to a variety of techniques, or observed visually on oscilloscopes. The desirability of a long base line on the oscilloscope has led to the development of circuits for successive sweeps displaced vertically so that as many as three screen width lines may be effectively observed at once.[14] Another development makes use of electronic switching to superimpose two or more channels simultaneously. (A further reference to the use of this arrangement appears in this text under the sub-heading Electromyography.) A great deal of material has been published regarding the problems in amplifier design connected with the low frequencies of brain waves.

The normal brain produces Alpha (8-12 per second, 10 to 125 microvolts) and Beta (18-30 per second, 10 to 20 microvolts) wave patterns, and also rambling, unorganized waves at 2-7 per second, up to 50 microvolts. When the patient closes his eyes and relaxes, the Alpha waves become increasingly prominent, but a stimulus, such as light or sound or the effect of doing simple arithmetic—voluntary concentration on a problem, may completely disrupt the pattern of these waves.

Alpha waves are also observed to have the same characteristics in animals as in humans, and even measurements on beetles show the same Alpha wave variations in response to a stimulus. The Beta waves are characteristically less regular, but are not so obviously affected by stimulation or mental activity.

These potentials are usually picked up with small lead electrodes attached to the scalp with conducting paste and sealed on with collodion. It is not necessary to cut the hair. The shunt effect of surrounding tissues is considerable, and voltages measured directly from the cortex during operative procedures are in a higher order of magnitude.

Delta waves (1 to 4 per second) appear in profound sleep or anes-



Do you recognize these insulators?

They are the first radio tower insulators made in this country. They were designed and built by Locke for the original wireless telegraph stations.

That was a long time ago and every day since has added to our skill and experience. Research facilities available nowhere else in the industry have been in constant use finding better, simpler, lower cost methods of producing the finest in radio insulators.

Whether your requirements are standard or special, we think you will find them better filled by Locke.

A COMPLETE "CLAY"RAMIC SERVICE

For every electrical, chemical and mechanical application, Locke has unrivalled facilities for the production of fired clay pieces by every known method.

(1) Dry Process — Porcelain and Steatite

A process ideally suited to the production of certain pieces with reasonable tolerances and adequate mechanical and electrical strength.

(2) Vacutite Process—Porcelain and Steatite

A process developed by Locke for forming intricate pieces. Close tolerances. Mechanical and electrical strength almost equal to wet process.

(3) Wet Process — Porcelain and Steatite

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Locke Wet Process porcelain and Locketite is produced by the following methods, the selection of method depending upon the piece.

(1) Pugging	(5) Jiggering
(2) Ram Extrusion	(6) Plastic Press
(3) Wet and Dry Turning	(7) Core Casting
	(8) Drain Casting
(4) Plunging	(9) Throwing

and certain other methods which at the present have only limited application.

Other clayramic products will be available in the future to meet special conditions. Whatever your problem, our experienced electrical, mechanical and ceramic engineers will be glad to help. Their services have resulted in material savings in money, time and critical materials to other manufacturers. Perhaps they can help you.

Locke **INSULATOR CORPORATION**

BALTIMORE, MARYLAND *"Leaders in Clayramics"* thesia; in general, the rythms are all slower during sleep, irregular, and of higher voltage.

When abnormal conditions are present in the brain, spikes and slow Delta waves reaching 200-500 microvolts appear. Periodic dysrhythmia of this kind is usually an indication of epileptic seizures, and may be correlated in magnitude and duration with severity and length of the attack, ranging from a few seconds to several minutes.

Abnormal high voltage patterns are also caused by blood clots and tumors on the brain, and by a series of triangulation measurements it is possible to locate these sources with great accuracy.[15, 16] Multichannel equipment greatly facilitates the procedure. The value of this method to the diagnostician and surgeon is incalculable.

Most large hospitals have brain wave departments, and since nearly an hour is required to obtain an adequate record, they are kept constantly busy.

Considerable experimental work has been done with measurements directly on the exposed surface of the cortex (outer portion of the brain including gray matter) in humans,[17] to obtain a more intimate knowledge of the electrical components of brain cell activity. Gen-

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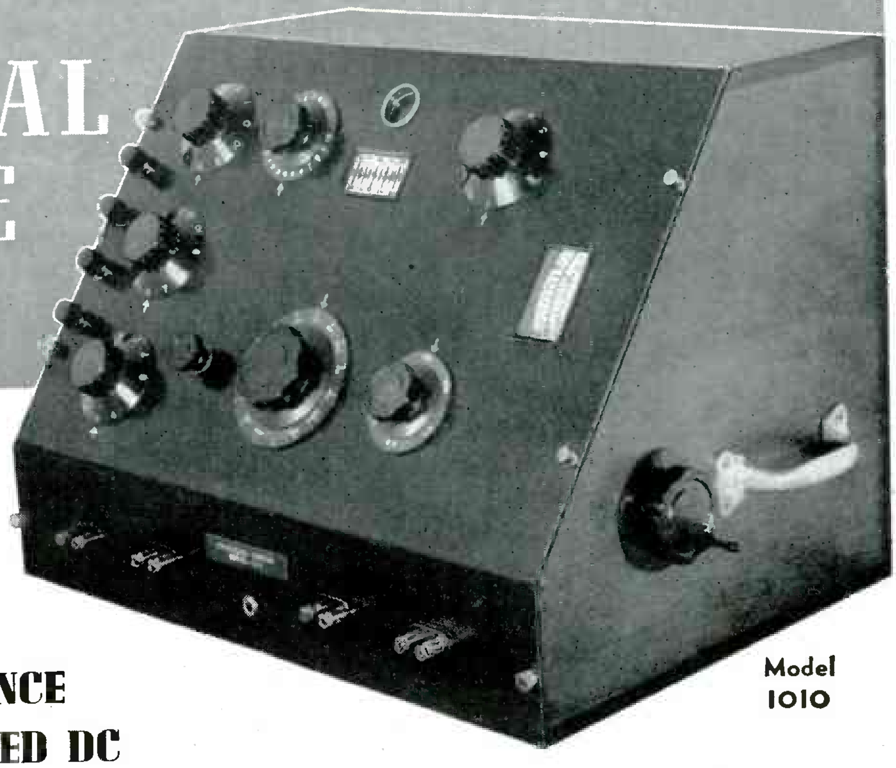
ELECTRONICS FOR BLIND

Anthony Mattei repairs a power supply from an old receiver under the guidance of his instructor, Robert Gunderson, at the New York Institute for Education of the Blind

A NEW

UNIVERSAL BRIDGE



Model 1010

- ★ **WIDE RANGE**
- ★ **½% ACCURACY**
- ★ **6 BRIDGES IN ONE**
- ★ **MEASURES INDUCTANCE WITH SUPERIMPOSED DC**

One of several instruments designed to meet the requirements of our military development program — now made available for general sale.

The Universal Bridge permits measurement of:

- **RESISTANCE** — Range: 10^{-4} to 10^{10} ohms.
  Accuracy: 1 ohm to 1 megohm, within ½%,
  below 1 ohm and from 1 megohm to 100 megohms within 1%
  above 100 megohms the error increases to 5%.

- **CAPACITANCE** — Range: 10^{-6} to 100 microfarads.
  Accuracy: 100 μμf to 1 μf within ½%,
  other ranges, within 2%.

- **INDUCTANCE** — *With no D. C. flowing*
  Range: 10^{-6} to 100 henrys
  Accuracy: 100 μh to h, within 1%,
  other ranges, within 2%.

  With superimposed D. C.
  Range: .1 to 100 henrys
  Accuracy: Within 2%

FEATURES — Inductance of iron cored chokes and transformers can be measured with up to 500 m. a. of D. C. flowing.

Facilities for measurement of frequency, Q and power factor are included in the Bridge.

The bridge contains a 1 megohm resistance decade in steps of one ohm – this is brought out to terminals so that it can be used externally.

Complete and self-contained unit . . . in addition, provision has been made to plug in external facilities such as outside standards, oscillators, null indicators, etc., to extend the usefulness of the bridge.

Your inquiry will receive prompt attention, as will inquiries concerning the application of our engineering facilities to the solution of your industrial control, inspection or instrumentation problems.

INDUSTRIAL PHYSICS—INSTRUMENT DEVELOPMENT

WR WHITE Research

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erally these operations are accomplished under local anesthesia with the patient fully conscious.

Motor centers are located by applying electrical stimulation directly to the cortical surface and correlating the response from the patient. Thus it is possible to localize the areas in which control of various portions of the body is centered. Some surgeons have used this procedure for determining the area causing convulsions in epileptics, and have achieved a measure of success with surgical removal of this portion of the brain.

Recordings obtained directly from the cortex have demonstrated that tumors are themselves inactive electrically, and the slow wave patterns characterizing their presence result from damage to adjacent tissues. Light-weight silver wire is used for electrodes in these measurements, and care must be taken to avoid brain damage resulting from piercing the surface coating (pia mater).

A great deal of data have been accumulated to obtain empiric correlation between brain waves and psychotic disorders, and many contributions are being currently made to the understanding of psychiatric problems.

There are many theories with regard to the source of Alpha and other brain rythms. An Alpha rythm appears in a state of repose with external and internal stimuli at a minimum. One explanation of the Alpha rythm that has been suggested conceives of many nerve cells of the brain changing potential in unison or in such a time distribution that a ten-cycle overall pattern is measured. Embarrassment, close attention, nervous tension or environmental stimulus usually serves to reduce both the voltage and the amount of time in 30 seconds of recording occupied by the Alpha rythm (percent time Alpha). It may be possible to extend this analysis to explain the excessively high-voltage discharges found during convulsions. In this situation an increased number of nerve cells may be locked in step at an abnormal frequency or pattern. Such a condition may lead to the control of a great number of cells by one activity pattern in such a manner as to result in convulsions, unconsciousness, etc. This may be

conceived of as comparable to a telephone exchange—the lines are kept busy so that no other cerebral activity may occur. Disruption of the Alpha rythm by internal or external stimuli is an indication of changes in the temporal orientation of cell discharges when they are individually engaged in the processes of perception, motivation or ratiocination.

Electromyography

There are many possibilities of correlation between measureable electrical phenomena and physiological events. The increased fund of such knowledge is reaching constantly into new branches of diagnostic practice. Among the fields in which the available data is rapidly increasing, and hence the opportunity for practical use, is the study of muscle pathology.

Electrode techniques in electromyography (recording of muscle potentials) include surface discs applied in much the same manner as in electroencephalography, and coaxial needle electrodes where an insulated core is inserted in a hypodermic needle. In the latter case the needle is thrust into the substance of the muscle, with the outside of the needle grounded.

Often electrical measurements may be the means for determining the origin of a malfunction. In connection with conditions where muscles refuse to relax after voluntary contraction, the action potentials from the nerve endings

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SALAD BOWL HORN

Because of its shape, this Western Electric speaker used by the Navy has been dubbed the "Salad Bowl"

SEE OUR ADVERTISEMENT ON SILK SCREENING—PAGE 400

have been shown to continue after the patient has made a voluntary effort to relax the muscle. This is interpreted as indicating that the problem is concerned with the stimulating mechanism rather than with the muscle tissues.[18]

A series of studies in connection with uncontrollable tremors has included comparisons between simultaneous recordings of brain waves and muscle potentials. No correlation was found to exist, and the data suggest that the origin should be sought in other areas of the central nervous system, such as the spinal cord.[19]

Dr. M. A. B. Brazier is currently active in research on poliomyelitis (infantile paralysis) and investigations of associated muscle disorders.[20] One of the interesting observations in certain neurological conditions is that a knee jerk applied to one leg sometimes produces an electrical discharge from muscles in both legs. The latent period between the two reflexes is too brief to measure with ink writing devices. An electronic switch developed by the DuMont Company is being used in an effort to determine the possible path of such crossed reflexes from the measured time interval between them. The electronic switch in conjunction with a

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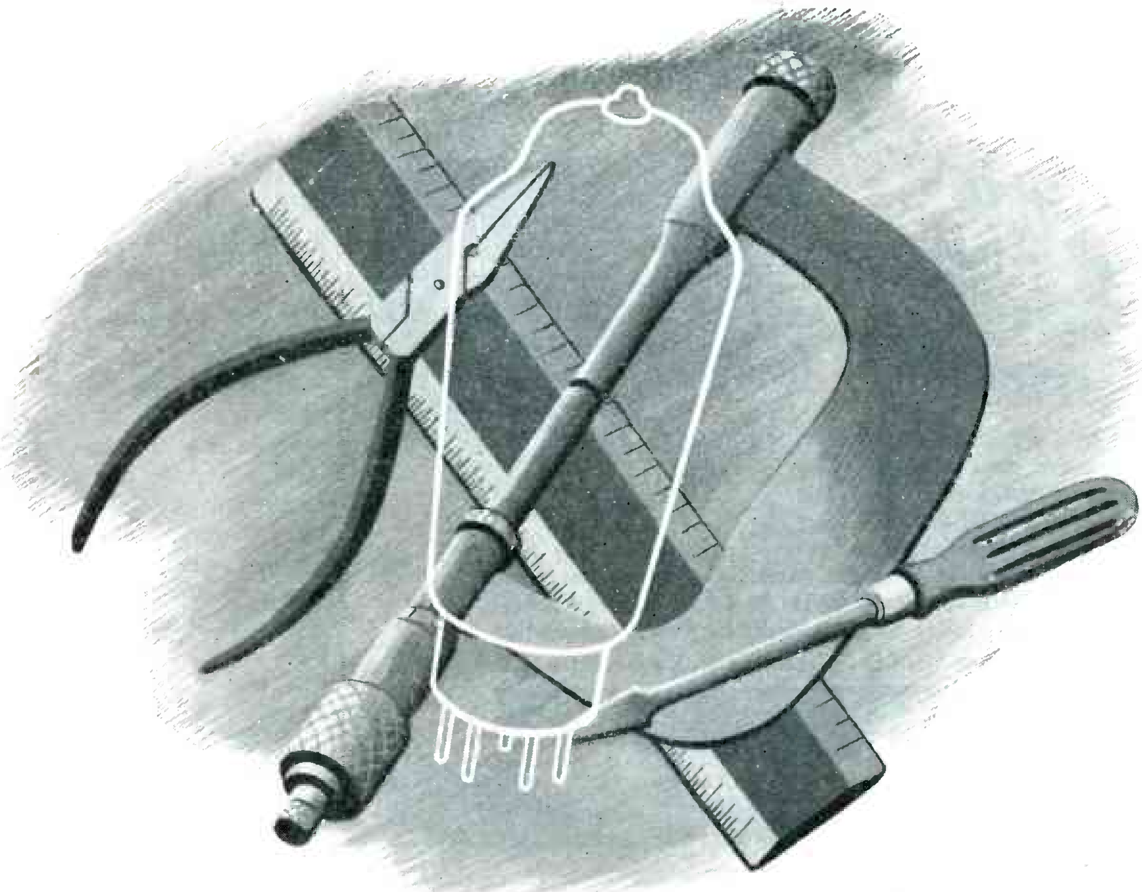
BRITISH MEGAPHONE

Traffic at busy crossroads in London is controlled by Scotland Yard men equipped with electronic megaphones mounted on tripods. They advise pedestrians and bawl them out for crossing against signals



SEQUEL TO "KNOW-HOW"... "Can Do"

The manufacture of delicate electronic equipment is not just a post-war dream with I. C. E.! Every day, carefully packed boxes leave the I. C. E. plant . . . bound for action. Obviously, just *where* and *how* this equipment is being used cannot be told. But we can tell you this: After the war when you're ready to put electronics to work in your plant . . . I. C. E. will be ready to work for you. Ready not only with the "know-how," but with the equipment and manpower necessary to produce what you want . . . when you want it!

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ICE

INDUSTRIAL & COMMERCIAL ELECTRONICS

BELMONT, CALIFORNIA

cathode-ray oscilloscope makes it possible to observe two separate phenomenon simultaneously, comparing amplitude, form and also phase relationship with wave forms superimposed on a single screen.

These experiments have greatly increased the understanding of characteristic effects in poliomyelitis, as well as providing a means for following the progress of therapeutic treatments.

Summary

A survey of developments in the field of electrophysiology has been presented. The increasing scope of correlations between pathological conditions and electrical measurements has been indicated. The intimate relationship between living structures and associated electrodynamic fields has been discussed.

Technical details of procedures have been limited mainly to an indication of electrode techniques. These methods, together with the low frequencies and low order of magnitude of bioelectric currents, constitute the fundamental problems presented to designers of electronic instruments for this work. Engineers interested in additional details regarding specific applications are referred to the brief bibliography of "key" references given below, many of which contain extensive lists of related literature.

It is clearly evident that the elec-

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BRITISH MOBILE RADIO

Communications operators of an artillery battery of the 8th Army at work in a communications truck. The mobile unit is also used as an advance observation post with ground fire

HE DOESN'T KNOW A THING ABOUT CATHODE COATING

BUT HE DOES KNOW THAT EVERY TIME A SET OF TUNG-SOL ELECTRONIC TUBES ARE ISSUED TO HIM, THEY GIVE EXACTLY THE SAME FINE PERFORMANCE AS THE PREVIOUS SET

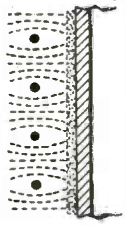
Even if you did mention cathode coating to the average G. I., or man on the street, his answer probably would be:

"What in thunder is Cathode Coating?"

It is a substance sprayed on the cathode of an electronic tube to induce the electrons to flow. On small cathodes the amount of this coating must not vary more than one-tenth of a milligram — a weight of about one-five-hundredth of a postage stamp.

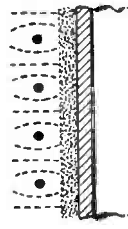
Tung-Sol coats its cathodes about twenty-five at a time. One out of each batch is weighed, then wiped clean of its coating and weighed again. If there was too much coating the whole lot is scrapped, or re-coated if there was too little. The amount of loss on this operation is more than compensated for by the high degree of uniformity in the performance of Tung-Sol tubes. This is one of the many reasons why builders of electronic devices have such high praise for Tung-Sol tubes and why, after the war, you should always remember to use Tung-Sol tubes for replacements.

THICKNESS OF CATHODE COATING GOVERNS TUBE CHARACTERISTICS



(Left) Electrons from cathode are controlled by grid wires. Volume of flow gives tube desired characteristics because space between cathode and grid is correct.

(Right) Space between cathode and grid reduced by too thick a coating. Electron flow materially changed, resulting in different tube characteristics.



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Acknowledgment is extended to Dr. A. J. Derbyshire of Harper Hospital and Wayne University, Detroit, Michigan, for reading this manuscript and providing helpful criticism and suggestions. Appreciation is expressed for the generous contribution of current information from R. F. Novotny, Rahm Instruments Inc., New York City; Albert M. Grass, Consulting Electrical Engineer, Quincy, Massachusetts; Lovett Garceau, Electro-Medical Laboratory, Inc., Holliston, Massachusetts; Dr. Franklin F. Offner, Offner Electronics, Inc., Chicago, Illinois; and Dr. John G. Lynn, Research Associate in Neurology, Columbia University, New York City, in addition to others mentioned in the text.

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PLUSWOOD is a high-density wood and resin laminate that is lighter than aluminum but can handle many of the structural loads of heavy metals. When a cutting torch, capable of burning through half-inch steel in 11 seconds, was applied to the same thickness of Pluswood, it took 39 seconds. In manufacture, layers of wood and phenolic resin are subjected to a pressure of 2,500 tons over a platen area of 7 x 18 feet, while heat is applied from a high-frequency electrostatic heating unit.

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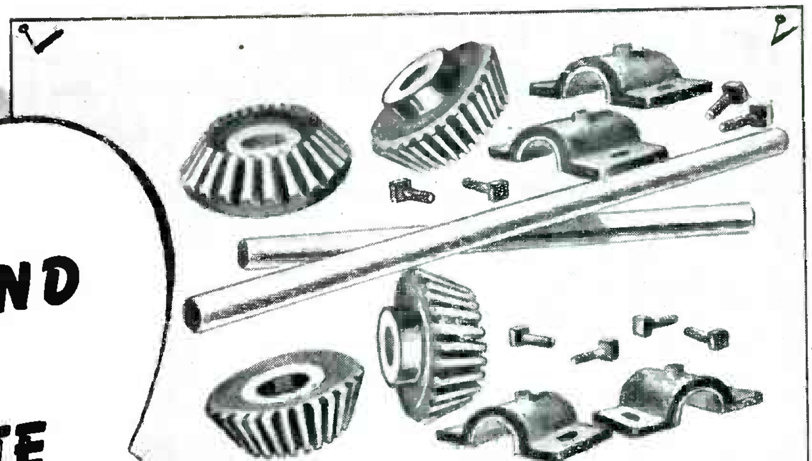
GIRL INSPECTOR

Inspector Lillian Pichman visually checks one of the radio transmitters for tanks manufactured at Western Electric's Hawthorne Works in Chicago. Operating channels are selected by pushbuttons



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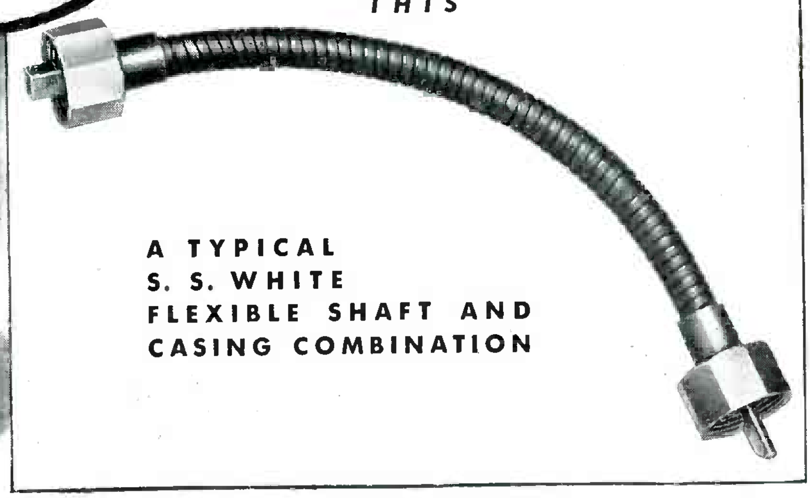

A TYPICAL S. S. WHITE FLEXIBLE SHAFT AND CASING COMBINATION

Where electronic equipment design calls for the transmission of power between points which can't be direct-connected, it will pay you to find out first, whether a flexible shaft will meet the requirements.

The illustrations above make clear why it will pay. In place of the various gears, shafts, bearings, bolts or other mechanical elements that would otherwise be required, a simple flexible shaft unit, like the one shown, will transmit power between any two points, regardless of the relative locations of the points or the distance between. And once the details of the flexible shaft unit have been worked out to meet the load and other requirements of the specific job, the units come to you all ready for easy connection to driving and driven members.

All this adds up to less manufacturing for you, easier assembly, lower costs.

For the same reasons it will pay you to consider flexible shafts first, where the design calls for mechanical remote control.

If you are not familiar with the range and scope of S. S. White Power Drive and Remote Control Flexible Shafts, the following Bulletins will give you this information:

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ARMY E NAVY

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FLEXIBLE SHAFTS — AIRCRAFT ACCESSORIES — MOLDED PLASTICS — MOLDED RESISTORS — FLEXIBLE SHAFT TOOLS

NEW BOOKS

Practical Radio Communication

By ARTHUR R. NILSON and J. L. HORNUNG, *McGraw-Hill Book Co., New York, Second Edition, 1943, 927 pages, price $6.00.*

A REVISION of the authors' well-known first edition, still constituting a complete course in radio operating and thorough preparation for all operator's license examinations but now increased considerably in size to cover very high and ultrahigh frequencies along with frequency modulation. Approximately two-thirds of the text is new, and a rearrangement of material concentrates basic radio principles in the first eight chapters. There are four complete new chapters on marine radio, including automatic alarms and modern direction finders. Other important additions include chapters on latest broadcast equipment, cathode-ray oscilloscopes, antenna arrays, and a collection of Ohm's law problems and explanations.—J.M.

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Technique of Radio Design

By E. E. ZEPLER, PH.D., *University College, Southhampton, England. John Wiley & Sons., Inc. 312 pages, price $3.50, 1943.*

Radio Receiver Design (Part I)

By K. R. STURLEY, PH.D., *Marconi School of Wireless Communication, England. John Wiley & Sons, Inc., 435 pages, price $4.50, 1943.*

THESE TWO RECENT BOOKS cover essentially the same subject matter, the aim of the author of the first being "to convey to the reader some of the experiences of a radio designer obtained over a number of years in a large works laboratory"; the aim of the second author being "to bring together the fundamentals of radio receiver design." The second book covers tubes, antennas and antenna coupling circuits, r-f and i-f amplifiers, frequency changers, detectors and oscillators for

superheterodynes. Part II of this book will take up audio circuits, power supply etc. In addition to these general subjects, the first book covers such matters as selectivity, volume control, shielding, distortion, trouble shooting.

Both are English books and use English terminology, which, in general, does not bother an American reader. The purport is usually clear even if the language differs somewhat. Both are useful books, full of mathematical derivations and formulas which are necessary to design the individual radio circuits, both containing many examples of design with numerical constants; both books are well illustrated. The choice, if one had to choose, would be whether he wanted a more detailed treatment in two volumes or wanted the whole subject buttoned up in a single, smaller volume.

The circuits treated are conventional, but the literature on them is widely scattered. Both books serve to assemble within single covers much information of practical as well as theoretical value.—K.H.

• • •

Glossary of Terms Used in Electrical Engineering

By BRITISH STANDARDS INSTITUTION, *28 Victoria St., London, S. W. 1. In eight paper-covered parts ranging from 16 to 32 pages each. Price 2s per part, 1943.*

OWING TO PRESENT CONDITIONS in England, it was not found practicable to publish this new edition of the Glossary as a complete volume. It has instead been issued in a number of parts, each containing one or more sections as follows:

Part 1—Contains Section 1 (General), covering elemental terms, fundamental electric and magnetic terms, units, technological terms, apparatus and general terms.

Part 2—Contains Section 2 (Machines and Transformers), covering generators, motors, composite machines, transformers, parts of machines and transformers, parts and types of windings, qualifying terms applied to machines and transformers, and miscellaneous terms applied to machines and transformers.

Part 3—Contains Section 3 (Switchgear and Control Gear) and Section 4 (Meters and Measuring Instruments), covering switches and circuit-breakers, fuses, starters and controllers, regulators, other devices and parts, switchgear, plugs, sockets, etc., qualifying terms applied to switchgear and control gear, and technological terms; general, indicating and graphic instruments, integrating meters, and instrument transformers.

Part 4—Contains Section 5 (Transmission and Distribution), covering systems, feeders and mains, conductors and cables, constructional features, overhead-line construction, tariffs, and miscellaneous.

Part 5—Contains Section 6 (Electrochemistry) and Section 7 (Traction), covering general electrochemistry, primary cells and accumulators, electro-plating, including metal finishing, electro-typing and elctrolytic refining; traction systems, bonding and general track equipment, conductor-rail, overhead construction, vehicles and equipment, vehicle equipment control, and miscellaneous terms.

Part 6—Contains Section 8 (Lighting, Heating and Domestic Appliances), covering illumination and photometry, filament lamps, arc-lamps and other lamps, parts of lamps, heating and cooking, fittings and accessories, and miscellaneous.

Part 7—Contains Section 9 (Lightning and Surge Phenomena), Section 10 (Miscellaneous Applications, including Lifts, Welding, X-Rays, and Electrical Terms). Addenda and Appendix (Symbols), covering lightning phenomena, lightning protection of buildings, surge propagation, surge protection of power and communication systems, research and testing apparatus, and impulse-voltage testing electrical lifts, electric welding, various applications, x-rays, and electromedical terms.

Part 8—Alphabetical Index to all the Sections.

Terms relating to Telecommunication, which were given in Sections 9 and 10 of the 1936 edition, will be issued separately in a revision of B.S. 204:1943.

The object of this glossary has been to standardize and coordinate the technical terms used in electrical science and industry. It gives the generally accepted meaning of a term in understandable language, with no attempt to make definitions rigid enough to take the place of specifications. When synonymous terms are in use, the favored term is given first with the intention that it should gradually displace the others. Terms considered undesirable are marked "deprecated". All in all, the work compares quite favorably with ASA-AIEE edition of American Standard Definitions of Electrical Terms. Both glossaries present capacitor and capacitance as preferred terms, and both list "inductor" without clearly stating when if ever this term should be used in place of coil.—J.M.

"PETE THE ICEMAN" is a manifold solenoid de-icer system with electronic control that inflates and deflates tubes along the wing edges of planes, so that ice broken loose by pulsating rubber boots can be carried off by the slip stream. Perfected by engineers of B. F. Goodrich Co. and Eclipse-Pioneer Division of Bendix Aviation Corp., it enables the pilot to vary the frequency of the pulsations to give maximum effectiveness in relation to the thickness and type of ice being formed.

Short Wave Wireless Communication

By A. W. Ladner, *Principal, The Marconi School of Wireless Communication, and* C. R. Stoner, *Lecturer at Queen Mary College. John Wiley & Sons, Inc., New York, Fourth Edition (Reprinted from British book), 1943, 573 pages, price $6.00.*

In modernizing this British text to cover latest publishable theories and facts on American, English and European short-wave developments, the authors have carefully retained essential fundamental data. The first half of the book contains these essentials along with 75 pages on propagation, a chapter on high-frequency feeders and a chapter on aerials of various types. The remaining half of the book deals with power amplifiers, oscillators, velocity-modulating systems, the Klystron and similar modern developments that are playing such important roles in short-wave communication, detection and control today. There is a comprehensive chapter on high-frequency therapeutic apparatus, and three chapters on commercial communications equipment (chiefly British). This new wartime edition, like its predecessors, uses mathematics only when essential and then in a prac-

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LAND MINE TECHNIQUE

In the U.S. Army, the soldier operating the mine detector marks the spot and moves on. Another soldier, trained in recovery, digs up the mine, but carefully. Other personnel in the vicinity lie on the ground to escape the upward blast if mishap occurs tical form without long derivations. As such, it should appeal to radio engineers, operators, amateurs, teachers and students who have need for information beyond that presented in elementary radio texts.—J.M.

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Time Bases (Scanning Generators)

By O. S. Puckle, *Research Department, A. S. Cossor, Ltd. London. John Wiley & Sons, Inc., New York. 1943, 204 pages, price $2.75.*

ONLY A FEW YEARS AGO, it would not have seemed possible that a whole book could be written around the methods for establishing a time base in cathode-ray oscillography. This is what Mr. Puckle has done.

In a cathode-ray oscilloscope, electrons are swept rapidly across the screen at a known velocity which may be constant or may not be. The time required for the electrons to move across (or around) the screen being known, occurrences causing a change in the motion of the electrons may be accurately timed by noting the position on the screen at which these events are signalized.

This book, a monograph on the many methods of establishing time

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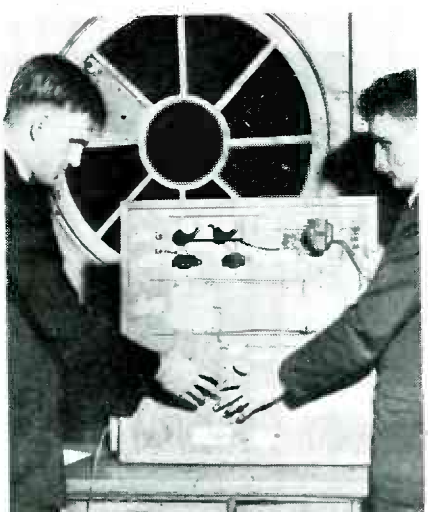
BLIND TAUGHT RADIO



Circuit demonstration board in use at the Institute for the Education of the Blind. The board, invented by instructor Robert Gunderson, left, has technical data in Braille for circuit components bases, outlines the historical development of the methods, describes them, indicates how to produce a linear trace, a circular trace, spiral traces or any other sort of time base that may be desired for a specific purpose.

Such matters as trigger circuits, blocking oscillators, synchronizaton, generation of square waves, the multivibrator, naturally comes into such a book. In fact anyone wanting to be up-to-date on much modern technique involving transient conditions and pulses could learn a great deal by studying this little volume, despite the fact that English terms and American terms do not agree at times.—K.H.

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Engineers' Dictionary—Spanish-English and English-Spanish

By LOUIS A. ROBB, *John Wiley & Sons, Inc., New York, 1944, 423 pages, price $6.00.*

COMPILED TO ANSWER a need in Latin America for Spanish equivalents of English engineering and construction terms. The field of the present volume is the vocabulary of civil engineering in all its branches, with many mechanical,

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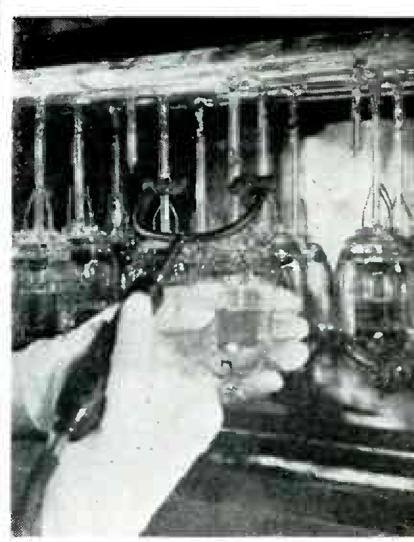
VACUUM TUBE CUTOFF



After evacuation, a gas flame is used to cut off tubes from the glass tubing connecting them to the air pump in the Western Electric Chicago plant electrical, chemical and other terms necessarily included because of their relation to civil engineering work.

There being considerable variation in the use of words among the eighteen Spanish-speaking republics of the Americas, local terms are given for words in this category, with identification of the countries in which they are used.

As with most two-language dictionaries, this book is divided into two equal sections. In the first, the Spanish words are listed alphabetically, each followed by its English equivalents. Example: *pila fotoeléctrica*, photoelectric cell. In the second section, English words are listed alphabetically and followed by Spanish equivalents. No definitions of the terms are included. Abbreviations are similarly handled in two separate tabulations.—J.M.

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Mathematics of Radio Communication

By T. J. Wang, Ph. D., *Ohio State University. D. Van Nostrand Co., New York. 370 pages, 1943. Price $3.00.*

RADIO AND ELECTRONICS are engineering sciences which depend very greatly upon mathematical bases; and the worker in these fields who does not have good access to these tools finds himself severly handicapped. Any book, therefore, which helps the radio engineer review his

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X-RAY INSULATION

Rubber insulation of wire for high-voltage use is given an x-ray examination at the research laboratories of General Cable Co.

mathematics, or which aims to initiate the radio man into the mysteries of mathematics, is an important book. Its value increases as some high powered function of its excellence.

It seems to this reviewer that Dr. Wang has produced a good book. It is not too simple; nor will the reader get stuck before he really gets started as is too often the case with many mathematical books which purport to be "refreshers."

The contents are divided broadly into fundamental processes including arithmetic and algebra; laboratory practice such as graphs, and other matters ordinarily called analytical geometry and such subjects as relative errors, slide rule procedure, and significant figures. Then follows a division devoted to the several basic algebraic manipulations including exponents. Next will be found the tools necessary to solve a-c problems; then a rather large section on vectors including complex notation; and finally a section on "advanced studies" which include differentiation, power functions, integration, Fourier series and determinants.

There are many useful problems; and the few typographical errors spotted by this reviewer will be more annoying to the author than to the reader.—K.H.

• • •

Basic Radio Principles

By MAURICE G. SUFFERN, *Captain, Signal Corps, Army of the United States. McGraw-Hill Book Co., New York, 1943, 271 pages, price $3.00.*

THE AUTHOR INTRODUCES this volume as a textbook designed to aid in the training of radio repairmen and technicians on a vocational-education level in a period of approximately 200 hours. Its goals include giving the student a knowledge of basic radio fundamentals, the ability to identify radio components and symbols, ability to interpret diagrams and an understanding of the principles involved in operation of the radio equipment.

A distinct innovation in textbooks is the use of multiple-choice questions at the end of each chapter for review purposes. The possible answers are carefully prepared, and provide a quick but informative check on student's mastery of the material.—J.M.

Permanent Magnets

(*Continued from page* 139)

netic circuit is closed by the movable member K. Coil C is connected by means of a pair of twisted leads to a fluxmeter located some distance from the permeameter, and the fluxmeter pointer is carefully set at zero. Next, switch S is closed in position 1 and a heavy magnetizing current sent through coils B. The fluxmeter pointer will swing up scale. The number of turns on coil C must be such that this deflection is at or near the full scale mark. Under no circumstances must the pointer touch the pointer stop or the test becomes valueless.

After three or four seconds or until all motion of the fluxmeter pointer has ceased, switch S is opened. The fluxmeter pointer immediately drops part way down the scale and a reading of the fluxmeter is taken at this point. Next, making sure that resistance R_2 is at maximum value, switch S is closed in position 2 and a light demagnetizing current put through coils B. The fluxmeter pointer immediately drops further down scale. R_2 is then gradually decreased in value, the operator carefully watching the fluxmeter pointer as it approaches zero. When it reaches zero, the reading of ammeter A_2, is taken. Switch S is opened, the test piece removed, a new one inserted, and the cycle starts again.

The two readings taken during the progress of the test are proportional respectively to the B_R and H_c points of the demagnetization curve of the test specimen. Referring again to Fig. 6, when switch S is closed in position 1 the magnet operating point runs up the curve oc. Resistance R_1 must be adjusted so that the operating point goes beyond point c, i.e., so that the magnetic

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AN OUTSTANDING EXAMPLE of simplification is the schedule for incandescent lamps. The number of types have been reduced from 3,500 to 1,700, the colors from 13 to 3, and the voltages from 32 to 7, a yearly saving of 35,000 lb of solder, 2,000 lb of tungsten, and 1,200,000 man hours of labor.

net is saturated. When switch S is opened, the operating point drops down to point B_R, as the magnet is in a completely closed soft iron circuit and no magnetizing or demagnetizing influences are present at this time. When switch S is closed to position 2 and R_2 gradually decreased until the fluxmeter returns to zero, the magnet operating point runs down the demagnetization curve until it reaches point H_c. Now, since the value of demagnetizing current is read at this point, we have a reading which is proportional to H_c because the field in the gap is directly proportional to the current through the coils (assuming no saturation of the soft iron magnetic circuit).

Thus, while the production permeameter, like the magnetometer, gives no answers in absolute quantities, it does give two readings for each test piece, the first of which is directly proportional to the residual induction of the magnet and the second of which is directly proportional to the coercive force of the magnet. It is an excellent production testing instrument for the quality of large numbers of magnets.

Because its two readings are directly proportional to two of the cardinal points of the demagnetization curve of the piece under test, the production permeameter is sometimes thought to be a more accurate instrument than the magnetometer. This undoubtedly is the

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WALKIE-TALKIE IN FOXHOLE

The beachmaster's signaller of the British 5th Army landing force occupies a foxhole while awaiting orders near the village of Campoleone, 15 miles from Anzio

case, but the additional accuracy supplied is in most cases unnecessary. The additional speed and ease of operation of the magnetometer is also an important consideration. It is sometimes quite difficult to choose between these two instruments. The ultimate choice must be governed entirely by the needs of the user.

APPENDIX

Analysis of Ballistic Galvanometers

Only an undamped ballistic galvanometer shall be considered, as space does not permit consideration of all conditions of damping. Assume that the coil is located in the magnetic field to be tested and it is connected to the galvanometer. As the search coil is removed from the magnetic field a voltage is developed in its windings, and current flows through the galvanometer circuit. This current produces a torque, T, on the galvanometer moving coil which is proportional to the physical size of the moving coil and its number of turns, on the field strength (produced by the permanent magnets of the galvanometer) in which the moving coil is located, and on the value of the current flowing through the moving coil. These factors may be broken up into those which are constants of the galvanometer and those which are not:

$$T = Ki \qquad (11)$$

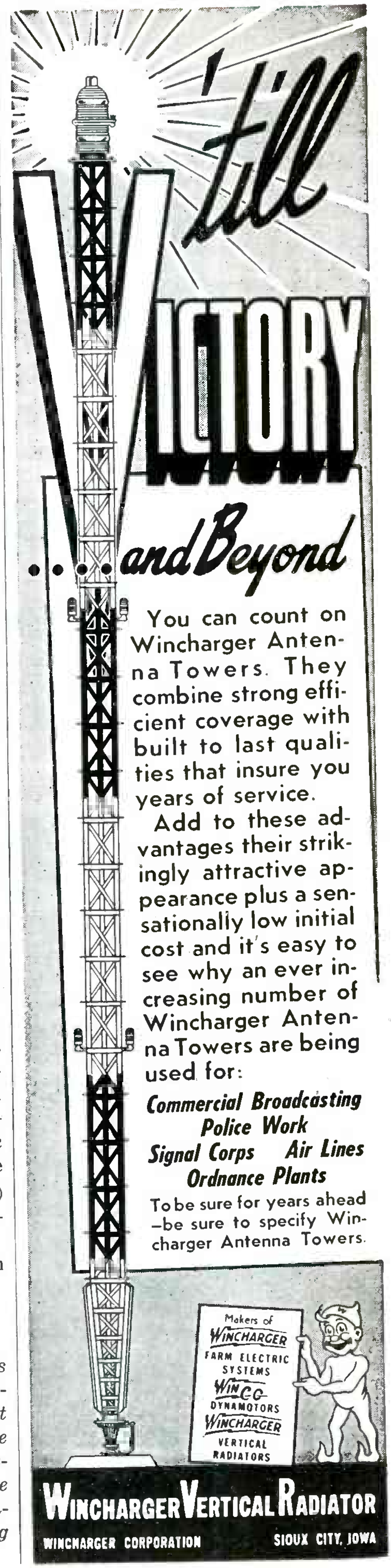
Now, assume that it takes a length of time, t_o, to completely remove the search coil from the magnetic field under test. During this time current flows through the galvanometers' moving coil. At the end of t_o the moving coil will have acquired a velocity, ω_o, and the kinetic energy of the moving system will be

$$E = \tfrac{1}{2} I \omega_o^2 \qquad (12)$$

where I is the polar moment of inertia of the moving system.

Since damping is not present in

PUTTY, often used to mount glass instrument windows, has been replaced by a synthetic cement that forms a tighter seal between the glass and the plastic case. The cement, developed by Westinghouse chemists, sets quickly in a low-temperature oven and glass cleaning is no longer necessary.



the galvanometer under study, the amount of energy of Eq. (12) will oscillate back and forth between the moving system and the suspensions, appearing in full at one instant (the instant of no twist to the suspensions) as kinetic energy in the moving system, at another instant (the instant of maximum twist to the suspensions) as potential energy in the suspensions, and between these times as part kinetic energy in the moving system and part potential energy in the suspensions. At the instant of maximum deflection of the galvanometer, this energy is all stored in the suspensions and we may write

$$\frac{1}{2} I\,\omega_o^2 = \frac{1}{2} k\,\theta_m^2 \qquad (13)$$

where k is the spring constant of the suspensions, and θ_m is the maximum deflection.

Hence:

$$\theta_m = \omega_o \sqrt{I/k} \qquad (14)$$

Now, the differential equation of motion for this moving system is

$$I \frac{d^2\theta}{dt^2} + k\theta = T$$

Assuming for the moment that the torque, T, is a constant, the solution for this equation is

$$\theta = \frac{T}{k}\left(1 - \cos\sqrt{\frac{k}{I}}\,t\right)$$

whence

$$\omega = \frac{d\theta}{dt} = \frac{T}{\sqrt{kI}} \sin\sqrt{\frac{k}{I}}\,t$$

Consequently,

$$\omega_o = \frac{T}{\sqrt{kI}} \sin\sqrt{\frac{k}{I}}\,t_o \qquad (15)$$

Substituting Eq. (15) into Eq. (14), we get

$$\theta_m = \frac{T}{k} \sin\sqrt{\frac{k}{I}}\,t_o \qquad (16)$$

Now, if t_o is small so that

$$\sin\sqrt{\frac{k}{I}}\,t_o \cong t_o\sqrt{\frac{k}{I}} \text{ (radians)} \qquad (17)$$

then Eq. (16) becomes

SOME 76,210 applicants for commercial radio operator licenses were examined by FCC during its fiscal year ending June 30, 1943. In the same period, the FCC employed 2,153 people; of these, 382 are regular employees and 617 are national defense workers in Washington; 206 regular and 948 national defense employees are in the field.

$$\theta_m = \frac{T\,t_o}{\sqrt{k\,I}} \qquad (18)$$

Substituting Eq. (11) into Eq. (18), we get

$$\theta_m = \frac{Ki\,t_o}{\sqrt{k\,I}} = \frac{K\,Q}{\sqrt{k\,I}} \qquad (19)$$

where Q is the total quantity of current flowing through the moving coil during the time, t_o.

Equation (19) shows the ballistic galvanometer to be a total-current-reading instrument. For simplicity, an undamped galvanometer was assumed in the analysis and it was assumed that the search coil was removed from the field under test in such a way that a constant torque, T, was applied to the moving coil of the galvanometer during the time, t_o. It may be shown rigidly that a ballistic galvanometer will read total current whether it be undamped, underdamped, critically damped, or overdamped, and that it will do this regardless of the wave form of the current impulse passing through it. The important requirement (true for all cases of damping) is that the condition of Eq. (17) be observed, wherein t_o is kept small with respect to the natural period of the instrument.

When a search coil is connected to a ballistic galvanometer the electrical circuit consists essentially of only two elements—the search coil and the moving coil of the galvanometer. Now, if we neglect the self inductances of each of these elements (for simplicity and because these inductances are truly negligible compared to circuit resistances in most cases), and lump the resistance of the search coil with that of the moving coil, a summation of voltages around the circuit during the time, t_o, of withdrawal of the search coil from the field under test gives

$$N \frac{d\phi}{dt} \times 10^{-8} = iR = R \frac{dQ}{dt}$$

where N = number of turns on search coil

$\frac{d\phi}{dt}$ = time rate of change of flux lines through search coil

i = current through circuit.

R = total circuit resistance.

The constant of integration being zero, integration gives

$$N\phi \times 10^{-8} = RQ \qquad (20)$$

This equation shows that the ballistic galvanometer reads interlinkages, $N\phi$, as well as total current, Q. It also serves to point out that the sensitivity of one galvanometer may be high for Q and low for $N\phi$, while that for another galvanometer may be low for Q and high for $N\phi$, depending upon the circuit resistance.

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CANADIAN COMMUNICATOR

This officer of the Royal Canadian Navy uses a "voice gear" to direct fire of guns aboard a warship

Aircraft Skins

(*Continued from page* 107)

definitely with r-f heating. There are other minor advantages which will be apparent to those thoroughly familiar with the bag process.

In applying r-f heating to thin surfaces an interesting problem occurs in the choice of frequency. Loads of this type have relatively high capacitance. Thus, if they are to be tuned by an inductance of practical size the frequency used must not be too high. At the same time the highest possible frequency is desirable from the standpoint of keeping voltage gradient down. Because of these opposing factors, the frequency choice narrows to a small range. This may pose a problem if the day comes when an attempt is made to allocate certain frequency bands for r-f heating applications. In the present case a frequency of 4 Mc was found to be about right. However, should attempts be made to extend the use of this method to the larger pieces—some of which are 16 ft. by 8 ft. in size— a very

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VOICE-POWERED TELEPHONE

A telephone that generates power from the human voice was useful on Guadalcanal, the War Department reports. Under favorable conditions, messages could be received over ten miles of wire line. It was used for fire control of Infantry mortars. Photo by U.S. Army Signal Corps much lower frequency, possibly as low as 500 kc, would have to be used.

Summary

The tests which have been described, together with others not related here, have been fairly succesful and have given results which show that r-f heating can be applied to the production of curved laminated and molded plywood parts, as well as to flat stock and spars. At the present time simple curved laminated parts such as wing tip bows and spar flanges are being made on a small scale in this way. To date there has been no actual production of molded shapes using r-f heating. The reasons are found in the more difficult application problems encountered and the small quantities of parts involved. Insofar as war production of wood aircraft is concerned, this situation will remain. However, post-war production in much larger quantities, not only of wood aircraft parts but also of molded and curved parts for other uses, may well justify the work and expense required to adapt r-f heating for applications of this kind.

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DIAL TELEPHONE SUBSCRIBERS in Holland overload the lines during daytime hours, apparently as delaying technique for sabotage. German occupation officials have warned that they "will not hesitate to exclude a large number of subscribers from telephone communication if the obstruction does not disappear through subscribers' cooperation"

Conserving Small Tubes

(*Continued from page* 142)

good operating condition. This tradition has, unfortunately, persisted into the present time. The almost universal use of heater-type tubes today does not justify the practice.

Present-day tubes generally become unusable because noise or distortion develops, usually as result of reduced emission. Since this is a gradually-changing condition, weekly or even monthly routine distortion measurements or listening tests will indicate when replacement is required.

Belief to the contrary notwithstanding, it is desirable to test a tube with respect to emission or noise factors while the tube is in its normal operating position. Tube testers usually give a "yes" or "no" answer but do not ordinarily indicate at which point on the gradually-changing emission slope a particular tube lies.

Standby Practice

Tube life can be directly increased by shutting off equipment which is not in use. In a majority of audio plants it was pre-war practice to have all equipment energized throughout the operating day. This procedure is often justified by the requirement that equipment must be immediately available, either for normal operation or emergencies, and by the fact that most tubes require a warm-up period.

Tubes are now more difficult to obtain and some variations in practice are advisable. Much equipment is never required for immediate use and instances will be found where groups of equipment can be turned on or off as the operating day approaches and recedes from its climax. Further, in the case of auditions and rehearsals warm-up time is not too important.

Sometimes the equipment shut-off problem involves lack of manpower for proper attention. This can usually be taken care of by the installation of convenient switches or by sectionalizing power-input circuits and switches to handle selected groups of equipment. Time switches can often be used to advantage in local as well as outlying equipment.

It is hoped that the foregoing will provide food for thought in dealing with the small vacuum-tube procurement and life problem. While it is not advocated that audio operating personnel engage in extensive projects to attain unusual tube-use efficiency, it is at least desirable that specific cases of reduced tube life be investigated and attended to. In any case, the desire for tube economies should be joined with some healthy curiosity and an open mind concerning possible solutions, even if they do seem to require some trouble. In that manner the required results will be assured. And do not overlook the practical and educational value of keeping records.

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AIR-MAIZE CORPORATION,
Cleveland, Ohio

ALLEN B. DUMONT LABORATORIES, INC.,
Passaic, N. J.

EASTERN ETCHING & MFG. CO.,
Chicopee, Mass.

ERCO RADIO LABORATORIES, INC.,
Hempstead, N. Y.

L. F. GRAMMES & SONS, INC.,
Allentown, Pa.

THE HALLICRAFTERS CO.,
Chicago, Ill.

MUEHLHAUSEN SPRING CO.,
Logansport, Ind.

SYLVANIA ELECTRIC PRODUCTS, INC.,
Danvers, Mass.

SYLVANIA ELECTRIC PRODUCTS, INC.,
Salem, Mass.

TUNG-SOL LAMP WORKS, INC.,
Newark, N. J.

Design Chart

(*Continued from page* 144)

chart, it is necessary to change the decimal points of the *L*, *C*, and *f* scales according to Fig. 1. This change doesn't affect the upper section of the chart, because the reactance values remain unchanged. The range of all other scales may be shifted by similarly shifting decimal points.

The fixed capacity- kva- and maximum-voltage lines are drawn in Fig. 1. The available frequency range is shaded, as is the resulting reactance-spread of 32 to 105 ohms. The desired kva obviously may be obtained at 1800 to 2500 v, depending on the frequency used. Since the maximum permissible stress of 2500 v is within the shaded range, the implied 62 ohms and 2500 kc would be used, giving a current of 40 amperes.

Capacitor Application

Assume that a certain 0.1-μf 10-kv d-c blocking capacitor may have a 2 percent super-imposed alternating voltage of 200 v at 200 kc, and that it is desired to know at what alternating voltage the capacitor may be operated at other frequencies. Referring to Fig. 2, or the chart, the 0.1-μf lines cross at 8.0 ohms in the lower half; this 8-ohm reactance line followed up to the 200-v line gives 5 kva and 25 amperes. These last two values es-

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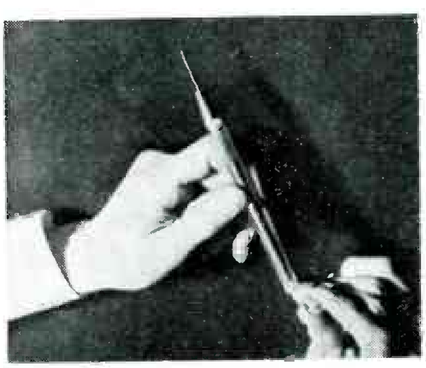
SOLDER DISPENSER



Contamination of solder by handling and dirt is prevented by a dispenser made of methyl methacrylate resin tubing and a brass nozzle. The solder is formed on a drill rod in a bench lathe and is pulled from the dispenser with pliers as needed by workers in the G-E Schenectady Works tablish the thermal limits of the capacitor, neither of which are to be exceeded.

At some new frequency—say 500 kc, the intersection with 0.1 μf occurs at 3.15 ohms, which—at 25 amperes, gives 2 kva and 80 v a.c.

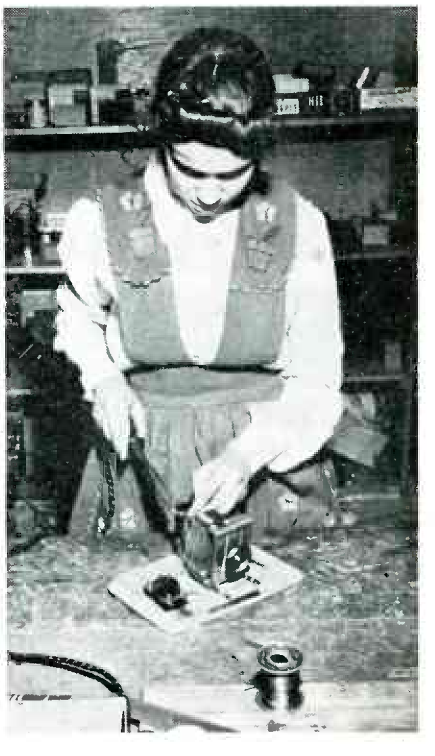
At 50 kc the capacitor's reactance is 31.5 ohms, resulting in a 20 kva burden at 25 amperes. So the 31.5-ohm line must not extend beyond its intersection with 5 kva, which corresponds to 13 amperes and 400 v a.c.

It is apparent, therefore, that the intersection of any reactance line with those of current and kva, shown heavy in Fig. 2, will determine the maximum permissible alternating voltage at the frequency desired, provided of course that the combined alternating and direct voltage do not exceed the rating for dielectric strength.

The same procedure could be followed in ascertaining permissible working conditions at various frequencies for power factor correction, or for tuning capacitors used with induction-heating coils or furnaces.

• • •

BLIND RADIO STUDENT



Mary Maderas, 19, solders leads of a one-tube receiver she is building in a beginner class at the New York Institute for the Education of the Blind

Backtalk

This department is operated as an open forum where our readers may discuss problems of the electronic industry or comment on articles which ELECTRONICS has published.

Why Industry Goes Slow on Electronics

I CAN GIVE YOU reasons given me by a large drink manufacturing plant. It is quite large and in most of its buildings it could use a large quantity of electronic gadgets in the mixing, weighing, packaging and conveying of the products before and after manufacture. There are, however, only one or two devices using electronics.

The main reason offered for this situation is the failure of all things electronic, tubes, condensers, etc. involving lots of time loss for trouble-shooting and repair.

Another reason is that even if they have all the electronic controls possible, they could not keep one or two men on the payroll for their maintenance alone as they would not be busy enough to warrant hiring and the equipment would be too complex for the usual run of plant electricians.

I have found that companies having electronic devices find it too expensive to get factory service for every breakdown, hence call the local radio service man who usually knows nothing about the equipment and depends upon the manufacturer's instructions books. These, from my experience, are about as clear as mud and tell all but what should be told for proper checking of the equipment. Usually they give circuits and components but neglect resistance and voltage charts. A checking procedure that could be followed with a good volt—ohm-meter, etc.

Several times I have worked on equipment and, because I placed the seat of trouble at sources requiring rebuilding the original setup used, (involving considerable work and expense getting the defective unit out, repaired, and replaced), was told I didn't know anything about it. Hence when the factory representative confirmed the diagnosis, I received no credit and practically no compensation for my pains.

I know that if I were running a plant I would use as little electronic equipment as possible, as I have no faith in any electronic device. That's the way I make my living, —off equipment failures.

What are the manufacturers (not radio, sound and talking picture) doing to get the general run of radio service men qualified to service other electronic equipment. Nothing! Usually they will not answer question letters. These cut the profits from their service departments.

The electronic manufacturers should give some qualified service man in each community instructions and service data for their equipment sold in a given territory. Something of this nature would do a lot to promote sales by showing the buyer that he can call in a local man at a moment's notice and get qualified service.

W. C.,
New Orleans

• • •

Electronics in Canada

IN YOUR Cross Talk Editorial in the December 1943 issue of ELECTRONICS, I noticed your article entitled "Ignorance". This article struck a responsive chord so I thought a word on this subject regarding our solution of this problem may help, or at least give you some idea of

PLYTUBE is a light-weight plywood tubing in which the lay of the winding of the veneers is adjusted to fit specific needs. One method of winding is used if the tube must withstand radial crushing pressure or internal hydrostatic pressure. Other methods are used for torsion, columnar compression, flexural and tensile strengths. It has found a variety of wartime uses, from sectional for life-rafts oars to radio antenna masts.

what we in Canada are doing.

Sometime ago a group of electrical men—representing most of the industries in this district—gathered together to discuss the possibilities of electronics and how it may effect our future thinking. Some of us had operated as "hams", and I suppose what meager knowledge we possessed helped us to get started properly. The outcome of this meeting was the formation of a group of electronic-minded electrical engineers whose purpose is to discuss developments; solve any problems (if we can) arising from the use of electronics; arrange for speakers to discourse in their particular field, providing it deals with electronics, and in this connection only.

While we meet every month, the alternate monthly meetings are devoted to a purely technical discussion for the benefit of the 30 members of this organization. For the other meetings we arrange to invite executives and production men to sit in, while our speaker is requested to address us in elementary language so far as it is possible. This way we feel we can acquaint our guests with some of the underlying principles of electronics and its effect on their particular phase of industry.

We have elected a slate of officers comprising a chairman, three directors, and a secretary-treasurer. Each member of this organization has to be prepared at all times to discuss a phase of electronic control. In this way we feel that the members must study or else be caught some day with nothing to say. All discussions and speeches are recorded verbatim in shorthand, and transcribed copies are made available to members for the purpose of study and also to provide a ready means of reference.

We feel we are off to a good start and only time will tell whether our

IN 1943, production of radio equipment jumped more than 110 percent over 1942, while the 1943 total for all types of signal equipment rose 130 percent above the 1942 level. There was declining emphasis on ground radio equipment, and a big expansion in airborne signal equipment.

efforts will bear fruit. In any case, we are getting acquainted with one another over the dinner table and hope, eventually, to dispel our ignorance regarding what "happens between cathode and anode across the evacuated space".

John R. Marsh
Chairman,
Society of Electronic Engineers
St. Catherines, Ontario

• • •

VHF Relays

In a recent speech Mr. James D. Shouse, vice-president of WLW, stated that American broadcasters had better start planning new technical equipment to get programs to Europe after the war at least as well as the BBC does now. He further stated that our present short-wave stations do not have an adequate signal reaching the European soil and the many millions who represent a powerful potential post-war market for American products.

The ideal frequency for European coverage, due to the type of receivers in use there, would be in the region of our standard broadcast band. The problem resolves itself into one of getting the programs over there reliably with reasonable fidelity and not subject to the vagaries of short-wave transmission, if they are to have any value as a commercial medium.

A system of VHF relays across the Atlantic would seem to be a good solution to the problem. These could be mounted on towers of considerable height with a foundation moored to the ocean floor. They could be designed to be virtually automatic in operation with dual channel safety changeover systems. A site could be chosen for the installation of standard broadcast

MORE THAN 7,000 tubes operate continuously in the receiving sets at RCAC's Receiving Central at Riverhead, L. I. Heat from the tubes keeps the equipment dry and stable in operation and saves 2800 gallons of fuel oil per season since an air circulating system was installed.

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FOR THE FIELD OF ELECTRONICS

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STANLEY D. EILENBERGER
Consulting Engineer
INDUSTRIAL ELECTRONICS
Design—Development—Models
Complete Laboratory and Shop Facilities
6309-13—27th Ave.
Kenosha, Wis. Telephone 2-4213

J. L. A. McLAUGHLIN
Designer of Communications Receivers
P. O. Box 529, LaJolla, Calif.

JOSEPH RAZEK, Ph.D.
Consulting Physicist
Electrical and Mechanical Engineering Problems
Instruments and Control Devices Electronics
Specialists in Colorimetry, Spectophotometry and Industrial Color Control
Laboratory and Shop Facilities
202 Darby Road Llanerch, Pa.
Phone Hilltop 6910

WOODWARD & KEEL
Consulting Engineers
Industrial Electronics
& Communications
Earle Bldg., Washington 4, D. C.

Make it a HABIT . . . to check this page—EACH ISSUE

THIS CONTACTS SECTION supplements other advertising in this issue with these additional announcements of products and services essential to efficient and economical operation in the field of ELECTRONICS transmitters on the other side, and we would have a reliable path for American broadcasting to our European listeners.

At first glance the idea may seem fantastic, but relays of this type are now in operation in this country and they will come into common use with the advent of post-war television networks. The cost would not be out of proportion to the advantages to be gained in goodwill and the commercial opportunities offered by European markets.

BERNARD SEAMON
Wiscasset, Maine

• • •

Polarized Speech

HAVING BEEN up against a peculiar problem for a few years, and having been unable to find a comprehensive discussion of the matter in any of the various manuals and texts, I am writing to ask whether you can steer me to a source of information, and also to suggest a topic of interest for a possible future article in ELECTRONICS.

This problem is one of unequal positive and negative peaks of modulation of the broadcast carrier wave. Before installing a limiter built along the lines of the one designed by Mr. Herrick, (Dec. 1943 ELECTRONICS), this differentiation was only slightly noticeable, but, when volume compression was used, the effect became quite pronounced!

Becoming interested in this, I substituted a dummy antenna on our RCA 250-K, and with both microphone, turntable, and b-f oscillator, began experimenting. I found that with a pure wave, the peaks were equal, also with musical transcriptions; but with speech the results were quite different! Using the voices of our various announcers, I soon found that the harsher male voice had a pronounced difference in positive and negative peaks, but that the average female voice had an effect of producing a condition of equal, or nearly so, peaks. The polarity of the peak condition could be reversed by reversing either the microphone connections, or the input connections to the limiter. I also found that the transcribed voice had the same effect as the spoken word into a microphone. Therefore, this would indicate that the cause is either in the human throat structure, or in the microphone itself.

Voices rich in harmonics had the most noticeable un-balance. Talking in my natural voice, the peak difference was apparent, but raising my tone to a high falsetto resulted in a condition wherein the peaks were almost perfectly balanced!

I noticed another pecularity: The 250-K speech-input stage of p/p 1620's has quite a large amount of inverse feed-back from the 828 modulators. With some voices, the right-hand modulator plate meter will kick slightly earlier than the other, and the two meters will be slightly out of step with each other. With music, they behave more like Class B plate meters. With the inverse feed-back circuit opened, the meters kicked in step on both speech and music, but of course the stage became unstable, due to the sensitivity of the 1620's and 828's.

LEE CLOUGH
Chief Engineer
KLUF

SEARCHLIGHT SECTION

POSITIONS VACANT

SALES ENGINEER WANTED, Chicago territory, for established manufacturer of metal fasteners widely used by industry on war and peacetime products. Prefer resident Chicago area, age 30-35 with engineering training. Give full details, education, experience, draft status, age, salary expected and recent photograph. Require statement of availability if engaged in war work or essential activity. P-615, Electronics, 330 W. 42nd St., New York 18, N. Y.

ELECTRONIC ENGINEERS wanted for new department in old company with outstanding reputation. Development or production abilities sought in field of electronic instruments and control devices. Advancement should be rapid. Write stating experience, education, salary expected, draft status and availability if now engaged in essential war work. P-637, Electronics, 330 W. 42nd St., New York 18, N. Y.

ELECTRONIC SALES ENGINEER—As field contact man with established parts manufacturer. Must be well acquainted with engineers in tube, set and components plants and active in radio engineering societies. Attractive proposition. State availability, education, experience and qualifications. Members of our organization know of this opening. Reply to P-638, Electronics, 330 W. 42nd St., New York 18, N. Y.

SALES PROMOTION MANAGER—Established parts manufacturer in radio and electronics field wants thoroughly experienced man, with executive ability, familiar with buying policies of these industries. In reply give availability, education, experience and qualifications. Draft status. Reply to P-639, Electronics, 330 W. 42nd St., New York 18 N. Y.

(Additional Position Vacant Ads on pages 404 and 405)

EMPLOYMENT AGENCY

ENGINEERS — Mechanical—Industrial—Electrical—Chemical—Civil—Architectural, etc. Our specialized service to Technical and Scientific men only, for over 50 years, continuously at the same address, enables us to offer a fine selection of positions for high grade Manufacturing Executives, Production Managers, Metallurgists and Technical men of all types. The Engineering Agency, Inc., 53 W. Jackson Blvd., Chicago 4, Ill.

POSITIONS WANTED

CONSULTING ENGINEER (electrical & mechanical) complete laboratory facilities. 15 years practical experience electronics & relay controlled systems, instruments, motion picture sound recording installations, broadcasting equipment. Authority on ground systems. Art Davis, 1508 W. Verdugo, Burbank, Calif.

ENGINEER experienced in audio design, midget tube production, wants post-war contacts in Chicago area. PW-647, Electronics, 330 W. 42nd St., New York 18, N. Y.

ENGINEER-PHYSICIST—Radio and Electronics desires permanent position in research and development in electronics. One year experience research high voltage cables, four years development and design of radio and electronic test equipment. PW-648, Electronics, 330 W. 42nd St., New York 18, N. Y.

WANTED

WANTED: 1 Farnsworth 6 Stage or 11 Stage Infra Red Sensitive Photo Multiplier tube for important war research work. W-640, Electronics, 330 W. 42nd St., New York 18, N. Y.

Additional Employment Advertising on pages 296, 308, 316 & 356

(Continued from page 403)

WANTED

ELECTRONIC ENGINEERS

A well established company of excellent reputation located in the east, offers permanent position to a few engineers who have educational training and background in Electronic engineering or Physics. Unusual opportunities offered men who possess originality and initiative in connection with research and developments relating to television, radio, sound reproduction and other applications. Write full particulars relative to education and experience.

P. 635, Electronics, 330 West 42nd St., New York 18, N. Y.

RADIO-ELECTRONIC

ENGINEERS
TESTERS
TECHNICIANS

EXCELLENT OPPORTUNITIES IN A MAJOR POST WAR FIELD

Openings available at our Research Laboratories and Electronic manufacturing unit. Leaders in the design and development of vital electronic equipment for the armed forces.

Essential workers need release statement.

Write, stating experience, education, draft status, salary requirements or apply to

SPERRY
GYROSCOPE CO., INC.
Research Labs. & Electronic Plant
Stewart Ave. & Clinton Rd.
Garden City, New York

Permanent Positions

Available with national manufacturer in essential X-Ray industry. Experienced Field Service and Sales Engineers will be placed in branch offices immediately. Factory training courses available for man with technical background. Excellent opportunity for Electrical Engineers. Work is interesting and under pleasant conditions. Ample opportunities for advancement.

Write the Supervisor, Technical Employment

Union Bank Building
Pittsburgh 22, Pennsylvania

WESTINGHOUSE ELECTRIC & MANUFACTURING CO.

PERMANENT POSITION
for

Electroacoustic or Electromechanical Engineer

Must have substantial experience and demonstrated initiative in design and measurement of practical electroacoustic or electromechanical transducers. To illustrate the requirements, he must be capable of taking full responsibility for determining the equivalent circuit constants of piezo-electric crystal plates and assemblies used as transducers, including the development of necessary measuring apparatus and techniques. The position offers excellent opportunity to contribute to the War effort, followed by a continuing program of post war development.

Write to: A. L. WILLIAMS, President

THE BRUSH DEVELOPMENT CO.
3311 Perkins Ave., Cleveland 14, Ohio

WANTED

Electrical Engineers

Development and design work in transformer applications for radar, lighting, power, etc. Also junior engineers for drafting and layout. 100% war work. Excellent post war potential in research laboratory or sales engineering department. If you are not utilizing maximum skill at present position apply by letter at once.

SOLA ELECTRIC COMPANY
2525 Clybourn Ave., Chicago 14, Ill.

WANTED

MOTOR DESIGN ENGINEER

Must be thoroughly experienced in design and production of fractional horse-power motors and generators. Only top-notch man considered. All replies confidential and must be complete. Excellent opportunities—location southern New England. Statement of availability required.

P-641, Electronics
330 W. 42nd St., New York 18, N. Y.

WANTED

ENGINEERS—DESIGNERS

ELECTRICAL, MECHANICAL
RADIO, ACOUSTICAL

For Research and Development Laboratory of established company engaged in war work. Activity includes electronic control equipment, continuous recorders, special radio devices, and aircraft accessories.

Excellent post-war opportunities. Laboratory located in central Manhattan. All replies strictly confidential. Write full details.

P-651, Electronics
330 W. 42nd St., New York 18, N. Y.

WANTED

ENGINEER

with

ELECTRONIC or ELECTRICAL
Experience for Research and Development in our

TOCCO HEAT TREATING INDUSTRY

Post War Future
Good Salary for Right Applicant

OHIO CRANKSHAFT
3800 Harvard Cleveland, Ohio

WANTED

ELECTROLYTIC CAPACITOR CHIEF ENGINEER

Capable of designing and supervising installation of equipment. To take complete charge of laboratory and supervise production quality control. Must have previous experience with etching and formation processes. Write stating experience, education, draft status, present and previous earnings and salary requirements. All replies will be held in strictest confidence. Excellent post war possibilities involving inclusion in owner-management group of young, aggressive capacitor manufacturer. Address,

P-644, Electronics
520 N. Michigan Ave., Chicago 11, Ill.

WANTED

DRAFTSMAN

Experienced man for real critical war work. We also have fine opportunity from postwar standpoint. If you have had plant layout, piping, machine design, architectural or any mechanical drawing background, write us at once. State experience and salary desired.

P-643, Electronics
520 North Michigan Ave., Chicago 11, Ill.

WANTED

ENGINEERS

Electronic Mechanical

This company is engaged in the design and manufacturing of radar testing equipment, audio amplifiers, and video equipment. Also, manufacturing small mechanical parts.

The engineers we need must have experience in the electronic industry. These positions offer immediate and postwar opportunities. Write and include full details as to experience and salary desired.

THE MODERN ELECTRONICS CO.
409 North Broad St., Elizabeth, N.J.

WANTED

ENGINEER - Communication Equipment

To design electronic devices, transformers, filters, etc.—mostly Audio frequency. Working knowledge of trigonometry and LC circuits necessary. Also some experience on communications equipment or mechanical manufacturing. Salary open. Draft exempt or deferable by reason of education or experience. Excellent post-war prospects. USES referral card will be required.

AUDIO DEVELOPMENT CO.,
2833—13th Ave. So. Minneapolis, Minn.

POSITIONS VACANT

The Engineering Experiment Station of the University of Florida is interested in obtaining radio and electronic engineers and radio-physicists for research on contracts with government agencies. While this work is of a war nature, some of the positions will be permanent, depending largely on the ability of the man.

THE ENGINEERING EXPERIMENT STATION
University of Florida Gainesville, Fla.

(Additional Position Vacant Ads on Page 405)

(Continued from pages 403 and 404)

Your Invitation

When in Boston (Beantown) let us know — We will be glad to acquaint you with the places to go, and see, including our new 4 story display storage and office building at 885 Boylston Street.

"EXCLUSIVE ITEMS"

Send your name to us and get on our mailing list. We have available, from time to time, choice items in electrical and radio specialties, that are not on the New York lists.

Write—Phone—Wire

THE LOUIS M. HERMAN CO.
885 Boylston St., Boston 16, Mass.

ARPIN MFG. CO.

Manufacturers & Designers of High Voltage Rectifier Tubes

WATER COOLED
Rebuilt TUBES Repaired

Write for data sheet

422 Alden St. Orange, N. J.

BEST QUALITY, USED ELECTRON TUBE MACHINERY

Equipment for the manufacture of all kinds of electron tubes, radio tubes, incandescent lamps, neon tubes, photo electric cells, X-ray tubes, etc.

AMERICAN ELECTRICAL SALES CO., INC.
65-67 East 8th St. New York, N. Y.

FREELAND & OLSCHNER PRODUCTS, INC.

REBUILDERS OF RADIO TRANSMITTING TUBES

611 Baronne St. New Orleans 13, La.

WANTED — SURPLUS

¶ Radio Parts of every description—Radio Hardware of all types—Screws, Nuts, Solder Lugs, Rubber Grommets, Hookup Wire, Etc.
We particularly seek government cancellation or rejected material

LOUIS GANCHER CO.
50 West Broadway, New York 7, N. Y.
"In Radio Since 1921"

OPPORTUNITY TODAY, FOR POSTWAR

If you want to become a permanent member of our engineering staff, and if you have the following qualifications, please write us fully.

- *A degree in electrical engineering or an equivalent knowledge obtained through direct experience in radio, acoustics or electronics.*
- *Ability to do experimental work on small electro-mechanical devices. Familiarity with mass production practices preferred.*

Position is with fast growing company now engaged in war work but with an 18 year peacetime record in electronics and electro-acoustics.

SHURE BROTHERS
225 West Huron Street Chicago

WANTED—ENGINEERS—TECHNICIANS

Radio, Electrical and Mechanical Design Engineers, Draftsmen and Technicians for war and post-war design work.

Engineering degree, or, actual design experience in Communication Radio, Broadcast Receivers, Television and other Electronic Fields is required.

Write giving full details, education, experience, draft status and salary desired. Essential workers need release statement and U.S.E.S. consent. All inquiries confidential.

Chief Engineer
ELECTRICAL RESEARCH LABORATORIES, INC.
2020 Ridge Avenue: Evanston, Illinois
ERLA-SENTINEL RADIO

WANTED

ELECTRICAL ENGINEER

with mechanical training. Knowledge of wire manufacturing preferred, but not necessary. Excellent, long post-war opportunities. All replies will be considered confidential, and must be complete to receive consideration. Our employees know of this ad. Location southern New England. Statement of availability required.

P-642, Electronics
330 W. 42nd St., New York 18, N. Y.

WANTED

ENGINEERS

CHEMICAL, MECHANICAL OR DEVELOPMENT

Major industrial company is setting up staff to handle postwar operations. Interested in several experienced men, college trained, for our Development, Engineering and Manufacturing Divisions. Our interest is in men capable of supervising and carrying forward important technical work of a very broad nature. In reply cover carefully experience, education, draft status and salary expected.

P-636, Electronics
520 N. Michigan Ave., Chicago 11, Ill.

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